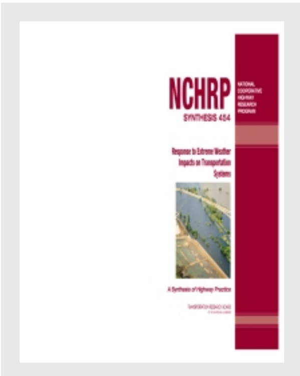


Response to Extreme Weather Impacts on Transportation Systems

DETAILS

92 pages | 8.5 x 11 | PAPERBACK
ISBN 978-0-309-27117-2 | DOI 10.17226/22376

AUTHORS

Baglin, Chris

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP SYNTHESIS 454

Response to Extreme Weather Impacts on Transportation Systems

A Synthesis of Highway Practice

CONSULTANT
Chris Baglin
AEA Group—Project Performance Corporation
McLean, Virginia

SUBSCRIBER CATEGORIES
Finance • Highways • Maintenance and Preservation • Security and Emergencies

Research Sponsored by the American Association of State Highway and Transportation Officials
in Cooperation with the Federal Highway Administration

TRANSPORTATION RESEARCH BOARD

WASHINGTON, D.C.
2014
www.TRB.org

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communication and cooperation with federal, state, and local governmental agencies, universities, and industry; its relationship to the National Research Council is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the National Research Council and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the National Research Council and the Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

NOTE: The Transportation Research Board of the National Academies, the National Research Council, the Federal Highway Administration, the American Association of State Highway and Transportation Officials, and the individual states participating in the National Cooperative Highway Research Program do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

NCHRP SYNTHESIS 454

Project 20-05 (Topic 44-08)
ISSN 0547-5570
ISBN 978-0-309-27117-2
Library of Congress Control No. 2013955095

NOTICE

The project that is the subject of this report was a part of the National Cooperative Highway Research Program conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council. Such approval reflects the Governing Board's judgment that the program concerned is of national importance and appropriate with respect to both the purposes and resources of the National Research Council.

The members of the technical committee selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and, while they have been accepted as appropriate by the technical committee, they are not necessarily those of the Transportation Research Board, the National Research Council, the American Association of State Highway and Transportation Officials, or the Federal Highway Administration of the U.S. Department of Transportation.

Each report is reviewed and accepted for publication by the technical committee according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

Published reports of the

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

are available from:

Transportation Research Board
Business Office
500 Fifth Street, NW
Washington, DC 20001

and can be ordered through the Internet at:
http://www.national-academies.org/trb/bookstore

Printed in the United States of America

TOPIC PANEL 44-08
NILES ANNELIN, *Michigan Department of Transportation, Lansing*
CYNTHIA J. BURBANK, *FHWA* (retired)
DESIREE FOX, *Office of Emergency Management, Sacramento, California*
PHILLIP GAINER, *Florida Department of Transportation, Tallahassee*
BROOKE HAMILTON, *Washington State Department of Transportation, Olympia*
FRANK N. LISLE, *Transportation Research Board*
JONATHAN T. LOCKMAN, *Catalysis Adaptation Partners, LLC, Scarborough, Maine*
A. KEITH TURNER, *Colorado School of Mines, Golden*
BRIAN L. BEUCLER, *Federal Highway Administration* (Liaison)
ROBERT KAFALENOS, *Federal Highway Administration* (Liaison)
JENNIFER BRICKETT, *AASHTO* (Liaison)

SYNTHESIS STUDIES STAFF
STEPHEN R. GODWIN, *Director for Studies and Special Programs*
JON M. WILLIAMS, *Program Director, IDEA and Synthesis Studies*
JO ALLEN GAUSE, *Senior Program Officer*
GAIL R. STABA, *Senior Program Officer*
DONNA L. VLASAK, *Senior Program Officer*
TANYA M. ZWAHLEN, *Consultant*
DON TIPPMAN, *Senior Editor*
CHERYL KEITH, *Senior Program Assistant*
DEMISHA WILLIAMS, *Senior Program Assistant*
DEBBIE IRVIN, *Program Associate*

COOPERATIVE RESEARCH PROGRAMS STAFF
CHRISTOPHER W. JENKS, *Director, Cooperative Research Programs*
CHRISTOPHER HEDGES, *Manager, National Cooperative Highway Research Program*
NANDA SRINIVASAN, *Senior Program Officer*
EILEEN P. DELANEY, *Director of Publications*

NCHRP COMMITTEE FOR PROJECT 20-05

CHAIR
CATHERINE NELSON, *Salem, Oregon*

MEMBERS
KATHLEEN S. AMES, *Springfield, Illinois*
STUART D. ANDERSON, *Texas A&M University*
BRIAN A. BLANCHARD, *Florida DOT*
CYNTHIA J. BURBANK, *FHWA* (retired)
LISA FREESE, *Scott County (MN) Community Services Division*
MALCOLM T. KERLEY, *Virginia DOT* (retired)
RICHARD D. LAND, *California DOT*
JOHN M. MASON, JR., *Auburn University*
ROGER C. OLSON, *Minnesota DOT*
ROBERT L. SACK, *New York State DOT*
FRANCINE SHAW WHITSON, *Federal Highway Administration*
LARRY VELASQUEZ, *JAVEL Engineering, LLC*

FHWA LIAISONS
JACK JERNIGAN
MARY LYNN TISCHER

TRB LIAISON
STEPHEN F. MAHER

Cover figure: Flooding at Interstate 29, near Hamburg, Iowa 2011 (credit: IDOT 2011).

FOREWORD

Highway administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to highway administrators and engineers. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire highway community, the American Association of State Highway and Transportation Officials—through the mechanism of the National Cooperative Highway Research Program—authorized the Transportation Research Board to undertake a continuing study. This study, NCHRP Project 20-5, “Synthesis of Information Related to Highway Problems,” searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute an NCHRP report series, *Synthesis of Highway Practice.*

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

PREFACE

By Jon M. Williams
Program Director
Transportation
Research Board

Extreme weather such as floods, hurricanes, snow storms, and prolonged heat test the people and infrastructure that make up our transportation systems. This study examined eight recent cases of extreme weather in the United States from the perspectives of transportation operations, maintenance, design, construction, planning, communications, interagency coordination, and data and knowledge management.

Information was collected for this report through a literature review and interviews with transportation officials.

Chris Baglin, AEA Group—Project Performance Corporation, McLean, Virginia, collected and synthesized the information and wrote the report. The members of the topic panel are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable with the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

CONTENTS

APPENDICES C–H beginning on page 97 are web-only and can be found at www.trb.org, search on “NCHRP SYNTHESIS 454.”

Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the web at www.trb.org) retains the color versions.

RESPONSE TO EXTREME WEATHER IMPACTS ON TRANSPORTATION SYSTEMS

SUMMARY

Extreme weather tests the people and infrastructure that make up our transportation system. From maintenance crews rendering roads passable to planners assessing investments for that same stretch of highway, state departments of transportation are on the front lines in addressing impacts from the floods, hurricanes, and other weather events that are projected to increase in frequency, severity, and unpredictability in the future.

Eight cases involving diverse weather events depict the broad and evolving nature of this challenge and identify many effective practices for addressing it. Often these weather events were on a scale well beyond the prior scope of experience, making strong communication and increased coordination with federal agencies and other resources, including in-house partners, critical.

Hurricane Sandy in New Jersey (2012): The storm visited the Jersey Shore for less than a day but sent ocean water well inland, killing many people. The destruction of roads, bridges, and other transportation infrastructure totals $2.9 billion.

River flooding in Iowa (2011): To avoid risks to population centers, authorities released spring melt and recent rains collected at flood control dams into the river system near rural areas, causing more than $50 million in damage to bridges and roads and inundating an interstate for more than three months.

Intense rains, floods, and tornadoes in Tennessee (2010): Two days of intense rain caused a once-in-a-thousand-years flood in central and western Tennessee, submerging an interstate and killing several people. The cost for transportation impacts was $45 million.

Intense rains and floods in Washington state (2007): Snowmelt, rains, and a Pacific wind storm led to widespread flooding, including in the Chehalis River basin, putting a segment of the main interstate between Portland and Seattle under 10 feet of water. The shutdown of that lifeline lasted about 4 days, resulting in $47 million in lost economic output. Statewide transportation damages totaled $23 million for state and interstate highways, and $39 million for city and county roads.

Tropical Storm Irene in Vermont (2011): Tropical Storm Irene hit Vermont at a time when its ground was already saturated with rain, leading to record flooding. The 2 to 3 days of flash flooding damaged 500 miles of highway and 200 bridges, and left 11 communities stranded. Recovery of the transportation system is expected to cost between $175 and $200 million.

Severe snowstorms in Alaska (2011–2012): An unusual cycle of heavy snow and rain led to 18 feet of snow in the marine town of Cordova, Alaska. The cost to the state and the municipality to remove it was more than $600,000 and nearly 25 times the town's annual snow-removal budget.

Drought and wildfires in Texas (2011): The worst drought on the state's records led to pavement damage and more than 30,000 wildfires throughout 2011. For many fires, the state department of transportation was asked to support the state's primary land management and fire control agencies; it later invested in protection equipment for its own crews. Pavement damage under the high heat conditions totaled $26 million, while support to wildfire control cost $5 million.

Prolonged heat event in Wisconsin (2012): Temperatures soared in the summer of 2012, causing from 30 to 40 incidents per day of heat buckling on Wisconsin roadways. Costs for repairs totaled $800,000 to $1,000,000.

These events had diverse impacts and covered different geographies, but it was possible to analyze each case example under a common framework: Operations, Maintenance, Design, Construction, Planning, Communications, Interagency Coordination, and Data and Knowledge Management. The review of activities in these areas produced a list of lessons learned and related practices that other states can utilize or tailor to suit their own circumstances. Some of these are:

Findings related to state-level responses to extreme weather

- Reimbursement from federal programs drives many state practices.
- Interagency coordination is important to the efficient allocation of tasks and resources, including activities with National Guard and Emergency Management Assistance Compact support.
- Investments in training (e.g., emergency management, federal program reimbursement, geographic information system, and other subjects) was a common practice often cited as having facilitated response and recovery.
- Meetings, workshops, and other structured activities help state personnel share and document knowledge in preparation for future similar events.

Findings related to a obtaining a unified, accessible knowledge base in this area

- Utilizing geospatial data to identify sites at risk and safe locations.
- Sharing information through online platforms, such as SharePoint and WebEOC, to enable a quick response.
- Developing After Action Reports and other records of effective practices and lessons learned from extreme weather events.
- Developing succession planning and record retention strategies to retain knowledge.

This report concludes with research needs, based on current gaps in knowledge or practice, including:

- Collect a common set of information from states that experienced the same extreme weather event to learn about differences before, during, and after the event as well as the lessons learned identified by each state;
- For each state, identify the extreme weather events projected to occur with more frequency or intensity in the future, develop a framework for an organized response, and collect a standard set of information and materials on previous events of a similar nature; and
- Develop research tools for identifying benefits and costs and the return on investment in extreme weather preparedness, resiliency, and adaptation strategies.

Identifying common and recurring practices will help to establish a knowledge base for extreme weather preparedness and resiliency, aiding the significant investment decisions in infrastructure and human capital that will be made in the future.

CHAPTER ONE

INTRODUCTION

OBJECTIVE

The objective of this Synthesis Report is to identify common and recurring themes in state-level responses to extreme weather events that affect transportation in the United States—both operations and infrastructure—and to contribute to the development of a unified, accessible knowledge base for this wide-ranging topic area.

BACKGROUND

Extreme weather events have costly impacts—in both human and monetary terms. For example, the National Oceanic and Atmospheric Administration (NOAA) found 2011's weather events to be the most expensive on record (NOAA n.d.). Physical damage and other effects on transportation systems from extreme weather highlight current vulnerabilities as well as future risks. Several U.S. states that have experienced extreme weather events are seeking ways to build more resiliency into their infrastructures (FHWA n.d.); for example, New Jersey, post–Hurricane Sandy, is seeking $2.3 billion for this purpose (*Community Development Block Grant Disaster Recovery Plan* 2013). At the same time, climate change projections suggest extreme weather events may occur more frequently and with greater severity in the future (*National Climate Assessment* 2013).

To address this risk to the nation's infrastructure, TRB has funded research on the threats to transportation investments and the potential ways to address them [*Potential Impacts of Climate Change on U.S. Transportation* 2008; NCHRP Project 20-83(05) n.d.; Baglin 2012]. Also, FHWA funds state-level planning efforts to manage the extreme weather and climate change risks to the nation's investments in transportation infrastructure (FHWA n.d.). State departments of transportation (DOTs) and metropolitan planning organizations in the following states have participated in the FHWA pilot program: Alaska, Arizona, California, Connecticut, Florida, Hawaii, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Jersey, New York, Oregon, Tennessee, Texas, Virginia, and Washington (FHWA n.d.). Federal programs established to help transportation systems recover from disasters and extreme weather impacts are evolving to address questions around resiliency (FHWA 2012, 2013b). More broadly, as this report went to press, the president signed Executive Order No. 13,653, "Preparing the United States for the Impacts of Climate Change" [78 Fed. Reg. 215 (Nov. 6, 2013)], which includes relevant directives to all major federal agencies including the Department of Transportation.

A benefit–cost analysis to support an investment decision could consider extreme weather or climate change as one of many risks; however, efforts to conduct even high-level risk assessments to support decision making in the transportation sector suggest that the actual availability of credible, actionable data is an important consideration (McLaughlin et al. 2011). There is an economic benefit from investing in the data sets and data collection technologies—especially geospatial data—that support extreme weather preparedness and response (Dasgupta 2013). Additionally, comparative studies that seek to weigh returns on investment require choices over appropriate methods and sound data; actual decision making on resiliency projects can require a certain level of detail in data sets in order to meet program and legal compliance. Yet the data and information needed to make short- and long- term decisions may not be fully understood or defined. Put another way, extreme weather events are termed "extreme" largely because they are rare (Leviäkangas et al. 2011); as such, there may not be routine collection of the data most suitable for decision support.

There are many ways that organizations can manage risks under such uncertainty, including development of a knowledge base. The emergency management community for example has highlighted accepted processes and protocols in key sectors, including those for transportation (Wallace et al. 2010). The emergency management community also is building a knowledge base for future decisions and action, such as the Lessons Learned Information System sponsored by the U.S. Department of Homeland Security. Many other sectors are organizing to address current and future responses to extreme weather and, more generally, climate change. For example, the National Climate Assessment, a program of the U.S. Global Change Research Program, convenes the National Climate Assessment Network, known as NCAnet. Nearly 100 nonfederal entities have organized under NCAnet to discuss and act on issues of common interest relating to climate change response, forming Affinity Groups to structure the dialogue around key topics (Cloyd et al. 2012; Staudt et al. 2012).

Affinity Groups are a type of Community of Practice, which are recognized tools for information sharing (Wenger 2002). The practice of actively acquiring, creating, and sharing knowledge is called Knowledge Management. In addition to Communities of Practice, a common Knowledge Management tool is a data collection framework. Such a framework can become the foundation for databases to store and share information. An example is the Climate Data Initiative in the President's plan to prepare the country for the impacts of climate change (*The President's Climate Action Plan* 2013).

A key element of a data collection framework is governance, such as setting the objectives for data collection and agreeing on data analysis methodologies and tools. Information governance is especially important when databases will contain multiple kinds of content, such as lessons learned, observed practices, and key decisions. A strategy to classify content types and categorize topics can support the creation of a successful database. For wide-ranging subjects, this categorization—or taxonomy—strategy enables diverse users of a database to find what they are looking for more easily through the use of multiple filters. Sample projects utilizing a taxonomy strategy include web portals, such as AASHTO's Workforce Toolkit, TRB's Freight Data Dictionary and Transportation Research Thesaurus, and the U.S.DOT Climate Change Clearinghouse. Such Knowledge Management tools can help users, such as state DOT staff, search for, assess, and leverage the content most relevant to their circumstances. As noted, a starting point is agreeing on key categories and their scope.

The review for this Synthesis Report proceeded from this background.

REPORT STRUCTURE

This report's intended audience is state DOT decision makers. The activities that constitute a state DOT's response to extreme weather occur at all levels: planning, budgetary, and those business offices that support front-line employees and managers before, during, and after extreme weather events.

Chapter two describes case examples from eight state DOTs that have managed the impacts of extreme weather events in the past decade. The case examples present approaches to addressing extreme weather effects, categorized according to functions commonly conducted by state DOTs, including operations, maintenance, planning, construction, design, public communications, interagency coordination and data and Knowledge Management. Activities in related areas, such as emergency management, are addressed when appropriate. Each case example includes a summary of practices that may assist in addressing extreme weather impacts.

Chapter three presents synthesis results. The chapter first summarizes the various lessons learned and practices across all case examples by the functional categories used to structure chapter two. Next, additional categories or subcategories that emerged from review and synthesis of the case examples are identified and described.

Chapter four presents findings and suggestions for further study.

RESEARCH METHOD

There were two main study elements to this Synthesis Report:

- A literature review of reports, articles, and interviews in the media, as well as other work products on extreme weather events and their impacts on transportation, occurring between 2002 and 2012 in the United States.
- Case examples that were selected based on information from the literature review and initial interviews with state DOTs, later supplemented by structured interviews and focused research on the extreme weather event in question.

This Synthesis Report was supported by a panel of experts from multiple disciplines, including state DOT operations and maintenance, emergency management, and sustainability units, as well as academics and consultants who are experts in transportation and climate change adaptation. Detailed descriptions of methods used and materials reviewed, as well as a profile of interviewees, are presented in Appendix A. Appendix B includes the interview discussion guide used with every interviewee.

GLOSSARY AND ACRONYMS

The focus of this Synthesis Report is extreme weather and ways to address its consequences, particularly its impacts on state DOT missions. This report uses several terms, such as "operations" to describe common mission-related functions of state DOTs that are likely to be familiar to the broad TRB audience. These terms are not defined, given variances within every state.

Other terms used in this report, such as "Incident Command System," fall under the rubric of emergency management. Under emergency management procedures, state transportation staff responsible for one function may get assigned temporarily to a different but related area of responsibility. The case examples note the management scheme in place both at the time of the extreme weather event and afterward.

The glossary provides details on the usage of certain terms. The case examples expand on such details as needed to distinguish the particular circumstances of a state. Recurring words and phrases are represented by acronyms throughout the report. A list of the most common acronyms follows the glossary.

Glossary

State DOT—A state department of transportation, including agencies whose names may not include the phrase "department of transportation." A state DOT is the primary agency in a state that owns, operates, regulates, and manages statewide transportation infrastructure.

Emergency Management—The broad class of agencies or people involved in the practice of managing emergencies and other incidents of all kinds.

Incident Command System (*ICS*)—A standardized on-scene emergency management construct specifically designed to provide for the adoption of an integrated organizational structure that reflects the complexity and demands of single or multiple incidents, without being hindered by jurisdictional boundaries. ICS is the combination of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure, designed to aid in the management of resources during incidents. It is used for all kinds of emergencies and is applicable to small as well as to large and complex incidents. ICS is used by various jurisdictions and functional agencies, both public and private, to organize field-level incident management operations.

Knowledge Management—Comprises the variety of principles, strategies, and practices used by an organization to identify, collect, organize, preserve, disseminate, share, generate, and apply critical knowledge.

Acronyms

DDIR	Detailed Damage Inspection Report
EM	Emergency management
EO	Emergency operations
ER	Emergency relief
ETO	Emergency Transportation Operations
FEMA	Federal Emergency Management Agency
ICS	Incident Command System
PA	Public assistance

CHAPTER TWO

CASE EXAMPLES

INTRODUCTION

Case examples are tools for assembling and transferring knowledge on a subject into a single synthesis. The goal of this Synthesis Report is to identify common or recurring elements in state DOT responses to a diverse range of extreme weather events in order to advance state DOTs' capabilities for addressing future events. The case examples here describe state activities in both a narrative and a bulleted form. Through the use of multiple formats, case example elements can be understood in context and also when compared across case examples for the purposes of the synthesis in chapter three.

The case examples have four main sections. The first three are an Introduction, an Event Summary, and a review of state DOT activities by certain common categories : Operations and Maintenance, Design and Construction, Planning, Communications, Interagency Coordination, Data, and Knowledge Management. The fourth section—Lessons Learned and Related Practices—derives from the review of state DOT activities in a given case example.

CASE 1: NEW JERSEY—HURRICANE SANDY (2012)

Introduction

The New Jersey Department of Transportation (NJDOT) is responsible for maintaining, developing, and operating the state's highway and public road system, including interstate, federal, and state highways. There are more than 38,000 miles of roadway in New Jersey, constituting one of the densest roadway systems in the United States (*Assessing New Jersey's Transportation System* 2005). NJDOT develops intermodal policies on freight and shipping that cover trucking, maritime, air, and rail freight (*Assessing New Jersey's Transportation System* 2005). NJDOT, through NJ Transit, also funds and supports nearly 240 bus routes and 11 rail lines. As such, NJ Transit is the nation's third-largest provider of bus, rail, and light rail service ("NJ Transit About Us" n.d.)

In 2012 the storm known as Hurricane Sandy made landfall near Atlantic City and took a rare westerly path inland from the coast and into Pennsylvania (see Figure 1). Ocean water followed the storm inland, causing severe flooding all along the East Coast and up into Maine (Blake et al. 2013). Sandy caused $2.9 billion in damage to New Jersey's entire transit, road, and bridge system, with $400 million in damage to the transit system alone (Blake et al. 2013). Sandy also damaged more than 340,000 homes and caused billions in economic losses (Community Development Block Grant Disaster Recovery Plan 2013).

FIGURE 1 Hurricane Sandy impact area on the New Jersey Shore. Dots highlight some of the areas with significant impacts (*Source*: USGS 2012).

The following case example describes actions taken by NJDOT to address the storm's impact and focuses on the damage to roadways along the Jersey Shore.

Event Summary

The weather event ultimately known as Hurricane Sandy began near the west coast of Africa on October 11, 2012. After nearly two weeks, on October 24, it was officially a hurricane and located off the coast of Jamaica (Blake et al. 2013). For NJDOT, that date "started the clock," particularly because models projected that New Jersey would be at the center of the storm. Initial preparedness efforts begun by NJDOT on October 24 included the following:

- Contact with the state Emergency Operations Center
- Dialogue in the form of e-mails and NJDOT staff review of preparedness checklists

- Tree cutting and weed removal to minimize debris and sewer pipe cleaning to optimize drainage by maintenance crews
- Staff checks of communications systems, flashlights, and other backup equipment, as well as checks of bulk fuel tanks and vehicles, which were topped off, as appropriate.
- Development of evacuation plans, including consideration of contraflow plan in consultation with state police.

On the morning October 26, the state's Office of Emergency Management increased alerts from Level 1 to 2. The State Emergency Operations Center facility in West Trenton, on the eastern side of the state, along the Pennsylvania border, was readied to go to the next level. At that point NJDOT created a job number for tracking the department's costs related to Hurricane Sandy, which was then in the Bahamas.

In the afternoon of October 26, the state Office of Emergency Management increased alerts to Level 3 and held two statewide teleconferences. In these calls, each state agency of relevance in a major weather event, including NJDOT, reported on their preparedness efforts and heard forecasts and projections from the National Weather Service (NWS). Those on the line included other state agencies, county offices of emergency management, and municipalities. The business rule for the meeting was to listen in for situational awareness purposes, and any feedback was directed through the state police. In addition to other preparations, Level 3 triggered NJDOT activities for locking down its 17 drawbridges, actions that included the evacuation of drawbridge operators and notification of the Coast Guard.

On October 26, officials in Cape May County advised residents on barrier islands to evacuate ("Christie Declares State of Emergency . . ." 2012). There was also a voluntary evacuation for Mantoloking, Bay Head, Barnegat Bay, Barnegat Light, Beach Haven, Harvey Cedars, Long Beach, Ship Bottom, and Stafford in Ocean County ("Ocean County Towns Issue Voluntary Evacuations" 2012). The Governor ordered all residents of barrier islands from Sandy Hook to Cape May to evacuate ("Hurricane Sandy: N.J. County by County Evacuations, Flooding, Closings" 2012). This area included Atlantic City, where the Governor also closed down the casinos ("Christie Declares State of Emergency . . ." 2012).

During this time, NWS declared the storm no longer a hurricane and projected that it would be a tropical cyclone at landfall. Sandy was becoming extra-tropical, which meant it could easily connect with nearby fronts and troughs and thereby increase in size. Sandy was, in fact, growing. Also, some models included the possibility of a rare westerly course rather than a coastal path, though many other models showed a coastal or seaward path (Blake et al. 2013).

Because Sandy was extra-tropical, the NWS National Hurricane Center and the local offices of the NWS did not release a hurricane warning. A warning would have set in motion extensive processes for the dissemination of information to the public, but NWS was concerned about confusion by the public over NWS terminology and its significance. As a result, the information products available from the NWS were largely forecasts indicating severe weather and a "downgraded" hurricane (Henson 2012; Blake et al. 2013).

NJDOT emergency management personnel paid close attention to weather forecasts and supplemented what they heard with their own analysis. For example, NJDOT staff assessed the storm surge risk from Sandy with NOAA's Sea, Lake, and Overland Surges from Hurricanes model, known commonly as the SLOSH model, and determined the range of storm surge possible from the magnitude of the storm projected. Based on their in-house analysis, NJDOT pulled crews from two maintenance yards, including one to the south near Cape May.

At the end of day on Friday, October 26, NJDOT had set its activation times for the coming weekend, including establishment of an "H-Hour." "H-Hour" was the time Sandy's winds were expected to be greater than 39 mph, which was projected to be Sunday night/Monday morning at 2 a.m. The activation timeline meant all three NJDOT regions were on alert, and the activities at the Statewide Traffic Management Center in Woodbridge, were increased beyond their usual 24/7 readiness. The system's 511 resources were increased. A key goal also was to ensure state workers were prepositioned and hunkered down when top winds came. By October 27, preparedness activities were fully under way, and NJDOT was "waiting for Sunday," October 28, the day when the storm's early effects were expected to arrive. By 6:00 p.m. on Sunday, October 28, the state was at Level 4, and NJDOT crews were reporting to maintenance yards as a pre-positioning measure. NJ Transit suspended operations, and ferry service was shut down. On Monday, October 29, rain and winds hit New Jersey, and the storm made landfall at 8:00 p.m. that night.

Hurricane Sandy sent a flood of ocean water over coastal seawalls and inland through inlets and rivers. According to a report by the National Hurricane Center:

> Sandy spared few parts of the central and northern New Jersey coast. The damage in the community of Mantoloking highlights the severity of the storm surge and waves across this region. A majority of structures there were flooded, badly damaged, or destroyed. The surge even carved a path through the barrier island, creating two new inlets. . . . In Seaside Heights, the iconic Casino Pier and Funtown Pier were destroyed; the loss of the latter caused the destruction of the local amusement

> park. . . . Long Beach Island, a barrier island offshore of the central New Jersey coast, suffered catastrophic damage with nearly every house on the seaside shore extensively damaged. The communities of Union Beach and Sea Bright witnessed similar devastation. The storm surge also pushed water into New York Bay and up the Hudson River, causing massive flooding in Jersey City. The surge into Raritan Bay forced water up the Raritan River that resulted in flooding in nearby Sayreville. Rescue efforts by the National Guard were required to save residents stranded in the town. About half of the city of Hoboken was reportedly flooded, and at least 20,000 of its residents were surrounded by water at the peak of the surge. . . . The rail operations center of the New Jersey Transit Authority in Kearny was flooded by up to 7 ft of water, damaging as many as 74 locomotives and 294 rail cars, and several weeks passed before rail services resumed (Blake et al. 2013).

More than 116,000 people were under mandatory evacuation order and displaced at the height of the storm (Blake et al. 2013). In some places, storm surge deposited 4 ft of sand onto roadways (Hutchins 2012). During and immediately after the storm hit on October 29, telephones landlines were down or broken. As a result, the NJDOT Chief of Operations Support, who was on site at the Statewide Traffic Management Center, could not communicate with NJDOT's regional operations centers around the state. Cell phone networks were overloaded and unreliable. One-third to half of NJDOT had no power and the rest was relying on emergency generators. NJDOT's Information Technology system had few, if any, problems, while NJDOT facilities in several parts of the state had wind and flood damage, as seen in the Kearny example cited by NOAA. NJ Transit was shut down entirely, and every rail line experienced damage of some kind (*Community Development Block Grant Disaster Recovery Plan* 2013).

NJDOT officials developed their initial characterization of key issues when there were few communication channels, little power, and extensive physical damage. They determined the most immediate concerns for NJDOT operations were collecting debris from rights-of-way, addressing road closures (then totaling 588, including those closed as a result of downed power lines), and managing a major highway wash-out at Mantoloking. Fuel shortages, another major issue, emerged within a day of the storm passing through. To address this matter, NJDOT, in coordination with law enforcement, opened up five of its maintenance fuel facilities to private citizens in the medical and emergency response professions. NJDOT also addressed the 1,100 traffic signals downed by power outages or wind. Much of this coordination was overseen by the Chief of Operations Support, still in the Statewide Traffic Management Center facility in Woodbridge, during a time when telecommunication lines were still poor.

When NJDOT had stabilized the services under its responsibility, it began its recovery phase. Clearing and reconstruction by NJDOT occurred at a steady pace, even as a November 7 snowstorm came through the region and required evacuation of NJDOT resources as well as others from the barrier islands. Despite this and other challenges, working 12-hour shifts back to back, day after day, NJDOT was able to remove its crews from shore communities by Christmas 2012. Across the state, recovery from Hurricane Sandy was ongoing when this report went to press.

State DOT Activities

Operations and Maintenance

As the threat from Sandy became apparent, NJDOT quickly shifted into its emergency preparedness mode. Management defined key activation times for the weekend of October 27–28, which helped drive decisions before those milestones. One such decision was the go/no-go decision on whether to institute contraflow for east-to-west evacuations. Because the shore population was not as high as it is during the tourist season, the New Jersey Office of Emergency Management and NJDOT did not initiate contraflow; working with the New Jersey Turnpike Authority, of which the Commissioner of NJDOT is the Chief Executive Officer, it did suspend tolls on the northbound Garden State Parkway and the westbound Atlantic City Parkway, starting at 6:00 a.m. on October 28 ("Christie Declares State of Emergency . . ." 2012). Other preparedness was as described earlier: clearing existing debris and pre-positioning resources based on projected storm impacts.

After the storm hit, management sought to create a 24/7 "battle rhythm," with calls in the early morning and a reconvening in the evening—so that everyone knew what was expected and when, despite downed communications and other disruptive events. NJDOT reported up to the Office of Emergency Management in West Trenton and communicated developments back down the chain (see Figure 2).

FIGURE 2 Aerial view of Hurricane Sandy damage to the New Jersey coast, including loss of highway in upper right-hand corner, October 30, 2012 (*Source*: Flickr Commons, DVIDSHUB).

NJDOT crews were supported by the Safety Service Patrol. The Safety Service Patrol normally patrols 225 miles of the state's most heavily traveled roads in 8-hour shifts in 53 trucks, helping to address obstructions to traffic, including breakdowns and debris (Stanley 2013). When the NJDOT emergency response plan is activated, patrol workers take on 12-hour shifts and otherwise prepare for the event, such as securing additional fuel, protective gear, and towing straps and hooks; some trucks are fitted with plows to push expected debris (Stanley 2013). After the event, the Safety Service Patrols focused on reopening those 225 miles of highway and assisting crews in other parts of the state (Stanley 2013).

Immediately after the storm passed, NJDOT sought to establish a physical presence in the hardest hit areas on the shore. They mobilized an emergency operations bus to enter the area in conjunction with the police command post at Seaside Heights. A key decision was to break down the massive damage into workable pieces. NJDOT dedicated specific people to each of the barrier island segments remaining after the storm and made them responsible for addressing issues in those areas. For example, one person handled Route 36, another person handled the segment from Point Pleasant to Mantoloking, two people handled Route 35 at Seaside Heights, one person handled Long Beach Island, and one managed Route 152 at Atlantic City. One person was dedicated to the Route 71 Bridge, whose electrical and mechanical systems were damaged by wind and water during Sandy. Dividing people's geographical scope of responsibility according to the damaged segments made for a clear demarcation and reinforced among locals the temporary nature of NJDOT's presence there.

The NJDOT Chief of Operations Support managed the NJDOT presence at the Mantoloking site. With the objective to get roads open, he organized contractors into a "dump truck train" for the temporary disposal of debris, which included trees, cars, parts of homes, and thousands of personal possessions. In total, NJDOT would supervise the collection and disposal of 4,425 truckloads of debris. In the course of this exercise, NJDOT set up three debris staging sites: a local traffic circle, NJDOT land to the north, and a local sewage authority lot. Use of the local lot was secured with verbal approval. At this point, it was 3 to 5 days after the storm and emergency responders still needed to get into the affected communities. Homes had burned in Brick Township, for example, where roads were blocked by debris.

NJDOT's objective was to clear the main streets for first responder access and make progress on debris removal so that communities could reopen and start their efforts to return to normal. However, in such places as Seaside Heights and Lavallette, for example, it was apparent that side streets had similar needs, and the state's crews, contractors, and trucks were already on hand there. The question of whether the state agency could conduct the work of clearing side streets, which typically the local government would do, was quickly elevated to the NJDOT Assistant Commissioner and Deputy Commissioner; approval was secured to go off the state right-of-way to assist. This allowed residents to return sooner and engage in the self-help needed for recovery to progress.

The NJDOT Chief of Operations Support brought in the agency's environmental unit and the Department of Environment Protection to manage the piles of debris. At that time, he also made a decision to separate out sand from the debris and vice versa, setting up a sand "cleaning" operation that resulted in 4,330 truckloads of sand set aside for reuse on the Jersey's Shore's devastated beaches.

Also during recovery, a new risk emerged: sinkholes would appear unexpectedly. NJDOT counted 80 of them between two main highways, Routes 36 and 35, for example. NJDOT needed more contractors to address this concern and had to manage pressure from local leaders to do so. According to the NJDOT Chief of Operations Support, there was an "hour-by-hour" balancing of what traffic control measures would be considered safe for the community. To support the agency in this and other work, NJDOT made the decision to use both in-house engineers as well as outside consultant engineers to conduct these assessments, with NJDOT making final decisions.

As noted, NJDOT was in the midst of collecting debris, assessing sinkholes, and managing the reentry effort when a Nor'easter struck in the form of a snowstorm a week later, requiring the evacuation of the barrier islands to the mainland. Crews had to switch from emergency operations to routine snow-fighting operations.

After the snowstorm, NJDOT went back to the recovery effort. Residents continued to return to the area. Their return made management of the projects more complex. During this time, NJDOT worked on restoring signage, making permanent patches to pavement, and other small and large recovery projects. NJDOT adopted an important management approach by setting a clear goal of accomplishing its work and leaving the area by Christmas. Managers stuck to this schedule, maintaining cohesion and morale in the process. By December 21, they had erected 1,250 new signs, oversaw major rebuilding projects, and kept the promise that crews would leave in the set time frame.

As noted earlier in this case example, NJDOT established a job number for the Sandy weather event on October 26, well before damages were incurred, anticipating that the Federal Emergency Management Agency (FEMA) might reimburse preparedness activities, such as cleaning inlets and clearing trees from power lines. When President Obama later signed an emergency declaration for New Jersey on October 30, the declaration allowed the state to request federal funding and other assistance for actions taken before Sandy's landfall and before the Presidential declaration (*The President's Climate Action Plan* 2012).

NJDOT used a lesson learned from 2011 in the aftermath of Hurricane Irene, which had caused $1 billion in damage in the state. After Irene, NJDOT staff developed “storm kits,” which NJDOT required Hurricane Sandy crews to bring with them as they assessed damage. These storm kits walk the user through what is needed for an assessment and for substantiating federal reimbursement applications, such as taking photos before, during, and after, and noting the exact location of the site by longitude and latitude. Portions of the storm kit are in a PowerPoint presentation used by NJDOT, which is included in this report as web-only Appendix C. This approach streamlined the process for developing applications to FHWA and FEMA, as evidenced by the fact that in April 2013, NJDOT stated that it was completing the application process for a $2.9 billion extreme weather event from less than 6 months before. Due in part to the storm kits, NJDOT was better prepared to manage the amount of work and documentation needed to address FHWA and FEMA reimbursement issues.

Design and Construction

NJDOT repaired the breach at Mantoloking in 53 days, completing work on December 21. Everything—traffic lights, curbing, and so forth.—was returned to its pre-storm state. Also, the Route 71 bridge was fully repaired by December 19. NJDOT’s Operations staff accomplished these accelerated repairs by using their emergency construction contractors as well as design consultants from the Capital Program Management arm of the construction unit of NJDOT. The department’s Operations unit teamed up with the Construction unit, with Operations in lead, to oversee this rapid emergency construction.

Planning and Related Activities

During the post-Sandy process of assessment and in the development of the applications for federal reimbursement, NJDOT prepared a list of resiliency projects it believes will ensure protection of roadways and transit systems from future weather events. The resiliency projects total $2.3 billion (*Community Development Block Grant Disaster Recovery Plan* 2013). Work by NJDOT, NJ Transit, and other state agencies under an FHWA climate change vulnerability grant project informed analysis and development of this sum and the project profiles.

Communications

Before, during, and after the storm, NJDOT followed the state’s Incident Command System approach for emergencies. The Emergency Operations Center spoke for the state, including with respect to transportation issues. In many cases, the Governor’s office spoke for the state. The timing and clarity of statements made by the New Jersey Governor are an example of how important leadership from the executive office can be, with the NJDOT interviewee believing it was especially critical in making decisions over fuel shortages immediately after the storm. The concept of using NJDOT fuel facilities to supply fuel to first responders and medical professionals was not the first alternative in the state Continuity of Operations Plan. NJDOT credits the successful execution of this ad hoc but effective plan to clear communication and leadership from the Governor’s office on down, with media and other channels getting the message out.

Interagency Coordination

Coordination was vital to road closures and clean-up after Sandy hit. NJDOT coordinated with local law enforcement to prioritize the roads for clearing. Previous coordination with the state police yielded a key communication and coordination tool during the storm In the years just prior to 2012, NJDOT had decided to “piggyback” on a police contract to buy P25 digital radios. These radios proved the most reliable form of communication during Sandy, facilitating coordination with the state police on road closures and other issues.

Road closures from downed power lines were a special circumstance requiring added coordination with the power companies. For safety purposes, NJDOT would not let its workers go in where a power line was draped over a tree, for example. Protocol required NJDOT crews to wait for the power company to determine whether the power line was alive or dead. The two entities—NJDOT and the power companies—had two different missions: one to clear the roads and the other to bring power back to the most customers. These aims were at odds with each other in many instances on the ground. NJDOT anticipates such issues and seeks to ameliorate them with each major storm, starting with underscoring with employees the safety message to wait for utility crews.

As NJDOT worked street by street to open access for the public along the Jersey Shore, it coordinated with law enforcement. First, NJDOT sought to ensure that its employees and contractors followed police directives. In the barrier islands and other shore areas, NJDOT followed the daily curfews imposed by law enforcement, just as all citizens had to do. This practice required leaving the storm zone by 4:00 p.m. every day, before nightfall, to address safety concerns over looting. Second, NJDOT had to manage governance issues regarding who was in charge. For example, as each section opened and energy, water, and other utilities were brought on line, residents returned, many with their own contractors. The return of the populous demanded the management of additional, diverse interests; local authorities often very strongly represented the concerns of local residents. For example, at the Mantoloking site, there were nine municipalities in an 8-mile stretch of road, each with different ideas on security and looting. There were questions around the desirability of contractors, for example, and what authority decides what person can be allowed into the area.

It was a “balancing act,” but NJDOT found ways to seek consensus. NJDOT also made incremental, executive decisions on governance to progress recovery, such as making a “permanent” traffic control change on a temporary basis: painting a double yellow line down the southbound lane of Route 35 to clearly allow north- and southbound traffic and covering any signs that indicated otherwise.

Data and Knowledge Management

Between pre-storm road closures for safety and the closures resulting from debris and damage to roadways, Hurricane Sandy impeded the interstate movement of freight and other private sector resources (All Hazards Consortium 2013). Typically, operators need permits to cross into the state with their goods and services. During Sandy, fleets from out of state faced permitting challenges when crossing the state line to help (All Hazards Consortium 2013). According to NJDOT’s Manager of Freight and Planning Services, NJDOT is developing an online permitting system to issue emergency permits in advance of an extreme weather event based on such information as type of vehicle, weight, size, and cargo (All Hazards Consortium 2013). This information would be used to analyze transportation options for the driver. Regarding toll roads and their impact on traffic flow, the state worked with various groups to address tolling barriers right after Sandy hit (All Hazards Consortium 2013). New Jersey’s Office of Information Technology is also working to move interstate truck traffic through tolls more quickly in such events (All Hazards Consortium 2013).

Since Sandy, NJDOT has managed its knowledge base about the event in several ways. NJDOT is having its planning office prepare a report on Sandy, for example. NJDOT engaged in working groups and workshops to record and transfer knowledge on managing impacts from extreme weather, such as those put on by the All Hazard Consortium, TRB, and AASHTO (All Hazards Consortium 2013; Shaw 2013).

Also, more generally, a NJDOT Safety Service Patrol keeps records of exchanges made during response efforts, including communications with the Transportation Operations Coordinating Committee, known as TRANSCOM, and the I-95 Corridor Coalition (Stanley 2013). Its post-disaster practice is to hold regular meetings with state police and to collect feedback from supervisors, with the purpose of refining response plans as needed (Stanley 2013).

Lessons Learned and Related Practices

The following list summarizes key practices identified in this case example by mission-related and crosscutting functions.

Practices by Mission-Related Function

Operations—Initial preparedness efforts included:

- Contact with the state Emergency Operations Center
- E-mail dialogue
- Review of preparedness checklists by state DOT staff
- Checks for needed tree cutting and weed removal to minimize debris and cleaning of sewer pipes to optimize drainage, by maintenance crews
- Checking of communications systems, flashlights, and other backup equipment, and checking of bulk fuel tanks and vehicles, topping them off as appropriate
- Development of evacuation plans, including consideration of contraflow plan in consultation with the state police.
- When alerts went higher, mapping out of activation times leading up to the “H-Hour,” which is when hurricane winds would be 39 mph or higher, and referring to these activation times to drive later decision making, such as the go/no-go on whether to institute contraflow for the shore evacuation.
- Operations ICS adopting a 24/7 battle rhythm with set calls in the morning and evening
- Usage of Safety Service Patrol, which added supplies of fuel, protective gear, and towing line, plus plows in some cases to move debris
- After the event, state DOT maintaining a physical presence at the most affected areas
- Division of the area (where recovery would take place) by the site of physical impacts, rather than agency boundaries, to make boundaries clear and temporary
- Seeking and facilitating high-level approval to clear side streets off the state right-of-way because state DOT equipment was already on site and clearing side streets would speed the return of residents
- Prior development of “storm kits” and the requirement that crews bring them along on assessments, including the information needed to substantiate federal reimbursement claims, such as photos and the exact location of damage sites
- Creating a job code when state Emergency Operations Center increased the alert from Level 1 to 2
- Creating the code before damage was incurred, including retroactive Presidential disaster declaration, capturing prior activity under that code
- Setting a well-understood target time frame (Christmas time) for state DOT departure from recovery area.

Maintenance:

- Deciding to have separate sites for debris and sand removed from streets, in order to clean and reuse the sand
- Addressing sinkhole-related issues regarding their proper assessment and over the most appropriate traffic control measures at the local level.

Design:

- At the location of the major, now iconic, barrier island breach, the decision to rebuild transportation infrastructure back to its original design and pre-disaster appearance under a fixed and aggressive time frame.

Construction:

- Full repair of key areas, using emergency contractors and working with the planning side of the house for on-call design contracts.

Planning:

- Decision to develop $2 billion in resiliency projects and make strategic choices about building back the right infrastructure, as informed by prior climate change planning funded by FHWA.

Practices by Crosscutting Function

Communications:

- Leveraging the clear communication by the Governor's office.

Interagency Coordination:

- Coordinating with the state police on common communication devices, P25 digital radios
- Where state DOT and power companies have conflicting missions and therefore challenges on the ground, reinforcing safety issues and complying with power company rules when power lines cross a roadway during recovery from an extreme weather event
- Resolving local traffic control issues by contracting out what appeared to be permanent traffic control changes on a temporary basis.

Data and Knowledge Management:

- To facilitate the flow of interstate freight and other traffic during an extreme weather event, development of an online permitting system to issue emergency permits in advance of the event
- Engaging in post-event workshops and other activities to share and record knowledge and lessons learned from the event.

CASE 2 : IOWA—RIVERINE FLOODING (2011)

Introduction

The Iowa DOT (IDOT) manages road, rail, transit, aviation, and other forms of transportation. The majority of Iowa's public roads, constituting nearly 90,000 miles, are county owned, whereas IDOT owns and manages 9,000 miles of roadway (*About the DOT* . . . n.d.). The state also owns more than 4,000 of the nearly 25,000 bridges in the state and maintains 15 railroad bridges crossing Iowa's state and interstate routes (*About the DOT* . . . n.d.).

In May 2011, the Upper Missouri River basin experienced an entire year's worth of rain, and the late melt from the Rockies snowpack was 200% its normal size for the basin. These two conditions combined to cause in northwest Iowa a once-in-500-years flood, which began May 27 and lasted to October 4, when the waters receded. Among many other consequences and disruptions, damage to federal-aid highways totaled $55 million.

This case example describes how IDOT used lessons learned from previous floods, key data sets, and communication and coordination to address a prolonged flood event that, among other challenges, shut down interstates for months.

Event Summary

In 2011, runoff from heavy May rains and a late spring melt filled the Missouri River and the six main reservoirs in the basin. Dam operators began to plan controlled releases of the water in order to avoid catastrophic flooding in heavily populated areas (*Missouri River Flood Coordination Task Force Report* n.d.). In late May, the Governor of Iowa asked the U.S. Army Corps of Engineers for assistance in preparing rural communities located downstream from the proposed dam releases. He formally declared a disaster emergency and directed the state's emergency management infrastructure to prepare for a sustained flood event (*Missouri River Flood Coordination Task Force Report* n.d.).

IDOT immediately convened its flood management team and used the time before dam releases to develop flood mitigation projects. IDOT interviewees reported that, as the situation developed in late May, IDOT maintenance participated in daily updates from the internal team. Given the lead time before the dam releases, maintenance staff could be pre-positioned in coordination with other districts. The staff watched for damage to the system on the ground, such as blocked culverts. Key preparedness activities included setting up these pre-determined staging areas, confirming disaster response staffing, and deploying the Intelligent Transportation System (ITS) capabilities of IDOT, including cameras for public views of inundated roads.

When the dam releases began, they led to flooding that closed downstream sections of Interstate 29, which is a north–south artery that runs along the Iowa side of the Missouri River, across from Nebraska (see Figure 3). By mid-June, the U.S. Army Corps was releasing water at twice the previous record; other parts of I-29 flooded, and four miles of Interstate 680 washed away (see Figure 4). Railroad tracks also flooded, and a change in the Missouri River channel damaged the IA-175 bridge between Iowa and Nebraska (see Figure 5).

FIGURE 3 Map of the flooding-affected area in Iowa, as delineated by the multiple-month interstate detour (2011).

FIGURE 5 Crews at work on the IA-175 Missouri River bridge at Decatur, Nebraska, 2011 (IDOT).

FIGURE 4 Flooding of the Missouri River in Iowa, with Interstate 29 inundated in proximity to Omaha, Nebraska, which is in the upper right-hand corner, August 3, 2011 (Flickr Commons, OMA STEVE).

In total, 60 miles of the primary highway system in Iowa were closed down, requiring detours hundreds of miles long. Soon, a 75-mile stretch of the Mississippi had no river crossings for vehicles (*After Action Report* . . . n.d.). In the case of I-680, the closure from the washout lasted 4 months. The out-of-distance travel had a cost to system users, with IDOT calculating that people had to travel an extra 1 million miles as a result of closed roads (*Missouri River Flood Coordination Task Force Report* n.d.). Nearly one-fifth of these extra miles were add-ons to worker commutes (*Missouri River Flood Coordination Task Force Report* n.d.). IDOT itself suffered impacts to maintenance garages, rest areas, and weigh stations, as well as to its Regional Weather Information System (*Missouri River Flood Coordination Task Force*

Report n.d.). Flooding of IDOT garages required the relocation of equipment and staff; the construction office staff had to locate to another facility as well.

According to one interviewee, the main categories of activities that IDOT engaged in were developing flood mitigation plans and projects; managing system closures and diversions; creating a public information call center; placing dynamic message signs and cameras for public information; staging areas for flood response supplies; responding to inundated communities; handling system recovery, including rebuilding of I-680, removing debris on I-29, and tackling reconstruction projects on State Highways 2 and 274, and the State Road 175 Bridge Recovery Project; and, finally, securing federal recovery funds from FEMA and FHWA. IDOT also made specific decisions at the local level that involved the following issues (*After Action Report* . . . n.d.):

- Identifying appropriate roadways for local detours to address immediate closures
- Opening and closing ramps with the fluctuation of water levels during rain events
- Conducting traffic operations
- Devising methods to handle water accumulation at sites treated with flood barriers
- Ensuring involvement of affected cities and counties.

Using streamlined approaches to projects and contracting, IDOT was able to complete a good deal of the reconstruction quickly. The washed-out sections of I-680 were rebuilt, and reopened two months ahead of schedule, for example ("Iowa DOT Reopens I-680 . . ." 2011) IDOT's very successful in-house effort before the 2011 flooding to prepare and implement a data management approach that could streamline FHWA reporting saved many hours of staff time and resulted in a more structured understanding of federal funding reimbursement status.

As a result of the prolonged flooding in 2011, IDOT-managed federal-aid roads sustained $49,730,841 in damage. After FHWA reimbursement, it is likely that $4,402,226 will remain unfunded, according to an interviewee. The interviewee also noted that IDOT submitted $149,071 in costs to FEMA for reimbursement and received 75% in return for these costs, which covered the IDOT call center and its work to assist communities. Overtime costs for the management team staff, design staff, contracts office, and related services were not eligible for reimbursement. In addition to the damage to federal-aid roadways, the interviewee stated that $5,480,672 in damages was associated with federal-aid routes maintained by counties and cities, of which $4,618,656 is likely to be reimbursed, leaving $862,016 unfunded. IDOT also secured reimbursement for nearly $50,000 in damage to railroad crossings. As of summer 2013, the 2011 flood recovery phase remained an ongoing effort.

State DOT Activities

Operations and Maintenance

In 2011, IDOT had many existing policies, tools, and protocols in place that were relevant to the actions needed to address a flood event. These included a 511 system, a dynamic messaging system, disaster response plans, an institutionalized ability to follow FHWA Emergency Relief funding application protocols using the new, in-house software application, and established policies for closures of interstate and primary highways.

Given the magnitude of the 2011 flood, IDOT's role extended beyond its routine activities for several weeks. IDOT was the lead on transportation issues in the state Emergency Operations Center, providing direct services, such as debris removal, to local communities. IDOT's second role was to run its own internal activities relating to the flood. There is within IDOT a Statewide Emergency Operations (SEOP) section that includes a 24-hour Operations Support Center (OSC) that monitors statewide issues and maintains the 511 system. Through Traffic Management Operations, IDOT worked with neighboring states to establish detours for closed roadways (*After Action Report* . . . n.d.). The Communication section of this case example has details on the detours.

IDOT also called on its "flood management team," referenced previously, which relied on the SEOP and the OSC for some resources. IDOT convened its flood management team daily. IDOT invited FHWA into its flood management team conference calls from the start. IDOT did so because, based on the projected flow levels in May, it was clear to IDOT that FHWA would be involved in critical response and recovery decisions.

Daily conference calls included the following topics (*After Action Report* . . . n.d.):

- Road closures
- Definition of global and local detours
- Best approaches for communicating with the public (such as what information to share, how to describe the event)
- IDOT's interaction with the media
- Sharing of inundation predictions based on the hydrologist's interpretation of Light Detection and Ranging (LIDAR) data, river gauge data, and the expected impact of U.S. Army Corps of Engineers releases from upstream dams
- Potential mitigation measures
- Alternatives to the contract-letting procedure for projects associated with beginning recovery efforts.

IDOT reports that it used a webinar uplink to facilitate review of maps and other materials. Over many weeks, the daily flood management team calls switched to weekly calls.

IDOT included in its flood management team participants from across IDOT, including purchasing, contracts, environmental, design, maintenance, IT, the Public Information Officer, communications, geographic information system (GIS) staff, and bridges and structures staff. Other state agencies and federal agencies were also included. IDOT had managed a major flood in 2008, and a key lesson learned was to focus on more than the event's response phase right at the start and to begin recovery work (*After Action Report* . . . n.d.).

IDOT officials believe the effort to include a broad range of divisions early on was effective in many ways. IDOT utilized an in-house hydrologist whose contributions to the preparedness activities in May and early June 2011 mitigated the impacts of the dam releases when they finally came. IDOT also maximized the IT specialists under its purview, using them for Internet communications and GIS activities.

Early coordination also was effective with respect to IDOT's responsibility to secure reimbursement from federal funding sources. IDOT draws on many units and experts to assess damage, estimate costs, conduct recovery work, and seek reimbursement. Because of its prior preparation, IDOT had on hand trained staff who could act as project officers on the federal program reimbursement process in disaster situations such as this. Additionally, the IDOT Contracts and Accounting Offices had designated staff trained in the Emergency Relief program process, and each district had a local system engineer to assist in that process as well. Coordination and pre-designation of trained staff also helped in debris removal. As the flood event played out, IDOT was able to put contracts in place for debris removal before the water levels went down. Ultimately, IDOT received 100% federal reimbursement for debris removal.

An IDOT interviewee reports that prior experience with disasters spurred the agency to use its own internal resources to improve applications for FHWA reimbursement; it developed an "electronic DDIR." As noted elsewhere in this report, DDIRs (Detailed Damage Inspection Reports) are the FHWA forms through which states provide certain data on infrastructure damage in application to the FHWA Emergency Relief program. The electronic DDIR application was developed to allow IDOT employees, counties, cities, and Iowa Department of Natural Resources and Iowa Office of Rail Transportation locations to initiate the DDIR process in the same way.

At the start of the electronic DDIR process, a person accesses the required DDIR form. Along with the form, the system generates the required map and allows documents and pictures to be attached.

The system allows the user to select certain information from drop-down menus (such as event number), generates messages to the user if certain fields are not correct, and issues a DDIR report number. When the submitter completes the form, the system generates an e-mail notification to the administrator. The administrator can approve or reject the DDIR. If approved, the DDIR is then forwarded through the system to FHWA. In doing so, the system generates an e-mail to FHWA and various offices, including Accounting, Environmental, Contracts, and any other office selected on the DDIR. FHWA then opens the DDIR in the system and has the ability to approve, approve with changes, or reject. The system saves all information from the form into a database and also sends the form with attachments to the Electronic Records Management System. As may be necessary in some instances, the system allows users to revise or cancel the DDIR. IDOT used its electronic DDIR for the first time during the 2011 flood. It was a very successful implementation that saved many staff hours, according to the IDOT interviewee.

After the flood receded, IDOT participated in the Governor's Missouri River Recovery Coordination Task Force, which oversaw the state's recovery efforts. The task force was a temporary group of state agency representatives and interested stakeholders that analyzed and shared damage assessment data, coordinated assistance across various stakeholders, monitored progress, and ultimately captured effective practices and lessons learned. It produced a report that included a statewide After Action Report (AAR) in its appendices (*Missouri River Flood Coordination Task Force Report* n.d.).

The Governor's task force exercise took place in the fall of 2011 while recovery and reconstruction efforts were under way. In 2012, when major recovery efforts were complete, IDOT produced an AAR at the department level. The IDOT AAR used surveys and structured interviews to record best practices, and IDOT hired a private consultant to support this work (*After Action Report* . . . n.d.). An AAR is a common practice for recording an agency's response to a major event. The IDOT department-level AAR is included in this report as web-only Appendix D.

The IDOT AAR organized findings around five key elements from the IDOT response to the 2011 flood. These five elements are Information Sharing and Communication, Staffing, Decision Making, Data and Technology, and Mitigation Measures (*After Action Report* . . . n.d.). It is useful to this Synthesis Report to align these five elements in the IDOT AAR with the functional categories used in each case example here. As a result, this case example reports on each IDOT AAR category with the following approach.

- The AAR's summary of Information Sharing and Communication is covered in the Communications section of this case example.
- The AAR's summary of Data and Technology is covered in the Data and Knowledge Management section of this case example.

- The AAR's summary of Staffing, Decision Making, and Mitigation Measures are addressed directly here because they pertain mostly to Operations and Maintenance.

Regarding staffing practices, the IDOT AAR highlighted certain lessons learned and related practices, summarized as follows:

- Using the event's staffing practices as a starting point to create a template for future events
- Involving at the outset all DOT offices affected by the event or with expertise that could aid in managing the event
- For events of long duration:
  – Seeking the assistance of vendors, contractors, or other outside resources, as needed, to ensure the timely completion of response-related activities
  – Designating a small group to focus on recovery as response efforts continue.
- Involving state agencies with responsibility for permitting or other related issues earlier in the event
- Adapting the current process/responsibility for managing vendor contacts so it can be more flexible and take less time
- Making arrangements to engage consultants, if needed, to assist with damage assessments and other recovery work while DOT staff is still engaged in the flood response
- On a case-by-case basis, weighing two factors of the consistency achieved through uniform control of consultants against the benefits gained through the application of local knowledge from internal staff members.

Regarding decision-making practices, the IDOT AAR highlighted certain lessons learned and related practices, summarized as follows:

- Involving the right people
  – Erring on the side of inclusion when developing the list of participants in the event response. Consider involving support services that handle equipment, signs, purchasing, and traffic and safety, as well as research and technology.
  – Ensuring the early and effective engagement of the Iowa DOT management, SEOP staff, and regional partners. Use the circumstances of each event to guide the extent of ongoing management participation.
  – Identifying critical connections and clearance requirements with resource agencies (FHWA, Iowa DNR, and the U.S. Army Corps of Engineers) early on, while considering the impacts to and involvement of local agencies.
  – Encouraging the active engagement of district staff in decision making and identifying innovative solutions.
- Structuring the decision-making process
  – Providing clear direction on the goals for response and preliminary recovery, and clarifying responsibilities for carrying out these related efforts
  – Expediting decision making with a small-group structure for project-level decisions and confidential matters
  – Ensuring that staff is trained and coordinating an agency wide implementation of a formal ICS
  – When possible, using established vendors or resources already under contract to control spending and avoid duplicating efforts.
- Managing the transition from response to recovery (while the response is ongoing):
  – Establishing a separate working group that begins work on recovery early in the event while others manage the flood response
  – Requesting advice from contractors' associations about how the agency can work more effectively with contractors in initiating a prompt and effective recovery effort
  – Avoiding seeking the "perfect" solution when preparing designs for emergency repairs
  – Applying innovative contracting practices such as lump-sum, limited-design contracts, and no-excuse bonuses to expedite reconstruction projects
  – Employing a debriefing process at the onset of the recovery efforts to document successes and challenges as the projects move forward.

Regarding mitigation measures, the IDOT AAR highlighted certain lessons learned and related practices, summarized as follows:

- Selecting a mitigation measure that fits the circumstances of the site. Consider length, location, available resources, and the time available before overtopping becomes a significant concern.
  – Considering the impact of mitigation measures on adjacent land uses
  – Conducting a cost–benefit analysis to compare measures
  – Using inundation predictions to assign mitigation resources to locations where they are most likely to help.
- Keeping abreast of new mitigation technologies. Enter new products as they are identified in the IDOT purchasing system to expedite their use during an emergency.
- Considering the following practices when using large flood-barrier systems:
  – Install on roadways with paved shoulders
  – Lower traffic speeds
  – Delineate the barriers using striping or another method
  – Establish width limits for treated areas
  – Identify alternate routes for trucks hauling material.
- Using sandbags and pumps for smaller, more confined locations when the water will not rise above 2 ft.
- Being prepared to develop innovations that address unintended consequences of mitigation measures (e.g.,

water accumulating because of a lack of drainage on the roadway).

- Tracking the areas that were overtopped during the current event and considering them for reconstruction projects that raise the mainline to prevent future problems.

Design and Construction

According to IDOT, recovery of Iowa's transportation system involved five major reconstruction projects at the state level, some of which were noted earlier in this case example. Two involved state roads, two were interstates, and one was a bridge to Nebraska.

Under the rules existing at the time, in order to get 100% reimbursement from FHWA, IDOT had to complete construction within 180 days from the start of the emergency. The start of the emergency is typically the day of the disaster declaration, which in this case example was May 25, 2011. The 180-day time frame meant the deadline for 100% reimbursement was November 20, 2011; however, the flood waters did not recede until mid-October, confounding the reconstruction schedule (*After Action Report* . . . n.d.). IDOT developed ways to accelerate both the contract process and construction.

The IDOT AAR describes the following practices used to expedite project procurement and delivery. First, IDOT was able to shorten the letting schedule commonly prescribed by state rules based on the emergency circumstances. IDOT also worked with its federal partners and secured an exemption from federal rules that required a 21-day time frame for advertising projects that are not emergency repairs. With this special exemption, IDOT was able to advertise projects in a 10-day time frame. Next, IDOT created a set cycle for letting contracts. Information on proposed projects was due internally each Wednesday afternoon, and those approved were placed on the IDOT website on Friday for bidding. By the following Wednesday, bids on the project subject to the shortened state schedule were accepted, whereas those using the 10-day federal advertising time frame were accepted at the end of that deadline.

IDOT also used incentive clauses in contracts to encourage quicker delivery. A "no-excuse bonus" tied payment of a bonus to delivery by a set date, which may or may not be the delivery date. IDOT ensured that the contract for the reconstruction of the damaged segment of I-680 included a "no-excuse bonus" date of November 20, which was the last day IDOT could receive 100% reimbursement. The contractor would get $2 million if it delivered by November 20. Also, each day before November 20 that the project was delivered would yield an $82,000 incentive. If the contractor went past the overall project due date of December 23, the contractor would be charged $82,000 per day for late delivery.

With respect to design, the I-680 reconstruction also provides an example of success in IDOT's management of the recovery phase. As noted, the flood washed away the interstate in the summertime, and IDOT needed to design the replacement before the winter season and before the 180-day period ended. To accelerate work, IDOT determined that a limited design–build approach was feasible. IDOT's determination was based on the availability of original plans from the interstate's development in the 1960s and on the fact that the footprint of the rebuild could be the same. IDOT initiated the design process even before the water levels had fallen. To do so, IDOT broke from its usual practice and used a consultant, rather than an in-house resource, to conduct the inspection of the project. IDOT interviewees considered this type of flexibility an effective practice under these circumstances.

Planning and Related Activities

As noted earlier, the 2011 flood event response drew from experts across IDOT. Because the dam releases were controlled, there was a window in which IDOT staff could prepare for the eventual inundation. For example, the IDOT planning team was brought in to support mitigation efforts. They first identified 21 locations as flood mitigation sites, and this number was later narrowed to 14. Of these, seven were eventually closed. Two sites did not need mitigation; however, five could remain open because of the mitigation measures IDOT was able to put in place (*Missouri River Flood Coordination Task Force Report* n.d.).

Ultimately, the IDOT planning team was able to design mitigation projects to keep major stretches of I-29 open, along with a key Iowa–Nebraska road, Highway 30 (*Missouri River Flood Coordination Task Force Report* n.d.). The team relied on geospatial data (e.g., GIS and LIDAR) in decisions on mitigation projects, as described by the Governor's Missouri River Recovery Coordination Task Force:

> Using LIDAR information, the entire preliminary bridge staff worked countless hours to more precisely pinpoint areas of potential impacts so that Iowa DOT management could coordinate possible detour routes with the districts and neighboring states. Without this data, Iowa DOT would not have been able to assess and predict the risks to infrastructure and identify potential mitigation opportunities.

IDOT planners also supported the flood recovery effort by determining the impact of various road closures that had been put in place. Road closures required detours, and IDOT used a computer-based travel model to determine the increase in the number of miles people had to travel in western Iowa because of the detours. The model compared total vehicle miles traveled before and after the roads were closed owing to flooding. It showed possible rerouting around road closures and anticipated the next most likely route a driver may choose. Based on the model, IDOT could understand the social and economic impacts its stakeholders may have been experiencing. For example, travel to and from work accounted for approximately 18% of the increased miles traveled under the detours (*Missouri River Flood Coordination Task Force Report* n.d.).

Another planning issue relates to training and readiness. Based on prior flood experiences, IDOT had made sure its staff received training in the essentials of an Incident Command System. According to an interviewee, field staff received ICS training in 2006–2007; and after the 2008 flood, division directors and construction leads also received the training. Although a mature ICS approach was not in place completely in 2011, when the flooding event began (*After Action Report* . . . n.d.), there was support for the ICS approach during the event "from the management level down to the garage-level staff," according to an interviewee. IDOT has implemented further ICS training, and it also is advancing its approach to Emergency Transportation Operations (ETO; *After Action Report* . . . n.d.). ETO seeks to prepare states departments of transportation for nonrecurring events that require the support or involvement of nontraditional transportation stakeholders, such as law enforcement and emergency management communities (*Emergency Transportation Operations* 2013). This demarcation of roles and responsibilities helps elevate and accelerate preparedness activities to a higher priority. IDOT is working with the Iowa State Patrol to incorporate ETO into its standard ICS structure (*After Action Report* . . . n.d.). According to one interviewee, IDOT is considering possible performance metrics for extreme weather events under an ETO.

Communications

According to IDOT, forms of public communications included traditional press releases and media contact by the department Public Information Officer. For the 2011 flooding event, IDOT also adopted new ways to communicate with the public, such as a 24-hour call center and a web page devoted to the flood. IDOT also directed ITS cameras along flood corridors so the public could see road impacts.

In its AAR, IDOT presents an analysis of the varied functionality seen across the ongoing 511 website, the flood website in place for 5 months, and the call center put in place for 5 weeks right after the flood. The *After Action Report* (n.d.) also notes that increased smart-phone use by the public suggested more use of the 511 website and the flood website than might have been seen in the past.

During the 2011 flood event, incoming requests to IDOT from communities arrived through the statewide EOC (*After Action Report* n.d.). IDOT picked up the queries and ensured the interests of particular groups and transportation stakeholders were handled by the relevant IDOT office. For example, according to an interviewee, IDOT worked directly with the Iowa Motor Truck Association to address the concerns of freight haulers seeking exceptions to permits and the suspension of certain regulatory provisions.

Another communications issue relates to detours. The prolonged detour of traffic was a major communication challenge to explain to a broad and diverse audience. IDOT decided between two different approaches. One school of thought was to encourage the use of global detours that utilize interstate highways and inform the public of closed routes. Another approach was to provide travelers with customized routes using local primary roads that limit out-of-distance travel (*After Action Report* n.d.).

Regarding information sharing and communication practices, the IDOT AAR highlighted certain lessons learned and related practices, summarized as follows:

- Identifying the participants
  - Considering the early engagement of DOT divisions or offices that may assist in the flood response, including front-line support services that handle equipment, signs, purchasing, and traffic and safety, as well as research and technology
  - Establishing a core group that expands as needed with the staff required to address the issues at hand that day
  - Engaging neighboring states immediately if it appears that a regional detour will be required
  - Ensuring that all communication with regard to regional or local detours is provided in a timely manner.
- Structuring the meetings
  - Setting a goal and purpose for project team meetings
  - Carefully structuring meeting agendas to move from general information sharing to more detailed discussions.
- Crafting and delivering the public message
  - Establishing consensus on the nature and extent of the public message and ensuring delivery of a consistent message
  - Designating one individual within the DOT as the party responsible for managing information flow
  - Implementing a policy that identifies the agency's philosophy with regard to detours—regional or localized—and describes how information about detours will be disseminated
  - Clarifying the DOT's position on the primacy of the state's 511 website as the source for traveler information
  - Regularly prompting those contributing information to an event-specific website to ensure that the site's information is accurate and current
  - Evaluating the need for a call center to respond to public inquiries, taking into consideration the extent and nature of an event and available resources

– Placing the call center team in one room with a cubicle design to enhance privacy
– Considering the use of a software program that provides statistics on caller volume.

Other forms of public communication associated with the 2011 flood include use of the "Turn Around Don't Drown" public service messaging. The National Weather Service has promoted use of the phrase as a cautionary message to the driving public in order to warn of the dangers of driving into water on a roadway ("Turn Around Don't Drown Success Stories" 2011). In September 2011, IDOT posted on its website a "Turn Around, Don't Drown" message alongside footage of a car abandoned in high water by its driver. The IDOT website described how the driver had been diverted by road closures from flooding, only to dangerously (and unsuccessfully) attempt to drive across a flooded roadway ("Turn Around Don't Drown Success Stories" 2011).

Interagency Coordination

Interviewees from IDOT provided a long list of the agencies and entities it relied on: Nebraska Department of Roads (NDOR), Missouri Department of Transportation (MoDOT), FHWA, the Iowa Homeland Security and Emergency Management Division (IHSEMD), Iowa State Patrol (ISP), Department of Corrections, U.S. Army Corps of Engineers (Army Corps), contractors, and consultants. IDOT also included the following agencies in ongoing planning and briefing meetings: department management and staff, district management and staff, the Motor Vehicle Division, ISP, HSEMD, NDOR, Kansas Department of Transportation, MODOT, Army Corps, NWS, and FHWA. As noted, IDOT held daily and, later, weekly flood webinar planning meetings. It also participated in NWS briefings, Army Corps phone calls, state homeland security activations, and conference calls.

IDOT addressed multimodal impacts through strong interagency coordination. A critical impact was damage to the railways. One illustration of the problem is described in the Governor's task force report and is summarized in this paragraph (*Missouri River Flood Coordination Task Force Report* n.d.). Two major railroad companies whose operations were threatened had rail lines that together carried as many as 75 to 85 trains per day across the Missouri River. These are key routes for carrying coal from the western mines to eastern power plants. Because of the potential economic consequences of the closures from the flooding, both railroads brought in the labor, equipment, and supplies needed to keep the lines open. They raised the track structure up to 7 ft for several miles. They also raised bridges, added culverts, and built dikes to avoid track damage. IDOT coordinated with the railroad companies in several ways. IDOT facilitated better access for repair materials by suspending an IDOT construction project. It also facilitated dialogue among railroad employees, state and county highway officials, and emergency management personnel during the repairs (*Missouri River Flood Coordination Task Force Report* n.d.).

Strong and sustained coordination with several stakeholders was also needed to secure agreement on rebuilding the Iowa state highway 175 bridge, according to IDOT interviewees. The following entities and their respective legal departments had a say in the project and its proposed funding sources: IDOT, the toll bridge authority, FHWA, and the state of Nebraska. IDOT believes it was a lesson learned that it should anticipate how to avoid or better manage such a complex negotiation among multiple organizations and during a limited window for reconstruction.

Data and Knowledge Management

IDOT had multiple sources of information that could aid in addressing the flood. Staff had to analyze the quality of each source for use in decision support (*After Action Report* n.d.). Data sets included federal water management data, LIDAR, GIS, aerial photography, and photogrammetry combined with over-flight data. Technologies for presenting information included the Internet; dynamic message signs, including overhead, side-mount, and portable signs; portable and fixed cameras for monitoring risk areas; Highway Advisory Radio to supplement cellular networks; and cellular communication, including technology permitting callers to access other networks when one provider failed.

The variety of data and technologies delivering them proved useful. IDOT determined that the Army Corps flood-inundation projections were useful generally but had some limitations. As a result, IDOT turned to the state's LIDAR data sets to make key asset management decisions, according to an interviewee. An example is detailed by the Missouri River Recovery Coordination Task Force:

> Iowa DOT was able to determine a worst-case flooding scenario that revealed that [a key maintenance] garage sat on high ground and would not be inundated. This allowed Iowa DOT to leave materials and equipment in place. Typically, Iowa DOT would have moved the resources as a precautionary measure, but because of LIDAR, it was determined that the movement of materials from this garage was unnecessary.

IDOT used LIDAR to identify areas of likely inundation where water was rising or if there were levee failure, supplementing aerial shots. It should be noted that IDOT invested in LIDAR data sets after a major 2008 flood, and its experts estimate that the superior coverage from these data sets puts the state among the top five states in this country with respect to this resource (*After Action Report* n.d.).

IDOT brought focus and attention to the role of geospatial information in flood response and recovery. For example, it convened sit-downs after its daily flood planning meetings specifically to review data and information in the form of the flood projections, LIDAR, real-time elevations, and aerial photography. Geospatial experts also received daily reports from district staff and supported the development of information used in Damage Survey Summary Reports submitted to FHWA, according to IDOT.

Regarding Data and Technology practices, the IDOT AAR highlighted certain lessons learned and related practices, summarized as follows:

- Establishing and maintaining lines of communication for effective collaboration and information sharing between the U.S. Army Corps of Engineers and IDOT to ensure early notice of the potential for flooding.
- Continuing to make effective use of LIDAR to prepare inundation predictions.
  - Consider investment in a 2-D hydraulic model of the Missouri River that shows inundation areas and automates the process used during this event that applied LIDAR data to develop inundation predictions.
- Making effective use of aerial photography and updating photogrammetry early in the event to gain a better understanding of the scope of the upcoming recovery efforts.
- Making effective use of Intelligent Transportation System components.
  - Placing portable cameras to monitor water levels at ramps and intersections prone to flooding during heavy rain events.
  - Using DMSs to notify travelers of detour routes. Supplement this signage with static signs to trailblaze the detour route.
  - Ensuring timely and effective management of messaging for DMSs.
  - Employing Highway Advisory Radio when cellular communications are interrupted.
- Evaluating opportunities to expand the development and use of GIS-related data.
- Considering gathering traffic data to aid in managing traffic flows during the event.

In addition to capitalizing on diverse data sets, IDOT engaged in important Knowledge Management practices. The creation of the IDOT AAR is a Knowledge Management practice. As may be observed in the preceding discussion, IDOT's AAR includes information and many insights supporting the case example presented here; for that reason, it is included as web-only Appendix D, as noted earlier.

Similarly, the content and format of the Iowa Governor's task force report, which included the Iowa Homeland Security and Emergency Management Division AAR, are useful as a reference for those not involved in the 2011 flood event. The statewide perspective in the Governor's task force *After Action Report* emphasized the utility of IDOT assets for staging disaster response activities, such as the strategic use of IDOT garages (*Iowa 2011 Missouri River Floods After Action Report* 2011). Further, the Iowa Homeland Security and Emergency Management Division notes in its AAR that it has identified the use of such facilities as staging areas as a candidate "Lesson Learned" for entry into the U.S. Department of Homeland Security's Lessons Learned Information Sharing (LLIS.gov) system (*Iowa 2011 Missouri River Floods After Action Report* 2011).

In another Knowledge Management effort, IDOT presents the story of the 2011 flood through an online "storify" project released in May 2012 ("Iowa DOT Captures Story . . ." 2012). On its web page, IDOT describes the flood and its impacts on transportation. IDOT also encourages members of the public to submit their own stories via the IDOT Facebook page ("Iowa DOT Captures Story . . ." 2012).

Lessons Learned and Related Practices

The following summarizes the key practices identified in this case example by mission-related and crosscutting functions.

Practices by Mission-related Functions

Operations:

- After the state Emergency Management was stood up, putting in place an internal flood management team and using group phone calls for cohesion
- Utilization of webinar uplink on group calls, for maps, and so forth
- Having a multiagency team and having FHWA and neighboring states join it
- Ensuring enterprise-wide understanding of ICS "from management to the garage level"
- Investment in ICS training ahead of time
- Development of a disaster response plan
- Training for staff to be project officers on federal programs
- Debris-removal contracts in place before flood waters had receded
- Mobilization of all staff through an Operations Support Center, including purchasing, contracts, environmental, design, materials, GIS staff, and bridges and structures staff
- Utilizing IT staff, especially with respect to Internet communications and GIS
- Development of global detours for interstate travelers.

Identifying staffing issues, such as the following:

- Using the staffing practices from the event as the starting point for a template for future events
- Involvement of all state DOT offices affected by the event or with expertise that could aid in managing the event from the outset

- For events of long duration:
  – Seeking the assistance of vendors, contractors, or other outside resources, as needed, to ensure the timely completion of response-related activities
  – Designating a small group to focus on recovery as response efforts continue.
- Involving state agencies with responsibility for permitting or other related issues earlier in the event
- Adapting the current process for managing vendor contacts so it can be more flexible and take less time
- Making arrangements to engage consultants, if needed, to assist with damage assessments and other recovery work while state DOT staff is still engaged in the flood response
- On a case-by-case basis, weighing two factors of the consistency achieved through uniform use of consultants against the benefits gained through the application of local knowledge from internal staff members.

Identifying decision-making issues, such as the following:

- Involving the right people
  – Erring on the side of inclusion when developing the list of participants in the event response. Consider involving support services that handle equipment, signs, purchasing, and traffic and safety, as well as research and technology.
  – Ensuring the early and effective engagement of the state DOT management, state emergency operations staff, and regional partners. Use the circumstances of each event to guide the extent of ongoing management participation.
  – Identifying critical connections and clearances with resource agencies (FHWA, the state natural resource agency, and the U.S. Army Corps of Engineers) early on, considering the impacts to and involvement of local agencies.
  – Encouraging the active engagement of district staff in making decisions and identifying innovative solutions.

- Structuring the decision-making process
  – Providing clear direction on the goals for response and preliminary recovery, clarifying responsibilities for carrying out these related efforts.
  – Expediting decision making with a small-group structure for project-level decisions and confidential matters.
  – Ensuring that staff is trained and coordinating an agencywide implementation of a formal ICS.
  – When possible, using established vendors or resources already under contract to control spending and avoid duplication of effort.

- Managing the transition from response to recovery (while the response is ongoing):
  – Establishing a separate working group that begins work on recovery early in the event while others manage the flood response.
  – Requesting advice from contractors' associations about how the agency can work more effectively with contractors in initiating a prompt and effective recovery effort.
  – Avoiding seeking the "perfect" solution when preparing designs for emergency repairs.
  – Applying innovative contracting practices such as lump-sum, limited-design contracts, and no-excuse bonuses to expedite reconstruction projects.
  – Employing a debriefing process at the onset of the recovery efforts to document successes and challenges as the projects move forward.

Identifying mitigation measures, such as the following:

- Selecting a mitigation measure that fits the circumstances of the site.
- Keeping abreast of new mitigation technologies. Enter new products in the state DOT purchasing system as they are identified to expedite their use during an emergency.
- Considering certain practices when using large flood-barrier systems and others for smaller sites.
- Being prepared to address unintended consequences of mitigation measures.
- Recording areas that were affected so they can be considered for projects to prevent future problems.
- Developing an in-house automated process for federal reimbursement when a commercial product could not be found.

Maintenance:

- Conducting preparedness activities before a controlled release of water from dams, including checking for blocked culverts, defining the disaster response staging areas, and deploying ITS, such as traffic cameras that could provide a view of inundated roads.

Design:

- To rebuild 4 miles of a washed-out interstate, starting the design process before water levels had fallen, and adopting a design-build approach given the availability of the original plans.

Construction:

- To rebuild 4 miles of a washed-out interstate, using predetermined contract rates, incentive clauses, and utilized contracted inspection services.

Planning:

- Using lead time before waters rose to develop flood mitigation projects, as identified through use of GIS and LIDAR.

- After road closures are made for safety, using planner expertise to determine and communicate the impact of road closures.
- Development of an Emergency Transportation Operations plan with the Iowa State Patrol.

Practices by Crosscutting Functions

Communications:

- Engaging directly with constituencies; for example, the freight haulers, through associations such as Iowa Motor Truck Association
- Using 511 system to communicate road status
- Directing ITS cameras toward vulnerable areas
- Using 24-hour public information call center
- Using dynamic messaging signs
- Using public website dedicated to the flood
- Using Highway Advisory Radio.

Identifying notable communications practices to include, such as:

- Considering the early engagement of DOT divisions or offices that may assist in the flood response, including front-line support services that handle equipment, signs, purchasing, and traffic and safety, as well as research and technology
- Establishing a core group that expands, as needed, with the staff required to address the issues at hand that day
- Engaging neighboring states immediately if it appears that a regional detour will be required
- Ensuring that all communication with regard to regional or local detours is provided in a timely manner
- Setting a goal and purpose for project team meetings
- Carefully structuring meeting agendas to move from general information sharing to more detailed discussions
- Establishing consensus on the nature and extent of the public message and ensuring delivery of a consistent message
- Designating one individual within the DOT as the party responsible for managing information flow
- Implementing a policy that identifies the agency's philosophy with regard to detours—regional or localized—and describes how information about detours will be disseminated
- Clarifying the DOT's position on the primacy of the state's 511 site as the source for traveler information
- Instituting regular prompting to those contributing information to an event-specific website to ensure that the site's information is accurate and current
- Evaluating the need for a call center to respond to public inquiries, taking into consideration the extent and nature of an event and available resources
- Placing the call center team in one room with a cubicle design to enhance privacy
- Considering the use of a software program that provides statistics on caller volume
- Utilizing "Turn Around Don't Drown" public service messaging from a multistate initiative.

Interagency Coordination:

- Including FHWA on the team from the start
- Coordinating with multiple state and federal agencies, including other states, through daily webinars and briefings by other agencies, such as NWS and the U.S. Army Corps of Engineers
- Clarifying whether the purpose of interagency meetings was for information sharing or decisions
- Interacting on multimodal issues directly with affected parties, supporting their efforts by standing down on nearby projects, and facilitating communications with local agency representatives
- Understanding the resources (e.g., time and staff) needed to address the complexities of working with another state linked by a heavily used toll bridge where such state had experienced less severe impacts and the toll bridge governing body had its own interests to assert in negotiations.

Data and Knowledge Management:

- Participating the Governor's task force and state-level After Action Report, conducting a state DOT After Action Report, and hiring a consultant or other external facilitator to run the exercise
- Supporting the communication of state DOT-related lessons learned to U.S. Department of Homeland Security
- Providing a forum for the public to tell stories about transportation issues from the event, under a web-based "storify" project
- Investing in LIDAR data sets and using them to determine at-risk sites and to identify places that would be safe and not require investment of precious time for protection
- Using aerial images of the event early on for situational awareness
- Convening a daily sit-down regarding GIS data alongside the state DOT's daily flood-management team call
- Maximizing the use of GIS staff available to contribute to damage survey reports.

CASE 3 : TENNESSEE—HIGH-INTENSITY RAIN AND TORNADOES (2010)

Introduction

The Tennessee Department of Transportation (TDOT) is a multimodal agency that builds and maintains 14,000 miles of state and interstate roadways (TDOT 2010a).

In May 2010, heavy precipitation in parts of Tennessee exceeded a 1,000-year, 48-hour storm event (Degges 2010). Flooding took 24 lives within the state, shut down portions of three interstates, heavily damaged roadways, and closed railway operations in the western part of the state for more than a week. It took approximately 83,000 TDOT maintenance hours to assess damage and recover, with $45 million in repairs estimated and 100 routes affected (Burbank 2011).

This case example describes how TDOT managed this extreme weather event at a statewide level.

Event Summary

On Friday, April 30, 2010, weather forecasts for both western and middle Tennessee projected 2 to 4 in. of rain and flash flooding of low-lying areas (*Response to May 2010 Flooding* . . . 2010). On Saturday, May 1, nearly 3 in. fell before noon (*Record Floods of Greater Nashville* . . . 2010). The state Emergency Operations Center and its Emergency Services Coordinators were activated at 12:30 p.m. More than 3 additional inches of rain fell by 6:00 p.m. (*Record Floods of Greater Nashville* . . . 2010). At that time, TDOT designated its Regional Maintenance Supervisors as Incident Commanders. For the rest of May 1, TDOT crews, working through the night, operated in cooperation with law enforcement to close ramps, roadways, and interstates. The storm system included at least 12 tornadoes (Degges 2010). One tornado tracked for 25 miles in the early morning hours of May 2, causing a fatality in Hardeman County (2010 Tornado Fatality Information n.d.), in the town of Pocahontas (Ascensio 2010).

On Sunday, May 2, the rain was just as heavy as it was May 1 (*Record Floods of Greater Nashville* . . . 2010). TDOT sustained damage to its Intelligent Transportation System, and the volume and intensity of the rain suggested that the regional TDOT office in Nashville would be at risk of flash flooding ("May Storms and Flooding of 2010" n.d.; *Response to May 2010 Flooding* . . . 2010). TDOT management called in staff to address the risk to the facilities and other property, such as agency vehicles. TDOT began developing detours for I-40, the major East Coast to West Coast interstate that runs across Tennessee from the Great

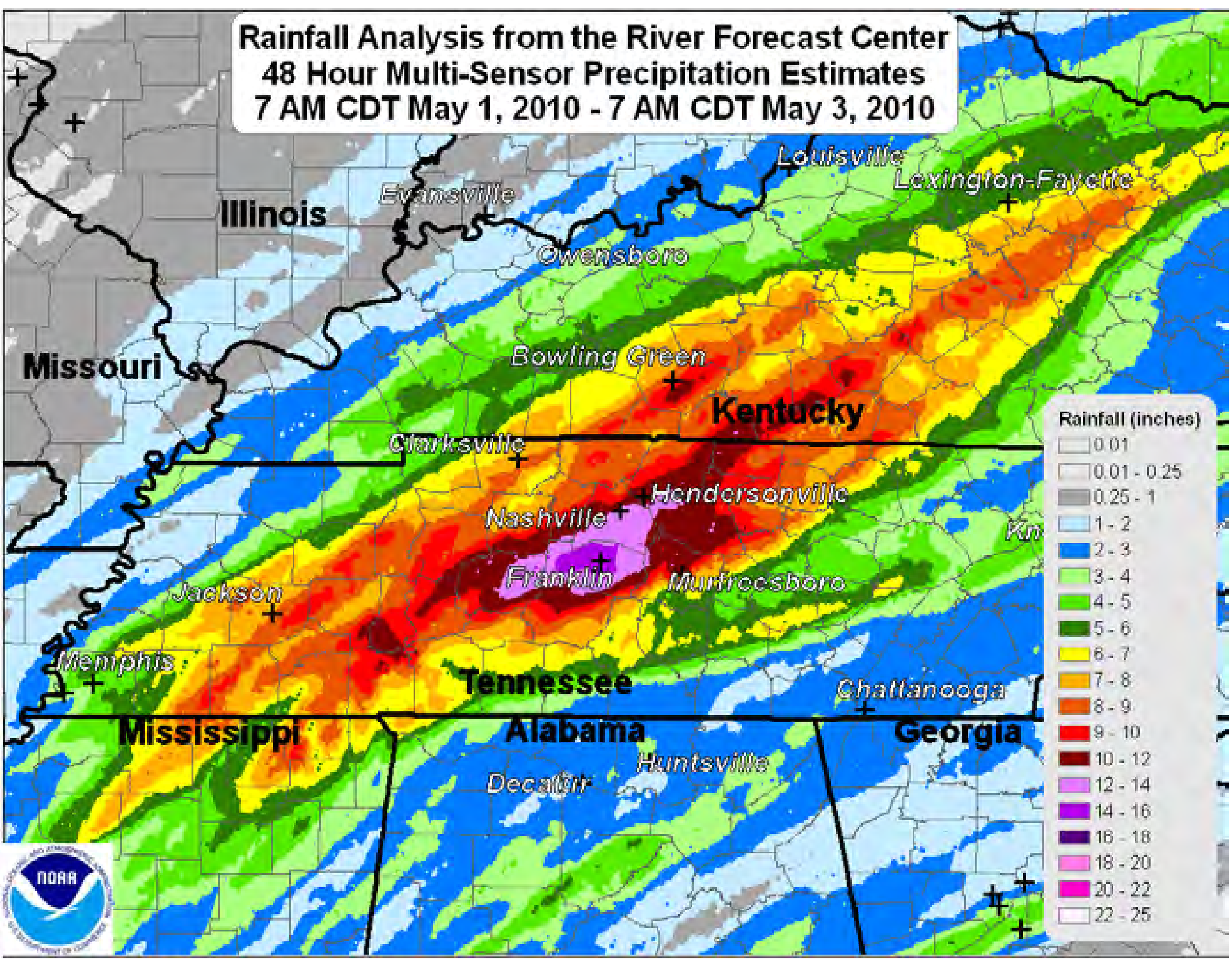


FIGURE 6 High-intensity rain and its impact area as seen on a map of western and central Tennessee, May 1–2, 2010 (NOAA 2010).

Smoky Mountains to the Mississippi River. FHWA decided to station staff at the State Emergency Operations Center, given the scope of the impacts, to help in reporting up to the U.S.DOT in Washington, D.C. (*Response to May 2010 Flooding* . . . 2010). During the event, TDOT kept maintenance crews and management tied in through regular conference calls.

By the end of May 2, Tennessee hit a new 2-day rainfall record of 13.57 in. (*Record Floods of Greater Nashville* . . . 2010). Rain gauges in several areas recorded 20 in. for that 2-day period (*Record Floods of Greater Nashville* . . . 2010; see Figure 6). By this time, a 65-mile stretch of I-40 was closed because of high water. The initial detour routes for I-40 were inundated as well. TDOT discussed detour plans with Kentucky and Alabama for 2 days, anticipating use of alternate interstates I-24 or I-65.

On Monday, May 3, the weather was clear, but flood waters would still rise for the next day or so. TDOT removed IT equipment from at-risk locations. On May 3, to assist in the evaluation of structures when waters receded, TDOT brought in inspection crews from the agency's two unaffected regions in the east (*Response to May 2010 Flooding* . . . 2010). Using these and other headquarters resources, TDOT headquarters formed five additional assessment teams. These teams would assist the regions in performing damage assessments as part of the FHWA Emergency Relief (ER) process ("TDOT Awards Emergency Contracts for Flood Repair" 2010). Each team reported to an Incident Commander/Regional Maintenance Supervisor (*Response to May 2010 Flooding* . . . 2010). TDOT also embedded its staff with FEMA field crews. These organizational efforts took place during flooding and required some managers to work remotely. According to the TDOT interviewee, one regional maintenance director was rescued from his home by inspection crews before he could join the effort. A TDOT maintenance engineer lost his own house but kept working. As the flood waters receded, TDOT was responsible for opening the roads. This responsibility included removing debris, including lost and deserted vehicles no longer drivable (see Figure 7).

TDOT chose a Regional Maintenance Engineer in the affected region to be the Incident Manager, given that individual's experience with ICS under a 2008 tornado event in Tennessee. To ready the assessment teams, TDOT used a simple diagram of the Incident Command System to train or refresh previous instruction, relying on standard forms—for example, FEMA Form 201—to brief participants. TDOT also ensured that each team had a designated person at the Incident Management Office tasked with ensuring that the needed documentation for each assessment was completed. TDOT used teleconferences to maintain situational awareness among management and the public information officer (*Response to May 2010 Flooding* . . . 2010).

FIGURE 7 Trucks backed up on I-40 in Tennessee due to flash flooding, May 2012 (prior use by TRB in *Research Circular E-C152*, 2011).

TDOT worked in consultation with FHWA to draft, let, and award on-call contracts to assist regional maintenance crews in repairing roadways damaged by the flood (*Response to May 2010 Flooding* . . . 2010). There was urgency to the assessments because the sooner localities knew whether FHWA would approve the ER, the sooner they could approach FEMA (*Response to May 2010 Flooding* . . . 2010). TDOT quickly coordinated its divisions—Environment, Structures, Design, Public Information, Construction, and Maintenance—to work with FHWA and to ensure projects got under contract quickly (*Response to May 2010 Flooding* . . . 2010). Also, TDOT was quick to begin working with counties to assist them in their own damage assessment ("TDOT Awards Emergency Contracts for Flood Repair" 2010).

On May 4, TDOT sent to FHWA a letter of intent to request ER funds (Degges 2010). By May 5, TDOT was ready to let contracts covering the needed recovery projects. Later on, contracts were let for more specific projects (*Response to May 2010 Flooding* . . . 2010). According to the TDOT Commissioner, when interviewed on that date, "With the contracts approved, we can begin to fully implement repairs just as soon as the inspection process has been completed" ("TDOT Awards Emergency Contracts for Flood Repair" 2010).

FHWA ultimately funded $39 million in Emergency Repair projects (Degges 2010), including $1.8 million that went to localities ("Portion of State Route 7 Damaged . . ." 2011). Through FEMA's cost share program, a total of $178 million for local, state, and federal funds was used on 5,600 recovery projects, of which more than $75 million went to repair bridges, roads, and public buildings ("Fact Sheet, One Year Later . . ." 2011).

State DOT Activities

Operations and Maintenance

Like many states, Tennessee utilizes an all-hazards approach and has disaster planning in place. Its disaster planning includes earthquake drills, given the state's location in the New Madrid seismic zone. In addition to this preparation, TDOT also drew from actual disaster responses, such as a 2008 tornado and more recent winter ice storms. According to an interviewee, for the 2008 tornado event TDOT had regional maintenance directors take over response and recovery modes. Therefore, in the case of the 2010 flash floods, TDOT leveraged the known experience of key staff in order to quickly stand up ICS internally.

According to an interviewee, prior professional relationships also facilitated trust and confidence in designating leads. Similarly, management could anticipate which staff did not have sufficient training. As a result, TDOT ensured ICS materials were on hand and used to train staff in the approach. Management called in staff from less-affected regions. Because each unit has a small travel budget, there was flexibility that permitted inspection crews from eastern regions to stay and support their colleagues for a week. Management also provided hands-on leadership early, which sharpened focus and impressed upon managers the significance of the event. For example, when a staff person stated on May 2—a Sunday—that "the TV says only to go out if it is an emergency," a TDOT manager clarified that the situation was an emergency that required the worker to leave his house and help prepare for the flood. Management also encouraged their crews to "think upstream" with respect to traffic flow and to close off ramps a distance before the most affected areas in order to prevent worse pileups on roadways.

Even with limited ICS training, TDOT staff knew to "take the lead on their stuff" in the highway right-of-way. They were aware that they had to seek clearance from management to go beyond their scope to support others (such as first responders). An interviewee provided an illustration of this defined role when describing the TDOT response to the storm's many tornadoes. He stated that during a tornado, staff would be expected to focus on transportation-related problems, as with any other event. Despite the wreckage they create, tornadoes typically do not present as large a problem for a state DOT as a flood does, because tornadoes will cut across a roadway at a single narrow point. In the event that they cut through a denser set of roadways, that situation is typically in a city, which brings its own resources to bear. The primary focus of TDOT in a tornado situation is to ensure workers know to shelter in place or know the detour from the tornado's path may have flooding issues. The focus is on conditions within the highway right-of-way and public safety there. In the interviewee's view, "all emergencies are local" and first responders lead on emergencies at the local level.

TDOT, with its regional and headquarters staff, developed a post-action report to determine lessons learned, such as what worked and what would need improvement during disaster operations (*Response to May 2010 Flooding* . . . 2010). This exercise included FHWA staff. Some key recommendations included refinement of the Continuity of Operations Plan to outline how critical duties would be performed during these events; creation of an operations center within the headquarters building to facilitate the rapid decision-making process required during emergency operations (especially those occurring in off-hours); designation of an assessment team prior to an emergency event and within each region and headquarters; and proper training (including ICS training) and equipment for future events (*Response to May 2010 Flooding* . . . 2010). The TDOT interviewee viewed this exercise as an effective practice.

Design and Construction

During the 2010 flood recovery period, TDOT expedited critical decisions on which activities would be done by in-house experts versus emergency contractors. Also, TDOT's decision to include design professionals on assessment teams and to include FHWA in the response effort from the start yielded important, timely collaboration on design issues. One example regards TDOT's handling of a heavily damaged road at Route 7 in Maury. TDOT determined that constructing a bridge over the damaged road would be more cost-effective than reconstructing the road and its environs. This solution was not straightforward, however, because it involved buying a right-of-way. Because reimbursement for reconstruction would be available at a higher percentage the sooner rebuilding began, TDOT had to make a judgment call early into the recovery period on whether to rebuild the road or construct the bridge. Ultimately, the future resiliency of the bridge won out over a road rebuild. TDOT's coordination with FHWA facilitated decision making on this "betterment" project.

As noted, TDOT was quick to use on-call contracts, for example, leveraging existing maintenance contracts. The Construction division, in particular, reacted quickly to the event despite the many compliance issues it needed to consider. The division approved letting 11 on-call contracts, one for each district, by May 5 ("TDOT Awards Emergency Contracts for Flood Repair" 2010), just a few days after the event. Information on the contract scope and details on procurement were posted on a dedicated website to provide access and transparency on the government's recovery efforts. TDOT determined where services went beyond the scope of on-call contracts (*Response to May 2010 Flooding* . . . 2010) and developed new contractual arrangements, such as for geotechnical engineers, and planners. Since the 2010 flood, TDOT is looking into developing contract specifications and proposal documentation for emergency management situations so TDOT might be able to take them right "off the shelf"—ready to go (*Response to May 2010 Flooding* . . . 2010). TDOT's proposed approach is expected to help implement emergency contracting authority more quickly during similar events.

Planning and Related Activities

As a consequence of the 2010 flood, TDOT created an Emergency Management Steering Committee under the Assistant Chief of Operations. The steering committee was designed to address cross-functional issues surrounding the department's various roles in emergencies and included the Directors of Human Resources, Community Relations, Central Services, Maintenance, and representatives from each region. This effort has spurred better coordination: instead of disbanding, the Steering Committee continues to meet nearly 2 years later.

The TDOT interviewee states that after the 2010 flooding event, he initiated a dialogue with a research group, the I-95 Coalition, in order to secure instruction for TDOT managers on using GIS for freight rerouting.

Communications

During the 2010 flood event, communications were centralized under the state emergency operations center so that formal communications to the public were consistent. The TDOT interviewee reported that at this level, the main message concerned search and rescue and the death toll, rather than the road closures. According to the interviewee, with the exception of interstate detours decision making, road closures were largely a local issue managed by TDOT and law enforcement at the local level.

TDOT lost the public website the during the intense rainstorm. Soon, however, it had a traffic map available on a website to get information out to the public. A recent upgrade to TDOT's 511 system also enhanced the delivery of information to the public. In 2009 TDOT upgraded its 511 system to include an automated voice response system that allows travelers to name any location in Tennessee and receive information about incidents involving lane closures ("Telvent SmartMobility Interactive Voice Response" n.d.). Designed to handle 60 calls simultaneously, up to 85,000 in a month, the system contributed to storm response ("Telvent SmartMobility Interactive Voice Response" n.d.). At peak, the system processed 45,000 calls in a day, with nearly 180 simultaneous calls, and 180,000 for the month of May ("Telvent SmartMobility Interactive Voice Response" n.d.).

Interagency Coordination

As noted, TDOT embedded staff in FEMA crews and included FHWA in meetings early on. TDOT reported that during the 2010 flood recovery period, it also sought to better understand the relationship between FHWA and FEMA decision making. TDOT observed that FEMA often waited for FHWA to render a decision before picking up a reimbursement issue (*Response to May 2010 Flooding* . . . 2010). TDOT sees opportunity for more collaboration to make stakeholders' interactions with both agencies more efficient. It is supplying more training to its staff on the assessment processes that support later claims for federal reimbursement. Such training was recommended after the 2010 event by the new TDOT Emergency Management Steering Committee (*Response to May 2010 Flooding* . . . 2010).

Data and Knowledge Management

TDOT developed an After Action Report with diverse participants after the 2010 flood event. A key recommendation was the formation of the Emergency Management Steering Committee mentioned earlier in this case example. Both support Knowledge Management, including information sharing.

The 2010 flood event highlighted to TDOT the utility of having diverse data sets. During the flood in 2010, TDOT used its own aerial photography and GoogleEarth topological maps to try to predict the elevation of facilities under threat of flooding. The results were mixed. Even with the collected data, the topographical information available was still imprecise. For example, the TDOT interviewee noted that there remained so much concern over the possible fate of a milling machine that TDOT staff considered building a kind of moat around the facility in which it was housed. In response, by 2011, the state had secured LIDAR maps, which have improved the precision of the spatial information and allowed better decision making. Data are now better for the areas TDOT anticipates as potential trouble spots in known vulnerable areas. Based on prior experiences during floods, TDOT is engaged in optimizing the data resources it has; it is currently determining how its LIDAR results can integrate with the way the U.S. Army Corps of Engineers describes water levels.

Lessons Learned and Related Practices

The following summarizes key practices identified in this case example by mission-related and crosscutting functions.

Lessons Learned and Related Practices

Practices by mission-related functions

Operations:

- Including FHWA in state DOT headquarters team so it could keep U.S.DOT updated
- Assessing risks to department assets and communicating that employee safety was paramount
- Maintaining regularly scheduled conference calls
- Drawing on prior experience to "think upstream" (up from the affected area) in conducting road closures
- Leveraging the small travel budget in each region to bring in resources from less-affected regions to support timely assessments critical to federal reimbursement

- Placing a design professional on assessment teams
- Supplying brief ICS training during the event
- Refining Continuity of Operations plan to outline how critical duties will be performed during these types of events
- Giving consideration to creating an operations center within the headquarters building to facilitate rapid decisions, especially in off-hours
- Designating assessment teams prior to these events, in each region and at headquarters
- Conducting training—for example, ICS training—and equipping for future extreme weather events.

Maintenance:

- Managing tornadoes occurring during larger storm as (1) an employee safety issue and (2) a right-of-way debris removal issue.

Design:

- Leveraging the FHWA "betterment" option to build a more resilient replacement structure.

Construction:

- Accelerating the drafting and letting of contracts for repair work so that repairs could begin as soon as inspections were completed
- Ensuring all relevant units were working with FHWA as contracts and the formal letter of intent to request Emergency Relief funds were developed
- Giving consideration to developing "off-the-shelf" contractual terms for emergency situations
- Posting the contracts let under exigent circumstances on website for transparency.

Planning:

- Using associations such as I-95 Coalition to find ways to improve interstate coordination under an extreme weather event
- Supplying training in GIS for freight rerouting, using the resources of the I-95 Coalition.

Practices by crosscutting functions

Communications:

- Using 511 system, given public familiarity with it
- Developing public-facing traffic map for the website to deliver up-to-date information on closures
- Using new, enhanced 511 call-in system that permits travelers to name any location in the state and receive information on lane or road closures.

Interagency Coordination:

- Embedding of staff in FEMA field crews to enable better collaboration on the federal reimbursement process
- Including FHWA in ICS
- After the event and in response to a recommendation in the After Action Report, creating an Emergency Management Steering Committee to ensure a cross-functional approach to the state DOT's various roles in an emergency, including Human Resources, Community Relations, Central Services, Maintenance, and representation from regional agencies
- Providing additional training to staff on the assessment process to support federal reimbursement applications.

Data and Knowledge Management:

- In absence of preassigned staff, leveraging of personnel known to have ICS experience from a previous disaster to lead the operation, educating crews using standard ICS forms, and ensuring there is a dedicated person for each crew in the central office (UC)
- Developing an After Action Report that records effective practices, lessons learned, and new approaches going forward
- Upgrading geospatial data sets to include GoogleEarth, the state's aerial photography, and LIDAR maps
- Working with other agencies well ahead of extreme weather events to optimize each other's data sets and methods used.

CASE 4 : WASHINGTON—HIGH-INTENSITY RAIN (2007)

Introduction

The Washington State Department of Transportation (WSDOT) manages 18,600 miles of highway and 3,600 bridge structures ("Who We Are and What We Do" n.d.). Its 23 ferry vessels and 20 ferry terminals make up the largest ferry system in the nation ("Who We Are and What We Do" n.d.). It is responsible for supporting transportation-related emergency management activities in nearly 40, largely rural, counties.

During The Great Coastal Gale of December 1–3, 2007, a sequence of snow, wind, and rainstorms and a temperature swing from frigid to warm led to flooding that affected many communities in western Washington. In addition to general flooding, there were other dangerous impacts in several locations. A major sinkhole appeared in King County near Seattle. Hurricane strength winds hit the coast. A landslide closed a state road for a month. State and interstate highways saw $23 million in damage, while city and county roads experienced $39 million in damage (*Preparing for a Climate Change* . . . 2012).

Among the most severe impacts was flooding in the Chehalis River Basin. After 15 in. of rain in one 24-hour period, the Chehalis River Basin experienced a one-in-100-year flood that inundated and ultimately closed a 20-mile stretch of Interstate 5 (I-5), the major road connecting Portland, Oregon, to the Seattle area. This case example focuses on the 4-day closure of I-5, a major north–south corridor. The flooding led to delayed or rerouted freight and a lost economic output totaling $47 million (*Preparing for a Climate Change* . . . 2012).

Event Summary

On the morning of Friday, November 30, a large storm was forecast for western Washington state, and WSDOT staff at the headquarters and regional level studied projections

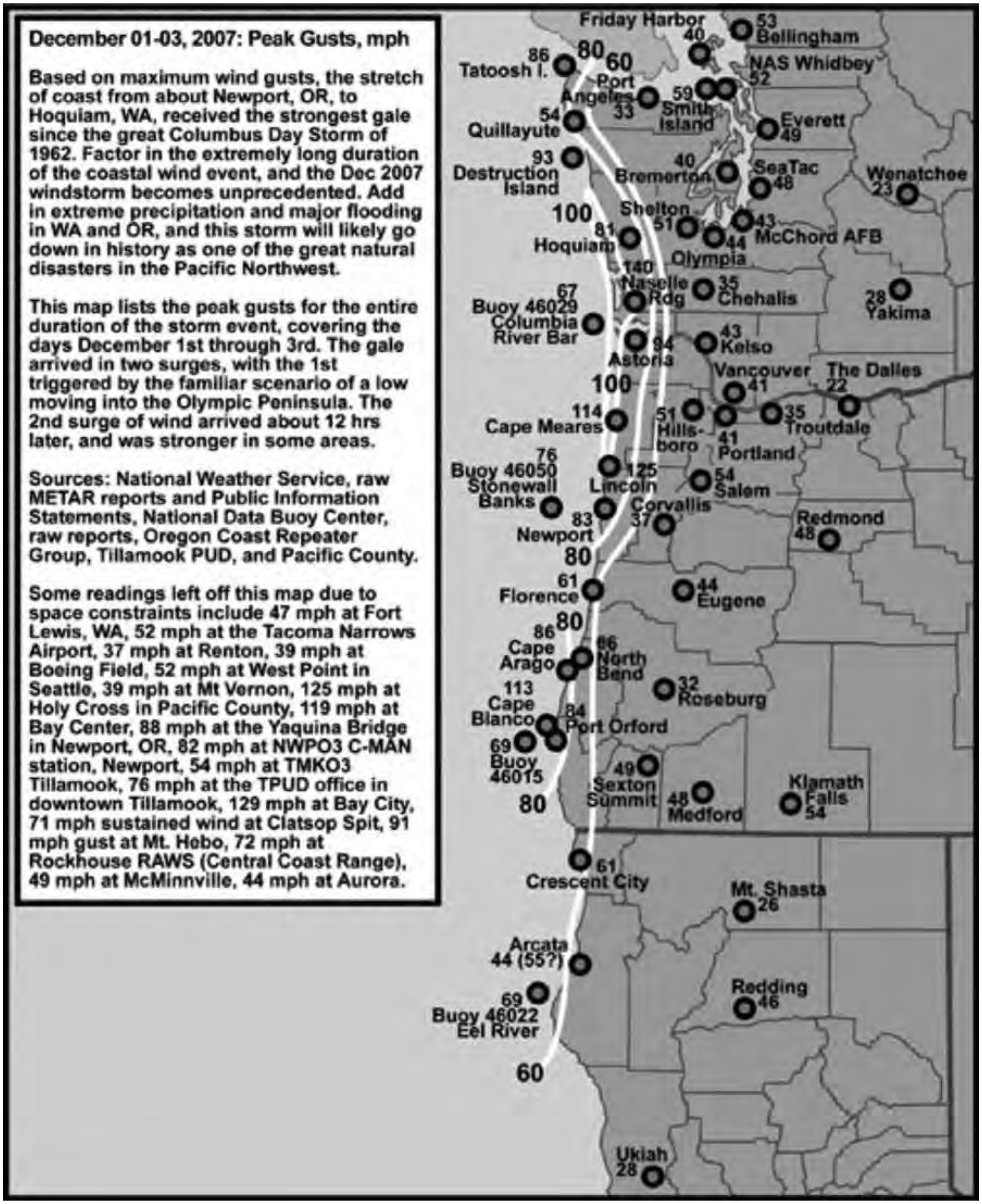


FIGURE 8 Regional view of The Great Coastal Gale of December 1–3, 2007, including wind speeds in Chehalis, which saw severe flooding caused, in part, by extreme temperature swings in nearby mountain areas that has just experienced snowstorms (Reed 2007).

and took several preparedness steps (WSDOT 2008). These actions included setting the times at which to activate the Emergency Operations Centers (EOCs) and developing staffing plans to ensure 24/7 operations would be available as long as necessary. They also engaged in a call with the NWS, which confirmed previous weather information and introduced the likelihood of heavy snowfall in the mountains; WSDOT then addressed this snowfall in planning. Communications staff prepared a plan that outlined risks, messaging, and communications tactics for the event.

On Saturday, December 1, heavy snow fell in the Cascades under Arctic conditions; then, 12 hours later, the temperature warmed to the 50s. The recent snow melted that Sunday and could not be absorbed by the saturated ground, creating conditions for a major flood. On the morning of Monday, December 3, WSDOT staff examined weather data from the NWS and commercial sources, and concluded that the storm arriving off the ocean would be substantial. Therefore, WSDOT continued preparedness efforts.

WSDOT began planning the closure of I-5 even before the storm hit. Typically, I-5 sees 10,000 commercial vehicles a day (WSDOT 2008); however, in 2007, there was no viable, well-defined detour. When the extreme weather hit in December 2007, WSDOT developed a detour for traffic from Portland to Seattle, which relied on interstates and added an estimated 440 miles and 7 hours to the typical I-5 trip between Portland and Seattle (WSDOT 2008). Shorter detours were identified but were to be for local traffic only. The preference was to hold commercial traffic, including freight, in safe, fixed locations until the projected flood waters subsided. Anticipating the need for assistance in enforcing the detour, WSDOT made a Request for Assistance through the state EOC for National Guard support. Communications staff refined their messaging in collaboration with executives and operations personnel, and WSDOT also planned to hand out maps to commercial vehicles at the rest areas before the I-5 detour.

On December 3, the storm, which was the remnant of a Western Pacific typhoon (WSDOT 2008), hit western Washington with high-intensity rain and powerful winds (see Figure 8). The Chehalis River reached flood stage by 4:00 p.m., December 3, and was a record 9 ft higher in less than 12 hours (WSDOT 2008). At headquarters, the WSDOT Security and Emergency Operations Manager, who in 2007 was just one year on the job, quickly activated the EOCs. He and others set up "an abbreviated" EOC in the office of the State Maintenance Engineer (WSDOT 2008) and worked through WSDOT's six maintenance regions to link to the field.

While keeping the safety of its crews and the public the priority, WSDOT began managing recovery during the response phase. The main priority of recovery was to reopen state highways. Through the efforts of WSDOT staff, some of whom spent overnight hours in the cabs of their trucks (WSDOT 2008), many roads were reopened soon after the storm was over, allowing emergency responders and utility crews to travel.

The same day, December 3, WSDOT implemented the planned closure of I-5 because of flooding, landslides, and downed trees and power lines (see Figure 9). When the waters crested on December 4, there were approximately 3 miles of I-5 under 10 ft of water ("Residents of Washington, Oregon Dig Out" 2007).

WSDOT engaged in recovery activities at the same time it was managing its response, seeking to safely open up I-5 to passenger and commercial vehicles. WSDOT assessed the viability of opening the interstate through use of a camera at the I-5 worksite and with other GIS support. I-5's closure

FIGURE 9 Location of the Interstate 5 inundation in the Chehalis River basin, between Olympia, Washington, and Portland, Oregon (WSDOT 2007).

increased calls from the public at WSDOT headquarters and two regional offices. Calls at headquarters were so heavy that three people were needed to answer them continually until just before the end of the closure. After more than 3 days of the I-5 closure, on the evening of December 6, WSDOT allowed certain commercial traffic through I-5. The interstate opened completely at noon on December 7.

State DOT Activities

Operations and Maintenance

During the 2007 storm event and flood response, WSDOT maintenance staff, as noted earlier, focused on reopening roads across the affected part of the state. There is an understanding that WSDOT "writes off" its costs in supporting rural areas, such as those affected so severely by the 2007 event. Maintenance staff logged their hours to a work order and focused on the activities needed to be done. Collaboration sites helped document activities. For example, to manage road closures and reopening tactics, road closure reports from the field went to the corresponding region's EOC. The EOCs used WebEOC to record and maintain the status of road and bridge closures and to document actions taken.

Later, as part of its emergency management approach, WSDOT developed an After Action Report, which is typically called for under the EM model. Through the process of summarizing the preparedness, response, and recovery activities it undertook, WSDOT identified and defined the lessons learned from its operations and other activities during the event (WSDOT 2008). One finding was that the three to four people devoted to WSDOT emergency management were not enough (WSDOT 2008).

Regarding the I-5 closure in particular, lessons learned included the following (WSDOT 2008):

- Engaging air assets provided helpful information on the scope of the flooding.
- Use of the National Guard was effective, but the chain of command needs clarity from the start.
- Information sharing through SharePoint, WebEOC, and conference calls enabled a quicker, more coordinated response.
- GIS support for the event in headquarters helped to create a visual scope of the incident.

A lesson learned relating to the I-5 closure was detailed by the WSDOT interviewee. He noted that the issues and techniques associated with addressing freight traffic were sometimes very different from those relating to passenger traffic. In the case of the December 2007 storms, the impact of shutting down freight traffic on the I-5 was far reaching: Gas stations lost fuel and the supply chain to nearly all of Alaska was under threat of a shutdown, for example (see Figure 10). To aid the situation, WSDOT established State Road 7 as a detour for commercial and passenger vehicles, but the local roads could not handle a large amount of traffic, so WSDOT did not post it as a detour. Passenger vehicles alone had another alternative route, State Road 12, but it was at risk for flooding (WSDOT 2008).

FIGURE 10 Flooding on Interstate 5 in Chehalis, Washington, December 4, 2007 (Flickr Commons, WSDOT).

To enforce the I-5 detour, WSDOT planned 24/7 traffic control points at a southerly junction in Morton, Washington, and one near Eatonville, Washington, farther to the north. Exits could become entry points, so exits were manned 24/7 as well (see Figure 11). Commercial and other traffic that did not take the 400-mile I-5 detour stayed at either Morton or Eatonville, with the Morton site in the south having to manage a substantial amount of activity and traveler needs. WSDOT appreciated having armed members of the National Guard for a simple show of authority; however, WSDOT soon learned that certain freight simply had to get through by means of the non-interstate detours. WSDOT developed a list of criteria (WSDOT 2008) to decide which commercial vehicles could go through. These criteria were the following:

- Loads related to disaster relief in affected communities
- Supplies for hospitals, medical centers, and pharmacies
- Perishable loads that would not survive the longer detour
- Food and other goods destined for grocery stores, schools, and institutions
- Supplies of fuel
- Local deliveries to certain counties.

Shipments to ports, with the exception of commodities listed earlier, were specifically excluded.

From this experience in 2007, the WSDOT interviewee reports, WSDOT has since created a Commercial Vehicle Path System with a section on freight and handling detours through rural routes. Tools include a mobile message board, cameras, and pre-signage. Under this system, a trucking company seeking to move through a restricted area applies for a pass depending on its level of priority: A, B, or C. The WSDOT, National Guard, and local law enforcement at the traffic control point are to ensure only certain freight haulers go through. It was an internal WSDOT decision to develop the Commercial Vehicle Path System, and it is designed to work anywhere in the state, not just in the I-5 corridor.

Another change in Operations since 2007 has been WSDOT's expansion to include a wholly new function. WSDOT added an Aviation Division to support disaster relief, including both search and rescue and remote sensing of images for decision support. The WSDOT interviewee reports that this new division has conducted 300 rescues since its inception, accomplished through coordination of a multiagency force. WSDOT considers this a significant change that it has managed since the 2007 floods.

Design and Construction

The major detours required in the 2007 Chehalis River Basin flood underscored that detours implicate long-term design issues. When more projects are moved onto side roads, more assessments are needed of slope stability and the robustness of the road surface. In the absence of such

FIGURE 11 Aerial view of inundated Interstate 5, showing the freeway overpass in center of photo, Chehalis, Washington, December 4, 2007 (Flickr Commons, WSDOT).

assessments, there is a strong disincentive to send traffic to unprepared roads, because WSDOT has to pay for damages to local roads.

Policy makers moved quickly after the December 2007 event to address the flooding issue in particular. By early 2008, the legislature had called for $50 million to be appropriated to WSDOT for a flood-control project (*Flood in the Chehalis River Basin* 2008). The risk of flooding also has moved several projects up in priority within the state budget. WSDOT reports it is trying to get out the message that doing mitigation work now will help later. Separately, the Washington State government has used the Chehalis River Basin flooding in 2007 to illustrate risks to infrastructure from climate changes (*Preparing for a Changing Climate* 2012).

Planning and Related Activities

WSDOT's Emergency and Security Operations Manager states that the 2007 flood was a triggering event in the development of WSDOT's emergency management program. At the time of the 2007 flood, the emergency management arm of WSDOT had a staff of three to four people. As noted elsewhere in this case example, WSDOT identified low staffing in the headquarters of EOC as a barrier to its ability to ensure all actions were accomplished. Six years later, WSDOT has an Emergency Operations Center with 45 staffers. WSDOT staff engaged in the FHWA-funded climate-change vulnerability study that has identified at-risk areas of the state, and this information supports planning activities.

Communications

With respect to external communications, WSDOT believed conducting communications planning in advance helped get the right messages to the public during the December 2007 event (WSDOT 2008). External communications relied, in turn, on strong internal communications, and WSDOT believed having conference calls at the same time each day was important, as did coordinating the timing of calls around maintenance calls. WSDOT "communicators" stationed at the regional operation center took the information delivered internally and created and distributed WSDOT Highway Alerts (WSDOT 2008).

WSDOT communicators also used press releases to direct the media (and through the media, the public) to the state's 511 dial up or web information system. In summary, WSDOT communicators in each office did the following:

- Responded to media calls for updates
- Facilitated media interviews with key WSDOT personnel
- Updated WSDOT's traffic web pages
- Posted closure information on web pages
- Updated Highway Advisory Radio messages
- Crafted alert messages for the 511 Traveler Information System
- Monitored media coverage of the storm.

As a result of this broad plan of action for communications, the WSDOT status of roads and bridges was in nearly every news story and broadcast (WSDOT 2008). The Road and Bridge Closure List was in the "news ticker" at the bottom of every television station's screen. WSDOT's website was also a resource to the public (WSDOT 2008). For example, although there were an average of 4 million page views per day in November, there were 11,084,998 views on December 3, at the height of the storm (WSDOT 2008).

The WSDOT After Action Report describes how the agency also took phone calls directly from the general public. This task, unfortunately, overwhelmed the staff's ability to address questions, especially when the website and 511 reporting system crashed or they did not have up-to-date closure reports. As a result of the AAR process, a key recommendation within WSDOT was to create a call center during these types of events and to have a phone system that allows for easy and rapid transfer of calls. Another issue that surfaced was ensuring up-to-date information for those on the front lines answering calls.

With respect to the I-5 closure specifically, WSDOT reports innovative communications strategies to manage the situation in 2007 (WSDOT 2008), including the following:

- Direct mail postcards to truckers about the closure
- Portable cameras at the I-5 closure point
- Listserv messages
- Graphic communications for non-English-speaking public
- Having a front-line spokesperson providing information on the larger picture
- Use of Incident Response Team truck signs while cruising up and down the truck holding area
- Getting photos to tell stories and posting them on Flickr, an online photo-sharing site.

WSDOT reports that it has developed freight alerts since 2007. Individuals can sign up to receive an e-mail on the status of closures and other activities affecting freight, and 30,000 people have signed up so far. The alert system has been an effective practice for enhancing communications within this distinct and important sector.

Interagency Coordination

As noted earlier, WSDOT engaged with NWS early and directly, thereby securing up-to-date and actionable information rather than simply relying on general NWS reports.

Another important area of interagency coordination was the interaction with the National Guard at the I-5 closure. WSDOT staff expended considerable time managing the I-5 detour for several reasons, which follow (WSDOT 2008). First, after I-5 closed, there were many truckers holding in the town of Morton, where the detour began in the south. The situation required attention as the truckers engaged with local authorities. Second, the National Guard members did not understand that they were to report to WSDOT staff. Communications were hindered further by lack of equipment interoperability between WSDOT and the National Guard. Third, it became clear that some classes of commercial vehicles needed to use the State Road 7 detour. As a result, WSDOT had to develop criteria and render decisions on which commercial traffic could go through checkpoints manned, in part, by the National Guard. These guidelines, detailed elsewhere in this case example, were implemented by WSDOT's traffic-control points in the north and south, with the help of local law enforcement and the National Guard.

Data and Knowledge Management

During the event, WSDOT used SharePoint, WebEOC, as well as teleconferences to coordinate information. WSDOT engaged in the AAR exercise noted earlier and had all regions supply input. WSDOT had those regions not directly affected by the storm (or the I-5 closure) submit reports as well, creating an enterprise view of an event (WSDOT 2008). As part of the AAR process, WSDOT concluded that during a disaster situation, better information needs to be collected. For example, the AAR suggested that the roads report link on the WSDOT website should have had all state roads listed. Also, from a layperson's perspective, more site-specific information is needed to describe a road; for example, it is not sufficient to simply name the milepost (WSDOT 2008). A milepost number is not immediately useful to most motorists, who require landmarks or other evidence of where it is actually located.

Also, since 2007, WSDOT has expanded the use of GIS among its maintenance crews. WSDOT is also now supplying its maintenance staff with handheld GPS so they can enter the exact coordinates of mitigation activities for a database; therefore, the agency will not have to rely on institutional knowledge. Also, there are GPS units in 50% of the WSDOT fleet so that WSDOT can track where resources are at any time and especially during an emergency.

With respect to the I-5 closure in particular, when the event was over, WSDOT sought to collect and synthesize relevant information on the Chehalis River Basin flood issues (*Flooding in the Chehalis River Basin* 2008). More information would support more effective transportation planning and perhaps prevent the shutdown of I-5. As a result, the WSDOT Environmental and Engineering Programs Director, the Southwest Region Administrator, and the Deputy State Design Engineer all submitted requests for a Transportation Synthesis Report from the Washington State Transportation Center, a cooperative transportation research partnership whose members include University of Washington, Washington State University, and WSDOT (*Flooding in the Chehalis River Basin* 2008). The resulting synthesis document provided a timeline of Chehalis Basin studies and flood, and a list of official publications, including those developed after two other "once-in-100-year floods" that occurred in 1990 and 1996. These documents describe a long history of WSDOT, the U.S. Army Corps of Engineers, and other agencies grappling with the flood risk. At about the same time, the Washington legislature, as noted earlier, called for $50 million to be appropriated to WSDOT for a flood-control project in the basin, based on their understanding of the problem and the capabilities of WSDOT to address it (*Flooding in the Chehalis River Basin* 2008).

Lessons Learned and Related Practices

The following summarizing key practices identified in this case example by mission-related and crosscutting functions.

Practices by Mission-Related Functions

Operations:

- Setting times to activate emergency operations and developing a staffing plan for 24/7 operations
- Engaging air assets to provide helpful information on the scope of the flood
- Utilizing real-time geospatial information at the site of the flooding to create a visual scope of impacts
- Taking road closure reports from the field for recording in WebEOC
- Detour planning to address needs of local traffic, with guidance on allowing exceptions that serve local communities, such as
  - Loads related to disaster relief in affected communities
  - Supplies for hospitals, medical centers, and pharmacies
  - Perishable loads that would not survive the longer detour
  - Food and other goods destined for grocery stores, schools, and institutions
  - Supplies of fuel
  - Local deliveries to certain counties
  - Shipments to ports, but only for above items.
- Addressing freight as a distinct issue in a detour, including developing procedures for implementing access for certain freight haulers through a permit system; using tools such as pre-signage, cameras, and messaging boards; enforcing restrictions in collaboration with local law enforcement or the National Guard; and communicating relevant information through "freight alert" e-mails to people who have signed up to receive such alerts

- Developing a Commercial Vehicle Path System so that a statewide process is in place for diverting commercial traffic for future extreme weather events.

Maintenance:

- Beginning the recovery phase during the response phase, with the priority to get transportation moving again
- Maintaining flexibility in determining what to ask from localities in the way of reimbursement for state DOT services provided during extreme weather events.

Design:

- Considering the impacts of increased detours on secondary roads—for example, slope stability—and considering these in design of roads and in design of detours.

Construction:

- Not available.

Planning:

- Linking to and supporting information transfer to climate-change vulnerability assessments and related planning efforts
- Preparation for growth in program and responsibilities, given increased awareness of extreme weather.

Practices by Crosscutting Functions

Communications:

- Stationing "communicators" at regional emergency operations centers to allow for efficient knowledge transfer and approvals through such activities as
  - Responding to media calls for updates
  - Facilitating media interviews with key personnel
  - Updating traffic web pages
  - Posting closure information on web pages
  - Updating Highway Advisory Radio messages
  - Crafting alert messages for the 511 Traveler Information System
  - Monitoring media coverage of the storm.
- Maintaining a set of metrics for website activity to substantiate site utility and level of interest from the public
- Developing a detour and the methods for enforcing closures and maintaining flow of through-traffic; addressing entry points, including exits; and notifying the public and key sectors through the following communication tools:
  - Direct mail postcards to truckers about the closure
  - Portable cameras at the I-5 closure point
  - Listserv messages
  - Graphic communications for non-English-speaking public
  - Having a front-line spokesperson providing information on larger picture
  - Use of Incident Response Team truck signs while cruising up and down the truck holding area
  - Getting photos to tell stories and posting them on Flickr, an online photo-sharing site.

Interagency Coordination:

- Engaging in direct calls with NWS before the weather event hits
- Convening a conference call at regular times, coordinated around other standing meetings with common attendees, such as maintenance calls
- Ensuring the National Guard leaders and troops are aware of the chain of command on the ground before their use at a detour requiring their show of authority
- Coordinating on the potential mismatch of communication devices on the ground.

Data and Knowledge Management:

- Sharing information through SharePoint, WebEOC, and conference calls enabling a quick response
- Developing an After Action Report to assess the agency response, with contributions from all regions, not just those affected
- Using state academic resources to research information on key issues related to impacts from extreme weather events of concern (e.g. flooding) and developing synthesis of the body of knowledge
- Increasing use of GIS—for example, so that 50% of the state DOT fleet has GIS in its vehicles so they can be located during an extreme weather event.

CASE 5 : VERMONT—TROPICAL STORM IRENE AND RIVERINE FLOODING (2011)

Introduction

The Vermont Agency of Transportation (VTrans) is responsible for building and maintaining more than 14,000 miles of roadway (*VTrans 2012 Fact Book* 2012). VTrans also oversees 451 miles of state-owned railway and 10 state-owned airports (*VTrans 2012 Fact Book* 2012).

On August 28, 2011, Tropical Storm Irene hit Vermont with strong winds and heavy rain. Because the ground was already saturated from previous rains, run-off in streams and rivers led to extensive flooding across the middle and southern parts of the state, and lives were lost. More than 220 of the state's 251 towns and villages sustained damage (*Lessons Learned from Irene. . .* 2012). More than 500 miles of highway and 200 state-owned bridges sustained damage (*Irene Recovery Report: A Stronger Future* 2012), leading to closures including the shutdown of the state's primary east–west highway (see Figure 12). More than 200 miles of state-owned railway were impassible, and six rail bridges were badly damaged (*Irene Recovery Report: A Stronger Future* 2012). The enormity of the flooding and its impacts overwhelmed preparedness efforts, and ultimately recovery is expected to cost $175 to $250 million (*Lessons Learned from Irene. . .* 2012).

This case example describes the state's approach to managing the unforeseen scope of this event and instituting new practices to address similar hazards in the future.

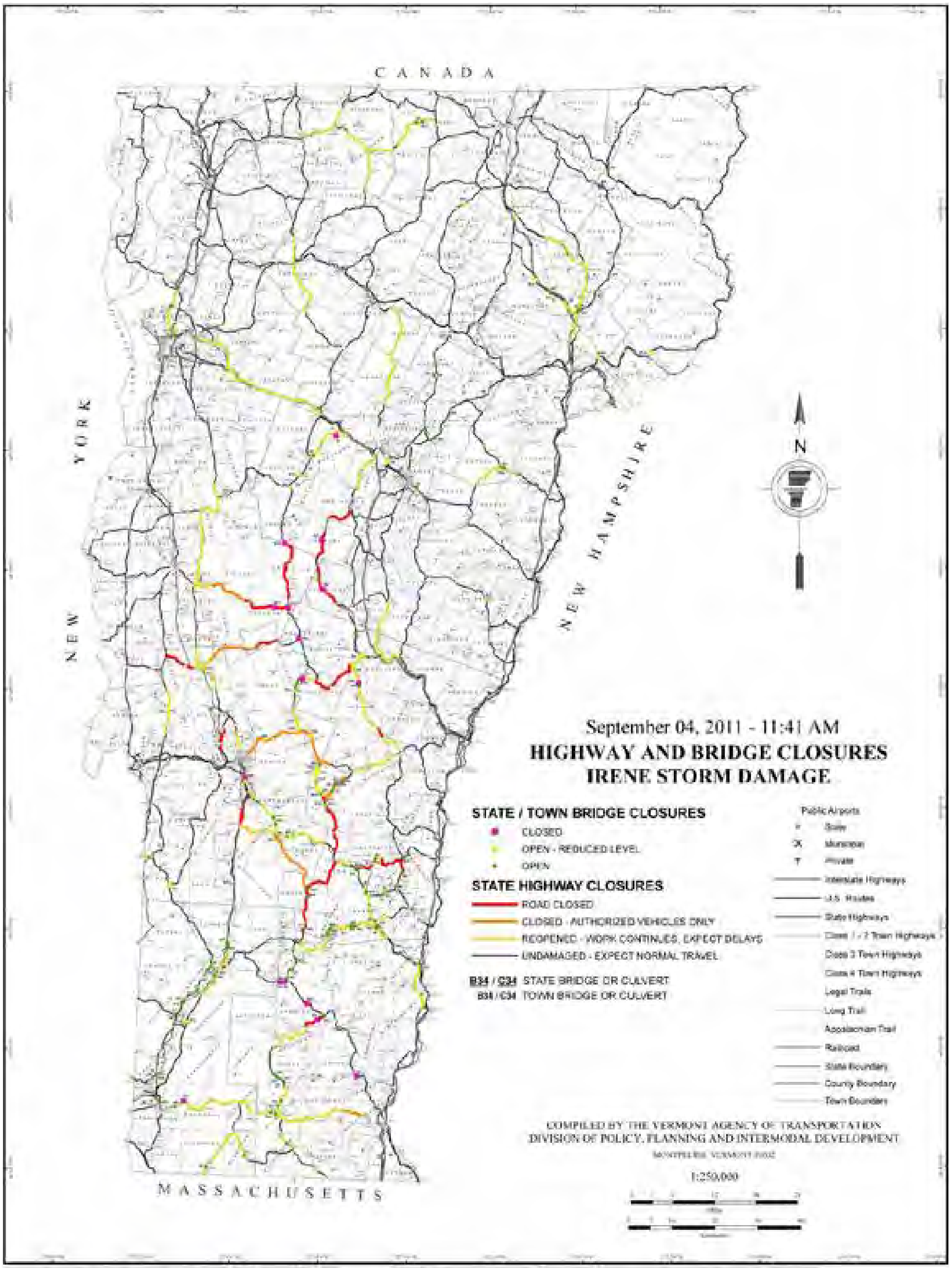


FIGURE 12 Vermont highway and bridge closures after flooding caused by Tropical Storm Irene (2011).

Event Summary

In late August 2011, states in the eastern United States tracked Hurricane Irene as it moved through the Caribbean and toward the East Coast. In Vermont at that time, as a result of prior storm events, soil moisture ranked well into the 90th percentile compared with long-term averages (Lubchenco and Furgione 2012), which created conditions for rapid runoff and uprooting of trees. VTrans interviewees report that the agency studied NWS projections and prepared for flash flooding. VTrans expected impacts across a large part of the state and prepared equipment and resources. With respect to evacuation, authorities reported to the media that the tall mountains of Vermont can confound preparedness efforts because no one can predict down which side of a mountain any expected rainfall will flow (Reston 2011). Before Irene's arrival, the NWS worked directly with the Governor's office (Lubchenco and Furgione 2012). On August 27, the Governor proactively declared a state of emergency, and the Vermont state government initiated emergency management procedures (Lubchenco and Furgione 2012).

By August 28, Irene had lost its tropical characteristics (Lubchenco and Furgione 2012), in that it remained a strong storm but its core was no longer thrusting it forward. A strong storm, when pushing up against high mountains, such as those in Vermont, creates an uplift wherein air is forced to rise against the mountains; as a result, as NOAA states, "tropical moisture is wrung out much like a sponge, bringing even more rainfall" (Lubchenco and Furgione 2012).

Beginning in the early morning of August 28, the "downgraded" Irene sent a foot of torrential rain to the already saturated Vermont landscape. Rivers forged new courses, and 11 communities were cut off from the transportation network entirely (ReGeneration Resources 2012). The NWS' Burlington, Vermont, field office had its fiber-optic cable severed by the storm and came close to transferring its forecast operations to another office in either Maine or New York (Lubchenco and Furgione 2012). As noted previously, more than 500 miles of highway sustained damage, leading to widespread closures (*VTrans 2012 Fact Book* 2012).

For half a day, the VTrans Operations Division Director sought to establish the facts and conditions that the state would address. Although radio contact was available with eight of the nine maintenance districts, there was initial difficulty in establishing contact with some employees. Some crews spent the night in their trucks, and one employee hiked 5 miles through the woods to get to a location where he could contact his supervisor. Meanwhile, anecdotal reports of the storm's severity made their way to the state's Secretary of Transportation, who, in turn, reached out to VTrans staff for information.

At about this time, the Director of the Program Development Division—which handles Design, Construction, Environmental Permitting, and other program areas—reached out to the Operations Director. He had previous experience with an Incident Command System (ICS), and he provided a helpful analysis from that perspective. Working with that approach, the two directors together came up with ICS architecture for VTrans, which had not used this approach with prior weather events. The two framed the ongoing impacts from Irene and VTrans' response in ICS terms. It was a "span of control" problem: Simply put, the event was at a scale never experienced, expected, or planned for at VTrans, and the personnel it needed were too many and too scattered to provide a meaningful foundation for delivery of services.

The State Emergency Operations Center, which normally houses representatives from relevant agencies in a coordinated disaster response, had flooded and evacuated early in the emergency. It would later regroup at the FEMA Joint Field Office.

Unlike other state agencies, VTrans does not have a statewide 24/7 Transportation Management Center, so it was important that VTrans took an extra step and stood up an ICS, with a Unified Command (UC) at Montpelier, the capital. The UC deployed volunteers from across the agency for staffing Incident Command Centers (ICCs) at Rutland, Dummerston, and Berlin.

One VTRANS interviewee understood at the time that ICC personnel may have to be changed out quickly as more facts about impacts and needs were received. He accepted that it may be disruptive; he also anticipated that people in some locations might resist the ICS approach. VTrans developed a 30-to-60-minute presentation on ICS that it could present "on a moment's notice" in order to familiarize community leaders with ICS and its purpose. VTrans also outlined a fixed set of primary objectives in storm response and recovery (TS Irene . . . n.d.) that interviewees believed proved very useful to maintaining focus:

- Establish emergency access to cut-off/isolated towns and locations within communities.
- Establish access for utility companies to restore power to areas that are still cut off.
- Establish mobility (public access) to towns that currently have emergency access only.
- Establish mobility along east–west corridors (to include truck traffic/commerce).
- Inspect all bridges of concern.
- Prepare state roads for winter operations.

Irene entered the state in the summertime; in a few months, VTrans would be making final preparations over the equipment and material stockpiles needed for winter snows and related maintenance requirements. The same equipment was used to respond to Irene and as a result was subjected to the storm's flash flooding and was pounded by rocks when hauling road-building materials in the storm's aftermath.. Also, Vermont businesses were planning for two key tourist seasons: fall leaf-peeping and winter skiing. Transportation is key to these activities, yet, one by one, the storm's impacts forced local authorities to close roads and bridges. Additionally, the VTrans 511 transportation information system had been "brought to its knees." Interviewees emphasized that sticking to the six primary objectives was very important in response and recovery.

With the 511 system down, Google reached out to VTrans on August 30 to set up jointly a system for real-time mapping of closed roads, with public updates twice daily. By this time, the storm had passed and communities were stabilizing and assessing impacts. The service was widely used, with the 1-800-Vermont call center referring to this map when counseling travelers to the state, for example. At about the same time, the VTrans website began to list daily the release times for "Irene Storm Event Information." VTrans also used a mobile phone microsite to allow for easy access to information and used social media to communicate conditions. Media outlets followed VTrans Facebook and Twitter accounts; at one point, VTrans had five administrators updating the Facebook page. A 20-line call center and dedicated Irene e-mail address for inquiries were established as well. VTrans also began supporting national and local media visits to damaged locations and provided agency personnel for interviews (ReGeneration Resources 2012).

Recovery extended into September and beyond. As many as 700 VTrans employees from across the state (as well as transportation workers from New Hampshire and Maine, National Guard troops from eight different states, scores of volunteers, and approximately 1,800 private-sector workers) were rebuilding roads (*TS Irene* . . . n.d.), some with holes as deep as 100 feet, according to one interviewee. To manage the sustained recovery effort, VTrans maintained a clear, updated roster of personnel and sought to ensure they were fed, in touch, and rested throughout the recovery.

Traditionally, VTrans would have been working hand in hand with the local governments in assessing their damages. Owing to the overwhelming need at the state level, there were no resources remaining to assist the towns in this capacity. Therefore, to assess damages in the field at the municipal level, VTrans tapped the state's 11 Regional Planning Committees, which developed a standard assessment form; identified damage to roads, bridges, culverts, and other assets; provided input into road opening decisions; and performed other key services, including support for the reconstituted state EOC (*Lessons Learned from Irene* . . . 2012).

Right after Irene hit on August 28, there were 500 miles of state highways closed, 34 state bridges closed, 6 railroad bridges damaged, and 200 miles of impassable railroad (*VTrans 2012 Fact Book* 2012; see Figure 13). Within 1 month of the storm, 28 of the 34 closed bridges had reopened, and more than 96% of the 531 miles of state highway road segments had been reopened (ReGeneration Resources 2012). By late December, all of these state assets were serviceable again (ReGeneration Resources 2012). Town bridges, culverts, and highway segments had a substantial recovery in the 4-month period from late August to late December 2011. To accomplish this, VTrans expedited and streamlined procedures, which resulted in a reduction in the initial estimate of transportation system damages, from $700 million to $175–$250 million (*Lessons Learned from Irene* . . . 2012). In 2012, VTrans' Irene storm recovery accomplishments won an award from AASHTO in its "Ahead of Schedule" category ("Vermont Agency of Transportation Wins National Honor for Irene Recovery" 2012). As of summer 2013, VTrans continued to close out certain federal reimbursement issues, plan and design permanent repairs, and watch for sinkholes and riverbank landslides (*VTrans 2012 Fact Book* 2012).

FIGURE 13 Tropical Storm Irene roadway damage and debris, Killington, Vermont, August 29, 2011 (Flickr Commons, Ashly Hauck).

State DOT Activities

Operations and Maintenance

As noted, VTrans formed an ICS internally when it realized the flooding from Irene was beyond its usual response capacity. Adoption of ICS for internal efforts is viewed as an effective practice at VTrans, and this section details the lessons learned from building an ICS "from scratch."

After the decision to use ICS, VTrans established, as noted, a Unified Command in Montpelier, the capital, which received direction from the office of the state Secretary of Transportation and was co-led by the Directors of Operations and Program Development. The UC set priorities, provided overall management through directives, and took the lead on communication and public information. Under the UC were Incident Command Centers in three regions of the state, each of which had an incident commander and clearly identified sections, including operations, planning, logistics, and administration (*TS Irene* . . . n.d.).

The ICC in Rutland oversaw 52 towns in southwest Vermont and the ICC in Dummerston oversaw 56 towns in Vermont's southeast (*VTrans 2012 Fact Book* 2012). These two regions had the most severe impacts. All Irene-related activity in the north was overseen by an ICC in Berlin, near Montpelier. At the most active time of the recovery, the Rutland and Dummerston ICCs each were home to 200 VTrans employees plus hundreds of National Guard and contract employees (*VTrans 2012 Fact Book* 2012). This was the case despite the fact that in the first day or so after the storm, VTrans officials were aware of only four of their staff having ICS training.

One lesson learned by VTrans in standing up its own ICS was that a couple days' delay limited the ICS effectiveness (ReGeneration Resources 2012). On the other hand, VTrans enmeshed FHWA in the ICS as soon as it could, and this was an important part of the very good interaction VTrans experienced with that agency. The Director of Operations adds an important, intangible point for standing up an ICS in a crisis situation: Egos need to be kept at home. Both he and the VTrans Director of Program Development believe that if there had been other personalities or behavior at this critical juncture in the response, things might not have gone as well. These interviewees also reported that an important issue for the ICS to address, in both the command center or in remote areas, was keeping people fed. More generally, VTrans employees had hastened to support storm response and recovery despite road and bridge closures and other physical barriers, but in doing so they had not packed for what turned out to be, in some cases, a 3-month separation from their homes.

As more and more roads opened and rebuilding progressed, VTrans made sure there was a clear-cut demobilization of staff. A VTrans interviewee noted that as they closed out the ICS and people returned to their usual jobs, the ICS Logistics Section made a point to tell employees about the typical feelings experienced after a traumatic event. Subsequently, VTrans held brown bags and offered a counseling program. The state of Vermont created a coin to commemorate the assistance of major stakeholders, and the coin went to everyone, including those who had kept on with day-to-day activities ("Natural Disasters and State Transportation Lessons Learned: The Northeastern Operational Experience" n.d.). VTrans also sent thank-you letters to everyone involved, including their families ("Natural Disasters and State Transportation Lessons Learned, State/FHWA/FEMA Coordination Process Improvement," 2012). The demobilization phase is sometimes referred to as the "forgotten phase" in emergency management (Natural Disasters and State Transportation Lessons Learned, State/FHWA/FEMA Coordination Process Improvement" n.d.), and Vermont's practices after Irene were important for closure for many involved. An effective practice is to set procedures to identify when demobilization will occur—for example, after a certain time limit or when money is received ("Natural Disasters and State Transportation Lessons Learned, State/FHWA/FEMA Coordination Process Improvement" n.d.).

Many practices, observations, and recommendations emerged from post-Irene studies that VTrans initiated or participated in, in order to review and improve upon its response to Irene. In addition to usual debriefs and reports from various entities, two major activities are particularly noteworthy:

1. VTrans' own Irene Innovation Task Force

2. An initiative titled "A Regional Conversation: Natural Disasters and State-Regional Transportation—Insights, Lessons Learned, and Future Directions" convened by the Coalition of Northeastern Governors' (CONEG) Transportation Lead, Vermont Governor Shumlin

The following subsection summarizes the work product of these two activities.

The VTrans Irene Innovation Task Force is addressed first. The VTrans Irene Innovation Task Force separated lessons learned in emergency management—for example, under an ICS approach—from those in ongoing operations. This distinction is useful when reviewing and analyzing practices for possible adoption. Practices used under emergency management procedures can have different drivers and context than those used for more routine activities.

The Irene Innovation Task Force identified several areas where VTrans might improve processes and delivery of services when under the ICS framework and identified many practices for potential adoption (ReGeneration Resources 2012). The following is a sample.

Regarding ICS governance, the following practices were noted as potentially helpful in the future (ReGeneration Resources 2012).

- Pre-assignment of personnel to be Incident Commanders and section chiefs for emergency situations
- More formal ICS training for those personnel pre-assigned to ICS duties
- Adequate resources for emergency response, which could include a review of communication equipment, ensuring adequate shift coverage for critical positions, determining which roles need to be backfilled during an emergency response, giving key people in the ICCs administrative support to monitor e-mails and other

communication, and considering emergency fleet capacity when purchasing new vehicles

- Identification and training of key personnel for future ICC duties in state-of-the-art technology (iPads, iPhones, etc.) through use on a daily basis so they will be familiar with them in an emergency
- Standard Operating Procedure for the ICS, which may include standardizing financial processes, clarifying the role of planning, formalizing the role of IT, formalizing communication processes, ensuring that the Unified Command fully utilizes the ICS, and developing a three-tiered system because different disasters demand varying levels of resources and governance
- Recording of the background and experience of all appointed staff team leaders to better understand their talents and ensure that the right people are in appropriate positions in ICS
- Analysis of physical and geographic issues, including identifying the best locations for ICCs around the state, taking into account that those furthest from the ICCs tend to experience the most isolation
- Understanding of the significance to the effort of where the UC is established
- A Continuity of Operations Plan that reflects the ICC structure.

Regarding training to support the effective use of ICS, the following practices were noted as potentially helpful in the future (ReGeneration Resources 2012):

- Annual training in disaster response for staff at all levels
- Training for the pre-identified leaders and people on the front lines
- Checklists and emergency Standard Operating Procedures, especially with regard to how finances are handled, and a manual with clear information on FHWA DDIRs
- Pocket manuals for ICC units, especially the heads of the Logistics, Planning, Operation, Finance sections; the manuals might note which documents are needed, who responds, what they do, where they go, and when they do it, as well as FAQs addressing ICC operations
- Use of "mini-disasters" as a chance to practice and evaluate the skills of potential leaders
- A plan for technology use in emergency response
- Clear roles on who trains stakeholders, including contractors, towns, other departments, and subcontractors
- Use of VTrans Operation's training institute to institutionalize river engineering into infrastructure engineering.

Regarding Contract Administration conducted under an ICS structure, the following practices were noted as potentially helpful in the future (ReGeneration Resources 2012):

- A "Contractor Registry" database
- A standardized electronic contract-processing system
- An electronically available emergency administrative packet for use by ICC and UC administrative teams that covers invoicing, contracting, DDIR requirements, the levels of emergency, safety protocols, and the different funding sources for emergency work
- A contractor's emergency packet, with common forms and instructions; some how-tos on insurance guidelines, the Davis-Bacon Act, and other federal requirements, instructions, and steps for compliance; and instructions for accessing electronic information, such as maps, traffic, and road information
- An "Emergency Waiver" process for when certain emergency declarations are in place
- A standardized process for paying contractors to ensure more prompt payment
- Alternative emergency contracting processes.

Regarding Information Technology in an ICS environment, the following practices were noted as potentially helpful in the future (ReGeneration Resources 2012):

- A master distribution list for cell phone users
- Expanded training in the state's maintenance tracking systems beyond the Operations division
- Cloud technology that can facilitate real-time views of contractor agreements and environmental permits for emergency responders in the field
- Use of Google Maps during emergencies
- Central location for human resources documents, maps, and other ICC information designated for emergencies
- Locating response data on a single, internal, shared drive from "day one" of an emergency.

Regarding Work Flow in an ICS environment, the following practices were noted as potentially helpful in the future (ReGeneration Resources 2012):

- Processes to keep track of equipment lent to contractors
- Processes to improve tracking of materials received from contractors used on sites
- Clarification of DDIR process on
  - Ownership of the DDIR process under ICS—for example, UC or ICC
  - Training on DDIR work, including capacity to train others in DDIR writing

Regarding the Operations function in an ICS environment, the following practices were noted as potentially helpful in the future (ReGeneration Resources 2012):

- A "Emergency Design Manual" for reestablishing slide slopes for riverbanks in an emergency
- Clarification and standardization across ICCs of civil-engineer testing and documentation levels in emergency response efforts

- Better use of technology for gathering and sharing information immediately after the emergency, such as reliance on remote sensing in addition to scouts, including live video from a helicopter, satellite imagery, and LIDAR.

Regarding Communications under an ICS, the following practices were noted as potentially helpful in the future (ReGeneration Resources 2012):

- Use of neutral observers who visit the ICCs to check for communication problems
- Internal emergency communication systems and protocols to minimize communication overload among the UC, ICC, and localities
- Assessment of the right equipment to have on hand in emergencies, such as portable cell towers, radios and cell phones, and emergency software
- External communication protocols that clarify communications among localities and the Emergency Operations Center
- Identification of communication contingencies under a loss of power and cell reception for long periods of time.

The items listed previously from the Irene Innovation Task Force Report are pertinent to this synthesis of practices. The entire report is in web-only Appendix E, which contains additional information on potential use (ReGeneration Resources 2012).

The CONEG (Coalition of Northeastern Governors) initiative occurring post-Irene is addressed in the following paragraphs. The Governor of Vermont was the CONEG Transportation Lead at a time when this organization could be called on to address the impacts of Irene. He led an initiative under which member states met and reviewed their experiences, lessons learned, and needed actions in disasters, largely in relation to Hurricanes Irene and Lee, which occurred in the same year (Anne Stubbs, memorandum, Disaster Transportation Planning Group, Dec. 5, 2011).

Through workshops and other reviews, member states selected the following items for action in 2012, with a report due the following year ("Natural Disasters and State Transportation Lessons Learned, The Operational Experience, Next Steps/Recommendations, Group report out" n.d.).

- Alignment of FHWA information in the Detailed Damage Inspection Report (DDIR) with the FEMA Public Assistance Project Worksheet (PW) format
- Development of common FHWA/FEMA debris-removal guidance, with "cradle to grave" procedures
- Investment by member states in providing more communication/information to state staff and local government officials
- Development of a FEMA/FHWA "tool kit" for emergency managers, Departments of Transportation and municipalities, such as
  - Standard forms
  - National GIS -based maps of federal highway systems, with pointer system to states
  - Pocket guides.
- Development by member states of standardized Emergency Management Assistance Compact costs, fee schedules, and so forth.

With respect to the first bullet, VTrans volunteered to do a "dry run" of the FHWA/FEMA forms alignment, including review of the DDIR that is critical to reimbursement. This exercise stems partly from the fact VTrans has observed inconsistencies in the FHWA manual and knows how it sometimes does not mesh well with the local government structure found in New England states, where towns have primacy over counties ("Natural Disasters and State Transportation Lessons Learned, State/FHWA/FEMA Coordination Process Improvement" 2012). As of the summer of 2013, this effort is under development, according to an interviewee.

Financial Support to Localities

As noted earlier in this case example, VTrans Operations led the effort to rebuild and reopen roads in the immediate aftermath of the storm. The philosophy was to rebuild and actively address reimbursement issues, not wait on them (*Irene Recovery Report: A Stronger Future* 2012). As a result, recovery from Irene entered 2012 with open roads and federal reimbursement efforts under way (*Irene Recovery Report: A Stronger Future* 2012).

The FHWA Emergency Relief funding that supports state- and local-system collector roads totaled $175 to $250 million, including state and federal funds (*Lessons Learned from Irene* . . . 2012). The state also decided to pay half of the town match (half of the requisite 20%) required to receive FHWA payments (*Update on Vermont's Recovery* . . . n.d.). Additionally, after several appeals, Vermont also secured a ruling from FHWA that permitted $4.4 million in FHWA funds to be used for work performed by National Guard troops during response and recovery (*Vermont Recovering Stronger Irene Recovery Status Report* 2012).

Irene damaged 963 town culverts and damaged or destroyed 277 town bridges (*Update on Vermont's Recovery* . . . n.d.), and more than 200 towns had to rebuild damaged roads, bridges, and culverts (*Vermont Recovering Stronger Irene Recovery Status Report* 2012). FEMA was a primary source of funding pursued. VTrans designated district technicians as well as contractors to support the towns in these efforts, including completing the proper paperwork (Vermont Recovering Stronger Irene Recovery Status Report

2012). Towns developed Project Worksheets for the FEMA Public Assistance process, administered by VTrans (*Lessons Learned from Irene* . . . 2012). By June 2012, 9 months after the event, 2,231 Project Worksheets had been processed for payment by FEMA, representing more than 75% in line for reimbursement (*Vermont Recovering Stronger Irene Recovery Status Report* 2012). VTrans also supported efforts to change existing rules to ease the financial burden to towns and villages, and the state now provides added assistance at a certain threshold: Where FEMA-funded repairs increase the town's tax rate by more than $0.03 per dollar, the state now covers the nonfederal share of the cost above $0.03 (*Vermont Recovering Stronger Irene Recovery Status Report* n.d.).

The state's congressional delegation was active in facilitating recovery, by identifying possible federal administrative and legislative fixes to reduce the financial burden to the state and localities (Kinzel 2011). Ultimately, it secured a provision that allows FHWA to cover 90% of the cost of road repair in states recovering from extreme natural disasters (*Vermont Recovering Stronger Irene Recovery Status Report* 2012). That provision translates to up to $10 million in additional funds for Vermont's Irene recovery efforts (*Vermont Recovering Stronger Irene Recovery Status Report* 2012).

Maintenance

As Irene advanced on Vermont, VTrans used its usual approach for addressing severe weather events. Specifically, because Vermont covers a small land area, VTrans believes with its nine districts and 65 facilities distributed across the state, its staff can quickly respond to any affected area. Effectively, under the VTrans model, crews preparing for a major event at these locations are "deployed already." The VTrans interviewee states that with Irene bearing down, crews readied equipment and other resources, and he believes that distributing resources even farther would have made the situation worse. As it stands, radio contact was lost with only one district, and eight of nine districts were in contact and interacting with the chain of command despite storm impacts.

All repairs made during recovery from Irene required inspection as well as stabilization, as necessary. In spring 2012, VTrans conducted what it referred to as a "Scan Tour." VTrans collected a cross-section of state and federal partners (VTrans, Agency for Natural Resources, FHWA, and U.S. Army Corps of Engineers) and traveled the state to closely inspect and evaluate the stability of existing repairs, as well as to determine how permanent repairs will be made (*Vermont Recovering Stronger Irene Recovery Status Report* 2012b).

As part of the more formal Emergency Response plan being developed since Irene, VTrans is staging key equipment—such as cones, message boards, and portable traffic lights—in specific areas. To VTrans, the storm reinforced the role of its central garage, and the VTrans interviewee reports that the central garage has experienced more activity in the tracking of equipment wear and performance. Additionally, the VTrans Operations Director states that crews are paying more attention to equipment breakdowns and maintenance needs, partly because breakdowns were anticipated after the battering the equipment received during the storm and recovery. By coincidence, when Irene struck, VTrans was already considering ways to better track maintenance, and the storm made crews more vigilant. VTrans is also creating a statewide inventory so that VTrans can know what its resources are and where they are, and regions can "shop" from the inventory in an extreme weather situation.

Design and Construction

VTrans' approach to rebuilding its own roads was to get in and get the entire job done, not put in temporary measures in the cases that VTrans would have to pay for anyway and where they had control over the entire segment of roadway. In this way, it reduced an initial estimate for post-Irene repairs from $700 million to $175–$250 million (*Lessons Learned from Irene* . . . 2012). One interviewee also noted that with VTrans making storm recovery the agency's priority, it found ways to accomplish recovery sooner, by, for example, extending the completion date for other construction so that resources could leave a site and work on the new recovery projects in the areas affected.

VTrans administered the state's FEMA Public Assistance program, and after Irene it sought to ensure more resilient infrastructure (*Vermont Recovering Stronger Irene Recovery Status Report* 2012). The state has been working with and "challenging FEMA when necessary" to institute hazard mitigation measures wherever possible (*Vermont Recovering Stronger Irene Recovery Status Report* 2012). In May 2012, for example, VTrans contested a FEMA ruling that stated that the Vermont Agency of Natural Resources' permit requirements for replacement of damaged bridges and culverts are not uniformly applied across the state and therefore do not constitute standards, as the term is defined in FEMA's regulations. As a result of this ruling, FEMA denied public assistance costs associated with upgrading damaged or destroyed bridges and culverts to Agency of Natural Resource' requirements ("Election 2012: Issue Paper No. 1: Transportation" 2012). For towns that had already conducted substantial infrastructure repairs (often through lines of credit) and expected FEMA to fully reimburse their work expenses, there would be a risk of a financial shortfall if the FEMA ruling were to stand ("Election 2012: Issue Paper No. 1: Transportation" 2012). As a result, an interviewee states that VTrans was rewriting its hydraulics manual to ensure the standards that it uses are codified "for everyone to see, including FEMA."

VTrans is seeking to understand the most resilient approach to building or rebuilding its infrastructure. It is focusing on the influence of fluvial geomorphology on the behavior of rainfall. Irene changed river flows and channels across the state. According to an interviewee, VTrans understands it may take 20 years before these waterways “settle” into equilibrium, thereby creating a design challenge. One lesson learned, according to the Irene Innovation Task Force Report, is that design processes for everyday capital construction projects, not just those developed in response to extreme weather damage, could be improved (ReGeneration Resources 2012).

Regarding Construction, the following practices were noted in the Irene Innovation Task Force as potentially helpful in the future (ReGeneration Resources 2012):

- Bridge design criteria addressing the structure’s ability to withstand flooding
- Review of riverbank design methodologies and increasing the use of riprap
- Route logs as a resource for design engineers in identifying structures and their locations
- Simplification of design plans, including minimization of repetitive information.

During Irene recovery, VTrans insisted on complete road and bridge closures in order to finish repair work more quickly and safely. Post-Irene, VTrans is mainstreaming this approach into its construction program, starting with a provision in the state’s 2012 transportation bill that provides an incentive to replicate that success. Towns will see their local match requirement cut in half if they take the traditional approach in a rebuild and keep some level of access. If a town closes a bridge completely without erecting a temporary bridge, they will get the entire local match because closure reduces total project costs and saves both state and town funds (*Vermont Recovering Stronger Irene Recovery Status Report* 2012).

This approach is one part of an Accelerated Bridge Construction program, a VTrans initiative begun in 2007 and spurred forward by the Irene experience (*2012 Report to the Legislature’s House and Senator Transportation Committees* 2012). The incentive for road and bridge closures works in conjunction with new construction techniques, such as prefabricating structure components, utilizing advanced new materials, and using new contracting/management techniques (*2012 Report to the Legislature’s House and Senator Transportation Committees* 2012). Together, these strategies realized savings in repairing the damage from Irene. To keep momentum, VTrans has prepared performance measures that include limiting the time from design to “shovel ready” to 2 years (*2012 Report to the Legislature’s House and Senator Transportation Committees* 2012). The intent in 2012 was, over the short term, to have 30% of all bridge construction and rehabilitation projects developed under this program (*2012 Report to the Legislature’s House and Senator Transportation Committees* 2012).

Planning and Related Activities

In describing VTrans’ preparedness for Irene’s massive impact, the Operations Director states, “Had the talent; didn’t have the plan to respond.” For example, one interviewee noted that, pre-Irene, VTrans’ most notable evacuation procedure was the drill for the state’s nuclear plant. He notes that VTrans will fold lessons learned into an Emergency Response Plan. A more formal role of Regional Planning Committees is being incorporated into the plan (*Lessons Learned from Irene* . . . 2012). A VTrans interviewee also noted that in response to the impacts of Irene, VTrans developed three types of training:

1. Web-based ICS awareness training for all staff;

2. Hands-on, classroom, and field-based river management training, to include “knees in the brook” experiences; and

3. Subject-matter expert-level training, in conjunction with the Vermont Agency of Natural Resources (ANR), in river management so that hydraulics engineers and other can anticipate design issues. The Tier One training module can be accessed through the following link: http://wsmd.vt.gov/rivers/roadstraining/.

In addition to supporting ANR river management goals, VTrans is also encouraging a more holistic view of highway and other infrastructure planning, such as considering the watershed rather than a narrow valley and, as mentioned previously, examining the role of fluvial geomorphology in such planning (ReGeneration Resources 2012).

Communications

VTrans considers its adoption of Google Maps during Irene response and recovery as a key communication tool and important success. First, the decision to integrate this tool into its response and recovery effort was made quickly (“VTran’s Irene Google Map Transitions to 511” 2011). Although Google offered the service for free, VTrans had to weigh the investment of critical GIS staff resources into time spent with Google on developing and populating the map. Google’s head of community affairs, who reached out to VTrans, was a former state senator, so there was an existing rapport and understanding during an emergency situation. Second, VTrans staff worked “through the night,” August 30 and 31, and published at the end of the day on August 31 easy to use maps of real-time bridge and road closures. This timely and significant level of effort aided success. Third, these maps became an accepted source of information for the State Command Center. VTrans would work with mappers routinely to update them. Fourth, the maps also were quickly adopted by other agencies, such as the Vermont Tourism and Marketing Commission's information centers, and supported the message that Vermont was "open for business" as the important fall tourist season approached. Finally, VTrans coordinated the termination of Google's service with the transition back to VTrans' longstanding 511 travel website and the transition of its official web page back to its normal messaging, with a simple link to an Irene Recovery page ("VTran's Irene Google Map Transitions to 511" 2011).

VTrans also used social media during Irene, and an interviewee notes this is effective because it allows a single point of entry for a user. Facebook and Twitter users received the same information as on the 511 site and Google maps. The five staff manning the Facebook account, noted earlier, made it more interactive (*TS Irene* . . . n.d.).

Irene's timing created a communications challenge involving two broad sets of stakeholders: (1) the tourists who came to Vermont to view the leaves in the fall or to ski in the winter; and (2) the businesses that cater to them. Interviewees noted that the message VTrans had to form for tourists was not simple: There were closures, but travelers should enjoy what the state had to offer. In other words, the state had to discourage tourists from taking certain roads but not to signal that Vermont's borders were closed. VTrans then had to convince businesses that complete closure of a road or bridge was preferable to partial road or bridge closures. VTrans' rationale was that although closure inhibited business in fall leaf season, it would mean completed repairs by the ski season. The messaging was complex because VTrans had to let some traffic through in some instances. Vermont's Agency of Commerce and Community Development's Department of Tourism and Marketing helped VTrans reach out to visitors, supplying roadway information, in part, from Google Maps (*Irene Recovery Report: A Stronger Future* 2012).

A final point on communication relates to pre-event preparedness. The public's primary sources of weather information were news reports that rely on NWS information. In the case of Irene, NOAA suggests that word choice may have affected public behavior, because the reporting on the storm's weakening could have sounded like less risk to the public (Lubchenco and Furgione 2012). As NOAA reported (Lubchenco and Furgione 2012, p. 49),

> Communicating a well-crafted message to the public requires a nuanced understanding of how people interpret specific words in the context of a forecast. NHC, WFOs, and the media used the phrases "weakened into a Tropical Storm" and "downgraded" when describing changes in the meteorological conditions during the progress of Irene, with unintended and unanticipated consequences.

> "I think that what I needed to hear was that the downgrade to a tropical storm does not mean that this is no longer a threat." —Central Vermont resident

> "I mean they said 'There's this huge, huge hurricane, oh my God . . . and then it was like 'Oh it's downgrading, Oh, it's downgrading, and now it's just a tropical storm,' right, and that's what we heard! And so it was like 'Oh, it's not really that big of a deal now . . ." –Central Vermont resident

VTrans leadership tracked NWS reports and prepared for the flood event as they understood the event would present itself. River levels peaked and crested by the time the storm passed through August 28–29; during that time and afterward, VTrans adjusted, moving to an ICS approach to communication and adopting the other tools described earlier.

Interagency Coordination

During Irene response and recovery, VTrans coordinated with more than 1,800 people in total (*TS Irene* . . . n.d.), including the following:

- The Emergency Operations Center, including state agencies represented and the Regional Planning Committees set up pursuant to federal transportation funding requirements.
- 700 VTrans employees, who were assigned to Irene recovery tasks.
- Other state agencies.
- The Vermont National Guard, which added approximately 200 troops.
- National Guard troops from other states, which included 220 from Maine, eight from New Hampshire, 145 from Illinois, 93 from Ohio, 51 from South Carolina, 30 from West Virginia, and 16 from Virginia. These contingents variously brought equipment, vehicles, and aircraft. Maine National Guard Members provided the Command and Control function for out-of-state troops.
- State DOT partners, including Maine, which supplied 150 people and 145 pieces of equipment, and New Hampshire, which supplied 75 people and 60 pieces of equipment.
- Medical professionals from Maine, Louisiana, New Hampshire, Arkansas, Missouri, Idaho, and Florida.
- Red Cross, church groups, and fraternal organizations.
- More than 200 private contractors and consultants.

A VTrans interviewee notes that the National Guard required added coordination efforts because troops simply are not trained to address this type of flood event. For example, they did not know to be sensitive to stream health when stabilizing stream banks. VTrans included them in briefings every day to maintain clear lines of communication and rapport ("Natural Disasters and State Transportation Lessons Learned: The Northeastern Operational Experience" 2012). VTrans also coordinated internally. For example, so that material haulers from Maine and New Hampshire could pass into the state easily, the VTrans Operations Director worked with the VTrans DMV to secure weight and time of operation waivers ("Natural Disasters and State Transportation Lessons Learned: The Northeastern Operational Experience" 2012).

After the initial recovery efforts ended, the Governor appointed the VTrans Deputy Secretary for Transportation as the Irene Recovery Officer. With respect to mitigation efforts after Irene, the Irene Recovery Office is distributing information about many useful state and federal programs supporting recovery and mitigation of future hazards. These programs very appropriately extend beyond the transportation sector, but they maintain transportation as a key focal point. For example, the literature explains how the FEMA Hazard Mitigation Program is available for road and culvert upgrades under certain conditions (*Update on Vermont Recovery* . . . n.d.).

Vermont's Irene Recovery Officer cites interagency coordination as a key piece of a state strategy to address a disaster as well as to adapt and prepare for future flooding (*Vermont Recovering Stronger* . . . 2012). According to a VTrans interviewee, closer collaboration between VTrans and the Agency of Natural Resources has become a regular part of doing business post-Irene. VTrans views this relationship as "the beginning of a resilient infrastructure standard" (*Vermont Recovering Stronger* . . . 2012).

Regarding Interagency Coordination, the following practices were noted in the Irene Innovation Task Force as potentially helpful in the future (ReGeneration Resources 2012):

- Including a VTrans environmental liaison in planning at the ICC level
- Stewardship agreements and memoranda of understanding with key agencies to accommodate emergency response efforts, such as defining agency responsibilities and protocols for state personnel to identify themselves in the field during an emergency
- Convening a meeting within a year of a major weather event to allow discussion of the "who's and what's" of responsibility and contacts for any future events
- Incorporating Regional Planning Committees, Vermont ANR, FEMA, and FHWA into ICC planning
- Working to ensure that all key agencies are engaged from day one
- Improved integration of rail and state airports into the emergency operations
- Working to ensure that all state agencies use the same districts in an emergency
- Assigning a full-time attorney general to work with FEMA
- Working with FEMA and FHWA to better align the FEMA Public Assistance (PA) and FHWA Emergency Relief requirements.

Data and Knowledge Management

The recovery phase from the August 2011 tropical storm ended with the completion of the last mile of rebuilt highway on December 29, 2011 (*TS Irene* . . . n.d.). As noted, VTrans soon after established the Irene Innovation Task Force team to identify lessons learned. VTrans also supported the Vermont Governor in the Coalition of Northeastern Governors/CONEG initiative on disasters and transportation.

To collect information on the VTrans response, the Irene Innovation Task Force team conducted a survey, led eight focus groups, and interviewed 60 participants in the response effort. The team also reviewed debriefing surveys, meeting notes, and AARs prepared by others. They synthesized their conclusions and developed a report. It also appended a summary of the comments they did not agree with but wished to present for the reader's information. The report, found in web-only Appendix E of this report, divided the lessons learned, as noted earlier in this case example, into those relating to emergency management and those that can be integrated into ongoing operations (ReGeneration Resources 2012). Many of the lessons learned from this exercise are referenced in the case example. Both the specific lessons learned and the act of convening a task force itself are practices of potential value in other situations.

A theme seen in the Irene Innovation Task Force Report is access to technical information. During the Irene response, detailed, routine bridge inspection information was not readily available and was not always provided to contractors before their site visits. A lesson learned was to consider the use of a bridge information database so that such information can be obtained online by anyone who has prior approval from VTrans. Another approach is to have a custodian for record drawings so that there is a designated point of contact, rather than having this function as a peripheral duty for program managers. Succession planning can also keep technical information visible and transferable to other skilled individuals. Another practice that surfaced at the CONEG workshops was allowing, in times of emergency, the rehire of former state employees who are otherwise barred ("Natural Disasters and State Transportation Lessons Learned, State/FHWA/FEMA Coordination Process Improvement" n.d.).

Appropriate and relevant weather information is important for state DOTs. For example, one lesson learned recorded during the CONEG initiative was increased data sharing, such as ways states can share weather information so that neighboring states understand "what's coming at them" ("Natural Disasters and State Transportation Lessons Learned, State/FHWA/FEMA Coordination Process Improvement" n.d.). Preparedness involves collection and assessment of information pertaining to the extreme weather event, and typically this function is the purview of operations because even a low-impact change in environmental conditions implicates the maintenance division.

In Vermont, VTrans Operations and Maintenance staff relied on forecasts from NWS and others in the days leading up to Irene. NOAA has concluded that these sources did not present forecasts of intense flooding with the clarity needed to achieve the appropriate level of preparedness in Vermont and emphasizes that rainfall forecasts and inland flood threats still needed communication even when Irene was downgraded (Lubchenco and Furgione 2012). Also, in the case of Irene, even where information products were available for public consideration, they were confusing (Lubchenco and Furgione 2012). NOAA recounts the following situation in communicating Irene's flood threat in Vermont (Lubchenco and Furgione 2012).

> NWS offices issued seven different hydrologic product types to convey the flooding threat from [Irene], which cluttered hazard maps and created confusion. Some media partners opted to stop receiving flood warning updates because they were too numerous and confusing.
>
> > "We can't even keep them straight. We turned the automatic notification off all together."—Matt Noyes, Meteorologist, New England Cable News
>
> These media partners also refused to use a graphic display of flood and flash flood watches and warnings due to the complexity of the hazards map.
>
> > "It is hard to explain the different colors on a watch/warning map to viewers. . . ."—Sharon Meyer, WCAX, CBS Burlington, VT
>
> Feedback from NWS product users reflected a lack of understanding for Irene's extreme hydrologic potential:
>
> > "We didn't get a forecast from the National Weather Service that made us sit up and pay attention."—Ross Sneyd, News Editor, Vermont Public Radio
>
> > "I never saw any forecast that suggested rivers might crest at record levels; however, the warnings of record flooding were certainly there. Although it was listed as flash flood watches, I'm not sure the public makes that distinction as a flood warning. In retrospect, I would put more emphasis on that."—Mark Breen, Eye in the Sky forecaster for Vermont Public Radio

The NOAA report suggests that decision makers who rely on NWS, as well as on FEMA, to relay NWS information in an emergency management situation need to understand the institutional limitations and data-presentation challenges at play (Lubchenco and Furgione 2012). NOAA/NWS states in its post-Irene report that is ready to work with its stakeholders (Lubchenco and Furgione 2012). In doing so, NOAA recounts the following statement from a local leader in Vermont (Lubchenco and Furgione 2012).

> "We had no warning saying it would be so bad. I knew it was going to rain a lot, but I thought it was going to be the kind of rain that would test the patch I just put on my roof. I had no idea it would be the kind of rain that would wash my neighbor's house away." —Rochester, VT, Selectman

Lessons Learned and Related Practices

The following summarizes key practices identified in this case example by mission-related and crosscutting functions.

Practices by General State DOT Functions

Practices by mission-related functions

Operations:

- Standing up of an ICS, with the appropriate scope of organization of the event—for example, Unified Command and regional or local Incident Coordination Centers
- Identification and utilization of a short, set list of objectives for the recovery effort
- Awareness of employee attitudes and their basic necessities
- Improving alignment of FHWA information in its DDIR with the FEMA PA PW format
- Pursuit of rulings on issues of first impression with the federal government (e.g., FHWA and National Guard costs)
- Training and provision of designated technical assistance to localities attempting to seek federal reimbursement
- Provision of technical assistance to policy makers exploring changes to state cost sharing where localities that cannot afford to repair damage to transportation system, changes to federal program cost sharing where state cannot afford repairs to transportation system, or other approaches
- Ensuring demobilization of ICS is defined, described (including the social after-effects of event), and implemented, using methods such as the following: having the Incident Command Center Logistics leader discuss how personnel may feel after returning home, holding brownbags, offering counseling, issuing a coin as a memento, and sending thank-you notes to personnel and their families
- Preparing for and using the federal reimbursement process to support projects that build resiliency
- Preparing for and using ICS, including pre-assigning roles; knowing the experience of staff when assigning roles; providing ICS training; familiarizing staff with mobile IT and other equipment used in the field; preparing/updating Standard Operating Procedures for use of ICS; considering event-related criteria when standing up an ICS, UC, or IC; and updating the Continuing Operations Plan
- Developing training for effective use of ICS, through basic training at all levels; annual training; checklists and pocket manuals with key information for ICS section leads on each role; practicing use of ICS under small events; developing a plan for use of technology in emergency response; clarifying the role of state DOT in ICS training; providing training in technical details of likely events (e.g., riverine flooding)

- Addressing contracts administration under ICS by having contractors register; electronic invoicing and contracts processing system; developing administrative packet on invoicing, federal forms, emergency management levels, state and federal compliance issues, for state and for contractor staff; developing an emergency waiver process; standardizing the process for paying contractors under an ICS
- Enhancing the use of technology when using ICS, including having a master list of cell and smart-phone contacts, expanding training in the state's maintenance tracking system, exploring use of cloud technology to enable robust use of mobile applications, continuing use of Google Maps, storing information needed in an emergency situation in one place, and enabling a single internal location for sharing data during an event
- Improving workflow under ICS, including developing a process to track equipment lent to contractors, developing process for tracking materials supplied by contractors, and improving internal data collection for federal reimbursement by defining roles and supplying training, including training the trainers
- Preparing for Operations role under ICS, including developing an "Emergency Design Manual" for use when reestablishing structural elements in an emergency, clarifying the level of civil engineer testing and documentation expected under response, and improving collection and use of geospatial data immediately after the event
- Improving communications under ICS, including developing/updating internal processes for communications in ICS, developing/updating with stakeholders' external processes for communications in ICS, ensuring proper equipment will be on hand (including portable cell towers), inspecting radios and cell phones, assessing emergency management software ahead of time, and developing alternatives for when power or cell reception is down.

Maintenance:

- Staging equipment in specific areas, including cones, message boards, portable traffic lights
- Identifying a central storage location or garage for equipment needed in a major event
- Tracking maintenance needs with a view to statewide events
- Coordinating and running a multiagency "Scan Tour" with relevant state and federal agencies to assess together existing repairs and determine how permanent repairs will be made
- Developing an equipment inventory, including what and where the resources are.

Design:

- Developing new design criteria in order to meet projected risks—for example, bridge height for flooding, use of riprap
- Using existing data sets—for example, route logs—to support design process in emergency response scenario
- Simplifying the design plan process.

Construction:

- Enabling shifts in construction schedules to accommodate new priorities
- Adopting an approach to rebuilding that completely closes a road or bridge for safer and faster construction (rather than partial closure that maintains access during construction)
- Articulating the existing technical and policy foundation for projects that support better resiliency (e.g., rewriting hydraulic manual to underscore existing practices)
- Exploring new construction techniques—for example, prefabrication of structure components, advanced new materials, and new contract/management techniques
- Taking advantage of change management after an extreme weather event to mainstream new construction practices—for example, by developing an Accelerated Bridge Construction program initiative, staggering its implementation, and providing metrics for success.

Planning:

- Creating an Emergency Response Plan, including the express identification of the role of nongovernmental resources, such as the Regional Planning Committees set up under federal transportation laws
- Developing training and related content to educate employees to better address flooding events, including general ICS awareness, instruction in river management, and in-depth technical training for engineers
- Articulating a holistic, watershed-based approach to siting and building transportation infrastructure.

Practices by Crosscutting Functions

Communications:

- Supplementing 511 system with a call-in center dedicated to the event, Google Maps, social media, mobile phone micro-site, and website with regular updates
- Where adopting web-based tool, such as Google Maps, making timely decision on investing staff time, encouraging and facilitating adoption by others, and planning for its maturity into an ongoing tool
- Considering the staffing and protocols needed to ensure the social media site has desired effect
- Tying in transportation information to existing agency communications lines—for example, 1-800 numbers for tourist information
- Transporting media to the site and providing agency personnel for interviews.

Interagency Coordination:

- Embedding FHWA in state DOT activities related to the extreme weather event—for example, in the ICS
- Understanding the management requirements for using the National Guard
- Accelerating approvals for weight and time waiver for trucks through internal coordination
- Better integrating air and rail into emergency operations
- Maintaining key role and place at the table in broader recovery effort, by taking responsibility for its early management
- Including an environmental liaison in the ICS
- Developing agreements and memoranda of understanding to define/update roles of agencies under Emergency Response situations
- Meeting annually to check in on "who is who" at each agency and confirming contacts for future events
- Defining roles in a state DOT ICS of Regional Planning Committees, which are congressionally required bodies of potential use in emergency response
- Ensuring early engagement by all relevant agencies
- Using same district boundary for all agencies in Emergency Response, noting state DOT maintenance districts may not be the most effective
- Assigning or dedicating a state attorney to federal program reimbursement and other emergency response issues.

Data and Knowledge Management:

- Distinguishing Emergency Management processes from day-to-day processes in post-event assessment of a state DOT response to extreme weather event
- Providing a structured forum and process for developing lessons learned from extreme weather events to capture practices and ideas for improvement, dedicating resources to hire a contractor
- Identifying the data sets (e.g., information on bridges, record drawings) that benefit decision making and the ways to enable better collection or access to the data
- Developing succession planning to maintain continuity and a knowledge base
- Understanding the limitations of weather information products and seeking to develop expertise to better assess weather events.

CASE 6 : ALASKA—SOUTH CENTRAL SNOWSTORMS (2011–2012)

Introduction

The Alaska Department of Transportation and Public Facilities (ADOT&PF) is responsible for 5,600 paved and gravel highways, 245 airports, 43 small harbors, and a ferry system covering 3,500 nautical miles ("About Alaska DOT&PF" n.d.). Much of this infrastructure lies within vast, remote areas with significant temperature extremes on a land mass one-fifth the size of the continental United States.

In the winter of 2011–2012, a series of storms hit Alaska. Weather conditions did not allow for snowmelt between storms, so snow accumulated, becoming deep and heavy on roads and buildings. The severity of the snow hazard in the coastal town of Cordova, for example, triggered a local disaster declaration by the Governor and later expanded to a regional disaster declaration ("Prince William Sound Storm Declared Disaster" 2012). The storms affected transportation across the state; to keep roads open, maintenance crews recorded nearly 61,000 hours of overtime that cost $2,710,000 (Grass 2012).

This case example focuses on the snow- and rainstorms in south central Alaska, a land area roughly the size of Virginia that stretches from Anchorage down to the Kenai Peninsula and across to Valdez, Cordova, Yakutat, and Haines. Cordova's situation, in particular, illustrates the state's role in handling impacts from this type of extreme weather event.

Event Summary

Cordova is a coastal city of 2,200 that is accessible only by air or marine transportation. Beginning in mid-December 2011 and continuing through January 2012, Cordova received snowfall that put it on a pace to meet or break record precipitation accumulations for the winter season ("Prince William Sound Storm Declared Disaster" 2012). Typically, breaks between winter snowstorms in Cordova offer snowmelt conditions (Rosen 2012), but not in this case. Any warming during this period led to rain that made the snow heavier and more of a hazard (Anderson 2012).

On December 12, after this series of heavy snowstorms, Cordova went into emergency snow removal status (see Figure 14). Several roofs collapsed during this time. Side streets were closed off and used as snow dumps (*Incident Overview 2012—Prince William Sound Winter Storm* 2012). In the end, the city spent more than $500,000 on its snow emergency (Grass 2012).

The primary focus in snow removal was public safety, including provision for at least a single passable lane for emergency response vehicles and the removal of snow from some rooftops. When the city of Cordova could not keep lanes open into subdivisions, the mayor declared a local disaster emergency in December 2011 (Memmott 2012). By early January, there had been 18 ft of snow (Memmott 2012). At about that time, Cordova's snow dumps filled up and the state of Alaska then declared an emergency for Cordova (Campbell 2012). The declaration permitted use of additional state resources. These state resources included more than 50 members of the National Guard for snow clear-

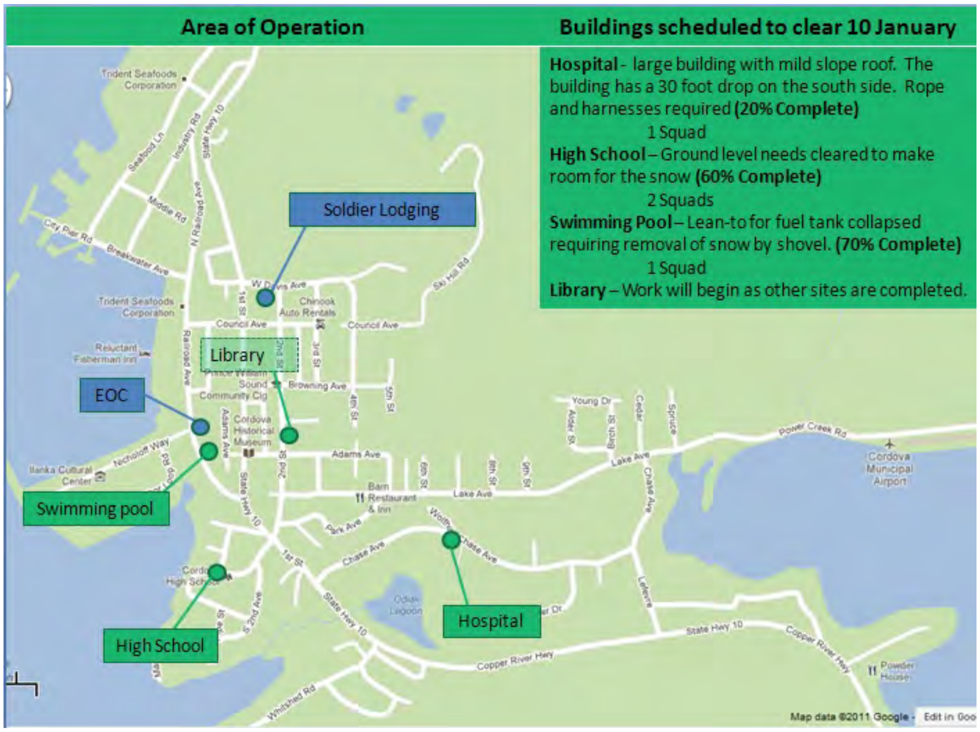


FIGURE 14 Map of the city of Cordova, Alaska, and sites for priority snow removal (January 2012).

ing; more heavy equipment, such as loaders, dump trucks, graders, and snow-melters from ADOT&PF (in collaboration with the private sector); and additional employees from the ADOT&PF to operate the equipment (*Situation Report 12-012—January 12, 2012* 2012). At the same time, an avalanche blocked access to the airport from the state-owned Copper River Highway, triggering formal engagement by the ADOT&PF leadership to prioritize snow and ice removal from that location (Anderson 2012).

The ADOT&PF's District Superintendent feels the overall response in Cordova "got behind" in mid-January. Then, the community saw no break in the storms into the first part of February 2012. To manage the night shift for ice and snow removal in February, the ADOT&PF interviewee reports, the agency brought in four people from other areas of the state to support local crews. ADOT&PF interviewees reported that by the end of March 2012, Cordova had received more than 320 in. (26 ft) of snow, with 280 in. (23 ft) at the airport, more than twice what it typically sees in a winter—which is "only" 120 in. (10 ft)—and the total cost to ADOT&PF for supporting Cordova during this event was $117,000. As noted, the city itself estimated snow-removal costs of more than $500,000.

State DOT Activities

Operations and Maintenance

The Statewide Maintenance and Operations Chief stated that he has to be a "professional weather watcher" to do his job. He receives daily briefings on weather across the state that will affect the agency's infrastructure and mission. He also relies on NOAA staff to report on ice conditions that will affect transportation.

ADOT&PF knew of the 2011–2012 south central storm from its beginnings. In late 2011, when the first set of storms was identified, the Chief of Statewide Maintenance and Operations increased communication with his district and local staff as well as with other agencies that supply information. Increased communication helped with identifying supplemental resources in advance of what looked like a major weather event. At the field level, the relevant district superintendent for Cordova reports that he reviewed the daily weather chart and made an estimate of what resources would be needed to remove the snow. Key issues included a possible deployment's timing and duration. These factors are important because most Alaska towns are many miles apart and not on the road system, requiring fly-ins. As a result, in that region of the country, a single day's deployment may not justify the cost of the flight, and the timing of a flight has to be accurate or a crew may arrive too late to be of assistance (see Figure 15).

ADOT&PF's express policy is to take proactive steps to position maintenance resources (ADOT&PF Winter Maintenance Coordination 2012). This policy was in place informally before the 2011–2012 storms; it was then formally promulgated during the storms. When the policy was simply an unwritten practice, employees understood its general features; however, a separate winter storm event in another part of the state had precipitated the agency writing it down. The triggering event was a severe weather incident on Kodiak Island that required extended overtime work by crews. The overtime wore the crews out, yet relief was not requested. To avoid any hesitation in the future, ADOT&PF codified what it informally refers to as its "no boundaries" maintenance coordination policy: Maintenance and Operations Directive 2012-2 (ADOT&PF Winter Maintenance Coordination 2012).

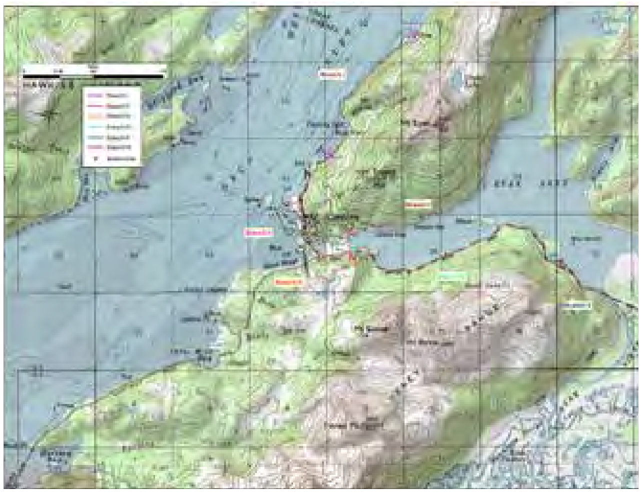


FIGURE 15 Map showing the locations of the city of Cordova, Alaska, and its remote administrative areas during the 2011–2012 snow emergency, within the Prince William Sound area of South Central Alaska (January 2012).

Also referred to as the "Winter Maintenance Coordination" policy, Directive 2012-2 states it is the responsibility of the Chief of Statewide Maintenance and Operations and the Regional Maintenance Directors to ensure the appropriate resources are allocated to winter operations, particularly during major weather events. Also, "personnel, equipment and materials from any and all maintenance stations can be dispatched to any area of the State at the discretion of the Chief" and his superiors. Primary consideration is to be given to coordinating with adjacent areas in order to ensure that continuous sections of roads crossing jurisdictions receive the same level of service. Stations must consider requesting assistance from stations in the same region. Above the district level, the regional manager must look across his jurisdiction for available resources as well, in order to support a district requiring a resource. Where a region cannot meet its own resource needs, it must go to the chief before contacting another region so that coordination is ensured (ADOT&PF Winter Maintenance Coordination 2012).

When Cordova was in an "emergency snow removal status" and staff was working 7 days a week to keep one lane of traffic open in town and out to the airport, ADOT&PF, consistent with Maintenance and Operations Directive 2012-2, brought in staff from other districts to support Cordova. The ADOT&PF employees were assigned to the city of Cordova's emergency operations, as were the National Guard troops also brought to Cordova (*Incident Overview 2013—Prince William Sound Winter Storm* 2012; see Figure 16). According to an interviewee, payment was arranged through a preexisting Reimbursable Services Agreement.

FIGURE 16 Alaska National Guard clears snow, Cordova, Alaska, January 11, 2012 (Flickr Commons, U.S. Department of Defense).

In Prince Williams Sound area where Cordova is located, and elsewhere in the field, maintenance crews rely on Road Weather Information Systems in 55 locations around the state to provide real-time weather data for getting crews into the field at the right time (*Situation Report 12-012—January 12, 2012* 2012). ADOT&PF is also testing a Maintenance Decision Support System (MDSS) that will provide crews with route-specific weather forecast information and road condition forecasts and treatment recommendations relating to the materials and timing of the application (*Situation Report 12-012—January 12, 2012* 2012). The MDSS will combine weather data from multiple sources, including the National Weather Service, Road Weather Information Systems, mobile temperature and moisture sensors on department equipment in the field, and other sources (*Situation Report 12-012—January 12, 2012* 2012).

Regarding financial procedures supporting the management of extreme weather events, the ADOT&PF had a mature set of processes in place to meet the financial demands of the 2011–2012 winter storms. First, ADOT&PF finance staff routinely subjects cost-collection to a clearly defined set of procedures that provide an early indication of what costs will and will not get approved (Schram 2012). The decision over whether to create a distinct code for a new event, however, is not overcomplicated by "process." According to the Chief of Statewide Maintenance and Operations and the Regional Maintenance, it is acceptable that "lots of little things don't go anywhere." In other words, job codes are created for weather events that do not materialize and this not an administrative problem. ADOT&PF staff reports that the key is to permit flexibility under uncertain conditions.

Second, ADOT&PF developed a set of documents and educational materials as "how-to" resources. These resources include a February 2012 presentation, developed before statutory changes in late 2012, used to instruct state staff. It details key issues for developing documentation for FHWA and FEMA applications (Schram 2012). Considerations and activities include identifying FHWA and FEMA thresholds for reimbursement of damage, listing the allowable and unallowed costs under each program, documenting damage and costs by site, detailing the kinds of photos needed, and explaining the retention schedule necessary for audits, which may occur well after the project is closed. The February 2012 ADOT&PF presentation also flags other issues relevant to recovery from an extreme weather event. It notes that reimbursement from FEMA and FHWA is only available if the site is restored to pre-disaster conditions, so, for example, if a recovery project creates a culvert when there was none before, there cannot be reimbursement for it. However, in these instances, FEMA and FHWA each allow a state DOT to seek prior approval for what was called a "betterment" project before recent statutory changes. The presentation's instruction on betterment is an example of how ADOT&PF has flagged key issues for consideration early on in decision making at the recovery stage. Although the February 2012 presentation predates some recent statutory changes, it is included for informational purposes as web-only Appendix F to this report.

Design and Construction

In the case of Alaska's 2011–2012 south central region snowstorms, there was no rebuilding needed on state roads or on ADOT&PF buildings. An ADOT&PF interviewee states that had one of its 720 buildings caved in from the snow, there may have been a claim made. It is noteworthy that a key design feature of Cordova's infrastructure mitigated the storms' impact. Because of the large amounts of snow the region receives, local authorities had had utility lines buried over the prior 6 to 8 years. The burial of utility lines makes them much less vulnerable to the high winds and other hazards (Anderson 2012). ADOT&PF staff confirmed the agency supports this approach in that area, making rights-of-way available for the buried lines where needed. As discussed in the Data and Knowledge Management section, design exercises will also need to consider changes to the freeze–thaw cycle.

Planning and Related Activates

In addition to checking weather forecasts, the Statewide Maintenance and Operations Chief keeps current on the work product of the Alaska Center for Climate Assessment and Policy (ACCAP), including ACCAP's snow projections for Alaska that are based on its climate change models. ACCAP is located at the University of Alaska–Fairbanks and is funded, in part, by NOAA's Regional Integrated Science Applications program, known commonly as the RISA program.

Based on these and other climate products, the Statewide Maintenance and Operations Chief anticipates future storms as severe as those in 2011–2012. As a result, in Anchorage, for example, he is working to expand the land area available for snow dumps. The relevant analysis involves consideration of environmental issues and the cost effectiveness of remote sites that require added time and resources to reach. He also is seeking to acquire snow-melters for Anchorage, noting the environmental consequences of their run-off are a current concern. This project he is undertaking is one example of decisions ADOT&PF need to manage in the future.

To broaden knowledge of these future trends and agency needs, the Statewide Maintenance and Operations Chief had ADOT&PF develop a document titled "Emerging Practices in Winter Highway Maintenance," released in October 2012 (*Emerging Practices in Winter Highway Maintenance* 2012). This document notes several winter maintenance concerns, including, as ACCAP projects, "more frequent, intense, and unpredictable weather events, including storms and winter warming periods." Technical solutions being planned include improved de-icing formulas, which reduce the corrosiveness of the de-icer; the use of sensors at a major bridge to determine when de-icing should be applied remotely; and the use of smart snowplows, which use GPS to provide a virtual view of the highway in whiteout conditions (*Emerging Practices in Winter Highway Maintenance* 2012).

Communications

To address the impacts of weather conditions on transportation, Alaska uses a 511 system that offers the public information on road conditions, closures, and construction. The public can also see road and weather conditions through the

Road Weather Information Systems cameras noted earlier. The 511 system provides information in multiple formats, including via the department's web page, by telephoning 511, by means of an RSS feed, and via an iPhone application, Facebook, and Twitter (*Emerging Practices in Winter Highway Maintenance* 2012). The department also has snow-plowing hotlines for the areas of the state connected to the state road system (*Emerging Practices in Winter Highway Maintenance* 2012). ADOT&PF is supportive of its staff giving interviews to the media but will follow the ICS model for centralized communications when appropriate.

Interagency Coordination

As noted in the Event Summary section of this case example, the National Guard deployed to Cordova in early January 2012. Owing to the closure of the Cordova airport, they had to journey from their muster site to Whittier, Alaska, which was at least a 2-hour trip. Then the troops took a 6-hour ferry trip on Alaska marine highway from Whittier to Cordova. To reduce the administrative burden to the National Guard troops, the Deputy Commissioner of Transportation and Public Facilities waived the near $100 fee for the ferry ride to Cordova, a potential value of $5,000. When they arrived in Cordova, the troops, along with ADOT&PF personnel, were integrated completely into the city crews, clearing such roads as the Copper River Highway.

Other interagency coordination occurred with partners, including the federal government, and its timeliness was critical to operations. To help clear the Copper River Highway and ensure airport access, for example, the FAA executed an emergency waiver to allow the use of airport snow-removal equipment off the premises of the Cordova airport.

Data and Knowledge Management

ADOT&PF uses various information sources and other materials to support planning decisions. As noted earlier, ADOT&PF has released a report on emerging winter maintenance issues and technical approaches to them, driven, in part, by the fact that winter weather will become less predictable. New practices being tested include sensors on bridges that can help determine when de-icer is needed, and more consideration is being given to the changing freeze–thaw cycle (*Emerging Practices in Winter Highway Maintenance* 2012).

An ADOT&PF interviewee noted that information pertaining to extreme weather may include the reports from a given incident and the data collected to support applications for reimbursement requests to FEMA, FHWA, and other agencies. These applications record the conditions at a site and costs. The applications are stored in paper or scanned form, and are kept by ADOT&PF under a defined retention schedule that supports responses to auditing requests for a significant time into the future. Where there is no federal reimbursement being requested, there is no separate project file; however, the ADOT&PF accounting system enables quick itemization of costs, under a distinct code, for its support to localities in these weather events.

The ADOT&PF Statewide Maintenance and Operations Chief states that he relies on the post-event reports developed by NOAA to understand past events and the possible reoccurrence of similar conditions and impacts in the future. In turn, he also has conducted an ACCAP webinar on ADOT&PF challenges under a changing climate. He views the relationship ADOT&FP has pursued with NOAA and ACCAP, the in-state RISA entity NOAA funds, as an important collaboration activity in the effort to address extreme weather impacts from a multidisciplinary perspective.

Lessons Learned and Related Practices

The following summarizes key practices identified in this case example by mission-related and crosscutting functions.

Practices by General State DOT Function

Practices by mission-related functions

Operations:

- Familiarity with weather forecasting and relying on NOAA for specific reports, such as ice conditions
- Reliance of maintenance crews on the Road Weather Information System, with real-time information on weather data so crews can get to the field at the right time
- Consideration of an MDSS, which combines weather data from multiple sources
- A "no boundaries" maintenance coordination policy that requires districts to seek assistance, as needed, and provides a framework for coordination with other districts, regional and statewide
- Assignment of codes to a weather event in order to advance decision making, with no concern about developing codes that "go nowhere" if the weather event does not become significant
- Development of detailed presentations on disaster response, including one setting out the requirements for federal and state reimbursement for damage and expenditures, including FHWA and FEMA thresholds as well as information on the "betterment" option to avoid rebuilding to the way state infrastructure was before, rather than improving it.

Maintenance:

- Under a disaster declaration, providing assistance to municipalities in the form of staff and heavy equipment such as loaders, dump trucks, graders, and snow-melters

- Considering several factors in deploying crews outside of their immediate geographic area, given the size of the state and limited transportation routes, such as the duration of the need and whether it is feasible to get the support there in time.

Design:

- Consideration of more severe storms and unpredictable weather that is expected and their implications on design; for example, the effects of the freeze–thaw cycle.

Construction:

- Supporting the burial of utility lines to avoid downed utility poles on the highway right-of-way.

Planning:

- Staying current on climate projections from the NOAA-funded entity intended to provide decision support for state and local entities and provision of briefings on state needs under more unpredictable weather
- Using snow and climate projections as a basis for seeking increased space for snow dumps, while addressing related environmental issues
- Researching and drafting a document outlining emerging practices in winter highway maintenance, noting that drivers for the document include the more unpredictable weather that is expected.

Practices by Crosscutting Functions

Communications:

- To communicate weather impacts, use of the 511 system that shows road conditions, closures, and construction, with camera views through the Road Weather Information System used by crews, and relaying information by means of the department web page, telephone, RSS feed, iPhone, Facebook, and Twitter
- Routine use of snow-plow hotlines
- Use of ICS communications protocol under an emergency but with support for interviews by staff.

Interagency Coordination:

- Facilitating the deployment of the National Guard by waiving substantial transportation fees for the long trip necessitated by the closure of airport at disaster declaration site
- Working with FAA to secure a waiver allowing use of FAA airport equipment off site to clear the state highway leading to the airport and ensure airport access
- Supporting state DOT employees assigned to city emergency operations team, with effort paid for through preexisting reimbursable agreement.

Data and Knowledge Management:

- Collecting and reporting on emerging winter maintenance practices in light of more severe and unpredictable winter weather
- Using NOAA post-event reports and providing briefings on state needs under more unpredictable weather to the NOAA-funded entity designed to provide decision support for state and local entities
- Storing applications for federal reimbursement in paper or scanned form, with defined retention schedule of projects searchable by event code.

CASE 7 : TEXAS—DROUGHT AND WILDFIRES (2011)

Introduction

The Texas Department of Transportation (TxDOT) is responsible for the construction and maintenance of the Texas highway system, the largest in the United States. Through a routine maintenance budget of $900 million per year, a workforce that includes 5,000 maintenance personnel, and 254 maintenance stations across the state, TxDOT manages 193,000 miles of roadway. These roads include farm-to-market, ranch-to-market, state, U.S., and interstate highways (*The Compass Project* 2009). Many of these routes cross rural, remote counties. TxDOT also oversees aviation, ferry, rail, and public transportation systems in Texas.

In 2011, Texas experienced the worst 1-year drought since its rainfall records began in 1895 (Kennedy 2011). The drought cost the state $5.2 billion in livestock and crop losses, and some communities simply ran out of water (Jervis 2011). Temperatures hit record highs.

The prolonged heat also caused pavement distress that required vigilance from TxDOT maintenance crews and the public. Additionally, low moisture and high temperatures conditions catalyzed more than 30,000 wildfires throughout the state, which, according to an interviewee, burned in aggregate an area the size of Connecticut. TxDOT has a limited role in wildfires, supporting other agencies that have first responder, emergency management, or public land management responsibilities (Nash et al. 2012). During the 2011 wildfires, TxDOT protected and repaired assets within its rights-of-way and assisted state, local, and federal agencies in wildfire suppression.

This case example reviews TxDOT's response to these two risks—wildfire and pavement distress—that arose in 2011 in extreme drought situations. TxDOT practices are described generally, and details from the Childress–Amarillo and Bastrop wildfires provide further illustration. This case example uses the term "wildfire"; however, TxDOT employees involved in wildfire control on public land use the land management term "wildland fire."

Event Summary

In 2011, 80% of Texas experienced "exceptional" drought, the most severe ranking according to the National Oceanic and Atmospheric Administration (NOAA; Jervis 2011). The 2011 drought followed a wet summer in 2010, which had spurred vegetation growth. The high volume of vegetation made wildfire conditions more acute and widespread (see Figure 17). Two fires exemplify the disruption caused by the 30,000 wildfires that year. In February, a fast-moving blaze in west Texas near Childress and Amarillo forced evacuations and charred more than 120,000 acres ("TxDOT Crews Helped Battle West Texas Wildfires" 2011). In September, sparks from wind-damaged power lines caused a 6-week fire in Bastrop County in the south (George and O'Rourke 2011), outside Austin, that burned more than 1,600 houses, killed two people, and caused $350 million in damage (Insurance Council of Texas 2011).

The 2011 wildfires affected TxDOT directly as a land and asset manager. For example, in September 2011, the Bastrop County wildfire destroyed a TxDOT wildlife corridor for endangered species as well as the wooden posts that secure guardrails, effectively decommissioning miles of TxDOT guardrails (see Figure 18). TxDOT's other role in wildfires falls under the rubric of the state's emergency management procedures. On request from the Texas Division of Emergency Management, TxDOT provides equipment and manpower to create fireguards along the state right-of-way, and again, if requested, off the state right-of-way. In 2011, TxDOT provided several services to agencies and entities responding to the wildfires, such as local volunteer fire departments. These activities included the supply of fuel, signage, and other forms of public information. TxDOT also allowed several counties to deploy burn bans signs on the state highway right-of-way.

The 30,000-plus wildfires were a major focus for TxDOT in 2011 (Nash et al. 2012). Whereas TxDOT maintenance districts typically have one to six requests for assistance annually, in 2011 at least one district responded to 50 wildfires (*Best Practices for TxDOT . . .* 2012). TxDOT's interviewee reports that fuel vehicles used primarily for hurricane evacuation and reentry were used for wildfires in 2011. TxDOT supplied these fuel resources to local volunteer firemen when requested by the Department of Public

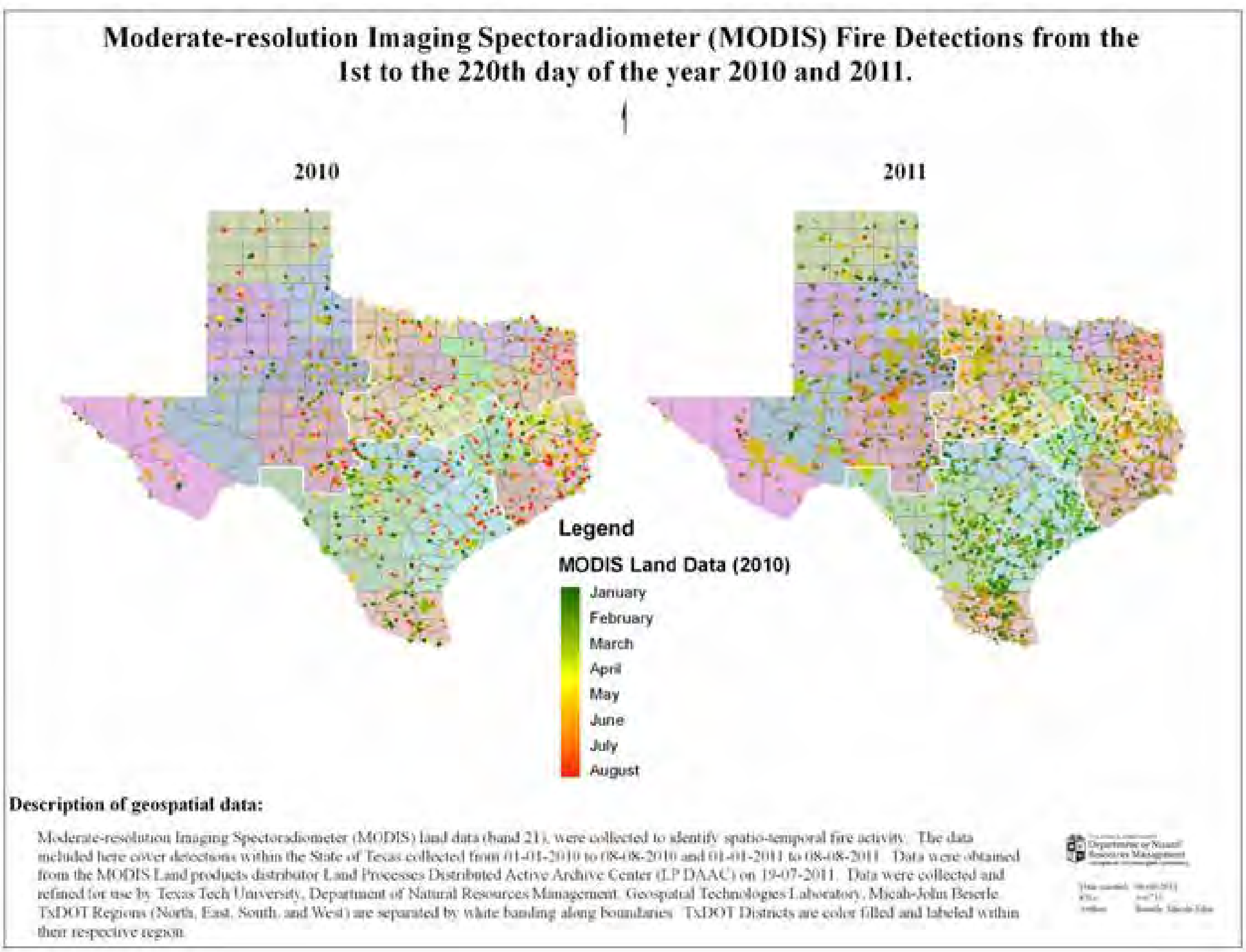


FIGURE 17 Map of Texas, showing increased distribution and instances of wildfires in the state between 2010 and 2011 (2011).

Safety's (DPS) District Chairman to do so. And TxDOT was expected to come through in these instances—wherever the fire was located in the state. For example, nearly all of the TxDOT Childress District's 120 maintenance employees worked in shifts for 3 days, transporting fuel, building fireguards, and carrying water to support suppression of fires on 120,000 acres ("TxDOT Crews Helped Battle West Texas Wildfires" 2011). They also provided motor graders and bulldozers to help extinguish and block the fires from spreading ("TxDOT Crews Helped Battle West Texas Wildfires" 2011). According to an interviewee, TxDOT expended a total of $5 million from its budget to assist with wildfire suppression activities in 2011.

FIGURE 18 Smoke from wildfires nearing roadways in Bastrop County, near Austin, Texas, September 5, 2011 (Flickr Commons, jonl).

Although TxDOT addressed the wildfires largely through its role in land management and the DPS' emergency management framework, the 2011 drought also affected the delivery of road maintenance important to the safety of the traveling public. For example, owing to 2011's high temperatures, in some locations the armor joints on guardrails buckled, popped up, and bent, lessening their strength and utility.

Pavement distress, especially, was a maintenance issue exacerbated by the prolonged heat. TxDOT reports that it managed pavement distress quite actively in 2011. High heat and dry soils cause shrinkage under roadways. The resulting cracks can be 4 to 6 in. wide and extend 4 to 5 ft into the soil. A TxDOT interviewee reported that local maintenance crews rode the roads every other day in 2011 and reported problems to the area engineer, who would tell the District Maintenance Director if the problem was outside the norm. In west Texas, because high heat is the norm, pavements are designed to handle related stresses. However, in 2011, the drought was so extreme that TxDOT began to identify and differentiate other drought conditions that cause increases in cracking. For example, growth of vegetation within the highway right-of-way during water-poor conditions affects pavement because root systems extract moisture from the soil, causing shrinkage that leads to cracking in the pavement. Also, in the southern part of the state where pavement is not designed for the high temperatures that can occur, for example, in west Texas, the high temperatures in 2011 led to road distress. Such road distress was worsened by truck rutting from energy development in that region. TxDOT sought to address rutting as soon as possible and took active steps to keep vegetation away from the pavement to prevent edge-cracking. Overall, pavement distress cost TxDOT $26 million in 2011.

State DOT Activities

Operations and Maintenance

According to the TxDOT Emergency Manager Coordinator, wildfires are a year-round threat in Texas, and TxDOT districts keep equipment "pre-loaded" and ready to deploy. Although TxDOT has no formal staging protocols, it seeks to pre-position resources so that TxDOT can respond quickly to a request for assistance during a hurricane, wildfire, or other disaster. TxDOT noted that Texas is different from many other states in that its transportation agency handles wildfire matters. For example, the neighboring state of New Mexico has similar geography but its state department of transportation does not engage as heavily as TxDOT does in wildfire activities.

Under wildfires, TxDOT provides several services to agencies and entities, such as local volunteer fire departments, including, as noted previously, the supply of fuel, signage, and other forms of public information. The TxDOT maintenance crews keep 700-gallon tanks (diesel or unleaded) mounted on the back of 6-yard dump trucks, and it maintains contracts for bulk fueling so it can activate the use of larger, 6,000-gallon transport with eight fuel pumpers on each side of the truck. On request from the State Division of Emergency Management's Disaster District Chairmen (DDC), TxDOT also provides equipment and manpower to create fireguards along the state right-of-way. Additionally, as noted, TxDOT will work with counties in advance of a wildfire to allow them to deploy burn bans on the state right-of-way if they meet TxDOT's standards and policy.

During wildfire events, TxDOT works with the Division of Emergency Management's State Operations Center (SOC) and DDC, and keeps abreast of daily operational fire conference calls. TxDOT districts typically coordinate with the DDCs, Department of Public Safety, Texas Forest Service, local governments, Texas Commission on Environmental Quality, and utility companies during a wildfire event, using ICS principles. To maintain a consistent chain of command, however, TxDOT and its crews do not respond to a wildfire until notified by the DDC, which gives official notice to the Director of Maintenance or TxDOT Director of

Operations, who, in turn, contacts the Maintenance Supervisor (see Figure 19).

FIGURE 19 Controlling a wildfire along highway right-of-way near Highways 71 and 21, southeast of Austin, Texas, October 8, 2011 (Flickr Commons, MotleyPixel).

TxDOT keeps strict adherence to its own transportation-focused mission when deployed, including use of equipment. The equipment typically requested are dozers, motor graders, fuel trailers, water trailers, sign trailers, and traffic control devices, and the policy is that only TxDOT personnel use TxDOT resources. Also, TxDOT will not engage in wildfire activities off its right-of-way until officially directed by the District Disaster Chairperson. Even where TxDOT acts as a first responder, which can be the case in very rural areas, TxDOT still cannot and will not go off the right-of-way to aid a community. There must first be an imminent threat to life or property, and even then TxDOT's role will be to create firebreaks or reduce the threat of destruction until support arrives. Additionally, TxDOT employees do not fight fires directly. As a result, while on duty for TxDOT in 2011, no TxDOT employee used fire safety equipment or personal protective equipment. However, where a TxDOT employee worked for a local volunteer fire department, they were very often granted personal leave for a wildfire event during 2011. TxDOT's response may be immediate if the wildfire poses an imminent threat to life and property.

TxDOT seeks reimbursement from FHWA for some wildfire activities, usually for major catastrophic fires, as described in the Interagency Coordination section of this case example. To collect data on events, the interviewee stated that many districts use Daily Activity Reports and Microsoft SharePoint. TxDOT tracks the cost of task for a particular event by giving it a task number and passing that task number on to the district. Using SharePoint, anyone helping in the development of the file or its related application to FHWA can see changes to the file and add to it.

The interviewee stated that TxDOT talks to maintenance crews about drought practices in maintenance workshops. The TxDOT interviewee also reports that it is common for TxDOT to write off the costs of supporting wildfire suppression work for rural communities, and the reimbursement documentation required by the federal government sometimes outweighs the actual cost of the response. In 2011, few districts applied to FHWA or FEMA for reimbursement for wildfire fighting.

Separately, where TxDOT has surplus material of potential use to a locality, such as reclaimed asphalt, the materials may be offered to a local country government. TxDOT keeps the process transparent when providing such services to a rural county. Offers of assistance to counties are sent to the county judge, a position that in Texas has executive power. Requests for assistance from the county must be on the judge's letterhead. Abiding by these detailed procedures sees TxDOT maintenance personnel maintaining a clear line of communication and authority on resource decisions in the many localities across the state.

Design and Construction

TxDOT has established ways to address emerging issues relating to the condition of the state's highways, relying on in-house and outside support for research. To find trends, TxDOT will work with academic institutions, which advise on where they see recurring problems, and develop research methods to determine the cause. For example, there is a current TxDOT initiative to look at the effect on state roads of energy development and associated truck traffic. The TxDOT interviewee notes that the Texas Petroleum Producers wish to support TxDOT in addressing impacts. A study is under way with the Texas Transportation Institute to determine the costs for design and construction alternatives in order to progress discussions around this industry commitment.

Planning and Related Activities

After the 2011 drought, TxDOT's emergency management role commanded the attention of planners and management, given the criticality of the TxDOT function as well as the many other agencies and stakeholders involved. As a result, TxDOT has made sure to focus on drought impacts in its maintenance workshops. TxDOT also is a participant in the State of Texas Drought Preparedness Council in order to help define and plan for its likely role in future years. The function of TxDOT in addressing drought will vary from emergency utility permits to hauling water, along with the functions detailed in this case example.

The TxDOT interviewee reports that TxDOT has required staff to take FEMA Independent Study training online from the FEMA Emergency Management Institute. TxDOT also ensures employees are clear on the agency's responsibilities in a wildfire setting via training on TxDOT's role and other approaches. A key message in training is "we are not firemen," which TxDOT management believes can be a lifesaver during a wildfire event. As noted, TxDOT employees do not fight fires, so while on duty for TxDOT in 2011, no TxDOT employee, as noted earlier, used fire safety equipment or personal protective equipment. However, to ensure TxDOT preparedness and safety, after 2011's major wildfires ended, TxDOT also invested in two response trailers. Response trailers are 30-ft-long mobile workspaces wherein local TxDOT crews (at one of the 254 TxDOT maintenance stations, for example) can receive information on wildfire characteristics and shelter deployment training. The trailers can be pre-positioned and are stocked with fire protective suits, helmets, and fire shelters. In December 2012, for example, when the number of wildfires was low but still posed a threat, TxDOT was able to position the trailers and crews so that they could be nearest the at-risk locations.

Communications

For wildfires, TxDOT keeps to emergency management/ national incident management protocol wherein public communications are handled entirely by the public information officers of the state administration. If an event relates only to internal TxDOT activities, then the TxDOT Public Information Officer at the relevant district level will speak for the agency.

In support of strong public communication, TxDOT provides updates to the public on highway conditions and road closures related to wildfires through the state Highway Condition Reporting System (TxDPS 2011). Districts are required to enter highway and weather conditions into a Highway Condition Report every workday morning by 8:10 a.m. and to update the information as needed (Manual Notice 2008-01 2008). Districts are required to report the following types of information (Manual Notice 2008-01 2008):

- Local NWS forecasts
- Highway conditions that close travel in one direction for more than 4 hours or that create hazardous travel, including construction or maintenance sites, roadway or right-of-way damage, major accidents, or hazardous spills
- Weather-related events that may cause unsafe driving conditions, such as ice, sleet, snow, floods, high winds, or hurricanes.

Although TxDOT has no formal responsibility for public notification of wildfire events, wildfires are the type of weather-related event reported in Highway Condition Reports. The public, news media, public agencies, and designated advisory services may access information in the state Highway Condition Reporting System by calling TxDOT or by accessing TxDOT's web page.

It also is TxDOT's responsibility during wildfires to display appropriate information on its network of dynamic message signs. TxDOT works with the Division of Emergency Management's State Operations Center to determine the best message content and where and when to display it. Sign messages can be tailored to the situation in a given area, warning of highway closings, burns bans, and wildfire danger. An effective practice, especially with wildfires, is not to keep the message up for too long because the public begins to ignore the same message over time. During the wildfire season, TxDOT alternates wildfire awareness messages with other messages. When there is a very specific message on wildfire, TxDOT can change the message quickly if asked by the SOC.

After the 2011 events, TxDOT also needed to communicate and explain its role during the year's drought to various policy makers. For example, it provided the Texas state legislature with technical replies to inquiries about various pieces of legislation introduced in response to the 2011 drought.

Interagency Coordination

Where TxDOT knows a wildfire will be a major event that can contribute to the destruction of highway infrastructure, it notifies FHWA and FEMA and brings them in on response and recovery early. In the case of the September 2011 Bastrop County wildfire, for example, TxDOT estimated the cost of repair, reached out to FHWA (which concurred verbally), and then sent the paperwork over to FHWA for review and approval. Within a few days after the Bastrop County fire, TxDOT secured approval for reimbursement from FHWA. The collaborative relationship with FHWA worked well for TxDOT in other ways. After the Bastrop County fire, through negotiation with FHWA, TxDOT secured reimbursement for the costs of removing scorched trees at risk of falling into the roadway. FHWA paid for the removal of the tree. TxDOT praised FHWA for its simple processes and the continuity in the staff with whom TxDOT interacts. TxDOT noted that other agencies, such as FEMA, may provide a different representative each time—each with the different message and each with a seemingly different interpretation of the FEMA public assistance manual.

Data and Knowledge Management

TxDOT supported the development of a recent work product from Texas researchers, a report on TxDOT Best Practices for Wildfires, which is included as web-only Appendix G to this report, along with two related presentations. That synthesis of TxDOT fire-control activities was commissioned after 2011's devastating wildfire season.

The TxDOT interviewee has observed that the larger the weather event, the more entities that may offer help, which creates data management issues. TxDOT came across a reimbursement hurdle, for example, involving volunteers who came to Texas from out of state to lend help pursuant to Emergency Management Assistance Compact (EMAC). Under EMAC, other states will offer up and quickly send resources to another state affected by a major disaster. Under EMAC and a related grant program, TxDOT may provide fuels to volunteer fire departments from other states supporting the Texas emergency management leadership on wildfires. TxDOT has developed and successfully used a fuel issue invoice to facilitate that activity. On the other hand, TxDOT also has been denied the ability to process a Fire Management Assistance Grant because it had lacked documentation of an out-of-state emergency response vehicle's license plate. Not knowing which state the non-Texan was from made it difficult for the grant administrator to determine whether the out-of-state responder was asking for the same costs to be covered under his own state's application process. TxDOT views not having that level of documentation as a lesson learned. It was not a severe problem but a problem for consideration in future events.

One aspect of Data and Knowledge Management implicates program definitions, their applicability, and use. The TxDOT interviewee noted the correct term to use for this case example concerning wildfires was "wildland fires." He had this preference because the term "wildland fire" is the one used by the land managers whose job it is to manage public land resources, including the fires on it. Although the term "wildfire" is the more commonly known term and the one adopted by the sponsors of this TRB research, it is distinct from the land management program terminology deliberately adopted by TxDOT personnel. TxDOT's role in this area is still developing (Nash 2012), yet TxDOT is disciplined in defining the limited scope of its responsibilities, by adopting, for example, the terminology of sister agencies with direct responsibility for managing the fires, such as the Texas Forest Service.

Lessons Learned and Related Practices

The following summarizes key practices identified in this case example by mission-related and crosscutting functions.

Practices by General State DOT Function

Practices by mission-related functions

Operations:

- Ensuring the state DOT role is defined as a supporting role to the primary agencies that respond to wildfires, using ICS principles and relying on express instructions on actions to take
- Reaching out to FHWA to seek early buy-in on project for which state DOT would like see federal reimbursement
- Participating in daily operational calls during a wildfire event
- Supporting the statewide emergency response to wildfires by
  - Supplying fuel and water
  - Supplying traffic control
  - Supplying sign trailers and other signage, website information, and other information for the public
  - Creating firebreaks in part by supplying heavy equipment, such as graders and bulldozers, and employees to use them
  - Permitting counties' access to state rights-of-way for posting burn ban signs
  - Issuing emergency utility permits.
- Leveraging fuel vehicles used for hurricane evacuation and re-entry to support local volunteer fire departments in fighting catastrophic fires
- Weighing the administrative and opportunity costs of seeking federal reimbursement for support to counties and other state agencies, with the benefit received
- Challenging FHWA on issues of first impression, including attempting reimbursement from FHWA for damage from wildfire for scenarios that have not been requested before but may become routine under increased wildfires—for example, payment for removal of scorched trees that may fall onto roadways.

Maintenance:

- Keeping fire control-support resources "pre-loaded" and ready to deploy throughout the state
- Ensuring primary message to employees involved in supporting wildfire-control is that the state DOT are not firemen
- In fire situations, having only state DOT employees use state DOT equipment
- Ensuring employee preparedness and safety through the acquisition and pre-positioning of two response trailers with protective gear where local crews can receive briefings on wildfire characteristics and shelter deployment training
- Discussing drought issues in maintenance workshops
- Patrolling for road cracks and other pavement degradation from drought.

Design:

- Determining the possible causes of road degradation under drought in order to assess the most appropriate response, through materials design or landscape approaches.

Construction:

- Enlisting in-house and external resources to collect and record existing effective practices, as well as emerging stressors, such as increased highway degradation from energy development.

Planning

- Participating in the state's Texas Drought Preparedness Council

- Ensuring employees have both FEMA training and a clear understanding of the state DOT's supporting role in wildfire control.

Practices by Crosscutting Functions

Communications:

- Using the state's general Highway Condition Reporting System to present information on wildfires
- Working with the state EOC to determine proper messaging for state DOT dynamic messaging signs in wildfire areas
- Supporting knowledge transfer by providing technical comments to state legislature draft documents.

Interagency Coordination:

- Working with FHWA early on in estimating costs of repairs from wildfires to expedite approvals for reimbursement
- Using collaboration tools such as Daily Activity Reports and SharePoint to collect data on events.

Data and Knowledge Management:

- Researching structural and operational issues arising under drought response
- When implementing a new or expanded role that supports the primary mission of a sister agency, such as wildfire control, remaining very disciplined as to the state DOT's exact role and own mission—for example, by adopting the terminology of the lead agency
- With the increased need to use the EMAC system, considering lessons learned from prior use of resources from out of state.

CASE 8 : WISCONSIN—PROLONGED HEAT EVENT (2012)

Introduction

The Wisconsin Department of Transportation (WisDOT) plans, builds, and maintains 11,750 miles of state highway, which carries 60% of the state's traffic (Bessert n.d.) There are also 103,000 miles of county highways and town and municipal streets in Wisconsin (Bessert n.d.). WisDOT also engages in planning for rail, public transit, waterborne freight, and air transport (Bessert n.d.).

July 2012 was the hottest month on record for the contiguous United States (Samenow 2012; *2012 Wisconsin Yearly Weather Summary* n.d.). In that month, Wisconsin had 12 deaths attributable to the heat (*2012 Wisconsin Yearly Weather Summary* n.d.), given the record-setting heat in the early part of the month followed by sustained high temperatures. In Wisconsin, a quick rise in temperature from late June into July created the conditions for road buckling. The heat buckling or "blow-ups" appeared randomly ("Relief in Sight for Heat, and Why Roads Buckle" 2012); according to the WisDOT interviewee, they were over a foot high in several instances, causing traffic incidents that sent people to the hospital ("Relief in Sight for Heat, and Why Roads Buckle" 2012).

WisDOT responded by preparing maintenance crews and conducting risk communication. When the season was over, WisDOT initiated research to analyze trends, determine costs, and consider the proper data to collect for its maintenance tracking system for future heat events.

This case example describes how WisDOT managed this extreme weather event's impacts and developed a structured response to future events of this kind.

Event Summary

In 2012, temperatures quickly spiked well into the 90s from July 2 through July 6, with some places hitting 100°F between July 4 and July 6. Heat buckling–induced incidents and lane closures arose quickly as a result. For example, on July 1, an SUV hit a blow-up on State Highway 29, launched off the pavement, landed on the roadway, crossed the median, managed to avoid opposing traffic, and stopped in a grassy area ("Relief in Sight for Heat, and Why Roads Buckle" 2012). According to a WisDOT interviewee, other instances of blow-ups averaged 30 to 40 a day (see Figure 20).

When the spike in temperature first occurred, WisDOT engineers closely tracked temperatures because they knew from experience that just a few days at 90°F would create risk conditions for Wisconsin's concrete roadways. When high humidity was factored in, the heat indices ranged from 100°F to 115°F in the afternoon, so WisDOT and crews had a sense of how long blow-up activity might continue.

WisDOT also was aware that blow-ups would occur after midday and worked with the assumption that maintenance crews had a fixed window of time to fix blow-ups before the evening peak hour. Based on temperature increases and this insight, WisDOT maintenance coordinators ensured county service providers were prepared by organizing crews and repair teams. Each crew had a set of equipment, and to ensure proper staffing decisions, WisDOT communicated to crews that blow-ups would occur in the afternoon when the pavement was hottest.

According to the interviewee, WisDOT staff and county crews primarily learned about actual heat-buckling events through reports. Although there was an occasional patrol for heat buckling, WisDOT relied on 911 or the other reports made by the public or law enforcement to the WisDOT State Traffic Operations Center to learn of instances of heat buckling. WisDOT mapped the blow-ups on a Google Map, inputting a "pin" for each blow-up site. The State Traffic Operations Center provided hourly updates to WisDOT upper management and Operations leaders.

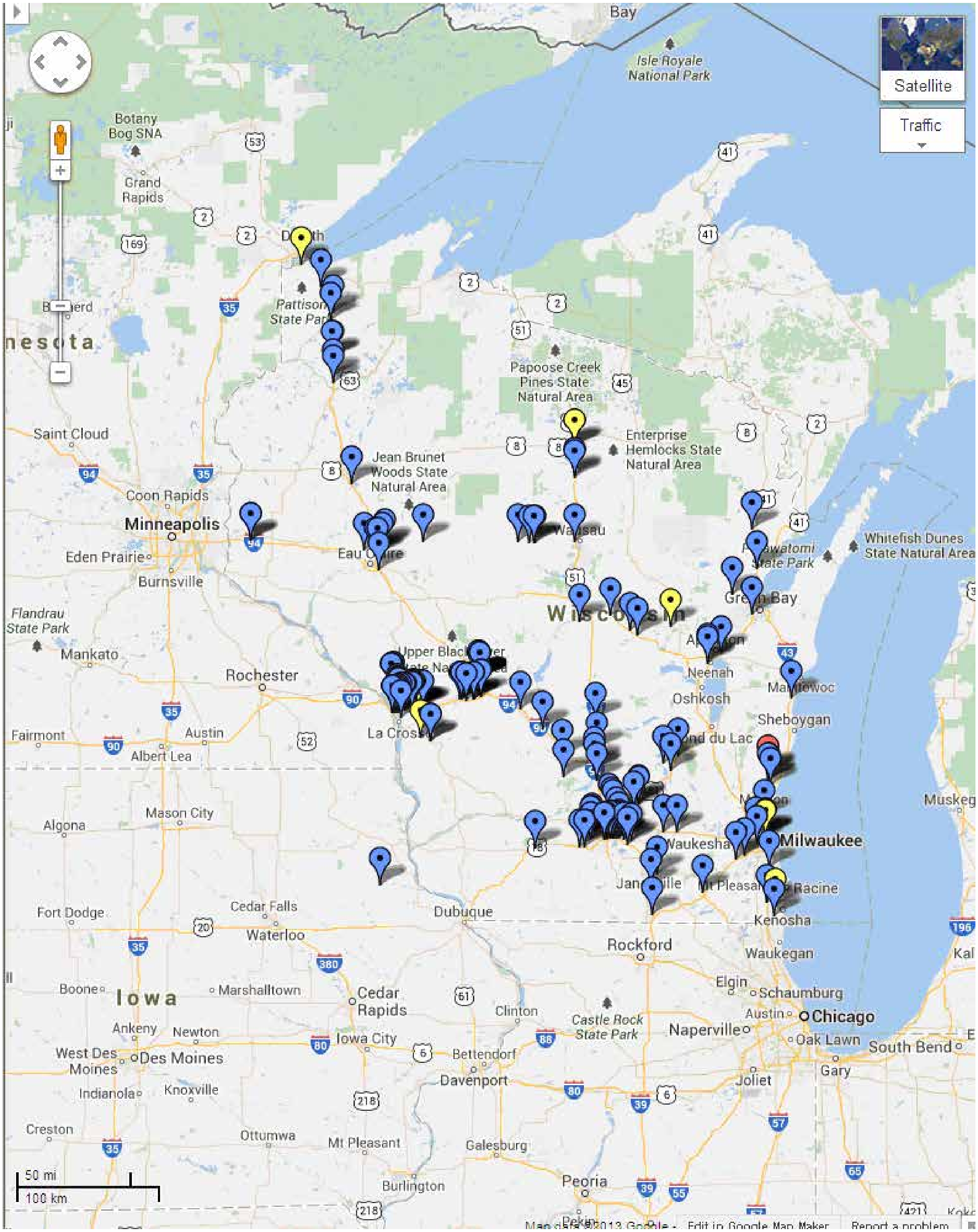


FIGURE 20 Map of Wisconsin, showing heat-buckling incidents on roadways between June 9 and July 6, 2012 (2012).

The WisDOT response was conducted under its “Adverse Conditions Communications Plan.” A WisDOT interviewee stated that WisDOT had developed this plan largely for flood and winter storm events; however, by using its processes, the heat-buckling event could be treated as a major weather event. Although not Emergency Management, the plan’s approach enabled clear lines of communication with state law enforcement on the ground, including, for example, timely deployment of Portable Changeable Message Systems. The WisDOT Adverse Conditions Communications Plan and Emergency Transportation Operations Plan are in web-only Appendix H.

When a blow-up was reported, WisDOT would contact a county maintenance crew. The crew would rush to the location, assess the problem, coordinate with law enforcement, and typically put in a temporary fix to get traffic moving again. Specifically, crews either cut or jackhammered away the affected materials and put in a temporary asphalt patch (“Relief in Sight for Heat, and Why Roads Buckle” 2012). Depending on the bump-up, a repair can take from 30 minutes to 3 hours. Traffic-control tools—such as arrow-boards, drums, and crash cushions—divert vehicles from the patched site. Crews used cold patch materials to do the temporary fill. As noted, these activities were done in coordination with law enforcement, which often arrived first in response to a 911 call or a report from the public. The WisDOT interviewee reported that, early in the event, WisDOT would ask a county maintenance service partner to create a separate “job number” and document the exact location of the blow-up.

WisDOT also conducted public communication efforts and outreach during the 2012 blow-ups. WisDOT uses a 511 system and directed the public to it; there, they could receive online updates of road conditions, incident alerts, and cautionary messages. WisDOT also uses Twitter to relay cautionary messages and incident alerts, but not traffic updates.

The July 1 blow-up on Highway 29, mentioned earlier in this case example, was caught on video, and had gone viral on the Internet by the July 4 holiday. WisDOT responded to this incident and the broader problem with more press interviews, including one with CNN, which also aired the video (Sperry 2012). WisDOT also issued the following warning on July 5 (WisDOT 2012):

> With most of the state under an excessive heat warning until Friday night, the risk of pavement buckling will be high today and tomorrow, according to Wisconsin Department of Transportation officials.
>
> During hot weather, pavement tends to expand. Where there are expansion joints, the slabs of pavement push against each other and if the pressure becomes high enough, the pavement may buckle.
>
> On July fourth, approximately 17 pavement buckles on major highways were reported to WisDOT. County maintenance crews were able to repair the highway buckling, on average, in about two to three hours.
>
> “We are continuing to monitor the major highways and are coordinating with county highway maintenance crews in case of more buckling today and tomorrow,” says Rory Rhinesmith of WisDOT. “However, pavement bucklings typically are quite random and motorists need to be prepared.”
>
> WisDOT officials recommend the following safety tips for motorists in case of pavement buckling:
>
> - Report pavement buckling by calling 911.
> - Before your trip, check highway traffic conditions via the 511 Wisconsin Travel Info system by dialing 511 or visiting www.511wi.gov on the web.
> - To protect highway crews as they repair buckled pavement, shift lanes or slow down as required by the state’s Move Over law.
> - And as always slow down, pay attention, buckle up, and be prepared to move over.

In addition to the information in the earlier warning, WisDOT representatives took media interviews and asked drivers to “stay alert and be on the lookout” for blow-ups.

Over a two-month span in 2012, WisDOT recorded 30 days in which pavement heat topped 115°F. For 2012, according to an interviewee, the estimated total cost of repairs was $800,000 to $1,000,000, counting temporary fixes and return trips to the site specifically for permanent repair of the blow-up. That figure does not reflect the cost of permanent repairs, which were later conducted during routine road maintenance and without the specific purpose of patching the blow-up site. As a result of the 2012 heat event, WisDOT is actively pursuing methods for anticipating heat buckling and improving highway design to mitigate it.

State DOT Activities

Operations and Maintenance

WisDOT’s State Traffic Operations Center set up a map to record blow-ups and chose Google Maps because it was available online, which helped in updating the WisDOT leadership. The Google Map was shared internally within WisDOT and the state Emergency Operations Center. WisDOT used the 511 website for external communications and included the locations of pavement buckling that was relevant to the traveling public. The State Traffic Operations Center was responsible for keeping both the Google Map and the 511 website up to date.

A temporary fix to the blow-up site might be replaced with a permanent fix fairly soon after the event, or it may remain in place for months. In the case of the July 2012 heat wave, some fixes were left in place until pre-winter maintenance activities came through the area, providing opportunity for a more permanent fix. WisDOT is aware that it is not capturing the full cost of the blow-ups by folding the permanent repair into routine maintenance, but it believes efficiency is better served by making fewer trips to the relevant segment of roadway (see Figure 21).

FIGURE 21 Vehicle goes airborne after hitting a heat-buckling site on State Highway 29 Chippewa Falls, Wisconsin, in 2012 (*Courtesy*: Theresa L. Reich).

As noted, early in the July 2012 heat event, WisDOT asked county crews to create a separate job number for a blow-up and identify and document its exact location. Despite this level of reporting, WisDOT did not apply for FHWA funding for costs associated with this event because WisDOT determined that the roadwork from the extreme heat event did not meet the threshold for FHWA reimbursement. Also, WisDOT did not look to FEMA for funding because its funding is not available for state roadway damages of this kind, though it will pay for roadway debris removal and emergency protective measures.

Design and Construction

The WisDOT Chief Materials Engineer manages a state laboratory that reviews pavement and geotechnical issues, and also provides quality assurance in those areas. As such, he often is "the tip of the spear" on design issues. In response to the July 2012 heat-buckling event, the chief materials engineer is reviewing design criteria used in construction practices, and an initial focus is urban area roadway joints. To support this review, WisDOT created a database of heat-buckling locations in the state for 2012. Data were derived from the Google Maps developed at the time of the event, and the number of heat-buckling sites totaled 300. Unlike places where asphalt is used for pavement, such as the southwest United States, Wisconsin's concrete roadways are stiffer and its joints more stressed from winter, increasing the risk of blow-ups under high heat conditions. Age of the concrete is another factor in whether it will heave. Data being collected in the WisDOT database include age and depth of the pavement, including the type and orientation of the joints. Joint factors describe whether spacing is consistent or random, skewed or non-skewed. This information will support analysis of what is occurring and where so that WisDOT's construction office can understand how existing agency assets and materials may be performing.

Planning and Related Activities

Wisconsin is one of 16 states that pooled money to purchase and share a Maintenance Decision Support System (MDSS). Until recently, WisDOT's use of this tool had been geared to winter weather events. The 2012 event demanded more and more information from WisDOT staff, and WisDOT now intends to add heat-buckling forecasts into MDSS.

Heat buckling occurs when pavement expands at a crack or weakened joint. When the expansion has no place to go, it goes up and over the pavement surface. Much of the roadways in Wisconsin are concrete, which does not expand easily, and the region's repeated freeze–thaw cycles deteriorate joints. Asphalt pavement can be more elastic, but where it lies over or adjacent to concrete, asphalt will heave as well. When a heat event comes on quickly, as it did in July 2012, WisDOT staff knew that there would be a "much higher frequency" of buckling. When Fahrenheit temperatures are in the upper 90s, the pavement's heat can be 115°F, a point at which buckling can occur. In July 2012, there were readings of 135°F on the pavement. To better structure an enterprise response to these types of event, WisDOT is looking into configuring MDSS to provide e-mail and phone alerts for when pavement will be hot enough to trigger buckling in certain locations (see Figure 22).

Communications

WisDOT's "Adverse Conditions Communications Plan" scaled the state's response to the 2012 heat-buckling incidents to the relevant sector involved: transportation. Its reporting structure enabled quick action but did not require the resources of emergency management. WisDOT reports that an emergency management approach may have been used under this heat event if there had been widespread heat illness and other public health conditions not controllable by behavior change.

Interagency Coordination

As noted earlier, the 2012 heat-buckling incidents in Wisconsin were managed as a traffic issue. WisDOT relies on strong ongoing relationships with county maintenance and law enforcement to manage the problem. Coordination with local law enforcement facilitated access to sites for temporary fixes by county crews. WisDOT contracts all of its highway maintenance to each county. The WisDOT interviewee states that the relationship is seamless and has been so "for

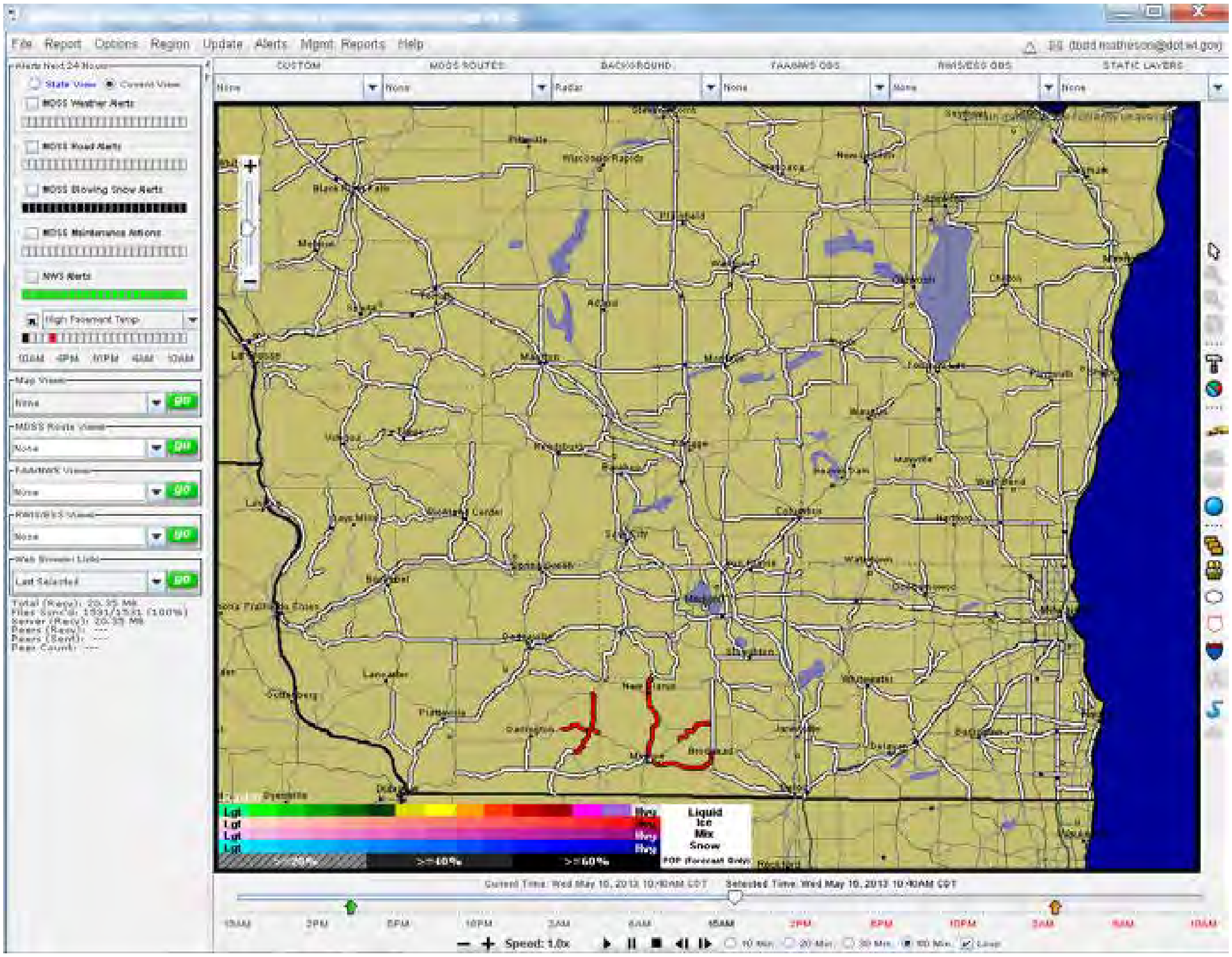


FIGURE 22 Screenshot of a pilot presentation of WisDOT's Maintenance Decision Support System (MDSS) reconfiguration, which will provide alerts about roadways experiencing temperatures that can induce heat buckling, May 2013 (WisDOT).

100 years." In short, if WisDOT says there is a blow-up, then county crews don't hesitate to go out and fix it.

Data and Knowledge Management

In 2012, WisDOT had awareness of the potential for heat-buckling impacts, based on events in prior summers. Past experiences include another video, from 2008, of a Madison, Wisconsin, off ramp blow-up that was shown nationally on The Weather Channel. In May 2010, buckling as high as 14 inches was reported after a quick rise in temperatures. In an interview from that time, David Veith, WisDOT Director, WisDOT Bureau of Highway Maintenance, Freight Operations Section, emphasized the need for drivers to pay attention to road conditions in order to avoid incidents such as rear-end crashes (Flynt 2010). He warned that unreported blow-ups will not have a road sign nearby to warn drivers because road crews cannot anticipate the precise location of buckling (Flynt 2010). In July 2012, drawing on this previously experienced risk of traffic backups, rear-ending, and the related safety issues, WisDOT communicated to maintenance crews the type of temperature conditions that precipitate blow-ups. This reflects organizational Knowledge Management in that prior insights were not lost but put to effective use in 2012.

As noted previously, WisDOT collected data on the sites affected. WisDOT aggregated that and other information into a database to support decision making. As of spring 2013, WisDOT was using the MDSS system on a pilot basis to notify maintenance crews when pavement temperatures are predicted to be in excess of 115°F. At that time, the process was still being fine-tuned, with WisDOT looking to refine the temperature thresholds and triggers for pavement buckling. Because it has built a database of heat-buckling site attributes, WisDOT is also able to analyze the issue, especially in urban areas, and consider changes to construction methods for concrete pavements, which may help to reduce pavement buckling.

Lessons Learned and Related Practices

The following summarizes key practices identified in this case example by mission-related and crosscutting functions.

Practices by General State DOT Function

Practices by mission-related functions

Operations:

- Activating the state DOT's Adverse Conditions Communications Plan, developed for snow and ice events, to address heat-buckling risk during prolonged heat events
- Monitoring for impacts of an unusual weather event, leveraging prior experience
- Identifying and marking the location of each impacted site using GoogleMaps and maintaining the map as an internal resource
- Ensuring county maintenance crews are ready
- Providing hourly updates to management
- Asking the county partner to create a job code and to document the exact location of an event
- Using detailed knowledge of federal programs to determine whether to pursue for FHWA or FEMA reimbursement.

Maintenance:

- Identifying and communicating the best time frame within a day for acting on heat buckling
- Using temporary patch to quickly address heat-buckling incident to keep traffic moving and returning for specific patching or during routine maintenance
- Providing crews with set of equipment needed, including traffic control (drums, arrowboards, crash cushions) and cold patch kits.

Design:

- The Construction Division's materials engineer is considering design changes, owing to projections of continued and increased heat events, starting with urban pavement.

Construction:

- Using the Construction Division's research arm to understand how agency assets and materials are performing under certain kinds of extreme weather event.

Planning:

- Configuring the state DOT's MDSS, which is geared toward certain weather events (winter storms) to help forecast newly emerging extreme weather impact (heat buckling).

Planning by crosscutting functions

Communications:

- Use of 511 system to provide online updates of road conditions, derived from Google Maps
- Use of Twitter for cautionary messages and incident alerts
- Use of press release and interviews to convey the following: risk of a road safety issue (heat buckling) is high, for a defined period; the technical reasons for the problem; the number of incidents and how long it takes crews to fix them; coordination with counties; the randomness of the incidents; the need for the public to be prepared; and safety tips.

Interagency Coordination:
- Reliance on county crews to transition from traffic control by law enforcement personnel to traffic control by arrowboards, drums, and other equipment
- Contracting with each county for roadway maintenance and maintaining strong relationship such that the state DOT is always confident the county will not hesitate to answer a request from the state DOT to provide maintenance at a site.

Data and Knowledge Management:

- Reuse of data from Google Maps to populate a database for analyzing trends in heat-buckling sites
- Use of state DOT in-house staff resources to collect and analyze data on extreme weather event impacts in order to support configuration of an MDSS and future decision making.

CHAPTER THREE

SYNTHESIS OF CASE EXAMPLE ELEMENTS

INTRODUCTION

The case examples in chapter two organize each state DOT's responses to extreme weather impacts based on operations, assets, and mission-support activities. Specifically, these groupings cover key functional areas (Operations, Maintenance, Design, Construction, and Planning and Related Activities) and certain crosscutting functions (Communications, Interagency Coordination, and Data and Knowledge Management). Lessons learned and related practices for each function are presented in the last section of each individual case example in chapter two.

To begin the synthesis across case examples, this chapter collects the lessons learned and related practices from all the cases and groups them by the functions used to organize the case examples in chapter two. Next, this chapter describes the recurring or other noteworthy features within each group and presents additional themes identified during the synthesis process.

CASE EXAMPLE LESSONS LEARNED AND RELATED PRACTICES

Introduction

The following are the lessons learned and related practices noted in the cases presented in chapter two. They are grouped here by the same functional categories used in each case: Operations, Maintenance, Design, Construction, Planning and Related Activities, Communications, Interagency Coordination, and Data and Knowledge Management.

It is useful to note that the contexts in which certain practices were employed may have differed among the cases. For example, the eight extreme weather events reviewed were different in kind and had disparate impacts, while state DOT responses sometimes occurred under emergency management protocols and sometimes they did not. For this reason, the relevant case example is named for further reference by the reader. The practices listed here can be a starting point for more detailed discussion and judgments by state DOT subject matter experts and decision makers.

Lessons Learned and Related Practices	State
Practices by mission-related functions	
Operations:	
Initial preparedness efforts included: • Contact with the state Emergency Operations Center • E-mail dialogue • Review of preparedness checklists by state DOT staff • Checks by maintenance crews for needed tree cutting and weed removal to minimize debris and cleaning of sewer pipes to optimize drainage • Checks of communications systems, flashlights, and other backup equipment, and checks of bulk fuel tanks and vehicles, topping them off as appropriate • Development of evacuation plans, including consideration of contraflow plan in consultation with the state police.	New Jersey
When alerts went higher, mapping out of activation times leading up to the "H-Hour," which is when hurricane winds would be 39 mph or greater, and referring to these activations times to drive later decision making, such as the go/no-go on whether to institute contraflow for the shore evacuation	New Jersey
Operations ICS adopting a 24/7 battle rhythm with set calls in the morning and evening	New Jersey
Usage of Safety Service Patrol, which added supplies of fuel, protective gear, and towing line, plus plows in some cases to move debris	New Jersey
After the event, state DOT maintaining a physical presence at the most affected areas	New Jersey
Division of the area where recovery would take place by the site of physical impacts, rather than by agency boundaries, to make boundaries clear and temporary	New Jersey
Seeking and facilitating high-level approval to clear side streets because their equipment was already there and it would speed the return of residents	New Jersey

Table Continued on p.65

Lessons Learned and Related Practices	State
Practices by mission-related functions	
Operations:	
Prior development of “storm kits” and requirement that crews bring them along on assessments, including the information needed to substantiate federal reimbursement claims, such as photos and the exact location of damage sites	New Jersey
Creating a job code when state Emergency Operations Center increased alert from Level 1 to 2 to get an early start on substantiating federal reimbursement	New Jersey
Creating the job code before damage was incurred and benefitting from retroactive Presidential disaster declaration, capturing prior activity under that code	New Jersey
Setting a well-understood, target time frame (Christmas time) for state DOT departure from recovery area	New Jersey
After the state EM was stood up, putting in place an internal flood management team and using group phone calls for cohesion	Iowa
Utilization of webinar uplink on group calls, for maps, etc.	Iowa
Having a multiagency team and having FHWA and neighboring states join it	Iowa
Ensuring enterprise-wide understanding of ICS “from management to the garage level”	Iowa
Investment in ICS training ahead of time	Iowa
Development of a disaster response plan	Iowa
Training for staff to be project officers on federal program	Iowa
Debris-removal contracts in place before flood waters had receded	Iowa
Mobilization of all staff through an Operations Support Center, including purchasing, contracts, environmental, design, materials, GIS staff, and bridges and structures staff	Iowa
Utilizing IT staff, especially with respect to internet communications and GIS	Iowa
Development of global detours for interstate travelers	Iowa
Identifying staffing issues, such as: • Using the staffing practices from the event as the starting point for a template for future events • Involvement of all state DOT offices affected by the event or with expertise that could aid in managing the event from the outset • For events of long duration: – Seeking the assistance of vendors, contractors, or other outside resources, as needed, to ensure the timely completion of response-related activities – Designating a small group to focus on recovery as response efforts continue • Involving state agencies with responsibility for permitting or other related issues earlier in the event • Adapting the current process for managing vendor contacts so it can be more flexible and take less time • Making arrangements to engage consultants, if needed, to assist with damage assessments and other recovery work while state DOT staff is still engaged in the flood response	Iowa
• On a case-by-case basis, weighing the benefits of the consistency achieved through uniform use of consultants against the benefits gained through the application of local knowledge, when internal staff members are charged with a task	Iowa
Identifying decision-making issues, such as: • Involving the right people – Erring on the side of inclusion when developing the list of participants in the event response; consider involving support services that handle equipment, signs, purchasing, and traffic and safety, as well as research and technology – Ensuring the early and effective engagement of the state DOT management, state emergency operations staff, and regional partners; use the circumstances of each event to guide the extent of ongoing management participation – Identifying critical connections and clearances with resource agencies (FHWA, the state natural resource agency, and the U.S. Army Corps of Engineers) early on, considering the impacts to and involvement of local agencies – Encouraging the active engagement of district staff in making decisions and identifying innovative solutions • Structuring the decision-making process – Providing clear direction on the goals for response and preliminary recovery, clarifying responsibilities for carrying out these related efforts – Expediting decision making with a small-group structure for project-level decisions and confidential matters – Ensuring that staff is trained and coordinating an agency-wide implementation of a formal ICS approach – When possible, using established vendors or resources already under contract to control spending and avoid duplication of effort.	Iowa

Table Continued on p.66

Lessons Learned and Related Practices	State
Practices by mission-related functions	
Operations:	
• Managing the transition from response to recovery (while the response is ongoing) – Establishing a separate working group that begins work on recovery early in the event while others manage the flood response – Requesting advice from contractors' associations about how the agency can work more effectively with contractors in initiating a prompt and effective recovery effort – Avoiding seeking the "perfect" solution when preparing designs for emergency repairs. – Applying innovative contracting practices such as lump-sum, limited-design contracts and no-excuse bonuses to expedite reconstruction projects – Employing a debriefing process at the onset of the recovery efforts to document successes and challenges as the projects move forward.	Iowa
Identifying mitigation measures, such as the following: • Selecting a mitigation measure that fits the circumstances of the site • Keeping abreast of new mitigation technologies; entering new products in the state DOT purchasing system as they are identified to expedite their use during an emergency • Considering certain practices when using large flood-barrier systems and others for smaller sites • Being prepared to address unintended consequences of mitigation measures • Recording areas that were affected so they can be considered for projects to prevent future problems	Iowa
Developing an in-house, electronic process for federal reimbursement when a commercial product could not be found	Iowa
Including FHWA in state DOT headquarters team so it could keep U.S.DOT dated	Tennessee
Assessing risks to department assets and communicating that employee safety was paramount	Tennessee
Maintaining regularly scheduled conference calls	Tennessee
Drawing on prior experience to "think upstream" (up from the affected area) in conducting road closures	Tennessee
Leveraging the small travel budget in each region to bring in resources from less-affected regions to support timely assessments critical to federal reimbursement	Tennessee
Placing a design professional on assessment teams	Tennessee
Supplying brief ICS training during the event	Tennessee
Refining Continuity of Operations plan to outline how critical duties will be performed during these types of events	Tennessee
Giving consideration to creating an operations center within the headquarters building to facilitate rapid decisions, especially in off-hours	Tennessee
Designating assessment teams before these events, in each region and at headquarters	Tennessee
Conducting training—for example, ICS training—and equipping staff and facilities for future extreme weather events	Tennessee
Setting times to activate emergency operations and developing a staffing plan for 24/7 operations	Washington
Engaging air assets to provide helpful information on the scope of the flood	Washington
Utilizing real-time geospatial information at the site of the flooding to create a visual scope of impacts	Washington
Taking road closure reports from the field for recording in WebEOC	Washington
Detour planning to address needs of local traffic, with guidance on allowing exceptions that serve local communities, such as: • Loads related to disaster relief in affected communities • Supplies for hospitals, medical centers, and pharmacies • Perishable loads that would not survive the longer detour • Food and other goods destined for grocery stores, schools, and institutions • Supplies of fuel • Local deliveries to certain counties • Shipments to ports but only for items previously noted	Washington
Addressing freight as a distinct issue in a detour, including developing procedures for implementing access for certain freight haulers through a permit system; using tools such as pre-signage, cameras, and messaging boards; enforcing restrictions in collaboration with local law enforcement or the National Guard; and communicating relevant information through "freight alert" e-mails to people who have signed up to receive such alerts	Washington
Developing a Commercial Vehicle Path System so that a statewide process is in place for diverting commercial traffic under future extreme weather events or for other purposes	Washington
Standing up of an ICS, with the appropriate scope of organization of the event—for example, Unified Command and regional or local Incident Coordination Centers	Vermont

Table Continued on p.67

Lessons Learned and Related Practices	State
Practices by mission-related functions	
Operations:	
Identifying and utilizing a short, set list of objectives for the recovery effort	Vermont
Having awareness of employee attitudes and their basic necessities	Vermont
Improving alignment of FHWA information in its DDIR with the FEMA PA PW format	Vermont
Pursuing rulings on issues of first impression with the federal government (e.g., FHWA and National Guard costs)	Vermont
Training and provision of designated technical assistance to localities attempting to seek federal reimbursement	Vermont
Providing technical assistance to policy makers exploring changes to state cost sharing where localities that cannot afford to repair damage to transportation system, changes to federal program cost sharing where state cannot afford repairs to transportation system, or other approaches	Vermont
Ensuring demobilization of ICS is defined, described (including the social after effects of event), and implemented, using methods such as the following: having the Incident Command Center Logistics leader discuss what personnel will feel after returning; holding brownbags; offering counseling; issuing a coin as a memento; and sending thank-you notes to personnel and their families	Vermont
Preparing for and using the federal reimbursement process to support projects that build resiliency	Vermont
Preparing for and using ICS, including pre-assigning roles; knowing the experience of staff when assigning roles; providing ICS training; familiarizing staff with mobile IT and other equipment used in the field; preparing/updating Standard Operating Procedures for use of ICS; considering event-related criteria when standing up an ICS, UC, and IC; and updating the Continuing Operations Plan	Vermont
Developing training for effective use of ICS through basic training at all levels, with more for assigned staff; annual training; providing checklist and pocket manuals with key information for ICS section leads on each role; practicing the use of ICS under small events; developing a plan for use of technology in emergency response; clarifying the role of the state DOT in ICS training; and providing training in the technical details of likely events (e.g., riverine flooding)	Vermont
Addressing contracts administration under ICS by having contractors register; having an electronic invoicing and contracts processing system; developing administrative packets on invoicing, federal forms, emergency management levels, and state and federal compliance issues for state and for contractor staff; developing an emergency waiver process; and standardizing the process for paying contractors under an ICS	Vermont
Enhancing the use of technology when using ICS, including having a master list of cell and smart-phone contacts; expanding training in the state's maintenance tracking system; exploring use of cloud technology to enable robust use of mobile applications, continuing use of Google Maps; storing information needed in an emergency situation in one place; and enabling a single internal location for sharing data during an event	Vermont
Improving workflow under ICS, including developing a process to track equipment lent to contractors; developing a process for tracking materials supplied by contractors; and improving internal data collection for federal reimbursement by defining roles and supplying training, including training the trainers	Vermont
Prepare for operations role under ICS, including developing an "Emergency Design Manual" for use when reestablishing structural elements in an emergency; clarifying the level of civil engineer testing and documentation expected under response; and improving the collection and use of geospatial data immediately after the event	Vermont
Improving communications under ICS, including developing/updating internal processes for communications in ICS; developing/updating with stakeholders' external processes for communications in ICS; ensuring proper equipment will be on hand, including portable cell towers, inspecting radios, and cell phones; assessing emergency management software ahead of time; and developing alternatives for when power or cell reception is down	Vermont
Being familiar with weather forecasting and relying on NOAA for specific reports, such as ice conditions	Alaska
Relying of maintenance crews on the Road Weather Information System, with real-time information on weather data so crews can get to the field at the right time	Alaska
Considering use of an MDSS that combines weather data from multiple sources	Alaska
Enacting a "no boundaries" maintenance coordination policy that requires districts to seek assistance as needed and provides a framework for coordination with other districts, regional and statewide	Alaska
Assigning codes to a weather event in order to advance decision making, with no concern about developing codes that "go nowhere" if the weather event does not become significant	Alaska
Developing detailed presentations on disaster response, including one setting out the requirements for federal and state reimbursement for damage and expenditures, including FHWA and FEMA thresholds as well as information on the "betterment" option to avoid rebuilding to the way state infrastructure was before, rather than improving it	Alaska
Ensuring the state DOT role is defined as a supporting role to the primary agencies that respond to wildfires, using ICS principles and relying on express instructions on action to take	Texas
Reaching out to FHWA to seek early buy-in on project for which state DOT would like see federal reimbursement	Texas
Participating in daily operational calls during a wildfire event	Texas

Table Continued on p.68

Lessons Learned and Related Practices	State
Practices by mission-related functions	
Operations:	
Supporting the statewide emergency response to wildfires by: • Supplying fuel and water • Supplying traffic control • Supplying sign trailers and other signage, website information, and other information for the public • Creating firebreaks in part by supplying heavy equipment, such as graders and bulldozers, and employees to use them • Permitting counties' access to state rights-of-way for posting burn ban signs • Issuing emergency utility permits	Texas
Leveraging fuel vehicles used for hurricane evacuation and re-entry to support local volunteer fire departments in fighting catastrophic fires	Texas
Weighing the administrative and opportunity costs of seeking federal reimbursement for support to counties and other state agencies, with the benefit received	Texas
Challenging FHWA on issues of first impression, including attempting reimbursement from FHWA for damage from wildfire for scenarios that have not been requested before but may become routine under increased wildfires—for example, payment for removal of scorched trees that may fall onto roadway	Texas
Activating the state DOT's Adverse Conditions Communications Plan, developed for snow and ice events, to address heat-buckling risk during prolonged heat events	Wisconsin
Monitoring for impacts of an unusual weather event, leveraging prior experience	Wisconsin
Identifying and marking the location of each impacted site using Google Maps and maintaining the map as an internal resource	Wisconsin
Ensuring county maintenance crews are ready	Wisconsin
Providing hourly updates to management	Wisconsin
Asking the county partner to create a job code and to document the exact location of an event	Wisconsin
Using knowledge of federal programs to determine whether to pursue FHWA or FEMA reimbursement	Wisconsin

Lessons Learned and Related Practices	State
Practices by mission-related functions	
Maintenance:	
Deciding to have separate sites for debris and sand removed from streets in order to clean and reuse the sand	New Jersey
Addressing sinkhole-related issues regarding their proper assessment and the most appropriate traffic control measures at the local level	New Jersey
Conducting preparedness activities before a controlled release of water from dams, including checking for blocked culverts, defining the disaster responses staging areas, and deploying ITS, such as traffic cameras that could provide a view of inundated roads	Iowa
Managing tornadoes occurring during larger storm as (1) an employee safety issue and (2) a right-of-way debris removal issue	Tennessee
Beginning recovery phase during response phase, with the priority to get transportation moving again	Washington
Maintaining flexibility in determining what to ask from localities in the way of reimbursement for state DOT services provided during extreme weather events	Washington
Staging equipment, including cones, messages boards, portable traffic lights	Vermont
Identifying a central storage location or garage for equipment needed in a major event	Vermont
Tracking maintenance needs with a view to statewide events	Vermont
Coordinating and running a multiagency "Scan Tour" with relevant state and federal agencies to assess together existing repairs and determine how permanent repairs will be made	Vermont
Developing an equipment inventory, including what and where the resources are	Vermont
Under a disaster declaration, providing assistance to municipalities in the form of staff and heavy equipment, such as loaders, dump trucks, graders and snow-melters	Alaska
Considering several factors in deploying crews outside of their immediate geographic area, given the size of the state and limited transportation routes, such as the duration of the need and whether it is feasible to get the support there in time	Alaska
Keeping fire-control support resources "pre-loaded" and ready to deploy throughout the state	Texas

Table Continued on p.69

Lessons Learned and Related Practices	State
Practices by mission-related functions	
Maintenance:	
Ensuring primary message to employees that the state DOT involved in supporting wildfire control are not firemen	Texas
In fire situations, allowing only state DOT employees to use state DOT equipment	Texas
Ensuring employee preparedness and safety through the acquisition and pre-positioning of two response trailers with protective gear where local crews can receive briefings on wildfire characteristics and shelter deployment training	Texas
Discussing drought issues in maintenance workshops	Texas
Patrolling for road cracks and other pavement degradation from drought	Texas
Identifying and communicating the best time frame within a day for acting on heat buckling	Wisconsin
Using temporary patch to quickly address heat-buckling incident and keep traffic moving, and returning for specific patching or during routine maintenance	Wisconsin
Providing crews with set of equipment needed, including traffic control (drums, arrowboards, crash cushions) and cold patch kits	Wisconsin

Lessons Learned and Related Practices	State
Practices by mission-related functions	
Design:	
At the location of the major, now iconic, barrier island breach, the decision to rebuild transportation infrastructure back to original design and pre-disaster appearance under a fixed and aggressive time frame	New Jersey
To rebuild 4 miles of a washed-out interstate, starting the design process before water levels had fallen and adopting a design-build approach, given the availability of the original plans	Iowa
Leveraging the FHWA “betterment” option to build a more resilient replacement structure	Tennessee
Considering the impacts of increased detours on secondary roads—for example, slope stability—and considering these in design of roads and detours	Washington
Developing new design criteria in order to meet projected risks—for example, bridge height for flooding, use of riprap	Vermont
Using existing data sets—for example, route logs—to support design process in emergency response scenario	Vermont
Simplifying the design plan process	Vermont
Considering the more severe storms and unpredictable weather that is expected and their implications on design—for example, the effects of the freeze–thaw cycle	Alaska
Determining the possible causes of road degradation under drought in order to assess the most appropriate response, through materials design or landscape approaches	Texas
Studying the needs for design changes owing to projections of continued and increased heat events, starting with urban pavement	Wisconsin

Lessons Learned and Related Practices	State
Practices by mission-related functions	
Construction:	
Fully repairing key areas using emergency contractors and working with the planning side of the house for on-call design contracts	New Jersey
Rebuilding 4 miles of a washed-out interstate, using predetermined contract rates, incentive clauses, and contracted inspection services	Iowa
Acceleration of the drafting and letting of contracts for repair work so that repairs could begin as soon as inspections were completed	Tennessee
Ensuring all relevant units were working with FHWA as contracts and the formal letter of intent to request Emergency Relief funds were developed	Tennessee
Giving consideration to developing “off-the-shelf” contractual terms for emergency situations	Tennessee
Posting of the contracts let under exigent circumstances on website for transparency	Tennessee
Enabling shifts in construction schedules to accommodate new priorities	Vermont
Adopting an approach to rebuilding that completely closes a road or bridge for safer and faster construction, rather than choosing a partial closure (that maintains access during construction)	Vermont
Articulating the existing technical and policy foundation for projects that support better resiliency (e.g., rewriting hydraulic manual to underscore existing practices)	Vermont
Exploring new construction techniques—for example, prefabrication of structure components, advanced new materials, and new contract/management techniques	Vermont

Table Continued on p.70

Lessons Learned and Related Practices	State
Practices by mission-related functions	
Construction:	
Taking advantage of change management after an extreme weather event to mainstream new construction practices—for example, by developing an Accelerated Bridge Construction program initiative, staggering its implementation, and providing metrics for success	Vermont
Supporting the burial of utility lines to avoid downed utility poles on the highway right-of-way	Alaska
Enlisting in-house and external resources to collect and record existing effective practices as well as emerging stressors, such as increased highway degradation from energy development	Texas
Using the Construction Division's research arm to understand how agency assets and materials are performing under certain kinds of extreme weather events	Wisconsin

Lessons Learned and Related Practices	State
Practices by mission-related functions	
Planning:	
Developing $2 billion in resiliency projects and making strategic choices about building back the right infrastructure, as informed by prior climate change planning funded by FHWA	New Jersey
Using lead time before waters rose to develop flood mitigation projects, as identified through use of GIS and LIDAR	Iowa
After road closures are made for safety, using planner expertise to determine, then communicate, the impact of road closures	Iowa
Developing an Emergency Transportation Operations plan with the Iowa State Patrol	Iowa
Using associations, such as I-95 Coalition, to find ways to improve interstate coordination under an extreme weather event	Tennessee
Supplying training in GIS for freight rerouting, using the resources of the I-95 Coalition	Tennessee
Linking to and supporting information transfer to climate-change vulnerability assessments and related planning efforts	Washington
Preparing for growth in program and responsibilities, given increased awareness of extreme weather	Washington
Creating an Emergency Response Plan, including the express identification of the role of nongovernmental resources, such as the Regional Planning Committees set up under federal transportation laws	Vermont
Developing training and related content to educate employees to better address flooding events, including general ICS awareness, instruction in river management, and in-depth technical training for engineers	Vermont
Articulating a holistic, watershed-based approach to siting and building transportation infrastructure	Vermont
Staying current on climate projections from the NOAA-funded entity intended to provide decision support for state and local entities and providing briefings on state needs under more unpredictable weather	Alaska
Using snow and climate projections as a basis for seeking increased space for snow dumps, while addressing related environmental issues	Alaska
Researching and drafting a document outlining emerging practices in winter highway maintenance, noting that one impetus for the document is the more unpredictable weather expected	Alaska
Participating in state's Drought Preparedness Council	Texas
Ensuring employees have both FEMA training and a clear understanding of the state DOT's supporting role in wildfire control	Texas
Configuring the state DOT's MDSS, which is geared toward certain weather events (winter storms) to also help forecast newly emerging extreme weather impact (heat buckling)	Wisconsin

Lessons Learned and Related Practices	State
Practices, by crosscutting functions	
Communications:	
Leveraging the clear communication by the Governor's office	New Jersey
Engaging directly with constituencies—for example, the freight haulers, through associations such as Iowa Motor Truck Association	Iowa
Using 511 system to communicate road status	Iowa
Directing ITS cameras toward vulnerable areas	Iowa
Using 24-hour public information call center	Iowa
Using dynamic messaging signs	Iowa
Using public website dedicated to the flood	Iowa
Using Highway Advisory Radio	Iowa

Table Continued on p.71

Lessons Learned and Related Practices	State
Practices, by crosscutting functions	
Communications:	
Identifying notable communications practices, such as: – Considering the early engagement of DOT divisions or offices that may assist in the flood response, including front-line support services that handle equipment, signs, purchasing, and traffic and safety, as well as research and technology – Establishing a core group that expands, as needed, with the staff required to address the issues at hand that day – Engaging neighboring states immediately if it appears that a regional detour will be required – Ensuring that all communication with regard to regional or local detours is provided in a timely manner – Setting a goal and purpose for project team meetings – Carefully structuring meeting agendas to move from general information sharing to more detailed discussions – Establishing consensus on the nature and extent of the public message and ensuring delivery of a consistent message – Designating one individual within the DOT as the party responsible for managing information flow – Implementing a policy that identifies the agency's philosophy with regard to detours—regional or localized—and that describes how information about detours will be disseminated – Clarifying the DOT's position on the primacy of the state's 511 site as the main source for traveler information – Instituting regular prompting to those contributing information to an event-specific website to ensure that the site's information is accurate and current • Evaluating the need for a call center to respond to public inquiries, taking into consideration the extent and nature of an event and available resources. • Siting the call center team in one room with a cubicle designed to enhance privacy. • Considering the use of a software program that provides statistics on caller volume.	Iowa
Utilizing "Turn Around Don't Drown" public service messaging from a multistate initiative	Iowa
Use of the 511 system, given public familiarity with it	Tennessee
Development of public-facing traffic map for the website to deliver up-to-date information on closures	Tennessee
Utilization of new, enhanced 511 call-in system that permits travelers to name any location in the state and receive information on lane or road closures	Tennessee
Stationing "communicators" at regional emergency operations centers to allow for efficient knowledge transfer and approvals, through such activities as: • Responding to media calls for updates • Facilitating media interviews with key personnel • Updating traffic web pages • Posting closure information on web pages • Updating Highway Advisory Radio messages • Crafting alert messages for the 511 Traveler Information System • Monitoring media coverage of the storm	Washington
Maintaining a set of metrics for website activity to substantiate site utility and level of interest from the public	Washington
Developing a detour and methods for enforcing closure and maintaining flow of through traffic, addressing entry points, including exits, and notifying the public and key sectors through the following communication tools: • Direct mail postcards to truckers about the closure • Portable cameras at the I-5 closure point • Listserv messages • Graphic communications for non-English-speaking public • Having a front-line spokesperson providing information on the larger picture • Use of Incident Response Team truck signs while cruising up and down the truck holding area • Getting photos to tell stories and posting them on Flickr, an online photo-sharing site	Washington
Supplementing 511 system with a call-in center dedicated to the event, Google Maps, social media, mobile phone micro-site, and website with regular updates	Vermont
Where adopting a web-based tool, such as Google Maps, making timely decisions on investing staff time, encouraging and facilitating adoption by others, and planning for its maturity into an ongoing tool	Vermont
Considering the staffing and protocols needed to ensure a social media site has the desired impact	Vermont
Tying in transportation information to existing agency communications lines—for example, 1-800 numbers for tourist information	Vermont
Transporting media to the site and providing agency personnel for interviews	Vermont
To communicate weather impacts, using the 511 system that shows road conditions, closures, and construction, with camera views through the Road Weather Information System used by crews, and relaying information by means of the department web page, telephone, RSS feed, iPhone, Facebook, and Twitter	Alaska
Routine use of snow-plow hotlines	Alaska
Use ICS communications protocol under an emergency but with support for interviews by staff	Alaska
Using the state's general Highway Condition Reporting System to present information on wildfires	Texas

Table Continued on p.72

Lessons Learned and Related Practices	State
Practices, by crosscutting functions	
Communications:	
Working with the state EOC to determine proper messaging for state DOT dynamic messaging signs in wildfire areas	Texas
Supporting knowledge transfer by providing technical comments to state legislature draft documents	Texas
Use of 511 system to provide online updates of road conditions derived from Google Maps	Wisconsin
Use of Twitter for cautionary messages and incident alerts	Wisconsin
Use of press release and interviews to convey the following: risk of a road safety issue (heat buckling) is high for a defined period; the technical reasons for the problem; the number of buckling incidents and how long it takes crews to fix them; coordination with counties; randomness of the incidents; the need for the public to be prepared; and safety tips	Wisconsin

Lessons Learned and Related Practices	State
Practices, by crosscutting functions	
Interagency Coordination:	
Coordinating with the state police on common communication devices, P25 digital radios	New Jersey
Where state DOT and power companies have conflicting missions and therefore challenges on the ground, reinforcing safety issues and complying with power company rules when power lines cross a roadway during recovery from an extreme weather event	New Jersey
Resolving local traffic control issues by constructing out what appeared to be permanent traffic control changes on a temporary basis	New Jersey
Including FHWA on the team from the start	Iowa
Coordinating with multiple state and federal agencies, including other states, through daily webinars and briefings by other agencies, such as NWS and the U.S. Army Corps of Engineers	Iowa
Clarifying whether the purpose of interagency meetings was for information sharing or decisions	Iowa
Interacting on multimodal issues directly with affected parties and supporting their efforts by standing down on nearby projects, and facilitating communications with local agency representatives	Iowa
Understanding the resources (e.g., time and staff) needed to address the complexities of working with another state linked by a heavily used toll bridge where such state had experienced less severe impacts and the toll bridge governing body had its own interests to assert in negotiations.	Iowa
Embedding staff in FEMA field crews to enable better collaboration on the federal reimbursement process	Tennessee
Including FHWA in the ICS	Tennessee
After the event and in response to a recommendation in the After Action Report, creating an Emergency Management Steering Committee to ensure a cross-functional approach to the state DOT's various roles in an emergency, including human resources, community relations, central services, maintenance, and representation from regional agencies	Tennessee
Providing additional training to staff on the assessment process to support federal reimbursement applications	Tennessee
Engaging in direct calls with NWS before the weather event hits	Washington
Convening a conference call at regular times, coordinated around other standing meeting with common attendees, such as maintenance calls	Washington
Ensuring the National Guard leaders and troops are aware of the chain of command on the ground before use at a detour requiring their show of authority	Washington
Coordinating on the potential mismatch of communication devices on the ground	Washington
Embedding FHWA in state DOT activities related to the extreme weather event—for example, in the ICS	Vermont
Understanding the management requirements for using the National Guard	Vermont
Accelerating securing approvals for weight and time waivers for trucks through internal coordination	Vermont
Better integrating air and rail into emergency operations	Vermont
Maintaining key role and pace at the table in broader recovery effort by taking responsibility for its early management	Vermont
Including an environmental liaison in the ICS	Vermont
Developing agreements and memoranda of understanding to define/update roles of agencies under emergency response situations	Vermont
Meeting annually to check in on who is who at each agency and confirming contacts for future events	Vermont
Defining roles in a state DOT ICS of regional planning committees, which are congressionally required bodies of potential use in emergency response	Vermont
Ensuring early engagement by all relevant agencies	Vermont
Using same district boundary for all agencies in emergency response, noting state DOT maintenance districts may not be the most effective	Vermont

Table Continued on p.73

Lessons Learned and Related Practices	State
Practices, by crosscutting functions	
Interagency Coordination:	
Assigning or dedicating a state attorney to federal program reimbursement, and other emergency response issues	Vermont
Facilitating the deployment of the National Guard by waiving substantial transportation fees for the long trip necessitated by the closure of airport at disaster declaration site	Alaska
Working with FAA to secure a waiver allowing use of FAA airport equipment off site to clear the state highway leading to the airport and ensure airport access	Alaska
Supporting state DOT employees assigned to city emergency operations team, with effort paid for through preexisting reimbursable agreement	Alaska
Working with FHWA early on, in estimating costs of repairs from wildfires to expedite approvals for reimbursement	Texas
Using collaboration tool such as Daily Activity Reports and SharePoint to collect data on events	Texas
Reliance on county crews to transition from traffic control by law enforcement personnel to traffic control by arrowboards, drums, etc.	Wisconsin
Contracting with counties for roadway maintenance and maintaining strong relationships, such that the state DOT is always confident a county will not hesitate to answer a request from the state DOT to provide maintenance at a site	Wisconsin

Lessons Learned and Related Practices	State
Practices, by crosscutting functions	
Data and Knowledge Management:	
To facilitate the flow of interstate freight and other traffic during an extreme weather event, development of an online permitting system to issue emergency permits in advance the event	New Jersey
Engaging in post-event workshops and other activities to share and record knowledge and lessons learned from the event	New Jersey
Participating in the Governor’s task force and state-level After Action Report, conducting a state DOT After Action Report, and hiring a consultant to run the exercise	Iowa
Supporting the communication of state DOT-related lessons learned to U.S. Department of Homeland Security	Iowa
Providing a forum for the public to tell stories about transportation issues from the event, under a web-based “storify” project	Iowa
Investing in LIDAR data sets and using them to determine at-risk sites and to identify places that would be safe and would not require investment of precious time for protection	Iowa
Using aerial images of the event early for situational awareness	Iowa
Convening a daily sit-down regarding GIS data alongside the state DOT’s daily flood-management team call	Iowa
Maximizing the use of GIS staff available to contribute to damage survey reports	Iowa
In absence of pre-assigned staff, leveraging of personnel known to have ICS experience from a previous disaster to lead the operation, educating crews using standard ICS forms, and ensuring there is a dedicated person for each crew in the central office (UC)	Tennessee
Developing an After Action Report that records effective practices, lessons learned, and new approaches going forward	Tennessee
Upgrading geospatial data sets to include GoogleEarth, the state’s aerial photography, and LIDAR maps	Tennessee
Working with other agencies well ahead of extreme weather events to optimize each other’s data sets and methods used	Tennessee
Sharing information through SharePoint, WebEOC, and conference calls to enable a quick response	Washington
Developing an After Action Report to assess the agency response, with contributions from all regions, not just from those affected	Washington
Using state academic resources to research information on key issues related to impacts from extreme weather events of concern (e.g., flooding) and synthesizing the body of knowledge	Washington
Increasing use of GIS, for example, so that 50% of the state DOT fleet has GIS in its vehicles so they can be located during an extreme weather event	Washington
Distinguishing Emergency Management processes from day-to-day processes in post-event assessment of a state DOT response to extreme weather event	Vermont
Providing a structured forum and process for developing lessons learned from extreme weather events to capture practices and ideas for improvement, dedicating resources to hire a contractor	Vermont
Identifying the data sets (e.g., bridge information, record drawings) that benefit decision making and the ways to enable better collection or access to the data	Vermont
Developing succession planning to maintain continuity and a knowledge base	Vermont
Understanding the limitations of weather information products and seeking to develop expertise to better assess weather events	Vermont
Collecting and reporting on emerging winter maintenance practices in light of more severe and unpredictable winter weather	Alaska
Using NOAA post-event reports and providing briefings on state needs under more unpredictable weather to the NOAA-funded entity designed to provide decision support for state and local entities	Alaska

Table Continued on p.74

Lessons Learned and Related Practices	State
Practices, by crosscutting functions	
Interagency Coordination:	
Storing applications for federal reimbursement in paper or scanned form with defined retention schedule of projects searchable by event code	Alaska
Researching structural and operational issues arising under drought response	Texas
When implementing a new or expanded role that supports the primary mission of a sister agency, such as wildfire control, remaining very disciplined as to the state DOT's exact role and own mission—for example, by adopting the terminology of the lead agency	Texas
With the increased need to use the EMAC system, considering lessons learned from prior use of resources from out of state	Texas
Reusing data from Google Maps to populate a database for analyzing trends in heat-buckling sites	Wisconsin
Using state DOT in-house staff resources to collect and analyze data on extreme weather event impacts in order to support configuration of MDSS and future decision making	Wisconsin

DISCUSSION OF COMMON AND RECURRING ISSUES

Mission Area Functions

Operations

State DOTs routinely watch for adverse weather, drawing on external and in-house sources of information. In order to inform their decisions early on, they will use multiple sources of information on weather and related impacts, including NWS, contracted weather services, and in-house expertise, when available. States also use NOAA after-storm reports, which clarify the type of event that occurred, the actual conditions experienced, scope of impact, and so forth, and that can also inform them of the potential outcomes from subsequent weather events. Some states rely on their MDSS, which draws from multiple data sources and can be configured to help forecast for certain events. For example, Wisconsin invested in an MDSS to address winter ice and snow events, but it is now configuring its MDSS for extreme heat in order to forecast heat buckling.

Where there is likely to be an extreme weather event, a state DOT may respond in three main ways: through routine operations, pursuant to ETO (Emergency Transportation Operations, which are designed for nonrecurring events), or pursuant to the state's disaster or emergency response processes. The approach depends on the scale and duration of the event, among other factors. A commonly cited practice in the extreme weather case examples was the use of an ICS for emergency response at the statewide level and to a lesser degree within state DOTs.

Initial decision making on a weather event includes determining likely impacts and the preparedness required. Preparedness for flooding, for example, may include clearing culverts, positioning signage, and staging crews. The actual checklist will depend on the type of event, but all states interviewed emphasized safety first and ensuring that crews are "hunkered down" as the event draws near. State DOTs will reach out early to federal, state, and local agencies for several reasons, such as to gather more information, fulfill agreed pre-disaster protocols, or pre-position resources in a coordinated way. In many cases, FHWA was reached by state DOTs to collaborate well in advance of developing damage assessments that support federal reimbursement of damages.

Key tools during preparation and response are a designated physical location, such as an operations center, fixed times for conference calls, and a shared platform for information transfer, such as SharePoint or WebEOC. Also important is access to aerial, real-time images, or other geospatial information that helps determine the scope of the event and its potential impacts. For flooding, use of LIDAR elevation data will help determine early on what to protect and where to focus precious resources.

Explicit policies that encourage or require coordination across a DOT's geographic divisions provide focus and structure for a discussion of district or regional needs and enable the elevation of resource issues to higher management. Other practices allow for the sharing of equipment typically used for other events, such as employing fuel vehicles used in hurricane evacuation or re-entry for wildfire efforts. Extreme weather conditions lead some DOT Operations staff to adopt or repurpose plans developed for the type of severe weather events more routinely seen in a region. For example, Wisconsin successfully used its Adverse Conditions Communications Plan for summer heat buckling despite the fact the plan was largely designed for and most commonly used for severe winter weather.

Detours are a common issue under extreme weather. Lessons learned for when a detour is needed include the following:

- Thinking "upstream" and closing ramps far before the affected area
- Early outreach to other states to agree on global detours
- Estimation of the road closure impacts on communities
- Securing a thorough understanding of the freight system, its operational requirements, as well as ways to deploy GIS to most effectively manage detours for commercial vehicles

- Communication strategy focused specifically on road closures and affected subsets of stakeholders, including real time status updates on such closures
- Preparation for the inevitable exceptions to road closures, including guidance, criteria, and/or permit system, as well as strong and coordinated law enforcement, National Guard, or other shows of authority.

During events with short lead times, state DOTs may draft and let contracts for recovery efforts before the weather event is over or the response is finished. IDOT developed a special procurement for a major highway repair, accelerated selection of a contractor, and finished two months ahead of schedule. NJDOT used on-call contractors for repairs after Hurricane Sandy and also managed another division's on-call design experts on short notice. This approach facilitated getting "boots on the ground" to conduct recovery.

Events with long lead times, such as a drought, see more time for preparation and less use of special contracting or the emergency response apparatus. The Texas and Wisconsin examples demonstrate the reliance on routine maintenance at the local and regional levels to address pavement distress. Where the extreme weather situation was unusual for the local climate and spanned a season, such as with Wisconsin's heat-buckling incidents, the state DOT successfully used the statewide traffic control center to address the problem. In Wisconsin, as a result, state-level managers received hourly updates while using county resources for the patching. This activity was conducted under a special adverse weather policy derived from an ETO plan. In contrast, increased pavement distress during the 2011 drought in Texas was managed largely at the district level.

State DOTs will operate its response to an extreme weather event under the rubric of the state emergency management function when it is activated by the Governor. This activity is described more fully here in a section devoted to the topic. However, emergency management influences many operational decisions and the following are key lessons learned for stepping down the statewide emergency management process into a DOT organization and standing up an internal ICS or similar tool within a state DOT:

- Ensure the ICS is at the appropriate scope for the event
- Ensure teams, both regional and headquarter, and employee roles are pre-assigned, as informed by knowledge of employee experience, skill sets, and familiarity with other potential team members
- Ensure teams have broad expertise, including design professionals, HR, and so forth
- Conduct training in ICS ahead of time and at the time of the event
- Include other agencies in the DOT's internal ICS, including FHWA
- Train project officers to work with FHWA and state and local representatives
- Clarify the jurisdictional boundaries of a field ICS, given the multiple agencies involved and their training and inclination to stick to their own boundaries
- Ensure explicit de-mobilization that among other things prepares personnel for the typical short- and long-term feelings and reactions to extreme weather deployments.

Maintenance

State DOTs will anticipate the need to brief or instruct their maintenance staff on emerging weather issues, such as changing winter maintenance requirements in Alaska, drought issues in Texas, river management in Vermont, and heat buckling in Wisconsin. When a specific type of event is actually forecast, state DOTs will utilize their maintenance crews to clear or otherwise prepare the state highway right-of-way for the impacts of the extreme weather event. Lessons learned from recent storms include designating central garages or other state structures as staging areas. Another lesson learned is to develop a statewide equipment inventory ahead of time so that resources can be readied and possibly transferred to an affected site. State DOTs also will designate the stages of its response ahead of time. In the case of Hurricane Sandy, for example, NJDOT mapped out key activation times in advance based on weather conditions and the likely milestones for the storm, including times when crews needed to get out of harm's way.

TxDOT's participation and contributions to wildfire control during a persistent drought demonstrate the strong management needed to ensure safety and a focus on agency mission. TxDOT instructs its employees that "we are not firemen" and trains them in the scope of its support to fire management agencies, which includes fuel, water, and signage transport as well as local use of the right-of-way for wildfire messaging. After the 30,000 Texas wildfires in 2011, TxDOT invested in two trailers that serve as training sites in the field and include fire protection equipment in case of an emergency.

States DOTs have a general policy of not conducting operations outside of the state right-of-way. TxDOT maintains this policy even (and especially) under a wildfire situation but will go outside the right-of-way under an imminent threat to life or property, and only then to conduct firebreak activities. In Tennessee, TDOT reported that it expected its crews to only react to problems on the state right-of-way for tornadoes occurring during a once-in-1,000-years flood event. In contrast, in a less hazardous situation, while removing debris post-Sandy, NJDOT quickly elevated a request for approval to clear side streets that were off the state right-of-way, when accessibility was important to community recovery.

In the aftermath of some extreme weather events, state DOTs have begun to pay more attention to maintenance and tracking repairs and costs associated with new forms of weather. When rebuilding is completed, maintenance crews will watch for follow-on problems, such as sinkholes after flooding. They will circle back for permanent fixes where there has been temporary patching and will inspect repairs over a period of time. In response to an extreme weather event, Wisconsin sought to address future maintenance issues by conducting research and developing a tool to help identify potentially problematic locations during future high heat events.

Design

Extreme weather events implicate design issues and processes in several ways. After Sandy, the immediacy of recovery needs spurred NJDOT Operations to bring in design experts who were on call with NJDOT's planning division, and this cross-divisional coordination facilitated rebuilding. TDOT included design professionals on assessment teams to work through recovery issues that would support later federal reimbursement. One key design decision, for example, required TDOT to secure FHWA approval to construct a betterment project rather than rebuild.

Setting detours away from likely flood zones implicates highway design in Washington State because heavier traffic on unimproved roads may produce severe facility damage, including slope failures. Also WisDOT's materials engineer is investing time and resources into design issues relating to heat buckling, especially for urban settings where traffic backups are a priority issue.

In response to severe flooding under Irene, VTrans has taken a comprehensive approach to the design issues that surfaced during recovery from Irene. First, the simplified design approach it adopted for Irene recovery projects is influencing its routine decision process. Data sets identified and used during Irene recovery, such as information from maintenance route logs, may continue to influence the design of projects. VTrans is also seeking to ensure that design criteria for infrastructure meets the projected needs of transportation infrastructure, such as enabling a bridge to withstand a flood. More broadly, the state is seeking resiliency with respect to the type of weather events projected for the future.

It is noteworthy that federal policy and programs are changing, particularly as they relate to some of the design issues implicated in recovery decisions. An outline of these changes is beyond the scope of this report; however, it is useful to bear in mind that these changes may produce different considerations and possibly more favorable outcomes for state DOTs in the future. Federal policy as it existed in 2011 had influenced key design choices in the IDOT case, for example. The flooding in the summer of 2011 was prolonged, with weeks of standing water. IDOT determined that in order to complete re-construction of I-680 by the end of the 180-day federal timeline (that was required to secure 100% reimbursement of the project cost) it would conduct a design-build based on the design plans from the 1960s. It also expedited the recovery work by contracting for inspection services. Through these efforts, reconstruction was completed on schedule, so the state received 100% reimbursement. Recent rule changes can allow for the clock to start after the flood recedes which will mean more design time, most likely under fuller information.

Construction

Extreme weather events have led to accelerated work in state DOT construction offices. As noted elsewhere in this report, construction offices in the case examples have taken approaches that are atypical for their states, such as predetermined contract rates for inspectors in Iowa. In Tennessee, the construction office worked quickly with FHWA staff to draft, let, and post online 11 contracts over a 2- or 3-day period, even before the flood waters had receded. Their lesson learned is to have "off-the-shelf" boilerplate contractual language on hand for such circumstances in the future. In the wake of Irene, VTrans is streamlining its construction office processes, exploring new construction techniques, and providing incentives for towns to shut down bridges and roads completely during construction, for safety and to accelerate construction. TxDOT uses in-house and outside expert advice to address design and construction issues arising from pavement degradation exacerbated by the severe drought, including seeking understanding on how heavier truck traffic from energy development compounds pavement distress problems.

Planning and Related Activities

State DOT planning offices play critical roles in applying GIS capabilities to response and recovery problems. In Iowa, the state DOT planning office determined that flood maps supplied by the U.S. Army Corps of Engineers were not sufficient for their purposes and used LIDAR maps to determine the areas vulnerable to the flood releases upstream. The maps also helped resolve which IDOT assets would be under threat and those which would likely be safe, saving precious time and resources in triaging actions before the flooding took place. In Tennessee, TDOT acquired LIDAR in the aftermath of its once-in-1,000-years flood. It currently anticipates issues in reconciling its data with those of the U.S. Army Corps of Engineers, so it is seeking to resolve that problem in advance of the next event.

State DOT planning staff is enlisted to put together reports that preserve lessons learned. In Vermont, for example, VTrans determined that it needed an Emergency Response plan and that it needed to refine its Continuity of Operations Plan after Irene; these documents will pull in the lessons learned in ICS management from the Irene experience. Maintaining a presence on multiagency committees and related workgroups proves helpful to state DOTs because such engagement maintains communication and relationships in addition to the primary task of addressing risks. Examples of such participation include TxDOT's work on the state's drought preparedness council and the Emergency Management Steering Committee convened by TDOT.

In Alaska, the Statewide Maintenance and Operations Chief stays abreast of the snow, climate change, and other projections released by the NOAA-funded program in the state responsible for informing the public on these issues. The chief cites projected increases in storm severity and unpredictability as a reason he is looking to expand snow dump space in Anchorage, Alaska's largest city.

To better plan for extreme weather events, states are requiring more training in ICS for transportation staff as well as more specialized training addressing the particular issues extreme weather poses for their state. In the case of Vermont, VTrans is requiring general ICS training, river management training for decision makers, and highly technical training in river dynamics for its engineers. TDOT has required its managers to take a course in GIS for freight rerouting to prepare for detours under flooding and other conditions. TDOT is also conducting more training on the post-event damage assessment process to support federal reimbursement.

Two case example states, Washington and New Jersey, were also pilot states for FHWA climate change vulnerability studies, which examined risks to transportation infrastructure under projected changes. These planning efforts have informed thinking on where to invest for extreme weather events. In New Jersey, the state has identified $2 billion in projects to increase resiliency. VTrans reports that it also is seeking to buttress efforts to fund more resilient projects, for example, by clarifying its practices in a hydraulic manual rewrite.

Crosscutting Issues

Communications

Every state uses a 511 system of some kind to communicate to the public information about highway conditions. This may be supplemented by social media, smart-phone applications, and other channels of information as a routine service.

Under extreme weather scenarios, states have developed online, publicly available traffic maps where they did not already have them. VTrans enlisted its IT and GIS staff to work with Google to develop an online map which showed all road closures in real time. This became a resource for VTrans, its stakeholders, the general public, as well as other agencies supporting various constituencies, such as tourists.

In many instances state DOTs quickly established call-in centers during the extreme weather events. It was important to have enough staff to tend to these centers. The same is true for managing and updating social media sites. Under an emergency response situation, WSDOT ensured it had a "communicator" in each of its regional operations centers, with the following duties:

- Responding to media calls for updates
- Facilitating media interviews with key WSDOT personnel
- Updating WSDOT's traffic web pages
- Posting closure information on web pages
- Updating Highway Advisory Radio messages
- Crafting alert messages for the 511 Traveler Information System
- Monitoring media coverage of the storm.

The results of this strategy included the public's high use of the web page and the local news media running WSDOT-supplied road closures as a ticker on the bottom of the television screen. Where electronic forms of communication are not available, the Washington state example is also a model for strong communication by more traditional means: When WSDOT needed to close down Interstate 5, it sent postcards to truckers that might be making the trip on that corridor, handed fliers out at truck stops, and used a trailer to pull a message board around truck stops. Both WSDOT and IDOT provided examples of interacting directly with freight hauler associations to work through issues associated with an event's impacts. To get its message out to a broad audience, VTrans transported the media to flooded sites and made staff available for interviews.

In the field, state DOTs use dynamic messaging boards, including ones set on trailers. Under emergency response procedures in Texas, TxDOT will work through the state emergency management office on the proper message regarding wildfires for its dynamic message boards. Wisconsin handled the heat buckling risk in the summer of 2012 under normal procedures rather than emergency response but used its Adverse Conditions Communications Plan and developed a press release focused on risk communication. The press release and related interviews by WisDOT conveyed the following message to the public: The risk of heat buckling is high but is for a defined period; there is a technical explanation for the problem; WisDOT knows the number of buckling incidents; it takes crews a short amount of time to fix them; there is local participation in the effort through counties; and there is a need for the public to be prepared. WisDOT also supplied a simple list of safety tips. This brief, clear public safety message was picked up by the media, providing a caution to the public.

Interagency Coordination

In all case examples in this report, the state DOTs' emergency response procedures may direct very specific forms of coordination. State DOTs often brought the FHWA in early and maintained the agency as a partner throughout, even as states challenged FHWA rulings regarding federal financial support.

In some cases, state DOTs lead coordination efforts during the extreme weather event. Such leadership is seen in Vermont, which spearheaded response and recovery given the dramatic impact of Irene on the state infrastructure. In the case of Iowa, IDOT convened an internal flood team that served as an internal ICS before, during, and after the event. In Tennessee and Vermont, a lesson learned by the DOTs was that more offices could have been brought in earlier, such as human resources in Tennessee and an environmental liaison in Vermont. However, in both instances the events were far beyond the scope of impacts experienced previously in those states.

State DOTs used active coordination with other divisions as well as stakeholders across the state government in order to facilitate interstate travel, effectively utilize National Guards troops, and execute evacuations, often by temporarily waiving certain rules. VTrans worked internally with its motor vehicle division to waive time and weight requirements for vehicles seeking to bring various forms of aid to the state. NJDOT addressed similar issues, and it is developing a permitting process to clear interstate carriers through in advance of the extreme weather event impacts. During Sandy, NJDOT worked with an external but closely allied partner, the New Jersey Turnpike Authority, to waive tolls on the toll routes leading out from the Jersey Shore in order to facilitate evacuation. In Alaska, the ADOT&PF waived substantial ferry fees (totaling about $5,000) for more than 50 National Guard members who needed to take a ferry to snow-trapped Cordova when the Cordova airport had been shut down.

Deploying the National Guard has important implications for some agency relationships. Use of the National Guard sends a message to the public that an extreme weather event has attention at the highest level of state government. In those instances, the state DOT and its partners, very often local law enforcement, find ways to integrate and utilize the National Guard troops at a time when they are managing their own personnel. Coordination is important at the most local level, with the National Guard requiring a clear understanding of the chain of command. Active coordination is required especially where a National Guard troop's task is not a part of their core training. For example, an issue over the proper alignment of skill sets was observed when troops did not know the correct methods for debris removal from Vermont riverbanks and the environmentally sensitive areas nearby. Inserting National Guard troops and other forms of extraordinary support into an emergency response situation can require an understanding of the communication technologies needed and those actually on hand. For example, there was a mismatch of communications equipment in the Washington state case, which required added time to resolve.

State DOTs routinely work with FHWA on many issues, and this ongoing relationship aids coordination before, during, and after extreme weather events. Iowa, Tennessee and other states embedded FHWA in their ICS. Iowa interacted with FEMA through the state's emergency management office, whereas Tennessee embedded its own staff on FEMA teams that came to the state. New or increased occurrences of extreme weather may lead to federal program reimbursement requests that present new program or legal issues for resolution. Early coordination with FHWA in the face of extreme weather events has helped secure reimbursement. For example, in 2011, TxDOT asked for and received reimbursement for the cost of removing dead trees scorched by wildfires that might have fallen into the roadway. This was a new precedent and TxDOT ascribes FHWA's support to early coordination.

A federal partner important to state DOTs is NOAA, whose NWS provides the regional and local forecasts that a state will rely on, such as flash flood, ice, and snow projections. ADOT&PF has taken advantage of other NOAA products, including post-storm reviews that evaluate the effectiveness of NOAA weather products. ADOT&PF also engages in the NOAA-sponsored RISA (the aforementioned Regional Integrated Science Applications) in Alaska, using RISA outputs to support development of winter maintenance practices.

As needed, the state DOT may serve as a facilitator on issues arising at the field level, often when the issues implicate interstate transportation. For example, IDOT facilitated discussion among railway interests and local authorities as the railway companies sought track repairs to keep western coal moving to East Coast power plants during the prolonged 2011 flood.

Data and Knowledge Management

Personnel responsible for planning at state DOTs consider ways to identify and manage the data and information needed before, during, and after an extreme weather event. For example, IDOT decided to invest in LIDAR after a 2008 flooding event, and these data sets were very useful during the 2011 flood described in this Synthesis Report. After 2010's once-in-1,000-years flood, Tennessee invested in LIDAR; as noted earlier, TDOT is actively reviewing now, ahead of any future flood, the possible disconnects between its LIDAR data sets and those data sets used by key partners such as the U.S. Army Corps of Engineers. VTrans is seeking to ensure there are custodians for key data sets useful during recovery efforts. Multiple state DOTs have developed training on the FHWA and FEMA reimbursement process and this training has emphasized the importance of securing photos and the exact location of damage, as well as requirements for records retention.

During an event, state DOTs attempt to share information in several ways. They schedule calls at fixed times. They also collaborate through webinars, Share Point, or WebEOC applications. Geospatial data can be difficult to share by e-mail or verbally, so some states have found ways to collaborate, such as IDOT's "sit-downs" on GIS issues around the time of its broader planning call. IDOT also facilitated access to GIS experts in the actual assessment process that would support federal reimbursement applications. Google Maps has been a key tool for state DOTs. One reason is because there is the option to make the maps publicly available, and they can be set to deliver real-time information. In the case of heat buckling, where pavement damage was temporary, Wisconsin chose to make the Google Map available to a more limited group that included senior management. With respect to weather and climate information, states rely on NWS and contracted weather reporting, as noted earlier. VTrans is encouraging early adoption of important communication technologies to facilitate information sharing during the next extreme weather event.

After recovery from an extreme weather event is well under way or complete, state DOTs conduct after-event exercises to capture lessons learned. Emergency Response protocols call for AARs (After Action Reports), and these often serve as the record of the event institutionally. One example of a typical AAR is seen in the 2007 case example in Washington. To provide details on the Alaska case, however, the ADOT&PF interviewee referred back to the daily reports issued by the state's emergency management office from the time period. Some AARs discuss the event only, others broaden the scope, and still others take the opportunity to make much more universal recommendations, such as in the case of Iowa's statewide AAR supporting the Governor's task force report.

Federal agencies will produce post-event reports, such as those developed by NOAA that provides a technical analysis of the event and the federal agency's actions. As noted elsewhere, Alaska's Chief of Statewide Maintenance and Operations reviews the post-event reports created by NOAA and also provides briefings to the NOAA-funded climate center in Alaska. His briefings are intended to enable stakeholders to learn about the issues ADOT&PF viewed as important during extreme weather events and how it is addressing them going forward.

After Irene, VTrans conducted an exercise that was much broader than an AAR, involving workshops and interviews with multiple stakeholders. Vermont's effort resulted in the Irene Recovery Innovation Task Force Report, which covers both VTrans modernization efforts and practical suggestions for emergency response and for "ongoing operations." Iowa's Governor formed a task force, which also developed a report that serves as an important statewide narrative about the 2011 flood. TxDOT commissioned a lengthy survey of best practices for TxDOT in supporting wildfire suppression, and it also provided technical responses to inquiries from the state legislature. Vermont was involved in convening a regional exercise to share the perspectives and lessons learned by states in the northeastern United States in the aftermath of Hurricanes Lee and Irene. Many important ideas on information management surfaced in that forum. One major example was the need to share weather forecast and impacts information during an event so that others "know what's coming." The form and content of these event narratives vary greatly, but they capture data, information, knowledge, analysis, and ideas useful to managing future events.

Another response to extreme weather events is the production of purely technical studies to support decision making. For example, after the 2007 extreme weather event in Washington State, WSDOT requested a synthesis of all technical studies conducted on the Chehalis River Basin. That Chehalis River flooding had closed down a major interstate, I-5, for the third time in 25 years provided context and perspective for decision making inside and outside of WSDOT. After a major heat event in 2012, WisDOT developed database of 300 heat-buckling locations, and their profiles. As a result, its engineers can study conditions and identify trends on this problem.

States are considering issues related to maintaining institutional memory so that key technical facts about prior weather events are not lost. At the meeting of northeastern states noted previously, there was discussion of succession planning as well as the need to facilitate temporary rehiring of former employees with institutional knowledge important to managing an extreme weather event.

The case examples in this report represent diverse programs, issues, and responses. Each state DOT was compelled to capture what they learned from the extreme weather events, and every exercise included interagency or interdisciplinary stakeholders. No state DOT wanted to reinvent the wheel the next time, and greater collaboration in information sharing was viewed as yielding a higher return on investment.

Additional Issues

The case examples in chapter two presented information on state DOT responses to extreme weather events based on common state DOT functions: Operations, Maintenance, Design, Construction, Planning, Communications, Interagency Coordination, and Data and Knowledge Management. Other notable topics emerged from the synthesis of case examples. These topics include financial issues, Emergency Response, the influence of event type, multimodal aspects, impacts to local transportation infrastructure, and what might be described as change management in the face of new or increased extreme weather events.

Financial

In addressing extreme weather events, state DOTs focus significant attention on the process for receiving federal reimbursement for the costs from extreme weather damage. Major reimbursement programs for damage to transportation infrastructure are the FHWA Emergency Relief (ER) program and FEMA Public Assistance (PA). For wildfire damage, states will look to Fire Management Assistance Grants. Recent law and policy changes make other programs available for planning and for rebuilding costs; however, the case examples in chapter two focus on the terms of the FHWA ER and the FEMA PA programs as they existed at the time of the disaster.

The FHWA and FEMA programs are very important resources for state DOTs experiencing severe impacts from an extreme weather event, even before the event's impacts are felt. Significant attention and resources are focused on the successful reimbursement of costs, including staff training and in-house streamlining of the application process. In preparation for such events, states have sought to educate their employees on the FHWA and FEMA programs and processes. Alaska and New Jersey, as previously noted, provide examples of very instructive presentations by state DOTs, and these are included as appendices to this report. Prior to the 2011 flood, IDOT had ensured that staff was trained to be project officers on federal reimbursement issues. In post-Irene recovery, VTrans is seeking to have a state attorney dedicated to these issues and has hired and contracted experts to provide technical assistance to communities on these programs.

State DOTs facilitate the reimbursement process in other ways. ADOT&PF is flexible in allowing the creation of job codes, even when the projects associated with a code may "go nowhere." NJDOT set up a job code early on, before Sandy's geographical path was clear. By doing, NJDOT was ready when the President implemented his disaster declaration retroactively, allowing NJDOT to capture costs incurred in preparedness efforts under that job code. TxDOT uses collaboration sites to build up the paper work needed by FHWA and FEMA. To work better with FHWA, IDOT built its own "electronic DDIR" system that ultimately saved many hours of staff time before, during, and after the 2011 flood.

It can be highlighted that state DOTs provide services even when the likelihood of federal reimbursement is not at all certain. In states with rural areas with a large geographic scope, such as Washington, Texas, and Wisconsin, state DOTs sometimes weigh the benefit of federal reimbursement against the administrative resources needed to secure it. Almost always, they provide the services needed in rural or unincorporated areas even when they will not be reimbursed.

Emergency Response

Prior TRB reports, such as *NCHRP Report 525: A Guide to Emergency Response Planning at State Transportation Agencies*, discuss the Emergency Response principles of state DOTs (Wallace et al. 2010). In almost every extreme weather situation depicted in the case examples in chapter two, state DOTs sought to utilize emergency response processes at some scale. Where there was no emergency response, there was a state-level awareness of the problem, as in the case of the Wisconsin and Texas pavement-distress examples.

The IDOT case serves as an example of a maturing emergency response system with respect to extreme weather events, with the development of an ETO as another indicator of Iowa's focus in this area. VTrans, although prepared for the worst of winter weather and prior levels of severe flash flooding, had to confront the impact of a new causal chain of weather events and built up an ICS to address transportation issues virtually from scratch. Both states developed excellent reports on the lessons learned and practices they found effective for emergency response under those extreme weather events. Key points include prior training in ICS, preassigned roles and teams, and access to data depicting the scope of the event. In New Jersey, NJDOT operated effectively within the state's Emergency Management apparatus during response to Hurricane Sandy.

Influence of Event Type

The type of extreme weather event has an influence on a state DOT's management approach and is a key consideration when comparing the lessons learned and effective practices identified in this report.

If the event is unusual for the climate, then the state may not have set process in place for addressing it. In Texas, TxDOT crews routinely patrol for cracks and other pavement distress caused by heat. Up north, Wisconsin has protocols for tracking damage to pavement from winter conditions, which is the routine source of severe weather. After the 2012 heat-buckling event, WisDOT conducted research and began to configure its MDSS to forecast for not just adverse winter conditions but those arising from high heat. TxDOT's expenditures were 20 times that of WisDOT.

Additionally, the type of weather event can demand actions that conflict with another set of state DOT protocols or priorities. Employees must use their best judgment or await directives from management in those instances.

- For example, where a tornado occurs while flood waters are rising, one must decide whether to shelter in place or head to higher ground. In these instances, TDOT, for example, stresses to its field crews that safety comes first and will work with them to communicate the latest forecasts and other relevant information.

- In the case of wildfire suppression, TxDOT employees are instructed that they do not fight fires. However, the agency is expected to provide critical fuel and water supplies to those fighting the fire, so it invested in two TxDOT trailers that include protective gear if the fires get too close.
- When a snowstorm interrupted Sandy storm surge clean-up, NJDOT crews evacuated the shore area and quickly moved from emergency response to routine snow maintenance activities. It was a new and disruptive element in the recovery from Hurricane Sandy. Having the Chief of Operations Support available to manage the situation aided the shift in efforts for that short period of time.

The type of event can influence decision making when it is a prolonged event, as opposed to a more acute situation. Lessons learned from Iowa's weeks of inundation may be different from those learned during the once-in-1,000-years flood that came and went within a week in Tennessee. Similarly, geographical distinctions may matter when comparing cases. Flash floods in Vermont's mountain river basins may be very different from flooding on the plains of Iowa but similar to those occurring in western Washington State. That said, strategies on detours and the need for outreach to freight carriers may have commonalities in all three cases.

Multimodal Aspects

State DOTs often manage more than state and federal roadways. Their role may include direct responsibility over other forms of transportation, such as transit in the case of NJDOT. State DOTs may regulate but not own transportation infrastructure, especially at the local level, such as Vermont's role in state railways. An extreme weather event implicates the interplay among modes, such as where closure of a roadway affects the volume of traffic on another mode of transportation. In the case of Iowa, closure of I-680 saw freight haulers using alternate modes of transportation, including rail, to convey their goods. Emergency response protocols can drive coordination efforts, as seen in the ICS model. Climate change and its broad range of extreme weather risks implicates multimodal planning, as seen in the highway and transit components of the New Jersey pilot study on climate vulnerability, funded by FHWA.

Local Transportation Infrastructure

The case examples in chapter two largely focus on a statewide perspective of extreme weather events because that is the mission of state DOTs. However, as one interviewee put it: "All emergencies are local." This approach means that field crews and local law enforcement typically are the people on the ground when state DOT mission requirements are implicated.

Two key issues related to local transportation infrastructure emerged from the case examples: (1) the need to ensure local infrastructure can handle traffic diverted from state roads during an extreme weather event and (2) the need to address damage to local infrastructure where the cost far exceeds the resources of a locality to fix it.

Regarding detours, state DOTs typically make sure to develop detours that local roads can handle, in terms of weight and other traffic volume characteristics. State DOTs do not want these to exceed the design standards of the detour. The WSDOT interviewee pointed out that WSDOT can be asked to pay when its detours damage local roads. As a result, the agency evaluates the impact on the slopes and pavement from detours. Based on engineering and other considerations, WSDOT engaged in some important activities after the 2007 event that support improved detours. WSDOT introduced a detour planning and permit system useable throughout the state. WSDOT also joined with partners in researching and developing a map and other tools that identify state and local transportation infrastructure vulnerable to climate change impacts (State of Washington Department of Ecology 2012).

Regarding damage to local transportation infrastructure, the cases indicate two sample practices of note. First, immediately after Sandy, NJDOT made it easy for its crews on the ground to elevate the issue of whether they should clear side streets of debris. Although the side streets were off the state DOT's right-of-way, it was in the best interests of the state to make it easier for local authorities and residents to return and undertake their own recovery activities, including those related to local transportation infrastructure. Second, in Vermont, VTrans encouraged cost-sharing rule changes designed to increase state support to damaged local infrastructure. VTrans also helped create a new scheme wherein the state pays for those local transportation infrastructure repairs that require an increase in local taxes above a certain amount.

Change Management

The case examples in chapter two describe how state DOTs are developing or maturing their responses to extreme weather events. As noted previously, a common theme is the increased use of emergency management approaches in some form. Washington State, as the oldest example in this set of cases, provides a clear-cut example of an evolution in a state DOT's response to extreme weather. In 2007, its emergency operations staff numbered three or four; in 2013, the division had more than 40 people and an air-rescue function it previously did not have. That growth is a significant organizational change. Iowa also matured in its management of extreme flood events between 2008 floods and those in 2011. Changes included an electronic federal aid reimbursement system and investment in LIDAR data sets. In Vermont, the Irene experience triggered an important shift at VTrans, as indicated by plans within its design and construction sections to mainstream new bridge construction approaches by 2014.

An important trend is seen in the recent shifts in federal policy and law. Several states have embraced changes that allow for the consideration of future extreme weather risks, which is a break from the belief that rebuilding simply to "pre-disaster" conditions is satisfactory. In every case example, strategic Data and Knowledge Management supported learning and more efficient use of information resources, demonstrating that these practices are important aspects of change management.

CHAPTER FOUR

CONCLUSIONS

The objective of this Synthesis Report is to identify common and recurring themes in state-level responses to extreme weather events impacting transportation and to contribute to the development of a unified, accessible knowledge base on this topic.

Chapter one provides background on the importance of examining extreme weather impacts on the transportation sector and how Knowledge Management approaches can help state DOTs to identify and assess practices appropriate to their circumstances. It was observed that investment decisions rely on good data, and collecting information on state DOT responses to extreme weather events complements efforts to prepare for the range of climate changes projected for the future and their anticipated impacts on transportation.

The case examples in chapter two provide narratives of extreme weather events from the past decade, organize activities related to these extreme weather events by common state DOT functions, and summarize lessons learned and related practices.

Chapter three's synthesis of information from the eight case examples highlights themes that are the basis for the findings and suggestions for research that follow.

FINDINGS

Findings Related to State-level Responses to Extreme Weather Events Impacting Transportation

The case examples suggest some broad, thematic elements to state DOT responses to extreme weather events:

- Emergency management processes are a common element of state DOT activities before, during, and immediately after an extreme weather event.
- Reimbursement from federal programs drives many state practices.
- States reached out to the FHWA almost immediately during many extreme weather events, and this early knowledge and participation in state activities facilitated federal decisions on financial reimbursement.
- Interagency coordination is important to the efficient allocation of tasks and resources, including activities with National Guard and Emergency Management Assistance Compact (EMAC) support.
- The quality of the information on the weather event and its projected impacts affects decisions on deploying resources, assessing damage, and other critical matters.
- Collecting data about the situation on the ground (including images and the location of damage) is a key activity often conducted in the aftermath of a catastrophic event, making training in this area an important part of the maturity of extreme weather response.
- States record response, recovery, and other relevant efforts in post-event reports, ranging from a focused review of the event to a more wide-ranging analysis. Coordination with localities (e.g., through long-term maintenance agreements or shared technologies) is critical and has benefits beyond the narrow purpose of the engagement.
- Investments in training (e.g., in emergency management, federal program reimbursement, geographic information system, and other subjects) were a common practice often cited as having facilitated response and recovery.
- In policy and in practice, the federal and state governments are developing ways to address new and increased extreme weather events in transportation investments.

Findings Related to a Obtaining a Unified, Accessible Knowledge Base in This Area

The case examples show that data and Knowledge Management practices support responses to extreme weather events impacting transportation. These practices include:

- Researching and recording information and key issues on severe weather conditions
- Utilizing geospatial data to identify at-risk sites and safe locations
- Facilitating the use of tools and processes that aid collaboration on weather events as they occur
- Sharing information through online platforms, such as SharePoint and WebEOC, to enable a quick response
- Developing After Action Reports and other records of effective practices and lessons learned from extreme weather events

- Engaging in meetings, workshops, and other structured activities to share and document knowledge in preparation for future similar events
- Developing succession planning and record retention strategies to retain knowledge
- Developing maintenance management systems that address newer weather risks
- Acquiring or developing the data sets and other aspects of an information base to facilitate analysis of investments in preparedness and resiliency.

SUGGESTIONS FOR FURTHER RESEARCH

The following research would support state department of transportation (DOT) efforts to address extreme weather impacts:

1. Research ways to increase state DOT technical expertise to complement and supplement federal weather forecasting at the local, regional, and national levels.

2. Identify technologies, training, and standards in Knowledge Management that can support informed decision making and coordination within state DOTs and with external partners, given the increased risk of extreme weather events.

3. Collect a common set of information from states that experienced the same extreme weather event to learn about differences before, during, and after the event as well as the lessons learned, identified by each state.

4. For each state, identify the extreme weather events projected to occur with more frequency or intensity in the future, develop a framework for an organized response, and collect a standard set of information and materials on previous events of a similar nature.

5. Conduct research and synthesis of EMAC case examples to surface effective practices in the transportation sector under extreme weather events.

6. Conduct research on the disposition of state applications to FHWA and FEMA following extreme weather events and create a body of knowledge for reference and use in similar cases.

7. Research current design and engineering practices at the state level and their relationship to provisions of the FEMA Public Assistance manual and the FHWA Emergency Relief manual provisions, before and after updates.

8. Research emerging practices in transportation sector investments under the projected increases in extreme weather events, and related policies.

9. Research tools for identifying benefits and costs and the return on investment in extreme weather preparedness, resiliency, and adaptation strategies.

State DOT responses to extreme weather impacts continue well beyond the immediate management of an extreme weather event, which experience shows can occur at unexpected and near-biblical scales. Every state interviewed is conducting reviews and assessments, seeking out new sources of information and expertise, and adapting their people, programs, and processes to extreme weather risks. This Synthesis Report is intended to support those and similar efforts.

REFERENCES

New Jersey 2012: Hurricane Sandy

All Hazards Consortium, *The Multi-State Fleet Response Initiative Working Group Workshop Report, Rapid Critical Infrastructure Restoration Through Joint Integrated Planning for the Movement of Private Sector Resources in Response to Hurricane Sandy*, Jan. 30, 2013, 23 pp.

Assessing New Jersey's Transportation System, Transportation Choices 2030: New Jersey Long Range Transportation Plan Update, New Jersey Department of Transportation, Trenton, Oct. 2005 [Online]. Available: http://www.nj.gov/transportation/works/njchoices/pdf/assessment.pdf [accessed June 24, 2013].

Blake, E.S., T.B. Kimberlain, R.J. Berg, J.P. Cangialosi, and J.L. Beven II, *Tropical Cyclone Report, Hurricane Sandy*, National Hurricane Center, Miami, Fla., Feb. 12, 2013, 157 pp.

"Christie Declares State of Emergency: Evacuations Ordered for All Barrier Islands," *Press of Atlantic City*, Nov. 23, 2012 [Online]. Available: http://www.pressofatlanticcity.com/news/breaking/christie-declares-state-of-emergency-evacuations-ordered-for-all-barrier/article_cff012e4-1f59-11e2-a753-0019bb2963f4.html [accessed Apr. 9, 2013].

Community Development Block Grant Disaster Recovery Plan, New Jersey Department of Community Affairs, Newark, Mar. 27, 2013.

Henson, B., "Dissecting Sandy's Surge, Part 2," *AtmosNews*, University Corporation for Atmospheric Research, Boulder, Colo., Dec. 31, 2012 [Online]. Available: https://www2.ucar.edu/atmosnews/opinion/8585/dissecting-sandys-surge [accessed Apr. 9, 2013].

"Hurricane Sandy: N.J. County by County Evacuations, Flooding, Closings," *New Jersey News*, Oct. 29, 2012 [Online]. Available: http://www.nj.com/news/index.ssf/2012/10/hurricane_sandy_nj_county_by_c_1.html [accessed Apr. 9, 2013].

"Hurricane Sandy: Emergency Relief and Disaster Recovery Updates," U.S. Department of Transportation Press Office, Washington, D.C., Nov. 26, 2012 [Online]. Available: http://www.dot.gov/sandy [accessed Apr. 9, 2013].

Hutchins, R., "Extensive Damage from Sandy Litters Long Beach Island," *The Star-Ledger*, Oct. 21, 2012 [Online]. Available: http://www.nj.com/news/index.ssf/2012/10/extensive_damage_from_sandy_li.html [June 24, 2013].

"NJDOT Announces Realigned Emergency Safety Patrols, Weekend Service Added to High-Volume Corridors Throughout New Jersey," New Jersey Department of Transportation, News Release, Newark, Dec. 7, 2010 [Online]. Available: http://www.nj.gov/transportation/about/press/2010/120710.shtm [accessed April 25, 2013].

"NJ Transit About Us," New Jersey Transit, Newark [Online]. Available: http://www.NJ Transit.com/tm/ tm_servlet.srv?hdnPageAction=CorpInfoTo [accessed Apr. 9, 2013].

"Ocean County Towns Issue Voluntary Evacuations," *Asbury Park Press*, Oct. 27, 2012 [Online]. Available: http://www.app.com/article/20121026/NJNEWS/310260086/Ocean-County-towns-issue-voluntary-evacuations [June 24, 2013].

"President Obama Signs New Jersey Disaster Declaration," The White House Press Office, Washington, D.C., Oct. 30, 2012 [Online]. Available: http://www.whitehouse.gov/the-press-office/2012/10/30/president-obama-signs-new-jersey-disaster-declaration [accessed Apr. 15, 2013].

Shaw, R., "Case Studies on Storms and Flooding—Hurricane Sandy in New Jersey," *National Symposium on Extreme Weather Event Impacts on Transportation*, Washington, D.C., May 21–22, 2013.

Stanley, S., "Weathering the Storm, How Safety Service Patrols Prepare for and Respond to Natural Disasters," *Safe Highways* [Online]. Available: http://www.safehighways.org/safe-highway-matters/winter-2013/weathering-the-storm/ [accessed Apr. 25, 2013].

Iowa 2011: Flood

About the DOT—Roads, Streets, and Bridges, Iowa Department of Transportation, Ames, n.d. [Online]. Available: http://www.iowadot.gov/about/Roads,Streets,andBridges.html [June 24, 2013].

After Action Report: 2011 Missouri River Flooding, Iowa Department of Transportation, Ames, n.d., 26 pp.

"Emergency Transportation Operations," Office of Operations, Federal Highway Administration, U.S. Department of Transportation, Washington, D.C., 2013 [Online]. Available: http://www.ops.fhwa.dot.gov/eto_tim_ pse/index.htm [accessed April 7, 2013].

Iowa 2011 Missouri River Floods After Action Report (*AAR*), Iowa Homeland Security and Emergency Management Division, Johnston, Dec. 20, 2011.

"Iowa DOT Captures Story of Historic 2011 Missouri River Flood," Iowa Department of Transportation, May 31, 2012 [Online]. Available: http://www.news.iowadot.gov/newsandinfo/2012/05/iowa-dot-captures-story-of-historic-2011-missouri-river-flood.html [accessed Nov. 12, 2012].

"Iowa DOT Reopens I-680 Two Months Ahead of Schedule," *AASHTO Journal*, Weekly Transportation Report, Nov. 4, 2011 [Online]. Available: http://www.aashtojournal.org/ pages/110411iowa.aspx [accessed Mar. 8, 2013].

Missouri River Flood Coordination Task Force Report, Missouri River Flood Coordination Task Force, n.d., 53 pp.

"Turn Around, Don't Drown," Iowa Department of Transportation, Ames, Sep. 2011 [Online]. Available: http://www.iowadot.gov/ floods/turnaround.html [accessed Nov. 12, 2012].

"Turn Around Don't Drown Success Stories," Southern Region Headquarters, National Weather Service, Fort Worth, Tex., updated Feb. 8, 2011 [Online]. Available: http://www.srh.noaa.gov/srh/tadd/ [accessed Nov. 12, 2012].

Tennessee 2010: High-Intensity Rain and 1,000-Year Flood

2010 Tornado Fatality Information, Storm Prediction Center, National Weather Service, n.d., 2010 [Online]. Available: http://www.spc.noaa.gov/climo/torn/2010deadlytorn.html [accessed June 24, 2013].

Ascensio, A.J., "Tornadoes Cause Additional Damage to Already Devistated (sic) West Tennessee," Yahoo Contributor Network, May 2, 2010 [Online]. Available: http://voices.yahoo.com/tornadoes-cause-additional-damage-already-devistated-5950146.html [accessed June 24, 2013].

Burbank, C., "Early Signs of Climate Change: 2010 Flooding in Tennessee, Rhode Island, and Iowa," In *Transportation Research Circular E-C152: Adapting Transportation to the Impacts of Climate Change, State of the Practice 2011*, Transportation Research Board of the National Academies, Washington, D.C., June 2011.

Degges, P., *Damage Survey Summary Report: Widespread Flooding in Tennessee Due to Severe Weather of April 30–May 2, 2010*, Tennessee Department of Transportation, Nashville, July 2, 2010.

"Fact Sheet, One Year Later: Tennessee Flood Recovery by the Numbers," Federal Emergency Management Agency, Washington, D.C., Apr. 19, 2011.

"May Storms and Flooding of 2010," Tennessee Emergency Management Agency, Nashville [Online]. Available: http://www.tnema.org/events/index.html [accessed Mar. 4, 2013].

Multimodal Transportation Resources Division 2010 Annual Report, Multimodal Transportation Division, Tennessee Department of Transportation, Nashville, 2010.

"Portion of State Route 7 Damaged in May 2010 Floods Reopens to Traffic," State of Tennessee, Newsroom and Media Center, Nashville, Nov. 30, 2011 [Online]. Available: http://news.tn.gov/node/8127 [accessed Feb. 11, 2013].

Record Floods of Greater Nashville: Including Flooding in Middle Tennessee and Western Kentucky, May 1-4, 2010, National Oceanic and Atmospheric Administration, National Weather Service, U.S. Department of Commerce, Silver Spring, Md., 2010, 80 pp.

Response to May 2010 Flooding and Severe Weather After-Action Report, Maintenance Division, Tennessee Department of Transportation, Nashville, 2010.

"TDOT Awards Emergency Contracts For Flood Repair," Clarksville Online, May 7, 2010 [Online]. Available: http://www.clarksvilleonline.com/2010/05/07/tdot-awards-emergency-contracts-for-flood-repair/ [accessed Mar. 4, 2010].

"Telvent SmartMobility Interactive Voice Response," Telvent/Schneider Electric [Online]. Available: http://www2.schneider-electric.com/sites/country/en/products-services/former-brands/telvent/telvent_transp.page [accessed Apr. 29, 2013].

Washington 2007: High-Intensity Rain

Flooding in the Chehalis River Basin: Synthesis, TRAC, Feb. 29, 2008, pp. 11.

Preparing for a Changing Climate, Washington State's Integrated Climate Response Strategy, Publication No 12-10-004, Department of Ecology, State of Washington, Apr. 2012, 201 pp.

"Residents of Washington, Oregon Dig Out," *USAToday*, Dec. 5, 2007 [Online]. Available : http://usatoday30.usatoday.com/weather/storms/2007-12-04-northwest-storms_N.htm [accessed June 24, 2013].

Washington State Department of Transportation After Action Report Winter Storm December 1st–7th, 2007, Washington State Department of Transportation, Olympia, Aug. 25, 2008, 31 pp. 31.

"Who We Are and What We Do," Washington State Department of the Transportation, n.d. [Online]. Available: http://www.wsdot.wa.gov/about/ [accessed June 24, 2013].

Vermont 2011: Tropical Storm Irene

2012 Report to the Legislature's House and Senator Transportation Committees, Vermont Transportation Board, Montpelier, 2012 [Online]. Available: http://tboard.vermont.gov/sites/aot_transportation_board/files/documents/reports/TransportationReport_Jan21.pdf [accessed June 24, 2013].

"Election 2012: Issue Paper No. 1: Transportation," Vermont League of Cities and Towns, September 2012 [Online].

Available: http://www.hinesburg.org/selectboard/meeting_packet/12-1015/Agenda%20Item%20%2310%20-%20VLCT%20Policy%20Paper%20Transportation.pdf [accessed June 24, 2013].

Irene Recovery Report: A Stronger Future, Vermont Agency of Administration, Montpelier, Jan. 2012 [Online]. Available: http://vtstrong.vermont.gov/Portals/0/Documents/Irene_Recovery_Report_Jan_2012.pdf [accessed June 24, 2013].

Kinzel, B., "Road Repairs Will Top $700 Million, But Federal Aid Uncertain," Vermont Public Radio, Sep. 27, 2011 [Online]. Available: http://www.vpr.net/news_detail/92103/road-repairs-will-top-700-million-but-Federal-aid/ [accessed April 16, 2013].

Lessons Learned from Irene: Vermont RPCs Address Transportation System Recovery, NADO Research Foundation, Center for Transportation Advancement and Regional Development, Washington, D.C., July 2012, 14 pp.

Lubchenco, J. and L. Furgione, *Service Assessment Hurricane Irene, August 21–30, 2011*, National Weather Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Silver Spring, Md., Sep. 2012, 117 pp.

"Natural Disasters and State Transportation Lessons Learned, State/FHWA/FEMA Coordination Process Improvement," Sep. 24–25, 2012 Workshop, Coalition of Northeastern Governors, Oct. 18, 2012.

"Natural Disasters and State Transportation Lessons Learned: The Northeastern Operational Experience," Feb. 13–14, 2012 Session of the Disaster Planning Group, Disasters Lessons Learned Initiative, Coalition of Northeastern Governors, n.d.

"Natural Disasters and State Transportation Lessons Learned, the Operational Experience, Next Steps/Recommendations, Group Report Out," Coalition of Northeastern Governors, n.d.

Reston, M., "Irene Causes Heavy Flooding in Vermont," *Los Angeles Times*, Apr. 28, 2011 [Online]. Available: http://latimesblogs.latimes.com/nationnow/2011/08/hurricane-irene-causes-heavy-flooding-in-vermont.html [accessed June 24, 2013].

TS Irene: August 28, 2011 VTrans Response, Powerpoint presentation, Vermont Agency of Transportation, Montpelier, n.d., 43 pp.

Update on Vermont's Recovery from Tropical Storm Irene, Vermont Recovery Office, Montpelier, n.d., 11 pp. [Online]. Available: http://www.vtstrong.vermont.gov/Portals/0/Documents/IreneRecoveryreportspw.pdf [accessed June 24, 2013].

Vermont Agency of Transportation Irene Innovation Task Force, ReGeneration Resources, Brattleboro, Vt., Mar. 2012, 52 pp.

"Vermont Agency of Transportation Wins National Honor for Irene Recovery," *VTDigger* [Online]. Available: http://vtdigger.org/2012/06/12/vermont-agency-of-transportation-wins-national-honor-for-irene-recovery/ [accessed Feb. 26, 2013].

Vermont Recovering Stronger: Irene Recovery Status Report, Office of the Secretary, State of Vermont Agency of Administration, Montpelier, June 2012, 22 pp.

VTrans 2012 Fact Book, Vermont Agency of Transportation, Montpelier, 2012, 37 pp.

"VTran's Irene Google Map Transitions to 511," Governor's Office, Vermont, Montpelier, Nov. 18, 2011 [Online]. Available: http://governor.vermont.gov/newsroom-vtrans-irene-google-map-transitions-511 [accessed Nov. 12, 2013].

Alaska 2011–2012: South Central Winter Storms

"About Alaska DOT&PF," Alaska Department of Transportation and Public Facilities, Juneau, n.d. [Online]. Available: http://www.dot.alaska.gov/comm/about.shtml [accessed June 24, 2013].

Alaska Department of Transportation and Public Facilities (ADOT&PF), "Winter Maintenance Coordination," ADOT&PF, Juneau, Jan. 1, 2012.

Anderson, B., "No Weather Respite for Alaska Town of Cordova," *Alaska Dispatch*, Jan. 8, 2012 [Online]. Available: http://www.alaskadispatch.com/article/no-weather-respite-alaska-town-cordova [accessed Feb. 25, 2013].

Campbell, M. and B. Anderson, "Heavy Snows Prompt Local Emergency Declaration in Southcentral Alaska," *Alaska Patch*, Jan. 6, 2012 [Online]. Available: http://www.alaskadispatch.com/article/heavy-snows-prompt-local-emergency-declaration-southcentral-alaska [accessed Apr. 7, 2013].

Emerging Practices in Winter Highway Maintenance, Alaska Department of Transportation and Public Facilities, Juneau, Oct. 2012.

Grass, J., "Sno-way! Mother Nature Pounds City Streets, Budgets," *Alaska Journal of Commerce*, Mar. 1, 2012 [Online]. Available: http://www.alaskajournal.com/Alaska-Journal-of-Commerce/AJOC-March-4-2012/Sno-way-Mother-Nature-pounds-city-streets-budgets/ [accessed June 24, 2013].

Incident Overview 2012—Prince William Sound Winter Storm, 12-5-001, Alaska Department of Homeland Security and Emergency Management, Joint Base Elmendorf–Richardson, Anchorage, Jan. 10, 2012.

Memmott, M., "In Alaska: Nome Waits for Fuel; Cordova Digs Out from 18 Feet of Snow," National Public Radio, January 9, 2012 [Online]. Available: http://www.npr.org/blogs/thetwo-way/2012/01/09/144902598/in-alaska-nome-waits-for-fuel-cordova-digs-out-from-18-feet-of-snow [accessed Apr. 7, 2013].

"Prince William Sound Storm Declared Disaster," State of Alaska, Office of the Governor, Press Release, Juneau, Feb. 9, 2012.

Rosen, Y., "Alaska Town Buried in Snow Gets Help Digging Out," *Reuters*, Jan. 9, 2012 [Online]. Available: http://www.reuters.com/article/2012/01/09/us-alaska-snow-town-idUSTRE8082AZ20120109 [accessed June 24, 2013].

Schram, C., *Alaska Department of Transportation & Public Facilities Emergency Response Administration and Accounting*, Alaska Department of Transportation & Public Facilities, Juneau, Feb. 14, 2012.

Situation Report 12-012—January 12, 2012, Alaska Division of Homeland Security & Emergency Management, Anchorage, Jan. 2012.

Texas 2011: Drought

"Agency Partners: TxDOT and Wildfires," Texas Emergency Management Online, Texas Department of Public Safety, Austin, 2011 [Online]. Available: http://www.txdps.state.tx.us/dem/temo/archives/2011/Vol58No6/articles/article5.htm [accessed Nov. 12, 2012].

Best Practices for TxDOT on Handling Wildfires: What We Learned, Research Project 0-6735 Presentation, Texas Tech University Center for Multidisciplinary Research in Transportation, Austin.

George, P. and C. O'Rourke, "Bastrop Fire's Apparent Cause: Trees Hitting Power Lines," *Austin American-Statesman*, Sep. 21, 2011 [Online]. Available: http://www.statesman.com/news/news/local/bastrop-fires-apparent-cause-trees-hitting-power-1/nRfgg/.

Insurance Council of Texas (ICT), "Bastrop Wildfire Losses Rise," Press Release, ICT, Austin, Dec. 8, 2011[Online]. Available: http://www.insurancecouncil.org/news/2011/Dec082011.pdf.

Jervis, R., "Drought Threatens Way of Life for Texas Ranchers," *USA Today*, Oct. 5, 2011 [Online]. Available: http://usatoday30.usatoday.com/weather/drought/story/2011-09-12/texas-drought-Dust-Bowl-ranchers/50373618/1 [accessed Apr. 14, 2013].

Kennedy, C., "Drought Baking the Southern United States," National Oceanic and Atmospheric Administration, Sep. 2, 2011 [Online]. Available: http://www.climate.gov/news-features/features/drought-baking-southern-united-states [accessed June 24, 2013].

The Compass Project: Managing the Direction of Maintenance, Powerpoint presentation, Texas Department of Transportation, Austin, Sep. 29, 2009 [Online]. Available: http://www.dot.state.tx.us/iheep2009/presentations/1A_TxDOT_Maintenance_Management_Systems_Compass_BrandyePayne.pdf [accessed June 24, 2013].

Manual Notice 2008-01, *Maintenance Management Manual, Highway Condition Report Manual*, Texas Department of Transportation, Jan. 1, 2008 [Online]. Available: http://onlinemanuals.txdot.gov/txdotmanuals/mmt/highway_condition_reporting_system.htm [accessed June 24, 2013].

Nash, P.T., S. Senadheera, M. Beierle, W. Kumfer, and D. Wilson, *Best Practices for TxDOT on Handling Wildfires*, Texas Tech University Center for Multidisciplinary Research in Transportation, Austin, Sep. 2012, 141 pp.

"TxDOT Crews Helped Battle West Texas Wildfires," News and Information, Texas Department of Transportation, Mar. 14, 2011 [Online]. Available: http://www.txdot.gov/txdot_library/newsletters/txdot_update/2011/031411.html [accessed Nov. 12, 2012].

Wisconsin 2012: Prolonged Heat

2012 Wisconsin Yearly Weather Summary, National Weather Service, n.d. [Online]. Available : http://www.crh.noaa.gov/images/mkx/climate/2012/2012_WI_Yrly_Wx_Summary.pdf [accessed June 24, 2013].

Bessert, C.J., "Wisconsin Highways: Introduction," Wisconsin Highways, n.d. [Online]. Available: http://www.wisconsinhighways.org/introduction.html [accessed June 24, 2013].

Flynt, J., "Pavement Swelling, Protruding Due to Heat in WI," *WTAQ*, May 25, 2010 [Online]. Available: http://wsau.com/news/articles/2010/may/25/pavement-swelling-protruding-due-heat-wi/ [accessed Nov. 26, 2012].

"Relief in Sight for Heat Wave, and Why Roads Buckle," *The Chippewa Herald*, July 6, 2012 [Online]. Available: http://chippewa.com/news/local/relief-in-sight-for-heat-wave-and-why-roads-buckle/article_d66cd7da-c77d-11e1-80fb-001a4bcf887a.html [accessed Nov. 12, 2012].

"Risk of Pavement Buckling Is High Today and Tomorrow," Press Release, Wisconsin Department of Transportation, Madison, July 5, 2012 [Online]. Available: http://www.dot.wisconsin.gov/opencms/export/nr/modules/news/news_3444.html_786229440.html [accessed June 24, 2013].

Samenow, J., "U.S. Has Hottest Month on Record in July 2012 NOAA says," *Washington Post*, Aug. 8, 2012 [Online]. Available: http://www.washingtonpost.com/blogs/capital-weather-gang/post/us-has-hottest-month-on-record-in-july-2012-noaa-says/2012/08/08/0fae675ce169-11e1-98e7-89d659f9c106_blog.html [accessed June 24, 2013].

Sperry, T., "Use Caution if You Drive in Extreme Heat," CNN, July 6, 2012 [Online]. Available: http://www.cnn.com/2012/07/06/travel/heat-road-conditions [accessed Nov. 12, 2012].

General:

Baglin, C., *ACRP Synthesis of Airport Practice 33: Airport Climate Adaptation and Resilience*. Transportation Research Board of the National Academies, Washington, D.C., 2012, 87 pp.

Cloyd, E., C. Baglin, and A. Staudt, "NCAnet: Building a Network of Networks to Support the National Climate Assessment," Poster session presented at the National Workshop on Public Participation in Scientific Research, 97th Annual Meeting of the Ecological Society of America, Portland, Ore., Aug. 5–19, 2012.

Dasgupta, A., "Economic Value of Geospatial Data: The Great Enabler," *Geospatial World*, May 2013 [Online] Available: http://www.geospatialworld.net/Magazine/MArticleView.aspx?aid=30534 [accessed June 24, 2013].

"Eligibility of Activities to Adapt to Climate Change and Extreme Weather Events Under the Federal-Aid and Federal Lands Highway Program," Federal Aid Program Administration, Federal Highway Administration, Washington, D.C., Sep. 24, 2012 [Online]. Available: http://www.fhwa.dot.gov/federalaid/120924.cfm [accessed June 24, 2013].

"Extreme Weather 2011," National Ocean and Atmospheric Administration, Washington, D.C., n.d. [Online]. Available: http://www.noaa.gov/extreme2011/ [accessed June 24, 2013].

Federal Highway Administration (FHWA), *Climate Change Resilience Pilots*, FHWA, Washington, D.C., n.d. [Online]. Available: http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/vulnerability_assessment_pilots/index.cfm [accessed June 24, 2013].

Federal Highway Administration (FHWA), *Regional Climate Change Effects: Useful Information for Transportation Agencies*, FHWA, Washington, D.C., n.d. [Online] Available: http://www.fhwa.dot.gov/environment/climate_change/adaptation/resources_and_publications/climate_effects/index.cfm [accessed Aug. 24, 2013].

Leviäkangas, P., A. Tuominen, R. Molarius, H. Kojo, J. Schabel, and S. Toivonen, *Extreme Weather Impacts of Transportation Systems* (*EWENT*), VTT Working Papers 168, VTT Technical Research Centre of Finland, Apr. 2011, 133 pp.

"MAP-21—Moving Ahead for Progress in the 21st Century," Federal Highway Administration, May 29, 2013 [Online]. Available: http://www.fhwa.dot.gov/map21/qandas/qaer.cfm [accessed June 24, 2013].

McLaughlin, B., S. Murrell, and S. DesRoches, "Anticipating Climate Change," *Civil Engineering*, Apr. 2011.

National Climate Assessment (*draft*), National Climate Assessment Development Advisory Committee, U.S. Global Change Research Program, Washington, D.C., Jan. 2013, 1146 pp.

NCHRP Project 20-83(05): Climate Change and the Highway System: Impacts and Adaptation Approaches, Final Report [Online]. Available: http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2631.

Special Report 290: Potential Impacts of Climate Change on U.S. Transportation: Transportation Research Board of the National Academies, Washington, D.C., 2008, 234 pp.

Staudt, A., E. Cloyd, and C. Baglin, "NCAnet: Building a Network of Networks to Support the National Climate Assessment," Accepted for poster session at American Geophysical Union Fall Meeting, San Francisco, Calif., 2012.

The President's Climate Action Plan, Executive Office of the President, The White House, Washington, D.C. [Online]. Available: http://www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf [accessed August 24, 2013]

Wallace, C.E., A. Boyd, J. Sergent, A. Singleton, and S. Lockwood, *NCHRP Report 525, Vol. 16: A Guide to Emergency Response Planning at State Transportation Agencies*, Transportation Research Board of the National Academies, Washington, D.C., 2010, 170 pp.

Weather Information for Surface Transportation (*WIST*) *National Needs Assessment Report*, FCM-R18-2002, Office of the Federal Coordinator for Meteorological Services and Supporting Research, Washington, D.C., 2002.

Wenger, E., *Cultivating Communities of Practice—A Quick Start Up Guide*, Etienne Wenger, 2002 [Online]. Available: http://www.ewenger.com/theory/start-up_guide_PDF.pdf [accessed June 24, 2013].

BIBLIOGRAPHY

The National Incident Management System: A Workbook for State Department of Transportation Frontline Workers, Federal Highways Administration, Transportation Pooled Fund Study 5 (161), Sep. 2009.

Schwartz, H.G., Jr., *America's Climate Choices: Adaptation—A Challenge to the Transportation Industry*, Transportation Research Board Webinar, Nov. 3, 2010, 69 pp.

Transportation Research Circular E-C152: Adapting Transportation to the Impacts of Climate Change, Transportation Research Board of the National Academies, Washington, D.C., June 2011, 56 pp.

Venner, M., *Increased Maintenance Costs of Extreme Weather Events: Preparing for Climate Change Adaptation*, Paper No. 12-3459, 91st Annual Meeting of the Transportation Research Board, Washington, D.C., Jan. 22–26, 2012.

APPENDIX A

Research Method

The research method for this Synthesis Report is detailed here.

Literature Review

The literature review included analysis of extreme weather definitions and reports, largely from the National Oceanic and Atmospheric Administration (NOAA) and other science agencies; emergency management guides and reports related to the transportation sector; workshop and meeting minutes, as well as reports produced by states in the aftermath of extreme weather events; news articles; and materials prepared by associations and research bodies, such as AASHTO and the TRB.

Generally, the literature review covered professional literature, media reports, and federal, state, local, and nonprofit and agency websites. Research was supplemented by materials supplied by interview subjects.

Case Examples

Selection of Case Examples The extreme weather events used as case examples in this synthesis report were identified in the literature review and through other research and analysis.

The initial profile of weather events found in the literature was analyzed based on the type of weather events listed in the expert panel's October 2012 Scope of Work. As such, candidate case examples were to have the following characteristics:

- They occurred within the past decade (2002–2012).
- They had a significant effect on the transportation system, which included
  - Multiple modes
  - Local highways.
- They are geographically diverse.
- They are extreme events, including
  - Riverine flooding (two or more)
  - High-intensity rain events
  - Hurricanes
  - Wildfires
  - Drought
  - Tornadoes
  - Prolonged heat events
  - Snowstorms.

To narrow the field and establish an initial set of cases, judgments were made about the cases that may best represent extreme conditions. Examples of these judgments follow.

- The NOAA website devoted to "extreme weather" events, begun by that agency in 2011, was a useful and authoritative resource on extreme weather events. Reliance on this website may have resulted in the use of more recent events in this report.
- Consideration of how extreme weather events are defined by various experts.
- Consideration of the TRB expert panel's requirement to have at least two riverine flooding events among the eight events.
- Consideration of the TRB expert panel's requirement for geographic diversity. This requirement was interpreted, in part, as implicating weather events unusual to a region of the United States now and projected to increase in the future, as described in relevant sources (USGCRP; FHWA, 2010).
- Consideration of the kinds of transportation infrastructure that were of specific interest to the TRB expert panel, based on written comments from the expert panel's meeting of August 24, 2012, and a September 23, 2012, teleconference with the expert panel:
  - Multimodal impacts
  - Road system impacts (over other modes)
  - Local highways (not just interstates).

- Consideration of the thresholds at which weather may be “extreme” for a given mode, with reference to information on weather safety thresholds for surface transportation reported by the federal government (WIST).
- Consideration of the dimensions of extreme weather impacts and consequences for an affected geographical area, as outlined in Leviäkangas et al. (2011), which was referred to by the TRB expert panel as the “EVENT study” and cited as a favorable methodology for choosing among extreme weather events affecting transportation systems:
  - Climatologic zone
  - Technological and institutional preparedness
  - Frequency on chronological or probability scale
  - Intensity and severity of impacts and consequences
  - Chronology of impacts and consequences
  - Geographical dimension
  - Economic distribution effects.

The TRB expert panel considered a proposed list of case examples; through this expert panel review, the 2011 flooding in Tennessee also emerged as a candidate case example. Research and analysis confirmed that this event was an appropriate subject due to its 1,000-year flood status, NOAA’s categorization of the event as an extreme weather event, and the Leviäkangas et al. (2011) dimensions of this extreme weather event.

Case example interviews Structured interviews were conducted with operations, emergency management, and/or program leads in state DOTs where the extreme weather events had effect. Where needed, managers responsible for specific subjects—particularly programming, financial assistance, and field operations—were included in group interviews. Potential interviewees were identified during the case example selection process as well as through the assistance of the expert panel and TRB staff.

Each interviewee received a standard set of questions and accompanying guidance with which to prepare for the interview. The document provided to the interviewees was an interview discussion guide and is found in Appendix B.

Drafts of the case examples were reviewed by relevant interviewees. Short follow-up interviews were conducted to collect critical details as well as to supplement analysis across the case examples.

Interviewee Profiles

Extreme Weather Event	State	Department	Number of Interviewees(total)	Expertise
Hurricane Sandy (2012)	New Jersey	Department of Transportation	1	Operations; Management
Riverine Flooding (2011)	Iowa	Department of Transportation	2	Traffic Operations; Emergency Operations; Management
High-Intensity Rain and \ Tornadoes (2010)	Tennessee	Department of Transportation	1	Operations; Engineering; Management
High-Intensity Rain (2007)	Washington	Department of Transportation	1	Emergency Management
Tropical Storm Irene and Riverine Flooding (2011)	Vermont	Agency for Transportation	2	Operations; Programs; Management
Snowstorms (2011–2012)	Alaska	Department of Transportation and Public Facilities	4	Operations; Maintenance; Planning; Finance; Management
Drought and Wildfires (2011)	Texas	Department of Transportation	1	Emergency Management; Management
Prolonged Heat Event (2012)	Wisconsin	Department of Transportation	2	Maintenance; Engineering; Management

APPENDIX B

Interview Discussion Guide

Interview Questionnaire

Thank you for agreeing to support NCHRP 20-05/Topic 44-08, "Response to Extreme Weather Impacts on Transportation Systems." By answering the following questions, you will provide information that will form the basis of a case example on extreme weather impacts on transportation and the responses to those impacts in your state. This case example will be included with seven to nine others in a synthesis report that presents lessons learned and other practices, which can aid your peers seeking to address similar issues.

The following discussion guide, presented in questionnaire form, is designed to help develop the various case examples in this research project. The actual interview will track this document's contents and sequence of questions, but not every question will be fully relevant. We welcome efforts to consider your answers ahead of time, especially for Section I, and, at your discretion, to supply the Principal Investigator with an annotated copy before or after the interview.

I. Interviewee Data and Information on Selected Extreme Weather Event

1. Organizational information

   State:

   Agency/division (to most specific level):

   Name of designated interviewee(s):

   Contact information:

   Role of interviewee at the organization (current):

   Role of interviewee at the organization (time of the event):

   Role of interviewee in incident response (if different from organizational role at time of event):

2. Information on extreme weather event

   Weather event to be described:

   Specific weather phenomena observed (including relative severity, if information is available):

   Secondary weather event(s) influencing response to the primary event:

   Dates the weather event commenced, including year:

   Duration of the event:

   Duration of the organization's involvement over the course of the entire event:

   Have you documented the organizational response to this event? Have others?

Have you been involved in a research project in which you described aspects of this event? Do you have the citation or a reference?

3. Please describe the organization's major activities in this extreme weather event.

II. Impact of the Extreme Weather Event on Transportation

Please briefly describe the following items as they relate to your organization's mission, unless otherwise indicated.

1. Physical impacts
   a. To transportation infrastructure and operations (all modes and including impacts on local transportation facilities)
   b. To the infrastructure and operations of your organization
   c. To the mode(s) of transportation under your purview
2. Financial impacts to the organization
3. Financial impacts to transportation in the state
4. Economic consequences from the impact on transportation, where a basis of estimate exists
5. Environmental consequences from the impact on transportation
6. Social consequences from the impact on transportation
7. Policy and political consequences from the impact on transportation
8. Legal issues
9. Other entities on which your organization relied in managing impacts

Please describe why you would consider this an extreme weather event.

III. Government Activities Relating to Extreme Weather Events, including Preparedness, Response, Recovery, and Mitigation as well as Elements of Incident Command System Management, such as Operations, Planning, Logistics, and Finance/Administration.

1. Please describe, broadly, the level of preparedness (low, medium, high) you feel the organization had for this specific type of event.
2. For each of the following areas, as appropriate, please identify best practices your organization adopted or observed in decision support and in the management of this extreme weather event:

   Operations

   Maintenance

   Design

   Construction

   Planning

   Public communications

   Interagency coordination

   Data management

   Performance metrics

Other areas of significance under this extreme weather event

3. Please describe three to five examples of policies and protocols in place to address the needed action under this event (e.g., evacuation messaging, public safety messaging).

4. Did you have in place any policies and protocols to address the extreme weather event? For example, please describe any examples of preparedness for other types of events (security, other forms of extreme weather, etc.) that the organization had in place that were recognized as useful to this extreme weather event by management, operations, or the front line.

5. Please describe any challenges you faced in responding to the extreme weather event (for example, lack of data/information needed to respond appropriately).

6. Please describe successes in responding to the extreme weather event.

7. Please describe the scope and duration of the Incident Command System, if any, invoked at the time of the extreme weather event.

8. Were there preparedness policies or other directives and requirements that conflicted with or confused the response to this particular extreme weather event?

9. For this extreme weather event (and, broadly speaking, the timeframe within which your organizational managed it), please describe the top three to five most effective resources, processes, and other tools associated with each of the following, where applicable:
    a. Preparedness
    b. Response
    c. Recovery
    d. Mitigation

10. For instances where an event's severity built up over a long period of time or had a sustained impact requiring ongoing and non-routine management, please name or describe the stages or phases of action your organization developed to manage the event and any process invoked or developed.

11. Please describe the procedures for collecting data, observations, and narratives that will document and record the scope, severity, and other elements of the extreme weather event. Are these collected in a standard way? Are they used to inform decisions in a routine or replicable way?

12. Please describe interagency coordination before, during, and after this event, including coordination (if any) with local governments, National Guard, police, adjoining states, private operators of transportation (e.g., freight rail, intercity bus), transit, and other modes.

13. Please describe the communications efforts for this event, taking into account and differentiating among initial and later phases of the extreme weather event.
    a. Describe communications
        i. within the organization
        ii. with other state entities
        iii. with local entities
        iv. with each federal agency
        v. with the public generally
        vi. with affected individuals
        vii. with communities affected by the event directly

viii. with communities affected by agency action, such as detours

ix. with the media

x. with interests groups, such as private contractors, freight carriers, unions (internal and external to the organization).

b. Describe the most effective forms of communication (e.g., social media).

c. If social media was used for communication to the public, were there instances where social media was solely relied on to relay certain information? Describe how technical information that helped determine hazards and risks during this event was discovered, vetted, and communicated.

14. There are some emerging practices for addressing the increases in frequency or severity of extreme weather events. These include

- Positioning your agency for reimbursement from federal programs
- Pre-assigning internal roles
- Determining the use of detours
- Utilization of GIS (e.g., to identify hotspots, problem areas for maintenance)
- Public works emergency response mutual aid agreements
- Timely advocacy for more investments in studies for mitigation options
- Improving public communication.

Do you agree with this list? Please note those points that are irrelevant to your example of extreme weather in Section II, even when important in other instances. Would you add other activities, based on the specific instance you described above? Please detail the elements these additional activities that were successful for your organization or a case similar the one you described.

15. Please describe the funding sources used to prepare and respond to the extreme weather event and any challenges associated with securing funding. For example, describe the forms of funding used at each stage of the event and the following mechanics of their use: transfers among accounts, expedited requests, leveraging of the funding sources, etc. What data were needed to justify the request or allocation and the accessibility of each data source?

16. Please describe your satisfaction (low, medium, high) with the ways your organization used the financial analysis process (that for routine and for non-routine or emergency circumstances) to render decisions during the extreme weather event.

17. With respect to financial processes, please describe examples of innovation, streamlining, and/or collaboration that you wish to share. For example, did your organization assign specific project numbers and work codes prior to completing the work?

18. What were the methods for estimating cost, tools used in cost benefit, and other analyses used during the event, and what, if any, improvements have been instituted since?

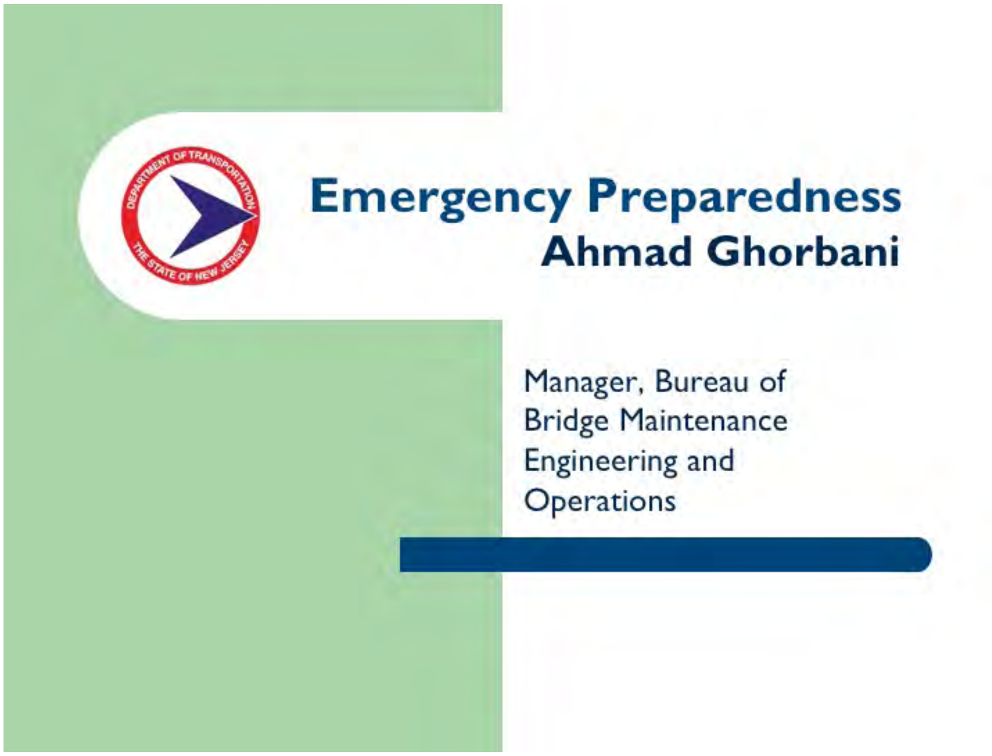
19. Please describe how your organization used geospatial data and tools to collect and share information on the extreme weather event. Did you also use this information to make financial decisions?

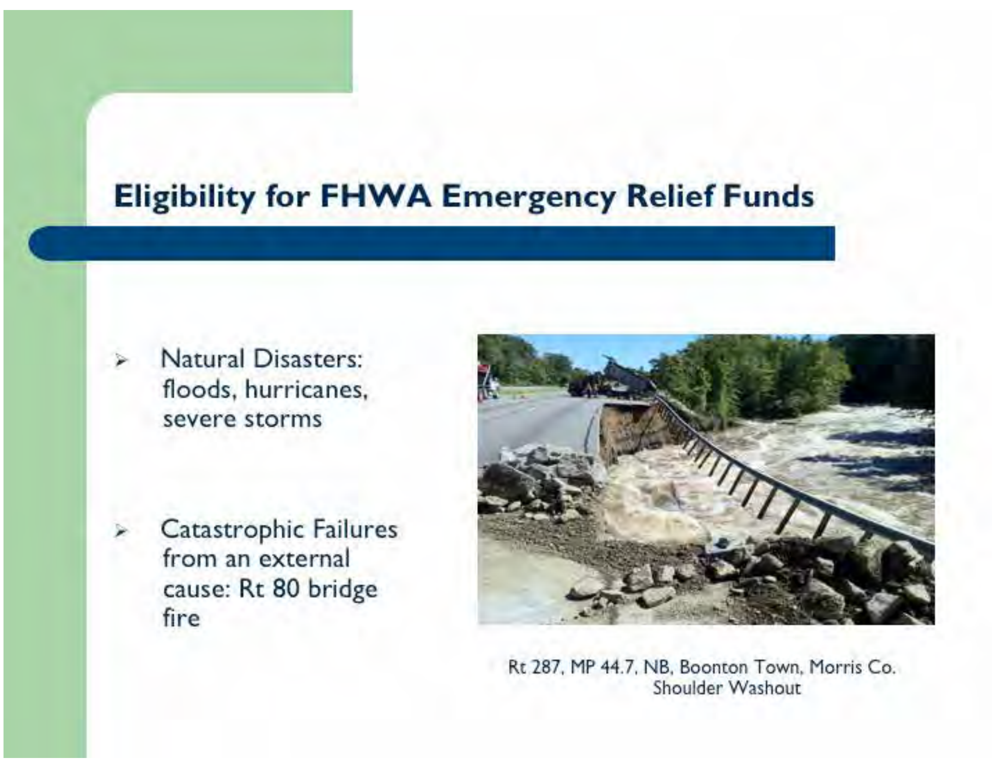
20. Does your organization have ways to measure response to an extreme weather event?

APPENDIX C

New Jersey - Preparedness Presentation, Including FHWA Process

Ghorbani, Ahmed, “Emergency Preparedness,” PowerPoint Presentation, NJ Department of Transportation, n.d.





Repair Types

Two Major Work Repair Categories:

- Emergency –Temporary
- Permanent

Emergency Repair

- Restore Essential Traffic
- Minimize Extent of Damage
- Protect Remaining Facility
- Work that cannot wait for finding of eligibility and project programming - Does Not Require FHWA Approval

Permanent

- Restore highway to its pre-disaster condition
- Must be approved and authorized by FHWA in advance of performing repairs
- FHWA engineers visit to verify extent, cost and eligibility of damages

Emergency Incident

Bridge Collapse due to scour - Route 70 over Friendship Creek

Rt. 70, MP 20.40, EB & WB, Str# 0310-154, Southampton Twp, Burlington Co.

Emergency- Temporary

Emergency -Temporary Repair to restore essential travel

Rt 70,MP 20.40, EB & WB, Str# 0310-154, Southampton Twp, Burlington Co.

Permanent

Permanent Repair to restore highway to its pre-disaster condition

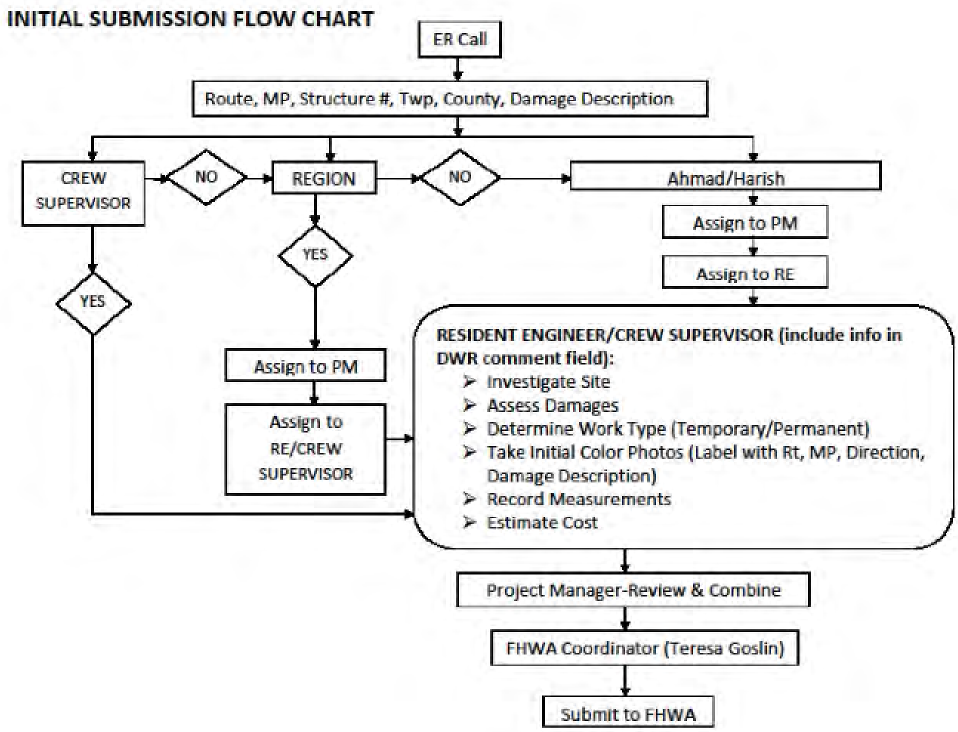
Rt 70,MP 20.40, EB & WB, Str# 0310-154, Southampton Twp, Burlington County

Emergency-Permanent

Emergency/ Permanent Repair

Report Submission

- Initial
- Final



Initial Submission

1. Receive call out for emergency (Rt, MP, Twp, County, Damage Description)
2. Crew Supervisor inspects Field Site/Resident Engineer inspects with Contractor' s Coordinator to assess damage
3. Determine the type of work
   - Emergency-Temporary/ Permanent
   - Take initial color photos (Label with Rt, MP, Dir, Structure # if applicable, Damage Description)
   - Record measurements
   - Estimate Costs

7. Crew Supervisor – notify Region of site status
8. RE - prepare and send ER Spread-Sheet to Project Manager for review
9. Project Manager review & send to FHWA Coordinator (Teresa Goslin)
10. FHWA Coordinator submits paperwork to FHWA

ER Spread Sheet

Event Name:
Total Sites:
Updated:

WO#	Location Description	Route	Direction	Begin MP	End MP	Region	Structure #	Municipality	County	Damage Description	Start Date	Completion Date	Estimated Cost	Actual Cost	Emergency Repair Cost			Permanent Repair Cost			Repair Description	NJDOT Unit	Contractor	Contact Person/ Number	RE/ Inspector/Crew Supervisor	Add Info/Comments
															Labor	Equipment	Material	Labor	Equipment	Material						

FINAL SUBMISSION FLOW CHART

Contract
RESIDENT ENGINEER:
- Establish WO number for all billing
- Prepare "DC-144 (a)" in detail, daily
- Take daily photos, label with Route, MP, Direction, Location, Damage Description
- Prepare & submit FINAL ER Spread Sheet
  - Include all Invoices, color photos, as-built, & proof of final payment

State Forces
CREW SUPERVISOR:
- Use MMS to track site cost
- Prepare DWR - info in comment field
- Take daily photos, label with: Route, MP, Direction, Location, Damage Description
- Prepare & submit all labeled color photos

PROJECT MANAGER:
- Prepare FHWA reimbursement Package for each site
  1) Cover Summary
  2) FHWA 1547 –Detailed Damage Inspection Report
  3) Straight Line Diagram – in color and labeled
  4) Google/Bing Map – in color and labeled
  5) Supporting Documents as prepared by:
     a) **Contract RE** - actual costs; invoices; as-built; proof of final payment; color before, during, and completion photos
     b) **State Force** - run DWR Parameter Report in MMS
- Combine all sites and prepare FINAL ER Spread Sheet

FHWA Coordinator (Teresa Goslin)

FHWA

Responsibilities of Resident Engineer

Contract

- Establish work order # through Client Application for all billing
- Prepare DC-144(a)in detail, daily
- Include damaged area dimensions in DC-144(a)
- Take clear color photos daily, to document work progress
- Caption photos with: Rt, MP, Direction, Location & Damage Description
- Prepare & submit FINAL ER Spread Sheet
  - Include all Invoices, labeled color photos, as-built, & proof of final payment

State Force

- Use MMS to track site cost
- Prepare DWR in MMS
- Take clear color photos daily, to document work progress
- Caption photos with: Rt, MP, Direction, Location & Damage Description
- Prepare & submit all labeled color photos
- Notify Region of site status

Responsibilities of Project Manager

- Prepare FHWA ER Final Package for each site:
  1) Cover Summary
  2) FHWA 1547 – Detailed Damage Inspection Report
  3) Color Straight Line Diagram - Labeled
  4) Color Bing/Google Map - Labeled
  5) Supporting Documents as prepared by
     a) **Contract RE** - actual costs; invoices; as-built; proof of final payment; color before, during, and completion photos
     b) **State Force -** run DWR Parameter Report in MMS

- Combine all sites and update ER Spread Sheet

Sample Documentation

Before Pictures

Night time picture

Day time picture

Rt 287 at Rockaway River, NB, MP 44.4, Boonton Twp, Morris Co, 140'x18'x32', right shoulder eroded & wash-out due to abutting Rockaway River size & force

Before Pictures (cont.)


Rt 202 over Branch of Mine Brook, MP 35.42, Structure # 1809153, Bernardsville Boro. Somerset Co, washout & undermining

During Pictures

Rt 287 at Rockaway River,

Rt 202 over Branch of Mine Brook

Completion Pictures

Rt 287 at Rockaway River

Rt 202 over Branch of Mine Brook

Cover Summary

NEW JERSEY DEPARTMENT OF TRANSPORTATION

FHWA Emergency Relief
April 2007 Nor' easter

Site:	**Rt. 80 Job# 0078**
Location:	**Milepost 67.3**
City:	**Ridgefield Park, Bergen County**
Classification:	

Damage: The embankment on Rt. 80 Westbound at milepost 67.3 experienced severe flood damage in April of 2007 as result of the Nor' easter Storm that delivered heavy rainfall and flooding. The subsequent rush of water across the embankment caused a section of the embankment to wash out

Repair: The 10 x 12 foot section of slope embankment was repaired by in-kind repair by replacing the washed away soil, installing geo-fabric and seeding. Work began on April 24, 2007 and was completed on April 24, 2007.

The work was performed by J.E.W. Construction Group, Inc. under the Timber/Underwater Structure Inspection & Repair Contract # 2006-008.

Actual Cost:

NJDOT

Maintenance Timber/Underwater

Contract# 2006-008		100 % of Cost	80% of Cost
Labor:		$ 4,400.00	$ 3,500.00
Equipment:		$ -	$
Materials:		$	$
	Total	$ 4,400.00	$ 3,500.00

FHWA-1547 Detailed Damage Inspection Report

DETAILED DAMAGE INSPECTION REPORT
(Title 23, Federal-aid Highways)

Cost Estimate

Traffic Control
Milling & Paving
Steel Sheet Piling
Concrete Cap
Final Site Work

Form FHWA-1547 (Rev. 4-96)

DC-144(a)

Form DC-144 (a) (05/25/2011)

New Jersey Department of Transportation
Daily Work Report

Project Name: ______ Date: ______
Contract ID: ______
Contractor: ______ Structure# ______ WO# ______

Inspector Name/Signature: ______

Weather/Temp AM ______ / ______ Route# ______ Township ______
PM ______ / ______ MP# ______ County ______

Item No	Item Description	Item Code	Plan Page #	Location	Subcontractor	Placed Qty	As Built Qty

Work Observations and Remarks

Description of damage:

DC-144(a) (cont.)

Description of Repair & Type (Emergency or Permanent):

TRAFFIC SAFETY REPORT

Location & Direction	LANE	TIME CLOSED	TIME OPENED	COMMENTS

DEVICE	REQUIRED YES	REQUIRED NO	COMPLIES YES	COMPLIES NO	COMMENTS
ARROW BOARD(4'X8")					
BREAKAWAY BARRICADES					
CONES					
CONSTRUCTION SIGNS					
CONSPICUITY TAPE ON EQUIP					
DRUMS					
IMPACT ATTENUATOR					
NIGHTTIME OPERATIONS					
TRAFFIC DIRECTORS					
TRUCK MOUNTED ATTENUATOR					
VARIABLE MESSAGE SIGN					
REMARKS:					

Environmental Remarks:

Work Hours	Regular	Overtime	Pay Items
RE			
Non- RE Supervision			
Office			
General			
Earth			
Drainage			
Aggregates			
Curb and Sidewalk			
Paving			
Structures			
Utilities			
Electrical			
Guide Rail			
Safety			
Miscellaneous			

Sketches - attach additional sketches, daily photos, calculation, delivery tickets

Benefit Leave	
Training	
Loaned off Project	

DC-144(a) (cont.)

Description of Repair & Type (Emergency or Permanent):

TRAFFIC SAFETY REPORT

Location & Direction	LANE	TIME CLOSED	TIME OPENED	COMMENTS

DEVICE	REQUIRED YES	REQUIRED NO	COMPLIES YES	COMPLIES NO	COMMENTS
ARROW BOARD(4'X8")					
BREAKAWAY BARRICADES					
CONES					
CONSTRUCTION SIGNS					
CONSPICUITY TAPE ON EQUIP					
DRUMS					
IMPACT ATTENUATOR					
NIGHTTIME OPERATIONS					
TRAFFIC DIRECTORS					
TRUCK MOUNTED ATTENUATOR					
VARIABLE MESSAGE SIGN					
REMARKS:					

Environmental Remarks:

Work Hours	Regular	Overtime	Pay Items
RE			
Non- RE Supervision			
Office			
General			
Earth			
Drainage			
Aggregates			
Curb and Sidewalk			
Paving			
Structures			
Utilities			
Electrical			
Guide Rail			
Safety			
Miscellaneous			

Sketches - attach additional sketches, daily photos, calculation, delivery tickets

Benefit Leave	
Training	
Loaned off Project	

DWR Report

DWR DATE	ACTICITY	ROUTE INFO			BEG_MP and END MP	
7/3/2012	MAINTAIN HWY LT/LT SGN	US	30	0	54.05	54.05

QUANTITY AND UNIT OF MEASURE: 1 LOAD CENTER

TOTAL LABOR COSTS: $166 | TOTAL EQUIPMENT COSTS: $11 | TOTAL MATERIAL COSTS: $0

DWR_CMT

DWR DATE	ACTICITY	ROUTE INFO			BEG_MP and END MP	
7/3/2012	MAINTAIN HWY LT/LT SGN	US	30	0	56	56

QUANTITY AND UNIT OF MEASURE: 1 LOAD CENTER

TOTAL LABOR COSTS: $166 | TOTAL EQUIPMENT COSTS: $11 | TOTAL MATERIAL COSTS: $0

DWR_CMT

DWR DATE	ACTICITY	ROUTE INFO			BEG_MP and END MP	
6/30/2012	REPAIR TRAFFIC SIGNALS	US	30	0	51.95	58.14

QUANTITY AND UNIT OF MEASURE: 9 SIGNALIZED INTERSECTION

TOTAL LABOR COSTS: $1,303 | TOTAL EQUIPMENT COSTS: $232 | TOTAL MATERIAL COSTS: $1,379

DWR_CMT

storm damage repair: 35645- replaced fixture 4; 35600- repaired fixture 3, refocused fixture 8; 35603- refocused 35' steel arm on STA 9+52; 35609- replaced fixture 4,9, refocused fixture 11; 35626- refocused fixture 8; 35630- refocused fixtures 3,5; 35636- replaced fixture 25; 35653- repaired and refocused "Absecon Blvd" sign on STA 889+89 no power at intersection -- Checked all related equipment

DWR DATE	ACTICITY	ROUTE INFO			BEG_MP and END MP	
6/30/2012	EMERGENCY SAFETY SERVICES	US	30	0	51.95	58.14

QUANTITY AND UNIT OF MEASURE: 14 PERSON HOURS

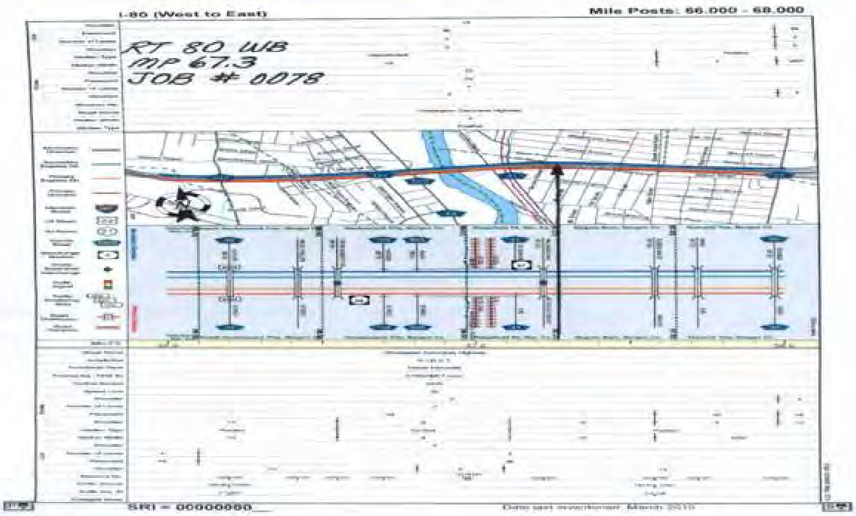
TOTAL LABOR COSTS: $529 | TOTAL EQUIPMENT COSTS: $65 | TOTAL MATERIAL COSTS: $0

DWR_CMT

Setup, close lanes and provide safety for traffic signal repairs. See report # 4198911

Google/Bing Map

Straight Line Diagram



Conclusion : Make the Effort

APPENDIX D

Iowa—After Action Report

Missouri River Flood Coordination Task Force Report, Missouri River Flood Coordination Task Force, n.d., 53 pp. (Missouri River Flood Coordination Task Force)

Iowa Department of Transportation

AFTER ACTION REPORT:

2011 Missouri River Flooding

Acknowledgments

The authors would like to thank the 28 individuals from the Iowa Department of Transportation (Iowa DOT) and the agency's external partners who generously shared their thoughts and suggestions in the course of the survey and interviews. Their input provided the content for this report. Thanks are also extended to the Iowa State Patrol and staff in the Iowa DOT's Research and Technology Bureau, Office of Maintenance and Statewide Emergency Operations for their valuable assistance with this project.

Cover Photos (clockwise from top left)

1) US 30 west of Missouri Valley
2) IA 2 looking west from I-29
3) Crews working on the IA 175 Missouri River bridge at Decatur, NE
4) Looking southwest from the I-29 and US 34 interchange
5) I-29 near Hamburg

Appendices

Executive Summary

A full year's worth of rainfall in the Upper Missouri River Basin in late May 2011 and heavy snowpack in the Northern Rockies—more than 200 percent above normal—worked together to create the longest duration flood event in U.S. history in western Iowa during the summer and into the fall of 2011.

Impacts of the flooding were significant. In Sioux City, the Missouri River was above flood stage for more than 80 days between early June and late August. Releases from Gavins Point Dam in South Dakota, the last downstream dam, were more than double the previous record release level since the dam's construction in 1955. At the height of the flooding, a 75-mile stretch of the Missouri River had no open highway crossings. Water several feet deep ran over roadways for more than four months, and the flooding event closed approximately 60 miles of roadway, including parts of Interstates 29 (I-29) and 680 (I-680) that remained closed for almost 100 days. A global detour established in June was in place for more than 100 days to redirect traffic around the closure of I-29 in western Iowa.

Purpose of This Report

This report summarizes the observations, reflections and conclusions of those most integral to the flood response. The report provides a concise summary of the lessons learned from participants in the 2011 flood response, examining events during the flood and the initial steps taken toward recovery. The report is not intended to provide a comprehensive analysis of the Iowa DOT's response to the 2011 Missouri River flood.

Methodology

This project began with the identification of key personnel from within the Iowa DOT and among the external partners involved in the flood response. Contact information for the 28 participants in this project appears in Appendix A.

Participants were asked to complete an online survey consisting of 14 questions. (Survey questions are provided in Appendix B.) A follow-up telephone interview with each participant addressed additional questions and allowed for further examination of survey responses. (Interview questions are provided in Appendix C.) Content for this report is drawn from the survey and interview results.

Lessons Learned

The lessons learned culled from the observations of participants in the response and initial recovery efforts appear in five sections of this report:

- Information sharing and communication.
- Staffing.
- Decision-making.
- Data and technology.
- Mitigation measures.

Each section provides background on the topic, an analysis of survey results and additional perspective gleaned from interviews, and trends or disparities in opinion. The sections close with a summary of the recommended practices that can serve as a ready reference for the Iowa DOT management responsible for future flood response operations in the state. This executive summary focuses on the best practices identified in each topic area.

Information Sharing and Communication

The Iowa DOT used a range of communication tools and practices to manage the flood response. Best practices are classified in three topic areas:

Identifying the Participants. Key to the communication process is identifying the right players and involving them early. Establish a core group that expands as needed with the staff required to address the issues at hand, and engage neighboring states immediately if it appears a regional detour will be required.

Structuring the Meetings. Set a goal and purpose for meetings of the project team, and carefully structure meeting agendas to move from general information sharing to more detailed discussions.

Crafting and Delivering the Public Message. Establish consensus on the nature and extent of the public message to ensure delivery of a consistent message that quells rumors, and identify a point person for managing the information flow. Implement a policy that identifies the agency's philosophy with regard to detours—regional or localized—and describes how information about detours will be disseminated. Evaluate the need for a call center to respond to public inquiries, and clarify the role of the state's 511 website in delivering traveler information.

Staffing

Participants offered a positive assessment of the staffing practices employed during this event. Possible enhancements for staffing future events include the earlier involvement of state agencies with responsibility for permitting and other early recovery-related issues, participation by representatives from the divisions and offices within the Iowa DOT that can bring a needed expertise to bear, and a case-by-case analysis of the appropriate use of consultants. Other recommendations relevant to prolonged events such as the 2011 flood include involving contractors in response efforts when internal resources are limited, and designating a small group to focus on recovery as activities related to the response proceed.

Decision-Making

Best practices in the area of decision-making tended to focus on three areas:

Involving the Right People. Err on the side of inclusion when developing the list of participants in an event response. Ensure the early and effective engagement of the Iowa DOT management, Statewide Emergency Operations (SEOP) staff and regional partners. Use the circumstances of each event to guide the extent of ongoing management participation, and encourage the active engagement of Iowa DOT district staff in decision-making and identifying innovative solutions.

Structuring the Decision-Making Process. Provide clear direction on the goals for response and initial recovery, and expedite decision-making with a small-group structure for project-level decisions and confidential matters. Ensure that staff is trained and coordinate an agencywide implementation of a formal incident command system. When possible, use established vendors or resources already under contract to control spending and avoid duplication of effort.

Managing the Transition from Response to Recovery. Establish a separate working group that begins work on recovery earlier in the event while others manage the flood response, and look for ways to more effectively engage contractors earlier in the recovery process. Avoid seeking the "perfect" solution when preparing designs for emergency repairs, and use innovative contracting practices to expedite reconstruction projects.

Data and Technology

Key to a successful flood response is obtaining early and comprehensive data and information from the National Weather Service (NWS) and U.S. Army Corps of Engineers (USACE) about the potential for flooding. Another critical component of the Iowa DOT's flood response toolbox was its effective use of LIDAR (light detection and ranging) data to prepare inundation predictions. Updated photogrammetry also proved helpful to augment aerial photography and gain a better sense of the extent of the damage and help start recovery efforts. Intelligent transportation system (ITS) components can be used to even greater advantage in future events, with portable cameras monitoring water levels at ramps and intersections prone to flooding during heavy rain events, dynamic message signs (DMSs) that notify travelers of detour routes, and highway advisory radio (HAR) that can fill in gaps when cellular communications are interrupted. Expanded development and use of traffic and geographic information system (GIS) related data can also contribute to an effective flood response.

Mitigation Measures

Mounting an effective flood response requires careful selection of mitigation sites and measures. Participants highlighted the importance of selecting a mitigation measure that best fits the circumstances of each site, giving consideration to the site's length, location, available resources and time available before overtopping becomes a significant concern. Cost-benefit analyses can be helpful when comparing equally appropriate measures. An analysis of inundation predictions is part of an effective mitigation strategy that assigns mitigation resources to locations where they are most likely to help.

Keeping abreast of new mitigation technologies and entering them in the agency's purchasing system provide ready access to a range of cutting-edge mitigation tools as they are needed. Maintaining the agency's enthusiasm for innovation will be critical when implementing new, and perhaps untested, measures that show potential for solving a unique problem.

Conclusion

The severity and duration of the 2011 Missouri River flood challenged those individuals engaged in the response and initial recovery efforts—from the Iowa DOT staff to the local, regional and federal partners that provided invaluable assistance and support. In offering their observations about the lessons to be learned from responding to this event, contributors to this report often described the opportunities for improvement in the context of enhancing an already effective process. Responses to future events can benefit from not only the best practices identified in this report, but also from the spirit of cooperation, enthusiasm for innovation and commitment to public service exemplified by those responding to the 2011 flood.

1. Introduction

A full year's worth of rainfall in the Upper Missouri River Basin in late May 2011 and heavy snowpack in the Northern Rockies—more than 200 percent above normal—worked together to create the longest duration flood event in U.S. history in western Iowa during the summer and into the fall of 2011.

Excessive rainfall in the Upper Missouri River Basin contributed to the summer-long flooding in western Iowa in 2011

Impacts of the flooding were significant. In Sioux City, the Missouri River was above flood stage for more than 80 days between early June and late August. Releases from Gavins Point Dam in South Dakota, the last downstream dam, were more than double the previous record release level since the dam's construction in 1955. At the height of the flooding, a 75-mile stretch of the Missouri River had no open highway crossings. Water several feet deep ran over roadways for more than four months, and the flooding event required the closure of approximately 60 miles of roadway, including parts of I-29 and I-680 that remained closed for almost 100 days. A global detour established in June was in place for more than 100 days to redirect traffic around the closure of I-29 in western Iowa.

Purpose of This Report

This report summarizes the observations, reflections and conclusions of those most integral to the flood response. The report provides a concise summary of the lessons learned from participants in the 2011 flood response, examining events during the flood and the initial steps taken toward recovery. The report is not intended to provide a comprehensive analysis of the Iowa DOT's response to the 2011 Missouri River flood.

2. Methodology

This project began with the identification of key personnel from within the Iowa DOT and among its external partners involved in the flood response. Contact information for the 28 participants in this project appears in Appendix A.

Participants were asked to complete an online survey consisting of 14 questions. (Survey questions are provided in Appendix B.) A follow-up telephone interview with each participant addressed additional questions and allowed for further examination of survey responses. (Interview questions are provided in Appendix C.) Content for this report is drawn from the survey and interview results.

3. Lessons Learned

Examination of the lessons learned is focused on five key elements of the flood response:

- Information sharing and communication.
- Staffing.
- Decision-making.
- Data and technology.
- Mitigation measures.

Each of the following sections includes background on the topic, an analysis of survey results and additional perspective gleaned from interviews, and trends or disparities in opinion. Each section closes with a summary of the recommended practices that can serve as a ready reference for the Iowa DOT management responsible for future flood response operations in Iowa. Lessons learned that cut across topic areas may appear in more than one section of the report.

3.1 Information Sharing and Communication

Central to the Iowa DOT's management of the flood event were daily conference calls with local, state and federal partners that began on June 3. The teleconference meetings were broadcast over the Internet via Adobe Connect, which allowed for the sharing of aerial photos, maps, plans and videos displayed during the meetings held at the DOT's Ames Complex. The daily meetings transitioned to weekly calls in August and lasted into October. The calls were coordinated by the Iowa DOT SEOP staff and documented in Operational Status Reports that were distributed to call participants.

In addition to these daily calls, two other sets of conference calls were held. A weekly call with Iowa, Kansas, Missouri and Nebraska provided a forum to discuss and coordinate detours, especially the multistate global detour established in June as I-29 and I-680 were closed in western Iowa. The other conference call was a daily call hosted by the USACE. This large-scale meeting addressed many of the pertinent issues, serving as a single dissemination point for USACE information and an opportunity to share information with the media. While the Iowa DOT did not host these calls, the agency was a key participant.

The public information officer in the Iowa DOT's Office of Public Affairs managed external communications. Information was provided to the public through a variety of channels, as indicated in the table below.

Public Information Sources

	Flood Website	511 Website	Call Center
Number of Site Visits/Calls	2.7 million	650,000 (June/July 2011)	50,000
Hours of Operation	24/7	24/7	7 a.m. to 9 p.m.
Period of Operation	Five months	Ongoing	Five weeks
Type of Information	News releases, detour maps, open/closed Missouri River bridge crossings, links to 511, photos/videos	Maps, road reports, open/closed Missouri River bridge crossings, electronic signs, cameras	Detours, point-to-point directions
Advantages	• Available anytime • Variety of information • Wide audience	• Available anytime • Variety of information • Wide audience • Up-to-date information • Consistent message	• Ability to speak with a person • Customized travel information
Disadvantages	• No personal contact • Information may not be current • Lack of customized travel information	• No personal contact • Lack of customized travel information	• Limited hours of access • More targeted audience • Information may not be current • Staffing challenges

This event marked the first time the public used smartphones as a primary method of obtaining information about an emergency. Many motorists accessed the flood website and the 511 site from their phones before and during travel, illustrating how rapidly changing technologies require agencies to adapt when delivering emergency information to the public.

3.1.1 Daily Conference Calls

One of the most commonly held opinions among the interviewees was the need to introduce flexibility during the daily conference calls and avoid becoming mired in details. Participants noted that the inclusivity of the calls, while important, led to some inefficiencies. Over time, the flood management team modified the daily call agendas to begin with high-level discussions and worked into discussions that were more detailed. As the discussions continued, staff without direct responsibilities could exit the calls.

This image from July 2 shows the extent of the flooding on I-29 near the Missouri state line.

Many participants recommended scheduling meetings with subsets of the larger team to talk about specifics and deal with targeted issues, bringing in key management as needed and ensuring that the subgroups had the appropriate oversight and direction. Phasing participants in and out of the daily or weekly meetings based on current events was recommended. As a prolonged flood response continues and some recovery efforts begin, the transition to a smaller, more agile group could help expedite decision-making.

Several participants noted that while the conference calls were critical to keeping staff informed of events on the ground, they cannot replace on-site visits, and recommend that members of the flood management team make regular on-site visits both during the event and as the water recedes.

3.1.2 Communicating with the Public

The Iowa DOT employed a range of tools to keep the public informed of road closures and other impacts of the flood event. More than one-third of participants noted the agency's 511 service when asked which efforts proved most effective in communicating directly with the traveling public. The remaining participants were almost evenly divided in citing the call center, flood website, and television and radio as most effective.

3.1.2.1 Flood Website

While the flood website offered a broad range of information for the traveling public—from news releases and photos to links to neighboring states' resources—participants expressed concern about the flood website's display of detours. At the heart of the issue was a difference in philosophy about how to present detours—a regional approach that encourages the use of a global detour utilizing Interstate highways and informs the public of closed routes, contrasted with a micro-level approach that provides travelers with customized routes using local primary roads and limiting out-of-distance travel.

This global detour map that appeared on the agency's flood website provided travelers with a wide range of information about road closures and detour routes

While some participants reported a concern about the flood website's effect in deflecting travelers from use of Iowa's 511 site, others highlighted a lack of consistency between 511 and the flood website, observing that it was critical for information on the flood website to be as current as the real-time 511 site.

Differences of opinion were also noted regarding the type of map displayed on the website. Technical staff advocated use of a GIS-based map that would allow for additional detail, including LIDAR data, GIS layers and historical photography, while the Office of Public Affairs recommended using a Google map, which was selected for use on the flood website because of its common platform. While they disagreed about the usefulness of a particular type of mapping, participants were in general agreement that the flood map was well used and positively received by the public.

3.1.2.2 Call Center

While not cited in survey responses as the most effective practice to communicate with the public, in interviews most project participants with an awareness of the call center's activities described the call center as an effective means of disseminating information to travelers. Many noted the call center served as a route planner for the general public, providing point-to-point travel information that might not be available through sources such as the Iowa 511 website, Iowa DOT flood website and DOT news releases. Many participants also noted that the call center was well received by the public.

Only two interviewees commented that the call center was unnecessary or ineffective, citing other, more effective methods to disseminate information such as 511 and the flood website; inconsistencies between the information provided by the call center and other information sources; and the high resource demand required to provide the traveling public with detailed travel information. Conversely, other interviewees described the call center as imperative because of the extent of the detours and the amount of out-of-distance travel required.

While participants were generally supportive of the call center, some observed that the center's provision of customized, point-to-point directions that utilized local roadways operated at cross-purposes with the global detour, which kept traffic off local roads. Others expressed concern that establishing the call center worked against the Iowa DOT's standard approach of encouraging the traveling public to use the 511 system, and the center may have suffered from providing outdated information that could have caused delays. A dearth of regional or local media coverage may have exacerbated the challenges in communicating with the public, with travelers arriving in affected areas unaware of the flooding and armed with a GPS device that did not reflect road closures.

Anywhere from two to 10 operators staffed the call center at any one time, initially open from 7 a.m. to 9 p.m.

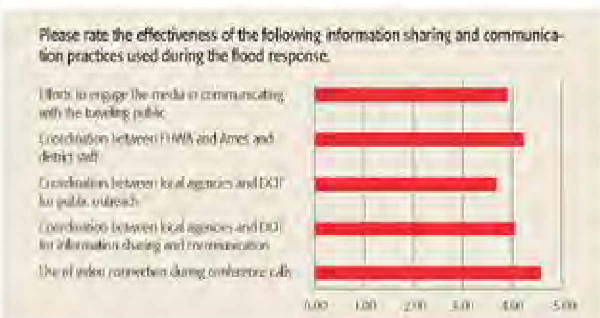
Staffing the center with volunteers from 7 a.m. to 9 p.m. also proved challenging, as did the structure and management of the call center, which lacked privacy and call monitoring tools.

3.1.3 Assessing Communication Practices

Survey respondents were asked to rate the effectiveness of some of the information sharing practices used during the flood response. The use of the Adobe Connect video connection received the highest average rating among the practices considered. The bar graph below illustrates the average rating for each practice (5 = extremely effective; 1 = not at all effective).

Participants reiterated the benefits associated with the daily calls and video access during interviews, with the Web component viewed as a particularly effective way to ensure that all participants had access to critical information in the form of aerial and still photos, and GIS data.

The involvement of staff from a range of disciplines was viewed as both helpful and somewhat problematic, in that the large number of staff participating in the calls, particularly in the early stages of the flood event, meant that the daily calls were quite lengthy and could be repetitive. Several interviewees noted that this was resolved as the event became less dynamic and fewer people were involved in the daily calls. Most participants felt course corrections were made as lessons were learned.



Average ratings of the effectiveness of information sharing and communication practices.

Survey respondents were almost evenly divided on the question of unnecessary duplication of effort in terms of information sharing and communication. Those who felt there was duplication most often noted that 511 provided travelers with the necessary information, and other efforts to provide traveler information—the call center and the flood website—were duplicative.

Spotlight on Best Practices:
Information Sharing and Communication

Identifying the Participants

- Consider the early engagement of DOT divisions or offices that may assist in the flood response, including front-line support services that handle equipment, signs, purchasing, and traffic and safety as well as research and technology.
- Establish a core group that expands as needed with the staff required to address the issues at hand that day.
- Engage neighboring states immediately if it appears a regional detour will be required.
- Ensure that all communication with regard to regional or local detours is provided in a timely manner.

Structuring the Meetings

- Set a goal and purpose for project team meetings.
- Carefully structure meeting agendas to move from general information sharing to more detailed discussions.

Crafting and Delivering the Public Message

- Establish consensus on the nature and extent of the public message and ensure delivery of a consistent message.
- Designate one individual within the DOT as the party responsible for managing information flow.
- Implement a policy that identifies the agency's philosophy with regard to detours—regional or localized—and describes how information about detours will be disseminated.
- Clarify the DOT's position on the primacy of the state's 511 site as the source for traveler information.
- Institute regular prompting to those contributing information to an event-specific website to ensure that the site's information is accurate and up-to-date.
- Evaluate the need for a call center to respond to public inquiries, taking into consideration the extent and nature of an event and available resources.
  - Site the call center team in one room with a cubicle design to enhance privacy.
  - Consider the use of a software program that provides statistics on caller volume.

3.2 Staffing

The flooding event affected two of the Iowa DOT's six districts. While the impact was felt in both Districts 3 and 4, flood damage was much more extensive in District 4. In addition to experiencing more damage, District 4 lacked a permanent District Engineer during the flooding. To address resource and staffing challenges, consultants in District 4 handled one aspect of the preliminary recovery effort—preparing damage assessments; internal staff completed damage assessments in District 3.

Resources from other DOT districts were moved to western Iowa to assist with the flood response while some state resources were used to support the local flood fight. Mounting an effective response to the flood event required a high degree of coordination between the districts and Ames Complex.

The prolonged flooding kept staff engaged in response-related efforts from June through August, with some staff starting recovery work in mid-July. The pace of the recovery work increased in September as the water receded and continued into November, when the construction season ended. Minor work continues as the 2012 construction season begins.

Typically, the response to a flooding event is much shorter in duration and the Iowa DOT is able to mount a self-contained response that utilizes DOT resources, supplemented by resources made available through a governor's proclamation. For example, Department of Corrections inmates may be used to support sandbagging efforts.

After flooding began, it soon became evident that the magnitude and duration of this flood event would force the Iowa DOT to look beyond traditional resources for assistance with the response. The agency contracted out response-related activities such as installing and removing flood barriers, delivering fill material, clearing debris and pumping water to clear roadways—tasks in-house staff would typically complete during smaller flood events—partly to ensure the flood response could continue unabated and deadlines for federal reimbursement could be met. See Initial Recovery: Completing Damage Assessments below for more information about the federal reimbursement program.

3.2.1 Gauging the Appropriate Level of Staffing

Survey respondents were asked to indicate whether they would recommend additional/other staff to manage the future response activities. At least three-quarters of respondents indicated the level of staff involved was appropriate. Below are recommendations offered by those indicating that participation could be improved:

- ***Flood management team.*** Once the magnitude of the event is realized, include as necessary DOT offices that can support the prolonged response, e.g., Offices of Contracts, Purchasing, Location and Environment and Systems Planning.
- ***District offices.*** Formalize involvement of garage supervisors.
- ***State of Iowa Departments.*** Include the Iowa Department of Natural Resources (DNR) for permitting and related issues and any other state agencies as needed, such as the Iowa Department of Public Health or the Iowa Department of Human Services.
- ***Contractors.*** Centralize the process/responsibility for making vendor contacts.


This aerial photo shows flooding in Pottawattamie County in mid-July 2011.

Almost 90 percent of respondents noted no significant duplication of effort with regard to staffing.

3.2.2 Initial Recovery: Completing Damage Assessments

Both districts were required to submit Detailed Damage Inspection Reports (DDIRs) for flood damage sites on roadways or bridges that are on a federal-aid highway. (See www.fhwa.dot.gov/reports/erm/fhwa1547.pdf for a sample DDIR form.) FHWA uses DDIRs to determine the scope of a project and its eligibility for reimbursement for emergency repair work through FHWA's Emergency Relief (ER) program.

The ER program provides funding for repair and restoration of highway facilities to predisaster conditions. An agency's reimbursement share depends on when the damage is repaired, and the work has to qualify as an emergency repair and be completed within 180 days of the Presidential Disaster Declaration. If the repair of an approved site is completed within the 180 days, the site is eligible for 100 percent reimbursement. After 180 days, Interstate sites are eligible for a 90/10 cost share; non-Interstate roadways are eligible for an 80/20 cost share.

There was a clear consensus among project participants that the differing approaches to handling damage assessments in Districts 3 and 4 reflected an appropriate use of resources. With extensive damage and a deadline looming, staff in both districts and the Ames Complex noted it would have been difficult for District 4 staff to complete its assessments without consultant assistance.

An FHWA accommodation also helped to expedite the assessment process. Typically, FHWA requires a DDIR for every site. For this event, the Iowa DOT was permitted to complete DDIRs for sections of affected roadway rather than for every damage site—for example, culverts or shoulders—requiring repair. Both districts completed damage assessments in a timely manner, and from a contract perspective, there were no differences identified between the assessments.

Participants did comment on potential advantages to both approaches:

- Damage assessments completed by internal staff may have provided more detail.
- Assessments completed by internal staff could benefit from an understanding of the assessment process gained from dealing with damage from previous floods.
- Benefits of having contractors complete both districts' assessments include:
  - Consistency in project reports and information flow.
  - Ability to respond more quickly with a consultant.

Spotlight on Best Practices:
Staffing

- Use this event's staffing practices as a starting point to create a template for future events.
- Involve all DOT offices affected by the event or with expertise that could aid in managing the event from the outset.
- For events of long duration:
  - Seek the assistance of vendors, contractors or other outside resources, as needed, to ensure the timely completion of response-related activities.
  - Designate a small group to focus on recovery as response efforts continue.
- Involve state agencies with responsibility for permitting or other related issues (such as the Iowa DNR) earlier in the event.
- Adapt the current process/responsibility for managing vendor contacts so it can be more flexible and take less time.
- Make arrangements to engage consultants, if needed, to assist with damage assessments and other recovery work while DOT staff are still engaged in the flood response.
- On a case-by-case basis, weigh the benefits of the consistency achieved through uniform use of consultants against the benefits gained through the application of local knowledge when internal staff members are charged with a task.

3.3 Decision-Making

We examined the decision-making processes utilized during this event through the prism of the following:

- Settings and circumstances under which decisions were made.
- Involvement of key players in the event response—DOT management and SEOP staff.
- Application of a formal incident command system (ICS).
- Adaptations to the contracting process.

The ICS under consideration by the Iowa DOT during the flood event and during its aftermath is supported by the Federal Emergency Management Agency (FEMA). FEMA describes ICS as a standardized, on-scene, all-hazards incident management approach that:

- Allows for the integration of facilities, equipment, personnel, procedures and communications operating within a common organizational structure.
- Enables a coordinated response among various jurisdictions and functional agencies, both public and private.
- Establishes common processes for planning and managing resources.

The Iowa DOT did not have a formal, fully developed ICS in place when the event began. SEOP staff are preparing a training plan to implement a formal ICS departmentwide over the next nine months to a year. Working in tandem with the Iowa State Patrol, the Iowa DOT is incorporating emergency transportation operations into the standard ICS structure to allow for its use on a daily basis and not just during an emergency event.

3.3.1 How and When Decisions Were Made

Decisions were made during the flood event in a variety of settings that involved different groups of participants.

Flood Management Team Conference Calls

The daily conference calls provided the setting for many of the decisions made in the early days of the flood response. Among the topics addressed:

- Road closures.
- Defining global and local detours.
- Best approaches for communicating with the public (such as what information to share, how to describe the event).
- The Iowa DOT's interaction with the media.
- Sharing inundation predictions based on the hydrologist's interpretation of LIDAR data, river gauge data and the expected impact of USACE releases from upstream dams.
- Potential mitigation measures.
- Alternatives to the contract letting procedure for projects associated with beginning recovery efforts.

Daily conference calls provided an opportunity to share information and make decisions about rising floodwaters and road closures.

The calls began with a focus on information gathering and dissemination and then shifted to a decision-making focus, which some participants identified as problematic. As the event transitioned from response to recovery, the conference calls tended to serve as more of a weekly briefing, with smaller groups of structural experts and planning and design staff meeting independently to manage the upcoming recovery tasks.

Small-Group Discussions Involving the Flood Management Team

Several times a week a subset of the flood management team spoke with each district about specific issues and projects. These more focused discussions laid the groundwork for the swift completion of the damage assessments, allowing recovery projects to begin and proceed in an expeditious manner. Many participants highlighted the effectiveness of these and other small-group discussions that addressed specific resource needs in the districts, clearances needed from resource agencies and specific plans of action to implement mitigation projects. Smaller groups also provided a more appropriate forum for confidential discussions and the dissemination of sensitive information.

The small-group discussions proved to be effective in identifying solutions and advancing projects to address impacts to the agency's infrastructure, particularly those projects that had to begin as soon as possible after the water receded to meet a federal timetable for reimbursement. The table below highlights a few of the mitigation projects addressed during small-group discussions.

Selected Mitigation Projects Advanced During Small-Group Discussions		
Mitigation Site	**District**	**Project Description**
IA 175 Bridge at Decatur, NE	3	The significance of this river crossing prompted immediate efforts to mitigate the effects of the high-velocity floodwaters that closed the bridge on June 27. Emergency repairs began by applying almost 20,000 tons of rock fill to armor the embankment and bridge abutment and fill a 50-foot-deep scour hole. The bridge reopened to traffic on November 3, 2011, allowing for the second repair phase to begin—construction of a U-shaped rock berm designed to stabilize the embankment and reduce the churning motion of the floodwaters next to the abutment.
I-29/I-680 North Interchange (Loveland Interchange)	4	This interchange was closed June 13. However, through the efforts of DOT staff and contractors, using a combination of pumps, sandbags and barriers, the interchange reopened June 17. This allowed traffic from I-80 (via I-680) to access I-29 north to Sioux City. In early July, contractors began work on the mitigation method selected by DOT staff—working within the existing right of way and pumping water to areas away from the ramps and mainline. Once the work was complete DOT staff placed sandbags, plugged culverts, installed pumps and performed other minor work to ensure this mitigation measure would function correctly.
I-29 at Milepost 1.4	4	As floodwaters farther north of this location moved east of I-29, it flowed into the drainage ditch running underneath I-29 at this point. The massive amount of water caused significant scour damage to the approaches to both the northbound and southbound I-29 mainline bridges. Once the debris was removed from the roadway crews placed sheet pile to isolate the bridge embankment from the water to begin repairs. Temporary lane crossovers allowed for repair of the southbound bridge approach. Traffic flowed in both directions on the southbound bridge until more extensive repairs could be made to the northbound bridge. All repairs were complete by late November 2011.

District-Level Decision-Making

Decisions with a significant local impact and those with regard to managing resources, equipment and staffing tended to be made locally. Examples of these in-the-field actions or decisions are the innovations developed by district staff during installation of the flood barrier wall system—actions taken with the benefit of local knowledge to meet a pressing need. Other examples of actions or decisions taken throughout the event include:

- Fielding survey teams and identifying where to place maintenance forces.
- Identifying appropriate roadways for local detours to address immediate closures.
- Opening and closing ramps with the fluctuation of water levels during rain events.
- Conducting traffic operations.
- Devising methods to handle water accumulation at sites treated with flood barrier walls.
- Involving affected cities and counties.

Participants also noted that the active engagement of Districts 3 and 4 in finding creative ways to address challenges in the response effort was critical to waging an effective flood response.

Discussions with Neighboring States

Initially, the Iowa DOT worked with five states (Kansas, Minnesota, Missouri, Nebraska and South Dakota) to coordinate detour routes. A primary global detour was in place for 113 days, from June 17 through October 8, redirecting travelers from I-29 in southwestern Iowa using I-80 and I-35. The detour added 152 miles to travelers' routes.

Shortly after response efforts commenced in Iowa, the Iowa DOT convened a weekly conference call with appropriate staff from Iowa, Kansas, Missouri and Nebraska, hosted on a Missouri DOT conference line, to discuss and coordinate the global detour. The calls were brief, with each state discussing current issues related to road closures and river crossings. The brevity of the calls was important in keeping all states engaged and on point. Over time, the frequency of the calls decreased.

Unlike the small-group discussions and, to a degree, the flood management team conference calls, participants characterized the weekly conference calls with global detour participants as more of an opportunity to share information than to make specific decisions.

3.3.2 Involving Key Players

The majority of participants felt that both DOT management and SEOP staff should become involved as early as possible in an event of this nature. Management is needed to approve the methods and resources used to mount the response and SEOP staff are critical in organizing the flood management team and coordinating communication efforts.

Participants differed on the frequency of management involvement, with most favoring management participation determined by circumstances. Contributing factors cited by participants in determining the frequency of management involvement include the regionality, severity, duration and dynamic nature of an event. As one participant described it, members of management stay informed until it becomes critical they become involved. Field operations are always involved in day-to-day operations, but management may not be.

Another participant noted that appointing a project manager could limit the need for daily management involvement. Appointing a project manager or managers involves defining the scope of decision-making responsibilities, communicating the decision structure and then allowing the project manager(s) to manage the project. Management is kept informed of progress when not involved on a day-to-day basis. A fully utilized project manager model may have improved response times during this event and eliminated occasional confusion with regard to roles and levels of authority.

3.3.3 Assessing the Benefits of an Incident Command System

Participants were almost uniformly enthusiastic about instituting a formal ICS within the Iowa DOT, with many noting that aspects of this system are already in place. Some participants commented that the Iowa DOT operated under an informal or loosely defined ICS during the event, and that the structure became more formalized as the event unfolded. For these participants, instituting the ICS is a matter of formalizing processes already in place and introducing them agencywide. Some participants noted that applying a localized ICS often occurs today in connection with SEOP missions conducted for the Iowa Homeland Security and Emergency Management Division, and district staff reported using an informal ICS for field operations during disaster events. The importance of providing training for all staff participating in the ICS was underscored by several interviewees.

3.3.4 Adapting the Contracting Process for Response and Recovery

The Iowa DOT's typical project letting process was modified to accommodate two aspects of this challenging, long-term event: a response effort that required resources beyond those available within the Iowa DOT, and accelerated recovery efforts that focused on the completion of as many emergency repair projects as possible within the 180-day time period for obtaining full federal reimbursement. (See page 10 of this report for more information about the federal reimbursement program.) Typically, the 180-day time period begins on the date of the disaster declaration—for this event, May 25, 2011. The deadline of November 20 and the fact that floodwaters did not begin to recede until mid-October presented significant challenges to the DOT in meeting the deadline to ensure full federal reimbursement.

Special contract provisions helped to expedite critical projects like this one at the IA 175 bridge crossing at Decatur, NE.

Modifications to the letting schedule were guided by state regulations that require projects be advertised unless an emergency exists that has closed roads or threatens to close them. Under such circumstances, the state can solicit bids from three contractors for all projects under $1 million. Federal regulations require a three-week advertising period unless the projects are for emergency repairs. The Iowa DOT received a special exemption from its federal partners that decreased the three-week advertising requirement to 10 days for projects such as the removal of debris and flood barrier walls, which do not fall under the umbrella of "emergency repairs."


IOWA STATE PATROL | Air Wing

The DOT established the following process for letting emergency projects for the expedited response and recovery work:

- Wednesday—staff provided information about projects to be let by the end of the day.
- Friday of the same week—the project was posted on the department website for contractors to bid on projects.
- Next Wednesday—the Iowa DOT accepts bids at 11 a.m. For projects designed to reopen roads or keep them open, contractors were given four days to prepare bids. For projects related to permanent restoration, a 10-day response period was permitted.

Contract periods were established with the 180-day timeframe in mind for the approximately 20 emergency projects let. To encourage contractors to complete work as quickly as possible, the contracts for reconstruction of I-680; the IA 175 bridge at Decatur, NE; and IA 2 were written with no-excuse bonuses. (A no-excuse bonus reduces contract time by tying a bonus to the completion of construction activities by a set date, which may or may not be the contract completion date.) This allowed contractors to receive additional funds if they completed the project within the 180-day window, which meant 100 percent federal reimbursement to the Iowa DOT. A project incentive/disincentive was also included in these contracts.

The $19 million, 3.10-mile I-680 reconstruction project is an example of the success of the innovative contracting provisions. This lump-sum, limited-design contract included an incentive/disincentive of $82,000 per day based on whether the contractor completed the project earlier or later than the contract completion date of December 23. The no-excuse bonus date was set at November 20 to encourage completion before the 180-day period elapsed. The contractor completed the project on November 1—53 days early—earning 53 days of the incentive rate plus the $2 million no-excuse bonus.

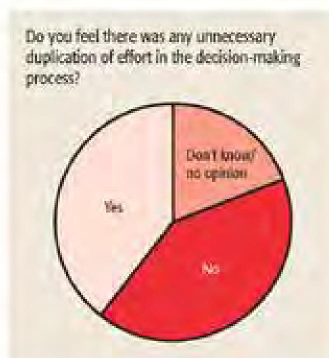
3.3.5 Assessing Decision-Making Processes

Having the right people involved on the flood management team and at the daily meetings was cited most often by participants as a strength of the decision-making processes employed during the event. Mentioned almost as frequently was the DOT's effective approach to gathering and sharing information. Other strengths cited by participants:

- Ames Complex support of Districts 3 and 4.
- Flexibility of the decision-making process. As the event unfolded, the team made adjustments as needed, introducing more innovation over time.

There was a lack of consensus among participants with regard to opportunities for improvement in decision-making, with participants offering the following:

- Ensure that feedback provided by the districts is coordinated and reflected in the decision-making process.
- Recognize the changes required when transitioning from response to recovery while the response is ongoing.
- Clarify roles, responsibilities and authority levels early in the event. (Participants noted this was addressed as the event unfolded.)
- Encourage greater coordination with local agencies, with consideration given to how actions by local agencies will affect the overall response effort.
- Analyze the potential or expected impact of mitigation measures.
- Use established vendors or resources.
- Provide backup and support for staff stretched too thin during an event of long duration.



More than half of the survey respondents with an opinion did not identify any duplication of effort in the decision-making process.

Spotlight on Best Practices:
Decision-Making

Involving the Right People

- Err on the side of inclusion when developing the list of participants in the event response. Consider involving support services that handle equipment, signs, purchasing, and traffic and safety as well as research and technology.
- Ensure the early and effective engagement of the Iowa DOT management, SEOP staff and regional partners. Use the circumstances of each event to guide the extent of ongoing management participation.
- Identify critical connections and clearances with resource agencies (FHWA, Iowa DNR and the USACE) early on, considering the impacts to and involvement of local agencies.
- Encourage the active engagement of district staff in decision-making and identifying innovative solutions.

Structuring the Decision-Making Process

- Provide clear direction on the goals for response and preliminary recovery, clarifying responsibilities for carrying out these related efforts.
- Expedite decision-making with a small-group structure for project-level decisions and confidential matters.
- Ensure that staff is trained and coordinate an agencywide implementation of a formal ICS.
- When possible, use established vendors or resources already under contract to control spending and avoid duplication of effort.

Managing the Transition from Response to Recovery (While the Response is Ongoing)

- Establish a separate working group that begins work on recovery early in the event while others manage the flood response.
- Request advice from contractors' associations about how the agency can work more effectively with contractors in initiating a prompt and effective recovery effort.
- Avoid seeking the "perfect" solution when preparing designs for emergency repairs.
- Apply innovative contracting practices such as lump-sum, limited-design contracts and no-excuse bonuses to expedite reconstruction projects.
- Employ a debriefing process at the onset of the recovery efforts to document successes and challenges as the projects move forward.

3.4 Data and Technology

Data and technology played a significant role in the Iowa DOT's response efforts leading up to the initial recovery phases. Participants commented on the significance of the following:

- *USACE data.* The DOT received information from the USACE, including:
  - 2010-2011 mountain snowpack data for the Upper Missouri River Basin.
  - May 2011 rainfall amounts in Montana and the Dakotas.
  - Water levels for the six Missouri River reservoirs.
  - Releases from Gavins Point Dam in South Dakota.

  Supplementing this data were gauge readings along the Missouri River provided by the NWS.

- ***LIDAR data.*** LIDAR is an established method for collecting very dense and accurate elevation values. The Iowa DOT's LIDAR data can provide statewide ground elevations with 8-inch accuracy and show levees, drainage channels, oxbows and meanders—potential problem areas for future flooding. The digital data can be viewed across multiple platforms and in various software packages; Google Earth was used during the daily flood management team calls.

  The Iowa DOT's hydrologist estimates that only three or four states have LIDAR coverage as extensive as Iowa's.

A Web connection allowed staff from around the state to view maps such as this one that provides a graphical representation of LIDAR data

- ***GIS.*** The use of GIS provided partners a common operating picture. Google Earth with custom layers (inundation levels, LIDAR, historical imagery, aerial photography, etc.) offered flexibility, ease of use and the ability to "move around" from site to site quickly. More robust GIS applications were developed and used for specific purposes. During future events, use of the agency's browser-based custom GIS applications as an alternative to paper-based or Google Earth mapping could enhance the DOT's ability to analyze rapidly changing conditions.
- ***ITS components.***
  - ***Dynamic Message Signs (DMSs).*** The Iowa DOT has invested heavily in an ambitious DMS program to help public mobility. The agency's overhead, side-mount and portable signs were used in the response effort, with additional signs provided by neighboring states or leased.
  - ***Portable and fixed cameras.*** Portable cameras were used to monitor:
    - Approaching floodwaters on open roads (for example, the I-29/I-680 interchange was monitored for flood levels, changing views as necessary for effective monitoring).
    - Status of at-risk levees.
    - Receding floodwaters on closed roads.
    - Reconstruction on I-680 (time-lapse).
  - ***Highway Advisory Radio (HAR).*** HAR proved helpful in managing communication in areas where cellular service was compromised, limiting the use of cellphones and cameras. While the permanent HARs receive auto messaging from the 511 system, the portable HARs were deployed with text-to-speech messages to share information about the event.

The Iowa State Patrol's aerial photography provided critical views of inundated areas such as this section of I-29 near Hamburg in Fremont County.

- ***Aerial photography.*** The Iowa State Patrol conducted flyovers every few days at the beginning of the event and continued with periodic missions throughout the flood response. These flyovers augmented the assessments troopers completed each day by driving affected roadway segments and detailing road conditions in a memo distributed to the flood management team. The State Patrol geolocated their images so they could be viewed in various formats such as Picasa and Google Earth. Special requests for flyovers were made when confirmation of water level predictions was needed.
- ***Photogrammetry.*** Photogrammetry is defined as the art and science of acquisition, measurement, interpretation and evaluation of photographs, imageries and other remotely sensed data.[1]

  Transportation agencies use photogrammetry to perform measurements of horizontal distances and elevations to obtain the surface terrain information needed by designers. The Iowa DOT supplemented photogrammetry of the flood area on file with two overflights conducted during the flooding period. Both aerial photography and infrared sensing were conducted during these flights. Infrared sensing is a useful tool during flooding events given its ability to permit viewing beneath the surface of the water.

1 Moffit, F.H., and E.M. Mikhail. Photogrammetry. Harper and Row, New York, 1980.

- *Cellular communication.* Gaps in cellular coverage in western Iowa (District 4) were attributed to the loss of several towers. Interruptions in cellular service affected portable cameras relying on cellular connections, cellphones used by DOT staff in the field, and some DMSs.

3.4.1 Fixed and Portable Cameras

Participants most often cited the portable camera used to monitor the reconstruction of I-680 as the most effective use of cameras during the flood event. While some noted the benefits of fixed cameras in urban areas to monitor traffic and water levels at interchanges where pumps were being used to keep ramps open, for the most part, participants identified greater benefits from the use of other tools and practices such as aerial photography, ground surveys and photogrammetry. Several participants noted that the slow-moving nature of this flood made the cameras less pivotal than if the event had involved more traditional flooding, as was the case during a 2008 event when it was essential to monitor changing conditions.

3.4.2 Dynamic Message Signs

The prevailing opinion among participants is that DMSs played an important role in disseminating information to the traveling public during the flood event. However, the message limitations of the DMS proved to be particularly challenging for this event.

Many participants noted that the most effective use of DMSs was for general messaging about road closures, such as "I-29 closed at I-680." Complex detour routes could not be adequately explained on a portable sign that accommodates six to eight words. Permanent signs can hold more text, but 10 to 12 words were often still insufficient to explain some detour routes. Participants cited the I-680/I-29 detour as an instance where DMSs, though helpful, could not detail the conditions under which travelers should proceed on this route. Travelers needing more detail about a detour could use one of the DOT's other information tools (511, flood website, call center) to obtain more complex travel instructions.

The mix of permanent and portable signs allowed for the placement of portable signs in locations that could have presented confusion to the traveling public. When it appeared travelers were not paying attention to the signs, staff moved them to try to circumvent travelers' attempts to find the shortest route. DMSs placed at the many decision points for commercial traffic along the global detour proved helpful in managing regional traffic.

Managing the information on the DMSs presented another challenge. The standard library of DMS messages maintained by the Operations Support Center was not entirely applicable due to the magnitude and duration of this event.

3.4.3 Cellular Communication

Interruptions in cellular communication during the flood event were limited to Fremont and Mills counties in District 4 and were resolved within a week. Actions taken to remedy the interruption in cellular coverage include:

- Verizon, one of two cellular providers in the area, does not own its network and relies on roaming agreements with other providers to offer its access in the area to its customers. With the loss of several towers in the area, Verizon's network was no longer capable of handing call volume. The Iowa DOT information technology staff worked with Verizon to alter its roaming sequence to allow callers access to the network of the area's other cellular provider—U.S. Cellular—which was able to handle the call volume. After the flood event, Verizon went back to its initial roaming agreement.
- U.S. Cellular set up a portable unit—a cellular on light truck (COLT)—to enhance its network in Fremont and Mills counties.
- The Iowa DOT information technology staff increased power to the radio system in Fremont and Mills counties to allow everyone to talk on one channel. (The agency is investing in modernizing its radio systems to create an interoperable radio communication system that links the Iowa State Patrol, the Iowa DOT, and cities and counties in the state.)

Participants noted that the temporary loss of communication in the affected area was relatively minor given the slow-moving nature of this event and the prompt, effective response of the Iowa DOT information technology staff. Uninterrupted cellular coverage would have been much more critical to keep cellphones and cameras in constant use had staff been monitoring flash flooding conditions or another more rapidly changing situation. It is also important to note that cellular providers are constantly improving their coverage in this area of the state, and some of the cellular communication issues faced during the 2011 flood may be resolved as coverage areas expand.

This railroad track along IA 2 near I-29 and the Council Bluffs levee is in an area that was particularly hard-hit.

3.4.4 Additional Data and Technologies to Aid in the Flood Response

There was almost universal agreement among participants that an earlier alert and more effective communication from the USACE of the potential for the flooding event would have been helpful in managing the Iowa DOT's response to the 2011 flood. A lack of early information meant that the flood management team was unable to predict levee breaches—a wild card in determining the extent of the potential damage caused during the event. Some participants also noted that once information was provided, USACE predictions tended to be overly cautious.

Participants offered the following when asked about additional data or technologies that would have been useful during the flood event:

Additional Data

- Traffic data. The agency has fixed and portable traffic counters that could be used to gather:
  - Real-time data about traffic flows to identify where the 14,000 to 15,000 vehicles that typically traveled I-29 each day went when it closed, and monitor roadways in areas where staff wished to limit detour traffic.
  - Average annual daily traffic data at interchanges to identify in which direction traffic was moving and aid in understanding the pattern of commuter traffic.
- GIS-related data:
  - Tie more information into GIS (pavement management system, culvert management system, sign management system).
  - A map layer of special-needs places such as hospitals.
  - A map layer showing all levees and their heights.
  - Data on bridges, including length, rating and condition reports as well as photography.
  - A GIS database that provides access to plan information and profiles.
- More flights to provide updated photogrammetry during the flood event, with the flights conducted early in the event.
- More water level determinations during the event and as the flooding event drew to a close.
- More detailed information about the magnitude of the Gavins Point Dam releases.
- Better understanding of what would be required by resource agencies (FHWA, Iowa DNR and USACE) earlier in the event.

Contemplating the data and technology that might have been helpful during the flood response prompted participants to offer their thoughts on the information that proved most crucial during the event. For many, this was LIDAR data—described by one participant as "the saving grace of the flood response." The ground elevations provided by LIDAR data identified the areas that would be inundated, allowing the flood management team to determine which roadway segments to mitigate and segments where mitigation attempts would not be warranted.

Additional Technologies

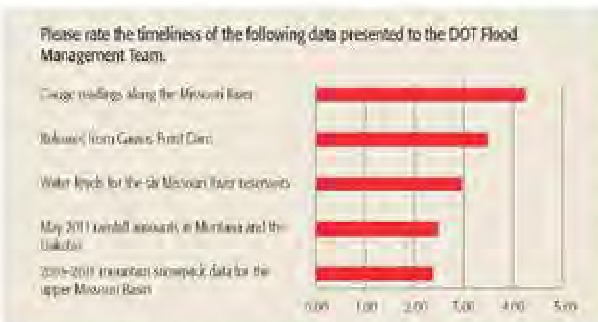
- A method to provide automatic water level readings near mitigation projects.
- More Interstate mainline gates and ramp gates to close the roadways quickly.
- Social media alternatives that can be more proactive than a website in pushing information to users; collaborate with private vendors (Google, Garmin) to get information to smartphones.
- Place static signs to trailblaze the global detour—a low-tech, low-cost solution that can be implemented quickly with in-house resources.

3.4.5 Rating the Data and Technologies

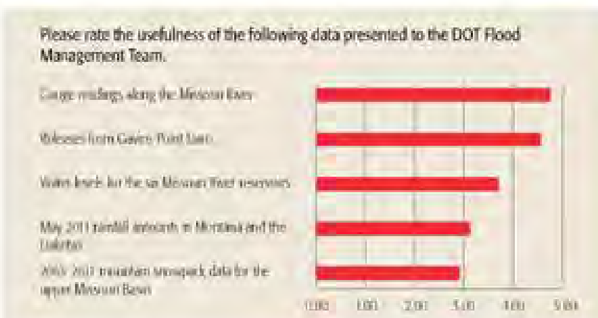
We asked survey respondents to rate the timeliness and usefulness of data provided by the USACE and the NWS.

The first chart (below) provides the average rating for the timeliness of each type of data (5 = extremely timely; 1 = not at all timely). While respondents expressed concern about the timeliness of some of the data, the data's usefulness fared better in the ratings. The second chart shows the average rating for the usefulness of each type of data (5 = extremely useful; 1 = not at all useful).

Almost three-quarters of survey respondents felt that technologies such as GIS and aerial imagery were extremely well utilized during the flood response. ITS components did not fare as well in respondents' estimation, with only 23 percent of respondents indicating that ITS components were extremely well utilized during the flood event.



Average ratings of the timeliness of some of the data provided during the flood event.



Average ratings of the usefulness of some of the data provided during the flood event.

Overall, respondents gave high ratings to the data and technologies used during the flood event. Using a scale of 5 for "extremely useful" and 1 for "not at all useful," the average ratings reflected below echo the interview results—LIDAR data was particularly useful in managing the flood response.

Use of LIDAR data	4.71
Field survey elevation shots taken to better estimate when water would cover certain roadways	4.64
Use of DOT hydrologic forecasts to determine courses of action for the flooding that actually occurred	4.61
Images from Iowa State Patrol flyovers	4.56
GIS-based application showing inundation forecasts and actual inundation areas over time	4.31
"Flooded Roads Public Map" prepared to meet the needs of the traveling public	4.12

Spotlight on Best Practices:
Data and Technology

- Establish and maintain lines of communication for effective collaboration and information sharing between the USACE and the Iowa DOT to ensure early notice of the potential for flooding.
- Continue to make effective use of LIDAR to prepare inundation predictions.
  - Consider investment in a 2-D hydraulic model of the Missouri River that shows inundation areas and automates the process used during this event that applied LIDAR data to develop inundation predictions.
- Make effective use of aerial photography and update photogrammetry early in the event to gain a better understanding of the scope of the upcoming recovery efforts.
- Make effective use of ITS components.
  - Place portable cameras to monitor water levels at ramps and intersections prone to flooding during heavy rain events.
  - Use DMSs to notify travelers of detour routes. Supplement this signage with static signs to trailblaze the detour route.
  - Ensure timely and effective management of messaging for DMSs.
  - Employ HAR when cellular communications are interrupted.
- Evaluate opportunities to expand the development and use of GIS-related data.
- Consider gathering traffic data to aid in managing traffic flows during the event.

3.5 Mitigation Measures

Of the 21 mitigation sites initially identified, seven eventually closed and five remained open with the use of a range of mitigation measures that helped to prevent damage and maintain vital links on the system. Participants stressed the importance of fitting the mitigation measure to the specific set of circumstances at each site.

Emergency projects to keep sections of I-29 and US 30 open with the extensive use of flood barrier walls on shoulders and medians helped hold back floodwaters on low-lying road segments. In another mitigation effort, emergency placement of material in fast-moving floodwaters helped protect the IA 175 Missouri River bridge approach, while in other locations pumps and pipe jacking kept water off roadways. Yet another mitigation effort involved the installation of a hot-mix asphalt (HMA) overlay on a mile-long segment of I-29.

This drainage ditch at milepost 1.4 on I-29 in southwestern Iowa was still poised to overflow two months after flooding began.

3.5.1 Flood Barrier Walls

In the early days of the flooding, the Iowa DOT identified a need for a quickly deployable flood barrier system that could cover miles of affected area. A vendor operating in a neighboring state was able to provide the volume of barrier material needed; other similar flood barrier systems were not available in the volumes required by the DOT.

The TrapBag system deployed by the Iowa DOT forms a continuous barrier, typically in 100-foot-long segments, and can be stacked in 2-, 4- and 6-foot heights. Once linked together, the segments are filled with sand, crushed rock or other materials. Innovations implemented by District 4 staff expedited installation, with the flood barrier project on US 30 proceeding at a rate of approximately 500 feet per hour—double the rate expected by the vendor. The vendor now recommends the installation practices developed by DOT staff to new users.

Participants deemed the flood barrier walls to be most appropriate for longer areas needing mitigation, with one participant commenting that the two-mile installation on US 30 represented the limit for the length of a typical flood barrier wall system. While the bags used to construct the flood barrier walls are a single-use item, the crushed rock that filled them was recycled and stockpiled at the Onawa garage. District staff estimates that the stockpiled material can be used for shouldering projects over the next 10 years.

A flood barrier wall installation on a section of I-29 in Monona County

High shipping costs prompted a recommendation for proactive research of similar products for entry in the Iowa DOT purchasing system to expedite the cost-effective use of new mitigation tools during future events.

Installation

Participants shared their recommendations for installing flood barrier walls or a similar mitigation tool:

- Use on roadways with paved shoulders.
- Ensure that at least 2 feet of the flood barrier comes into contact with the soil.
- While the installations appear to have a natural traffic calming effect, formally lower speeds in mitigated areas. The Iowa DOT lowered speeds to 45 mph in several treated locations.
- Consider the use of striping (paint was more successful than reflectorized tape) on the barriers, about 3 feet up from the roadway, to help motorists identify where the roadway ends and the flood barrier walls begin.
- Establish width limits for mitigated areas. Even with these limits, problems were identified with agriculture equipment driving through the treated areas and damaging the barriers, spilling rock onto the roadway.
- Recognize that obtaining the needed fill material can be challenging if routes between the quarries and the job site are closed due to flooding. Diverting trucks through areas not accustomed to handling these loads can cause traffic or road maintenance concerns.
- Consider placing barriers at entrances to culverts.

Troubleshooting

Many participants reported that the flood barrier walls were not only effective at keeping water out (off the roadway), they sometimes kept water in (on the roadway) by creating a long tunnel that did not allow water to drain off the roadway. Water also seeped through seams in the bags and made its way into the porous subbase, seeping up through joints in the roadway.

Solutions or recommendations to address water seepage and collection on the roadway:

- An extensive pumping system to manage water accumulation inside the flood barrier installations proved effective in most cases but could be overwhelmed during significant rain events.
- Drain pipes were installed under the flood barrier walls before the bags were filled and then capped. The caps could be removed when staff needed to drain water from the roadway that built up inside the barrier installation. However, when the water rose above the drain pipes, the water could not drain and pumping was required.

- The use of self-priming pumps rather than pumps that have to be started manually would enhance worker safety during rain events that threaten to saturate the roadway.
- Digging holes in the shoulder on both sides of the roadway to create a sump with a pump hooked up to a generator will create low areas for water to collect that can then be pumped out.

3.5.2 Sandbags

Participants considered sandbags and pumps to be more appropriate for smaller, more confined locations, with one participant recommending sandbags for sites of 300 feet or less. Participants also noted that if the water is expected to get too high (perhaps 2 feet or more), the number of sandbags required to meet the need becomes excessive.

District staff identified an innovation in sandbag placement when attempting to raise the elevation on a primary roadway. Staff laid down a row of concrete barrier in the area to protect workers from traffic, then lay plastic to help provide a seal and placed sandbags on top of the plastic. A large pump placed in the ditch kept water off the shoulder, essentially creating a pond and pumping it out. This type of installation cut the number of sandbags needed in half for a 300- to 400-foot installation. This mitigation method worked best on paved shoulders.

3.5.3 Hot-Mix Asphalt Overlay

In the lone application of this type of mitigation measure during the flood event, the pavement was raised 12 inches with an HMA overlay on a section of I-29 in District 3 to prevent floodwaters from overtopping the roadway. The overlay at milepost 103.5 provided a 1-foot rise over 4,000 feet of the southbound lanes. Work was completed in early July 2011. The HMA overlay on I-29 raised two lanes rather than four to provide a permanent mitigation that may prove helpful in future flood events.

The HMA overlay was used because its application could be timely (it took less than a week), a relatively small increase in height was needed to protect the road, and the treated area was relatively short in length. A cost-benefit analysis indicated that the HMA overlay was cheaper than using flood barrier walls.

Other factors that contributed to the decision to use the HMA overlay:

- The agency was tapping the limit of flood barrier availability when this mitigation came under discussion.
- The height of the water was expected to rise less here than in other areas, and it was complicated to identify expected inundation levels.
- The contractor was available, as were the materials needed to complete the job.

Debris on the roadway presented challenges after the water receded.

3.5.4 Bridge Repair (IA 175/Decatur Bridge)

Flooding forced the June 27 closure of the Missouri River bridge on IA 175 at Decatur, NE. High-velocity floodwaters produced changes in the river channel and a large scour hole formed around the Iowa-side bridge piers and abutment. Flooding also caused the loss of the bridge embankment on the Iowa side of the river, which supports the IA 175 roadway approach to the bridge.

Repair work unfolded in phases:

- With the road/bridge closed, the almost 50-foot-deep scour hole was filled to stabilize the bridge and embankment. After completion of this portion of the work, the bridge was inspected and deemed safe for travel on November 2, 2011.

- With the road/bridge open to traffic, the contractor constructed a U-shaped rock berm that begins north and ends south of the crossing. Designed to stabilize the embankment and reduce the churning motion of the floodwaters next to the abutment, the rock berm helps prevent erosion and reduces the threat to the abutment.

This repair work presented another opportunity for the Iowa DOT to employ special contracting provisions. An incentive/disincentive and no-excuse bonus encouraged an expedited repair that allowed the roadway to reopen as soon as possible and the DOT to meet the 180-day timeframe to qualify for federal reimbursement.

3.5.5 Other Mitigation Measures

Other mitigation measures attempted or recommended include:

- Shoulder paving to reduce damage to pavement from water flow.
- Proactive closure of culvert pipes in areas where a levee breach is predicted to address the follow-on effects of flooding, such as erosion around culverts leading to erosion on the roadway.

3.5.6 Assessing the Mitigation Measures

We asked survey respondents to rate the effectiveness of mitigation measures most often used during the event. The average ratings are reflected in the table (5 = extremely effective; 1 = not at all effective). Respondents' opinions did not vary significantly when it came to the three most often used mitigation measures.

Use of flood barrier walls	4.41
Plugging storm sewer outlets combined with pumping water to keep ramps and roadways open	4.23
Use of sandbags	4.12
Raising pavement	2.89

More than two-thirds of respondents cited levee breaches as posing the greatest overall risk to the primary road system. Most of the remaining respondents indicated that direct flooding from the river posed the greatest risk; none of the respondents cited groundwater flooding.

Spotlight on Best Practices:
Mitigation Measures

- Select a mitigation measure that fits the circumstances of the site. Consider length, location, available resources and the time available before overtopping becomes a significant concern.
  - Consider the impact of mitigation measures on adjacent land uses.
  - Conduct a cost-benefit analysis to compare measures.
  - Use inundation predictions to assign mitigation resources to locations where they are most likely to help.
- Keep abreast of new mitigation technologies. Enter new products in the Iowa DOT purchasing system as they are identified to expedite their use during an emergency.
- Consider the following practices when using large flood barrier systems:
  - Install on roadways with paved shoulders.
  - Lower traffic speeds.
  - Delineate the barriers using striping or another method.
  - Establish width limits for treated areas.
  - Identify alternate routes for trucks hauling material.
- Use sandbags and pumps for smaller, more confined locations when the water will not rise above 2 feet.
- Be prepared to develop innovations that address unintended consequences of mitigation measures (for example, water accumulation on the roadway during rain events).
- Track the areas that were overtopped during this event and consider them for reconstruction projects that raise the mainline to prevent future problems.

4. Conclusion

The severity and duration of the 2011 Missouri River flood tested the mettle of everyone involved in the response and initial recovery efforts – from the Iowa DOT staff to the local, regional and federal partners that provided invaluable assistance and support.

In offering their observations about the lessons to be learned from responding to this event, contributors to this report often described the opportunities for improvement in the context of enhancing an already effective process. Participants shared a common commitment and purpose in coming together to mount an effective response to this unprecedented event. Responders to future events can benefit not only from the best practices identified in this report, but also from the spirit of cooperation, enthusiasm for innovation and commitment to public service exemplified by those responding to the 2011 flood.

An additional challenge during this event was the Department had recently undergone a leadership change, with a new DOT director having started just prior to the onset of the flooding. The overall guidance and engagement from the new Director was seen in three different areas.

1) There was clear support from the highest level to be aggressive in dealing with the flood situation, but there was no second guessing or micro-management. This type of support allowed DOT staff to move rapidly and aggressively.
2) The Director supported and encouraged an aggressive and innovative approach to the flood response. This was particularly true in terms of getting facilities back in service, such as the contracting approach and terms set up for I-680 and other rapid repair services.
3) The Director's objective was to get facilities back for the benefit of the public as quickly as possible and effectively communicate efforts to the public.

Appendix A

After Action Report: 2011 Missouri River Flooding Participant List

	First	Last	Agency	Division	Office	Position	Telephone	Email
1	Tony	Lazarowicz	Iowa DOT	Highway	District 3	District Engineer	712-276-1451	Tony.Lazarowicz@dot.iowa.gov
2	Todd	Huju	Iowa DOT	Highway	District 3	District Maintenance Manager	712-274-5825	Todd.Huju@dot.iowa.gov
3	John	Jepson	Iowa DOT	Highway	District 3	District Operations Manager	712-732-4514	John.Jepsen@dot.iowa.gov
4	Jon	Allen	Iowa DOT	Highway	District 3	Highway Maintenance Supervisor	712-423-2040	Ilo.Allen@dot.iowa.gov
5	Don	Stevens	Iowa DOT	Highway	District 4	Acting District Engineer - Summer 2011	712-243-7622	Donald.Stevens@dot.iowa.gov
6	Jim	Bane	Iowa DOT	Highway	District 4	District Maintenance Manager	712-243-7623	James.Bane@dot.iowa.gov
7	Steve	Mefford	Iowa DOT	Highway	District 4	District Operations Manager	712-366-4642	Stephen.Mefford@dot.iowa.gov
8	Dick	Mattox	Iowa DOT	Highway	District 4	Highway Maintenance Supervisor	712-366-0332	Dick.MattoxJr@dot.iowa.gov
9	Tony	Arrick	Iowa DOT	Highway	District 4	Highway Maintenance Supervisor	712-622-8140	Antone.ArrickJr@dot.iowa.gov
10	John	Adam	Iowa DOT	Highway	Director	Highway Division Director	515-239-1124	John.Adam@dot.iowa.gov
11	Mitch	Dillavou	Iowa DOT	Highway	Engineering Bureau	Bureau Chief	515-239-1128	Mitchell.Dillavou@dot.iowa.gov
12	John	Selmer	Iowa DOT	Highway	Statewide Operations Bureau	Bureau Chief	515-239-1333	John.Selmer@dot.iowa.gov
13	Bob	Younie	Iowa DOT	Highway	Maintenance	Office Director	515-239-1589	Bob.Younie@dot.iowa.gov
14	John	Haas	Iowa DOT	Highway	Maintenance: Statewide Emergency Operations	Director	515-239-1040	John.Haas@dot.iowa.gov
15	Bonnie	Castillo	Iowa DOT	Highway	Maintenance: Statewide Emergency Operations	Disaster Operations Manager	515-239-1678	Bonnie.Castillo@dot.iowa.gov
16	Roger	Bierbaum	Iowa DOT	Highway	Contracts	Office Director	515-239-1414	Roger.Bierbaum@dot.iowa.gov
17	Mike	Kennerly	Iowa DOT	Highway	Design	Office Director	515-239-1243	Michael.Kennerly@dot.iowa.gov
18	Dena	Gray-Fisher	Iowa DOT	Operations and Finance	Public Affairs	Office Director	515-239-1922	Dena.GrayFisher@DOT.iowa.gov
19	Dave	Claman	Iowa DOT	Highway	Bridges and Structures	Hydrologist	515-239-1487	David.Claman@dot.iowa.gov
20	Sinclair	Stolle	Iowa DOT	Highway	Research and Technology Bureau	Traveler Information Program Engineer	515-239-1933	S.Stolle@dot.iowa.gov

Appendix A

After Action Report: 2011 Missouri River Flooding Participant List

	First	Last	Agency	Division	Office	Position	Telephone	Email
21	Jeff	Sundholm	Iowa DOT	IT	Enterprise Services	Network Services and Communications Manager	515-239-1543	Jeffrey.Sundholm@dot.iowa.gov
22	Pat	Harmeyer	Iowa DOT	Operations and Finance	Procurement and Distribution	Purchasing Director	515-239-1168	Patricia.Harmeyer@dot.iowa.gov
23	Matt	Haubrich	Iowa DOT	Highway	Maintenance	Asset Manager	515-233-7902	Matthew.Haubrich@dot.iowa.gov
24	Major Tim	Leinen	Iowa Department of Public Safety	Iowa State Patrol			515-725-6103	leinen@dps.state.ia.us
25	Joyce	Flinn	Iowa Homeland Security and Emergency Management Division		Response and Recovery Bureau	Bureau Chief	515-323-4313	Joyce.Flinn@iowa.gov
26	Rick	Bennett	Missouri DOT	Central Office Traffic			573-526-4842	richard.bennett@modot.mo.gov
27	Tom	Sands	Nebraska DOR	Operations Manager			402-479-4542	tom.sands@nebraska.gov
28	Lubin	Quinones	FHWA	Iowa Office			515-233-7300	lubin.quinones@dot.gov

Appendix B
After Action Report: 2011 Missouri River Flooding
Survey Questions

Information Sharing and Communication

1. Please rate the effectiveness of the following information sharing and communication practices used during the flood response (5 = extremely effective; 1 = not at all effective).
    - Use of video connection during conference calls
    - Coordination between local agencies and DOT for information sharing and communication
    - Coordination between local agencies and DOT for public outreach
    - Coordination between FHWA and Ames and district staff
    - Efforts to engage the media in communicating with the traveling public
2. What efforts proved most effective in communicating directly with the traveling public?
    - 511
    - Email/text messages
    - Twitter
    - Other services (please describe)
3. Do you feel there was any unnecessary duplication of effort in terms of information sharing and communication?

Staffing

4. Should additional or different personnel from the groups below be included in the future?
    - DOT Flood Management Team
    - District Operations
    - DOT Statewide Emergency Operations
    - Other Iowa state agencies
    - Neighboring states and federal government agencies
    - Contractors
5. Do you feel there was any unnecessary duplication of effort in terms of staffing?

Decision-Making

6. It appears that a formal risk classification (low, medium, high) scheme was used. Are there any changes to the development process or application of the scheme that you would recommend?
7. Do you feel there was any unnecessary duplication of effort in the decision-making process?

Appendix B
After Action Report: 2011 Missouri River Flooding
Survey Questions

Data and Technology

8. Please rate the timeliness of the following data presented to the DOT Flood Management Team (5 = extremely timely; 1 = not at all timely).
   - 2010-2011 mountain snowpack data for the upper Missouri Basin
   - May 2011 rainfall amounts in Montana and the Dakotas
   - Water levels for the six Missouri River reservoirs
   - Releases from Gavins Point Dam
   - Gauge readings along the Missouri River
9. Please rate the usefulness of the following data presented to the DOT Flood Management Team (5 = extremely useful; 1 = not at all useful).
   - 2010-2011 mountain snowpack data for the upper Missouri Basin
   - May 2011 rainfall amounts in Montana and the Dakotas
   - Water levels for the six Missouri River reservoirs
   - Releases from Gavins Point Dam
   - Gauge readings along the Missouri River
10. Please rate the degree to which technologies such as GIS and aerial imagery were utilized during the flood response (5 = extremely well utilized; 1 = extremely underutilized).
11. Please rate the degree to which intelligent transportation system components were utilized during the flood response (5 = extremely well utilized; 1 = extremely underutilized).
12. Please rate the usefulness or effectiveness of the following data or technologies employed during the flood response (5 = extremely useful/effective; 1 = not at all useful/effective).
    - GIS-based application showing inundation forecasts and actual inundation areas over time
    - Images from Iowa State Patrol flyovers
    - Field survey elevation shots taken to better estimate when water would cover certain roadways
    - Use of LIDAR data
    - "Flooded Roads Public Map" prepared to meet the needs of the traveling public
    - Use of DOT hydrologic forecasts to determine courses of action for the flooding that actually occurred

Mitigation Measures

13. Please rate the effectiveness of the following mitigation measures used during the flood response (5 = extremely effective; 1 = not at all effective).
    - Plugging storm sewer outlets combined with pumping water to keep ramps and roadways open
    - Use of TrapBags
    - Raising pavement
    - Use of sandbags

Appendix B
After Action Report: 2011 Missouri River Flooding
Survey Questions

14. What posed the greatest overall risk to the primary road system?
    - Groundwater flooding
    - Levee breaches
    - Direct flooding from the river
    - Other (please specify)

Appendix C

After Action Report: 2011 Missouri River Flooding
Interview Questions

Information Sharing and Communication

1. What were the strengths and weaknesses of the communication processes utilized by Iowa DOT during this flooding event?
2. The DOT flooding conference calls began June 3 and continued through September. Are there changes you would recommend to the timing and structure of the conference calls?
3. The call center was open June 9 through July 12. Please offer your observations on the role the call center played in disseminating information. Successes? Challenges?
4. Are there any changes you would recommend in connection with development of the Missouri River Flood website? Please describe.

Staffing

5. DOT staff conducted damage assessments in District 3 while contractors primarily completed damage assessments for District 4. What are the benefits of each approach?

Decision-Making

6. What types of decisions were made during:
    - DOT Flood Management Team conference calls?
    - Field operations?
    - DOT Flood Management Team discussions (not during the conference calls)?
    - Other conference calls (e.g., the detour conference calls with neighboring states)?
7. At which points in time should DOT management and Statewide Emergency Operations personnel be involved and how frequently?
8. Establishment of a Departmental Incident Command Structure was considered to better support a long-term event. Is this an option under consideration for future events? If not, why not?
9. What were the strengths and weaknesses of the decision-making processes utilized by Iowa DOT during this flooding event?
10. What changes, if any, should be made to the decision-making process for future events?

Data and Technology

11. What additional information do you wish had been available before, during and after the event?
12. What types of GIS-related data not used during the flood response would have been helpful?
13. What role was played by the fixed and portable cameras? Were they effective?
14. How were dynamic message signs used? Were they effective?
15. What other tools in addition to cameras and DMSs were or would be helpful?
16. What issues were encountered with cellular network coverage in some areas? Was this a critical or minor incident?

Appendix C

After Action Report: 2011 Missouri River Flooding
Interview Questions

Mitigation Measures

17. What mitigation efforts were most effective in keeping at-risk areas open?
18. TrapBags were used as a mitigation tool for the first time in Iowa. Please describe:
    - Successes and challenges of using the TrapBags.
    - Who was responsible for installation and removal?
    - How did the TrapBag installation affect traffic flow?
    - Under what conditions were TrapBags not favored as a mitigation tool?
19. Why was raising the mainline used in one area of I-29 instead of something like TrapBags?

Wrap-up

20. What would you do differently in a future flooding event? Anything you would not do?
21. What other advice or recommendations do you have?

Iowa Department of Transportation

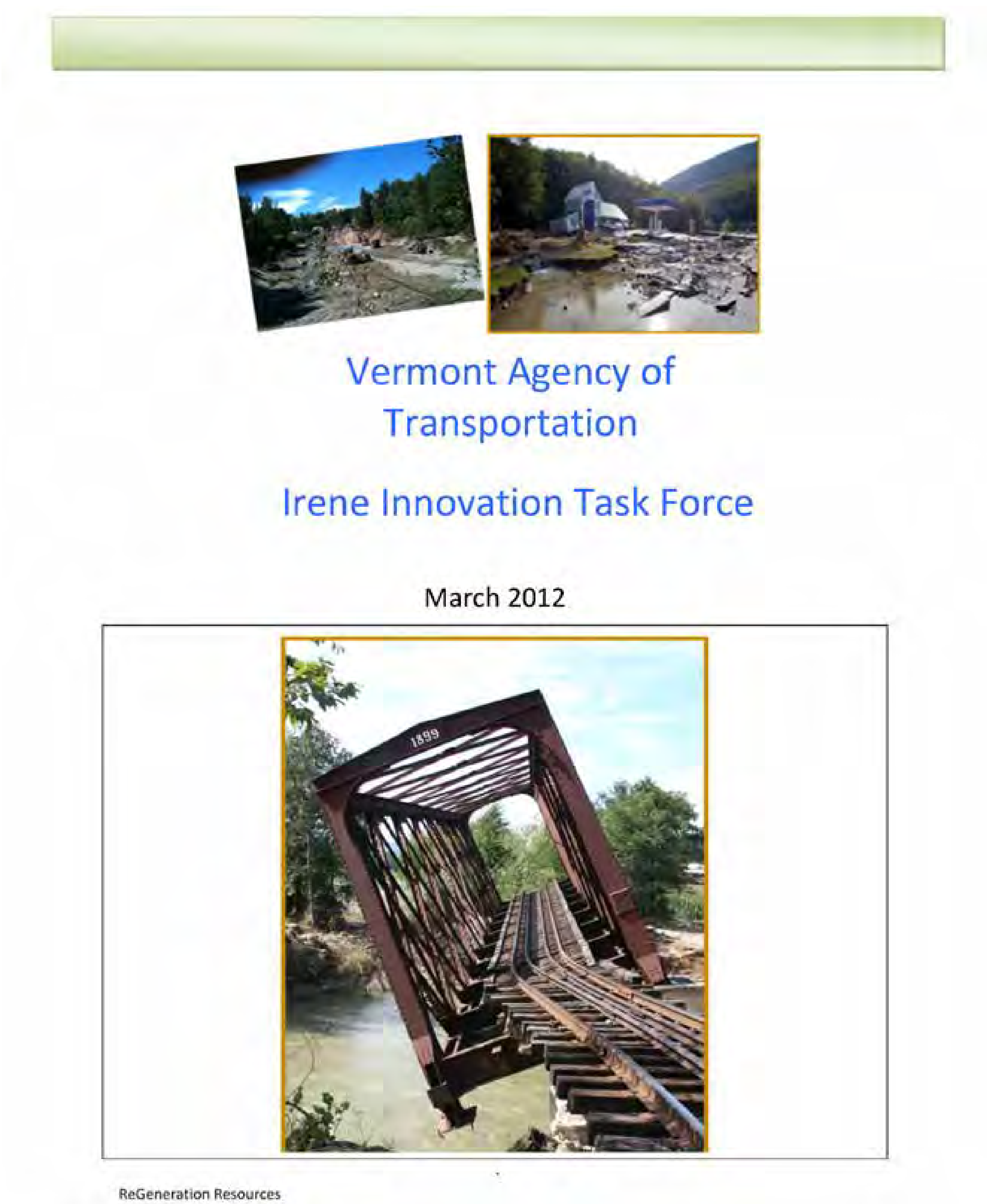
For more information, please contact the Iowa DOT's Research and Technology Bureau.
www.iowadot.gov/research

Prepared by
CTC & Associates LLC

APPENDIX E

Vermont – Task Force Report

Vermont Agency of Transportation Irene Innovation Task Force, ReGeneration Resources, Mar. 2012, pp. 52. (ReGeneration Resources)



Vermont Agency of Transportation

Irene Innovation Task Force

March 2012

ReGeneration Resources

Table of Contents

Table of Contents

Executive Summary

After Tropical Storm Irene devastated Vermont with flooding not seen in decades, the Vermont Agency of Transportation (VTrans) went to work rebuilding 260 state roads and 33 state-owned bridges. The agency quickly recognized that an Incident Command System (ICS) would be needed to respond to the magnitude of the disaster and it set up Incident Command Centers (ICC) in Dummerston, Rutland, and Berlin. It also established a Unified Command Center in Montpelier.

The Agency coordinated with dozens of key partners, including other state agencies, utilities, contractors, National Guard units, and transportation workers from other states. Through hard work, coordination, and the implementation of many innovative practices, the last segment of an estimated 531 miles of closed roads was reopened on December 29th, roughly four months after the storm hit. The Agency's response was unquestionably a huge success.

Once the recovery phase was completed, an Irene Innovation Task Team was established to identify the "lessons learned" from the VTrans tropical storm response. The work included determining which lessons learned could be applied to preparedness for future disasters and those that could be applied to ongoing operations. To accomplish this task, the team interviewed more than 60 participants involved in the Irene response effort, reviewed debriefing surveys, meeting notes, and numerous after-action reports compiled by others. The team also led eight focus groups and conducted their own survey.

The use of the ICS was essential to the successful response. However, a lack of planning, practice, and a three-day delay in implementation initially limited the ICS's effectiveness. Recommendations for improving emergency response include choosing leaders early, training leaders intensely, increasing technology available to key ICC leaders, training all staff in ICS principles, ensuring that adequate resources are available (including shift coverage and administrative support for key leaders) and writing Standard Operating Procedures (SOPs) that clarify the role of the planning section, the structure of Unified Command (UC), and the role of IT in the ICS.

Those working in Contract Administration (or those otherwise providing administrative support through the ICCs and other sections) were hindered by their lack of familiarity with Federal Emergency Management Administration (FEMA) and Federal Highway Administration (FHWA) documentation requirements and different financial practices used in different parts of the agency. Lessons learned for Contract Administration include the need to standardize internal practices, develop an emergency waiver process, and develop a contractor registry database. Other recommendations for emergency response include developing communication protocols, clarifying the level of civil engineer testing needed in disaster response, clarifying the Detailed Damage Incident Report (DDIR) process, and better utilizing technology in the initial assessment phase of the disaster.

While state agencies worked together in unprecedented ways during the disaster response, continued efforts to integrate VTrans internal functions and integrate VTrans functions with other state agencies are needed. Continuing the use of cross-functional teams will help integrate VTrans functions internally. Including Regional Planning Commissions (RPCs), Agency of Natural Resources (ANR), FEMA and FHWA in ICC planning should benefit future efforts. Stewardship agreements with key agencies to cover protocols for emergency response are also necessary. A complete listing of the recommendations for emergency response is in Appendix E.

Many of the ways the agency responded to Irene have great potential to increase VTrans efficiency in ongoing operations. Many of the innovations initiated during Irene were the product of 1) the use of cross functional teams; 2) the infusion of tech-savvy youth; 3) empowering staff to make more decisions at the local level; and 4) a level of urgency not experienced during ongoing operations. Continuing the use of cross-functional teams, as well as recruiting and training youth, empowering staff, and keeping some projects high–priority, is critical to ongoing innovation.

Moving forward with innovation, VTrans will need 1) people willing to champion new practices; 2) the capacity to design new business processes; and 3) the ability to develop policies and governance structures to support new practices.

Additional high-level recommendations to foster innovation in ongoing operations are to:

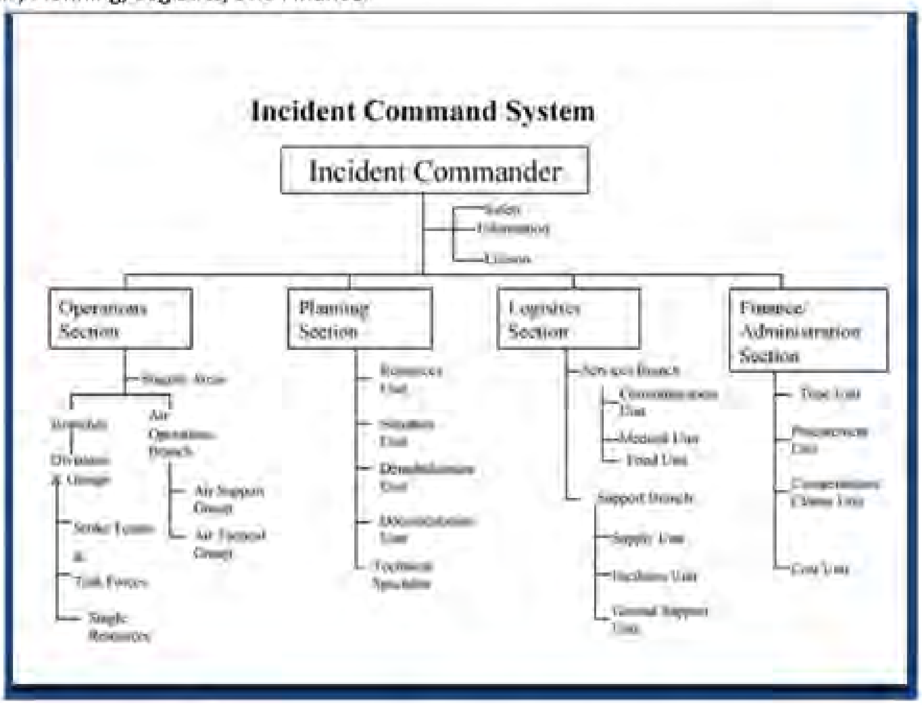
- Develop ideas to streamline the permitting process;
- Evaluate other processes for potential streamlining, including the design process;
- Close roads more frequently during repairs;
- Move away from committees and toward the use of "task groups" (teams established and dedicated to focus on high-priority projects);
- Work to improve communication and integration with other agencies and municipalities as well as improve integration and communication among divisions of VTrans. VTrans internal challenges include data integration and financial processing standardization;
- Find people to champion, test, and implement technology used during the Irene response;
- Work to create a culture less adverse to risk.

A complete list of recommendations to promote innovation during ongoing operations is included in Appendix F.

Introduction

On August 27 and 28[th], 2011, Tropical Strom Irene dumped more than seven inches of rain on parts of Vermont, resulting in the flooding and devastation that had not been experienced in over 80 years. In addition to hundreds of homes being lost and unthinkable damage to personal property, eleven communities were left completely isolated due to 260 road and 33 state highway bridge closures. Moreover, 90 municipal bridges were closed and 289 local bridges were left damaged. Within a few days the Vermont Agency of Transportation (VTrans) responded by establishing an Incident Command System (ICS).[1]

As the chart below indicates, the ICS organization consists of five major functions: Command, Operations, Planning, Logistics, and Finance.



[1] The National Interagency Incident Management System (NIIMS) was developed as a total system to collectively provide an approach to all-risk incident management. The ICS organizational structure for each incident is created in a modular fashion, based on the size and complexity of the incident as well as the specifics of the hazard environment created by the incident. When needed, separate functional elements can be established, each of which may be further subdivided to enhance internal organizational management and external coordination. Responsibility for the establishment and expansion of the ICS modular organization ultimately rests with Incident Command, which designs the ICS organization to suit the requirements of the situation. As incident complexity increases, the organization expands from the top down as functional responsibilities are delegated. Concurrently with structural expansion, the number of management and supervisory positions expands to address the requirements of the incident adequately.

In addition to local incident command set-ups, large incidents require a Unified Command (UC) or Central Command which allows agencies with different legal, geographic, and functional authorities and responsibilities to work together without affecting individual agency authority, responsibility, or accountability.

With the establishment of Incident Command Centers (ICC) in Dummerston, Rutland, and Berlin, along with a UC in Montpelier, VTrans established, and went to work addressing its major goals:

- Establish emergency access to cut-off/isolated towns and locations within communities;
- Establish access for utility companies to restore power to areas cut off;
- Establish mobility (public access) to towns that have emergency access only;
- Establish mobility along east/west corridors (to include truck traffic and commerce);
- Inspect all bridges;
- Prepare state roads for winter operations.

While as many as 700 VTrans employees from across the state (as well as transportation workers from New Hampshire and Maine, National Guard troops from eight different states, scores of volunteers, and approximately 1,800 private sector workers) were rebuilding roads, some with holes as deep as 100 feet, staff in Montpelier worked on communicating with the public. A 20-line call center was established, a mapping center worked with Google to constantly update the status of roads and bridges, a dedicated Irene email account was established, and Facebook and Twitter accounts were utilized.

Within one month of the storm, 28 of the 34 closed bridges had reopened and more than 96 percent of the estimated 531 miles of state highway road segments had been reopened. The last mile of state highway reopened on December 29th, roughly four months after the storm hit.

By any measure, this amazing recovery effort by VTrans was a huge and undisputed success. Through hard work, long hours, and innovation, an astonishing amount of rebuilding work was accomplished in the fall of 2011. This report looks more closely at what practices the agency employed that worked and will want to replicate in future disasters, what changes might have allowed recovery efforts to work even better, and what lessons learned might be applied to ongoing operations to increase the effectiveness of the agency.

Mission of the Task Force

The Irene Innovation Task Force was directed to gather, organize, and compile any and all information related to innovative practices or ideas resulting from lessons learned during the tropical storm Irene response and recovery effort. The team was asked to make recommendations to Executive Staff regarding innovative practices that should be implemented – or further explored – in the short, intermediate, and long term. Possible innovations included any business process the agency is responsible for during both normal and emergency operations. This report, intended for Executive Staff, is the main deliverable of the Task Force. Recommendations are based solely on potential for innovation within VTrans and do not consider the potential cost of innovations. Before moving forward with recommendations, some study of return on investment should be conducted.

Methodology

To accomplish the mission referenced above, the Task Force reviewed and analyzed the notes from the "Brown Bag" lunch series conducted by Sue Minter, notes from the weekly debriefing meetings of Unified Command, survey responses of demobilized employees (conducted by Dr. William Bress), and reports written by the Irene Recovery Coordination Team and the Regional Planning Commissions. Additionally, the Task Force conducted its own survey of all VTrans staff with access to email. Moreover, eight focus groups were held with VTrans employees who were involved in the response efforts and over 60 individual interviews with VTrans employees and outside stakeholders were conducted. The group met frequently to discuss and analyze findings. A list of those interviewed is included in Appendix B.

Some of those interviewed had already compiled a summary of their lessons learned. These summaries were very useful to the team and usually had some ideas that contained a level of detail beyond what we understood our mission to be. Therefore, we compiled these summaries and offer them unedited as a separate supplemental report. While we do not agree with all of the suggestions made by others, we do imagine that those who implement the recommendations set forth in this report will benefit from some of the ideas and detailed thinking contained in the supplemental report.

Finally, while the great majority of the recommendations we present in this report come from those we interviewed, we did not agree with every recommendation we heard and therefore this report is not a complete list of suggestions from those we interviewed. Additionally we occasionally used our professional expertise to reflect on suggestions and put them in the context of ICS or organizational theory. Therefore, a few of the recommendations presented are the Task Force's synthesis of ideas we heard.

Task Force Overview

The Irene Innovation Task Force was composed of Greg Hessel, Chair; Dr. William Bress, Incident Command Systems Expert; Donna Holden, Administrative Support; Denise Gumpper, Chief of Contract Administration; Al Neveau, Former LTF Chief, Retired; Rich Tetreault, Unified Command, Advisory; and Scott Rogers, Unified Command, Advisory. A short biography of each task force member is included in Appendix C.

Improving Future Disaster Response

"Productive things can happen without having to form a committee to study what needs to be completed." *VTrans employee*

Incident Command

It was recognized early on that an Incident Command would be necessary to carry out the storm damage response. Because many participants at the ICC s were not familiar with the Incident Command System, they were forced to learn on the job. The lack of ICC training, as well as different management styles of the ICC leaders, resulted in the ICCs using different techniques and lacking uniformity, leading to confusion among some workers and within communities. While the missions of the ICCs were successful, and complete uniformity is not needed for success, standardization in certain areas should improve future performance.

An ICS is an efficient, on-site tool to manage all emergency response incidents and UC is a necessary tool for managing multi-jurisdictional responses to disasters. Although a single Incident Commander normally handles the command function, an ICS organization may be expanded into a UC. The UC is a structure that brings together the Incident Commanders. The State of Vermont uses the Vermont Emergency Management State Emergency Operations Center, (SEOC) to coordinate disasters. Representatives from various state and federal agencies are represented at the SEOC. Unfortunately, the physical location of the SEOC in Waterbury was evacuated due to flooding early in the emergency. The magnitude of damage to roads and bridges in the state required a full emergency mobilization of VTrans. Therefore, it was a natural progression to institute a combination of Unified Command at the National Life Building in Montpelier and also separate Incident Command Centers in Dummerston and Rutland.

Four Keys to Incident Command Response

Experience has shown that there are four keys to successful Incident Command response. Those involved must ***learn, plan, start early, and practice.***

First, in learning, all responders learn the ICS and UC structures and protocols. The better these elements are understood, and the more familiar staff is with them, the easier it will be to form a common structure when an incident demands one.

Second, when planning, those involved develop protocols for how the ICS/UC will be implemented in varying situations. This should be decided well in advance of an incident. The planning process should be used to identify roles and responsibilities of the various participants during different response scenarios.

Third, it is important to start early. As soon as it is determined that a response is warranted, an ICS/UC should be implemented.

Finally, practice, including periodic training and role-playing drills, is crucial to success. To maintain proficiency, using ICS during smaller disasters should be considered. Planners and responders at all levels need to understand the authorities and resources that each response organization brings to a specific incident. When plans and procedures are understood, agencies can support each other effectively. However, each response results in new lessons learned, which necessitate continuing refinement of procedures and processes as well as development of better methods and meshing of agency needs and actions.

Suggestions for Incident Command Moving Forward

The fact that the ICS worked as well as it did, with little to no learning, planning, or practice speaks to the strength of the system and the people who adapted to it. Moving forward, we recommend planning which should include the clarification of roles, especially that of IT, the planning sections, and UC. IT, which played a critical role in the response, was not initially a part of either the UC or ICC system. Formalizing the role of IT as its own section moving forward will be important. A second role needing clarification is that of the planning section. Planning in ICC is not the same as planning in VTrans. Planning in the ICC model focuses on tracking people and materials and not performing design work. We recommend keeping design work in operations. Planning might also provide a short orientation to all new ICC staff. The orientation should include information such as required paperwork; supply and distribution of food; reimbursement procedures; and other logistics. It is the responsibility of planning to account for all staff including the whereabouts of everyone in the field on a daily basis. Safety of all workers and contractors should be part of the ICCs daily safety plan. Additionally, roles and tasks need clarification between ICCs and UCC, VEM and UC, DDIR writers, and ICCs, as well as the role of the National Guard (emergency repair vs. long-term repair use).

We also believe that future responses would be even more effective than the Irene response if the UC more closely mirrors the ICC structure, particularly with the inclusion of IT and administrative personnel. This would have alleviated communication and workflow issues including 1) Operation's business office did not believe they were brought into the effort soon enough; and, 2) unintentional competition for resources between the two ICCs. There was the perception that whoever spoke up first got the resources, resulting in friction. In the future, the UC logistic person should be tasked with anticipating critical needs and allocating resources based on prioritization of roads and not on a first-come, first-served basis.

The absence of SOPs for VTrans ICS operations created confusion. Notable is the lack of standardized practices for financial matters, which created confusion for contractors.

Finally, many people we communicated with commented on the importance of selecting UC and ICC candidates who are a good fit for the assignment. One way to accomplish this is to survey staff ahead of time to identify and match skills and abilities. Those assigned to leadership roles need to be comfortable operating under pressure and have confidence in their staff. It is not essential for an effective ICS that staff be assigned to their usual realm of expertise and in fact overall agency priorities and the benefits of cross functional teams (discussed elsewhere in this report) at times necessitate new assignments for some staff. However, we heard criticism that too many operations staff were taken to other functional and geographic areas when operations in their "home" districts had pressing needs, resulting in inefficiency. Additionally, we heard the desire to keep teams that normally work together unified as much as possible. In the future, in trying to strike the balance between overall agency priorities and the efficiencies gained from having staff work in familiar realms, it may make sense to reassign less staff.

Proposed Three-Tiered Incident Command System for VTrans

We propose a three- tiered incident command system for VTrans.

During ***Level One*** response, the districts are able to independently handle the situation, with support on an as-needed basis. An example of when a Level One might be declared was during the spring 2011 flooding when some districts found themselves near a breaking point. A single person is assigned to Unified Command in Montpelier to follow up with the districts during similar emergencies. If districts need more support than a single district can give, the agency would move to a Level Two.

During a ***Level Two*** response, Unified Command in Montpelier will activate the following sections and appropriate chiefs: Planning, Logistics, Information Technology, and Administration/Finance. These sections will assist the District Supervisors with requests for assistance. If the situation reaches the level that requires ICCs near the emergency, the agency will move to a Level Three response.

During a ***Level Three*** response, full Unified Command and also local ICCs are set up based on the geographical location of the damage. Clear thresholds should be developed to determine when to implement the different levels of response. Appendix A contains examples of a proposed three- tiered incident command system for VTrans.

Recommendations for Incident Command

1.1. Assign personnel to be Incident Commanders and section chiefs during an emergency (short term).
1.2. Give those assigned the proper ICS training for their duties (short term).
1.3. Ensure adequate resources for emergency response. These resources should include a review of communication equipment, ensuring adequate shift coverage for critical positions, determining which roles need to be backfilled during an emergency response, giving key people in the ICCs administrative support to monitor emails and other communication, and considering emergency fleet capacity when purchasing new vehicles (short term).
1.4. Provide key personnel identified and trained for future ICC duties with state of the art technology (iPads, iPhones, etc.) to use on a daily basis (mid-term).
1.5. Write a Standard Operating Procedure for VTrans ICS. SOPs should include standardizing financial processes, clarifying the role of planning, formalizing the role of IT, formalizing communication processes, ensuring that the UC fully utilizes the ICS, and developing a three- tiered system as described above (mid-term).
1.6. Learn background experience of all appointed staff team leaders to better understand their talents and ensure that the right people are in appropriate positions in ICS (mid-term).
1.7. Think through the physical and geographic issues, including identifying the best locations for ICCs around the state. In our focus groups, those furthest from the ICCs tended to experience the most isolation and feel the most resource-depleted. Additionally, knowing where the UC will be established is critical (mid-term).
1.8. Update the VTrans Continuity of Operations Plan to reflect the ICC structure (mid-term).

Integration Issues

Internal Integration of VTrans Functions

One of the keys to innovation during the VTrans' response to Irene was the agency's ability to integrate functions that typically operate in isolation. Examples of this include having IT and HR support within each ICC, having operations work together with planning, and increasing contract administration support within each ICC. This approach to structuring work has pros and cons (as will be discussed below in more detail). Research has shown that two huge advantages of this type of structure are that it decreases project time and also fosters innovative problem-solving in complex situations. Without this structure that encouraged multiple functions to operate together, it is doubtful that the ICCs would have developed the many innovative solutions that ultimately emerged.

Two groups that could have been better integrated into the emergency responses were those repairing rail lines and the state airport. A liaison between the ICC or UC and rail and airports and perhaps linking their logistics people could have increased efficiencies of those working to track down the same kinds of materials. Some whom we interviewed also wondered if a pre-determined "rail squad" should be named for quicker response to emergencies. Training in rail operations would be required for the squad to understand roles and responsibilities of the group. However, the squad could be quickly assembled and deployed for faster recovery.

Finally, we would suggest including a VTrans environmental liaison within the ICC structures. This would decrease dependence on other state agencies and could help ensure that an environmental perspective is contained within the ICCs.

Recommendations to Improve Internal Integration

2.1 In emergencies, continue to promote the use of cross-functional teams (short-term).

2.2. Think of ways to better integrate those working on rail lines and the state airport into the emergency operations (mid-term).

2.3. Include a VTrans environmental liaison in the ICCS planning (short-term).

Integration of Diverse Municipal, State and Federal Agencies

Many state, municipal, and federal agencies played a critical role in the success of the emergency response. In addition to VTrans, the state police, National Guard, Agency of Natural Resources (ANR), Corp of Engineers (COE), Federal Highway Administration (FHWA), US Fish and Wildlife, FEMA, utility companies, and the Regional Planning Commissions all played critical roles.

Efforts to integrate different functions of the state, federal, and municipal governments' responses were less uniform and coordinated than integration efforts within VTrans. While the integration of different state agencies would ideally have been done through Vermont Emergency Management (VEM), that agency's displacement from the Waterbury facility left it with a limited ability to play much of a coordinating role.

Furthermore, many of the above-mentioned agencies were overwhelmed internally by the impact of the flooding. For example, ANR's four river engineers were woefully too few in number to respond to the magnitude of the damage. Given agencies' limited resources, it took a bit of time to work out the details of the coordinating efforts. Roles and jurisdictions of the different agencies were sometimes unclear, and stewardship agreements, where they existed, did not accommodate emergency response efforts.

Despite these understandable delays, the ability of different agencies to get on the same page with rebuilding efforts was central to the success of the operations. Having one VTrans liaison working directly with the utilities was one often-mentioned success. A New Hampshire transportation leader credited leaders taking the time to work out the details before deployment as being critical to the success of the New Hampshire unit. "We coordinated early, were given high-level guidance, and were left alone. And that worked well", he said.

While understanding that VTrans does not have the ability to coordinate these diverse agencies, given the central role that integration played in the response effort, we offer the following recommendations in hopes that VTrans might be able to positively influence future integration efforts.

Recommendations to Improve External Integration

3.1. Develop stewardship agreements and memoranda of understanding with key agencies to accommodate emergency response efforts. These agreements should include better definitions of who is responsible for what in emergencies and where jurisdiction lies, and protocols for state personnel to identify themselves in the field during an emergency (short-term).

3.2. Convene a meeting this summer (before stakeholders forget this event) to allow towns, VTrans, ANR, COE, FHWA, FEMA, VEM, RPCs, and/or other state agencies to discuss the "who's and what's" of responsibility and contacts for any future events (short-term).

3.3. Incorporate the RPCs, ANR, FEMA, and FHWA into ICC planning (short-term).

3.4. Develop protocols for working with key agencies in emergencies including finding ways to identify all state workers in emergencies. Additionally, work to ensure that all key agencies are engaged from day one (mid-term).

3.5. Work to ensure that all state agencies use the same districts in an emergency. Having the state police, LEPC, RPCs, and others all conceiving districts' boundaries differently creates confusion. Even if this cannot be achieved, VTrans district lines, because they are irregular and include "fingers", probably should be ignored when thinking of the geographic parameters of the different ICCs (long-term).

3.6. As the state public assistance program is transferred from VTrans to VEM, it will be important that VEM (with VTrans support) push FEMA to pay for all eligible activities, including those designed to improve river management and prevent future floods. To this end, a full-time Attorney General assigned to work with FEMA has been identified as a need and should be actively pursued (short-term).

3.7. Different requirements from FEMA for PA funds and FHWA for ER funds created confusion. Therefore VTrans should work with FEMA and FHWA to explore possible changes to better align the PA and ER requirements (short-term).

Training and Preparedness

One of the most frequently heard comments during the interviews and focus groups we conducted was the need for ongoing training and preparedness in emergency response and also in the ICS. This recommendation has been echoed by in the *Irene Recovery Report*, which states, "Agencies across Vermont state government should consider increased training on ICS as the standard operating guideline for responding to both statewide and agency specific events."[2] VTrans' lack of training in the ICS structure resulted in some initial false starts, role confusion, and staff learning a new structure at the same time they were working to respond to an emergency. Having familiarity with the ICS, and a manual to refer to, would have helped make the response less overwhelming and confusing. While those chosen for leadership positions will need the most training, all staff should receive a minimal amount of training so they are familiar with the structure should they ever be deployed.

Moreover, many key partners lacked the knowledge and/or role clarity to know how to best respond. Sub-contractors were not always familiar with VTrans safety regulations; towns lacked clarity as to what was eligible for reimbursement under FEMA and FHWA rules; and most towns lacked an emergency response plan. Additionally, many contractors were not familiar with VTrans billing requirements, contributing to delays in getting contractors paid. As Tom McArdle, Assistant Director of Public Works (DPW) for Montpelier wrote,

> "Time elapsed before the ...'kick-off' meetings were conducted and guidance for towns was disseminated. During this time period, many decisions about repairs (immediate needs & permanent) needed to be made. This is a time period when mistakes in procuring services can and often do occur. This can include decisions about whether to repair or rebuild a road or culvert, whether competitive bids for services are necessary or not, whether environmental permits must be secured, and under which circumstances. With a wide impact area, VTrans officials are spread thin and guidance is limited. ... Periodic training (in public assistance) would be beneficial to conduct self-assessments in advance of the arrival of FEMA & FHWA disaster response teams so that funding of repairs is not jeopardized.[3]"

Training staff in the use of new technology used in the response (iPhone, iPads, laptops, wifi, mifi, sat cards, etc) was also identified as important. However, embedding IT staff in the ICCs mitigated this need. Our recommended solution to training in new technology is to encourage VTrans to incorporate new technology into daily operations (see above, ICC recommendations) so that staff learns technology by using it. This would both increase the ongoing efficiency of the agency and mitigate the need for IT training and support in an emergency.

Recommendations for Training

4.1. Conduct an annual training in disaster response for staff at all levels. While pre-identified leaders need the most training, those at the front lines also need to better understand roles. Training should include checklists and emergency standard operating procedures (SOPs), especially with regards to how finances are handled. A manual should be developed, possibly with the help of other states that have already written them. Clarity regarding Detailed Damage Incident Reports (DDIRs) should also be included in the training manual (short-term).

[2] Lunderville, Neale. *Irene Recovery Report: A Stronger Future*. Unpublished, written for the governor of Vermont. 2012. Page 60.

[3] Email from Tom McArdle to Chris Cochran, February 7, 2012, 4:06 p.m. Unpublished.

4.2. Pocket manuals should be developed for individuals in the ICC units. Each section head (Logistics, Planning, Operation, Finance) would receive a pocket manual. The manual would document who responds, what they do, where they go, and when they do it, as well as FAQs addressing ICC operations (mid-term).

4.3. Use ongoing mini-disasters as a chance to practice and evaluate the skills of potential leaders (ongoing).

4.4. If new technology is not incorporated into ongoing operations, develop a plan to support technology used in emergency response (short-term).

4.5. Clarify the role of VTrans in training key stakeholders, including contractors, towns, RPCs, DPW, and subcontractors (short-term).

4.6. Incorporate river management principles into VTrans Operation's training institute as one method of institutionalizing river engineering into infrastructure engineering (mid-term).

Contract Administration

One of the many lessons learned from the Irene response is that, although employees can (and did) meet the challenge of different emergency assignments and conditions, employees and the agency could have performed better with appropriate systems and tools in place. Irene also highlighted the essential fact that, during an emergency, Contract Administration is inseparable from financial operations, the business offices and, most essentially, IT. For that reason, made evident throughout the Irene "Event 12," the following summary, observations, and recommendations overlap with areas not traditionally considered Contract Administration.

As part of emergency planning, emergency documentation should be ready for distribution and implementation. Irene has shown however, that emergency documentation should be as similar as possible to ongoing documentation. Once an emergency has been declared and the relevant level determined, the documentation should be easily implemented with certain "step-skipping." This can be accomplished through previously agreed-to and approved waivers, which could address such measures as automatically increasing the threshold amounts of contracts and facilitating blanket approvals as well as eliminating signature routing. The development of the core documentation process (which is also linked to financial operations) may involve some dramatic decisions beforehand to ensure further success for either immediate or future innovations. While documentation is not difficult, the decisions surrounding it might be. These key decisions include:

- Whether MATS is an agency-wide or solely operations application. If MATS is an agency-wide application (as we recommend below), agency staff must be broadly trained to use it and it must be implemented consistently and to its fullest capabilities.
- Whether STARS is an agency-wide application. For reasons perhaps related to the Segregation of Duties concept, a component of the STARS application currently lies in Contract Administration. This has created a bottleneck situation. Training in STARS must be broad and implementation consistent.
- Whether to centralize or localize the processing of payment. Whichever decision is reached, standard operating procedures must be developed.
- Whether to commit to a 21^{st}-century documentation processing and tracking program (dashboard, electronic timeline, user-friendly and electronic contract components, online submission, etc.) for contractor registration and contract processing

One key recommendation made below is to compile a "Contractor Registry" or "Vendor Profile" database. The registry would provide a secure and centralized storage of information and eliminate the necessity of requesting the same forms and information repeatedly. The database would include information about contractors performing work for VTrans[4] collected for purposes of the prequalification process. Annual updates to the database would be culled to forms requiring such updates. The system would also allow VTrans to move to a "negative reporting" model; i.e., ask for what is omitted/out-of-date. Negative reporting allows quicker and more accurate review.

This registry should be developed and implemented immediately along with a Contract Processing System because a similar compilation is required to generate the Emergency Packet described below. It will be more cost-effective to develop the system and provide the Emergency Packet at the same time. The process developed and implemented for the Event 12 MRA CAT IIIs and ER and FEMA grant-tracking by Coleen Krauss's Grants Management Group is performing well and might be used as a model to follow (short-term).[5] Improvements to this process would include the aforementioned waivers setting the approvals in place for increased threshold amounts for contracts and forms with instructions for invoicing, which would track with and reflect information required for DDIR's.

The electronic Contract Processing system should include all the documentation currently employed by VTrans Contract Administration with menu selection and dashboard tracking of the approval process. The system should be integrated with an electronic storage warehouse. Additionally, a variety of "On-

[4] Information should include Tax ID numbers, W-9s, "Secretary of State" information, i.e., registered to do business, corporation in good standing, domestic or foreign corporation, DUNS numbers, contact information, licensing information, insurance Information, debarment status, and annual certifications, affidavits, and other requirements requiring updates.

[5] That process developed by the Grants Management Group includes items to be used in the Contract Processing, such as electronic signatures, Electronic Notice to Proceed forms associated with an Emergency CAT III contract, menu selection for state and/or federal requirements as appropriate to the contract, increased *Not to Exceed* amounts and electronic storage steps for compliance with reporting requirements and VTrans storage practices.

Call" or "Retainer" type contracts should be in place allowing Electronic Notices to Proceed or Work Assignments to be easily generated as an emergency mandates. The capabilities to develop and implement this system already exist within VTrans and it should be relatively easy to accomplish.

The need for a standardized process for paying contractors was highlighted throughout Event 12 and the Task Team understands that process is currently being reviewed and analyzed with that goal in mind. Some interviewees indicated that executing the last step of the payment process in Montpelier caused confusion and friction between the ICCs and contractors. In some instances, an administrative person was sent to the field to enter data into MATS to eliminate steps in the process and to ensure that the administrative staff was not falling behind. Others interviewed recommended centralizing the entire process for proper validation and consistency.

Recommendations for Contract Administration

5.1. Compile a "Contractor Registry" database as described above (short-term).

5.2. Develop a standardized electronic Contract Processing system as described above (short-term).

5.3. Develop an emergency administrative packet for use by ICC/UC Administrative Teams that also is available electronically. The administrative packet will include a clear explanation of the invoicing process, the contracting process, the DDIR requirements, the levels of emergency, safety protocols, and the different funding sources for emergency work. (short-term).

5.4. Develop an emergency packet for use by contractors doing emergency work, including the materials listed in 5.3, above. (mid-term)[6]

5.5. Develop an "Emergency Waiver" process. When an emergency of appropriate level has been determined and declared by the administration, the waiver would allow a pre-established emergency process to take effect for agencies involved in the emergency response. These emergency processes will have to be defined and developed (mid-term).

5.6. Review and standardize the process for paying contractors to ensure more prompt payment. (mid-term.)

5.7. Explore alternative emergency contracting processes that include, but are not limited to, changes to MRAs. (short-term)

Information Technology and Logistics

Information Technology played a key role in many innovations that were critical to the success of the Irene response. IPads, smart phones, electronic signatures, and Google Maps applications are just a few of the many new IT applications that expedited work and changed the way the agency did business. While IT staff played a key role in these innovations, end users, ripe and eager for new solutions, also played a key role in the innovations.

---

[6] This packet would include, but not be limited to, contact Information (extensive Vermont agency-wide contact info for Administration, very selective information for contractors); contracting requirements and forms with instructions (contractors also will receive instruction as required by Administration teams); invoice forms and instructions for submittal; support in meeting insurance guidelines, Davis-Bacon, and other federal requirements, instructions, and steps for compliance; and instructions for accessing electronic information such as maps, traffic, and road information.

Because the level of IT use was unprecedented in the agency, many hurdles needed to be (and need to be) overcome to maximize the effectiveness of new IT applications. These challenges included data integration, limited IT support (especially for MATS), and protocols for naming and storing electronic data. The following list of recommendations attempts to build on the IT innovations that worked and to mitigate challenges in future disasters. While these are IT recommendations, many of the solutions, if they are to be successful, will require the input and involvement of end users. We applaud IT and the agency for already beginning to implement a number of these recommendations.[7]

One suggestion that emerged from our work emphasized implementing "cloud" technology for working with contracts "so that parties involved could see pending action items in real time". This suggestion raises the larger role that cloud technology could play in agency innovation. Since the great majority of IT time in most organizations is spent installing and maintaining current systems, cloud technology holds great potential to free IT staff to focus on innovation. While concerns exist about cost, reliability, security, and regulation, a recent article in the *Harvard Business Review* suggests these concerns are overblown, in part by technology professionals invested in keeping the current system.[8] While it is not something to move into blindly, the advantages of moving to the cloud include freeing IT staff to focus on innovation, increased ability to share and analyze data (once the data is untangled), and improved ability to facilitate collaboration.

Recommendations for Information Technology

6.1. Develop an active master distribution list for users of iPhones and cell phones to avoid time wasted hunting for numbers during an emergency. This list could be downloaded by new users in an emergency (short-term).

6.2. While some people we spoke with did not think MATS is the best system to use in emergency response, others (including our team) believe that issues with MATS had to do more with VTrans' limited capacity to provide support for MATS than with the application itself. This lack of support and training led to bottlenecks, inefficient use, and some frustration. If MATS is to be used as an agency-wide application and not just an Operations application, VTrans must increase IT capacity in, and support for, MATS (short-term).

6.3. Explore the use of cloud technology, including having MRAs and Environmental Permits (Joint ANR and COE) for emergency responders to use in the field that would populate a warehouse and facilitate processing via the Internet so that all parties involved could see pending action items in real time (mid-term).

6.4. Continue to use the Google Maps application in emergencies (ongoing).

6.5. Consider storing HR documents, maps, and other ICC contact information in a central place (perhaps on VIPER). This could be accomplished by developing a section in VIPER for emergency information. Email distribution of maps during the response was not experienced as efficient (mid-term).

---

[7] Some recommendations that impact IT can also be found in the communications section of this report

[8] McAfee, Andrew. <u>What Every CEO Needs to Know About the Cloud.</u> Harvard Business Review, November 2011, p. 132.

6.6. Initially, Irene response data was stored in many different places, leading to confusion. Once the R drive was put into use, data storage issues were greatly mitigated. The R drive should be used from day one in emergencies (ongoing).

Workflow

As much as possible, workflow in an emergency should mirror workflow during normal operations. This minimizes the need for staff to learn new processes while responding to an emergency. However, in emergencies, FHWA and FEMA have needs for additional documentation and there is a need for some new processes to accommodate the scale of disaster response. Some workflow issues experienced during the Irene response will be solved through training in, and a better understanding of, the ICS. Other workflow processes have been addressed in the Contract Administration section of this report. What follows are workflow issues not addressed in those two previously mentioned sections.

Recommendations for Workflow

7.1. Develop a process to keep track of equipment lent to contractors (short-term).

7.2. Develop a process to improve tracking of materials from contractors used on sites. Due to the scale of the sites, tracking materials seemed to be an issue commonly experienced. One process that seemed to help was to have an administrative staff member on site recording materials into MATS as they were delivered. Regardless of the specific process or solution, developing a system ahead of time for tracking materials should help ensure accuracy of invoices and help expedite payments to contractors (short-term).

7.3. The DDIR process was confusing to those who performed it. There seemed to be a lack of clarity as to who owned this process (ICCs or UC) and not enough training in how the work should be carried out. The agency also seems to lack the capacity to train people in DDIR writing, creating a bottleneck and confusion. Addressing the needs of this process will be important to improving future emergency responses (short-term).

Communications

In an emergency response, communication is important to every aspect of the response. VTrans' emergency communication processes included successes as well as opportunities for improvement. Notable successes included the regular ongoing calls between UC and the ICCs, including private calls with commanders each day so that things could be said that people might be reluctant to say in a larger setting. Additionally, once people understood the ICC structure, they better understood appropriate channels for communication, which helped overall efforts to communicate more efficiently.

Since emergency communication protocols had not been developed, challenges also presented themselves. For example, some workers experienced a lack of clarity as to what types of communication needed to flow through UC and when Montpelier could contact the ICCs directly. Another challenge occurred when communication regarding VTrans' hiring of employees was funneled through the ICCs and not through the state unemployment office. Furthermore, some people were either not informed of ICC communication protocols or lacked the discipline to use them, increasing the burden on the already overworked ICC units. Spotty cell reception, different business offices buying different types of cell phones, and sub-optimal equipment added to the challenges.

Communication with other agencies and the public was also mixed. While the Google Maps application and the use of social media worked very well, the 511 system did not perform adequately and the public got mixed messages as to which roads were open. The lack of a protocol for how to communicate with towns also led to towns being overwhelmed with information from multiple sources (VTrans, RPC, VLCT).

Recommendations for Improving Communication

8.1. Having neutral observers visit the ICCs worked well and should be repeated (ongoing).

8.2. Develop internal emergency communication systems and protocols to minimize communication overload and feelings of being micro-managed. At a minimum, these should include clarifying when communication should flow through UC and when VTrans staff could contact the ICCs directly; how communication regarding hiring should be handled in an emergency; who at UC communicates with the ICCs; and who at the ICCs communicates with the UC. Encouraging discipline in using protocols is also important (mid-term).

8.3. Work to identify and ensure that the right equipment is on hand in emergencies. This should include the exploration of emergency uses of portable cell towers, an assessment of state radios and cell phones, and an assessment as to the usefulness of VTrans investing in emergency software such as DisasterLand (mid-term).

8.4. Work with partner agencies to develop external communication protocols. At a minimum, this should include clarifying how to best communicate with the towns, how to ensure timely information gets to the Emergency Operations Center (EOC), and how to improve the 511 system (mid-term).

8.5. Develop communication contingencies for emergencies that take out power and cell reception for long periods of time. While this is a worst-case scenario, it is important to spend time assessing options and developing a plan for this contingency (short-term).

Operations

Given the enormity of the rebuilding task, and how quickly it was accomplished, operations should be commended for its success. Despite a plethora of obstacles, bridges and roads were rebuilt and access to isolated communities was re-established. Many of the lessons learned regarding operations are more applicable to ongoing operations than emergency operations. What follows are a few recommendations for improving operations in an emergency response.

Recommendations for Improving Operations

9.1. Develop a procedural "Emergency Design Manual" for use by both state and local forces when re-establishing slide slopes for river banks in an emergency (mid-term).

9.2. Clarify the level of civil engineer testing and documentation expected in emergency response efforts. There was some ambiguity as to the level of testing and documentation that was required of those teams constructing new roads. This led to slightly different processes and priorities in the two ICCs. Clarifying expectations will help standardize ICC procedures (short term).

9.3. Better utilize technology for gathering and sharing information immediately after the emergency. One option would be having a designated crew survey damage via helicopter (or using a state airplane) and stream video to the situation room so discussion and decisions about repairs could be made instantly by qualified people. Satellite imagery and LIDAR technology should also be considered for appropriate application. In addition to getting better information this would also add another layer to the prioritization of roads—not only prioritizing based on the importance of the route, but also on the ability to get them open quickly. Waiting for information from scouts was time- consuming and less useful than a video stream would have been (short term).

Improving Ongoing Operations

"The future ain't what it used to be" Yogi Berra

General Comments About Ongoing Innovations at VTrans

As the agency's response to Irene demonstrated, new ways of doing business have great potential to increase efficiency and effectiveness. While much of VTrans' ability to accomplish what it did can be attributed to having permission to sidestep the planning, right-of-way and permitting process, the value of the new business practices developed during Irene cannot be minimized and must be leveraged.

Incorporating innovative practices into ongoing operations has two advantages. First, it allows the agency to reap ongoing gains in efficiency. In an era of limited budgets, we believe that all possible ways to improve efficiency should be explored. Second, when innovative practices are incorporated into ongoing operations, the need to learn new processes in emergencies is minimized. (For example, if electronic signatures, paperless systems, and iPads had been used on a daily basis, the emergency response would not have needed to fine-tune these new systems).

We believe that the major ingredients that fostered scores of innovative approaches during the Irene response were 1) the use of cross functional teams that minimized silo thinking and encouraged everyone focus on larger goals; 2) the infusion of young, tech savvy talent; 3) empowering staff to make more decisions without seeking permission; and 4) a level of urgency that opened employees to trying innovative approaches.

To incorporate innovative practices moving forward VTrans will need 1) people willing to champion and test ideas; 2) the capacity to design (map) new business processes; and 3) the ability to develop policies and governance that support the new, innovative practices.

While we believe that there is great potential to improve business practices at VTrans, without knowing which innovative practices people are willing to champion, it is hard for us to recommend priorities. In general, our guidance would be to test or pilot as many innovative practices as staff is willing to try out, then measure the results and make decisions based on those results.

High-Level Recommendations for Ongoing Innovation at VTrans

10.1. Increase the use of cross-functional teams within the agency (short term).
10.2. Consider the need to increase capacity in documenting new processes (short term).
10.3. Prioritize integration and strive to improve working relations with other state agencies (short term).
10.4. Commit to continual learning and innovation and consider developing a team to vet innovative ideas and encourage anyone willing to champion an idea to submit a request for innovation (short term).

Process and Workflow

The Irene response included many process and workflow changes that dramatically reduced project delivery times. For example, videos of damaged bridges were streamed to engineers in Montpelier who then e-mailed plans back to the site within hours; cross-functional teams worked together to solve complex problems using everyone's diverse expertise; electronic signatures were used, reducing the time it took to process new contracts; and the use of paper was reduced. Most of the new business processes developed reduced project delivery time and many of these processes should receive strong consideration for use in ongoing operations.

Research on different organizational structures clearly indicates that when different functions work together on cross-functional or product teams, innovation increases, products are delivered more quickly, communication improves, and conflict is reduced. One employee responding to our survey validated this research when he wrote, "The 'team' approach worked extremely well. People pulling together for a common cause, created a very supportive working atmosphere and work was completed quickly, seamlessly and a sense of accomplishment was the end result".

Research also shows that cross-function structures have a downside, however. This downside includes a tendency to give less attention to formal procedures (for example, IT might be more likely to bend a policy designed to ensure security to accomplish the overall project goal); functions tend to lose specialization (for example, if HR is embedded in each district, these staff members will tend to be generalists and not specialize in benefits or recruiting); and some economy of scale is lost[9]. While we are not in a position to weigh the pros and cons of these different structural approaches at VTrans, research demonstrates that innovation is much more likely to occur with cross-functional teams. While there are many ways to accomplish the increased use of cross functional teams, a few people we spoke with suggested that all projects over a certain dollar amount be assigned an engineer, an operations person, an administrative person, and someone from ANR. These teams could increase ongoing efficiency and begin to establish processes to be used in future emergencies.

Additionally, VTrans employees said that the innovation with the most potential impact to improve ongoing operations was streamlining the permitting process. While everyone knows permitting is essential, many people thought it has become too burdensome and frequently leads to long bureaucratic delays. Because VTrans is dependent upon the permitting processes of other agencies, it would be ideal if these processes, as well as the agencies, were reviewed for opportunities for improvement. While reviewing of the processes of other agencies is beyond VTrans' span of control, we strongly encourage the agency to work to improve integration with other agencies so that solutions to inter-agency permitting issues can be found.

We applaud the agency for its ongoing work to redesign processes. However, some people we spoke with thought more could be done. In addition to wanting to streamline the permitting process, employees also spoke to the desire to streamline the design process (especially when federal dollars are not being used) and the contracting process. One employee exemplified this opinion, saying that the agency should "Expand the current process workflow improvement efforts beyond documentation and deploy it at the task level".

Redesigning processes can be burdensome but it can also yield huge returns on investment. In order to minimize the initial investment of time, we recommend targeted, high-level process redesign work as a

---

[9] Walker, A., & Lorsch, J. (1968). Organizational choice: product versus function. In J. Shafritz, Ott, J., & Jang, Y., *Classics of organization theory* (pp. 208 – 218). Belmont, CA: Wadsworth.

starting point. When assessing processes for potential redesign, some questions we encourage clients to ask are:

- *Are there too many actors?*
- *Are there too many handoffs or a lot of movement across different functions?*
- *Are there non-value-added steps or non-critical steps holding up the main flow?*
- *Is there an obvious bottleneck?*
- *Are there clear process owners at all times?*
- *Are there many return loops indicating mistakes, incomplete work, duplication of efforts, or excess verification of standards?*
- *Are errors identified early in the process?*
- *Do problems get all the attention while the majority of the work waits?*
- *Is the process "one size fits all", resulting in excess documentation for simple cases?*
- *Is the process undocumented, leading to each individual or area doing it their own way?*
- *Is there poor collaboration across organizational boundaries, as in "We're working at cross purposes"? This often results from local or internal measures as opposed to process-oriented or customer-oriented measures that focus on outcomes, not tasks*[10].

Finally, in thinking of process, one of the things that helped get the job done during the Irene response was forming "task groups" that were given clear priorities and encouraged to work as hard as they could on one challenge until it was solved. This approach is in contrast to the typical approach of forming a committee which gets busy with other work and frequently loses focus. When addressing issues in the future, the "task group" approach with clear priorities, goals, deadlines, and increased accountability will increase the likelihood of high-priority work being accomplished. In light of this, we also suggest assigning a task team, perhaps with external support, to implement the recommendations in this report.

Recommendations for Improving Ongoing Processes and Workflow

11.1. Work to streamline the permitting process (start in the short term with hope of completing work in the mid-term).

11.2. Evaluate other processes for the need to streamline. This work should include continued revamping of the Right of Way (ROW) and contracting processes, exploring ways to streamline the design process (perhaps by keeping more design work in the districts and using processes with less documentation when federal dollars are not being used), and evaluating other processes that employees think could be more effective (evaluate in short term, commit to redesign in the mid-term).

11.3. Consider the use of a rotation program for interagency cross-training. This, like cross-functional teams, could mitigate the negative impact of silo thinking and add capacity to critical positions in emergencies (mid-term).

11.4. Move away from committees towards the use of "task groups" to work on all high priority projects (short-term).

[10] Taken in part from Sharp and McDermott, *Workflow Modeling*. Artech House, Boston: 2001.

11.5. "Consider changes to how Maintenance of Record Drawings are handled within VTrans. During the emergency repairs, there was one person assigned to a consulting team (Green International) who could be contacted to help find record plans and other additional existing information about the structures and roadways being inspected, enabling contractors to know whom to contact when drawings from VTrans were needed. Under typical design projects, record drawings are obtained through VTrans Project Managers, a task that can be burdensome to them. It would be beneficial to have a specific contact at VTrans who acts as a custodian of all the record drawings. Those who want record drawings can contact this custodian to acquire them. Rhode Island and Massachusetts have a custodian and a room to keep all their record drawings (mid-term)"[11].

11.6. Increase use of outside hired flaggers to allow for larger work crews and to ensure skilled workers are operating at full capacity. Additionally, consider establishing a statewide MRA for traffic control. This MRA could be used by all districts (short-term).

11.7. Continue to work toward a common utility map that provides Utility District coverage (telephone, power, cable and other utilities) (mid-term).

11.8. Continue to fast-track high-priority projects and increase use of the Accelerated Bridge Project (ongoing).

11.9. Close roads more frequently and promote road closures to do work more cheaply, safely, and quickly (short-term).

11.10. Assign a task team, perhaps with external support, to implement the recommendations in this report (short-term).

Integration within VTrans and with Other State, Municipal and Federal Agencies

The *Irene Recovery Report* stated that "The success of Vermont's transportation-related response to Irene is due in equal parts to the talented and dedicated staffs at multiple state agencies, as well as an unprecedented level of partnership and collaboration both outside of and within state government."[12] The report goes on to say that "making government more effective and flexible to the changes ahead will require an increased ability to tear down the 'silos' of state government."[13]

The *Irene Recovery Report* suggests a few specific agencies for VTrans to increase collaboration and partnerships with, including ANR, RPCs, the Department of Tourism and Marketing, the US Army Corp of Engineers, FEMA, and FHWA.[14] To this list, we would add the state police, Building and General Services, and the utility companies as key partners with whom increased collaboration is necessary. Additionally, internally VTrans needs to promote integration of processes, especially prioritizing the integration of data. To accomplish this, time must be dedicated to forming and building relationships with internal and external partners so that different perspectives and shared goals can be discussed.

[11] Ishikura, Ko. Emergency Repairs Assessment Memo. Emailed to Al Neveau January 20, 2012, 2:16 pm. Unpublished.
[12] Lunderville, Neale. *Irene Recovery Report: A Stronger Future*. Unpublished report written for the Governor of Vermont. 2012. P. 45
[13] *Ibid*, P. 45
[14] *Ibid*, P. 46

Recommendations to Improve Integration

12.1. Establish point people for initiating meetings with each of the above-mentioned partners. The point person for each group should be responsible for working with the key partner to identify common goals, identify challenges to meeting those goals, and develop solutions to increase effectiveness with each group (short term).

12.2. Form a task group, including IT and end users, assigned to develop a system(s) for standardizing data collection and data integration. Solutions need to be developed so that databases (NBIS, MATS, and BIZ) are seamless and work together (short term).

12.3. Increase contact between ANR and agency project managers and excavators, perhaps by having ANR conduct half-day trainings on river science a few times a year (short term).

12.4. The General Manager in District 2 is considering improving integration by inviting all project stakeholders to the district once a year for a site visit. The goal of the visit would be to have all parties agree in principle on a design plan. We recommend encouraging this new approach and tracking its progress (short term).

Communications

In most agencies the size of VTrans, communication is a challenge. The increased use of cross-functional teams, discussed above, should improve communication. Additionally, the agency might consider using the ICS approach of identifying communication specialists when conflicts arise. If all communication flowed through these specialists, communication could improve. The one drawback to implementing this communication protocol is that it would require clear communication processes and a cultural change so that people would respect the new processes. While the process could be designed and implemented, ensuring staff discipline in using it would be less than certain.

Recommendations to Improve Communication in Ongoing Operations

13.1. Consider the use of "communication specialists", similar to those used in the ICS, for ongoing conflicts and crisis management (mid-term).

Information Technology

As became evident during Irene, there are many ways that technology can contribute to ongoing agency innovation. As we stated above, in order to implement innovation into ongoing operations the agency will need 1) champions who are end users (as opposed to IT) willing to pilot and test new ideas; 2) the capacity to design and map the new processes; and 3) the ability to develop policies and governance structures for the new processes. If these three ingredients are in place, many IT innovations are possible at VTrans. The agency's general IT department and the operations divisions' IT leaders were very open to and excited about new IT possibilities when we spoke with them. However, others (champions, processes designers, and policy makers) will have to step forward for these innovations to be tested and evaluated. The following list of recommendations should be prioritized based on the level of enthusiasm and interest from VTrans employees.

Recommendations to Innovate VTrans IT Processes

14.1 Incorporate the use of GPS data cameras, iPads, smart phones, smart tablets, and other new technology in all operations. This technology should be embraced by all divisions and training and support provided. As a first step, begin to place new technology that was useful in the Irene response into the hands of those who could benefit from it. The transition to GPS could be especially useful as it is more aligned with other state government systems (i.e. safe dig, state police) while also standardizing site naming conventions.

14.2 Continue with the development and update of new series maps, such as bridge and culvert maps.

14.3. Continue the use of electronic signatures and expand their use beyond MRAs.

14.4. Eliminate paper whenever possible. Track people, equipment, materials, rooms, meals, and inventory through a database. The database could become the control point for generating all tracking information and reports.

14.5. Districts need people able to provide first-line IT support and who can support new technology. District IT specialists need to be better utilized in all districts.

14.6. Stay engaged in social media in an ongoing manner. This will require someone to manage the content and clear policies governing its management.

14.7. During the Irene response, detailed, routine bridge inspection information was not readily available and was not always provided to contractors prior to their site visits. Consider the use of a bridge information database (such as PONTIS or 4D) so that such information can be obtained through the web by anybody with prior approval by VTrans.

Operations

Incorporating innovations into ongoing operations has the potential to greatly improve organizational efficiency and effectiveness. Many of the recommendations we collected regarding innovations in ongoing operations relate to design changes, prevention procedures, and new operations practices. Additionally, creating a culture that is less risk-averse and finding ways to recruit more tech savvy youth surfaced as important long-term goals.

Many prevention suggestions we heard were thought to be easily incorporated and relatively low cost. Incorporating considerations regarding flooding into bridge design criteria and increasing the use of riprap on river banks were two such items. Additionally, Tom McArdle noted that, typically, culverts and bridges are frequently undersized resulting in their inability to carry high debris loads. Many points of failure occur on small, intermittent streams that are "typically out of right-of-way on private property where funding assistance is not available. Left unchecked, repeated damages are likely. Montpelier has now 'intervened' in three channel stabilization projects which proved beneficial in preventing repetitive damages."[15] More selective intervention/prevention work to stabilize streams, Tom believes, is needed.

Risk tolerance also emerged as a theme as we conducted our interviews. Many believed that the fast turnaround time VTrans accomplished in its recovery work could be attributed, in part, to its willingness to take appropriate risks due to the severity of the circumstances. Those we spoke with wondered if it would be possible to change VTrans' culture to make it less risk-averse. One example of this has to do

[15] Email from Tom McArdle to Chris Cochran, February 7, 2012. 4:06 pm. Unpublished.

with the ROW process, which is frequently slow as it attempts to meet everyone's needs and desires. Spending a bit more money up front in ROW negotiations, or sometimes moving forward before a final agreement is reached, might be more cost-effective in the long run than spending agency time and resources haggling over the final price.

As another example of increased risk tolerance during the Irene recovery, employees at all levels felt more empowered to make decisions on their own. One person we spoke with thought it would be more efficient if he could make ongoing decisions about work and priorities and replace the process of asking for permission with a reporting process to inform his supervisor. While we believe the movement towards a less risk-averse culture at VTrans would improve efficiency[16] and morale, we also recognize that state government in general, and VTrans specifically, have culturally engrained patterns of operating that will not be changed easily.

Finally, a few people we spoke with noted that much of the innovation that occurred during the Irene response was directly attributed to the infusion of youth into VTrans. While recruiting tech savvy youth has been difficult for the agency, we believe that finding ways to attract, develop and retain youth is critical to ongoing innovation at VTrans. Some of the ideas listed above (incorporating more cutting edge technology into operations, empowering employees at local levels to make more decisions, using cross- functional teams, and mitigating state agency integration issues) should help with recruiting and retention. While we realize that other obstacles remain, one of the easiest ways to promote outside–the-box thinking is to hire new people who have not been "in the box" very long.

These and other recommendations, mostly related to changes in the design process and operations practices, are listed below.

Recommendations to Promote Innovation During Ongoing Operations –General/Prevention

15.1. Work to recruit and retain young talent (long-term).
15.2. Promote selective stream stabilization—even when prevention work is needed is on private property (mid-term).
15.3. Work to create a less risk-averse culture (long-term).

Recommendations to Promote Innovation During Ongoing Operations –Design Related

16.1. Include ability to withstand flooding in bridge design criteria (short term).
16.2. Revisit riverbank design methodology and consider increasing the use of riprap (short term).
16.3. Simplify design plans. Design plans prepared for consultants during the Irene response did not follow the standard VTrans plan requirements and did not include Drainage and Item Details, Earthwork and Quantity sheets and did not list individual items on plan sheets. These omissions allowed plans to be more quickly and efficiently delivered to VTrans. Minimizing information in the design plans did not affect construction. VTrans should consider simplifying the design plans by omitting some of the repetitive information currently required to be shown on all VTrans plans. This change would allow faster and more efficient delivery of plans by design engineers.

[16] Simon, H., The Proverbs of Administration (1946). In J. Shafritz, Ott, J., & Jang, Y., Classics *of organization theory* p. 115. "Efficiency is enhanced by keeping at a minimum the number of organizational levels through which a matter must pass before it is acted upon."

For example, most information shown on Drainage and Item Details and Earthwork and Quantity sheets, and a listing of individual items on the plan sheets, can be found in the estimate and elsewhere in the design documents and may be provided to VTrans as design back-up documents. Simplifying design plans may reduce change orders during construction since there are fewer chances of design discrepancies (mid-term)[17].

16.4. Better utilize Route Logs. Route Logs provided by VTrans helped immensely in finding and identifying structures and their locations. Route Logs should be kept up to date and be made available to all design engineers to ensure that information in the Route Log is fully utilized in the design process (mid-term)[18].

16.5. Design engineers found the procedures provided by VTrans for emergency hydraulic assessment, as well as the Draft Hydraulic Manual, to be thorough and straightforward. An update that brings the Draft Hydraulic Manual up to date with the current bridge manual would also be helpful (mid-term)"[19].

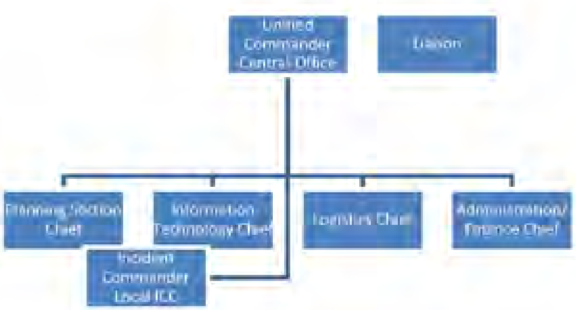
[17] Ishikura, Ko. Emergency Repairs Assessment Memo. Emailed to Al Neveau January 20, 2012, 2:16 pm. Unpublished.
[18] Ishikura, Ko. Emergency Repairs Assessment Memo. Emailed to Al Neveau January 20, 2012, 2:16 pm. Unpublished.
[19] Ishikura, Ko. Emergency Repairs Assessment Memo. Emailed to Al Neveau January 20, 2012, 2:16 pm. Unpublished.

Appendix A: Incident Command Recommended for VTrans

Level 1. A single incident commander at the central office is available for District Administrator's requests for assistance

Level 2. Planning, logistics, and administration/finance chiefs are available to help the Unified Commander meet districts' requests.

Level 3. In this level of ICS activation, the Central Office has a full staff operating under the Unified Commander. There is also a liaison responsible for communicating with various State officials involved in the incident. The Unified Command is available to meet requests from the various local Incident Command Centers established around the State.



Appendix B: Listing of those interviewed[20]

Organization	Name	Title
VTrans	Gil Newbury	Incident Commander
VTrans	Joe Flynn	Incident Commander
VTrans	Scott Rogers	Unified Command - Director of Operations
VTrans	Rich Tetreault	Unified Command - Director of Program Development
VTrans	Ann Gammell	Operations Chief - Rutland
VTrans	Dan Delabreuere	Logistics Chief - Dummerston
VTrans	Susan Clark	Information Officer - Dummerston
VTrans	Rob Gentle	Ops Tech Services
VTrans	Lenny LeBlanc	Director of Finance and Admin
VTrans	Kristin Higgins	Planning Chief - Dummerston
VTrans	Anne Candon	Logistics Chief - Rutland
VTrans	Angela Woodbeck	Administration Chief - Dummerston
VTrans	Morgan Tyminski	Administration Chief - Rutland
VTrans	Marlene Betit	OPS Business Office
VTrans	Marlene McIntyre	F&A Business Office
VTrans	Helen Estroff	PDD Business Office
VTrans	Coleen Krauss	MRA CAT IIIs
VTrans	Alec Portalupi	Ops Tech Services

[20] While the great majority of the recommendations we present in this report come from those we interviewed, we did not agree with every recommendation we heard and therefore this report is not a complete list of suggestions from those we interviewed. Additionally we occasionally used our professional expertise to reflect on suggestions and put them in the context of ICS or organizational theory. Therefore, a few of the recommendations presented are the Task Force's synthesis of ideas we heard.

VTrans	Mike Hedges	Structures
VTrans	Bruce Nichols	General Manager District 3
VTrans	Carl Senecal	Acting Foreman, North Montpelier Garage, Rutland ICC
VTrans	Jonathan Croft	Mapping - Fishbowl
VTrans	Roger Lyon-Surrey	Mapping - Fishbowl
VTrans	Kevin Viani	Mapping - Fishbowl
VTrans	David Hoyne	Construction
VTrans	Nick Wark	Environmental - Hydraulics
VTrans	Mladen Gagulic	Rail
VTrans	Chris Cole	Director of Policy and Planning
VTrans	Tammy Ellis	Operations Chief - Dummerston
VTrans	Chris Williams	Planning Chief - Rutland
VTrans	Rick Howard	Safety Officer - Dummerston
VTrans	Tom Hurd	IT Section Head
VTrans	Wayne Gammell	Maintenance Administrator / Rutland ICC OPS
VTrans	Rick Scott	Mapping - Fishbowl
ANR / DEC	Mike Klein	River Management
	Barry Cahoun	
Army Corps of Engineers	Marty Abair	Senior Project Manager
	Mike Adams	
Federal Highway Administration	Matthew Hake	Division Administrator
	Larry Dwyer	Assistant Division Administrator
	Roger Thompson	
Contractors	Cathy Voyer	AGC
	Roger Gilman	Miller Construction, Inc.
	Craig Mosher	Mosher Excavating, Inc.

	David Markowski	Markowski Excavating, Inc.
	David Renaud	Renaud Bros., Inc.
Consultants	Ko Ishikura, P.E.	Green International
NH DOT	Butch Knowlton	Director of Operations
(Vermont league of Cities & Towns)	Steve Jeffrey	Director
(Regional Planning Commission)	Michelle Boomhower	Director
	Peter Gregory	Executive Director, Two Rivers/Ottauquechee
	Tom Kennedy	Executive Director, Southern Windsor
	Chris Campany	Executive Director, Windham Regional Commission
Buildings & General Services	Mike "Obie" Obuchowski	Commissioner
NE Central RR	Rick Bushey	
VT Rail System	Shane Filskov	Operations Manager, Rutland,
Public Safety	Colonel Thomas J. L'Esperance	
CVPS	Brian P. Keefe	Vice President - Government and Public Affairs
FairPoint Communications	Randy Chapman	
National Guard	Lt Phillip Harrington	
White River Junction Focus Group Attendees		
Michael Orticari	Sal Balzanelli	Paul Stratton
Warren Pratt,	Jeremy Hoole	Dennis Rhoades
Jerold Kinney,	Robert S. Childs	Timothy M. Hold
Chris Bump,	Ervin Ricker	
St. Johnsbury Focus Group Attendees		

Christine Emmons	Dale Perron	John Dunbar
Lance Duquette	Shane Morin	Shauna Clifford
St. Albans Focus Group Attendees		
Dwight Robtoy	Sharon Resseguie	Christine Menard-O'Neil
Hobie Gates		

Rutland Sign up sheet

Name	Title
Alan Neveau	Irene Innovation Task Team
TOM ROBERTS	DIST 3 PROJ. MANAGER - RC PLANNING
Chuck Bashaw	Senior maint worker D-3
Morgan Tyminski	~~AA~~ AOT 03
Ashley Janas	Admin Temp - Irene work
John [illegible]	Tams Newbury
Carl Seneca	Tams North Montpelier
Seth Perry	Southwest Regional Parts specialist
BILL JEWELL	D#7 Tams (Lyndonville)
Randy Thomas	D#7 TAMS (Lunenburg)
Bruce Nichols	D-4 TAMS Rutland
Brian Roberts	D-3 TAMS (Clarendon)
Bob Blair	D-3 Tams mendon
NELSON BLANCHARD	D1 & D3 DTA

Sign Up Sheet Dummerston

Name	Title
Alan Neveau	Irene Innovation Task Team
Joe Ruzzo	District 2 General Manager
Shannon Gilbert	Rockingham TAMS
Steve Parrott	Rockingham TMW IV
Glenn Wilkinson	Dummerston TMW IV
Tom Cummings	Dummerston TAMS
Chad Carey	Chester TAMS
Robert Hale	BMW I
Kevin Richardson	SPFID TMW 4
Dave Davis	TSMW Dumm.
Jonathan Brown	TMW 4 Dumm
John Alexander	Project Manager
Sandra Dixon	Admin
Michael J. Fay	TMW 4

Bennington Focus Group

Bill Center
Auson Mason
Chris Oldham
Ken W. Troumbley
Walt Burdick
Brian Hawley
John A. Sweeney
Scott Moore
Russell Carrier
Wm Loeach Jr
[illegible]
[illegible]
Bonnie [illegible]
Clark [illegible]
Tracey Cassano
Marge Skinner

Sign-up Sheet -
Montpelier

Name	E-mail Address
Helen Estroff	helen.estroff@state.vt.us
Ralf Bullock	ralf.bullock@state.vt.us
Tom Anderson	Tom.Anderson@state.vt.us
Sara Moulton	sara.moulton@state.vt.us
Scott Rogers	scott.rogers@state.vt.us
Johnathan Croft	johnathan.croft@state.vt.us
Bill Farley	william.farley@state.vt.us
Ken Robbie	

WRJ 2/6/12 Hearing Irene - Lessons Learned

1pm

Bill Bress
Michael Ortizari
Sal Balzanell
Paul Stratton
Warren Pratt
Jeremy Hoole
Dennis Rhodes
Jerold Kinney
Robert S. Childs
Darin Bacon
Nelson Daley Jr
Timothy M Hall
Henry Harvey
Chris Bump
[illegible]

Appendix C: Task Force Member Overview

William C. Bress, PhD, DABFT holds a bachelor's degree in biology from C.W. Post College and master's and doctoral degrees in toxicology from St. Johns University. Prior to moving to Vermont, he worked in several clinical laboratories, a crime lab, and medical examiner's office on Long Island. William worked for the Vermont Department of Health from 1985 to 2011 as the State Toxicologist. He has 20 years' experience in emergency response, dealing with Vermont Yankee FEMA exercises and drills. He has also participated in chemical and biological Health Department Incident Command emergency responses. William served for 10 years on the Environmental Protection Agency Acute Exposure Guideline Committee, setting emergency evacuation standards for industrial accidents.

Denise Gumpper is the Agency of Transportation Contract Administration Chief, overseeing the work performed by the Bid Services and Administration Unit; Construction Contracting Unit; Personal Services Agreements Unit; and the Prequalification, Special Agreements, and Grants Unit of the Contract Administration Section. Prior to her move to Vermont this past July, Denise was an attorney in the Contracts Administration Section of the Connecticut Department of Public Works.

Donna Holden provided administrative support to the team.

Greg Hessel, Principal of ReGeneration Resources, is a professional trainer, facilitator, and senior organizational development consultant based in Brattleboro, Vermont. Greg works to help organizations grow, change, and manage conflict. Greg does this by conducting assessments and providing change management, process redesign, conflict management, team building, training, meeting facilitation, and strategic planning services to organizations throughout New England.

Alan Neveau retired after a 39-year career with the Agency of Transportation. Al started his career at the Materials & Research Lab, working his way through positions in Engineering and Planning until being promoted to the Local Transportation Facilities Program Manager. There, Al oversaw the many municipally-managed projects that the agency coordinates. Al's oversight of LTF also included many agency-managed projects such as bike paths, park-and-ride lots, and other capital asset improvements. Recently, Al was asked back to the agency to coordinate some of the financial aspects related to the Irene event.

Appendix D: Glossary of Acronyms

VTrans Acronym Index	
ANR	Vermont Agency of Natural Resources
COE	U.S. Army Corps of Engineers
DDIR	Detailed Damage Inspection Report
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
ICC	Incident Command Center
ICS	Incident Command System
MATS	Maintenance Activity Tracking System
MRA	Maintenance Rental Agreement
ROW	Right of Way
RPC	Regional Planning Commission
SEOC	State Emergency Operation Center
SEOP	State Emergency Operation Plan
SOP	Standard Operating Procedures
SSF	State Support Function
VIPER	VTrans Information Portal for Enterprise Resources
VEM	Vermont Emergency Management
UC	Unified Command

Appendix E: A Summary of Recommendations—Emergency Response

Recommendations	Short Term	Mid Term	Long Term
Recommendations for Incident Command			
1.1. Assign personnel to be Incident Commanders and section chiefs during an emergency.	✓		
1.2. Give those assigned the proper ICS training for their duties.	✓		
1.3. Ensure adequate resources for emergency response. These resources should include a review of communication equipment, ensuring adequate shift coverage for critical positions, determining which roles need to be backfilled during an emergency response, giving key people in the ICCs administrative support to monitor emails and other communication, and considering emergency fleet capacity when purchasing new vehicles.	✓		
1.4. Provide key personnel identified and trained for future ICC duties with state of the art technology (iPads, iPhones, etc.) to use on a daily basis.		✓	
1.5. Write a Standard Operating Procedure for VTrans ICS. SOPs should include standardizing financial processes, clarifying the role of planning, formalizing the role of IT, formalizing communication processes, ensuring that the UC fully utilizes the ICS, and developing a three- tiered system as described above.		✓	
1.6. Learn background experience of all appointed staff team leaders to better understand their talents and ensure that the right people are in appropriate positions in ICS.		✓	
1.7. Think through the physical and geographic issues, including identifying the best locations for ICCs around the state. In our focus groups, those furthest from the ICCs tended to experience the most isolation and feel the most resource-depleted. Additionally, knowing where the UC will be established is critical.		✓	
1.8. Update the VTrans Continuity of Operations Plan to reflect the ICC structure.		✓	

Recommendations	Short Term	Mid Term	Long Term
Recommendations to Improve Internal Integration			
2.1. In emergencies, continue to promote the use of cross-functional teams.		✓	
2.2. Think of ways to better integrate those working on rail lines and the state airport into the emergency operations.		✓	
2.3. Include a VTrans environmental liaison in the ICCS planning.	✓		
Recommendations to Improve External Integration			
3.1. Develop stewardship agreements and memoranda of understanding with key agencies to accommodate emergency response efforts. These agreements should include better definitions of who is responsible for what in emergencies and where jurisdiction lies, and protocols for state personnel to identify themselves in the field during an emergency (short-term).	✓		
3.2. Convene a meeting this summer (before stakeholders forget this event) to allow towns, VTrans, ANR, COE, FHWA, FEMA, VEM, RPCs, and/or other state agencies to discuss the "who's and what's" of responsibility and contacts for any future events.	✓		
3.3. Incorporate the RPCs, ANR, FEMA, and FHWA into ICC planning.	✓		
3.4. Develop protocols for working with key agencies in emergencies including finding ways to identify all state workers in emergencies. Additionally, work to ensure that all key agencies are engaged from day one.		✓	
3.5. Work to ensure that all state agencies use the same districts in an emergency. Having the state police, LEPC, RPCs, and others all conceiving districts' boundaries differently creates confusion. Even if this cannot be achieved, VTrans district lines, because they are irregular and include "fingers", probably should be ignored when thinking of the geographic parameters of the different ICCs (long-term).			✓

Recommendations		Short Term	Mid Term	Long Term
3.6.	As the state public assistance program is transferred from VTrans to VEM, it will be important that VEM (with VTrans support) push FEMA to pay for all eligible activities, including those designed to improve river management and prevent future floods. To this end, a full-time Attorney General assigned to work with FEMA has been identified as a need and should be actively pursued.	✓		
3.7.	Different requirements from FEMA for PA funds and FHWA for ER funds created confusion. Therefore VTrans should work with FEMA and FHWA to explore possible changes to better align the PA and ER requirements (short-term).	✓		
Recommendations for Training				
4.1.	Conduct an annual training in disaster response for staff at all levels. While pre-identified leaders need the most training, those at the front lines also need to better understand roles. Training should include checklists and emergency standard operating procedures (SOPs), especially with regards to how finances are handled. A manual should be developed, possibly with the help of other states that have already written them. Clarity regarding Detailed Damage Incident Reports (DDIRs) should be included in the training manual.	✓		
4.2.	Pocket manuals should be developed for individuals in the ICC units. Each section head (Logistics, Planning, Operation, Finance) would receive a pocket manual. The manual would document who responds, what they do, where they go, and when they do it, as well as FAQs addressing ICC operations.		✓	
4.3.	Use ongoing mini-disasters as a chance to practice and evaluate the skills of potential leaders.	✓	✓	✓
4.4.	If new technology is not incorporated into ongoing operations, develop a plan to support technology used in emergency response.	✓		
4.5.	Clarify the role of VTrans in training key stakeholders, including contractors, towns, RPCs, DPW, and subcontractors.	✓		
4.6.	Incorporate river management principles into VTrans Operation's training institute as one method of institutionalizing river engineering into infrastructure engineering.		✓	

Recommendations		Short Term	Mid Term	Long Term
Recommendations for Contract Administration				
5.1.	Compile a "Contractor Registry" database as described above.	✓		
5.2.	Develop a standardized electronic Contract Processing system as described above.	✓		
5.3.	Develop an emergency administrative packet for use by ICC/UC Administrative Teams that also is available electronically. The administrative packet will include a clear explanation of the invoicing process, the contracting process, the DDIR requirements, the levels of emergency, safety protocols, and the different funding sources for emergency work.	✓		
5.4.	Develop an emergency packet for use by contractors doing emergency work, including the materials listed in 5.3 above.		✓	
5.5.	Develop an "Emergency Waiver" process. When an emergency of appropriate level has been determined and declared by the administration, the waiver would allow a pre-established emergency process to take effect for agencies involved in the emergency response. These emergency processes will have to be defined and developed		✓	
5.6.	Review and standardize the process for paying contractors to ensure more prompt payment.		✓	
5.7.	Explore alternative emergency contracting processes that include, but are not limited to, changes to MRAs.	✓		
Recommendations for Information Technology				
6.1.	Develop an active master distribution list for users of iPhones and cell phones to avoid time wasted hunting for numbers during an emergency. This list could be downloaded by new users in an emergency.	✓		
6.2.	While some staff do not think MATS is ideal for emergency response, others believe that issues with MATS were a result of VTrans' limited capacity to provide support. This lack of support led to bottlenecks,	✓		

Recommendations		Short Term	Mid Term	Long Term
	inefficient use, and frustration. If MATS is used as an agency-wide application, VTrans must increase capacity in, and support for MATS.			
6.3.	Explore the use of cloud technology, including having MRAs and Environmental Permits (Joint ANR and COE) for emergency responders to use in the field that would populate a warehouse and facilitate processing via the Internet so that all parties involved could see pending action items in real time.		✓	
6.4.	Continue to use the Google Maps application in emergencies .	✓	✓	✓
6.5.	Consider storing HR documents, maps, and other ICC contact information in a central place (perhaps on VIPER). This could be accomplished by developing a section in VIPER for emergency information. Email distribution of maps during the response was not experienced as efficient.		✓	
6.6.	Initially, Irene response data was stored in many different places, leading to confusion. Once the R drive was put into use, data storage issues were greatly mitigated. The R drive should be used from day one in emergencies.	✓	✓	✓
Recommendations for Workflow				
7.1.	Develop a process to keep track of equipment lent to contractors.	✓		
7.2.	Develop a process to improve tracking of materials from contractors used on sites. Due to the scale of the sites, tracking materials seemed to be an issue commonly experienced. One process that seemed to help was to have an administrative staff member on site recording materials as they were delivered. Regardless of the specific process or solution, developing a system ahead of time for tracking materials should help ensure accuracy of invoices and help expedite payments to contractors (short-term).		✓	
7.3.	The DDIR process was confusing to those who performed it. There seemed to be a lack of clarity as to who owned this process (ICCs or UC) and not enough training in how the work should be carried out. The agency also seems to lack the capacity to train people in DDIR	✓		

	Recommendations	Short Term	Mid Term	Long Term
	writing, creating a bottleneck and confusion. Addressing the needs of this process will be important to improving future emergency responses.			
Recommendations for Improving Communication				
8.1.	Having neutral observers visit the ICCs worked well and should be repeated	✓	✓	✓
8.2.	Develop internal emergency communication systems and protocols to minimize communication overload and feelings of being micro-managed. These should include clarifying when communication should flow through UC and when VTrans staff could contact the ICCs directly; how communication regarding hiring should be handled in an emergency; who at UC communicates with the ICCs; and who at the ICCs communicates with the UC. Encouraging discipline in using protocols is also important		✓	
8.3.	Work to identify and ensure that the right equipment is on hand in emergencies. This should include the exploration of emergency uses of portable cell towers, an assessment of state radios and cell phones, and an assessment as to the usefulness of VTrans investing in emergency software such as DisasterLand.		✓	
8.4.	Work with partner agencies to develop external communication protocols. At a minimum, this should include clarifying how to best communicate with the towns, how to ensure timely information gets to the Emergency Operations Center (EOC), and how to improve the 511 system.		✓	
8.5.	Develop communication contingencies for emergencies that take out power and cell reception for long periods of time. While this is a worst-case scenario, it is important to spend time assessing options and developing a plan for this contingency	✓		
Recommendations for Improving Operations				
9.1.	Develop a procedural "Emergency Design Manual" for use by both state and local forces when re-establishing slide slopes for river		✓	

	Recommendations	Short Term	Mid Term	Long Term
	banks in an emergency.			
9.2.	Clarify the level of testing and documentation expected in emergency response efforts. There was some ambiguity as to the level of testing and documentation that was required of those teams constructing new roads. This led to slightly different processes and priorities in the two ICCs. Clarifying expectations will help standardize ICC procedures.	✓		
9.3.	Better utilize technology for gathering and sharing information immediately after the emergency. One option would be having a designated crew survey damage via helicopter (or using a state airplane) and stream video to the situation room so discussion and decisions about repairs could be made instantly by qualified people. Satellite imagery and LIDAR technology should also be considered for appropriate application. In addition to getting better information this would also add another layer to the prioritization of roads—not only prioritizing based on the importance of the route, but also on the ability to get them open quickly. Waiting for information from scouts was time- consuming and less useful than a video stream would have been (short term).	✓		

Appendix F: Summary of Recommendations—Ongoing Operations

Recommendation	Short Term	Mid Term	Long Term
High-Level Recommendations for Ongoing Innovation			
10.1. Increase the use of cross-functional teams within the agency.	✓		
10.2. Consider the need to increase capacity in documenting new processes.	✓		
10.3. Prioritize integration and strive to improve working relations with other state agencies.	✓		
10.4. Commit to continual learning and innovation and consider developing a team to vet innovative ideas and encourage anyone willing to champion an idea to submit a request for innovation.	✓		
Recommendations for Improving Ongoing Processes and Workflow			
11.1. Work to streamline the permitting process (start in the short term with hope of completing work in the mid-term).	✓	✓	
11.2. Evaluate other processes for the need to streamline. This work should include continued revamping of the Right of Way (ROW) and contracting processes, exploring ways to streamline the design process (perhaps by keeping more design work in the districts and using processes with less documentation when federal dollars are not being used), and evaluating other processes that employees think could be more effective (evaluate in short term, commit to redesign in the mid-term).	✓	✓	
11.3. Consider the use of a rotation program for interagency cross-training. This, like cross-functional teams, could mitigate the negative impact of silo thinking and add capacity to critical positions in emergencies.		✓	
11.4. Move away from committees towards the use of "task groups" to work on all high priority projects.	✓		
11.5. Consider changes to how Maintenance of Record Drawings are handled within VTrans. During the emergency repairs, there was one person assigned to a consulting team (Green International) who		✓	

	Recommendation	Short Term	Mid Term	Long Term
	could be contacted to help find record plans and other additional existing information about the structures and roadways being inspected, enabling contractors to know whom to contact when drawings from VTrans were needed. Under typical design projects, record drawings are obtained through VTrans Project Managers, a task that can be burdensome to them. It would be beneficial to have a specific contact at VTrans who acts as a custodian of all the record drawings. Those who want record drawings can contact this custodian to acquire them. Rhode Island and Massachusetts have a custodian and a room to keep all their record drawings.			
11.6.	Increase use of outside hired flaggers to allow for larger work crews and to ensure skilled workers are operating at full capacity. Additionally, consider establishing a statewide MRA for traffic control. This MRA could be used by all districts.	✓		
11.7.	Continue to work toward a common utility map that provides Utility District coverage (telephone, power, cable and other utilities).		✓	
11.8.	Continue to fast-track high-priority projects and increase use of the Accelerated Bridge Project.	✓	✓	✓
11.9.	Close roads more frequently and promote road closures to do work more cheaply, safely, and quickly.	✓		
11.10.	Assign a task team, perhaps with external support, to implement the recommendations in this report.	✓		
Recommendations to Improve Integration				
12.1.	Establish point people for initiating meetings with each of the above-mentioned partners. The point person for each group should be responsible for working with the key partner to identify common goals, identify challenges to meeting those goals, and develop solutions to increase effectiveness with each group.	✓		
12.2.	Form a task group, including IT and end users, assigned to develop a system(s) for standardizing data collection and data integration. Solutions need to be developed so that databases (NBIS, MATS, and BIZ) are seamless and work together.	✓		

Recommendation	Short Term	Mid Term	Long Term
12.3. Increase contact between ANR and agency project managers and excavators, perhaps by having ANR conduct half-day trainings on river science a few times a year.	✓		
12.4. The General Manager in District Two is considering improving integration by inviting all project stakeholders to the district once a year for a site visit. The goal of the visit would be to have all parties agree in principle on a design plan. We recommend encouraging this new approach and tracking its progress.	✓		
Recommendation to Improve Communication in Ongoing Operations			
13.1. Consider the use of "communication specialists", similar to those used in the ICS, for ongoing conflicts and crisis management.		✓	
Recommendations to Innovate VTrans IT Processes			
14.1. Incorporate the use of GPS data cameras, iPads, smart phones, smart tablets, and other new technology in all operations. This technology should be embraced by all divisions and training and support provided. As a first step, begin to place new technology that was useful in the Irene response into the hands of those who could benefit from it. The transition to GPS could be especially useful as it is more aligned with other state government systems (i.e. safe dig, state police) while also standardizing site naming conventions.	Prioritize based on ease of implementation and the availability of end users to test and champion		
14.2. Continue with the development and update of new series maps, such as bridge and culvert maps.			
14.3. Continue the use of electronic signatures and expand their use beyond MRAs.			
14.4. Eliminate paper whenever possible. Track people, equipment, materials, rooms, meals, and inventory through a database. The database could become the control point for generating all tracking information and reports.			
14.5. Districts need people able to provide first-line IT support and who can support new technology. District IT specialists need to be better			

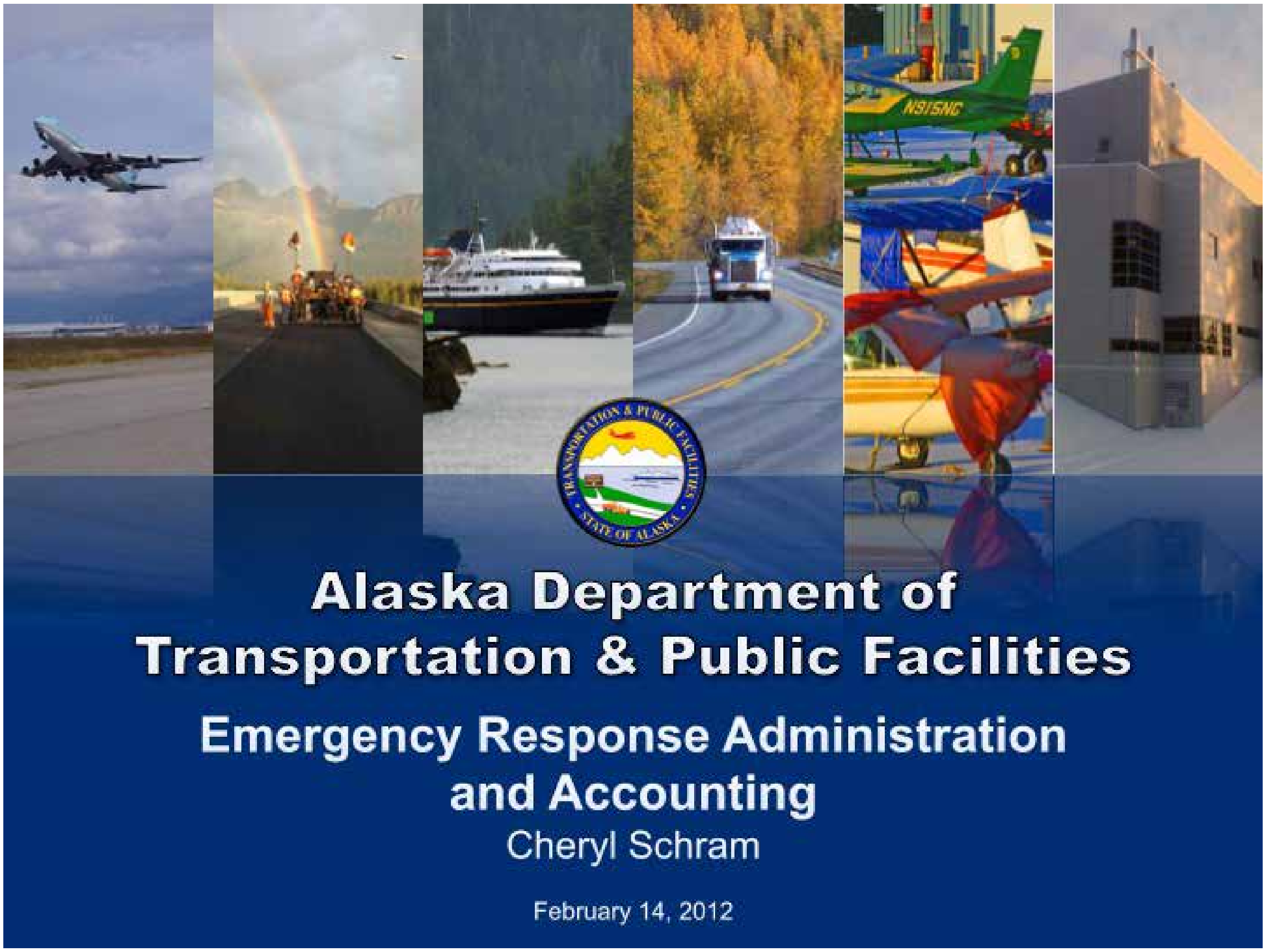
	Recommendation	Short Term	Mid Term	Long Term
	utilized in all districts.			
14.6.	Stay engaged in social media in an ongoing manner. This will require someone to manage the content and clear policies governing its management.			
14.7.	During the Irene response, detailed, routine bridge inspection information was not readily available and was not always provided to contractors prior to their site visits. Consider the use of a bridge information database (such as PONTIS or 4D) so that such information can be obtained through the web by anybody with prior approval by VTrans.			
Recommendations to Promote Innovation During Ongoing Operations -General/Prevention				
15.1.	Work to recruit and retain young talent.			✓
15.2.	Promote selective stream stabilization—even when prevention work is needed is on private property.		✓	
15.3.	Work to create a less risk-averse culture.			✓
Recommendations to Promote Innovation During Ongoing Operations -Design Related				
16.1.	Include ability to withstand flooding in bridge design criteria.	✓		
16.2.	Revisit riverbank design methodology and consider increasing the use of riprap.	✓		
16.3.	Simplify design plans. Design plans prepared for consultants during the Irene response did not follow the standard VTrans plan requirements and did not include Drainage and Item Details, Earthwork and Quantity sheets and did not list individual items on plan sheets. VTrans should consider simplifying the design plans by omitting some of the repetitive information currently required to be shown on all VTrans plans. This change would allow faster and more efficient delivery of plans by design engineers. For example, most information shown on Drainage and Item Details and Earthwork and Quantity sheets, and a listing of individual items on the plan sheets, can be found elsewhere in the design documents		✓	

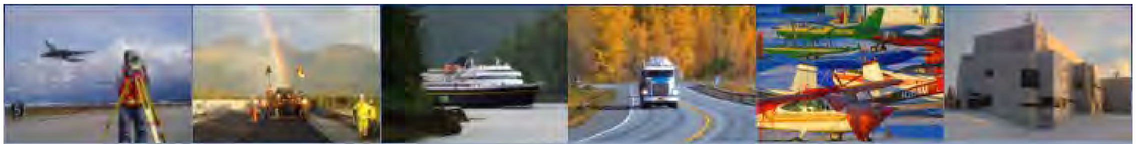
	Recommendation	Short Term	Mid Term	Long Term
	and may be provided to VTrans as design back-up documents. Simplifying design plans may reduce change orders during construction since there are fewer chances of design discrepancies.			
16.4.	Better utilize Route Logs. Route Logs provided by VTrans helped immensely in finding and identifying structures and their locations. Route Logs should be kept up to date and be made available to all design engineers to ensure that information in the Route Log is fully utilized in the design process.		✓	
16.5.	Design engineers found the procedures provided by VTrans for emergency hydraulic assessment, as well as the Draft Hydraulic Manual, to be thorough and straightforward. An update that brings the Draft Hydraulic Manual up to date with the current bridge manual would also be helpful".		✓	

APPENDIX F

Alaska – Emergency Reponse Funding Presentation

Schram, C., Alaska Department of Transportation & Public Facilities Emergency Response Administration and Accounting, Alaska Department of Transportation & Public Facilities, Feb. 14, 2012. (Schram)





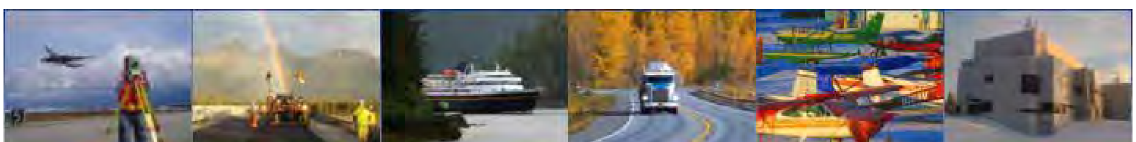
Emergency Response Administration

- State of Alaska, DOT&PF
  - Incident Field Operations Guide/2011 (revision of 2006 original)
  - DOT&PF, P&P - Alternate Procurements **10.01.040**

  Alternate Procurement Methods/Emergency Procurements

  http://www.dot.state.ak.us/admsvc/pnp/assets/chapt_10/10_01_040.pdf
- Federal Aid Highways - Emergency Relief Manual
  http://www.fhwa.dot.gov/reports/erm/
- Federal Emergency Management Agency (FEMA)
  http://www.fema.gov/government/index.shtm
  - Public Assistance Policy Digest FEMA 321/January 2008
  - Public Assistance Guide FEMA 322/June 2007
  - Public Assistance Applicant Handbook FEMA P-323/March 2010
  - 44CFR – Code of Federal Regulations

Integrity · Excellence · Respect 1



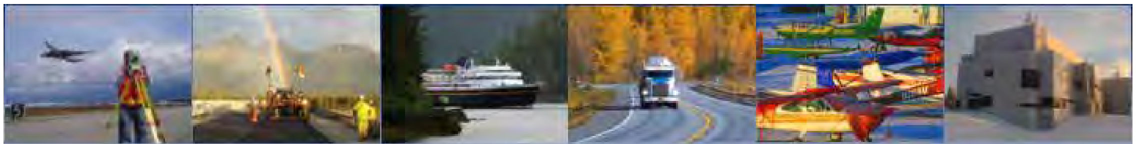
Understanding Thresholds

An Emergency Declaration must be made by the Governor to get State assistance, and by President to be inline for Federal assistance.

FEMA and DMVA Thresholds (Current):
Damage threshold - $1,000 per site/project worksheet
FY12 Small Project: up to $66,400
FY12 Large Project: $66,401 and up

FHWA threshold, only for eligible highways:
- **entire disaster total of $700,000.**
- **$5,000, or more, per site/Project Worksheet**

Integrity · Excellence · Respect 2



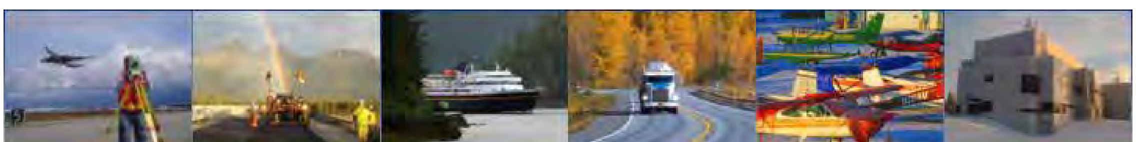
Emergency Project Tracking

From the on-set of the emergency, begin tracking costs daily on Foreman's Daily Reports (FDRs):

- Labor
- Equipment
- Materials

Daily tracking is crucial for reimbursement.

Integrity · Excellence · Respect 3



COST COLLECTORS

- As soon as possible, identify damage sites, to establish collectors and begin tracking costs. Include maps drawn with dimensions.
- Contact Cathy Dallaire, Northern Region Administrative Officer, 451-5286 to obtain coding cost collector codes to record efforts and expeditures by site.
- Damages are to be split out by site.

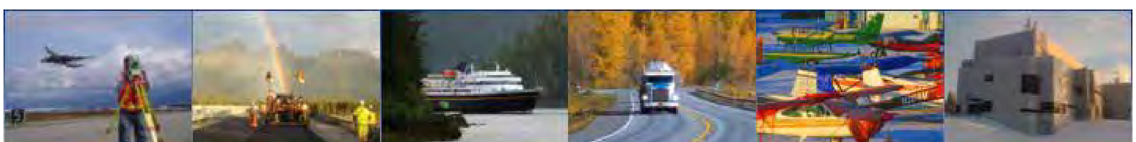
Integrity · Excellence · Respect 4

PHOTOS

Photos are an essential part of documentation and should be taken to document the event and changing phases:

- Emergency event
- Emergency response during the event
- Repairs (both emergency and permanent)
- Completion of temporary repairs
- Completion of permanent repairs to as-built conditions.
- Helpful if each photo has date, and is saved and packaged so the site and location of the photo can be clearly identified.

Integrity • Excellence • Respect 5

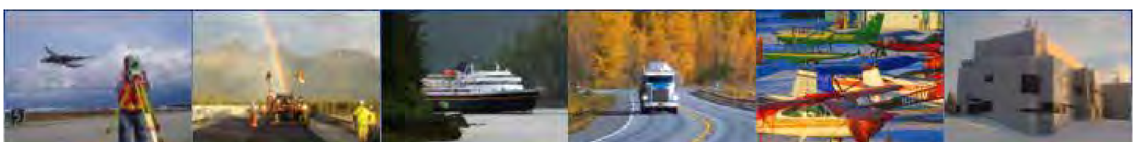


Keystone Canyon Before October 2006 Flooding Event

Integrity • Excellence • Respect 6

Keystone Canyon after October 2006 Flooding Event

Integrity · Excellence · Respect 7



Removing Debris

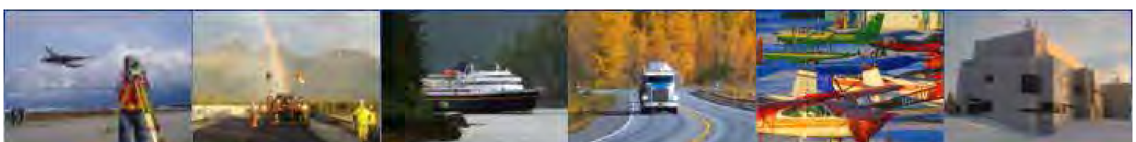
Take pictures of debris and document daily on FDRs and photographs <u>where and how it was disposed</u>, and the <u>total yards removed.</u>

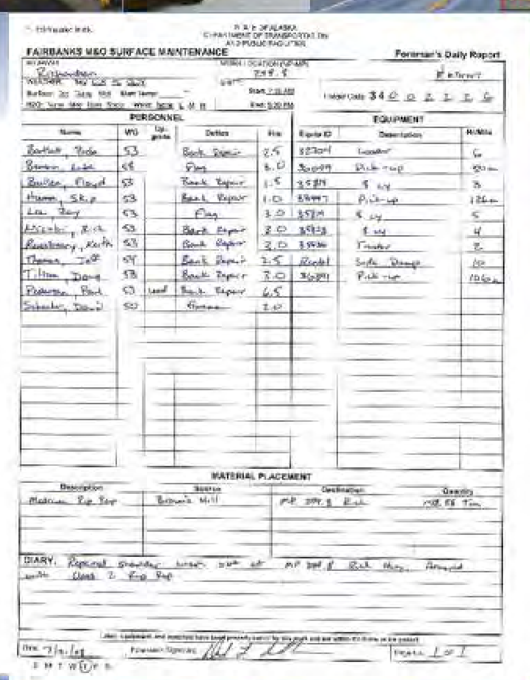
Integrity · Excellence · Respect 8

Foreman's Daily Reports

What is documented on the FDR:

- Date work performed
- Cost Collector identifier (Ledger Code)
- Force Account Labor
- Force Account Equipment
- Equipment matched to operator (Federal requirement)
- Rental Equipment used and for what purpose
- Materials used
  - Total CY
  - Type (aggregate, oil, borrow)
- Diary of work performed
- Maps and Dimensions of work areas





FAIRBANKS M&O SURFACE MAINTENANCE

Foreman's Daily Report

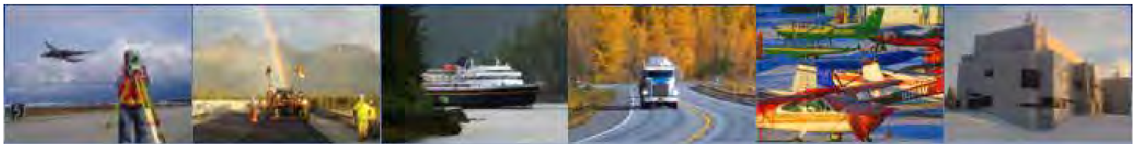
PERSONNEL

EQUIPMENT

MATERIAL PLACEMENT

DIARY:

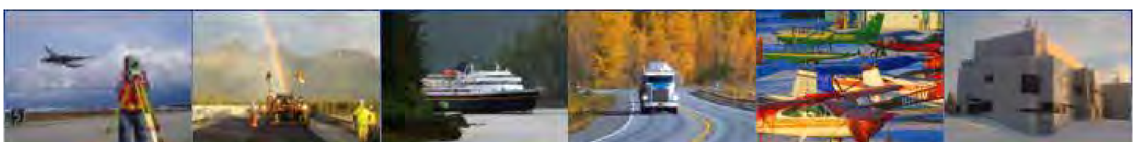
Foreman's Daily Report
FEMA DR-1796-AK 08
Tanana Basin Flooding
PW1 Richardson Hwy
MP 299.8



What is Eligible?

- Construction Engineering (Engineers)
- Preliminary Engineering
  - i.e. hydrologists and designers
- Consultants (Consulting Firms)
- Private Contractors
- Purchase of Materials
- Equipment Rentals
- State/DOT Employees physically working on the job (Operators/Laborers/Flagmen/Foreman)
- State/DOT Equipment

Integrity · Excellence · Respect 11



Additional Clarification Regarding Eligible Items:

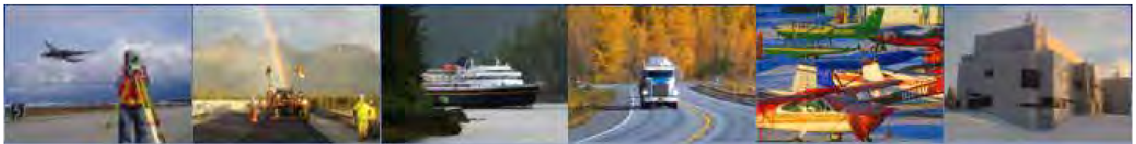
- For FHWA reimbursement, damage and work, has to be on Federal Aid Routes within the right-of-way only (No city or private roads).

- Work is eligible, only to restore to pre-disaster conditions – you cannot improve beyond "pre-existing conditions".

  Example:

  You cannot add a culvert, in an area where there wasn't one, without prior approval from FHWA, FEMA/DHS&EM (considered a betterment).

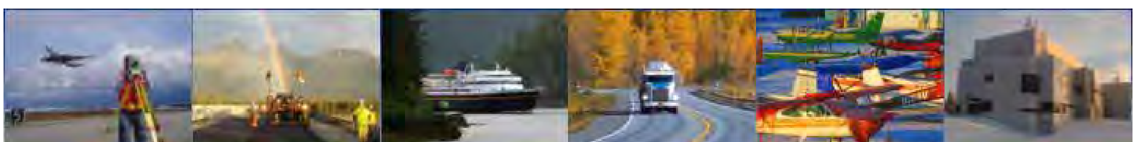
Integrity · Excellence · Respect 12



Non-Eligible Costs:

- Normal maintenance work
- Maintenance administration (Regional Staff, M&O and Other)
- Local costs for State, Local or other Federal agencies
- Overall assessment of the damage; early
- General Supervision – i.e. District Superintendents
- Project planning & scheduling
- Once it snows… ice and snow control is not eligible
- Emergency services, such as ambulances, helicopters (emergency evacuation).

Integrity · Excellence · Respect 13



Where do we send our documentation and backup?

All Northern Region documentation needs to be routed to:

State of Alaska
NR, DOT&PF, M&O Admin
Attn: Cheryl Schram, Accounting Tech III
2301 Peger Rd
Fairbanks, AK 99709

Or: scanned document via email: cheryl.schram@alaska.gov
(CC: ICS Commander & Cathy Dallaire cathy.dallaire@alaska.gov)

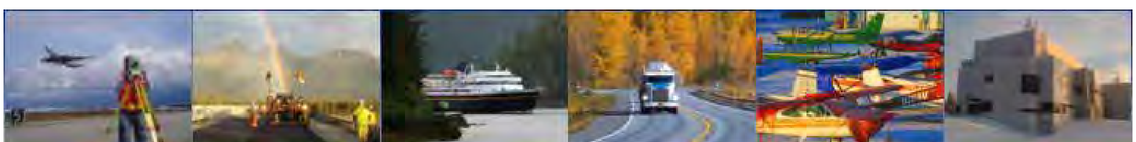
Integrity · Excellence · Respect 14

What documents and backup are needed?

For each site, for the following:

- Employee Timesheets (Hours separated by site collectors)
- Copies of invoices
- Stockpile material (material source listed along with total CY used on each FDR to provide backup for an adjusting journal entry to transfer costs to the cost collector/s)
- Any Materials Testing and the specific tests that were performed.
- Equipment Rental Contracts (showing hourly rates for equipment)
- All travel documentation (TAs, charters, Alaska Airline Receipts, etc.)
- All procurement documentation: (i.e. stock requests, purchase orders and contracts)
- Photos: before (if available), during emergency repairs, after repairs are complete (dated) for both temporary and permanent efforts.

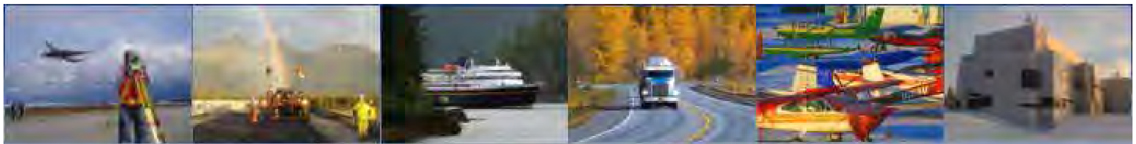
Integrity · Excellence · Respect 15

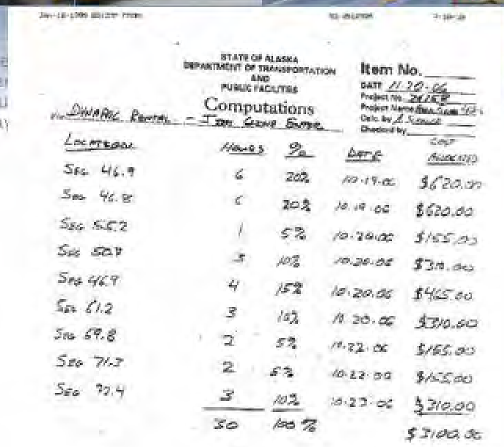


Final Considerations

- If there are specific determinations made that are not obvious, document why the determination was made and submit to the "file". Consider your audience reviewing and/or auditing the project is a non-engineer and are auditing to determine eligibility.
- Submit notes, files, maps, etc.. Anything that will clearly assist in understanding the why/how of what was done.
- In some instances, projects can take many years to get to the audit stage. Key personnel may no longer be available to discuss or review files.

Integrity · Excellence · Respect 16





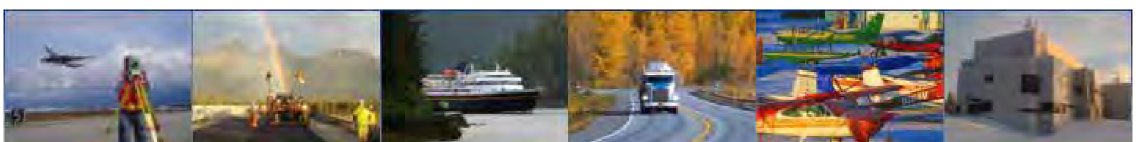
STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND
PUBLIC FACILITIES
Computations

Item No.
DATE 11-20-06
Project No.
Project Name
Calc. by
Checked by

DINAPOLI RENTAL - TON GOING SUPER

LOCATION	HOURS	%	DATE	COST ALLOCATED
SEC 46.9	6	20%	10-19-06	$620.00
SEC 46.8	6	20%	10-19-06	$620.00
SEC 55.2	1	5%	10-20-06	$155.00
SEC 50.7	3	10%	10-20-06	$310.00
SEC 46.9	4	15%	10-20-06	$465.00
SEC 61.2	3	10%	10-20-06	$310.00
SEC 69.8	2	5%	10-22-06	$155.00
SEC 71.3	2	5%	10-22-06	$155.00
SEC 72.4	3	10%	10-22-06	$310.00
	30	100%		$3100.00

Example of split coding computation document clearly defining hours and percentages by site.



Records Retention

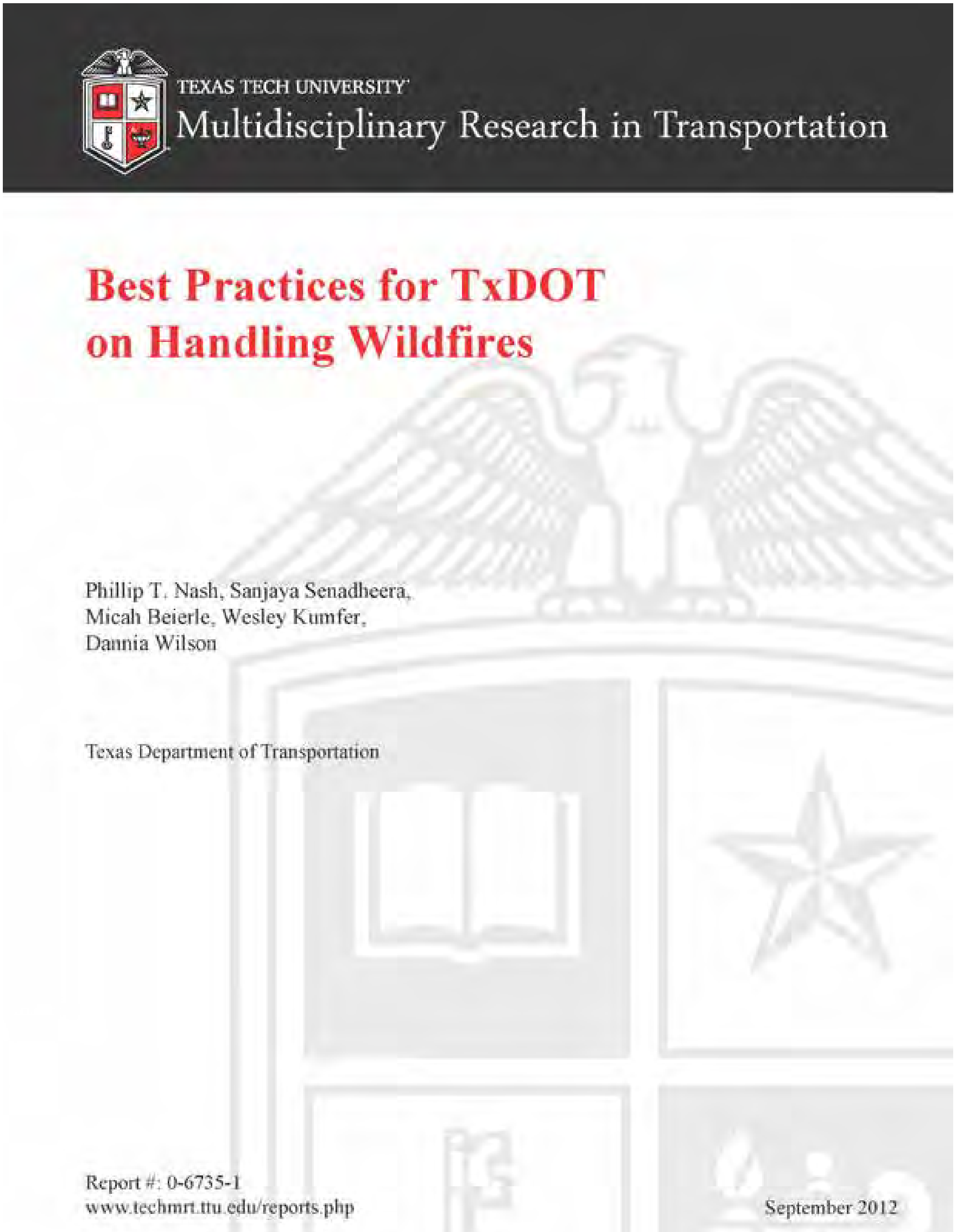
- **Audits can be initiated well after a project is closed. If you are have a Disaster event, even if you closed all of your emergency projects, the primary disaster "log" remains open until all projects related to the disaster are closed.**
- **The retention clock doesn't start ticking until you have received closure paperwork from FHWA/DHS&EM.**
- **Depending on the agency in charge we hold project documents from 3 to 7 years. Note: these timeframes are subject to change. Check with your retention schedule coordinator for current schedules.**


QUESTIONS/DISCUSSION
Integrity · Excellence · Respect
19

APPENDIX G

Texas – Report on TxDOT Best Practices for Wildfires

Nash, P.T., S. Senadheera, M. Beierle, W. Kumfer, and D. Wilson, *Best Practices for TxDOT on Handling Wildfires*, Texas Tech University Center for Multidisciplinary Research in Transportation, Austin, TX, Sept. 2012, 141 pp. (Nash)



TEXAS TECH UNIVERSITY
Multidisciplinary Research in Transportation

Best Practices for TxDOT on Handling Wildfires

Phillip T. Nash, Sanjaya Senadheera,
Micah Beierle, Wesley Kumfer,
Dannia Wilson

Texas Department of Transportation

Report #: 0-6735-1
www.techmrt.ttu.edu/reports.php

September 2012

NOTICE

The United States Government and the State of Texas do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

Technical Report Documentation Page

1. Report No. FHWA/TX-12-0-6735-1	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Best Practices for TxDOT on Handling Wildfires		5. Report Date August 2012
		6. Performing Organization Code
7. Author(s) Phillip T. Nash, Sanjaya Senadheera, Micah Beierle, Wesley Kumfer, Dannia Wilson		8. Performing Organization Report No. 0-6735-1
9. Performing Organization Name and Address Texas Tech Center for Multidisciplinary Research in Transportation Texas Tech University Box 41023 Lubbock, TX 79409		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. 0-6735
12. Sponsoring Agency Name and Address Texas Department of Transportation Research and Technology Implementation Office P. O. Box 5080 Austin, TX 78763-5080		13. Type of Report and Period Covered Interim Report June 2011-September 2011
		14. Sponsoring Agency Code
15. Supplementary Notes Project performed in cooperation with the Texas Department of Transportation and the Federal Highway Administration		

16. Abstract

The State of Texas suffered record-setting wildfires in 2011. More than 30,000 wildfires occurred, burning nearly four million acres. Although not directly responsible for fighting wildfires, the Texas Department of Transportation (TxDOT) provides valuable support during fire-fighting operations. The purpose of this research was to document lessons learned during recent wildfire events and to better define the role of TxDOT in responding to wildfires leading to guidance on best practices. Researchers collected information from a number of agencies responsible for emergency operations during wildfire response, including the Texas Division of Emergency Management, the Texas Forest Service, The Texas Intrastate Fire Mutual Aid System, National Wildfire Coordination Group, and the Texas Interagency Coordination Center. Personnel from ten TxDOT districts were interviewed along with personnel from the Department of Public Safety, Texas Forest Service, Volunteer and Community Fire Departments, National Weather Service, and other City and County Officials. Questions used for the interviews covered categories of preparation, communication, responsibilities, and training. Many common responses were found, although several districts provided unique insights. Lack of reimbursement and concerns regarding safety during incident response were two main themes throughout the interviews. Best practices found during the study were collected, synthesized and presented to TxDOT employees in four regional workshops. These workshops were designed to address safety and effectiveness of TxDOT personnel in efforts to improve response to future wildfires.

17. Key Word wildfire, emergency response, emergency management, preparedness, training, interview, survey		18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161 www.ntis.gov	
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages 152	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

Best Practices for TxDOT on Handling Wildfires

by

Phillip T. Nash, Sanjaya Senadheera, Micah-John Beierle, Dannia Wilson

Research Report Number 0-6735-1

Research Project Number 0-6735

Texas Tech Center for Multidisciplinary Research in Transportation

Texas Tech University

Performed in Cooperation with the

Texas Department of Transportation
and the
Federal Highway Administration

August 2012 **Report 0-6735-1**

Products

This report contains no products.

AUTHOR'S DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view of policies of the Texas Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

PATENT DISCLAIMER

There was no invention or discovery conceived or first actually reduced to practice in the course of or under this contract, including any art, method, process, machine, manufacture, design or composition of matter, or any new useful improvement thereof, or any variety of plant which is or may be patentable under the patent laws of the United States of America or any foreign country.

ENGINEERING DISCLAIMER

Not intended for construction, bidding, or permit purposes.

TRADE NAMES AND MANUFACTURERS' NAMES

The United States Government and the State of Texas do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

Table of Contents

Appendices

List of Figures

List of Tables

CHAPTER I

INTRODUCTION

Project Background

Texas has seen record-setting numbers of wildfires in 2010 and 2011. The maps shown in Figure 1 compare locations where fire ignitions were detected in 2010 and 2011.

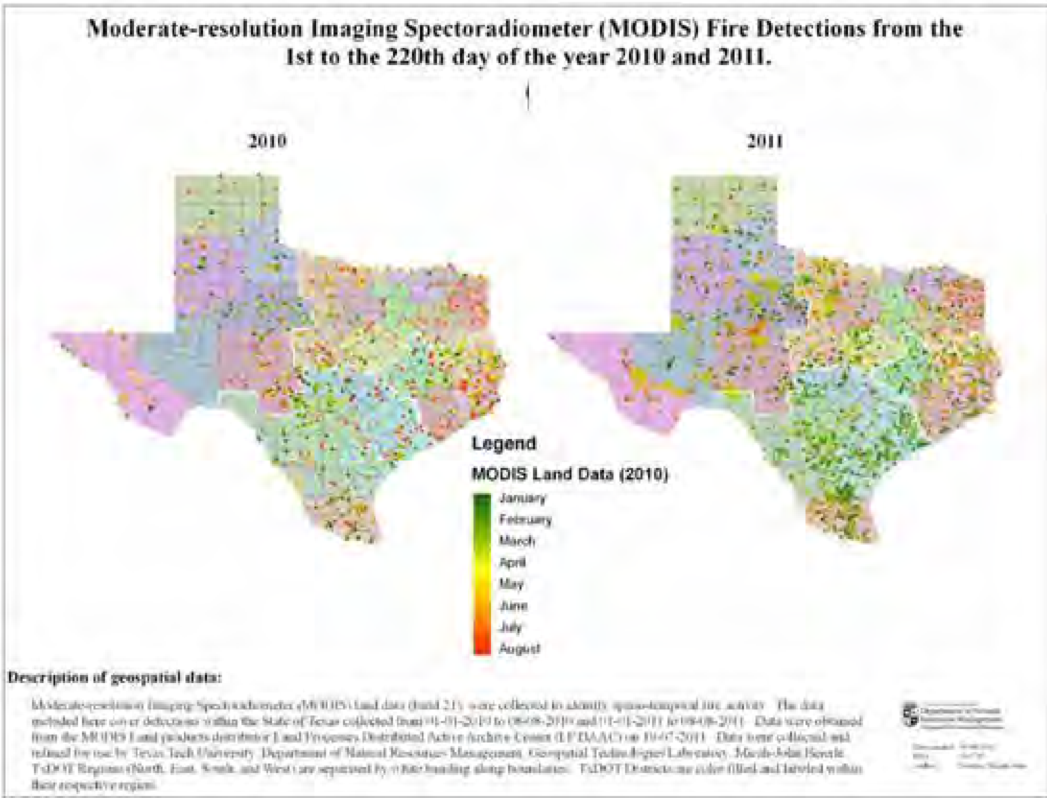


Figure 1. Fire Detections for First to 220th Day of 2010 and 2011

Personnel from the Texas Department of Transportation (TxDOT) are often called upon to provide support in responding to wildfires. In a typical year, the requests for TxDOT support are relatively few. However, the number of requests has increased dramatically over the past few years. TxDOT recently developed a draft Guidance Document for Wildfire Response (Appendix A), but frequently are asked to perform services not specifically addressed in that document. TxDOT decided to take advantage of the recent increase in wildfire response experiences to document the lessons learned from wildfire events and study the role of TxDOT in the mitigation, containment, and response to wildfires. The objective of this research project is to develop a protocol to help TxDOT effectively respond to wildfire situations that may occur in the state, and to present the protocol in the form of "Best Practices" based on information gathered from many sources both within TxDOT and from agencies outside the department. Using the information collected, researchers will develop a training course for TxDOT personnel who deal with wildfire situations and will conduct four regional training workshops.

To accomplish the research objectives, the research team designed a plan to review literature pertinent to wildfire response and to meet with and interview TxDOT personnel from several districts to gather information on their experience with wildfire response. Researchers also met with personnel from TxDOT Maintenance Division Emergency Management Coordinator's Office and outside agencies including the Texas Forest Service (TFS), Texas Department of Public Safety (DPS), the National Weather Service (NWS), Texas Parks and Wildlife Department and local government agencies. The purpose of this interim report is to present information collected during Task 1 of the research.

CHAPTER II

LITERATURE REVIEW

Researchers developed an extensive bibliographic list on topics pertinent to wildfire and emergency response. A review of the key parts of this review is provided below.

Emergency Management in Texas

Researchers reviewed a number of manuals and documents pertaining to the emergency operations associated with wildfire response in Texas. Summary findings for each document reviewed are presented in the following descriptions.

Provisions of the Texas Administrative Code Relevant to Emergency Response

The Texas Administrative Code (The State of Texas, 2011) stipulates the responsibilities and the authority of state and local government agencies to effectively respond to emergency situations. The following key excerpts highlight the important aspects related to emergency management. The full list of emergency management related legislation is provided in Appendix E.

1. Each county and incorporated city in Texas shall maintain an emergency management agency or participate in a local or inter-jurisdictional emergency management agency.
2. The mayor of each municipal corporation and the county judge of each county are designated as the emergency management director for their respective jurisdictions.
3. The mayor and county judge may each designate an emergency management coordinator who shall serve as an assistant to the presiding officer of the political subdivision for emergency management purposes when so designated.
4. The Division of Emergency Management of the Texas Department of Public Safety shall prepare and maintain a state emergency management plan.
5. The presiding officer of a political subdivision may declare a local State of Disaster if a disaster has occurred or is imminent.
6. In responding to emergencies and disasters, a local government agency is expected to use its own resources and the resources available to it through mutual aid agreements (Texas Forest Service 2011c) before requesting assistance from the State. Municipalities must request assistance from their county before requesting assistance from the State.
7. If local and mutual aid resources prove inadequate for coping with a disaster, the local government may request assistance from the state by contacting the local Disaster District Committee Chairperson, who is the commanding officer of the Texas Highway Patrol district or sub-district in which the jurisdiction is located.
8. All local disaster operations will be directed by officials of local government. Organized state and federal response teams and teams from other local governments and response organizations providing mutual aid will normally work under their existing supervisors, who will take their mission assignments from the local incident commander.

Texas State Emergency Management Structure and Operations

Chapter 418 (Emergency Management) of the Texas Government Code (The State of Texas 2011) requires that emergency management in the state be conducted according to an organized government structure. Chapter 421 (Homeland Security) of the Texas Government Code requires that the Governor shall direct homeland security in the state and develop a statewide homeland security strategy.

The Director of the Governor's Office of Homeland Security is appointed by executive order as the Director of the Governor's Division of Emergency Management (GDEM) and as the Chair of the State Emergency Management Council (SEMC). The SEMC includes representatives of each state agency, board, or commission whose functions or capabilities relate to important phases of emergency management. The SEMC has been authorized to issue directives that are necessary to effectively follow the Texas Disaster Act (The State of Texas, 2011). The membership of the SEMC is given below.

- Adjutant General's Department (AGD)
- American Red Cross (ARC) **
- Department of Information Resources (DIR)
- General Land Office (GLO) *
- Governor's Division of Emergency Management (GDEM)
- Office of Rural Community Affairs (ORCA)
- Public Utility Commission of Texas (PUC) *
- Railroad Commission of Texas (RRC) *
- Salvation Army (TSA)
- State Auditor's Office (SAO)
- State Comptroller of Public Accounts (CPA)
- Texas Animal Health Commission (TAHC)
- Texas Attorney General's Office (OAG)
- Texas Building & Procurement Commission (BPC)
- Texas Commission on Environmental Quality (TCEQ) *
- Texas Commission on Fire Protection (TCFP)
- Department of Aging & Disability Services (DADS)
- Department of Agriculture (TDA) *
- Department of Assisted & Rehabilitative Services (DARS)
- Department of Criminal Justice (TDCJ)
- Department of Housing & Community Affairs (TDHCA)
- Department of Insurance (TDI)
- Department of Protective & Family Services (DFPS)
- Department of Public Safety (DPS) *
- Department of State Health Services (DSHS)
- ***Department of Transportation (TxDOT) ****
- Texas Education Agency (TEA)
- Texas Engineering Extension Service (TEEX) *
- Texas Forest Service (TFS)

- Texas Parks & Wildlife Department (TPWD) *
- Texas Workforce Commission (TWC)

* Indicates departments and agencies which are members of the State Emergency Response Commission (SERC), which carries out certain planning, reporting and public information access responsibilities relating to hazardous materials that are mandated under federal law.
** Non-governmental organizations

The SEMC has been organized into Emergency Support Functions (ESF) by utilizing the personnel and resources of SEMC member agencies and organizations. Each ESF is directed by a primary agency selected based on its authority or capability in that particular functional area (Table 1). Several other agencies and organizations are designated for support based on their ability to provide equipment, personnel, and expertise (see Table 2).

Federal ESF #	Function	Primary Federal Agency	Primary State Agency
1	Transportation	Department of Transportation	Department of Criminal Justice
2	Communications	Office of Science & Technology Policy	Department of Information Resources
3	Public Works and Engineering	U.S. Army Corps of Engineers	Department of Transportation
4	Firefighting	Department of Agriculture	Texas Forest Service
5	Information & Planning	Federal Emergency Management Agency	Governor's Division of Emergency Management
6	Mass Care	American Red Cross	The Salvation Army
7	Resource Support	General Services Administration	Texas Building and Procurement Commission
8	Health & Medical Services	Department of Health and Human Services	Department of Health
9	Urban Search and Rescue	Federal Emergency Management Agency	Texas Engineering Extension Service
10	Hazardous Materials	Environmental Protection Agency	Texas Commission on Environmental Quality
11	Food	Department of Agriculture	Department of Human Services
12	Energy	Department of Energy	Public Utility Commission

Table 1. Primary Federal/State Emergency Functional Responsibilities (The State of Texas 2004)

	A - WARNING	B-COMMUNICATIONS	C-SHELTER AND MASS	D-RADIOLOCIAL EMER	E-EVACUATION	F-FIREFIGHTING	G-LAW ENFORCEMENT	H-HEALTH AND MEDICAL	I-PUBLIC INFORMATION	J-RECOVERY	K-PUBLIC WORKS AND ENGINEERING	L-ENERGY AND UTILITIES	M-RESOURCE SUPPORT	N-DIRECTION & CONTROL	P-HAZARD MITIGATION	Q-HAZMAT & OIL SPILL	R-SEARCH & RESCUE	S-TRANSPORTATION	T-DONATIONS MGMT.	U-TERRORIST INCIDENT RESPONSE	V- FOOD & WATER	W-MILITARY SUPPORT	O-RESERVED/FUTURE USE
ACG		S				S			S					S						S	S	P	
ARC			S					S	S	S				S							S		
CPA										S		S		S					S				
GDEM	S	S		S	S	S			P	P				P	P		S		P	S			
DIR		P												S					S				
DPS	P	S		S	P	S	P		S					S		S	S	S		P			
GLO		S							S					S	S	S		S					
TBPC		S								S	S		P	S				S	S	S			
MHMR								S	S	S				S				S		S			
OAG							S		S	S				S									
ORCA										S				S	S								
PUC		S										P		S									
RRC		S							S			S		S	S	S		S					
SAO														S									
TAHC								S	S	S				S	S					S			
TCFP						S			S					S		S							
TDA				S										S							S		
TDCJ		S				S	S	S			S		S	S			S	P			S		
TXED									S					S									
TDH		S		P				P	S					S		S		S	S	S	S		
DSHS		S		P				P	S					S		S		S	S	S	S		
TDADS								S															
DARS								S															
DFPS							S																
TDHCA										S				S	S								
DHS			S					S		S				S							P		
TDI						S			S	S				S	S	S							
TEA			S											S				S					
TEEX		S				S								S	S	S	P		S				
TFS		S				P	S		S	S	S		S	S	S		S			S			
TCEQ				S				S	S	S	S			S	S	P		S		S	S		
TPWD			S	S			S							S	S	S	S	S					
TRC								S						S									
TSA			P						S	S				S						S	S		
TWC										S			S	S					S				
TXDOT		S			S	S			S	S	P			S	S	S		S		S			

Table 2. State Emergency Management Council Matrix of Responsibilities
P = primary agency, S = support agency (The State of Texas, 2004).

State Disaster Districts have been established to divide the state into a number of manageable emergency response/operations areas. These districts parallel the Highway Patrol regions and districts of the Texas Department of Public Safety (Figure 2).

Figure 2. Texas Division of Emergency Management Region & District Map (TDEM 2011)

Each Disaster District Committee (DDC) consists of representatives from each agency/organization in the SEMC, who have regional offices at the Disaster District level. Commanders of Highway Patrol districts and sub-districts serve as DDC Chairs. Some SEMC agencies do not have field offices and cannot provide representatives at all DDCs. DDC Chairs report to the Director of the Office of Homeland Security on matters relating to disasters and emergencies and keep the Director of the Department of Public Safety apprised on all matters as requested by the director of that department. Districts of the Governor's Division of Emergency Management are assigned to each of the Department of Public Safety districts and assist the DDC Chairperson within their assigned areas. Typical state-local emergency management organizational arrangements in the response phase are depicted in Figure 3.

Texas Forest Service Authority, NIMS and ICS

The National Incident Management System (NIMS) consists of standardized framework from which incident command systems (ICS), multi-agency coordination systems, and public information systems are established. The current concepts of NIMS ICS are the same as those of the FIRESCOPE (**FI**refighting **RES**ources of **C**alifornia **O**rganized for **P**otential **E**mergencies) and NIIMS (National Interagency Incident Management System, which is the predecessor to NIMS) ICS from 1973 and 1982, respectively. This framework provides organizational guidance for a wide range of public safety organizations to work jointly in preparation for, prevention of, response to, and recovery from domestic incidences, regardless of cause, size, or complexity (HSDL 2011). NIMS was created in 2003 under the Homeland Security Presidential

Directive-5, also known as HSPD-5. (HSDL 2011). Because of the complex nature of both natural and anthropogenic incidences, the NIMS is designed to be flexible and standardized. Because of this the importance of the incident command system (ICS) is emphasized. The National Commission on Terrorist Attacks upon the United States recommends national adoption of the ICS to enhance command, control, and communications capabilities (HSDL 2011). In any capacity, TxDOT plays a critical role in public guidance during incident occurrence and their active communication and joint organization with multi-agency task forces under NIMS has been highlighted several times during our project.

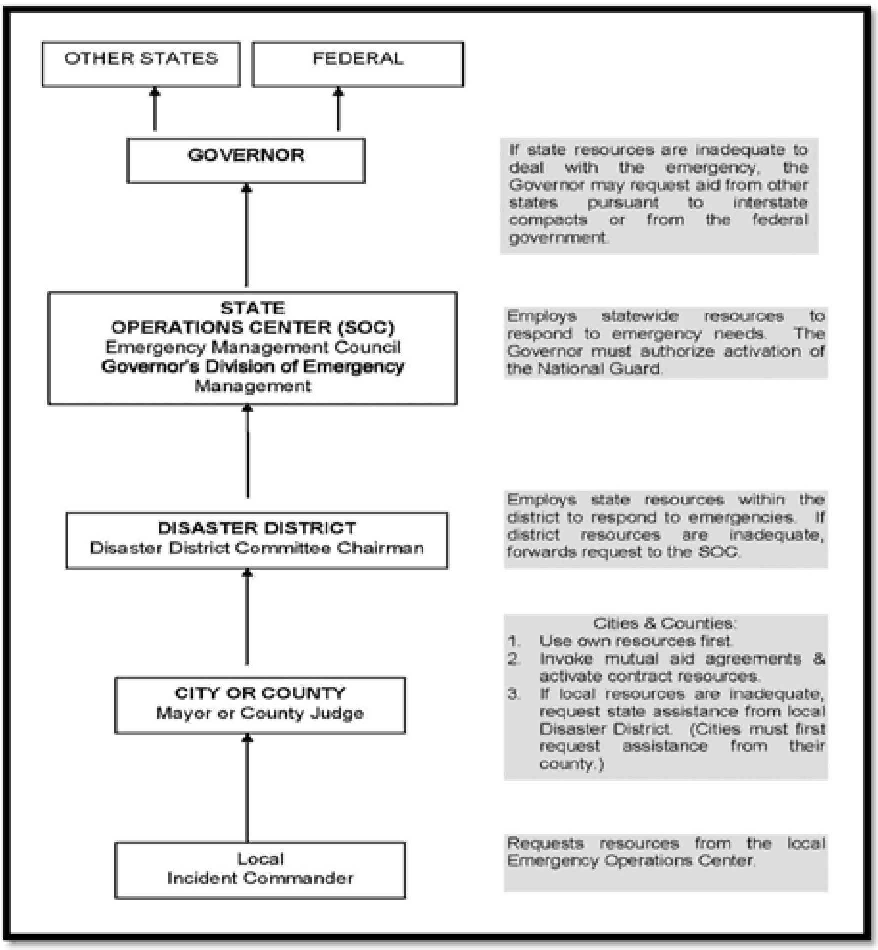


Figure 3. Texas Emergency Assistance Channels (TDEM 2008)

The Governor's Division of Emergency Management and the Texas Department of Homeland Security designate Texas Forest Service as the lead NIMS implementing agency (TFS 2011). NIMS is also the developing agency for Incident Management Teams (IMTs) for the State of Texas (TFS 2011). This responsibility means that once an emergency incident has exceeded a single jurisdiction at the local level and requires the involvement of emergency responders from multiple jurisdictions, TFS has the ability to:

- Deploy IMTs composed of ICS-experienced personnel to manage or assist in management of emergency response operations.
- Provide coordination and controlled infrastructure under NIMS to best manage emergency response.

A common theme has been the joint operations or Unified Command (UC) structure (HSDL 2011, TFS 2011). This structure provides agencies with different legal, geographic, and functional responsibilities to jointly determine objectives, strategies, priorities, resource allocations and needs, and work together to properly execute those needs.
Under NIMS there are five (5) types of incidents rated by complexity.

- Type V incident
  - Response – Initial
  - Resources – one to two
  - Time frame – a few hours
- Type IV incident
  - Response – Initial
  - Resources – multiple
  - Time frame – one operational period
- Type III incident
  - Response – Extended, initial action may fail
  - Resources – multiple
  - Time frame – may require multiple operational periods to resolve
  - Personnel – Some or all IMT command and general staff positions may be activated.
- Type II incident
  - Response – Extended, Complex
  - Resources – multiple
  - Time frame – extends into multiple operational periods
  - Documentation – Requires written action plans, planning meetings and briefings.
  - Personnel – Requiring most of the IMT command and general staff along with their functional staff. Response operations may involve several hundred personnel.
- Type I incident
  - Response – Extended, most complex
  - Resources – multiple
  - Time frame – may require multiple operational periods to resolve

- Personnel – IMT requires all of the command and general staff to be activated along with their functional staff. Response operations may involve thousands of personnel.
- Documentation – Requires written action plans, planning meetings and briefings.
- Public Relations – Management of the incident is often subject to great public and political scrutiny.

The Texas Forest Service is working to develop these management teams across the State of Texas. Currently there are multiple Type III Teams and one Type II Team formed under the Lone Star State IMT. (TFS 2011).

Texas Intrastate Fire Mutual Aid System (TIFMAS)

Texas was one of 10 states involved in the development of the Intrastate Mutual Aids System (IMAS) in 2006 (TFS 2011b). The objective of this movement by fire chiefs was to increase national fire service disaster response capabilities and mobilization using Intrastate Mutual Aid Systems. The Intrastate Fire Mutual Aid System of Texas, also known as **the** Texas Intrastate Fire Mutual Aid System (TIFMAS) is implemented and managed by the Emergency Response Committee (ERC). The ERC is made up of 14 agencies and associations. The State of Texas is divided into 21 geographic regions. Resources within these regions are monitored under the Texas Regional Resource Network (TRRN).

Formal requests from a region or local official are submitted through the normal TDEM channels. These communicational channels are through local to regional DDCs and to the State Operations Centers (SOCs) and to TFS. Once resources are located, TIFMAS coordinators are notified. TIFMAS regional resource coordinators are contacted and regional and local resources are then mobilized. TDEM has the authority to activate TIFMAS directly if resources are needed during any incident response where mutual aid is deemed necessary.

TIFMAS teams are typically Type III IMTs. These crews provide multiple resources over extended periods. They have command and general staff with expertise in incident response and management (TFS 2011b).

National Weather Service (NWS)

Hockenberry (2011) provided a summary of the weather information and guidance resources available that can aid in firefighting. The National Weather Service Instruction 10-401 is a NWS initiative that supersedes the 2009 NWSI 10-401 specification. Its intent is to provide the products and services consisting of the following:

- Digital Forecasts and Services
- Red Flag Warnings/Fire Weather Watches (RFW)
- Spot Forecasts (FWS)
- Fire Weather Planning Forecasts (FWF)
- National Fire Danger Rating System (NFDRS) Forecasts (FWM)

Local applications for forecast products are coordinated with NWS regional headquarters and weather forecast offices (WFOs). Additionally, the National Interagency Fire Center's (NIFC) Geographic Coordination Center (GICC) may coordinate with the WFO and other agencies to produce a Fire Weather Annual Operation Plan (AOP). The National Digital Forecast Database (NDFD) services specific to fire weather have been operational since 2011 for the continental United States. Additional information related to this topic can be found in Hockenberry (2011).

According to Hockenberry's (2011), the *Fire Weather Watch* and *Red Flag Warnings* are created by the Graphical Headline Generator (GHG) software of the Advanced Weather Interactive Processing System (AWIPS). This allows for individual generator and user need specifications to be detailed in the AOP in generating those two outputs. Establishment of regional Red Flag issuance criteria is done by the WFO(s) and land management users in reference to the National Fire-Danger Rating System (NFDRS) and other appropriate fire danger indices. These criteria must be well-documented and made available to WFO forecasters. Forecasters should coordinate with resources listed prior to issuance of a Fire Weather Watch or RFW to ensure accurate information. The *Fire Weather Outlook* prepared by the National Center for Environmental Prediction (NCEP) Storm Prediction Center (SPC) produces narrative and graphical descriptions of 1-day to 8-day outlooks (Hockenberry 2011). These are recommended for use in conjunction with antecedent fuel conditions which favor rapid wildfire propagation in determining large-scale CONUS fire danger risk assessments.

A *Fire Weather Watch* (FWW) is issued 18 to 96 hours prior to the expected onset of high potentials of Red Flag events. Red Flag Warnings (RFW) are issued within 48 hours of impending or occurring conditions consistent with local Red Flag Events. Both FWW and RFW are issued on an event-driven basis. Once criteria have been met for condition expectations to commence, the event begins and continues until the same conditions are expected to end. In addition, smoke Management Forecasts (SMFs) are also issued as needed. Huckenberry (2011) contains in-depth technical descriptions of how issuances should be written and formatted.

Agencies such as TxDOT can request spot forecasts from the regional WMO through the *NWS Spot* web interface. These are non-routine, near-term forecasts consisting of:

- Three forecast periods that detail forecast information as per user specifications.
- General outlooks and extended forecasts can be provided beyond the first three forecast periods when requested.
- A turn-around time of 30 to 60 minutes unless for the next day. Under these conditions it may be delayed due to forecast workload and duty priorities.
- Requests can be up to one day before an anticipated ignition time.

Spot forecasts can be made at http://www.erh.noaa.gov/bgm/fireweather/spotwx.shtml or by calling 607-798-6625. At or before time of a spot request the following information is to be provided:

- Location of response (latitude, longitude)
- Topography and elevation (if needed)

- Requesting official
- Government agency
- Phone number
- Reason for the spot forecast (natural hazard - wildfire response)

As outlined by Hockenberry (2011), TxDOT may request the *Fire Weather Planning Forecast* (FWF), which is, at a minimum, a once daily, zone-type product intended for decision-making related to pre-suppression and other resource planning management. With the spot forecasts producing Today, Tonight, and Tomorrow information, the FWF provides Today (with 24-hour trends), Tonight (with 24-hour trends), Next Day, and 3- through 7- days trends. Fire Weather Point Forecast Matrices are currently available for Austin/San Antonio NOAA regions. These data are fire-specific matrices and can be requested from http://www.srh.noaa.gov/ewx/?n=firewx.htm

The National Fire Danger Rating System (NFDRS) Forecast utilizes NWS next day forecasts to produce course scale Continuous United States (CONUS) fire danger indices. The Nelson model has been recently incorporated to estimate fuel time-lag moistures represented by an "N". There are also Wet Flag and State of Weather (SOW) user editing options denoted as "O" in the outputs. Rangeland/Grassland Fire Danger Statement (Product Category RFD, WMO Header FNUS6i) is a miscellaneous product providing advisory information.

Texas Statewide Interoperability Channel Plan (TSICP)

The following information was obtained from the Texas Statewide Interoperability Channel Plan (TSIEC 2009). This document is a Memorandum of Understanding (MOU) to address the need of clear communication mechanisms during joint operations under the NIMS/ICS systems, including guidance for use of interoperability or mutual-aid radio channels by multiple levels of governance (local, state, federal, and private sector incident response). Specifically the document imposes certain protocols, procedures, and obligations upon those jurisdictions with authorization for use of certain radio channels held by the Texas Department of Public Safety (TxDPS). Day-to-day frequencies recommended to be known by responding TxDOT operators are:

- **Texas Law 1:** analog wideband VHF coordination channel for mobile-to-mobile use by emergency personnel on a scene or incident
- **Texas Law 2:** analog wideband VHF calling channel for mobile-to-base use by transient or en-route emergency personnel
- **Texas Law 3:** national analog wideband VHF channel for coordination of law enforcement activities
- **Texas Fire 1, Texas Fire 2, Texas Fire 3**, analog wideband VHF frequencies primarily for fire service use or for use as dictated by Incident Commander on incidents
- **Texas Medical 1**, analog wideband VHF frequency primarily for use by EMS agency personnel on incidents
- **Texas Air 2,** analog wideband VHF frequency for air-to-ground use with state or federal aircraft only at direction of Incident Commander on incidents.

It is recommended that the TxDOT liaison monitor the Texas Law 2 or the designated interoperability calling channel monitored at the Incident Command Post on major incidents requiring significant aid from TxDOT.

For rural and displaced areas, Temporary Base and Repeater/Mobile Relay Stations might be needed and are permitted by the MOU associated with this channel plan under specified conditions. Note that the channel references are to comply with the Phase 1 CAI digital modulation plan beginning January 1, 2015 as discussed on page 25 of the TSIEC 2009 document. The following Mobile Portable Configurations should be pre-programmed into all radio devices and properly labeled:

Mobile and Portable Configuration					
Label	**Receive**	**Transmit**	**Station Class**	**CTCSS TX/RX**	**Use**
TXLAW1	154.950	154.950	FBT / MO	CSQ Only	Tactical Channel
TXLAW2 (Mobile)	155.370	154.950	FBT / MO	127.3 TX Only	Calling Channel (Mobile & Portable)
TXLAW3	155.475	155.475	FBT / MO	127.3	Tactical Channel
TXFIRE1	154.280	154.280	FBT / MO	127.3	Tactical Channel
TXFIRE2	154.265	154.265	FBT / MO	127.3	Tactical Channel
TXFIRE3	154.295	154.295	FBT / MO	127.3	Tactical Channel
TXMED1	155.340	155.340	FBT / MO	127.3	Tactical Channel
TXAIR2	151.385	151.385	FBT / MO	127.3	Tactical Channel
Mobile and Portable Configuration					
TXLAW2	155.370	154.950	FBT	127.3 (valid through 12/31/12)	For temporary on scene use (typically trailer/command vehicle

Table 3. SIEC VHF 150 MHz Wideband Interoperability Channels [Valid Until January 1, 2013] (TSIEC, 2009)

The Texas Law 1 and 2 channels are designated as multi-discipline, multi-agency public safety interoperability channels for all public safety agencies. These channels can be utilized for multi-incident types and should already be integrated into the TxDOT systems. The TXFires 1-3 and others not listed within this document should be noted and integrated into the TxDOT system for wildfire support response.

CHAPTER III

INTERVIEWS

Researchers contacted and interviewed personnel from twelve TxDOT Districts, TxDOT Maintenance Division, Texas Forest Service and the Department of Public Safety. Two of the TxDOT Districts contacted (Corpus Christi and Pharr) did not mobilize State forces for wildfire response in 2011. The other ten Districts were selected for face-to-face interviews due to their significant levels of mobilization during the 2011 wildfire season. Those districts were Abilene, Amarillo, Austin, Beaumont, Childress, El Paso, Fort Worth, Lubbock, Odessa and San Angelo. A detailed questionnaire presented in Appendix D was used in these District interviews to collect information appropriate for the capture of capturing the District experiences to formulate best practices. In many cases, several districts responded with the same or somewhat similar answers to some of the questions. Rather than repeating the same answer for many districts, *Common Answers* to questions are presented in the following section. Some districts had unique responses to some of questions, and those responses are documented in the section entitled *Unique Answers*. The District responses are presented under the same categories of questions identified in the Questionnaire.

Responses Common to All Districts Interviewed

The following section outlines the questions that elicited common responses from all the Districts.

How are they notified of a wildfire event?
District could not respond to a wildfire event until the DPS called to request assistance. Sometimes the districts receive requests for assistance before the DPS call, and in those cases the districts informed the other individuals or agencies that they must call the DPS to request assistance from TxDOT.

Who within the district receives the official notice?
The Director of Maintenance (DOM) received the official notice.

Chain of command for a wildfire event
The DPS calls the DOM or assistant, who in-turn calls the Maintenance Supervisor (MS) for that section, and they gather a crew. However, some districts contact the District Engineer (DE) and Area Engineer (AE) right away, while others wait.

How are resource utilization requests and approvals accomplished within a District?
The DOM authorizes the request, and the request usually comes in the form of a phone call.

District-to-District Communication
When a wildfire event included more than one district, the best way to handle coordination of the districts was to communicate DOM to DOM. Some stated that a possible improvement to this method of communication is to have only one person in charge who could be the DOM of the district that the fire started in.

TxDOT's responsibilities in notifying the general public regarding wildfire events, and who is involved in preparing and delivering such notifications?
The District public notification responsibilities are limited to the updating of Highway Condition Reports (HCR) and providing appropriate traffic control.

Which agencies use the TxDOT utilized in a wildfire event?
Only TxDOT personnel operate TxDOT equipments. However, fuel was another resource provided to marked vehicles involved in the fire response. In the Fort Worth district, mechanics have worked on other agencies' equipment. The rest of the questions had similar answers, with each district adding or taking away parts.

Other Responses for Each District Interviewed

Not all districts provided the same answers to the questions asked. Answers specific to individual districts are presented below by district, stating the question and presenting the district's unique answer.

Abilene District
What services from TxDOT are requested as part of this notification?
The Abilene district has requests for:

- Dozer (Only one available which is not fit for use)
- Maintainers (about 35 for district)
- Fuel trailers
- Water trailers
- Traffic control
- Pickup trucks

How many such requests are made to your district in a typical year?
Abilene has assisted on 22 wildfire events this year; typically they have less than five per year.

How is a district notified of a Governor's Proclamation or a Federal Disaster Declaration?
Abilene is currently working on their own formal protocol for notification. It relaxes the regulations and clears the way for reimbursement.

What TxDOT office both inside and outside the district but outside the chain of command is involved in the event?
The Abilene district involves their regional office as needed, and sends out a district-wide email to the DE, MS and regional office.

Do you use any forms to collect data at the district level to prepare reports or make reimbursement requests?

The Abilene district uses emails sent to the DOM by sections. The DOM then enters that information into the SharePoint site with a specific task number for each wildfire event.

What mechanisms are currently used to ensure adequate data collection?
Abilene indicated that Maintenance Supervisors need Blackberries to receive urgent e-mail notifications.

Do you conduct advance briefings for the district response team before they leave for wildfire-related activities? How are such meetings conducted and what information is conveyed to participants?
Abilene has a local county standard. They also conduct daily tailgate meetings. Once sent out to a wildfire, the crew goes to the command center for information. The MS or assistant is always present.

Once the fires have been extinguished, do you conduct a formal de-briefing session(s) to discuss lessons learned and to ensure that all action necessary for cost reimbursement is completed?
The Abilene district does not have de-briefing meetings in general. They are held as needed and the county makes that decision.

Once notified of a wildfire, what responsibilities does TxDOT have to notify others?
Abilene has no formal responsibilities except traffic control.

What agencies does TxDOT interact with relating to the wildfire event? Please provide information on such interactions
The Abilene district stated that they deal with the following agencies:

- TFS
- VFD
- County
- City
- DPS
- Local charities
- Red Cross
- USFS
- Media through PIO

What outside agencies does TxDOT interact with routinely in times other than during wildfire events and how often?
Abilene district meets as needed with DPS and TFS.

Are there formal protocols to be followed by TxDOT personnel when contact is made with outside agencies both during and outside of wildfire events?
Abilene does not have a formal protocol. There have been some problems related to trouble finding POC once on fire. The IC is the local fire chief.

What TxDOT resources are typically utilized during wildfire events?
In the Abilene district the following resources are used:

- Dozer (One is available but it is not fit for use)
- Maintainers (about 35 for district)
- Fuel trailers
- Water trailers
- Traffic control
- Pickup trucks

How many TxDOT field personnel are typically mobilized for a wildfire event? The districts were asked to give exact numbers if possible, but they were encouraged to indicate a range if they were not sure.
The Abilene district has four to 10 per shift, and operates on two 12 hr. shifts.

How many TxDOT District employees serve in volunteer fire departments in their locality?
Abilene has an average of two firefighters per county.

Does TxDOT release such firefighter employees from TxDOT duties during wildfire events?
The Abilene district stated that leave can be requested and can be paid through TxDOT.

How often does your District provide fuel to agencies outside of TxDOT that are involved in the wildfire event? How much fuel is typically provided?

- In the Abilene district, fuel is given out at most events. The maximum amount they have given out was at the Nolan county fire and it was $8000. A more typical amount given was for the Kent fire at 500 gallons of diesel and 50 gallons of gas.
- In addition to fuel, does your district provide any other resources to outside agencies to effectively deal with the wildfire event?
- The Abilene district has transported equipment for TFS while waiting for new equipment to arrive at the wildfire event.

Who handles the cost reimbursement requests related to wildfire events within your District?
The DOM is responsible for reimbursement requests.

What is your success rate of reimbursement for expenses incurred for a wildfire response? Indicate separately for different agencies that may be involved
The Abilene district stated that they have not received reimbursement so far, and that TxDOT receives the funds, not the district office.

What additional employee safety-related responsibilities does TxDOT have that are specific to wildfire events?
Abilene instructs employees to protect themselves and not to put themselves in bad situations.

Are TxDOT personnel who respond to wildfire situations provided with adequate safety garments, equipment, and training?
The Abilene district feels that they do not have adequate safety equipment for the roles they have been asked to perform. They need more training and equipment because in recent events

they have come very close to fires (feet away). During one incident, a grader would not start and fire was on three sides of it.

What public safety-related responsibilities does TxDOT have that are specific to wildfire events?
The Abilene district is responsible for smoke-related road closures, blading structures, and traffic safety.

Do you have any advance preparation and readiness protocols to respond to wildfire situations? If so, are they unique to your district?
The Abilene district monitors red flag warnings and gets TFS notifications on fire storm days. They prepare if called in advance. Also, they make sure that the equipment is ready to go at all times.

Do you make advance preparations by monitoring weather, ground conditions or other factors? Please provide details of how conditions affect your decision for readiness preparation.
Abilene utilizes information the TFS sends out. TFS can identify fire weather fairly well.

Provide information about your readiness plans including coordination activities, staging areas, resource mobilization, etc.
The Abilene district stated that they don't have a specific plan. They instruct their employees to know where they are going at all times. A side note that they shared was that cedar trees explode, so they are aware that the danger is great.

Comment on the following existing resources/guidance from TxDOT and other agencies such as TDEM, TFS, FEMA, etc.

- *TxDOT Guidance for Wildfire Response.* Abilene stated that their role needs to be defined and field coordinator breakdowns need to be placed in the document.
- *TxDOT Maintenance Operations Manual.* Abilene would like to address everything in one guidance document.
- *Training courses/modules.* The Abilene district indicated that after TxDOT's role in responding to wildfire events is defined, training needs to be determined. Some suggestions were survival training and TFS-offered training.

What are your suggested improvements to TxDOT wildfire response protocols? Please include topics such as employee safety, training, TxDOT command structure, TxDOT support services, dealing with outside agencies and dealing with the public.
Abilene made the following suggestions:

- DEFINE ROLE
- Protect structures
- Indirect, not direct attack
- Use wisdom and avoid dangerous situations.
- Overcome command breakdown

Amarillo District

What services from TxDOT are requested as part of this notification?
Amarillo has request for:

- Any equipment necessary
- Motor graders
- Trucks
- Barricades
- Fuel trailers
- Front-end loader
- Personnel
- Loading slurry mixture
- Burying livestock
- Traffic control
- Blocking roads

How many such requests are made to your district in a typical year?
The Amarillo district has had approximately 50 requests for assistance in 2011.

How is a district notified of a Governor's Proclamation or a Federal Disaster Declaration?
The Amarillo district was not sure if there is a formal protocol on this topic. Most districts heard about the proclamation on the news or received an email. The Amarillo district stated that the information comes from the Austin office or the State Operations Center (SOC). This facilitates easing of some regulations, opening for FEMA application options, proclamation pays for supervisor overtime, and the fact that TxDOT (State) pays the workers when under declaration and overtime counts toward FEMA application expenses.

What TxDOT office both inside and outside the district but outside the chain of command is involved in the event.
At the Amarillo district the Area Engineer is outside the chain of command.

Do you use any forms to collect data at the District level to prepare reports or make reimbursement requests?
Amarillo communicates through the District Maintenance Office Assistant using the standard notification SharePoint® site maintained by the Maintenance Division in Austin.

What mechanisms are currently used to ensure adequate data collection?
The Amarillo district uses Austin's SharePoint database. This is reported before 2pm the day after an event. One way they make sure that the information is all there is by using time sheets and making sure that fuel goes to designated fire vehicles/equipment.

Do you conduct advance briefings for the district response team before they leave for

wildfire-related activities? How are such meetings conducted and what information is conveyed to participants?
Amarillo generally does not conduct briefings. Personnel are sent to the IC on scene for a briefing.

Once the fires have been extinguished, do you conduct a formal de-briefing session(s) to discuss lessons learned and to ensure that all action necessary for cost reimbursement is completed?
Amarillo did not have any de-briefing sessions in 2011. However, in 2006 they did.

Once notified of a wildfire, what responsibilities does TxDOT have to notify others?
In Amarillo they have none unless ordered to not respond to a wildfire event by the chain of command.

What agencies does TxDOT interact with relating to the wildfire event? Please provide information on such interactions.
The Amarillo district interacts with:

- Major cities within district
- Amarillo
- Counties
- Local Gov
- DPS
- TAHC
- TCEQ
- Utilities
- TFS

What outside agencies does TxDOT interact with routinely in times other than during wildfire events and how often?
The Amarillo district primarily interacts with the EOC of Amarillo and PANTEX.

Are there formal protocols to be followed by TxDOT personnel when contact is made with outside agencies both during and outside of wildfire events?
The Amarillo district contacts the RLO.

What TxDOT resources are typically utilized during wildfire events?
Amarillo uses the following resources:

- Personnel
- Maintainers
- Pickups
- Tractor trailers
- Loaders
- Fuel trailers
- Small tractor loader
- Dump truck

The Amarillo district has had to shut down TxDOT operations to respond to wildfire events before. The shutdown may not be immediate, but they respond as soon as possible.

How many TxDOT field personnel are typically mobilized for a wildfire event?
The Amarillo district has a minimum of two personnel at an event. One example is when the DPS asked for two maintainers, so two operators and a supervisor were sent to the event. Typically what is requested is sent if it is available. However, it is sent with a supervisor/chief to act as the liaison/intermediate with the IC and an additional person for back up to get water, replacement or for support.

How many TxDOT District employees serve in volunteer fire departments in their locality?
The Amarillo district has quite a few, no specific number was given and no estimations. Notation was made that one supervisor is the chief in his area; however, it was not specified that he was a volunteer. It is most likely that he is not municipal or incorporated due to the fact that he is a TxDOT employee.

Does TxDOT release such firefighter employees from TxDOT duties during wildfire events?
The Amarillo district releases TxDOT employees on the honor system.

How often does your district provide fuel to agencies outside of TxDOT that are involved in the wildfire event? How much fuel is typically provided?
The Amarillo district avoids providing fuel to outside agencies, and when it is given, the amount is unknown. They estimate that the amount is low. They bring the fuel for TxDOT equipment only and try not to supply it to anyone else.

In addition to fuel, does your district provide any other resources to outside agencies to effectively deal with the wildfire event?
Amarillo district supplies water with the few small water tanks they have.

Who handles the cost reimbursement requests related to wildfire events within your district?
In the Amarillo district the Office Manager is responsible for reimbursement. To accomplish this they collect and relay reports to Austin.

What is your success rate of reimbursement for expenses incurred for a wildfire response? Indicate separately for different agencies that may be involved.
Amarillo district has not filed for reimbursement.

What additional employee safety-related responsibilities does TxDOT have that are specific to wildfire events?
Amarillo stated that there are no specific instructions regarding wildfire events. There is very little training on wildfires. They recommended best practices and Nomex®

equipment (EOC referenced fire fighter bunker gear a few times. However, bunker gear is for structure firefighting and is not wildland fire gear.

Are TxDOT personnel who respond to wildfire situations provided with adequate safety garments, equipment, and training?
Amarillo district stated NO. None are provided with PPEs but they would like to have access to them. They would like some training on how to respond when equipment fails or becomes stuck.

What public safety-related responsibilities does TxDOT have that are specific to wildfire events?
The Amarillo district stated is responsible for traffic control and public control notification for road closure.

Do you have any advance preparation and readiness protocols to respond to wildfire situations? If so, are they unique to your district?
The Amarillo district stated that although they previously had pre-staging protocols, these were abandoned due to complications involving unpredictability.

Do you make advance preparations by monitoring weather, ground conditions, or other factors? Please provide details of how conditions affect your decision for readiness preparation.
The Amarillo Area EOC sends out Red Flag notices, which are forwarded to a supervisor. However, typically that is all that is done in advance.

Please provide information about readiness plans including coordination activities, staging areas, resource mobilization, etc.
The Amarillo district did not respond to this question.

Please comment on existing resources/guidance from TxDOT and other agencies such as TDEM, TFS, FEMA, etc. you have.

- *TxDOT Guidance for Wildfire Response.* Amarillo district stated that there was not much guidance in the document.
- *TxDOT Maintenance Operations Manual.* Amarillo stated that most supervisors have done ICS through FEMA online training.
- *Training courses/modules.* The Amarillo district indicated that it did not have much guidance.

What are your suggested improvements to TxDOT wildfire response protocols? Please include topics such as employee safety, training, TxDOT command structure, TxDOT support services, dealing with outside agencies and dealing with the public.
Amarillo suggested the following:
District Maintenance Office and DDC has been proactive because they have been tested by numerous fires. They have set things up so they can respond when necessary. The Panhandle Regional Planning Commission (PRPC) has helped the District to get organized.

We could benefit from more assets and training.
District relies on supervisors or operators to know limits or ability of operator and equipment.
Would like to have improved training.
Would like a lot more guidance/training/information.
Effective communication during emergency situations.
Sometimes the State mutual aid channels are not fully utilized before State agencies are called upon, which is how it should be done by the county.
Some fires are too large for channel bands to cross.
Concerns of roots from trees, pipelines are a major hazard, and buried power lines
The cities may have access to maps but getting them to the crews in a timely manner is not always doable.
FIMSA, EXCEL or local coops may have some GIS data layers that could be beneficial but there is no standard GIS structure.
TNRIS may be having something in the future but the district does not know of anything currently in the pipeline.

Austin District

Once notified of a wildfire, what responsibilities does TxDOT have to notify others?
The Austin district said that its notification responsibilities are similar to those of a traffic incident or construction project.

What outside agencies does TxDOT interact with during a wildfire event?
The Austin district interacts with the following agencies:

- Parks and wildlife
- County emergency operation center
- DPS
- TFS
- NFS
- All state agencies
- Bastrop convention center

What outside agencies does TxDOT interact with routinely in times other than during wildfire events and how often?
The Austin district contacts the following agencies outside of a wildfire event:

- EOC
- DPS

Are there formal protocols to be followed by TxDOT personnel when contact is made with outside agencies both during and outside of wildfire events?
The Austin district indicated that their initial protocol when interacting with other agencies is to establish a staging area and cooperatively prepare a situational response.

What TxDOT resources are typically utilized during wildfire events?
During a wildfire event, the Austin district typically uses the following resources:

- Fuel trucks
- Water containers
- Traffic control
- Dozers
- Maintainers
- Water trailers
- Graders
- Fuel trailers
- Message boards

What agencies use the resources indicated above?
The Austin district indicated that only TxDOT personnel use TxDOT resources.

How many TxDOT field personnel are typically mobilized for a wildfire event?
The Austin district indicated that they typically mobilize 30 to 40 people for a wildfire event.

How many TxDOT district employees serve in volunteer fire departments in their locality?
The Austin district indicated that there are no firefighters in Bastrop.

Does TxDOT release such firefighter employees from TxDOT duties during wildfire events?
The Austin district releases volunteer firefighters to work at night.

How often does your district provide fuel to agencies outside of TxDOT that are involved in the wildfire event? How much fuel is typically provided?
The Austin district provides fuel on a basis of what is needed. The district can provide up to 7356 gallons of diesel fuel and 3379 gallons of gasoline.

In addition to fuel, does your district provide any other resources to outside agencies to effectively deal with the wildfire event?
The Austin district provides pumping trucks for pre-wetting and dust control.

Who handles district activities related to cost reimbursement requests on wildfire events?
The Director of Maintenance

What employee safety-related responsibilities does TxDOT have that are specific to wildfire events?
The Austin district has FEMA responsibilities and policies to follow.

Do you have any suggestions to change TxDOT practices for more effective wildfire responses?
The Austin district recommends:

- Better training
- Familiarity with the area
- Awareness of hazards

- PPE
- The ability to deny requests
- Observers paired with dozers
- Better utilization of state resources

Beaumont District

What services from TxDOT are requested as part of this notification?
The Beaumont district was asked for:

- Signs
- Fuel
- 300 gallon fuel tanks
- Traffic control

How many such requests are made to your district in a typical year?
This year is the first year that the Beaumont district has had to assist on a wildfire event, and they have had nine requests.

How is a district notified of a Governor's Proclamation or a Federal Disaster Declaration?
In Beaumont, because this is their first year dealing with wildfires, they have not had to know about the Governor's Proclamation.

What TxDOT office both inside and outside the district but outside the chain of command is involved in the event.
The Beaumont district informs the regional office and the TxDOT Emergency Management Coordinator.

Do you use any forms to collect data at the district level to prepare reports or make reimbursement requests?
Beaumont uses the Wildfire Resource Committed Notes made in Maintenance Sharepoint and emailed to the District Office Manager.

What mechanisms are currently used to ensure adequate data collection?
The Beaumont district uses the MNT SharePoint database. However, they indicated that the information is sent to the Director of Maintenance (DOM) on employees' Blackberry phones.

Do you conduct advance briefings for the District response team before they leave for wildfire-related activities? How are such meetings conducted and what information is conveyed to participants?
Beaumont district conducts tailgate meetings with the crew responding to the event.

Once the fires have been extinguished, do you conduct a formal de-briefing session(s) to discuss lessons learned and to ensure that all action necessary for cost reimbursement is completed?
The Beaumont district has informal supervisor team meetings.

Once notified of a wildfire, what responsibilities does TxDOT have to notify others?
Beaumont states that they are assisting only and have no responsibilities to notify others.

What agencies does TxDOT interact with relating to the wildfire event? Please provide information on such interactions.
The Beaumont district interacts with the following agencies:

- TFS – USFS
- DPS
- VFD
- County

What outside agencies does TxDOT interact with routinely in times other than during wildfire events and how often?
The Beaumont district interacts with the DPS every May for hurricane season.

Are there formal protocols to be followed by TxDOT personnel when contact is made with outside agencies both during and outside of wildfire events?
Beaumont district follows the protocol employed on May 1st for hurricane season.

What TxDOT resources are typically utilized during wildfire events?
Beaumont utilizes only the follow resources:

- Fuel
- Signs

How many TxDOT field personnel are typically mobilized for a wildfire event? The districts were asked to give exact numbers if possible, but they were encouraged to indicate a range if they were not sure.
Typically a three-person team is sent to a wildfire event.

How many TxDOT district employees serve in volunteer fire departments in their locality?
Approximately 10 volunteers.

Does TxDOT release such firefighter employees from TxDOT duties during wildfire events?
The Beaumont district has never had the issue arise before, so they follow standard procedure.

How often does your District provide fuel to agencies outside of TxDOT that are involved in the wildfire event? How much fuel is typically provided?
The Beaumont district gives out fuel every time they get a request. They have given out 600 gallons at large fires. However, 300 gallons is what is typically given.

In addition to fuel, does your district provide any other resources to outside agencies to effectively deal with the wildfire event?
The Beaumont district provides signs.

Who handles the cost reimbursement requests related to wildfire events within your district?

Jeanie Lecklider in MNT is in charge of reimbursement. However, it has been determined that in all fires, the expenses have been less than the minimum threshold set forth by FEMA to file for reimbursement.

What is your success rate of reimbursement for expenses incurred for a wildfire response? Indicate separately for different agencies that may be involved.
Beaumont has had some success when filing for reimbursement on hurricanes. However, they are still waiting for funds on the 2005 and 2008 hurricanes.

What additional employee safety-related responsibilities does TxDOT have that are specific to wildfire events?
The safety-related responsibilities Beaumont districts has are for employees/internal. They have a morning call/briefing every day during a wildfire event. They are instructed to stay out of harm's way, and that they are not firefighters and need to use proper judgment when asked to do things.

Are TxDOT personnel who respond to wildfire situations provided with adequate safety garments, equipment and training?
Extra safety equipment is not needed due to the fact that they are just there to fuel firefighting equipment. However, it would be helpful to have a 4X4 with a winch to pull fuel trailers. The 4X4 pickups would be used when TFS sends crews with TxDOT on trails to fuel equipment that could not make it back to the staging area.

What public safety-related responsibilities does TxDOT have that are specific to wildfire events?
Beaumont district is responsible for signs and traffic control.

Do you have any advance preparation and readiness protocols to respond to wildfire situations? If so, are they unique to your district?
Beaumont has staged "fuel takes" at strategic locations in order to adequately and quickly provide fuel in case of a wildfire event. In Beaumont they have moved the 300 gal fuel tanks to all maintenance yards. They have some 1,000 gallon fuel tanks at the district office but rarely use these for wildfire events.

Do you make advance preparations by monitoring weather, ground conditions or other factors? Please provide details of how conditions affect your decision for readiness preparation.
Since this is the first fire the Beaumont district has assisted with, they have not made any such advance preparations.

Provide information about your readiness plans including coordination activities, staging areas, resource mobilization, etc.
Beaumont does not have any type of readiness plan for wildfire events. However, they indicated that they would check to see if they could send to the TechMRT researchers the hurricane readiness plan.

Comment on existing resources/guidance from TxDOT and other agencies such as TDEM, TFS, FEMA, etc.

- *TxDOT Guidance for Wildfire Response.* Prior to our interview, the Beaumont district had not seen this document. They quickly looked it over and suggested that the central contact person be placed in it. They stated that it looked like just general guidelines.
- *TxDOT Maintenance Operations Manual.* The Beaumont district indicated that all the information would be best in one book and online.
- *Training courses/modules.* Beaumont would like training on FEMA paperwork and filing documentation. Beaumont District has undergone training for hurricanes, and think that there is a need for half-day training statewide for other emergency situations such as wildfires.

What are your suggested improvements to TxDOT wildfire response protocols? Please include topics such as employee safety, training, TxDOT command structure, TxDOT support services, dealing with outside agencies and dealing with the public.
Beaumont had the following suggestions:

- An emergency response manual similar to the hurricane manual would be beneficial.
- Emergency situation training, or at least general guidelines, would be beneficial. During hurricane events people from all over the nation come in for disaster response, so that response is not regional specific. Training for wildfire response may need to be more regional specific.
- Communications need to be better with FS, FDs
- Provide formal protocols for response to wildfire events.

<u>Childress District</u>

What services from TxDOT are requested as part of this notification?
Each district stated that they supply whatever is requested. However, the requested assistance varies by district.
The District has requests for:

- Dozers, bladers/motor-graders/maintainers, trailers, haulers, water trailers
- Personnel
- Fuel (provided only to equipment known to be involved in fire suppression and active fire departments. TxDOT maintains records such as vehicle tag and license numbers of vehicles fueled and no fuel is provided to personal vehicles).
- Signs
- In-kind activities such as transporting fire retardants

How many such requests are made to your district in a typical year?
District personnel stated that they have assisted in approximately 25 wildfires from the last weekend in February to the 20th of July, 2011. However, they have only had a few fuel requests this year.

How is a district notified of a Governor's Proclamation or a Federal Disaster Declaration?
The Districts are not sure if there is a formal protocol on this topic. Most districts heard about the proclamation on the news or received an email. The Childress district did not hear about the Governor's Proclamation regarding a state of wildfire emergency until March, 2011 and it was declared in December, 2010.

What TxDOT office, either inside and outside the district but outside the chain of command, is involved in the event?
The maintenance director and occupational safety division are involved. However, there is no special crew; whoever is available is contacted when fire occurs.

What forms are used to collect data at the district level to prepare reports or make reimbursement requests?
The District inputs entries into the maintenance division database for Austin to file for reimbursement. Also, Childress suggested that a comprehensive and unified database might be useful for record maintenance. Another thing that Childress stated was that the current system is insufficient for what FEMA defines as necessary information.

What mechanisms are currently used to ensure adequate data collection?
The Childress district uses the Maintenance Division's database for resources used. There are task numbers assigned – large fires receive their own task number; small fires are grouped and separated by time stamps.

Does your District conduct advance briefings for the District response team before they leave for wildfire-related activities? How are such meetings conducted and what information is conveyed to participants?
The Childress district conducts an on-site safety meeting but there is no standard protocol for the briefings.

Once the fires have been extinguished, do you conduct a formal de-briefing session(s) to discuss lessons learned and to ensure that all action necessary for cost reimbursement is completed?
The Childress District does not typically have a de-briefing meeting, except for large fires or incidents. However, at the close of season there are large meetings covering lessons learned, safety tips, things to improve upon, what worked and what did not work.

Once notified of a wildfire, what responsibilities does TxDOT have to notify others?
The Childress district stated that it has no responsibility to notify any agencies outside TxDOT.

What agencies does TxDOT interact with relating to the wildfire event?
The Childress District interacts with:

- Department of Public Safety
- Texas Forest Service
- County Officials

- Texas Commission on Environmental Quality
- Utility companies
- Local Fire Departments
- National Weather Service
- Local oil/gas producers

What outside agencies does TxDOT interact with routinely in times other than during wildfire events and how often?
The Childress district routinely interacts with utilities for road closures and traffic control when running cabling across the road.

Are there formal protocols to be followed by TxDOT personnel when contact is made with outside agencies both during and outside of wildfire events?
The Childress district indicated that there is no formal protocol. They go through Incident Command (IC), however access to the IC is sometimes a problem.

What TxDOT resources are typically utilized during wildfire events?

- dozers
- bladers
- motor-graders
- maintainers
- trailers
- haulers
- water trailers
- personnel
- fuel signs

How many TxDOT field personnel are typically mobilized for a wildfire event?
The Childress district indicated that they have 12-15 employees per shift on two 12 hr. shifts per day. There are usually three dozers, three to four motor-graders, and 'a few' pickups, supervisor, operators, and necessary personnel for equipment, plus a few additional personnel in case the situation changes. The maximum number of TxDOT personnel who worked this season's fire suppression was 50 from this district, plus they had an additional 25 at one time from the Lubbock district.

How many TxDOT District employees serve in volunteer fire departments in their locality?
In the Childress district there were three volunteer firefighters present at the interview. There were approximately one to five volunteers per section, with an average of two. Approximately 25 personnel from the entire district are volunteer firefighters.

Does TxDOT release such firefighter employees from TxDOT duties during wildfire events?
Childress stated that TxDOT employment is the first priority. However, employees may request leave, and have eight hours per year to work on fire events outside TxDOT.

How often does your District provide fuel to agencies outside of TxDOT that are involved

in the wildfire event? How much fuel is typically provided?
The Childress district has rarely given out fuel for a wildfire event, and then only to requesting fire departments. They have given approximately 500 gallons this 2011 season.

In addition to fuel, does your District provide any other resources to outside agencies to effectively deal with the wildfire event?
The Childress district has provided resources including personnel and in-kind transportation for TFS or U.S. Forest Service (USFS). They transported slurry from Odessa to East Amarillo Complex (EAC) suppression staging in 2006.

Who handles the cost reimbursement requests related to wildfire events within your District?
The Childress DOM provides the information to the database for the Maintenance Division to file.

What is your success rate of reimbursement for expenses incurred for a wildfire response?
The Childress district was unsure of the reimbursement success rate and suggested that the Maintenance Division would be the best source of information on success rate. The best reference would be task numbers. FEMA reimburses the State and not the District.

What additional employee safety-related responsibilities does TxDOT have that are specific to wildfire events?
The Childress district stated that the employees do not have the proper safety equipment.

Are TxDOT personnel who respond to wildfire situations provided with adequate safety garments, equipment and training?
The Childress district stated are NOT equipped properly.

What public safety-related responsibilities does TxDOT have that are specific to wildfire events?
The Childress district did not offer any beyond normal operations.

Do you have any advance preparation and readiness protocols to respond to wildfire situations, if so are they unique to your district?
The Childress district has end of day equipment preparation and loading, and monitoring of weather during 'fire season' [February to August]. Childress has a training PowerPoint presentation that they adapted from a TFS PowerPoint presentation. Childress has no permanent DMS signs, but have trailer signs so they make sure that these are ready each day.

Do you make advance preparations by monitoring weather, ground conditions or other factors? Please provide details of how conditions affect your decision for readiness preparation.
The Childress district monitors weather from the NWS; during fires and fire season , the district monitors information from TFS and the EOC.

Please provide information about readiness plans including coordination activities, staging areas, resource mobilization, etc.
Childress indicated that readiness plans depend on the fire. Supervisors usually know of fires before the County Judge knows. The crews have on-site coordination with fire departments. The central station for heavy equipment is the district headquarters, while the motor graders are located within sections. Message boards may be dispatched if necessary. However, the signs are not fixed and are not often used unless during multi-day events.

Please comment on the following existing resources/guidance from TxDOT and other agencies such as TDEM, TFS, FEMA, etc. that they might have.

- *TxDOT Guidance for Wildfire Response*. Childress stated that they would like more detail in *TxDOT Guidance for Wildfire Response.*
- *TxDOT Maintenance Operations Manual.* Childress responded that they were unsure this resource applied to wildfire response but were sure it also needed more detail. Also, they think an update to fire guards would be beneficial.
- *Training courses/modules.* Childress indicated that they like TFS training materials. They would like the materials to have more explanation for those employees who are not exposed to any fire suppression. Also, they would be interested in a specified TxDOT training. The TFS training materials are not included in TxDOT training materials. For now, employees take some firefighting training including Independent Study (IS) from FEMA training, and NWCG training.

When asked for suggested improvements to TxDOT wildfire response protocols and employee safety, training, TxDOT command structure, TxDOT support services, dealings with outside agencies and dealing with the public, the Childress TxDOT personnel had the following suggestions:

- Improve safety training/experience
- Provide "stories:" condensed into a Powerpoint presentations or videos

El Paso District

What services are requested from TxDOT as part of this notification?
The El Paso district receives requests for the following services:

- Personnel
- Water
- Maintainers/ dozers
- Traffic control
- Fuel
- Road closures
- Mop up

How many such requests are made to your district in a typical year?
The El Paso district typically receives two to three such requests in a year, although they

may receive 11 in an extreme year.

How is the district notified of a Governor's Proclamation or Federal Disaster Declaration? How does a District benefit from this?
The El Paso district usually hears about a Governor's Proclamation either through the DPS website, the TxDOT Maintenance Administration, or an FMAG issuance.

What TxDOT offices (both within and outside the district) but outside of the district chain of command are involved in the wildfire event?
The El Paso district responded that the following TxDOT offices are involved in a wildfire event:

- Maintenance
- Regional
- Local
- Purchasing
- Area Engineer

Do you use any forms to collect data at the district level to prepare reports or make reimbursement requests?
The El Paso district the following resources for data collection and entry:

- Employee diaries
- DARs
- Situation reports
- Summaries of fuel and water use
- Equipment and personnel logs

The district collects this data using MMIs with task numbers.

What mechanisms/ technologies are currently used to ensure adequate data collection?
The El Paso district uses an employee-driven data entry system that uses Maintenance Division EOC website diaries and DARs.

Do you conduct advance briefings for the district response team before they leave for wildfire-related activities? How and where are such meetings conducted and what information is conveyed to participants?
The El Paso district conducts no formal briefing but provides advice and a needs assessment upon dispatch. If a briefing is done, it is at the Section or Command site.

Once the fires have been extinguished, do you conduct a formal de-briefing session(s) to discuss lessons learned and to ensure that all action necessary for cost reimbursement is completed?
The El Paso district conducts a safety briefing the following morning, and equipment is discussed. The district meets with the DPS RLO as part of the process.

Once notified of a wildfire, what responsibilities does TxDOT have to notify others?
The El Paso district's only responsibility to notify others is to update the HCR if there are road closures. The district sometimes sends advisories out to local media.

What outside agencies does TxDOT interact with during a wildfire event?
The El Paso district interacts with the following agencies:

- County officials
- City officers
- USFS
- TFS
- Volunteer fire departments
- Local residents
- DPS
- State and US Congressmen
- Sheriffs and police

What outside agencies does TxDOT interact with routinely in times other than during wildfire events and how often?
The El Paso district routinely interacts with the following agencies:

- County officials
- City officials
- US and State Congressmen
- Local residents
- Border Patrol
- US Customs
- TFS
- DPS
- Sheriffs and Police
- International Boundary and Water Commission
- Vendors
- Contractors
- Consultants
- Media

Are there formal protocols to be followed by TxDOT personnel when contact is made with outside agencies both during and outside of wildfire events?
The El Paso district first works to determine the need and usage of personnel and equipment. They work to cooperate with other agencies to "get it done." All information is channeled through the district EOC office and area ROL.

What TxDOT resources are typically utilized during wildfire events?
The El Paso district indicated that during wildfire events, the following TxDOT resources are typically used:

- Water trucks/ tanks
- Maintainers/ dozers
- Excavators
- Mop-up/ debris clean-up
- Fuels trucks
- Traffic control

- Message boards
- Pickups
- Dump trucks
- Loaders
- Personnel
- Trailers

How many TxDOT field personnel are typically mobilized for a wildfire event?
The El Paso district indicated that they have anywhere from two to 20 employees mobilized for a wildfire depending on the severity of the fire. A very severe fire required 54 employees.

How many TxDOT district employees serve in volunteer fire departments in their locality?
The El Paso district has indicated that there is one employee who has served with a volunteer fire department, and he has done so for over 20 years.

Does TxDOT release such firefighter employees from TxDOT duties during wildfire events?
The El Paso district indicated that they do release their volunteer firefighter during an event, but he normally assists TxDOT during the event. The decision on what to do is left with him.

How often does your district provide fuel to agencies outside of TxDOT that are involved in the wildfire event? How much fuel is typically provided?
The El Paso district does not often provide fuel to outside agencies, although it will on large events. The amount of fuel ranges from no fuel to 5000 gallons on one event.

In addition to fuel, does your district provide any other resources to outside agencies to effectively deal with the wildfire event?
The El Paso district provides the following resources:

- Water
- Traffic control
- Mop-up
- Debris hauling

Who handles district activities related to cost reimbursement requests on wildfire events?
The El Paso district indicated that the Maintenance Management section handles cost reimbursement.

What is your success rate of reimbursement for expenses incurred for a wildfire response?
The El Paso district has had a high success rate for reimbursement. This has been aided by the MNT handling the reimbursement process and sending emails to a website formatted to capture necessary information for submission of information.

What employee safety-related responsibilities does TxDOT have that are specific to wildfire events?

The El Paso district places extra emphasis on safety and reminds TxDOT employees that they are not authorized to do anything for which they are not trained. District employees hold tailgate meetings and attend safety meetings from outside agencies.

Are TxDOT personnel who respond to wildfire situations provided with adequate safety garments and training?
The El Paso district indicated that their employees have typical PPE and paper masks for smoke, but need radios in compliance with interoperability standards. The district indicated a desire for improved gear.

What public safety-related responsibilities does TxDOT have that are specific to wildfire events?
The El Paso district indicated that their safety responsibilities during a wildfire event include traffic control, providing message boards, and updating the HCR.

Do you have any advance preparation and readiness protocols to respond to wildfire situations?
The El Paso district indicated that they do not have any advance preparation protocols, although they put employees and equipment on standby and move them to a needed area if it is anticipated that TxDOT will be needed.

Do you make any advance preparations by monitoring weather, ground conditions, or other factors? Please provide details of how conditions affect your decision for readiness preparation.
The El Paso district does monitor weather and environmental conditions because not doing so would create a safety risk for their employees.

Please comment on existing resources/ guidance from TxDOT and other agencies?

- *TxDOT Guidance for Wildfire response*: The El Paso district has received good directions from this resource.
- *TxDOT Maintenance Operations Manual:* The El Paso district has received good directions from this resource.
- *Training courses/modules including those conducted by the District, TxDOT (statewide) and outside agencies:* The El Paso district uses ICS training from FEMA. This has been extremely beneficial when working an emergency. A good understanding of the ICS command structure and the relationship between TxDOT and the SOC is crucial for a proper response to an event.
- *Other (please specify):* The El Paso district would like to have good working relationships prior to an event, ICS training, and a cohesive management joint structure.

Do you have any suggestions to change TxDOT practices for more effective wildfire response?
The El Paso district recommended the following suggestions:

- Equipment operator training
- Fire training video

- Better equipment and PPE
- Understand do's and don'ts during a fire
- Acknowledgment form management to improve morale
- Safety training specific to wildfires.
-

Fort Worth District

What services from TxDOT are requested as part of notification of a wildfire?
The Fort Worth district is asked for:

- Traffic control
- Signs
- Fuel (TFS has requested this lately)
- Heavy equipment
- Dozers (operator)
- Motor grader
- Track loader
- Water tenders

How many such requests are made to your district in a typical year?
The Fort Worth district has had 10 to 12 requests at the time of the interview. In a typical year Fort Worth has around six requests.

How is a district notified of a Governor's Proclamation or a Federal Disaster Declaration?
The Fort Worth district was not sure of a formal protocol on this topic. They were also unaware of who should be the point of knowledge. However, at the Fort Worth interview the DPS were present and stated that the district can sign up for e-mails to receive state notifications. State agencies such as TxDOT can receive additional funding and restraints can be waived during Governor's Proclamations.

What TxDOT office both inside and outside the district but outside the chain of command is involved in the event?
For the Fort Worth district, the purchasing and regional offices are involved.

Do you use any forms to collect data at the district level to prepare reports or make reimbursement requests?
Fort Worth District has a system but it can use some improvement. The agency-to-agency mechanisms/technologies do not match-up for auditing when applying for FEMA, so their system is inadequate. There needs to be a daily report to Austin for the FEMA record applications.

What mechanisms are currently used to ensure adequate data collection?
Fort Worth discussed the ***Compass*** project and stated that Brandye Munn is the POC for this program development and implementation.

Do you conduct advance briefings for the District response team before they leave for wildfire-related activities? How are such meetings conducted and what information is conveyed to participants?
In the Fort Worth district, advanced briefings are held at staging zones. The crew that is sent out to the wildfire is dispatched with the request, contact person, and contact number.

Once the fires have been extinguished, do you conduct a formal de-briefing session(s) to discuss lessons learned and to ensure that all action necessary for cost reimbursement is completed?
The Fort Worth district has "lessons learned" meetings. They discuss what to do for the next wildfire event. TxDOT may check with other agencies/entities to see if there is anything for cleanup, but these are not official de-briefing meetings.

Once notified of a wildfire, what responsibilities does TxDOT have to notify others?
Fort Worth district office has none listed in their system. However, if the wildfire is a large event, the Maintenance Division (MNT) is informed. Also, the PIO informs the County Commissioner.

What agencies does TxDOT interact with relating to the wildfire event? Please provide information on such interactions.
The agencies that the Fort Worth district interacts with are:

- TFS
- TX Parks and Wildlife
- TX Dept. of Criminal Services
- DPS
- USFS
- TCEQ
- Texas Animal Health

What outside agencies does TxDOT interact with routinely in times other than during wildfire events and how often?
The Fort Worth district stated that they only routinely interact with the DPS.

Are there formal protocols to be followed by TxDOT personnel when contact is made with outside agencies both during and outside of wildfire events?
Fort Worth indicated that there is no formal protocol.

What TxDOT resources are typically utilized during wildfire events?
In the Fort Worth district the resources used are:

- Dozers
- Fuel trucks/Fuel
- Maintainers/Blades
- Crowd control devices
- Mechanics

- Traffic Control
- Personnel
- Water

How many TxDOT field personnel are typically mobilized for a wildfire event?
This depends on the fire size and is relative to personnel need. The maximum number the Fort Worth district has had on one wildfire event is 78 on the Possum Kingdom (PK) fire. They do not have employees working a fire at night due to visibility issues.

How many TxDOT District employees serve in volunteer fire departments in their locality?
The Fort Worth district has 10 to 12 district wide and had several in the past. A few of the current volunteers are in more rural counties.

Does TxDOT release such firefighter employees from TxDOT duties during wildfire events?
There appears to be some discrepancy on this between rural and urban sections within the Fort Worth District. They referenced the HR manual § 2 Ch. 10.

How often does your District provide fuel to agencies outside of TxDOT that are involved in the wildfire event? How much fuel is typically provided?
Fort Worth has had issues with giving out fuel. They stated that they give out fuel "too often" and are trying to reduce this. One agency that routinely asks for fuel is TFS.

In addition to fuel, does your district provide any other resources to outside agencies to effectively deal with the wildfire event?
Fort Worth provides county maps, mobile message signs, ROW debris clean up, and ROW reclamation.

Who handles the cost reimbursement requests related to wildfire events within your district?
Fort Worth is in the process of filing for reimbursement for the PK fire. Tom Brown and Vickie Webb are in charge of reimbursement for that event.

What is your success rate of reimbursement for expenses incurred for a wildfire response? Indicate separately for different agencies that may be involved.
Fort Worth is in the process to filing for FEMA reimbursement so the success rate is unknown.

What additional employee safety-related responsibilities does TxDOT have that are specific to wildfire events?
Fort Worth has an RLO preparing a document for Lookouts-Communications-Escape Routes-Safety Zones (LCES) type instructions. However, there are two safety officers for the Fort Worth District.

Are TxDOT personnel who respond to wildfire situations provided with adequate safety garments, equipment and training?
The Fort Worth district indicated that there is no safety equipment. They have been provided some Nomex® jumpers when working with USFS on the PK fire. Also, they have SAT phones but their use is limited to employees' knowledge.

What public safety-related responsibilities does TxDOT have that are specific to wildfire events?
The Fort Worth district had typically 50 troopers per shift in the PK complex fire , while DPS and TxDOT maintain road blockades. This frees-up local PD to evacuate.

Do you have any advance preparation and readiness protocols to respond to wildfire situations? If so, are they unique to your district?
Fort Worth stated that they are always fueled and ready to go. Once notified the crews in the areas will prepare based on resources requested.

Do you make advance preparations by monitoring weather, ground conditions or other factors? Please provide details of how conditions affect your decision for readiness preparation.
Fort Worth relies on the State Operations Center (SOC) and daily weather alerts on the news.

The district was asked to provide information about readiness plans including coordination activities, staging areas, resource mobilization, etc.
Fort Worth has a readiness plan for the ROWs. If the fire is on ROW then they use stock pile locations as staging areas.

Comment on existing resources/guidance from TxDOT and other agencies such as TDEM, TFS, FEMA, etc.

- *TxDOT Guidance for Wildfire Response* – The Fort Worth district stated that this document was mostly about signs.

TxDOT Maintenance Operations Manual – Fort Worth district would like to see information on fire breaks and fire lines. Richard stated that they have a red binder for emergency events with specific SOPs. He would like all emergency events in one red book.
Training courses/modules – Fort Worth indicated that they would like some training but it depends on what they are getting into. They indicated that they would like TFS expectations training and DPS training on ICP and ICS for upper level personnel.

What are your suggested improvements to TxDOT wildfire response protocols? Please include topics such as employee safety, training, TxDOT command structure, TxDOT support services, dealing with outside agencies and dealing with the public.

- Need a mechanism in place for hands-on training for all field personnel with TFS.
- Ideas from maintenance supervisors on what can be done to give more

knowledge and safety-related training recommendation from DPS

- Have DOM, DPS, and TFS work together to identify what TxDOT needs to organize.
- Match training with real-world expectations.
- How should TxDOT regional employees respond to wildfire events?
- Define the district's role in wildfire response.

Lubbock District

The Lubbock district submitted the following unique answers during our interview.

What services from TxDOT are requested as part of this notification?

- Fuel
- Maintenance
- Traffic control
- Water
- Dozers
- Lightning
- Personnel

How many such requests are made to your district in a typical year?
The Lubbock District stated that this is not a typical year. They had more than 23 requests during 2011. In 2010, they received four to five requests, and in prior years had on average two requests per year.

How is a district notified of a Governor's Proclamation or a Federal Disaster Declaration?
Information on the Governor's Proclamation has sometimes come from the District Disaster Coordinator (DDC) or the Regional Liaison Officer (RLO). Some of the restrictions are relaxed, such as working off right-of-way (ROW) without the DPS notification. Also, some of the procurement restraints are released as a result of such proclamations.

What TxDOT office both inside and outside the district but outside the chain of command is involved in the event? For the Lubbock district the other agencies involved are the TxDOT Public Information Office (PIO) and the regional offices (in the case of equipment fleet and purchasing).

Do you use any forms to collect data at the district level to prepare reports or make reimbursement requests?
The Lubbock district has the section supervisors summarize and enter data into a Maintenance Division SharePoint website. Allocations are updated by 3:00 p.m. daily to SharePoint for record keeping reporting.

What mechanisms are currently used to ensure adequate data collection?
Lubbock utilizes the Daily Activity Reports (DARs). This information could be accurately gathered using the task numbers for labor, equipment, and all other resources used. One person remarked that this is standard for districts and is not unique to Lubbock. Lubbock District suggested that one thing that could be done is to setup a survey form, similar to other hazard response survey forms, for wildfire response. This would make entry uniform and more complete within the system.

Do you conduct advance briefings for the district response team before they leave for wildfire-related activities? How are such meetings conducted and what information is conveyed to participants?
The Lubbock district has on-site meetings at the location of a wildfire event. If time permits they have a meeting prior to leaving for a fire. However, they typically do not conduct the meetings until they are on-site. These briefings are informal general safety meetings.

Once the fires have been extinguished, do you conduct a formal de-briefing session(s) to discuss lessons learned and to ensure that all action necessary for cost reimbursement is completed?
The Lubbock district sometimes has post-event meetings. For example, they had a meeting after the Borden County fire. Lubbock also sends out closed notification e-mails. After the Matador fire they had a meeting but it was not necessarily a debriefing, because it involved upper management, RLO, and TFS organizing future potential training ops.

Once notified of a wildfire, what responsibilities does TxDOT have to notify others?
The Lubbock district says that they update HCR and have no other responsibilities than for internal employees.

What agencies does TxDOT interact with relating to the wildfire event? Please provide information on such interactions.
The Lubbock district interacts with the following agencies;

- DPS
- RLO
- TFS
- Electric
- Utility providers
- Local Emergency Management Coordinator (A county level employee designated by the Judge)
- County Commissioner
- Sherriff's Office
- FD
- Mayor
- TCEQ
- DHHS (livestock disposal)
- FEMA

- FHWA
- RRC
- NOAA

What outside agencies does TxDOT interact with routinely in times other than during wildfire events and how often?
The Lubbock district stated that most of the agencies they interact with during a wildfire event may also be intermittently interacted with *outside* of a wildfire event. However, they routinely interact with utilities for installations, and dig tests. They also interact with NOAA on a routine basis.

Are there formal protocols to be followed by TxDOT personnel when contact is made with outside agencies both during and outside of wildfire events?
The Lubbock District referred to the TxDOT Communications Manual. However, this manual is not necessarily always followed.

What TxDOT resources are typically utilized during wildfire events?

- Maintainers
- Dozers (Only dozer available was broken)
- Pickups
- Sedan (for transport of personnel)
- Trailers
- Emergency trailers (contain – signs, barricades, message boards)
- Water tanks
- Loaders
- Supplies (non-specific)
- Personnel

How many TxDOT field personnel are typically mobilized for a wildfire event? The districts were asked to give exact numbers if possible, but they were encouraged to indicate a range if they were not sure.
A minimum of eight personnel are on the scene of a wildfire event. Typically there are two to three motor graders, so two to three operators plus one supervisor. Lubbock has had a maximum of 30 personnel on one event.

How many TxDOT District employees serve in volunteer fire departments in their locality?
Approximately 50 volunteer firefighters.

Does TxDOT release such firefighter employees from TxDOT duties during wildfire events?
Employees may be released to work on fire events. In fact, most have left in response to a wildfire before TxDOT receives notification of a wildfire event. However, they are not on the clock after the eight-hour coverage is used.

How often does your district provide fuel to agencies outside of TxDOT that are involved in the wildfire event? How much fuel is typically provided?
Fuel is rarely provided. Only upon request is fuel taken out and given to the fire departments. Only 110 gallons were given this year.

In addition to fuel, does your district provide any other resources to outside agencies to effectively deal with the wildfire event?
Lubbock stated that water is the other most common resource provided to outside agencies.

Who handles the cost reimbursement requests related to wildfire events within your District?
The Maintenance Management officer is in charge of reimbursement.

What is your success rate of reimbursement for expenses incurred for a wildfire response? Indicate separately for different agencies that may be involved.
The Lubbock district has not filed for reimbursement.

What additional employee safety-related responsibilities does TxDOT have that are specific to wildfire events?
Lubbock does not have any wildfire firefighting or personal protection equipment. TFS is working with them to develop a shortened course for TxDOT personnel on how to handle potential hazards when working suppression associated with wildfire events. This will be an abbreviated course specific to heavy machinery with some wildfire behavior, tactics, according to the Lubbock RFC.

Are TxDOT personnel who respond to wildfire situations provided with adequate safety garments, equipment, and training?
Lubbock stated that currently no they are not provided with adequate resources. However, they would like to have the proper equipment, as well as maps for detours. They recommended possible up-to-date electronic mapping to show best routes possible for large events to avoid issues with road closures.

What public safety-related responsibilities does TxDOT have that are specific to wildfire events?
Traffic control and livestock disposal.

Do you have any advance preparation and readiness protocols to respond to wildfire situations? If so, are they unique to your district?
Lubbock has advanced planning under red flag conditions, but this is rare. They do pre-loading only with minimal pre-staging.

Do you make advance preparations by monitoring weather, ground conditions or other factors? Please provide details of how conditions affect your decision for readiness preparation.
The regional fire weather contact from NOAA sends an e-mail notifying of hazardous

weather warnings. These e-mails are then forwarded to the supervisors. However, if supervisors only have cell phones and no e-mail contact when out on a job, sending an e-mail notifying of hazardous conditions won't be received until they arrive back in the office.

Please provide information about readiness plans including coordination activities, staging areas, resource mobilization, etc.
Lubbock has no formal readiness plans. They use TxDOT emergency response protocols. Their plan is reactive, primarily because they have a large area and do not have the personnel or abilities to respond according to a planned manner. They have general preparation such as specific weekend prep during high wildfire season.

Please comment on existing resources/guidance from TxDOT and other agencies such as TDEM, TFS, FEMA, etc.
The first resource discussed was the TxDOT Guidance for Wildfire Response. Lubbock indicated that they have seen parts of this document, and some of the parts are okay. Based on the responses during the interviews, few have seen/read the document. The second document in this topic was the TxDOT Maintenance Operations Manual. Lubbock thinks expansion of this document would be beneficial. Also, they stated that they would like "crash cards" for reference and for new employees. These cards would have tips and rules on them. The third set of documents discussed in the section was training courses/modules. The Lubbock district thinks that customized training with TFS would be helpful. Right now they use online FEMA ICS courses and (NIMS) training.

What are your suggested improvements to TxDOT wildfire response protocols? Please include topics such as employee safety, training, TxDOT command structure, TxDOT support services, dealing with outside agencies and dealing with the public.
Lubbock made the following suggestions:

- Better communication or better command post establishment with better communication
- Radio communication
- Supervisor should ask requestor (DPS) who else has been contacted.
- Need established point of contact (POC) and a better ICS
- Supervisor training so they can make safe knowledgeable calls on go/no-go situations.
- Representative with the IC at the Incident Command Post to relay information to the personnel on the ground on activities and actions
- Residential versus pasture protocol
- No work in dark.
- Typically have a motor-grader followed by a pickup or pumper truck if close to the fire.
- Would like safety equipment requisition through equipment supply – shelters (on equipment) Nomex® overalls

What services from TxDOT are requested as part of this notification?

- Fuel

- Maintenance
- Traffic control
- Water
- Dozers
- Lightning
- Personnel

How many such requests are made to your district in a typical year?
The Lubbock District stated that this is not a typical year. They had more than 23 requests during 2011. In 2010, they received four to five requests, and in prior years had on average two requests per year.

How is a district notified of a Governor's Proclamation or a Federal Disaster Declaration?
Information on the Governor's Proclamation has sometimes come from the District Disaster Coordinator (DDC) or the Regional Liaison Officer (RLO). Some of the restrictions are relaxed, such as working off right-of-way (ROW) without the DPS notification. Also, some of the procurement restraints are released as a result of such proclamations.

What TxDOT office both inside and outside the district but outside the chain of command is involved in the event? For the Lubbock district the other agencies involved are the TxDOT Public Information Office (PIO)tand the regional offices (in the case of equipment fleet and purchasing).

Do you use any forms to collect data at the district level to prepare reports or make reimbursement requests?
The Lubbock district has the section supervisors summarize and enter data into a Maintenance Division SharePoint website. Allocations are updated by 3:00 p.m. daily to SharePoint for record keeping reporting.

What mechanisms are currently used to ensure adequate data collection?
Lubbock utilizes the Daily Activity Reports (DARs). This information could be accurately gathered using the task numbers for labor, equipment, and all other resources used. One person remarked that this is standard for districts and is not unique to Lubbock. Lubbock District suggested that one thing that could be done is to setup a survey form, similar to other hazard response survey forms, for wildfire response. This would make entry uniform and more complete within the system.

Do you conduct advance briefings for the district response team before they leave for wildfire-related activities? How are such meetings conducted and what information is conveyed to participants?
The Lubbock district has on-site meetings at the location of a wildfire event. If time permits they have a meeting prior to leaving for a fire. However, they typically do not conduct the meetings until they are on-site. These briefings are informal general safety

meetings.

Once the fires have been extinguished, do you conduct a formal de-briefing session(s) to discuss lessons learned and to ensure that all action necessary for cost reimbursement is completed?
The Lubbock district sometimes has post-event meetings. For example, they had a meeting after the Borden County fire. Lubbock also sends out closed notification e-mails. After the Matador fire they had a meeting but it was not necessarily a debriefing, because it involved upper management, RLO, and TFS organizing future potential training ops.

Once notified of a wildfire, what responsibilities does TxDOT have to notify others?
The Lubbock district says that they update HCR and have no other responsibilities than for internal employees.

What agencies does TxDOT interact with relating to the wildfire event? Please provide information on such interactions.
The Lubbock district interacts with the following agencies;

- DPS
- RLO
- TFS
- Electric
- Utility providers
- Local Emergency Management Coordinator (A county level employee designated by the Judge)
- County Commissioner
- Sherriff's Office
- FD
- Mayor
- TCEQ
- DHHS (livestock disposal)
- FEMA
- FHWA
- RRC
- NOAA

What outside agencies does TxDOT interact with routinely in times other than during wildfire events and how often?
The Lubbock district stated that most of the agencies they interact with during a wildfire event may also be intermittently interacted with *outside* of a wildfire event. However, they routinely interact with utilities for installations, and dig tests. They also interact with NOAA on a routine basis.

Are there formal protocols to be followed by TxDOT personnel when contact is made with outside agencies both during and outside of wildfire events?

The Lubbock District referred to the TxDOT Communications Manual. However, this manual is not necessarily always followed.

What TxDOT resources are typically utilized during wildfire events?

- Maintainers
- Dozers (Only dozer available was broken)
- Pickups
- Sedan (for transport of personnel)
- Trailers
- Emergency trailers (contain – signs, barricades, message boards)
- Water tanks
- Loaders
- Supplies (non-specific)
- Personnel

How many TxDOT field personnel are typically mobilized for a wildfire event? The districts were asked to give exact numbers if possible, but they were encouraged to indicate a range if they were not sure.
A minimum of eight personnel are on the scene of a wildfire event. Typically there are two to three motor graders, so two to three operators plus one supervisor. Lubbock has had a maximum of 30 personnel on one event.

How many TxDOT District employees serve in volunteer fire departments in their locality?
Approximately 50 volunteer firefighters.

Does TxDOT release such firefighter employees from TxDOT duties during wildfire events?
Employees may be released to work on fire events. In fact, most have left in response to a wildfire before TxDOT receives notification of a wildfire event. However, they are not on the clock after the eight-hour coverage is used.

How often does your district provide fuel to agencies outside of TxDOT that are involved in the wildfire event? How much fuel is typically provided?
Fuel is rarely provided. Only upon request is fuel taken out and given to the fire departments. Only 110 gallons were given this year.

In addition to fuel, does your district provide any other resources to outside agencies to effectively deal with the wildfire event?
Lubbock stated that water is the other most common resource provided to outside agencies.

Who handles the cost reimbursement requests related to wildfire events within your District?
The Maintenance Management officer is in charge of reimbursement.

What is your success rate of reimbursement for expenses incurred for a wildfire response? Indicate separately for different agencies that may be involved.
The Lubbock district has not filed for reimbursement.

What additional employee safety-related responsibilities does TxDOT have that are specific to wildfire events?
Lubbock does not have any wildfire firefighting or personal protection equipment. TFS is working with them to develop a shortened course for TxDOT personnel on how to handle potential hazards when working suppression associated with wildfire events. This will be an abbreviated course specific to heavy machinery with some wildfire behavior, tactics, according to the Lubbock RFC.

Are TxDOT personnel who respond to wildfire situations provided with adequate safety garments, equipment, and training?
Lubbock stated that currently no they are not provided with adequate resources. However, they would like to have the proper equipment, as well as maps for detours. They recommended possible up-to-date electronic mapping to show best routes possible for large events to avoid issues with road closures.

What public safety-related responsibilities does TxDOT have that are specific to wildfire events?
Traffic control and livestock disposal.

Do you have any advance preparation and readiness protocols to respond to wildfire situations? If so, are they unique to your district?
Lubbock has advanced planning under red flag conditions, but this is rare. They do pre-loading only with minimal pre-staging.

Do you make advance preparations by monitoring weather, ground conditions or other factors? Please provide details of how conditions affect your decision for readiness preparation.
The regional fire weather contact from NOAA sends an e-mail notifying of hazardous weather warnings. These e-mails are then forwarded to the supervisors. However, if supervisors only have cell phones and no e-mail contact when out on a job, sending an e-mail notifying of hazardous conditions won't be received until they arrive back in the office.

Please provide information about readiness plans including coordination activities, staging areas, resource mobilization, etc.
Lubbock has no formal readiness plans. They use TxDOT emergency response protocols. Their plan is reactive, primarily because they have a large area and do not have the personnel or abilities to respond according to a planned manner. They have general preparation such as specific weekend prep during high wildfire season.

Please comment on existing resources/guidance from TxDOT and other agencies such as TDEM, TFS, FEMA, etc.

- *TxDOT Guidance for Wildfire Response.* Lubbock indicated that they have seen parts of this document, and some of the parts are okay. Based on the responses during the interviews, few have seen/read the document.
- *TxDOT Maintenance Operations Manual.* Lubbock thinks expansion of this document would be beneficial. Also, they stated that they would like "crash cards" for reference and for new employees. These cards would have tips and rules on them.
- *Training courses/modules.* The Lubbock district thinks that customized training with TFS would be helpful. Right now they use online FEMA ICS courses and (NIMS) training.

What are your suggested improvements to TxDOT wildfire response protocols? Please include topics such as employee safety, training, TxDOT command structure, TxDOT support services, dealing with outside agencies and dealing with the public.
Lubbock made the following suggestions:

- Better communication or better command post establishment with better communication
- Radio communication
- Supervisor should ask requestor (DPS) who else has been contacted.
- Need established point of contact (POC) and a better ICS
- Supervisor training so they can make safe knowledgeable calls on go/no-go situations.
- Representative with the IC at the Incident Command Post to relay information to the personnel on the ground on activities and actions
- Residential versus pasture protocol
- No work in the dark.
- Typically have a motor-grader followed by a pickup or pumper truck if close to the fire.
- Would like safety equipment requisition through equipment supply – shelters (on equipment) Nomex® overalls

Odessa District

What services from TxDOT are requested as part of this notification?
Odessa has request for the following services:

- Traffic control 80% of the time their services are requested.
- Equipment
- Fuel

How many such requests are made to your district in a typical year?
Odessa typically has less than five requests per year, excluding traffic control. However, this year they have had 10 requests. Including the traffic control, this year there has been a total of 100 requests.

How is a district notified of a Governor's Proclamation or a Federal Disaster Declaration?

There have not been any fires started in this district.

What TxDOT office both inside and outside the district but outside the chain of command is involved in the event?
The Odessa district does not have a structured chain of command. The request can go up or down the ladder.

Do you use any forms to collect data at the district level to prepare reports or make reimbursement requests?
Odessa uses DARs for data collection. However, they are waiting on the Fire Management Assistance Grant (FMAG) meeting that the DPS has scheduled.

What mechanisms are currently used to ensure adequate data collection?
The Odessa district does not have anything to ensure adequate data collection. They call the sections after the fact, to get what is available.

Do you conduct advance briefings for the district response team before they leave for wildfire-related activities? How are such meetings conducted and what information is conveyed to participants?
Odessa watches the weather service during fire season and try to be prepared to respond to situations.

Once the fires have been extinguished, do you conduct a formal de-briefing session(s) to discuss lessons learned and to ensure that all action necessary for cost reimbursement is completed?
The Odessa district does not have de-briefing meetings because they are never the lead agency on a wildfire event.

Once notified of a wildfire, what responsibilities does TxDOT have to notify others?
The Odessa district has no responsibility to notify others. Most of the time everyone already knows.

What agencies does TxDOT interact with relating to the wildfire event? Please provide information on such interactions.
Odessa interacts with the following agencies for a wildfire event:

- DPS
- VFDs
- TFS
- Maintenance
- Utilities
- Counties

What outside agencies does TxDOT interact with routinely in times other than during wildfire events and how often?
In the past, the Odessa district office had an annual meeting with the DPS. However, the DPS has not arranged that meeting in the last few years.

Are there formal protocols to be followed by TxDOT personnel when contact is made with outside agencies both during and outside of wildfire events?
The Odessa district has all requests go through the RLO.

What TxDOT resources are typically utilized during wildfire events?
In Odessa the following resources are utilized:

- Traffic control
- Message boards
- Blades
- Water
- Small amounts of fuel
- Transportation of fire retardant

How many TxDOT field personnel are typically mobilized for a wildfire event? The districts were asked to give exact numbers if possible, but they were encouraged to indicate a range if they were not sure.
Odessa does not have a standard number of employees that are sent to assist on wildfire events. The number of employees varies from one to 20, depending on the fire.

How many TxDOT District employees serve in volunteer fire departments in their locality?
In Odessa there are approximately 20 volunteer firefighters.

Does TxDOT release such volunteer firefighter employees from TxDOT duties during wildfire events?
The volunteer firefighters are released if TxDOT can spare them, otherwise they are not. These employees can request compensatory time. They are allowed five days a year for volunteer firefighter training.

How often does your district provide fuel to agencies outside of TxDOT that are involved in the wildfire event? How much fuel is typically provided?
The Odessa district rarely gives out fuel for wildfire events. This year they have given out 80 gallons of fuel.

In addition to fuel, does your district provide any other resources to outside agencies to effectively deal with the wildfire event?
The Odessa district provides water and transportation of fire retardant.

Who handles the cost reimbursement requests related to wildfire events within your district?
The DOM handles activities related to reimbursement.

What is your success rate of reimbursement for expenses incurred for a wildfire response? Indicate separately for different agencies that may be involved.
Odessa has never had to file for reimbursement.

What additional employee safety-related responsibilities does TxDOT have that are specific to wildfire events?
In the Odessa district the employees are told that they are not firefighters. They are support only for wildfire events. The district feels that they should not be in the wildfire event at all.

Are TxDOT personnel who respond to wildfire situations provided with adequate safety garments, equipment, and training?
No. Odessa District has someone stay around the firefighters to know if there is a shift in the fire so they can keep TxDOT employees out of harm's way. Usually, TxDOT is briefed by the IC. There is a hurricane video that the Odessa employees watch. This video gives information on what to expect, and situational awareness.

What public safety-related responsibilities does TxDOT have that are specific to wildfire events?
The Odessa district is responsible for traffic control. Sometimes they are asked to help evacuate by knocking on doors.

Do you have any advance preparation and readiness protocols to respond to wildfire situations? If so, are they unique to your district?
The Odessa stages equipment based on DPS information. They also have the trailers loaded and traffic control equipment ready.

Do you make advance preparations by monitoring weather, ground conditions or other factors? Please provide details of how conditions affect your decision for readiness preparation.
Odessa does not base advanced preparations on the weather. They rely on the weather service or the RLO will give notice.

Provide information about your readiness plans including coordination activities, staging areas, resource mobilization, etc.
The Odessa district has no formal protocols.

Please comment on the following existing resources/guidance from TxDOT and other agencies such as TDEM, TFS, FEMA, etc.

- TxDOT Guidance for Wildfire Response.
  The Odessa district stated that the Guidance document needs to be updated.
- TxDOT Maintenance Operations Manual.
  Odessa indicated that the Maintenance Operations Manual is not of much use.
- Training courses/modules.
  For the Odessa district, local training is the key.

What are your suggested improvements to TxDOT wildfire response protocols? Please include topics such as employee safety, training, TxDOT command structure, TxDOT support services, dealing with outside agencies and dealing with the public.

Odessa had the following suggestions:

- Some districts may be overstepping in terms of what TxDOT should be doing on wildfires
- TxDOT's responsibilities at a wildfire event should be clearly defined and not overstepped.
- These districts may need to be pulled back before an accident occurs
- Do not contract traffic control

San Angelo District

What services from TxDOT are requested as part of this notification?
San Angelo District has provided:

- Dozers
- Bladers
- Motor graders
- Fuel trailer
- Water trailer
- Sign trailers
- Pickup trucks
- Personnel
- Portable Changeable Message Signs (PCMS)

How many such requests are made to your district in a typical year?
The San Angelo district has received 19 requests this year. In a typical year they have one to two requests.

How is a district notified of a Governor's Proclamation or a Federal Disaster Declaration?
The San Angelo district heard on the news that the Wildcat fire received the Governor's Proclamation.

What TxDOT office, either inside or outside the district but outside the chain of command is involved in the event?
In San Angelo the District engineer (DE), area engineer (AE), regional office, and purchasing office are outside the chain of command but involved in a wildfire event.

Do you use any forms to collect data at the district level to prepare reports or make reimbursement requests?
The San Angelo district relies on an email sent by DOM to Maintenance Supervisors asking for information on the event.

What mechanisms are currently used to ensure adequate data collection?
San Angelo uses DARs and SharePoint to ensure adequate data collection.

Do you conduct advance briefings for the district response team before they leave for wildfire-related activities? How are such meetings conducted and what information is conveyed to participants?
The San Angelo district does not conduct advanced briefings, because the fires are usually emergency situations. A supervisor meeting is held to give the information to the crews responding.

Once the fires have been extinguished, do you conduct a formal de-briefing session(s) to discuss lessons learned and to ensure that all action necessary for cost reimbursement is completed?
There is no standard procedure for debriefing.

Once notified of a wildfire, what responsibilities does TxDOT have to notify others?
If there are road closures, the San Angelo district updates (HCR).

What agencies does TxDOT interact with relating to the wildfire event? Please provide information on such interactions.
San Angelo interacts with the following agencies:

- DPS
- Local Gov.
- TFS
- USFS
- VFD

What outside agencies does TxDOT interact with routinely in times other than during wildfire events and how often?
San Angelo district interacts with the DPS on a routine basis.

Are there formal protocols to be followed by TxDOT personnel when contact is made with outside agencies both during and outside of wildfire events?
The DOM handles all contact with outside agencies.

What TxDOT resources are typically utilized during wildfire events?
The San Angelo district uses the following:

- Dozers
- Blades
- Motor graders
- Fuel trailer
- Water trailer
- Sign trailers
- Pickup trucks
- Personnel
- PCMS

How many TxDOT field personnel are typically mobilized for a wildfire event? The districts were asked to give exact numbers if possible, but they were encouraged to

indicate a range if they were not sure.
The San Angelo district usually has four to five personnel that run on shifts of 12 hours. The maximum number of personnel on one wildfire event was 37 for the Wildcat Fire.

How many TxDOT district employees serve in volunteer fire departments in their locality?
San Angelo district has two in Junction, one in Sterling City, and one in Ballinger for a total of four volunteer firefighters district wide.

Does TxDOT release such firefighter employees from TxDOT duties during wildfire events?
San Angelo allowed miscellaneous leave this year for those who serve in VFDs.

How often does your district provide fuel to agencies outside of TxDOT that are involved in the wildfire event? How much fuel is typically provided?
San Angelo district has provided fuel at every fire they have responded to. The most fuel given at one event was 10,000 gallons. They usually give out 500 gallons at one event.

In addition to fuel, does your district provide any other resources to outside agencies to effectively deal with the wildfire event?
The San Angelo district also provides water.

Who handles the cost reimbursement requests related to wildfire events within your district?
In the San Angelo district, Adie Gomez from the DOM office aids MNT for filing of reimbursement.

What is your success rate of reimbursement for expenses incurred for a wildfire response? Indicate separately for different agencies that may be involved.
San Angelo has been reimbursed for ice emergencies but not for fires.

What additional employee safety-related responsibilities does TxDOT have that are specific to wildfire events?
The San Angelo district instructs teams that they are not firefighters and should get no closer to a fire than blading.

Are TxDOT personnel who respond to wildfire situations provided with adequate safety garments, equipment, and training?
The San Angelo would like shelters, as nothing is currently provided. Also they would like to look into fire clothing.

What public safety-related responsibilities does TxDOT have that are specific to wildfire events?
San Angelo district handles road closures notifications.

Does the district have any advance preparation and readiness protocols to respond to wildfire situations? If so, are they unique to your district?
San Angelo prepares by having the equipment on trailers and fueled by Thursday for the weekend. They work a four-day work week.

Do you make advance preparations by monitoring weather, ground conditions or other factors? Please provide details of how conditions affect your decision for readiness preparation.
San Angelo district does not have any formal advance preparation. They listen to weather alerts on the news.

Provide information about your readiness plans including coordination activities, staging areas, resource mobilization, etc.
The San Angelo district has staging areas established by TFS. They also have the hurricane plan that they adapt to wildfires. Another way that the district is prepared is that supervisors know whom to call for the teams that assist with wildfire events.

Please comment on existing resources/guidance from TxDOT and other agencies such as TDEM, TFS, FEMA, etc. that they might have.
TxDOT Guidance for Wildfire Response. The San Angelo district indicated that this document was pertinent to signs, and needs to be expanded to include how to help, how close to get, and what to do sections.
TxDOT Maintenance Operations Manual. The San Angelo district responded that this document was sketchy and brief. They also think the information needs to be in one place.
Training courses/modules. The San Angelo district thinks there should be some fire training ICS (FEMA), and TIFMAS.

What are your suggested improvements to TxDOT wildfire response protocols? Please include topics such as employee safety, training, TxDOT command structure, TxDOT support services, dealing with outside agencies and dealing with the public.
San Angelo suggested the following:
Clarification on who is POC on events. This will allow for more clear communication and coordination during the event.

BIBLIOGRAPHY

FEMA, (2011). NIMS ICS Position Paper. Available at: http://www/fema.gov/txt/nims_ics_position_paper.txt.

Hockenberry, H., (2011). Fire Weather Services Product Specification. Department of Commerce, National Oceanic & Atmospheric Administration, National Weather Service Products and Services to Support Fire and Other Incidents, NWSPD 10-4, NWSI 10-401. Pg32. http://www.nws.noaa.gov/directives

HSDL (Homeland Security Digital Library), (2011), New position paper on National Incident Management System (NIMS) Incident Command System (ICS), Accessed at https://www.hsdl.org/hslog/?q=node/1206

Hull, J.B. (2007). *Texas Wildfire Protection Plan*. Austin (TX): Texas Forest Service. 37 p.

NIFC (2011). *National Mobilization Guide* Washington D.C: National Interagency Fire Center.

NWCG (2006). *Task Book For The Position Of Public Information Officer (PIOF)*. Washington D.C: National Wildfire Coordinating Group and Bureau of Indian Affairs.

NWCG (2006). *GIS Standard Operating Procedures*. Washington D.C: National Wildfire Coordinating Group.

NWCG (2004). *Fireline Handbook* Washington D.C: National Wildfire Coordinating Group.

NWCG (2009). *Interagency Incident Business Management Handbook* Washington D.C: National Wildfire Coordinating Group.

NWCG (2011). *Operating Principles and Guidelines* Washington D.C: National Wildfire Coordinating Group.

TDEM (Texas Division of Emergency Management). (2008). "Local Emergency Management Planning Guide," Texas Division of Emergency Management, Texas Department of Public Safety, TDEM-10 Revision 4, January 2008, Austin, Texas.

TDEM (Texas Division of Emergency Management). (2011). http://www.txdps.state.tx.us/dem/, Accessed September 2011.

TDEM (Texas Division Of Emergency Management). (2001). *Emergency Management Plan*. Austin, (TX): Texas Department Of Public Safety. (SS)

TDEM (Texas Division Of Emergency Management). (2001). *Managing Disaster Logistics Response*. Austin, (TX): Texas Department Of Public Safety. (SS)

TFS (Texas Forest Service). 2011. Incident management Teams: Incident Management System. Available at: http://txforestservice.tamu.edu/main/article.aspx?id=1548&terms=Incident+Management+T.

TFS (Texas Forest Service). (2011b). Texas Intrastate Fire Mutual Aid System (TIFMAS): State of Emergency Management Plan, V1.2. Available at: http://ticc.tamu.edu/Documents/IncidentResponse/TIFMAS/TIFMAS_Appendix_6_to_Annex_F.pdf

TFS (Texas Forest Service). (2011c). Business and Mobilization Procedures: Texas Intrastate Fire Mutual Aid System (TIFMAS). Available at: http://ticc.tamu.edu/Documents/IncidentResponse/TIFMAS/TIFMAS_Business_Deployment_Manual.pdf

TSIEC (Texas Statewide Interoperability Executive Committee). (2009). Texas Statewide Interoperability Channel Plan: Change #11). Texas Department of Public Safety. Accessed on: 08/20/2011; Available at: http://tsiec.region49.org/.

The State of Texas, (2011), Texas Administrative Code http://www.sos.state.tx.us/tac, Office of the Texas Secretary of State, Austin, Texas.

Texas Administrative Code Title 43. (2011). Transportation. Accessible at http://info.sos.state.tx.us/pls/pub/readtac$ext.viewtac

The State of Texas, (2006), *Texas Government Code Chapter 418*. Texas Disaster Act of 1975. Texas Emergency Management Statutes. Updated 2006. 102 p.

The State of Texas, (2004), "Local Homeland Security Strategic Plan – State of Texas Emergency Management Plan, Part III," Office of the Governor, February 2004, Austin, Texas.

TxDOT (Texas Department of Transportation). (2011). *Guidance for Wildfire Response*. Austin (TX): Texas Department of Transportation.

TxDOT (Texas Department of Transportation). (2010). *Maintenance Operations Manual*. Austin (TX): Texas Department of Transportation.

USDHS (U.S. Department of Homeland Security). (2008). *National Incident Management System*, Federal Emergency Management System (FEMA).

USDI-NPS (US Department of the Interior-National Park Service). (2003). *Fire Monitoring Handbook*. Boise (ID): US Department of the Interior.

USDI-NPS (U.S. Department of Interior-National Park Service, (2008). *Reference Manual 18*. Boise (ID): US Department of the Interior.

Appendices

A. Texas Department of Transportation, Draft Guidance for Wildfire Response
B. List of Acronyms
C. Data Maps for Each District Interviewed
D. Questionnaire
E. Texas Administrative Code

APPENDIX A

Texas Department of Transportation

DRAFT GUIDANCE FOR WILDFIRE RESPONSE

Texas Department of Transportation

GUIDANCE FOR WILDFIRE RESPONSE

Burn Ban Signs

Electronic Message Signs

Generally, the Texas Department of Transportation (TxDOT) does not post burn ban messages on electronic message signs such as permanent Dynamic Message Signs or Portable Changeable Message Signs. However, TxDOT may post burn ban messages on electronic message signs, under special circumstances:

- Permanent Dynamic Message Signs (DMS)
    - If there is an active, catastrophic wildfire affecting the area, and the Disaster District Committee (DDC) Chairperson directs TxDOT to post burn ban messages,

      or

    - Upon request by the State Operations Center and with the approval of TxDOT Administration,

      or

    - At the discretion of the District Engineer, with regard to heightened fire activity.
- Portable Changeable Message Signs (PCMS).
    - If there is an active, catastrophic wildfire affecting the area, and the Disaster District Committee (DDC) Chairperson directs TxDOT to post burn ban messages,

      or

    - At the discretion of the District Engineer, with regard to heightened fire activity.

TxDOT approval is required for message content, mainly to ensure that the message is effectively displayed based on the capabilities of the message sign. Portable Changeable Message Signs (PCMS) have less character-space than permanent Dynamic Message Signs

(DMS), so they are less-effective at handling longer messages. For example, a message about calling an Arson Hotline would need to be displayed on DMS rather than PCMS.

The Dynamic Message Signs and Portable Changeable Message Signs are traffic control devices used for managing travel, controlling and diverting traffic, and identifying current and anticipated roadway conditions. Use of the message signs for the purpose of publicizing burn bans is restricted, because the message signs are better suited for other purposes. If needed and available, electronic message signs can be used to display TxDOT-approved messages about detours, road closures, visibility problems due to smoke, or other traffic control issues, as warranted by the emergency. This is normal TxDOT practice.

The target audience for routine burn ban messages tends to be the people living in a county that has a county commissioner's court burn ban in effect. Those people are typically made aware of the burn ban by newspapers and radio. Drivers passing through that county are not the main target audience.

What if a County wants burn ban messages displayed?

- During a catastrophic wildfire, a local elected official who wants TxDOT to display burn ban messages may request this through the DDC Chairperson.
- If a county perceives a need to display burn ban signs, and electronic display is denied, perhaps permanent, county-provided, ground-mounted signs would be an appropriate alternative.

Permanent Ground-Mounted Signs for Burn Bans

Counties are permitted to provide and install their own burn ban signs along TxDOT-maintained right of way, but only if those signs comply with TxDOT policy. (See table and references below.) TxDOT approves sign-mount locations and inspects and documents installations according to District-determined procedures. It is the County's responsibility to coordinate with utility companies, as applicable, when placing signs.

Burn ban signs must be concealed or removed from view unless a burn ban is in effect. (Example: A hinged sign opened to display a burn ban advisory should be returned to its folded/closed position when a burn ban is discontinued.) TxDOT suggests that burn ban signs be white with red letters. Burn ban signs must not block other signs from view.

Sign material	Location	Type of Support	Notes
Metal	Adjacent to ROW line	Breakaway	
Wood	Adjacent to ROW line	Breakaway	
Paper	Adjacent to ROW line or with location approval by TxDOT	If within the clear zone (which typically means within 30' of the travel lane), must be on a compliant work zone traffic control device	• Temporary or permanent • Safer sign material
Plastic	Adjacent to ROW line or with location approval by TxDOT	If within the clear zone (which typically means within 30' of the travel lane), must be on a compliant work zone traffic control device	• Temporary or permanent • Safer sign material

Burn Ban signs allowed on TxDOT ROW

County Provided, Installed and Maintained

- Substrate: Metal or Wood- 30" x 36"
- White reflective background with red lettering and font
- County provided, installed and maintained, including flipping up and down
- TxDOT approved breakaway support provided, installed and maintained by County
- Bottom of sign must be minimum 7' above travel lane (unless >30' from travel lane)
- Installed at location agreed upon by District Engineer
- Fabricated at 3rd party shop (county or private business)
- Not allowed as attachment to existing sign post
- Displayed only during burn bans

- Substrate: composite (thermoplastic between 2 sheets of thin aluminum)- 24" x 24"
- White reflective background with red lettering and font
- County provided, installed and maintained, including flipping up and down
- May be attached on existing TxDOT route marker or county line sign support
- Top of this sign must be within 3" of the bottom of the route marker shield
- Installation must be approved by District Engineer
- Fabricated at TDCJ- (Tim Williams of TDCJ at 903-928-2217, Ext. 3462).
- No substitutes permitted due to traffic hazards
- Displayed only during burn bans

- Substrate: Vinyl- 48" x 48" with grommets
- Red non-reflective background with white lettering and font
- County provided, installed and maintained, including removal from ROW after burn ban is lifted
- May be attached on 'T' post, and only adjacent to ROW line
- Fabricated by any supplier
- Installation must be approved by District Engineer
- Substitutes for substrate, size, wording and color permitted with District Engineer's approval
- Displayed only during burn bans

TxDOT policies for permanent ground-mounted signs can be found on the TxDOT Internet Site, accessible through the following link: http://www.dot.state.tx.us

1. On the TxDOT web page, click on Business.

2. On the Business page, scroll down to Specifications and Plans and click on CAD Standards.

3. At the Statewide CAD Standard Plan Files Disclaimer, click on I Accept.

4. Scroll down to the Traffic Operations Division section; click on Traffic Engineering Standard Plan Sheets.

5. Scroll down to the Sign Mounting Standards. Recommended printout size is 11"x17".

(The TxDOT Intranet link is: ftp://ftp.dot.state.tx.us/pub/txdot-info/cmd/cserve/standard/traffic/smd2002.pdf)

Approved supports for temporary signs are in the Compliant Work Zone Traffic Control Device List, available upon request. The TxDOT Intranet link is: http://crossroads/org/trf/TRFTEPS2/cwztcd.pdf

Fuel for Volunteer Fire Departments

Under circumstances that warrant it, TxDOT will supply Volunteer Fire Departments (VFDs) with fuel. When supplying VFDs with fuel, the District should track the fire name, amount of fuel supplied, itemized by type, license plate number of the volunteer vehicle and signature. Enclosed is a sample sheet which can be used.

- Fire name
- Number of gallons of gasoline
- Number of gallons of diesel
- License number of VFD vehicle
- Signature of Volunteer receiving fuel

Providing fuel to VFDs

- Must be in response to a catastrophic active fire.
- Only upon request by the State Operations Center or Disaster District Committee (DDC).
- Will be at the discretion of the District Engineer who will ensure fuel is being used as intended.

TxDOT Employees Who Are Volunteer Firefighters

TxDOT employees who are volunteer firefighters may be granted miscellaneous leave to respond to emergency fire calls as needed during normal work hours. DE/DD/OD/RD may use discretion in granting leave for firefighting duty. Under no circumstances will employees perform firefighting duties while on TxDOT time.

Responder Equipment Repairs

TxDOT is not tasked to repair or maintain vehicles of other agencies. Assistance for repairing equipment's mechanical problems will need to be handled through the Texas Forest Service.

Fireguards

General

For locations on the TxDOT right of way (ROW), TxDOT will conduct shredding, mowing, emergency blading, or other activities to assist in prevention of wildfire spread. Personnel safety is our number one concern, when requested to perform emergency wildfire support, if possible request a fire response unit to be near to provide protection for the operator and equipment. For another agency to assist with such ROW activities, a wildfire must be approaching and the Incident Commander must have decided to use the highway as a firebreak. Work on the right of way in unapproved areas or using unapproved methods will be considered a violation of this effort and will be dealt with as needed to prevent unnecessary destruction of state property.

To interrupt the spread of wildfire and assist in its containment, blading of vegetation may be needed, to form firebreaks. The result of this process, unfortunately, has the potential to cause erosion, pollution, and possibly a need for additional resources to re-vegetate the bladed ROW. Operational vigilance and completion of compliancy paperwork are needed, in an effort to preserve the environment as much as possible.

Because of the environmental impact of firebreaks, TxDOT strives to limit emergency blading to special circumstances:

- If there is an active, catastrophic wildfire affecting the area, and the DDC Chairperson directs TxDOT to clear vegetation,

  or

- Upon request by the State Operations Center

  and

- with the approval of TxDOT Administration.

What if a County wants TxDOT to create a firebreak?

A local elected official requesting TxDOT to perform emergency activities, for locations either on or off of the ROW, may request this through the DDC Chairperson. Standard procedures for mobilizing TxDOT equipment for assistance remain in place. Use of TxDOT equipment to clear vegetation is at the discretion of the District Engineer, and without an immediate threat of fire danger, it is highly unlikely that TxDOT will provide off-ROW assistance.

Paperwork Requirements for On-ROW Fireguards

Fireguards constructed within TxDOT's right-of-way for the protection of agricultural lands do not require authorization under the Construction General Permit (CGP). Chapter 2 (State Agricultural Policy) of the Agriculture Code defines agriculture as the cultivation of the soil to produce crops, horticulture, floriculture, or viticulture, forestry or the raising of livestock or poultry.

When a disaster proclamation issued by the Governor suspends all rules and regulations that may inhibit or prevent the prompt response to the threat, the CGP may be considered suspended with regard to blading of fireguards in the counties specified in the proclamation. Under these conditions, fireguards may be constructed as necessary to prevent or to lessen the potential for disaster.

Fireguards constructed in counties not included in the Governor's disaster proclamation or not constructed to protect agricultural lands, may be authorized under the CGP as described in the streamlined Storm Water Prevention Plan (SW3P) for Fireguards. SW3P for Fireguards can be found as an attachment to this document and at the following link:

http://crossroads/org/env/Guidance/NRM/wrm.htm

Operational Considerations for Emergency Blading

- **Safety of our personnel is our number one concern, when possible have fire personnel near, standing by.**
- Blading should be conducted at a depth of no more than 2-4 inches.
- During blading, earthen dams should be created at each outfall to create a temporary holding basin for runoff.
- No blading will be allowed within the high water mark of creek and river crossings that fall under US Corps of Engineers' jurisdiction. (TxDOT offices should be familiar with these locations.)
- After the event, materials bladed from TxDOT ROW should be redistributed at the bladed site.
- Where TxDOT ROW vegetation was bladed, if re-vegetation does not occur within 90 days after normal rainfall patterns have resumed, TxDOT must employ additional stabilization techniques.

Carcass Disposal

Texas Commission on Environmental Quality (TCEQ) is generally responsible for ensuring compliance with environmental regulations in the aftermath of a wildfire. For obtaining approved procedures for carcass disposal, contact the TxDOT District Environmental Quality Coordinator (DEQC) who may coordinate with TCEQ and Texas Animal Health Commission. Typically, livestock as a wildfire casualty is buried. Regulations apply, such as restrictions regarding proximity to water sources, the amount of material allowed burial in each location, the amount of coverage needed, and permission to work on private property.

Critical Incident Stress Management (CISM)

TxDOT employees should be reminded that they may use EAP as a resource.

- Employee Assistance Program (EAP) counselors can be called on by individuals or asked to serve a group.

It is possible that teams of counselors will be available from other state and non-profit agencies. TxDOT may request their services via the State Operations Center.

Updates on Road Conditions

TxDOT will continue to enter road closures into the Highway Condition Reporting System (HCRS) which the public can access online or by calling (800) 452-9292.

Media Relations

TxDOT's normal public information activities will be in place. This includes providing appropriate representation at the TxDOT EOC and respective TxDOT District Emergency Operations Centers (EOC's). Public Information Officers serving at the district level and/or at the TxDOT statewide level will be available to coordinate with a Joint Information System (JIS).

A District Public Information Officer (PIO) should:

- Publicize burn bans issued for a county, via local media. The goal is to reduce need for burn ban signs along roadways.
- Set up a Joint Information Center (JIC) if asked to do so by the DDC Chairperson. This could entail finding and/or providing a location and serving as a lead PIO.

Governor's Proclamation

During an extreme fire hazard which threatens many counties in the state, the Governor may issue a proclamation certifying a state of disaster for the entire state or for certain named counties. A governor's proclamation means all rules and regulations that may inhibit or prevent prompt response to the threat of fire are suspended (reference Texas Government Code 418.016).

TxDOT Web Sites

TxDOT will continue to provide information as applicable to the external TxDOT Internet Site and to the Maintenance Intranet Site http://crossroads/org/mnt/MS/EmgyMgmt/index_files/Page599.htm (on Crossroads). The Maintenance Intranet Site offers a link to Texas Forest Service information. (Note: Internet access is required for a user to access information via this Texas Forest Service link.) http://txforestservice.tamu.edu/main/default.aspx

APPENDIX B

LIST OF ACRONYMS RELATED TO WILDFIRE RESPONSE

LIST OF ACRONYMS RELATED TO WILDFIRE RESPONSE

AAR – After Action Review
AC – Area Commander
ACA – Alternative Consultation Agreement
AD – Administratively Determined Pay Plan
AFF – Automated Flight Following
AFS – Alaska Fire Service
AMD – Aviation Management Directorate
AMR – Appropriate Management Response
AMRS – All-Hazards Meteorological Response System
APMC - Agency Provided Medical Care
APT – Administrative Payment Team
ARD – Air Resources Division
ARD – Associate Regional Director
ASAT – Aviation Safety Assistance Team
ASCADS – Automated Sorting, Conversion, and Distribution System
ASM1 – Aerial Supervision Module
ATD – Actual Time of Departure

BAER – Burned Area Emergency Response
BAR – Burned Area Rehabilitation
BAU – Budget Advisory Unit
BIA – Bureau of Indian Affairs
BLM – Bureau of Land Management
BPA – Blanket Purchase Agreement / Business Purchase Agreement
BUYT – Buying Team

C# - Crew Resource Request Number
CA – Community Assistance
CAA – Clean Air Act
CAR – Communities-at-Risk
CAT – Cost Apportionment Team
CBI – Composite Burn Index
CDO – Communications Duty Officer
CE – Categorical Exclusion
CESU – Cooperative Education Studies Unit
CFFP – Cooperative Forest Fire Prevention Program
CFR – Code of Federal Regulations
CIO – Chief Information Officer
CLMS – Claims Specialist
CMMS – Computer Maintenance Management System
CMSY – Commissary Manager
CO – Contracting Officer
COMC – Communications Coordinator

COML – Incident Communication Unit Leader
COP – Continuation of Pay / Chief-of-Party
COR – Contracting Officer Representative
COST – Cost Unit Leader
COTR – Contracting Officer Technical Representative
CPIC – Capital Planning and Investment Control
CREP – Crew Representative
CRM – Crew Resource Management
CTR – Crew Time Report
CWN – Call-When-Needed agreements
CWPP – Community Wildfire Protection Plan

DASHO – Designated Agency Safety and Health Official
DASP – Disaster Assistance Support Program
DAWG – Data Administration Working Group
DCO – Defense Coordination Officer
DIAR – Department of the Interior Acquisition Regulation
DM – Departmental Manual
DMS – Dispatch Messaging System
DO – Director's Order
DOD – Department of Defense
DOI – Department of the Interior
DOT – Department of Transportation
DRGS – Direct Readout Ground Station
DRM – Data Reference Model
DROT – DOMSAT Receive-only Terminal

E# - Equipment Resource Request Number
EA – Enterprise Architecture
EA – Environmental Assessment
EERA – Emergency Equipment Rental Agreements
EFT – Electronic Funds Transfer
EFTR – Emergency Firefighter Time Report
EIS – Environmental Impact Statement
ELA – Enterprise License Agreement
EPA – Environmental Protection Agency
EQTR – Equipment Time Recorder
ES – Emergency Stabilization
ESA – Endangered Species Act
ESF – Environmental Screening Form
ESM – Environmental Statement Memorandum
ESR – Emergency Stabilization and Rehabilitation
ETA – Estimated Time of Arrival
ETD – Estimated Time of Departure
ETE – Estimated Time En route

FAAP – NPS Fire and Aviation Applications Portal
FAR – Federal Acquisition Regulation
FAST – Wildland Fire and Aviation Safety Team
FBO – Fixed Base Operator
FEA – Federal Enterprise Architecture
FEAT – Fire Ecology Assessment Tool
FEC – Fire Executive Council
FECA – Federal Employees Compensation Act
FEIS – Fire Effects Information System
FEMO – Fire Effects Monitor
FFS – Federal Financial System
FGDC – Federal Geographic Data Committee
FIREMON – Fire Effects Monitoring and Inventory System
FISMA – Federal Information Security Management Act
FLE – Fire Line Explosives
FLSA – Fair Labor Standards Act
FMLB – Fire Management Leadership Board
FMO – Fire Management Officer
FMP – Fire Management Plan
FMPC – Fire Management Program Center
FMU – Fire Management Unit
FOG – Field Operations Guide
FONSI – Finding of No Significant Impact
FOR – Fixed Ownership Rate
FPA – Fire Program Analysis
FPU – Fire Planning Unit
FRAMES – Fire Research and Management Exchange System
FRAWS – Wildfire Support Remote Automated Weather Station
FRCC – Fire Regime and Condition Class
FS – Forest Service
FSC – Finance/Administration Section Chief
FTE – Full Time Equivalency
FTP – File Transfer Protocol
FTS – Forest Technology Systems
FUM – Fire Use Manager
FUMT – Fire Use Management Team
FWS – Fish and Wildlife Service

GACC – Geographic Area Coordination Center
GACG – Geographic Area Coordinating Group
GIS – Geographic Information System or Geospatial Information System
GMAC – Geographic Multi-Agency Coordination Group
GMP – General Management Plan
GOES – Geostationary Operational Environmental Satellite
GPO – Government Printing Office
GPRA – Government Performance Results Act

GPS – Global Positioning System
GS – General Schedule (Pay Plan)
GSA – U.S. General Services Administration
GTG – NWCG Geospatial Technology Group
GVW – Gross Vehicle Weight Rating

HFI – Healthy Forests Initiative
HMGB – Helicopter Manager Single Resource
HSPD – Homeland Security Presidential Directive
HUDC – Host Unit Dispatch Center

I&M – Inventory and Monitoring
IA – Initial Attack
IAP – Incident Action Plan
IARR – Interagency Resource Representative
IBC – Incident Business Advisor
IC – Incident Commander
ICC – International Code Council
ICO – Incident Contracting Officer
ICP – Incident Command Post
ICS – Incident Command System
ICS 209 – Incident Status Summary
IDIQ – Indefinite Delivery, Indefinite Quantity
IDT – Interdisciplinary Team
IFP – Incident Finance Package
IFPM – Interagency Fire Program Management
IGO – Intra-Governmental Order
IHC – Interagency Hotshot Crew
IMET – Incident Meteorologist
IMSR – Incident Management Situation Report
IMT – Incident Management Team
INCINET – Incident Network
INJR – Injury Compensation Specialist
IPAC – Intra-Governmental Payment and Collection
IQCS – Incident Qualifications and Certification System
IRAWS – Incident Remote Automatic Weather Station
IRIN – Infrared Interpreter
IRM – Information Resource Management
IRPG – *Incident Response Pocket Guide* (NFES 1077, PMS 461)
ISO – Incident Support Organization
ISOG – Interagency SEAT Operations Guide
IT – Information Technology
ITIC – Information Technology Investment Council

JCC – Job Corp Center
JFSP – Joint Fire Science Program

JFO – Joint Field Office
JHA – Job Hazard Analysis

LAL – Lightning Activity Level
LCES – Lookouts-Communications-Escape Routes-Safety Zones
LODD – Line of Duty Death
LWOP – Leave Without Pay

M# - Medical Resource Order Number
MAC – Multi-Agency Coordinating Group
MAFFS – Modular Airborne Fire Fighting System(s)
MCAD – Military Crew Advisior
MCR – Human-caused Risk
MIST – Minimum Impact Suppression Tactics
MMA – Maximum Manageable Area
MOA – Memorandum of Agreement
MOU – Memorandum of Understanding
MRE – Meals Ready to Eat
MTBS – Monitoring Trends in Burn Severity

NAAQS – National Ambient Air Quality Standards
NAFRI – National Advanced Fire and Resource Institute
NASF – National Association of State Foresters
NCO – National Contracting Officer
NEPA – National Environmental Policy Act
NFDRS – National Fire Danger Rating System
NFES – National Fire Equipment System
NFP – National Fire Plan
NFPA – National Fire Protection Agency
NFPET – National Fire Prevention Education Team
NFPORS – National Fire Plan Operations and Reporting System
NGO – Non-governmental Organization
NHPA – National Historic Preservation Act
NICC – National Interagency Coordination Center
NIFC – National Interagency Fire Center
NIIMS – National Interagency Incident Management System
NIMO – National Incident Management Organization Teams
NIRSC – National Incident Radio Support Cache
NISC – National Information Systems Center
NITC – National Information Technology Center
NMAC – National Multi-Agency Coordination [Group]
NMAS – National Map Accuracy Standard
NOI – Notice of Intent
NPS – National Park Service
NRCC – National Response Coordination Center
NRF – National Response Framework

NWCG – National Wildfire Coordinating Group
NWFEA – National Wildland Fire Enterprise Architecture

O# - Overhead Resource Request Number
OF – Optional Form
OFDA – Office of Foreign Disaster Assistance
OGC – Office of General Council (USDA)
OMB – Office of Management and Budget
ONPS – Operations of NPS funding
OPF – Official Personnel Folder
OSHA – Occupational Safety and Health Administration
OWCP – Office of Workers' Compensation Programs
OWDC – Operations and Workforce Development Committee
OWFC – Office of Wildland Fire Coordination

P.L. – Public Law
PAX - Passengers
PII – Personally Identifiable Information
PM – Particulate Matter
PMIS – Project Management Information System
PMS – Publication Management System
PMU – Program Management Unit
POC – Point of Contact
POE – Point of Entry
PPE – Personal Protective Equipment
PRAWS – A non-fire project support Remote Automated Weather Station
PROC – Procurement Unit Leader
PRM – Performance Reference Model
PSD – Prevent Significant Deterioration
PTB – Position Task Book
PTRC – Personnel Time Recorder
PWE – Primary Work Element

QA/QC – Quality Assessment / Quality Control

RAMS – Risk Assessment and Mitigation Strategies
RAO – Regional Aviation Officer
RAWS – Remote Automated Weather Station
RCU – Responsibilities for Computer Use
RFD – Rural Fire Department
RMP – Resource Management Plan
ROD – Record of Decision
ROMAN – Real-time Observation Monitoring and Analysis Network
ROSS – Resource Ordering and Status System
RRCC – Regional Response Coordination Center
RSFWSU – Remote Sensing Fire Weather Support Unit

RSS – Resource Stewardship Strategy
RX – Prescribed (fire)

S# - Supply Resource Request Number
SACS – Shared Application Computer System
SAIT – Serious Accident Investigation Team
SCC – Service-wide Comprehensive Call
SCSEP – Senior Community Service Employment Program
SEAT – Single Engine Air Tanker
SF – Standard Form
S&PF – State and Private Forestry
SHPO – State Historic Preservation Office
SIP – State Implementation Plan
SLA – Service Level Agreement
SME – Subject Matter Expert
SMIS – Safety Management Information System
SMTP – Simple Mail Transfer Protocol
SOP – Standard Operating Procedure
SPOC – Single Point of Contact
STLM – Strike Team Leader - Military
SUA – Satellite User Agreements
SWB – Statement of Work and Budget

T&E – Threatened and Endangered
TFR - Temporary Flight Restriction
THPO – Tribal Historic Preservation Office
THSP - Technical Specialist
TIME – Time Unit Leader
TMA - Truck- Mounted Attenuator

USC – United States Code
USDA – United States Department of Agriculture
USFA – United States Fire Administration
UTF – Unable to Fill

VOR - VHF Omnidirectional Range
VLAT - Very Large Airtanker

YCC – Youth Conservation Corp
YOYP – You Order You Pay

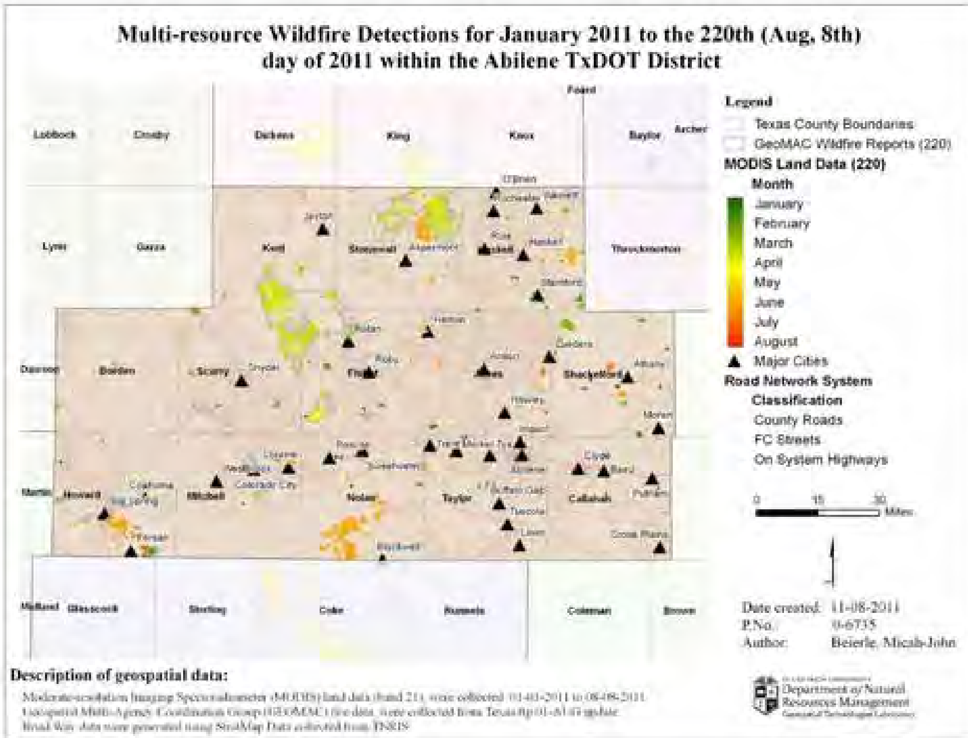
WASO – Washington Support Office
WCF – Working Capital Fund
WFEWT – Wildland Fire Education Working Team
WFIEB – Wildland Fire Investment Evaluation Board

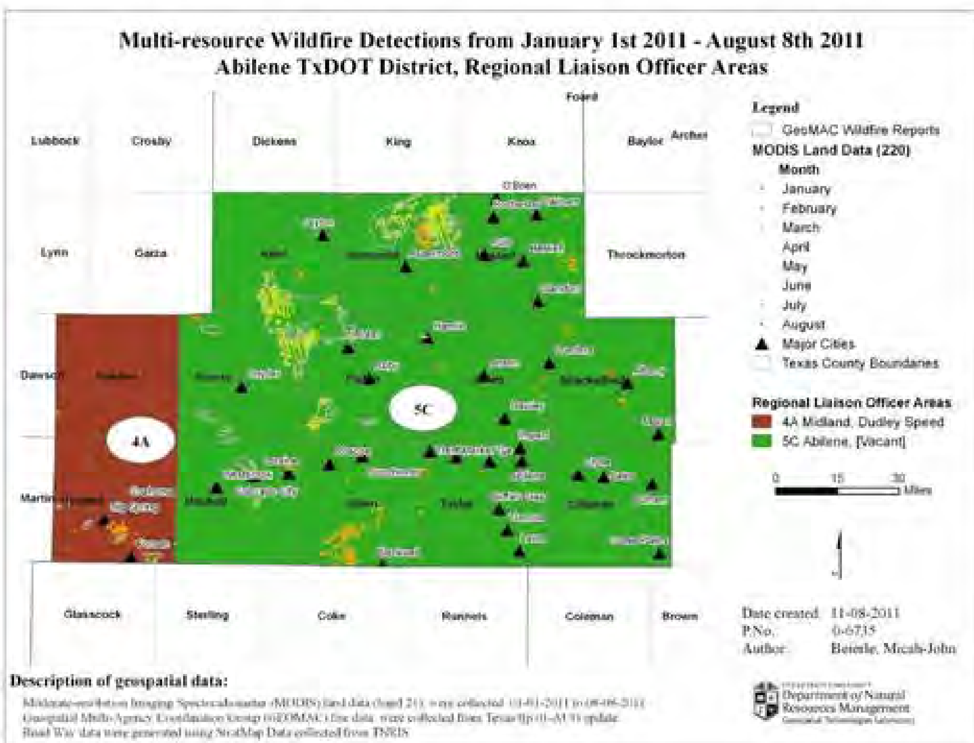
WFIP – Wildland Fire Implementation Plan
WFLC – Wildland Fire Leadership Council
WFMI – Wildland Fire Management Information System
WFSA – Wildland Fire Situation Analysis
WG – Wage Grade (Pay Plan)
WIMS – Weather Information Management System
WL – Wage Leader
WRCC – Western Region Climate Center
WS- Wage Supervisor
WUI – Wildland Urban Interface

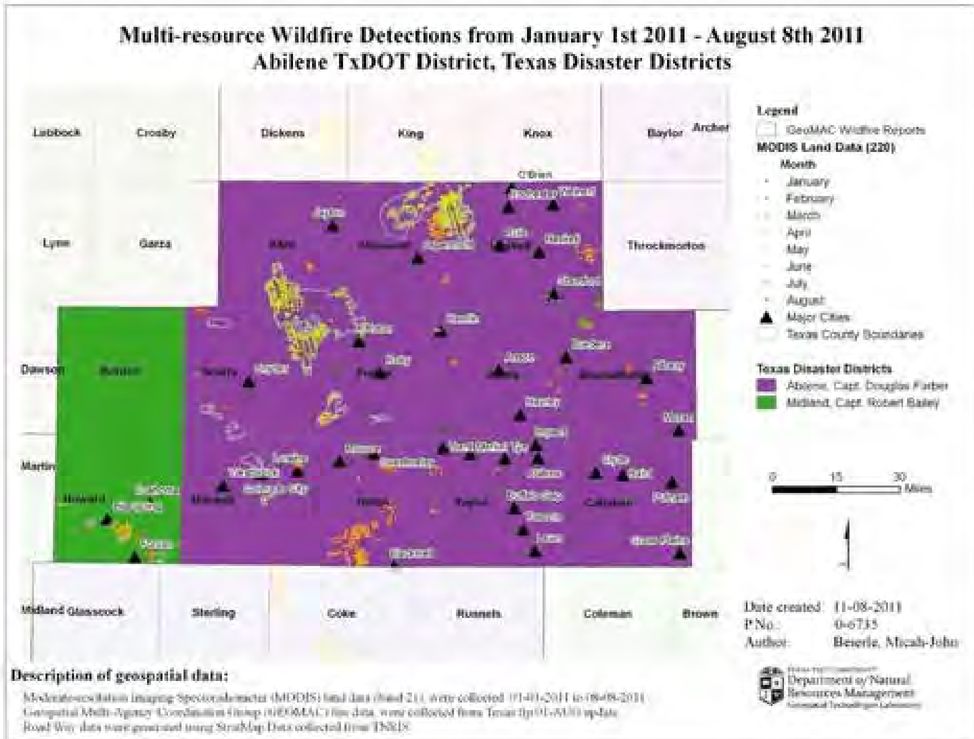
APPENDIX C

WILDFIRE LOCATION AND EMERGENCY MANAGEMENT DISTRICT MAPS FOR EACH DISTRICT INTERVIEWED

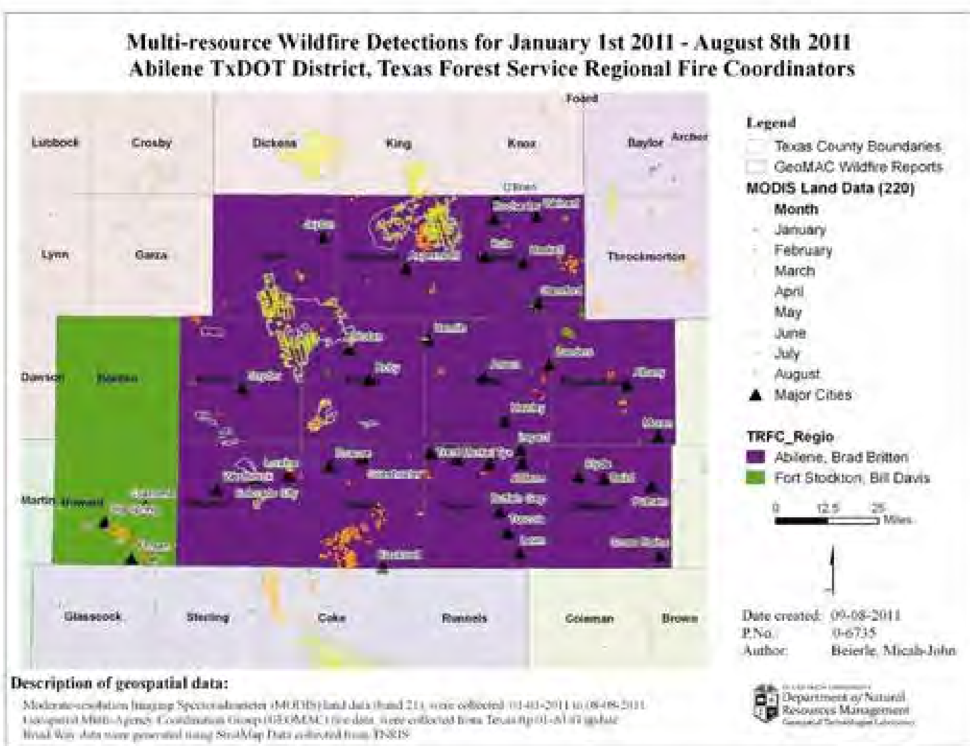
Abilene


Multi-resource Wildfire Detections for January 2011 to the 220th (Aug, 8th) day of 2011 within the Abilene TxDOT District
Legend
Texas County Boundaries
GeoMAC Wildfire Reports (220)
MODIS Land Data (220)
Month
January
February
March
April
May
June
July
August
Major Cities
Road Network System
Classification
County Roads
FC Streets
On System Highways
0 15 30 Miles
Lubbock
Crosby
Dickens
King
Knox
Baylor
Archer
Foard
Lynn
Garza
Kent
Stonewall
Throckmorton
Dawson
Borden
Scurry
Fisher
Shackelford
Martin
Howard
Mitchell
Nolan
Taylor
Callahan
Midland
Glasscock
Sterling
Coke
Runnels
Coleman
Brown
Date created: 11-08-2011
P.No. 0-6735
Author: Beierle, Micah-John
Description of geospatial data:
Department of Natural Resources Management


Multi-resource Wildfire Detections from January 1st 2011 - August 8th 2011
Abilene TxDOT District, Regional Liaison Officer Areas
Legend
GeoMAC Wildfire Reports
MODIS Land Data (220)
Month
January
February
March
April
May
June
July
August
Major Cities
Texas County Boundaries
Regional Liaison Officer Areas
4A Midland, Dudley Speed
5C Abilene, [Vacant]
0 15 30 Miles
4A
5C
Lubbock
Crosby
Dickens
King
Knox
Baylor
Archer
Foard
Lynn
Garza
Throckmorton
Dawson
Martin
Glasscock
Sterling
Coke
Runnels
Coleman
Brown
Date created: 11-08-2011
P.No. 0-6735
Author: Beierle, Micah-John
Description of geospatial data:
Department of Natural Resources Management



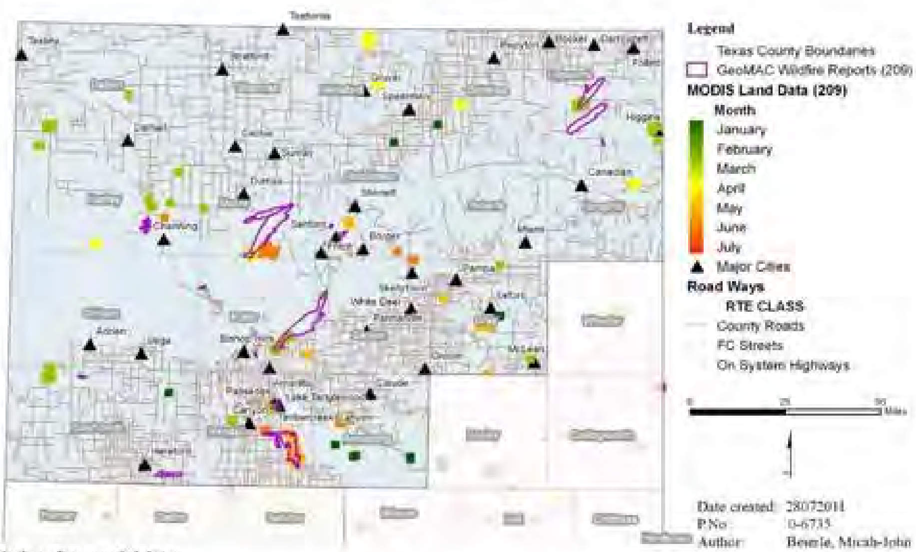
86 | Page



87 | Page

Amarillo

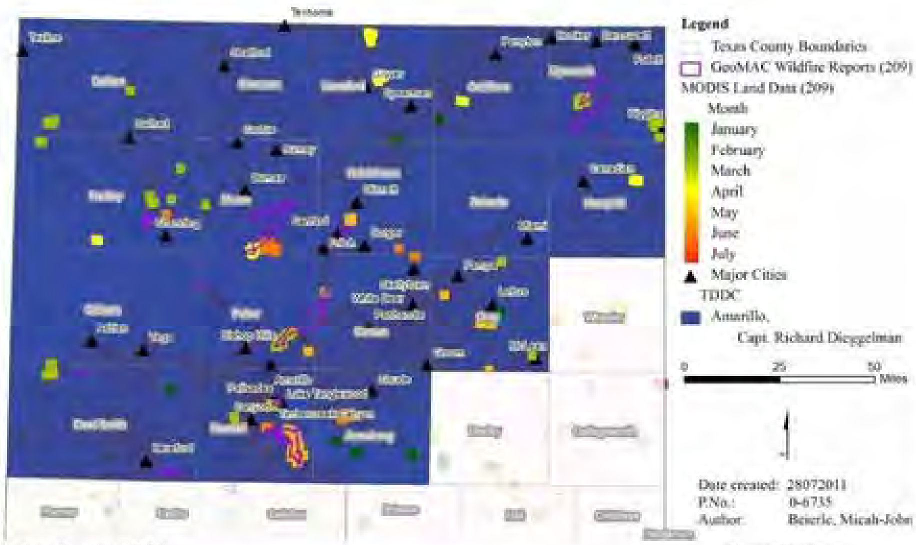
Multi-resource Wildfire Detections for January 1st 2011 to the 209th (Jul, 28th) day of 2011 within the Amarillo TxDOT District



Description of geospatial data:

Moderate-resolution Imaging Spectroradiometer (MODIS) land data (band 21) were collected 01012011 to 28072011. Geospatial Multi-Agency Coordination Group (GEOMAC) fire data were collected from Texas ftp (GAPS) update. Road Way data were generated using StratMap Data collected from TNRIS.

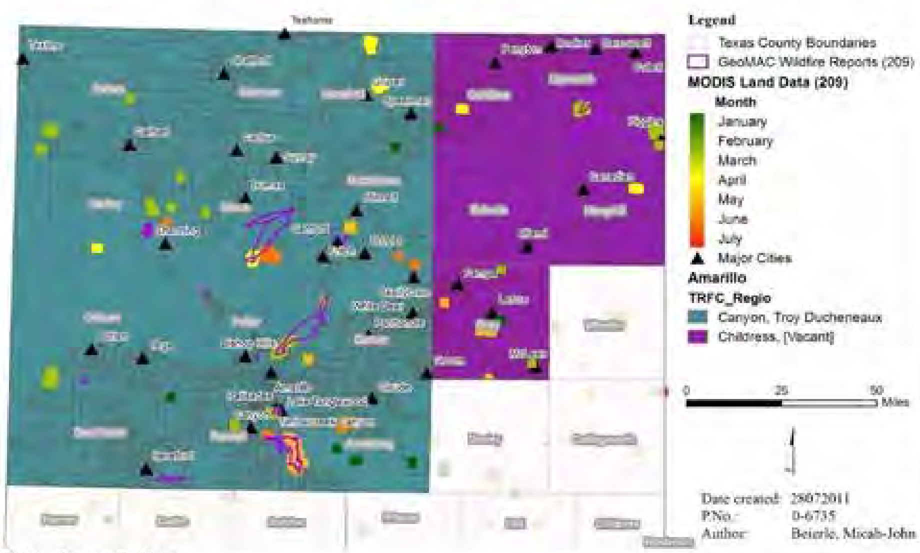
Multi-resource Wildfire Detections for January 1st 2011 to the 209th (Jul, 28th) day of 2011 within the Amarillo TxDOT District, Texas Disaster Districts



Description of geospatial data:

Moderate-resolution Imaging Spectroradiometer (MODIS) land data (band 21), were collected 01012011 to 28072011.
Geospatial Multi-Agency Coordination Group (GEOMAC) fire data, were collected from Texas ftp 01-AUG update.
Road Way data were generated using StratMap Data collected from TNRIS.

Multi-resource Wildfire Detections for January 1st 2011 to the 209th (Jul, 28th) day of 2011 within the Amarillo TxDOT District, Texas Forest Service Regional Fire Coordinators

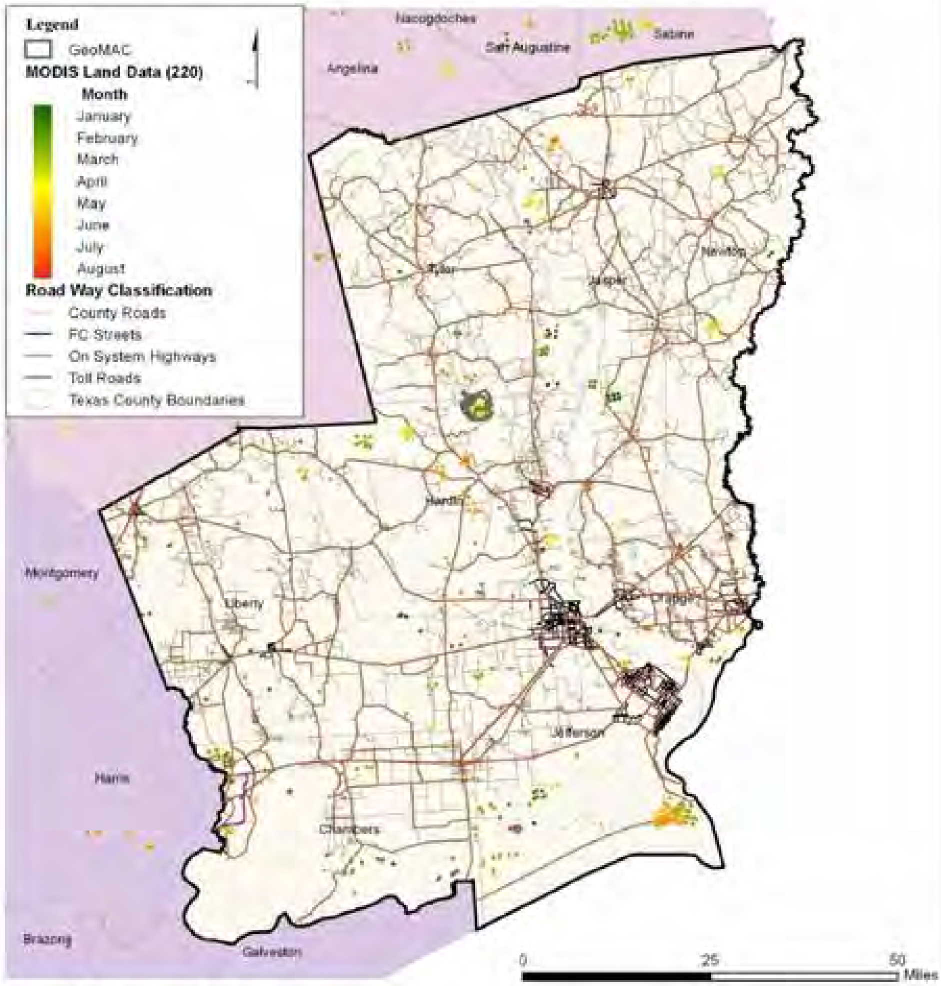


Description of geospatial data:

Moderate-resolution Imaging Spectroradiometer (MODIS) land data (band 21), were collected 01012011 to 28072011.
Geospatial Multi-Agency Coordination Group (GEOMAC) fire data, were collected from Texas ftp 01-AUG update.
Road Way data were generated using StratMap Data collected from TNRIS.

Beaumont

Multi-resource Major Wildfire Detections for January 2011 to the 220th (Aug, 8th) day of 2011 within the Beaumont TxDOT District



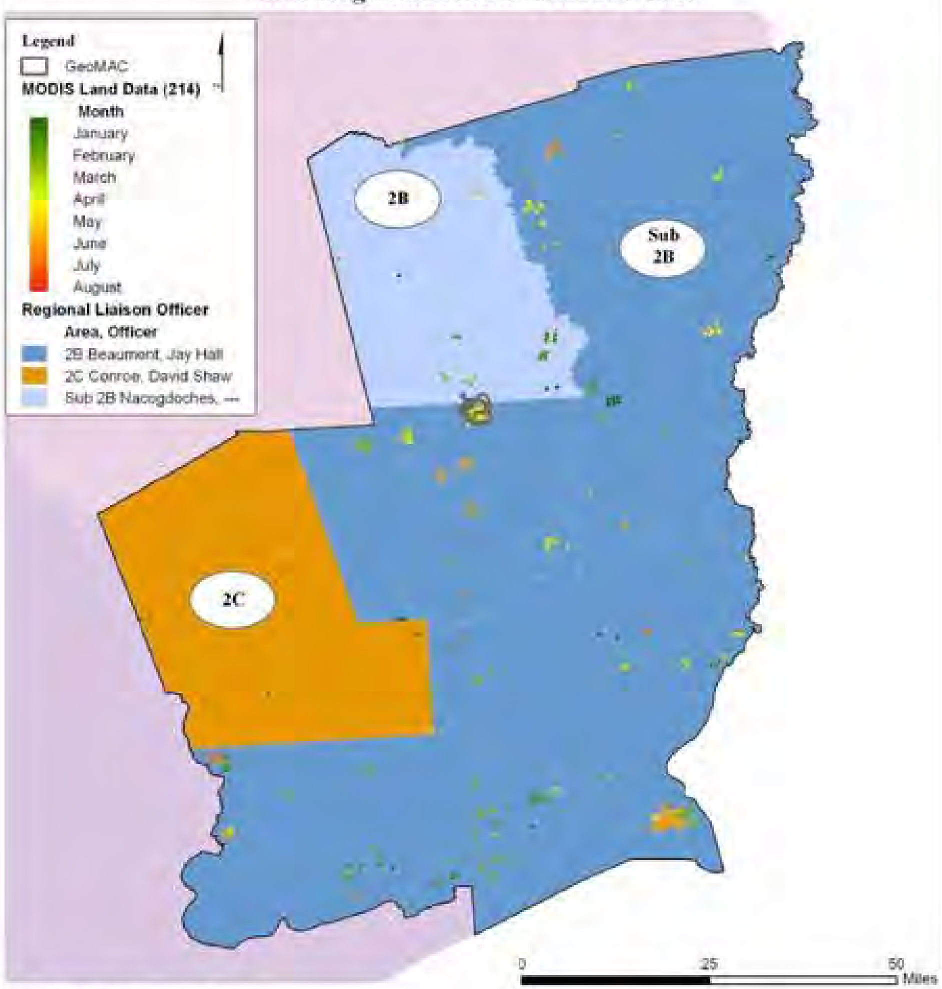
Description of geospatial data:

Moderate-resolution Imaging Spectoradiometer (MODIS) land data (band 21) were collected 01-01-2011 to 08-08-2011
Geospatial Multi-Agency Coordination Group (GEOMAC) fire data were collected from Texas ftp 01-AUG update
Road Way data were generated using StratMap Data collected from TNRIS.

Date created: 08-08-2011
P.No.: 0-6735
Author: Beierle, Micah-John

Department of Natural Resources Management
Geospatial Technologies Laboratory

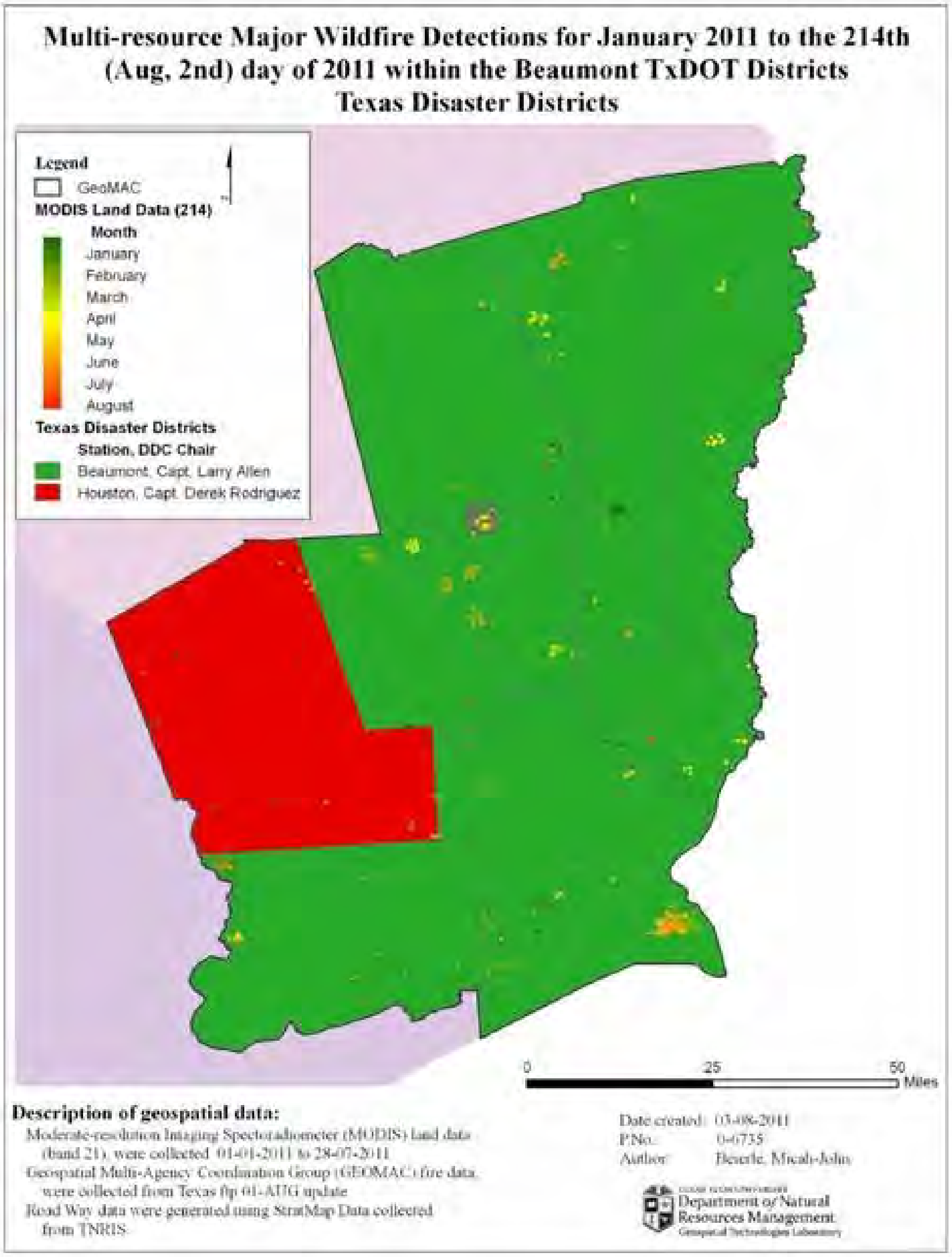
Multi-resource Major Wildfire Detections for January 2011 to the 214th (Aug, 2nd) day of 2011 within the Beaumont TxDOT Districts three Regional Liaison Officer Areas

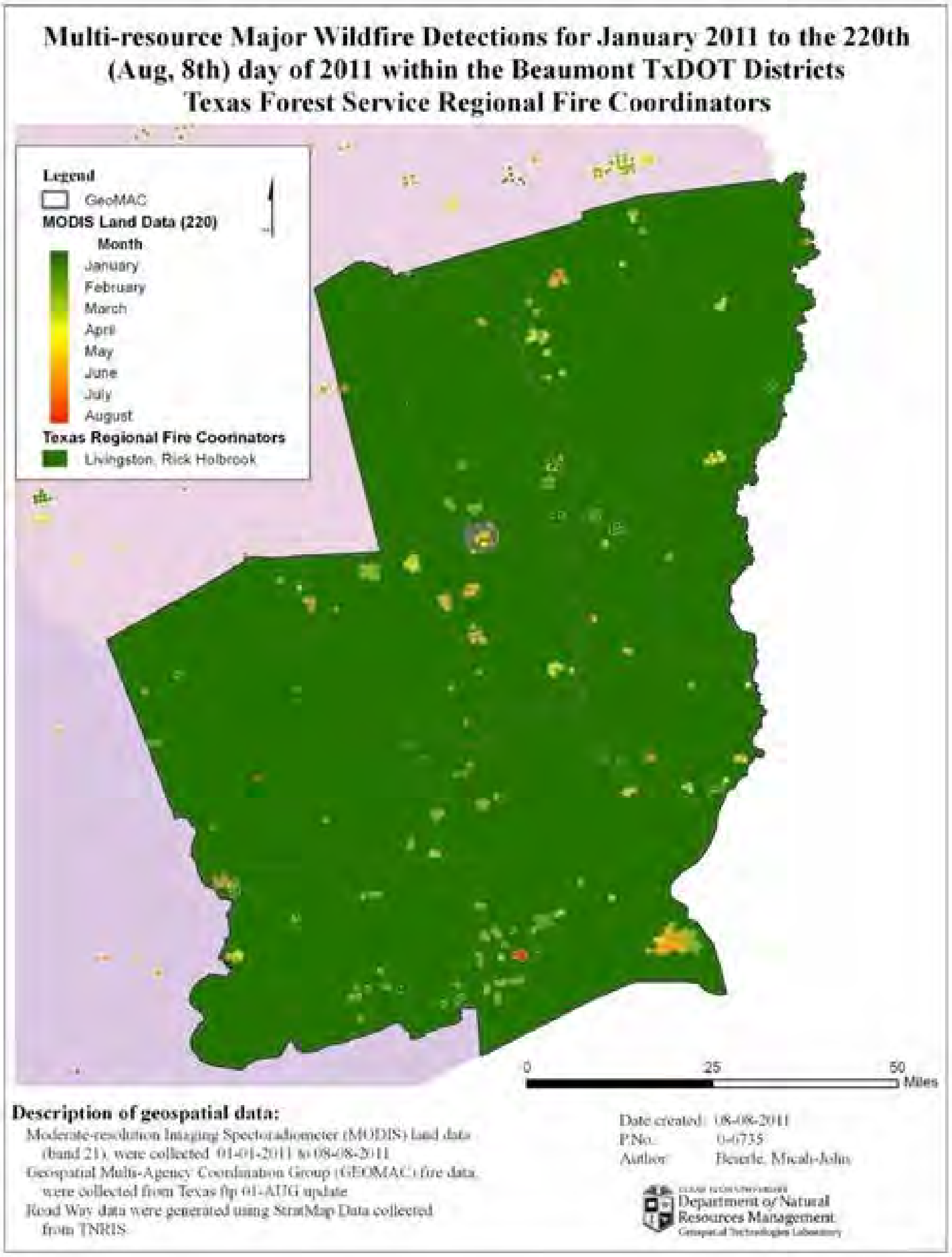


Description of geospatial data:
Moderate-resolution Imaging Spectoradiometer (MODIS) land data (band 21), were collected 01-01-2011 to 28-07-2011
Geospatial Multi-Agency Coordination Group (GEOMAC) fire data were collected from Texas ftp 01-AUG update
Road Way data were generated using StratMap Data collected from TNRIS

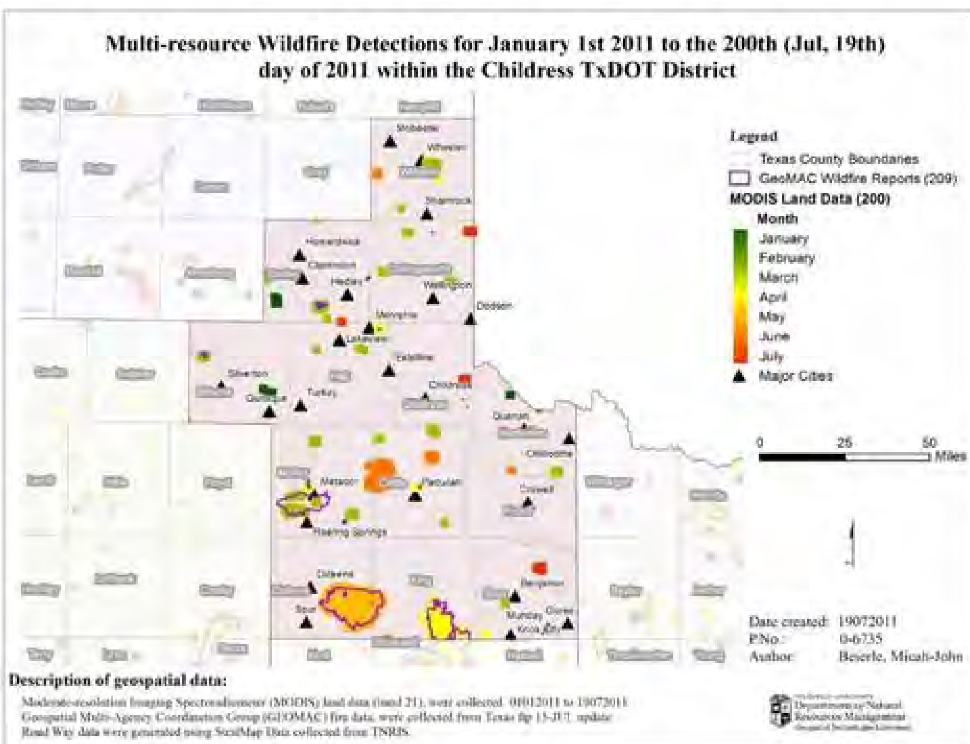
Date created: 03-08-2011
P.No. 0-6735
Author: Beierle, Micah-John

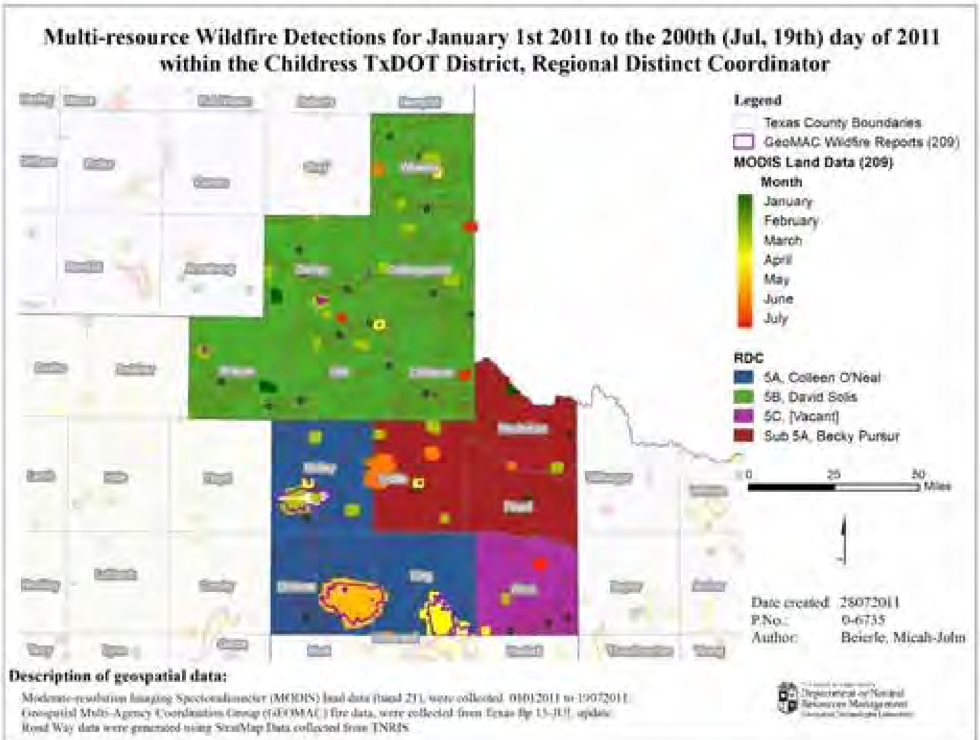
Department of Natural Resources Management
Geospatial Technologies Laboratory


Multi-resource Major Wildfire Detections for January 2011 to the 214th (Aug, 2nd) day of 2011 within the Beaumont TxDOT Districts
Texas Disaster Districts
Legend
GeoMAC
MODIS Land Data (214)
Month
January
February
March
April
May
June
July
August
Texas Disaster Districts
Station, DDC Chair
Beaumont, Capt. Larry Allen
Houston, Capt. Derek Rodriguez
0
25
50
Miles
Description of geospatial data:
Moderate-resolution Imaging Spectoradiometer (MODIS) land data (band 21), were collected 01-01-2011 to 28-07-2011
Geospatial Multi-Agency Coordination Group (GEOMAC) fire data were collected from Texas ftp 01-AUG update
Road Way data were generated using StratMap Data collected from TNRIS
Date created: 03-08-2011
P.No.: 0-6735
Author: Beierle, Micah-John
Department of Natural Resources Management
Geospatial Technologies Laboratory

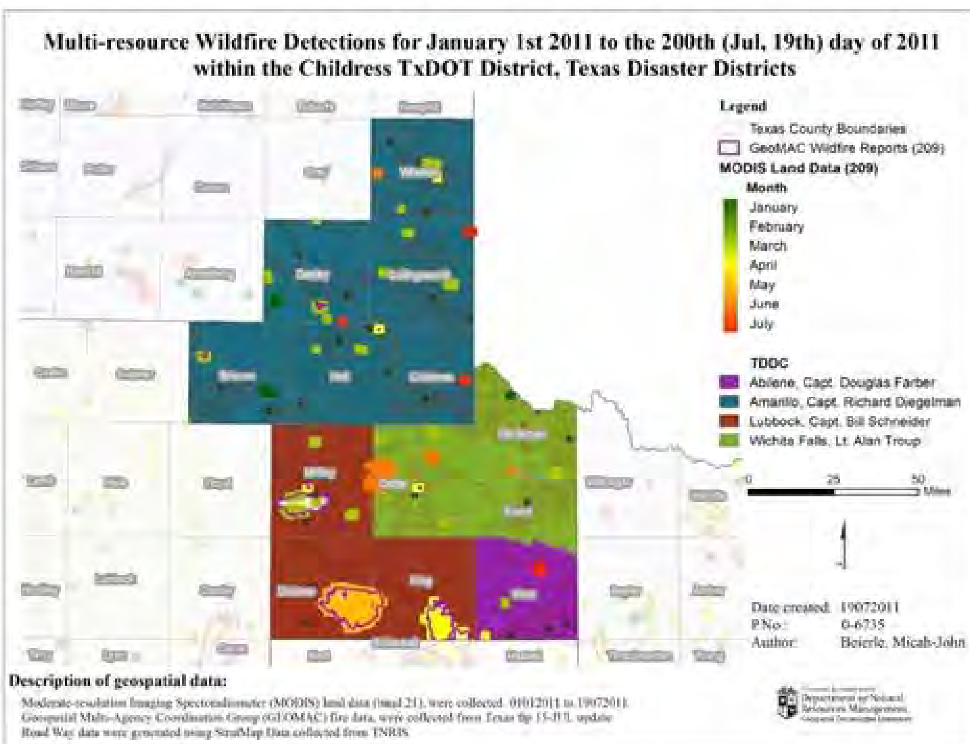

Multi-resource Major Wildfire Detections for January 2011 to the 220th (Aug, 8th) day of 2011 within the Beaumont TxDOT Districts
Texas Forest Service Regional Fire Coordinators
Legend
GeoMAC
MODIS Land Data (220)
Month
January
February
March
April
May
June
July
August
Texas Regional Fire Coorinators
Livingston, Rick Holbrook
0
25
50
Miles
Description of geospatial data:
Moderate-resolution Imaging Spectoradiometer (MODIS) land data (band 21), were collected 01-01-2011 to 08-08-2011
Geospatial Multi-Agency Coordination Group (GEOMAC) fire data, were collected from Texas ftp 01-AUG update
Road Way data were generated using StratMap Data collected from TNRIS
Date created: 08-08-2011
P.No.: 0-6735
Author: Beierle, Micah-John
Department of Natural Resources Management
Geospatial Technologies Laboratory

Childress

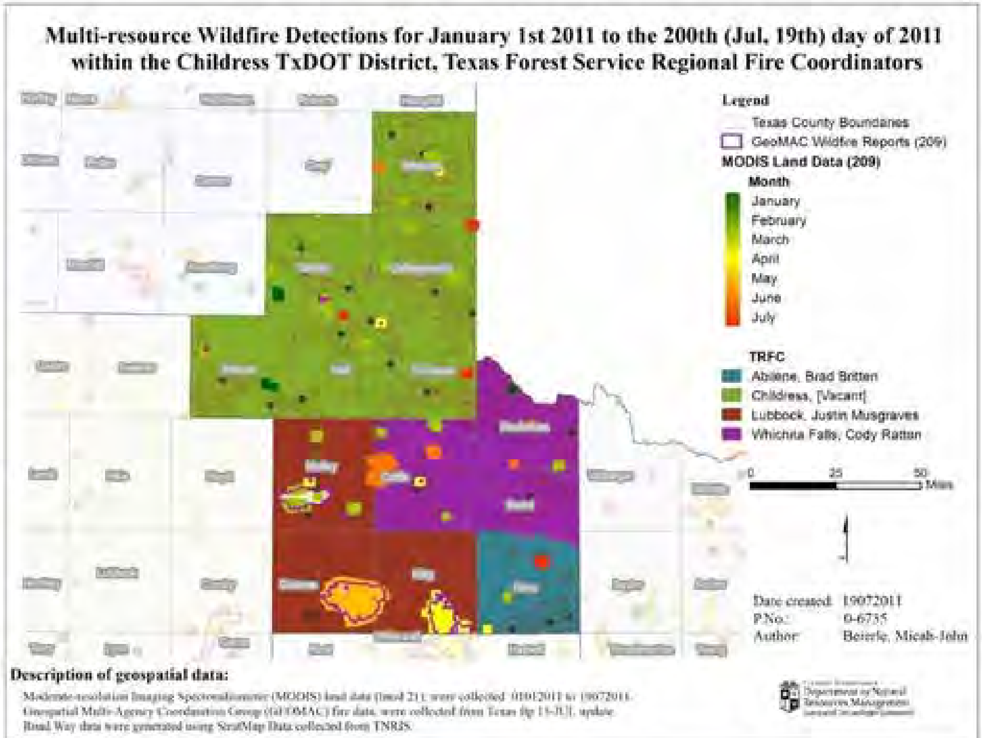

Multi-resource Wildfire Detections for January 1st 2011 to the 200th (Jul, 19th) day of 2011 within the Childress TxDOT District
Legend
Texas County Boundaries
GeoMAC Wildfire Reports (209)
MODIS Land Data (200)
Month
January
February
March
April
May
June
July
Major Cities
0
25
50
Miles
Mobeetie
Wheeler
Shamrock
Howardwick
Clarendon
Hedley
Wellington
Dodson
Memphis
Lakeview
Estelline
Silverton
Quitaque
Turkey
Childress
Quanah
Chillicothe
Crowell
Matador
Paducah
Roaring Springs
Dickens
Spur
Benjamin
Munday
Goree
Knox City
Date created: 19072011
P.No.: 0-6735
Author: Beserle, Micah-John
Description of geospatial data:
Moderate-resolution Imaging Spectroradiometer (MODIS) land data (band 21), were collected 01012011 to 19072011
Geospatial Multi-Agency Coordination Group (GEOMAC) fire data, were collected from Texas ftp 15-JUL update
Road Way data were generated using StratMap Data collected from TNRIS.
Department of Natural Resources Management



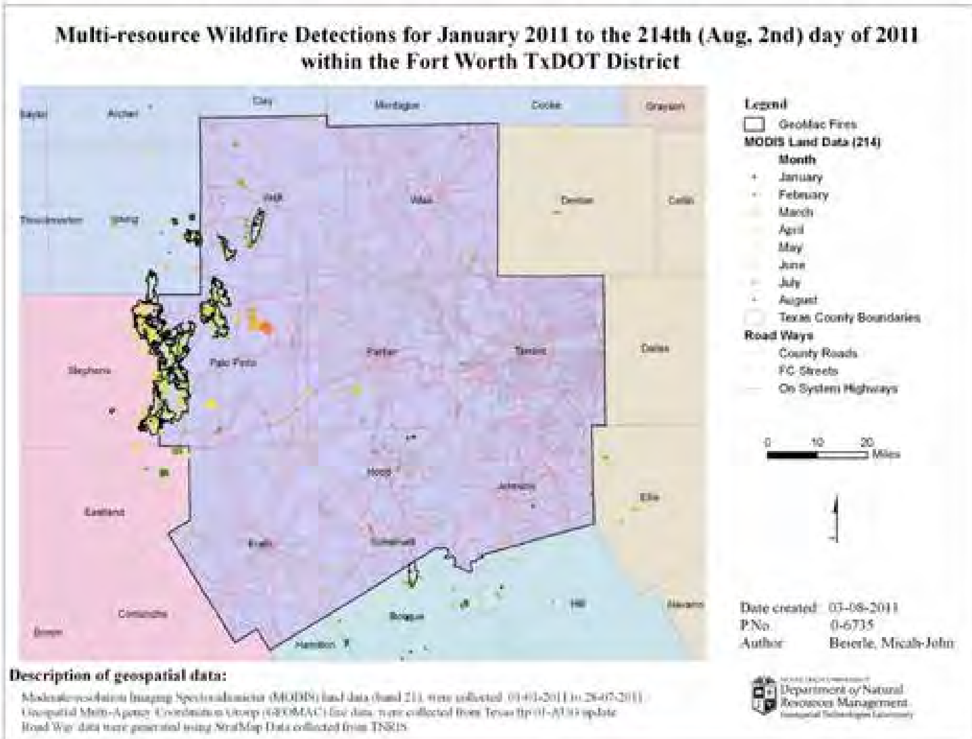
100 | Page

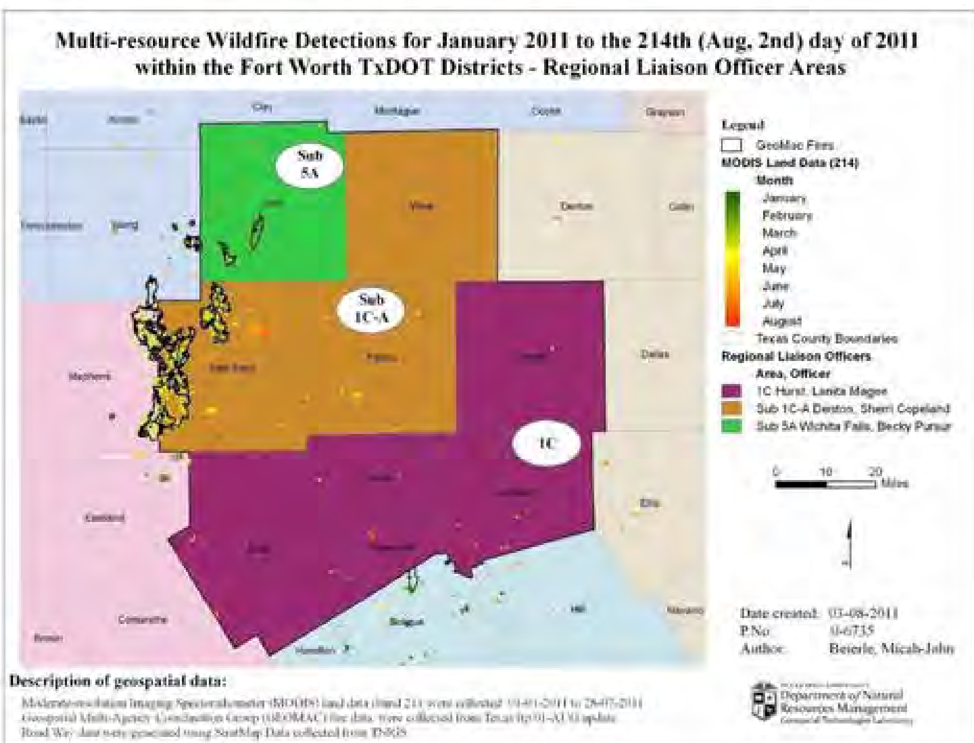


101 | Page

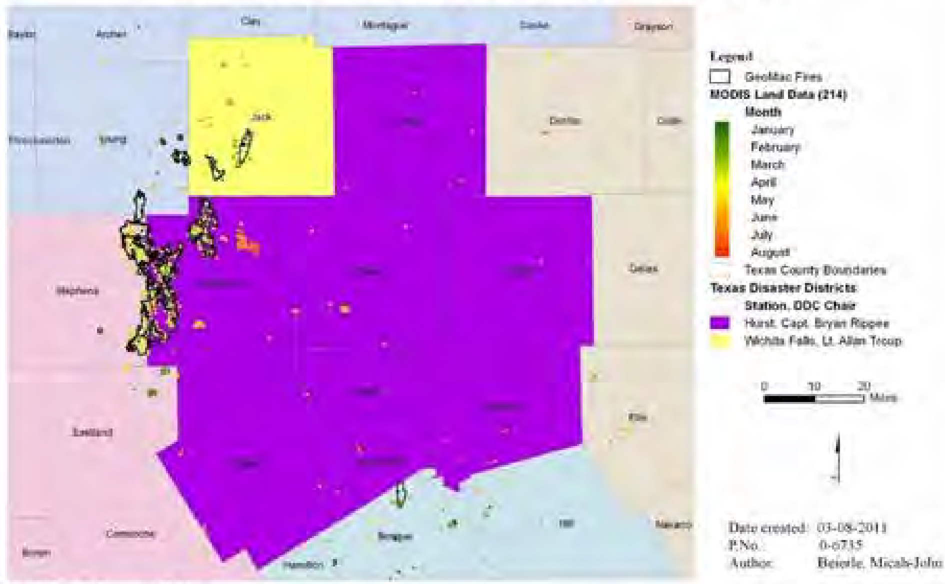

Multi-resource Wildfire Detections for January 1st 2011 to the 200th (Jul, 19th) day of 2011
within the Childress TxDOT District, Texas Forest Service Regional Fire Coordinators
Legend
Texas County Boundaries
GeoMAC Wildfire Reports (209)
MODIS Land Data (209)
Month
January
February
March
April
May
June
July
TRFC
Abilene, Brad Britten
Childress, [Vacant]
Lubbock, Justin Musgraves
Whichita Falls, Cody Ratton
0
25
50
Miles
Date created: 19072011
P.No.: 0-6735
Author: Beierle, Micah-John
Description of geospatial data:
Road Way data were generated using StratMap Data collected from TNRIS.

Fort Worth


Multi-resource Wildfire Detections for January 2011 to the 214th (Aug. 2nd) day of 2011
within the Fort Worth TxDOT District
Baylor
Archer
Clay
Montague
Cooke
Grayson
Throckmorton
Young
Jack
Wise
Denton
Collin
Stephens
Palo Pinto
Parker
Tarrant
Dallas
Eastland
Hood
Johnson
Ellis
Erath
Somervell
Comanche
Bosque
Hill
Navarro
Brown
Hamilton
Legend
GeoMac Fires
MODIS Land Data (214)
Month
January
February
March
April
May
June
July
August
Texas County Boundaries
Road Ways
County Roads
FC Streets
On System Highways
0 10 20 Miles
Date created: 03-08-2011
P.No. 0-6735
Author: Beierle, Micah-John
Description of geospatial data:
Department of Natural Resources Management


Multi-resource Wildfire Detections for January 2011 to the 214th (Aug. 2nd) day of 2011
within the Fort Worth TxDOT Districts - Regional Liaison Officer Areas
Sub 5A
Sub 1C-A
1C
Baylor
Archer
Clay
Montague
Cooke
Grayson
Throckmorton
Young
Wise
Denton
Collin
Stephens
Dallas
Eastland
Ellis
Comanche
Bosque
Hill
Navarro
Brown
Hamilton
Legend
GeoMac Fires
MODIS Land Data (214)
Month
January
February
March
April
May
June
July
August
Texas County Boundaries
Regional Liaison Officers
Area, Officer
1C Hurst, Lanita Magee
Sub 1C-A Denton, Sherri Copeland
Sub 5A Wichita Falls, Becky Pursur
0 10 20 Miles
Date created: 03-08-2011
P.No. 0-6735
Author: Beierle, Micah-John
Description of geospatial data:
Department of Natural Resources Management

Multi-resource Wildfire Detections for January 2011 to the 214th (Aug, 2nd) day of 2011 within the Fort Worth TxDOT Districts - Texas Disaster Districts

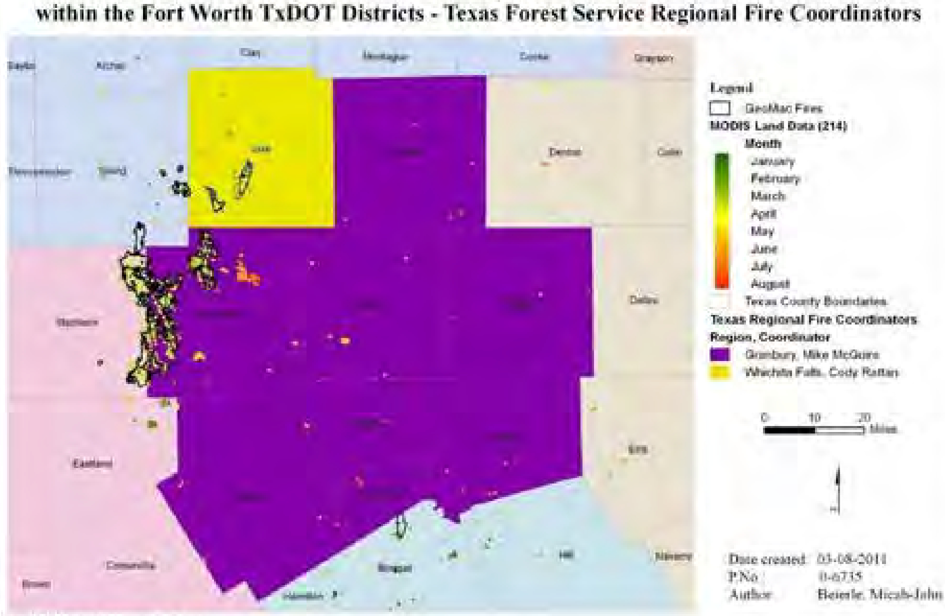


Description of geospatial data:

Moderate-resolution Imaging Spectroradiometer (MODIS) land data (band 21), were collected 01-01-2011 to 28-07-2011
Geospatial Multi-Agency Coordination Group (GEOMAC) fire data, were collected from Texas ftp 01-AUG update
Road Way data were generated using StratMap Data collected from TNRIS

Department of Natural Resources Management

Multi-resource Wildfire Detections for January 2011 to the 214th (Aug, 2nd) day of 2011 within the Fort Worth TxDOT Districts - Texas Forest Service Regional Fire Coordinators

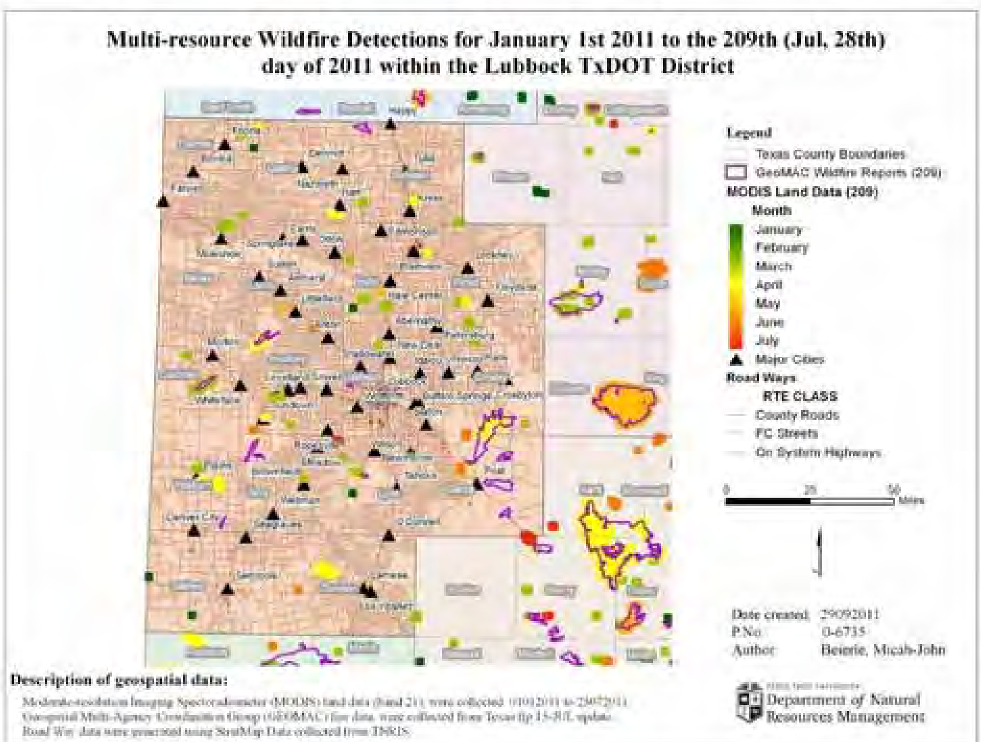


Description of geospatial data:

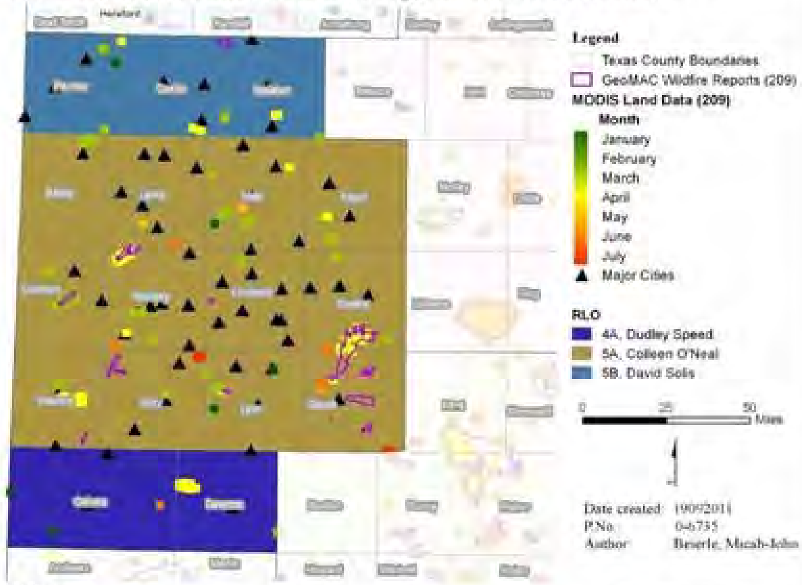
Moderate-resolution Imaging Spectroradiometer (MODIS) land data (band 21), were collected 01-01-2011 to 28-07-2011
Geospatial Multi-Agency Coordination Group (GEOMAC) fire data, were collected from Texas ftp 01-AUG update
Road Way data were generated using StratMap Data collected from TNRIS

Department of Natural Resources Management

Lubbock


Multi-resource Wildfire Detections for January 1st 2011 to the 209th (Jul, 28th) day of 2011 within the Lubbock TxDOT District
Legend
Texas County Boundaries
GeoMAC Wildfire Reports (209)
MODIS Land Data (209)
Month
January
February
March
April
May
June
July
Major Cities
Road Ways
RTE CLASS
County Roads
FC Streets
On System Highways
0
25
50
Miles
Date created: 29092011
P.No: 0-6735
Author: Beierle, Micah-John
Description of geospatial data:
Department of Natural Resources Management

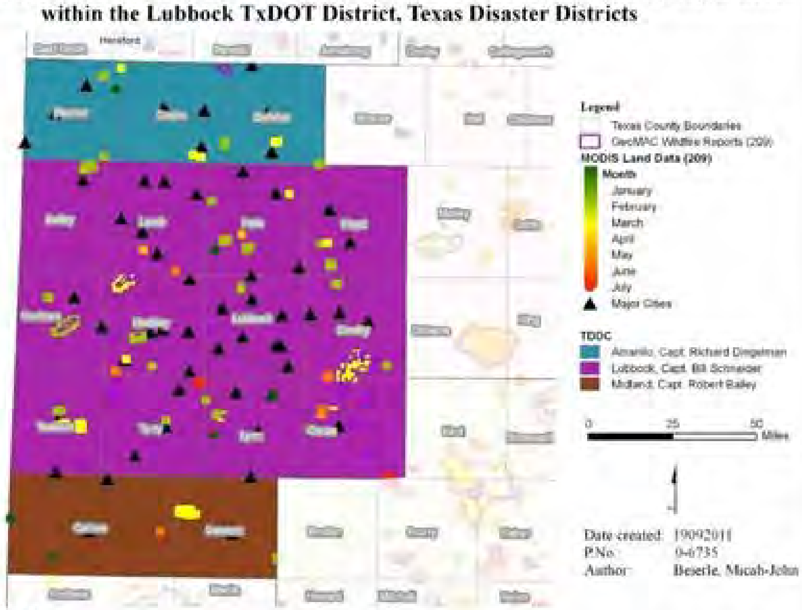
Multi-resource Wildfire Detections for January 1st 2011 to the 200th (Jul, 19th) day of 2011 within the Lubbock TxDOT District, Regional Distinct Coordinator



Description of geospatial data:

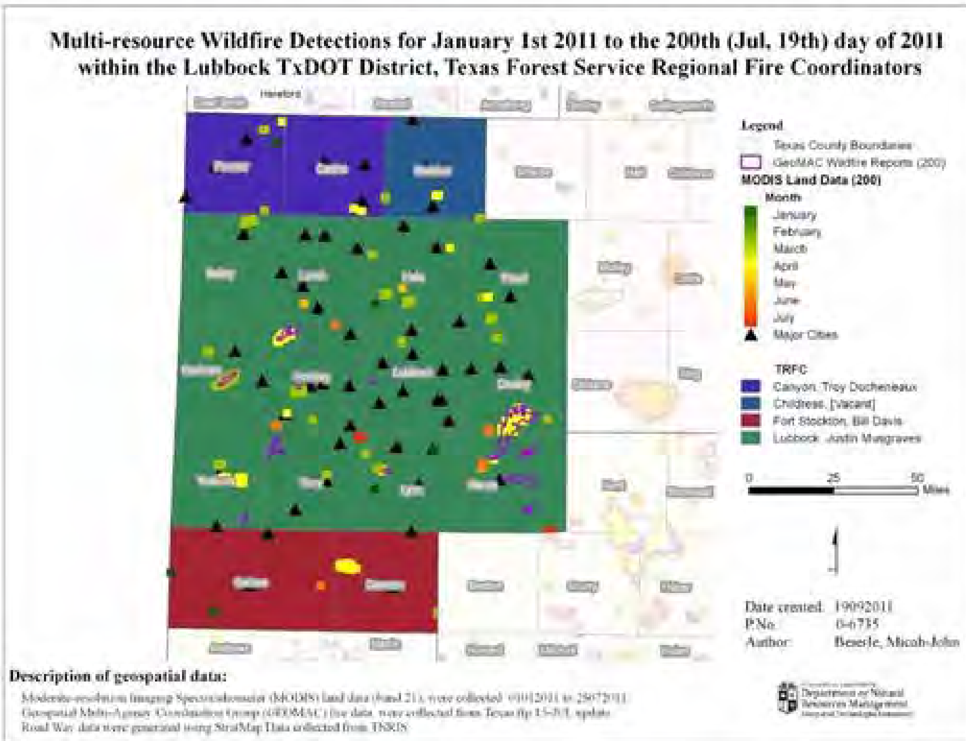
Moderate-resolution Imaging Spectroradiometer (MODIS) land data (band 21), were collected 01012011 to 25072011
Geospatial Multi-Agency Coordination Group (GEOMAC) fire data, were collected from Texas ftp 15-JUL update
Road Way data were generated using StratMap Data collected from TNRIS.

Multi-resource Wildfire Detections for January 1st 2011 to the 200th (Jul, 19th) day of 2011 within the Lubbock TxDOT District, Texas Disaster Districts



Description of geospatial data:

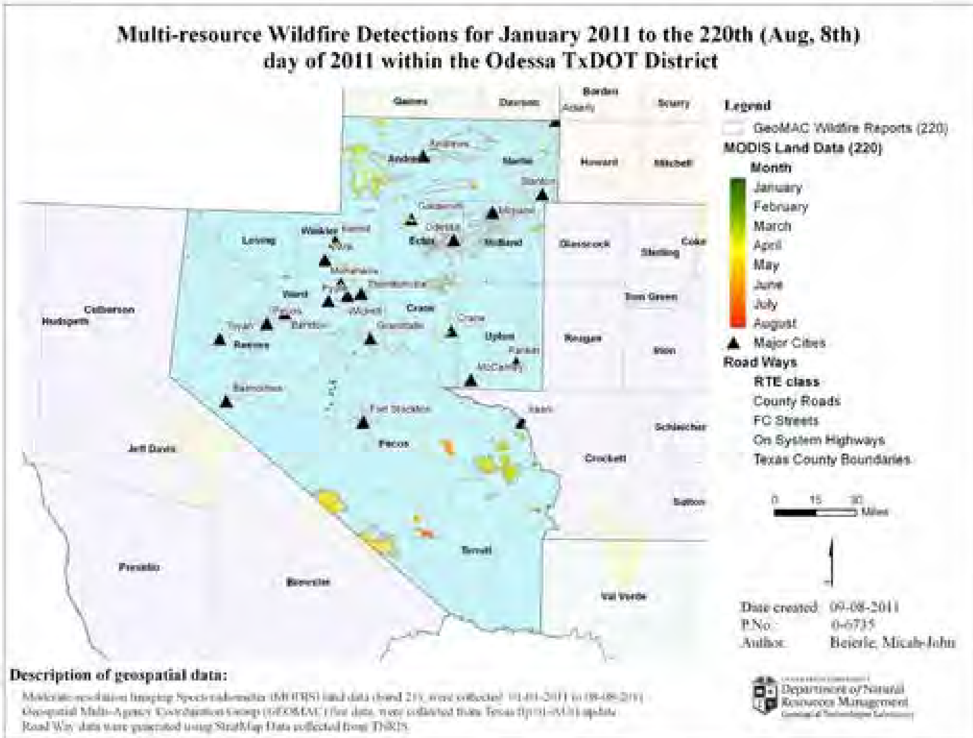
Moderate-resolution Imaging Spectroradiometer (MODIS) land data (band 21), were collected 01012011 to 25072011
Geospatial Multi-Agency Coordination Group (GEOMAC) fire data, were collected from Texas ftp 15-JUL update
Road Way data were generated using StratMap Data collected from TNRIS.

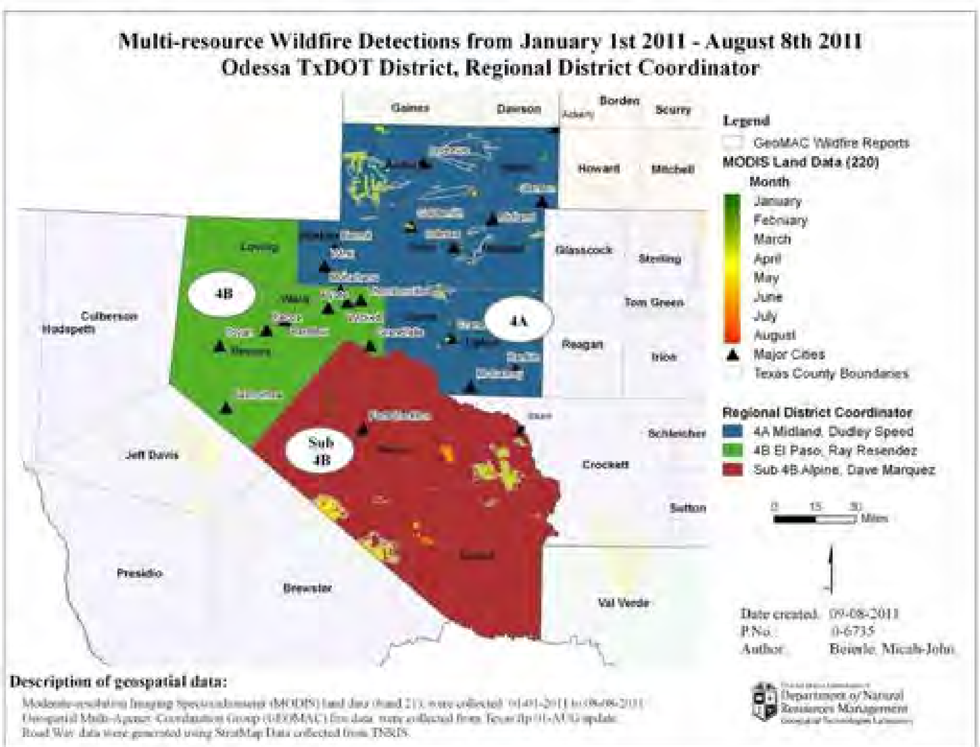


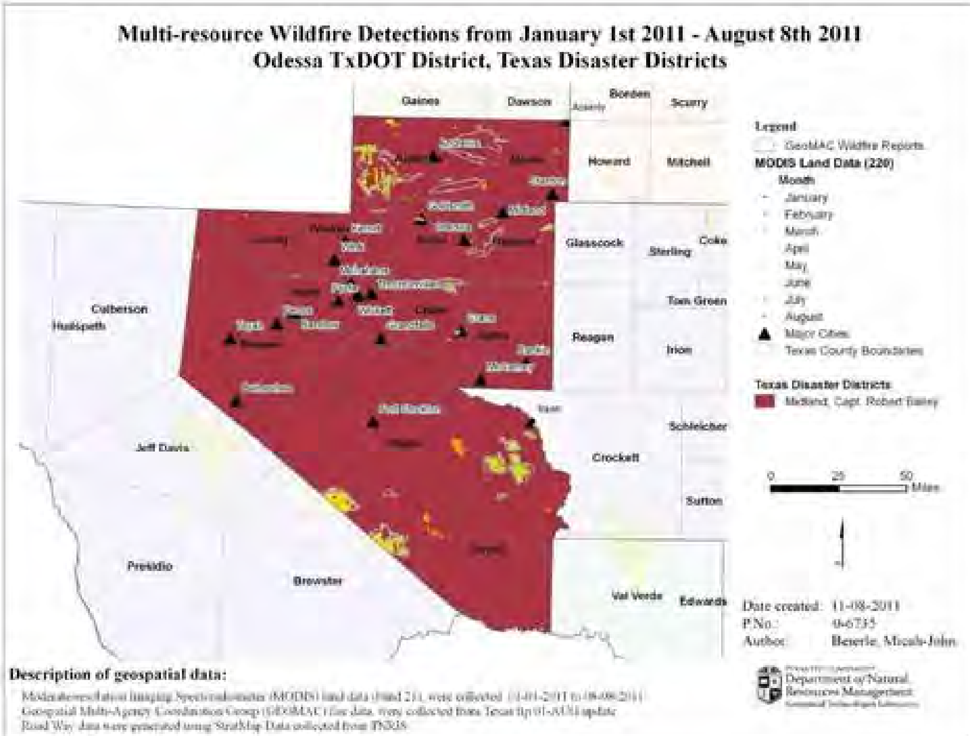
112 | Page

Odessa

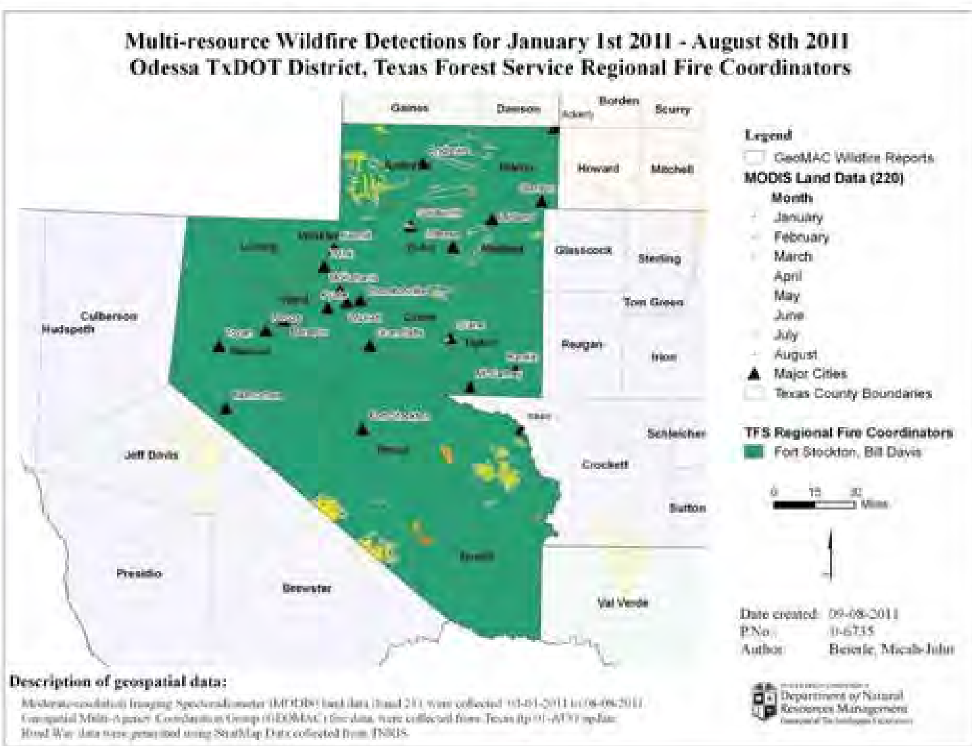
113 | Page


Multi-resource Wildfire Detections for January 2011 to the 220th (Aug, 8th) day of 2011 within the Odessa TxDOT District
Legend
GeoMAC Wildfire Reports (220)
MODIS Land Data (220)
Month
January
February
March
April
May
June
July
August
Major Cities
Road Ways
RTE class
County Roads
FC Streets
On System Highways
Texas County Boundaries
0 15 30 Miles
Date created: 09-08-2011
P.No.: 0-6735
Author: Beierle, Micah-John
Description of geospatial data:
Department of Natural Resources Management


Multi-resource Wildfire Detections from January 1st 2011 - August 8th 2011
Odessa TxDOT District, Regional District Coordinator
4B
4A
Sub 4B
Legend
GeoMAC Wildfire Reports
MODIS Land Data (220)
Month
January
February
March
April
May
June
July
August
Major Cities
Texas County Boundaries
Regional District Coordinator
4A Midland, Dudley Speed
4B El Paso, Ray Resendez
Sub 4B Alpine, Dave Marquez
0 15 30 Miles
Date created: 09-08-2011
P.No.: 0-6735
Author: Beierle, Micah-John
Description of geospatial data:
Department of Natural Resources Management

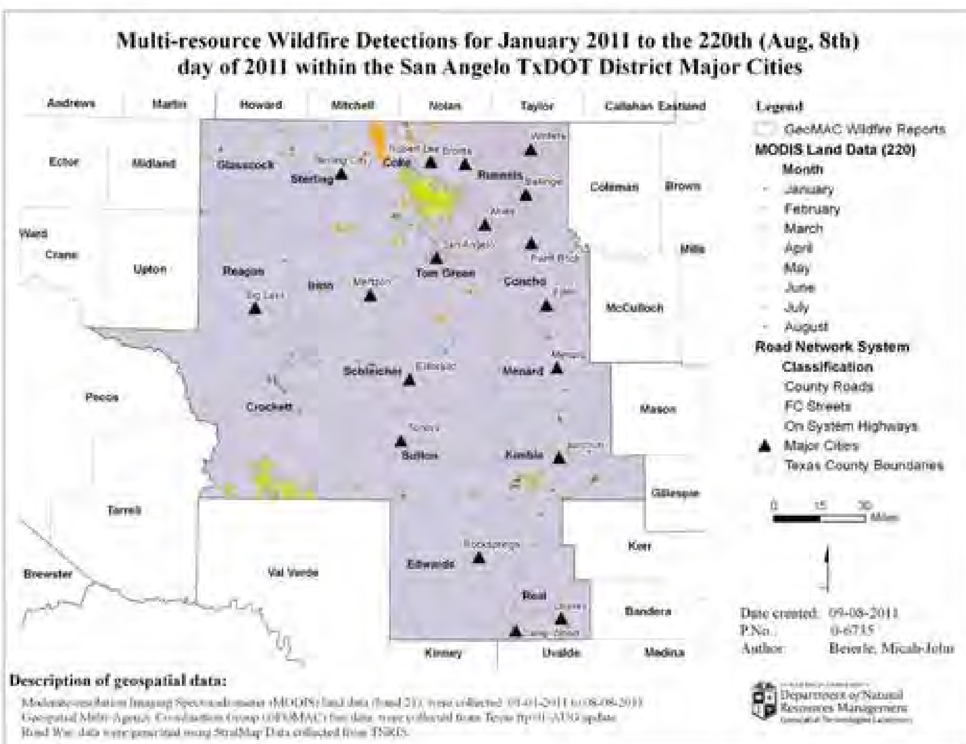


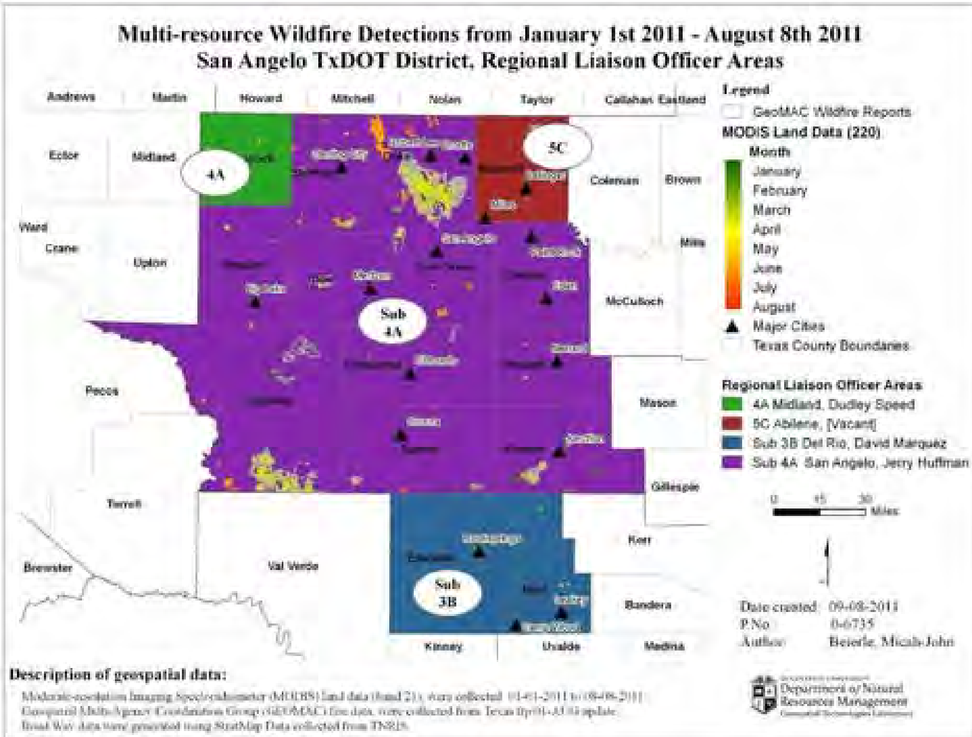
116 | Page



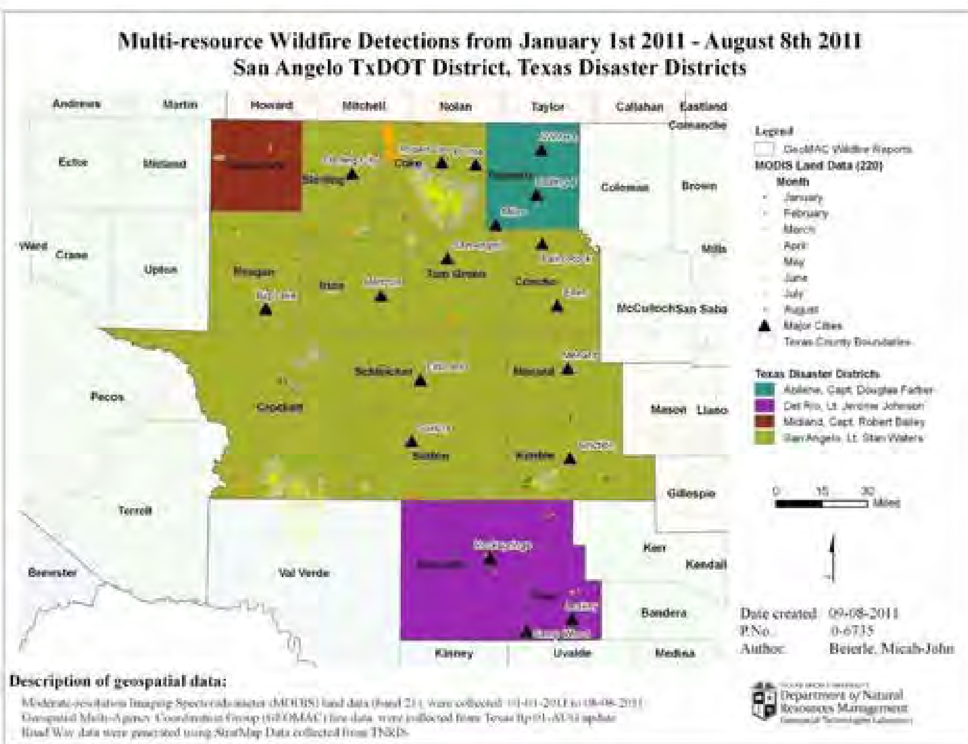
117 | Page

San Angelo

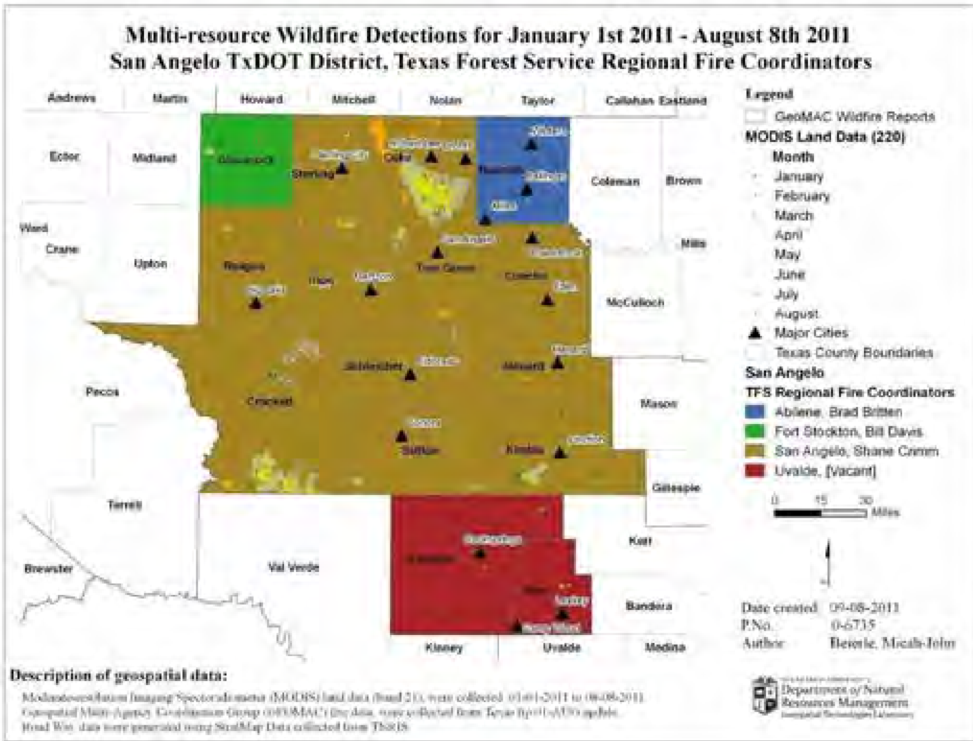

Multi-resource Wildfire Detections for January 2011 to the 220th (Aug. 8th) day of 2011 within the San Angelo TxDOT District Major Cities
Andrews
Martin
Howard
Mitchell
Nolan
Taylor
Callahan
Eastland
Ector
Midland
Glasscock
Sterling
Coke
Runnels
Coleman
Brown
Ward
Crane
Upton
Reagan
Irion
Tom Green
Concho
Mills
McCulloch
Pecos
Crockett
Schleicher
Menard
Mason
Sutton
Kimble
Gillespie
Terrell
Brewster
Val Verde
Edwards
Kerr
Real
Bandera
Kinney
Uvalde
Medina
Legend
GeoMAC Wildfire Reports
MODIS Land Data (220)
Month
January
February
March
April
May
June
July
August
Road Network System
Classification
County Roads
FC Streets
On System Highways
Major Cities
Texas County Boundaries
Miles
Date created: 09-08-2011
P.No.: 0-6735
Author: Beierle, Micah-John
Description of geospatial data:
Department of Natural Resources Management



Multi-resource Wildfire Detections from January 1st 2011 - August 8th 2011
San Angelo TxDOT District, Regional Liaison Officer Areas
Andrews
Martin
Howard
Mitchell
Nolan
Taylor
Callahan
Eastland
Ector
Midland
4A
5C
Coleman
Brown
Ward
Crane
Upton
Mills
Sub 4A
McCulloch
Pecos
Mason
Gillespie
Terrell
Kerr
Brewster
Val Verde
Sub 3B
Bandera
Kinney
Uvalde
Medina
Legend
GeoMAC Wildfire Reports
MODIS Land Data (220)
Month
January
February
March
April
May
June
July
August
Major Cities
Texas County Boundaries
Regional Liaison Officer Areas
4A Midland, Dudley Speed
5C Abilene, [Vacant]
Sub 3B Del Rio, David Marquez
Sub 4A San Angelo, Jerry Huffman
0 15 30 Miles
Date created: 09-08-2011
P.No. 0-6735
Author: Beierle, Micah-John
Description of geospatial data:
Department of Natural Resources Management

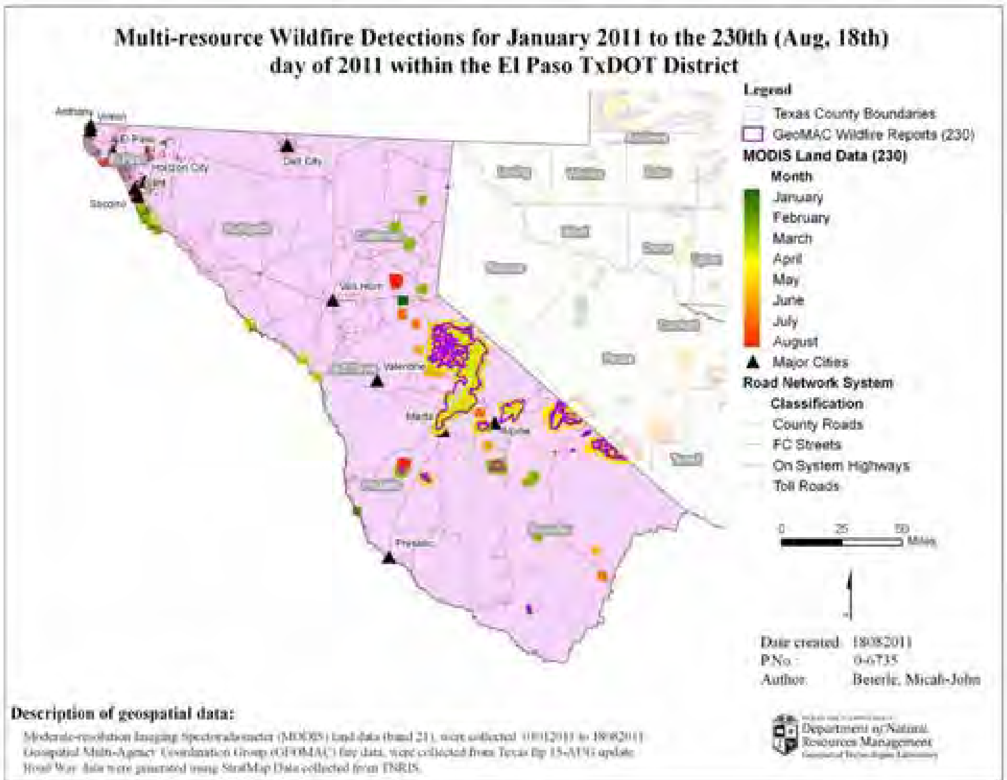


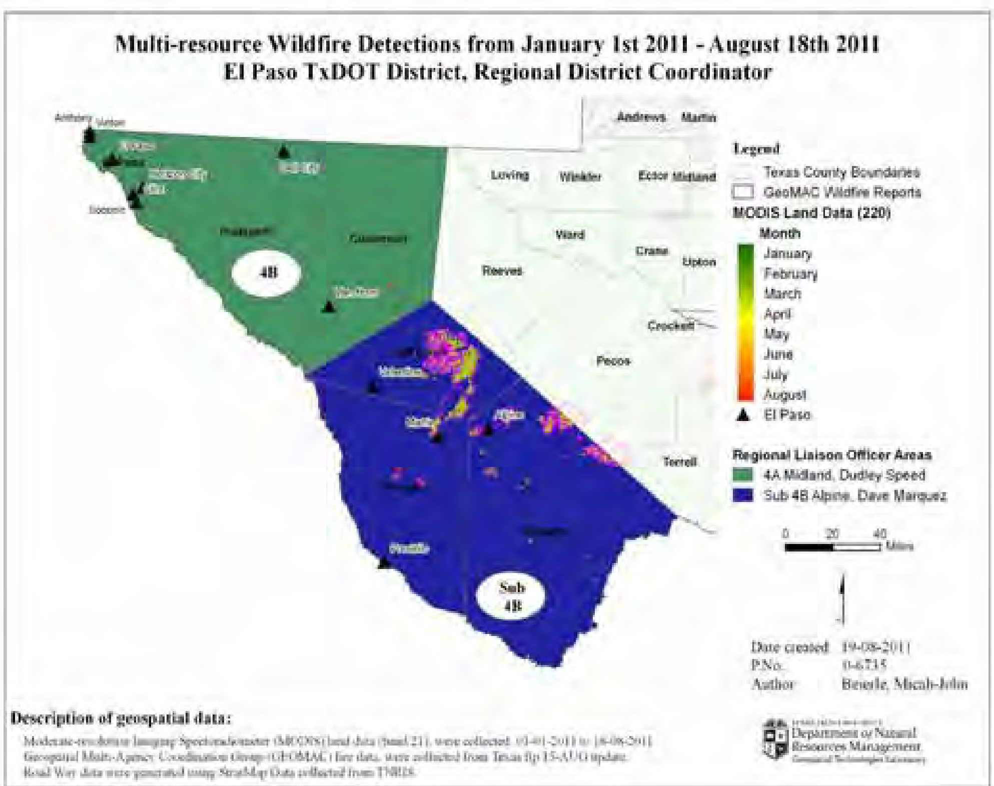
Multi-resource Wildfire Detections from January 1st 2011 - August 8th 2011
San Angelo TxDOT District, Texas Disaster Districts
Andrews
Martin
Howard
Mitchell
Nolan
Taylor
Callahan
Eastland
Comanche
Ector
Midland
Sterling
Coke
Coleman
Brown
Ward
Crane
Upton
Mills
Reagan
Irion
Tom Green
Concho
McCulloch
San Saba
Schleicher
Menard
Pecos
Crockett
Mason
Llano
Sutton
Kimble
Gillespie
Terrell
Kerr
Kendall
Brewster
Val Verde
Bandera
Kinney
Uvalde
Medina
Legend
GeoMAC Wildfire Reports
MODIS Land Data (220)
Month
January
February
March
April
May
June
July
August
Major Cities
Texas County Boundaries
Texas Disaster Districts
Abilene, Capt. Douglas Farber
Del Rio, Lt. Jerome Johnson
Midland, Capt. Robert Bailey
San Angelo, Lt. Stan Waters
0 15 30 Miles
Date created: 09-08-2011
P.No. 0-6735
Author: Beierle, Micah-John
Description of geospatial data:
Department of Natural Resources Management



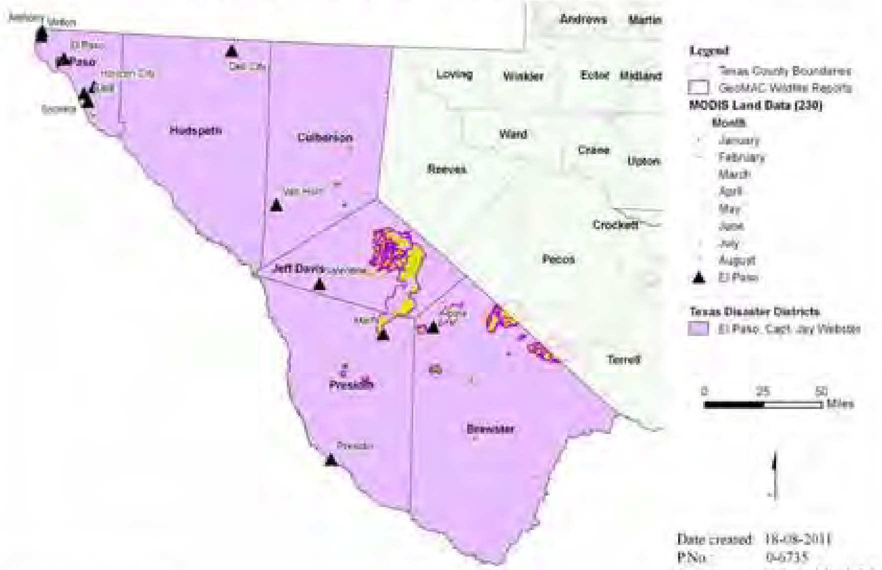
Multi-resource Wildfire Detections for January 1st 2011 - August 8th 2011
San Angelo TxDOT District, Texas Forest Service Regional Fire Coordinators
Andrews
Martin
Howard
Mitchell
Nolan
Taylor
Callahan
Eastland
Ector
Midland
Glasscock
Sterling
Coleman
Brown
Ward
Crane
Upton
Reagan
Tom Green
Concho
Mills
McCulloch
Pecos
Crockett
Schleicher
Menard
Mason
Sutton
Kimble
Gillespie
Terrell
Val Verde
Kerr
Brewster
Bandera
Kinney
Uvalde
Medina
Legend
GeoMAC Wildfire Reports
MODIS Land Data (220)
Month
January
February
March
April
May
June
July
August
Major Cities
Texas County Boundaries
San Angelo
TFS Regional Fire Coordinators
Abilene, Brad Britten
Fort Stockton, Bill Davis
San Angelo, Shane Crimm
Uvalde, [Vacant]
0 15 30 Miles
Date created 09-08-2011
P.No. 0-6735
Author Beierle, Micah-John
Department of Natural Resources Management
Description of geospatial data:

El Paso


Multi-resource Wildfire Detections for January 2011 to the 230th (Aug, 18th) day of 2011 within the El Paso TxDOT District
Legend
Texas County Boundaries
GeoMAC Wildfire Reports (230)
MODIS Land Data (230)
Month
January
February
March
April
May
June
July
August
Major Cities
Road Network System
Classification
County Roads
FC Streets
On System Highways
Toll Roads
0
25
50
Miles
Anthony
Vinton
El Paso
Dell City
Horizon City
Socorro
Van Horn
Valentine
Marfa
Alpine
Presidio
Date created: 18082011
P.No.: 0-6735
Author: Beierle, Micah-John
Description of geospatial data:
Moderate-resolution Imaging Spectroradiometer (MODIS) land data (band 21), were collected 01012011 to 18082011
Geospatial Multi-Agency Coordination Group (GEOMAC) fire data, were collected from Texas ftp 15-AUG update
Road Way data were generated using StratMap Data collected from TNRIS.
Department of Natural Resources Management


Multi-resource Wildfire Detections from January 1st 2011 - August 18th 2011
El Paso TxDOT District, Regional District Coordinator
Andrews
Martin
Loving
Winkler
Ector
Midland
Ward
Crane
Upton
Reeves
Crockett
Pecos
Terrell
Anthony
Vinton
Socorro
4B
Sub 4B
Legend
Texas County Boundaries
GeoMAC Wildfire Reports
MODIS Land Data (220)
Month
January
February
March
April
May
June
July
August
El Paso
Regional Liaison Officer Areas
4A Midland, Dudley Speed
Sub 4B Alpine, Dave Marquez
0
20
40
Miles
Date created: 19-08-2011
P.No.: 0-6735
Author: Beierle, Micah-John
Description of geospatial data:
Moderate-resolution Imaging Spectroradiometer (MODIS) land data (band 21), were collected 01-01-2011 to 18-08-2011
Geospatial Multi-Agency Coordination Group (GEOMAC) fire data, were collected from Texas ftp 15-AUG update
Road Way data were generated using StratMap Data collected from TNRIS.
Department of Natural Resources Management

Multi-resource Wildfire Detections from January 1st 2011 - August 18th 2011
El Paso TxDOT District, Texas Disaster Districts



Description of geospatial data:

Moderate-resolution Imaging Spectroradiometer (MODIS) land data (band 21), were collected 01-01-2011 to 08-08-2011
Geospatial Multi-Agency Coordination Group (GEOMAC) fire data, were collected from Texas ftp 15-AUG update
Road Way data were generated using StratMap Data collected from TNRIS

Department of Natural Resources Management

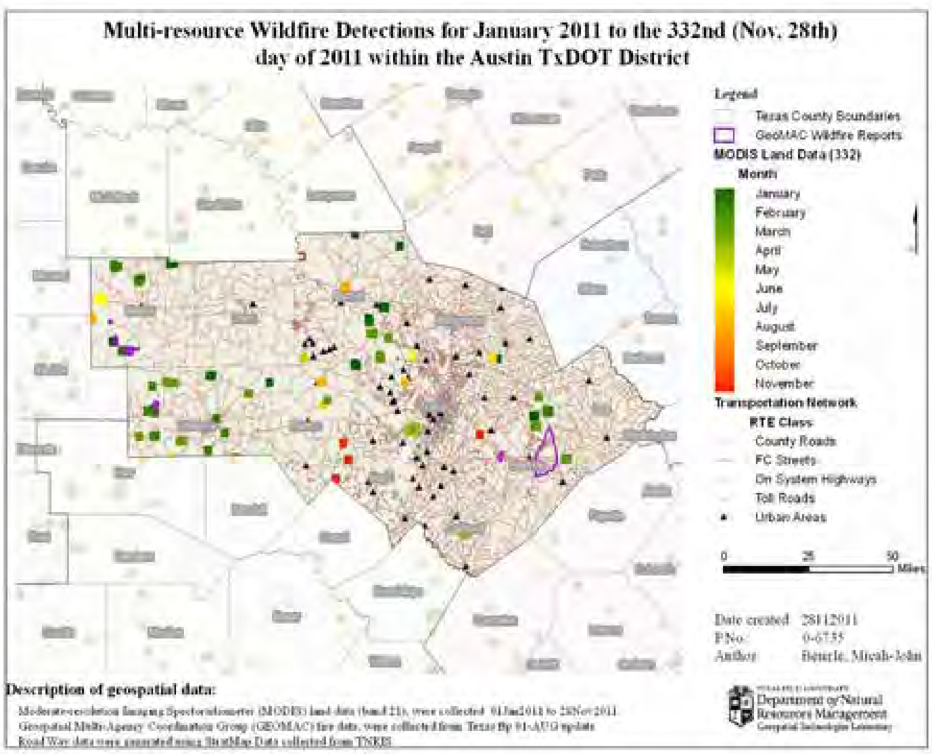
Multi-resource Wildfire Detections for January 1st 2011 - August 18th 2011
El Paso TxDOT District, Texas Forest Service Regional Fire Coordinators

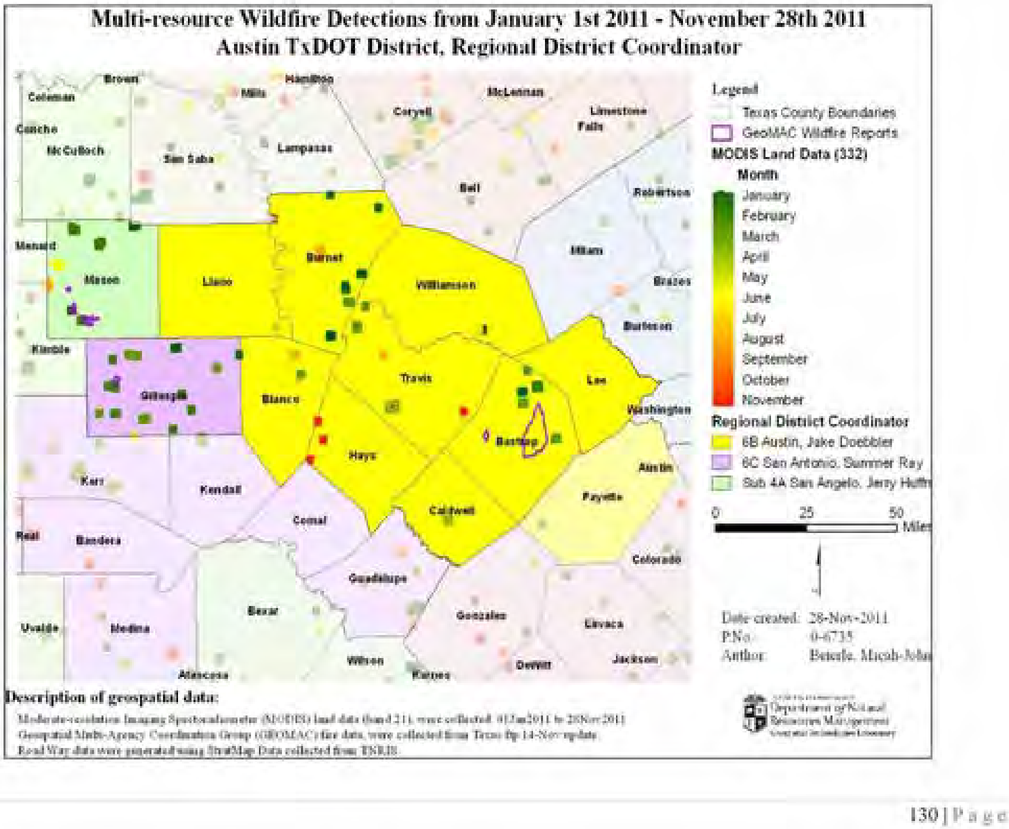
Description of geospatial data:

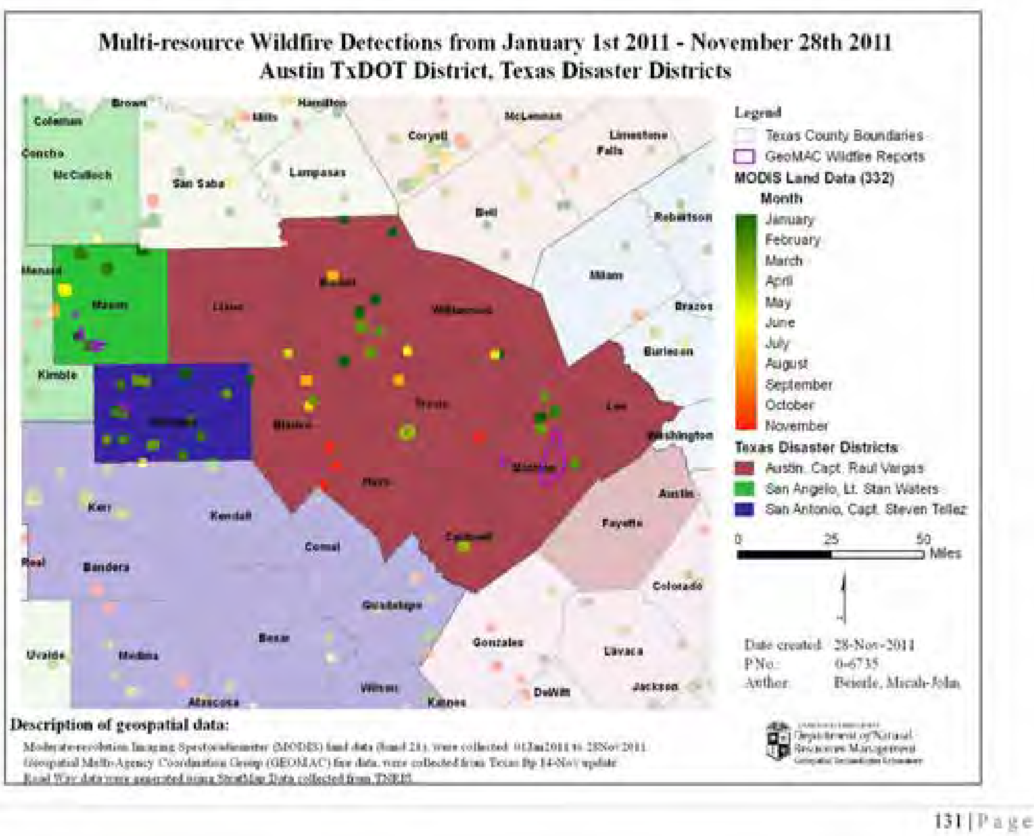
Moderate-resolution Imaging Spectroradiometer (MODIS) land data (band 21), were collected 01-01-2011 to 18-08-2011
Geospatial Multi-Agency Coordination Group (GEOMAC) fire data, were collected from Texas ftp 15-AUG update
Road Way data were generated using StratMap Data collected from TNRIS

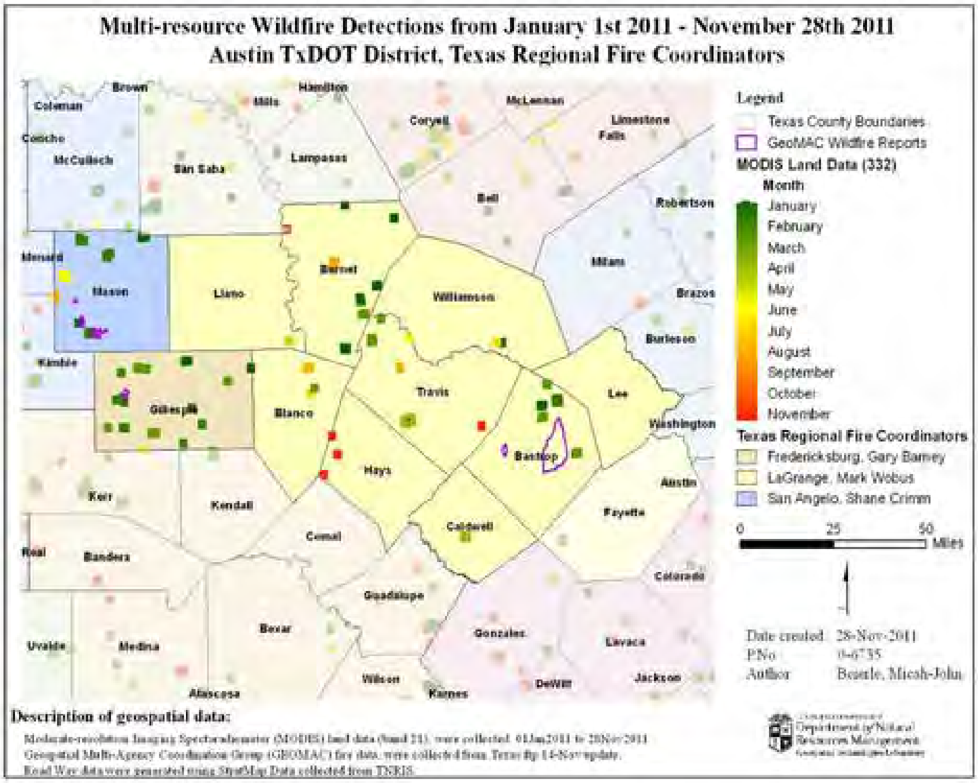
Department of Natural Resources Management

Austin


Multi-resource Wildfire Detections for January 2011 to the 332nd (Nov. 28th) day of 2011 within the Austin TxDOT District
Legend
Texas County Boundaries
GeoMAC Wildfire Reports
MODIS Land Data (332)
Month
January
February
March
April
May
June
July
August
September
October
November
Transportation Network
RTE Class
County Roads
FC Streets
On System Highways
Toll Roads
Urban Areas
0
25
50
Miles
Date created 28112011
P.No. 0-6735
Author Beierle, Micah-John
Department of Natural Resources Management
Description of geospatial data:


Multi-resource Wildfire Detections from January 1st 2011 - November 28th 2011
Austin TxDOT District, Regional District Coordinator
Legend
Texas County Boundaries
GeoMAC Wildfire Reports
MODIS Land Data (332)
Month
January
February
March
April
May
June
July
August
September
October
November
Regional District Coordinator
6B Austin, Jake Doebbler
6C San Antonio, Summer Ray
Sub 4A San Angelo, Jerry Huffn
0
25
50
Miles
Date created: 28-Nov-2011
P.No.: 0-6735
Author: Beierle, Micah-John
Description of geospatial data:
Department of Natural Resources Management
130 | Page


Multi-resource Wildfire Detections from January 1st 2011 - November 28th 2011
Austin TxDOT District, Texas Disaster Districts
Legend
Texas County Boundaries
GeoMAC Wildfire Reports
MODIS Land Data (332)
Month
January
February
March
April
May
June
July
August
September
October
November
Texas Disaster Districts
Austin, Capt. Raul Vargas
San Angelo, Lt. Stan Waters
San Antonio, Capt. Steven Tellez
0
25
50
Miles
Date created: 28-Nov-2011
P.No.: 0-6735
Author: Beierle, Micah-John
Description of geospatial data:
Department of Natural Resources Management
131 | Page


Multi-resource Wildfire Detections from January 1st 2011 - November 28th 2011
Austin TxDOT District, Texas Regional Fire Coordinators
Coleman
Brown
Mills
Hamilton
Coryell
McLennan
Limestone
Falls
Concho
McCulloch
San Saba
Lampasas
Bell
Robertson
Menard
Mason
Llano
Burnet
Williamson
Milam
Brazos
Burleson
Kimble
Gillespie
Blanco
Travis
Lee
Washington
Bastrop
Hays
Austin
Kerr
Kendall
Fayette
Comal
Caldwell
Real
Bandera
Colorado
Guadalupe
Uvalde
Medina
Bexar
Gonzales
Lavaca
Wilson
Karnes
DeWitt
Jackson
Atascosa
Legend
Texas County Boundaries
GeoMAC Wildfire Reports
MODIS Land Data (332)
Month
January
February
March
April
May
June
July
August
September
October
November
Texas Regional Fire Coordinators
Fredericksburg, Gary Barney
LaGrange, Mark Wobus
San Angelo, Shane Crimm
0
25
50
Miles
Date created 28-Nov-2011
PNo 0-6735
Author Bearle, Micah-John
Description of geospatial data:
Department of Natural Resources Management

APPENDIX D

Interview Questionnaire

0-6735: Best Practices for TxDOT on Handling Wildfires

Interview Questionnaire

1. **Advance preparation, readiness and training**
   a. Do you have any advance preparation and readiness protocols to respond to wildfire situations? If so, are they unique to your district?
   b. Do you make advance preparations by monitoring weather, ground conditions or other factors? Please provide details of how conditions affect your decision for readiness preparation.
   c. Please provide information about your readiness plan including coordination activities, staging areas, resource mobilization, etc.
   d. Do you have training programs already in place or being planned for your District personnel regarding wildfire response? If so, please provide details of such activities or efforts.

2. **Notification/Request for services to a TxDOT District for a wildfire event**
   a. What agency/office issues the official notification of a wildfire event? What is the form(s) of this notification?
   b. Who within the District receives the official notification?
   c. What services from TxDOT are requested as part of this notification?
   d. How many such requests are made to your district in a typical year?
   e. How is the District notified of a Governor's Proclamation or Federal Disaster Declaration?

3. **Communication related to a wildfire event within TxDOT**
   a. What is the chain of command for wildfire-related action within your district?
   b. What offices within TxDOT but outside of the District chain of command in (a) above are involved in the wildfire event?
   c. How are resource utilization requests and approvals accomplished within a District?
   d. What forms do you submit for reporting and reimbursement requests? (Please provide a copy)
   e. What mechanisms are currently used to ensure adequate data collection?
   f. Do you use any internal forms to collect such data within the District?
   g. If a wildfire event includes more than one District, how do you handle coordination efforts between Districts?
   h. What are TxDOT's responsibilities in notifying the general public regarding wildfire events? Who is involved in preparing and delivering such notifications?
   i. Do you conduct advance briefings for the District response team before they leave for wildfire-related activities? How are such meetings conducted and what information is conveyed to participants?
   j. Once the fires have been extinguished, do you conduct a formal de-briefing session(s) to discuss lessons learned and to ensure that all action necessary for cost reimbursement is completed?

4. **Communication with outside agencies**
    a. Once notified of a wildfire, what responsibilities does TxDOT have to notify others?
    b. What agencies does TxDOT interact with relating to the wildfire event? Please provide information on such interactions.
    c. What outside agencies does TxDOT interact with routinely in times other than during wildfire events and how often?
    d. Are there formal protocols to be followed by TxDOT personnel when contact is made with outside agencies both during and outside of wildfire events?

5. **TxDOT Responsibilities to ensure employee and public safety**
    a. What additional employee safety-related responsibilities does TxDOT have that are specific to wildfire events?
    b. What additional public safety-related responsibilities does TxDOT have that are specific to wildfire events?

6. **Resource utilization by TxDOT during wildfire events**
    a. What TxDOT resources are typically utilized during wildfire events?
    b. What agencies use the resources indicated in (a) above?
    c. How many TxDOT field personnel are typically mobilized for a wildfire event? (You may indicate a range here.)
    d. How many TxDOT District employees serve in volunteer fire departments in their locality?
    e. Does TxDOT release such firefighter employees from TxDOT duties during wildfire events?
    f. What is your success rate of reimbursement for expenses incurred for a wildfire response? Indicate separately for different agencies that may be involved.
    g. How often does your District provide fuel to agencies outside of TxDOT that are involved in the wildfire event? How much fuel is typically provided?
    h. In addition to fuel, does your District provide any other resources to outside agencies to effectively deal with the wildfire event?
    i. Who handles the cost reimbursement requests related to wildfire events within your District?
    j. Are TxDOT personnel who respond to wildfire situations provided with adequate safety garments, equipment and training?

7. **Information from recent wildfires (Be sure to take a list of fires to the district/agency interview)**
    a. Name of fire
    b. Code/Key of the fire in the State wildfire information database
    c. Extent of the wildfire and its duration
    d. Cause(s) of wildfire (if known)
    e. What work was performed by TxDOT during the wildfire event and immediately thereafter?
    f. What resources were utilized by TxDOT in responding to this wildfire event?
    g. What other outside agencies responded to the wildfire event? What were their duties?
    h. What resources were expended by other outside agencies to help fight the wildfire?

i. What was the total cost incurred by TxDOT for this wildfire event?
j. What is the success rate of cost reimbursement for each reimbursing agency
k. Challenges faced by TxDOT and its employees during the wildfire event
l. Lessons learned by TxDOT and its employees during the wildfire event
m. Suggested improvements to TxDOT wildfire response protocols in areas including employee safety, training, TxDOT command structure, TxDOT support services, dealing with outside agencies and dealing with the public.

8. **In your opinion, how effective was the training and/or guidance documentation in effectively responding to wildfire situations?**

9. **Comments on existing resources/guidance from TxDOT and other agencies such as TDEM, TFS, FEMA, etc.**
   a. TxDOT Guidance for Wildfire Response
   b. TxDOT Maintenance Operations Manual
   c. Training courses/modules
   d. Other (please specify)

APPENDIX E

Texas Administrative Code

Texas Administrative Code

TITLE 37 PUBLIC SAFETY AND CORRECTIONS
PART 1 TEXAS DEPARTMENT OF PUBLIC SAFETY
CHAPTER 7 DIVISION OF EMERGENCY MANAGEMENT

Subchapter A: EMERGENCY MANAGEMENT PROGRAM REQUIREMENTS

Rule #	Rule Title	Adopted	Amended	Rule Description
7.1	Emergency Management Organization Required	01/01/1976	12/22/1982 12/20/2007	Each county and incorporated city in Texas shall maintain an emergency management agency or participate in a local or inter-jurisdictional emergency management agency.
7.2	Responsibilities of the Chief Elected Official	01/01/1976	12/22/1982 03/14/1999 12/20/2007	The mayor of each municipal corporation and the county judge of each county are designated as the emergency management director for their respective jurisdictions. The mayor and county judge may each designate an emergency management coordinator who shall serve as an assistant to the presiding officer of the political subdivision for emergency management purposes when so designated.
7.3	Notification Required	01/01/1976	12/22/1982 03/14/1999 12/20/2007	The presiding officer of each political subdivision of the state shall notify the Governor's Division of Emergency Management of the manner in which the political subdivision is providing or securing an emergency management program and the person designated to head that program. Notification should be made using form DEM-147 (Emergency Management Director/Coordinator Appointment), which is available from the division's web site* and from its Regional Liaison Officers stationed around the State.

* http://www.txdps.state.tx.us/dem/pages/index/htm

138

Subchapter B: EMERGENCY MANAGEMENT PLANNING AND PREPLANNING REQUIREMENTS

Rule #	Rule Title	Adopted	Amended	Rule Description
7.11	State Plan Required	01/01/1976	12/22/1982 12/20/2007	The Division of Emergency Management of the Texas Department of Public Safety shall prepare and maintain a state emergency management plan. This plan is on file at the division's office, 5805 North Lamar, Austin, Texas, and with each member agency of the Emergency Management Council. A copy of the plan is posted on the division's web site*.
7.12	Local Planning Required	01/01/1976	12/22/1982 06/18/2003 12/20/2007	Each local and interjurisdictional emergency management agency shall prepare, keep current, and distribute to appropriate officials a local or interjurisdictional emergency management plan that includes the minimum content specified by the Division of Emergency Management in its local emergency planning standards and has been signed by the presiding officer(s) of the jurisdiction(s) for which it was prepared. Local and interjurisdictional plans shall be reviewed annually and must have been prepared or updated during the last five (5) years to be considered current. A copy of each plan and any changes to it will be provided to the Division.
7.13	Eligibility for Federal Incentive Programs Described	01/01/1976	12/22/1982 03/14/1999 06/18/2003 12/20/2007	(a) The Division of Emergency Management administers certain federal assistance programs authorized under the Robert T. Stafford Disaster Relief and Emergency Assistance Act as amended, and other statutes. To participate in these programs, a city or county must meet, as a minimum, the following basic eligibility requirements: (1) Have a local emergency management agency legally established by city ordinance or commissioner's court order or participate in an interjurisdictional emergency agency established by joint resolution of the participating local government. (2) Have a local or interjurisdictional emergency management plan that meets state planning standards for minimum content and is current. (3) Have formally adopted and be implementing the National Incident Management System (NIMS) as its incident management system. (4) Submit an acceptable project narrative or work plan and budget for eligible activities. (b) Many grants have more specific eligibility requirements and additional terms and conditions.

* http://www.txdps.state.tx.us/dem/pages/index/htm

139

Subchapter C: EMERGENCY MANAGEMENT OPERATIONS

Rule #	Rule Title	Adopted	Amended	Rule Description
7.21	Declaration of a State of Disaster and Effects of a Declaration	01/01/1976	12/22/1982 12/20/2007	The presiding officer of a political subdivision may declare a local State of Disaster if a disaster has occurred or is imminent. A disaster declaration activates the response provisions of the local emergency plan, if that has not been previously accomplished, and also activates recovery provisions of the plan. Such a declaration can be sustained for a maximum of seven days, unless extended by the governing body of the political subdivision.
7.22	State of Disaster Publicized	01/01/1976	12/22/1982	A local declaration of disaster must be given general publicity and shall be promptly filed with the city secretary or county clerk.
7.23	Local Government's Responsibility	12/20/2007		In responding to emergencies and disasters, a local government is expected to use its own resources and the resources available to it through mutual aid agreements before requesting assistance from the state. Municipalities must request assistance from their county before requesting assistance from the state.
7.24	Requesting State Assistance	01/01/1976	12/22/1982 12/20/2007	If local and mutual aid resources prove inadequate for coping with a disaster, the local government may request assistance from the state by contacting the local Disaster District Committee Chairperson, who is the commanding officer of the Texas Highway Patrol district or sub-district in which the jurisdiction is located.
7.25	Request from Chief Elected Official Required	01/01/1976	12/22/1982 03/14/1999	Requests for assistance must be made by the chief elected official of the city or county or by another official specifically authorized by them.
7.26	Local Government Control Affirmed	01/01/1976	12/22/1982 12/20/2007	All local disaster operations will be directed by officials of local government. Organized state and federal response teams and teams from other local governments and response organizations providing mutual aid will normally work under their existing supervisors, who will take their mission assignments from the local incident commander.
7.27	Protective Action Recommendations for the Public	01/01/1976	12/22/1982 03/14/1999 06/18/2003 12/20/2007	The decision to recommend that the public take shelter, evacuate, or relocate rests solely with the Governor and with the officials of local government. The chief elected official of a local government has the legal authority to order the evacuation of areas within the government's jurisdiction that are at risk from or have been impacted by a disaster.

Subchapter D: RECOVERY AND REHABILITATION REQUIREMENTS

Rule #	Rule Title	Adopted	Amended	Rule Description
7.41	Initiation of Requests for Recovery Assistance	01/01/1976	12/20/2007	Requests for state or federal recovery assistance must be initiated by local government. The chief elected official of the jurisdiction must have declared a local State of Disaster before requesting disaster recovery assistance.
7.42	Written Request Required	01/01/1976	03/14/1999 12/20/2007	Requests for recovery assistance and/or a state disaster declaration by the Governor must be made by the local chief elected official in writing to the Governor of Texas through the Division of Emergency Management. The request must indicate that the disaster is of such magnitude that local resources are inadequate to deal with it and the affected locality cannot recover without state and/or federal assistance. Request should be transmitted to the Division by facsimile or courier.
7.43	Supporting Information for a Request for Assistance	12/20/2007		The following should be attached to requests for assistance and/or for a state disaster declaration by the Governor. (1) An estimate of the extent of damage sustained to public and private property, including homes and business and data on the number of people who are deceased, injured, or displaced. The Damage Summary Outline (form DEM-93), available from the Division of Emergency Management field staff and posted on the division's web site* should be used for this purpose. (2) A copy of the local disaster declaration issued for the disaster.
7.44	Joint Damage Assessments	12/20/2007		When a local government has requested state or federal disaster recovery assistance and/or a state disaster declaration, state and, where appropriate, federal emergency management officials will normally deploy to the affected area to conduct a joint damage assessment with local officials that will be used in developing state and federal disaster recovery program recommendations. Local governments are expected to make available personnel who are knowledgeable about the damages suffered by the community to participate in this effort.
7.45	State and Federal Disaster or Emergency Declarations	12/20/2007		(a) After consultation with appropriate emergency management officials, the Governor may issue a state disaster declaration for a local, regional, or statewide emergency situation. (b) The Governor may also request a federal major disaster or emergency declaration for the emergency situation, which would, if approved, activate certain federal disaster relief and recovery programs.

* http://www.txdps.state.tx.us/dem/pages/index.htm

TEXAS TECH UNIVERSITY
Multidisciplinary Research in Transportation

Texas Tech University | Lubbock, Texas 79409
P 806.742.3503 | F 806.742.4168

APPENDIX H

Wisconsin – Adverse Weather Procedures

Adverse Weather Communication and Coordination Procedure, Emergency Transportation Operations Program, Wisconsin Department of Transportation, Oct. 8, 2012.

Wisconsin Department of Transportation

Emergency Transportation Operations (ETO) Program

Adverse Weather Communication and Coordination Procedure

October 8, 2012 - Final Draft

December 12, 2012 – Final Draft (pg. 15, first paragraph)

TABLE OF CONTENTS

APPENDICES

GLOSSARY OF TERMS

AAR	|	After-Action Review
AWCCP	|	Adverse Weather Communication and Coordination Procedure
BHM	|	Bureau of Highway Maintenance
BTO	|	Bureau of Traffic Operations
DMS	|	Dynamic Message Signs
DSP	|	Division of State Patrol
DTSD	|	Division of Transportation System Development
EOC	|	Emergency Operations Center
ETO	|	Emergency Transportation Operations
HAR	|	Highway Advisory Radio
ICS	|	Incident Command System
iNWS	|	interactive National Weather Service
NWS	|	National Weather Service
OPA	|	Office of Public Affairs
PCMS	|	Portable Changeable Message Signs
RCM	|	Regional Communications Manager
RDO	|	Regional Duty Officer
RIMC	|	Regional Incident Management Coordinator
SINP	|	Statewide Incident Notification Process
SINS	|	Statewide Incident Notification System
STOC	|	Statewide Traffic Operations Center
SWBDO	|	Statewide Bureaus Duty Officer
WEM	|	Wisconsin Emergency Management
WisDOT	|	Wisconsin Department of Transportation
WisHELPer	|	WisDOT Highway Emergency Liaison Personnel

1 | INTRODUCTION

1.1 Background

The State of Wisconsin maintains the state-jurisdiction highway system through maintenance agreements with each of the 72 counties within its borders. This contractual arrangement has been in effect for many decades and has provided drivers with reliable, safe and passable roads in nearly all conditions, especially since the adoption of a "clear roads" winter maintenance policy in the late 1950s.

In 2007, winter storms in Pennsylvania and Iowa created significant response challenges for their state transportation agencies along portions of the Interstate highway systems. These challenges highlighted shortcomings in adverse weather response planning and operations coordination. In February 2008, a strong winter storm severely impacted a large portion of Wisconsin, also creating significant response challenges to portions of the Interstate highway system in Dane and Rock Counties. These winter weather incidents prompted the Wisconsin Department of Transportation (WisDOT) to implement effective communication and coordination procedures with the State's 72 counties to address severe weather events as part of WisDOT's Emergency Transportation Operations (ETO) program.

1.2 Purpose

This Adverse Weather Communication and Coordination Procedure (AWCCP) provides a linkage for adverse weather event notifications, resource requests, and potential Interstate travel restriction or closure notifications. This link is among the 72 counties, WisDOT's Division of Transportation System Development (DTSD) through the Statewide Traffic Operations Center (STOC) and the five WisDOT Regions, and the Division of State Patrol (DSP).

The AWCCP is for WisDOT and the other agencies responsible for roadway maintenance to maximize the State of Wisconsin's response capabilities to potential adverse weather conditions that may severely impact the Interstate highway system.

The AWCCP ensures that WisDOT is communicating internally as well as externally by keeping in contact with counties during a major weather event, with the goal of preventing a failure in Interstate highway operations.

The AWCCP supplements the existing ETO plan and other emergency response plans and/or standard operating procedures of WisDOT and various county and state agencies. The AWCCP is intended to allow WisDOT to meet the following objectives:

- Ensure accurate, consistent and timely communication between WisDOT, county highway departments, law enforcement and other concerned agencies.
- Provide a uniform communication and coordination procedure for:
    - Notification of an impending adverse weather event
    - County request for assistance
    - Potential Interstate restriction or closure

2 | NOTIFICATION PROCESS SUMMARY

The following situations will initiate action by WisDOT upon notification. Detailed flow charts and checklists for each of these situations are provided further in this document.

The WisDOT initial point of contact for these notifications is the Statewide Traffic Operations Center (STOC) and/or the regional WisDOT Area Maintenance Coordinator, depending upon the situation.

Notification of an Impending Adverse Weather Condition

When a National Weather Service (NWS) 'Warning' or 'Advisory' is issued, a teletype will be issued by the National Weather Service via the Department of Justice system and an e-mail message will be sent to the STOC from WisDOT's weather subscriber (Meridian). The STOC will notify the appropriate Regional Incident Management Coordinator (RIMC) of the weather warning or advisory via e-mail. The STOC will document the notification and retain the information. The STOC will not make notifications in instances of NWS weather 'Watches'.

County Request for Assistance

Accounts for situations in which a county highway department indicates that additional resources are needed to maintain the Interstate during an adverse weather event. For example:

- Snowplow driver on-duty hours being exhausted and plowing operations may need to halt.
- Supply of road treatment material is running low.
- Maintenance issues have exhausted snowplow reserves (e.g. plow truck breakdowns).
- Ice has created a situation worse than county resources can handle.
- Flooding situation requires additional sandbags, signage and traffic control equipment.

Potential Interstate Restriction or Closure

Occurs when the county highway department(s), in collaboration with the WisDOT regional office(s) and area law enforcement agencies, determines that conditions on the Interstate necessitate restricted travel or closure.

3 | WEATHER DEFINITIONS

For the purpose of this AWCCP, the standards adopted by the National Oceanic and Atmospheric Administration (NOAA)/National Weather Service (NWS) will be used to determine when the STOC is notified of potential threatening weather situations.

There are two NOAA/NWS forewarning categories that will be used in this plan: 'Warning' and 'Advisory'. A 'Warning' or 'Advisory' is used when a hazardous weather event is imminent, or is already occurring. The forecaster confidence is generally greater than 80%. A 'Warning' is used for conditions that pose a threat to life and property. An 'Advisory' is used for less serious conditions that cause significant inconvenience and, if proper precautions are not taken, could pose a threat to life and property.

NOAA/NWS weather 'Watches' will not activate any notifications as part of this guideline due to the extended duration of watches and the likelihood of changing conditions.

3.1 Select Weather 'Warning' Definitions

The NWS definitions of 'Warnings' for select adverse weather events that have the potential to impact the Interstate system are as follows:

Blizzard Warning – Sustained winds or frequent gusts above 35 mph causing falling and/or blowing snow to reduce visibilities below ¼ mile for 3 hours or longer.

Excessive Heat Warning – High temperatures greater than 105°F during the day and high temperatures greater than 75°F at night for a 48-hour period.

Flash Flood Warning – Within 6 hours of the causative event:

- Flash flooding is reported; and/or
- A dam or levee failure is imminent or occurring; and/or
- A sudden failure of a naturally-caused stream obstruction is imminent or occurring: and/or
- Precipitation capable of causing flash flooding is indicated by radar, rain gauges and/or satellite; and/or
- Precipitation is indicated by radar, rain gauges, satellite and/or other guidance is capable of causing debris flows; and/or
- Local monitoring and prediction tools indicate flash flooding is likely; and/or
- A hydrologic model indicates flash flooding for locations on small streams.

Flood Warning – Flooding that produces a life/property threat within 6-12 hours of a causative event.

High Wind Warning – Sustained winds of at least 40 mph for 1 hour or longer, or wind gusts of at least 58 mph of any duration are expected.

Ice Storm Warning – Heavy ice accumulations of ¼ inch or greater within 12 hours due to freezing rain.

Lake Effect Snow Warning – Heavy lake effect snow accumulations of generally more than 6 inches in 12 hours or 8 inches in 24 hours.

Red Flag Warning – Red Flag Warnings are issued anytime there is an ongoing wildfire, or critical weather conditions will occur within the next 24 hours. These conditions are:

- Sustained winds averaging 15 mph or greater,
- Relative humidity 25 percent or less, and/or
- Temperature 75°F or greater.

Severe Thunderstorm Warning – A thunderstorm producing 1 inch or larger hail and/or wind gusts of at least 58 mph.

Tornado Warning – A tornado has been sighted by a trained observer or is highly likely to occur based on Doppler radar signatures.

Tornado Emergency – Added to tornado warning in exceedingly rare situations, when a severe threat to human life and catastrophic damage from a tornado is imminent or ongoing.

Wind Chill Warning – Wind chill temperatures of -35°F or colder with winds at least 4 mph for 3 hours or more.

Winter Storm Warning – One or more of the following weather events occurring within12 hours (unless otherwise stated):

- More than 6 inches of snow (or 8 inches within 24 hours).
- Freezing rain (less than ¼ inch and while accompanied by another event).
- Sleet accumulations of 2 inches or more.
- Intermittent blowing snow reducing visibilities to less than ½ mile and winds 25-34 mph, or closed roads.
- NWS forecaster discretion, e.g., up to 6 inches of snow with sustained winds gusts of 25-34 mph.

3.2 Select Weather 'Advisory' Definitions

The NWS definitions of 'Warnings' for select adverse weather events that have the potential to impact the Interstate system are as follows:

Dense Fog Advisory – Widespread or localized fog reducing visibilities to ¼ mile or less.

Dense Smoke Advisory – Widespread or localized smoke reducing visibilities from ¼ mile to 1 mile or less for 3 hours or more.

Freezing Fog Advisory – Fog freezing deposits on cold objects resulting in an adverse impact on transportation.

Freezing Rain Advisory – Ice accumulations less than ¼ inch within 12 hours due to freezing rain.

Heat Advisory – High temperature greater than 100°F during the day or high temperature between 95°- 99°F for 4 consecutive days or more.

Lake Effect Snow Advisory – Lake effect snow accumulations between 3 – 6 inches within 12 hours.

Sleet – Ice accumulation causes driving or walking problems, but no damage to trees or power lines.

Wind Advisory – Sustained winds 30 mph or more for 1 hour or more, or any gust 45 to 57 mph.

Wind Chill Advisory – Wind chill temperatures -20°F to -34°F with winds at least 4 mph for 3 hours or more.

Winter Weather Advisory – One or more of the following weather events in 12 hours or less:

- Three to 6 inches of snow
- Freezing rain (less than ¼ inch and while accompanied by another event)
- Sleet accumulations of less than 2 inches
- Intermittent blowing snow reducing visibilities to less than ½ mile and winds less than 25 mph

4 | HIGHWAY TERMS AND DEFINITIONS

The terms and definitions that follow were developed in response to after-action reviews conducted following weather events during the 2010-2011 winter season. The reviews consistently identified gaps in the common understanding of winter weather roadway terms and the associated highway conditions. The use of these terms and definitions are highly encouraged by the internal stakeholders of the State highway system.

4.1 Winter Weather Roadway Descriptions

18-Hour Coverage – When conditions warrant, coverage should be provided up to 18 hours per day during the storm. The gap in coverage is necessary to provide for operator recovery time. The operator recovery time should typically be between the hours of 10:00 PM and 4:00 AM, but will vary with specific storm conditions. Some minimal ability to respond to emergencies should be provided during the hours that full coverage is not provided. Typically, a plow operator's time should not exceed a continuous 18-hour shift. (*Reference: WisDOT HMM 06-05-01 Winter Highway Classifications*)

24-Hour Coverage – The County has a presence on the highway for 24 hours per day during a winter storm event unless passable roadway conditions have been achieved. This would only happen during winter storm events of long duration and when conditions warrant. When this does occur it may mean further reducing the coverage on routes in the "all other" classification to assure available manpower, or extending the winter operation section lengths on the high volume routes. However, continuous coverage does not mean that the county runs three shifts or that there are patrol trucks on the highway 24 hours per day throughout the winter irrespective of the weather conditions. (*Reference: WisDOT HMM 06-05-01 Winter Highway Classifications*)

A map depicting the "high volume" and "all other state trunk highways" classification can also be found on the WisDOT website at:
http://www.dot.wisconsin.gov/travel/road/docs/winterclassmap.pdf

Advisory and/or Road Condition Report – An announcement (either written or oral) or a roadway condition from a person with the approved authority. These advisories or condition reports are normally issued by the STOC, DSP or County Highway Department.

Bare/Wet Pavement – A winter pavement condition essentially free of all ice and snow from shoulder to shoulder. The paved traveled way can be either naturally wet or chemically wet.

Black Ice – A thin coating of glazed ice on a surface. While not truly black, it is virtually transparent, allowing black asphalt roadways to be seen through it, hence the term "black ice". The typically low levels of noticeable ice pellets, snow, or sleet surrounding black ice means that areas of the ice are often practically invisible to drivers and thereby do not serve as a good indicator that drivers should reduce their speeds.

Closure – The active closure of a highway using traffic control devices or other approved means to both restrict vehicles from entering the highway and directing motorists off the roadway.

Declaration – A formal written announcement of a roadway condition from a person with the approved authority. This term may be used in conjunction with a roadway restriction or closure.

Passable Roadway – A roadway surface that is free from drifts, snow ridges, and as much ice and snow pack as is practical and that can be traveled safely at reasonable and prudent speeds. A passable roadway should not be confused with "dry pavement" or "bare pavement", which is essentially free of all ice, snow, and any free moisture from shoulder to shoulder. This "dry/bare pavement" condition might not exist until the weather conditions improve to the point where this pavement condition can be provided. (*See: HMM 06-15-01 Passable Roadway – During a Winter Storm*)

Pull the Plows – When a County Highway Department determines that snowplows can no longer plow the Interstate. This can be due to safety or resource issues.

Reasonable Speed – Is considered a speed at which a vehicle can travel without losing traction. During and immediately after a winter storm event, a reasonable speed will most likely be lower than the posted speed limit. Motorists can expect some inconvenience and will be expected to modify their driving practices to suit road conditions. (*Reference: WisDOT HMM 06-15-01 Passable Roadway – During a Winter Storm*)

Restriction – A proactive measure to restrict access to a segment of the highway by closing select on-ramps. The mainline would remain open, but additional vehicles will be prohibited from entering the roadway.

Wheel Tracks – A winter pavement condition when only the wheel tracks are bare/wet or bare/dry. All other paved areas including the centerline, between the wheel tracks, and shoulders, are mostly snow or ice covered.

Whiteout Conditions – A weather condition in which visibility and contrast are severely reduced. The horizon disappears completely and there are no reference points at all, leaving the driver with a distorted orientation. A whiteout may be due simply to extremely heavy snowfall rates (as seen in lake effect conditions), or to other factors such as diffuse lighting from overcast clouds, mist or fog, or a background of snow cover.

4.2 Winter Roadway Terms Provided to the Public via 5-1-1

The following terms are used to describe winter state highway driving conditions to the public via the 5-1-1 Traveler Information System:

- Good Winter Driving (green)
- Slippery Stretches (purple)
- Snow Covered (blue)
- Ice Covered (red)
- Travel Not Advised (black)
- No Information (gray)

The 5-1-1 system provides information to the public via website (www.511wi.gov), telephone, Twitter feeds and Facebook. The status of state highway conditions during the winter season is reported daily by State Patrol troopers to their communication dispatch operators who subsequently update the 5-1-1 traveler information system. The color-coded terms are used to show those highway segments on the 5-1-1 statewide highway map, which is illustrated in Figure 4.1 below.

Figure 4.1: 5-1-1 Winter Road Conditions Map

Last updated on Friday, September 14, 2012 at 02:40:00 PM

4.3 Highway Condition Definitions

In the past, the term impassable was used to describe highway conditions. That term was determined to be ambiguous and has been replaced with the following three terms:

Travel Not Advised

A proactive measure to advise motorists to refrain from traveling due to current conditions. Triggers for field personnel to consider:

- Quickly deteriorating road conditions

- Rate of snowfall and projected weather forecast (e.g. drop in temperatures)
- Poor/limited visibility
- Ability of public safety personnel (including tow services) to respond to incidents
- Ability of county resources to maintain plowing operations
- Multiple incidents occurring (e.g. vehicles in ditch)
- Major incidents that cause significant roadway blockage/closures
- Standing water covering the entire highway.

Triggers for supervisory consideration:

- Recommendations from field personnel
- Communication/coordination with counterparts (WisDOT/DSP/Sheriff/County Highway Commissioner)
- Should be used at a countywide level at a minimum
- Caution against overuse – this term (Travel Not Advised) should only be used in extreme conditions

Travel Restricted

A proactive measure to restrict public access to a segment of the highway by physically blocking selected on-ramps (historically referred to as a "soft closure"). The mainline would remain open. Collaboration is necessary among WisDOT Regional staff; State Patrol/sheriff personnel, and county highway department staff. The DTSD Administrator and DSP Superintendent's offices will be notified through established procedures when this occurs.

Highway Closed

A proactive measure for a hard closure of the Interstate. Collaboration between the WisDOT regional staff, State Patrol/sheriff, and the county highway commissioner is necessary. Example: Closure due to flooding or a bridge out. The DTSD Administrator and DSP Superintendent's offices will be notified through established procedures when this occurs.

5 | COMMUNICATION AND COORDINATION PROCEDURES

In order to ensure that information is shared in a consistent and accurate manner when an emergency event occurs, it is imperative that all responding agencies have a clear understanding of inter-agency communication flows. The following flow charts and checklists were created to illustrate the communication and coordination flows that will be followed during adverse weather conditions. The communication and coordination flows are for the following situations:

- Notification of an Adverse Weather Event
- County Request for Assistance
- Potential Interstate Restriction or Closure

The flow charts do not represent a hierarchy for responding agencies. Rather, the flow charts are meant to illustrate the initial flow of communication among agencies and/or positions.

5.1 Notification of an Adverse Weather Event

For weather and natural disasters, the source of information is the National Weather Service (NWS) providing National Oceanic & Atmospheric Administration (NOAA) based 'Warnings' and 'Advisories'. WisDOT (STOC, DSP & Regional Offices) and the county highway departments receive these notifications and weather data through a contracted weather provider, currently Meridian.

The STOC is notified when the 'Warning' and/or 'Advisory' classifications previously described in sections 3.1 and 3.2 are issued by the NWS. The 'Warning' and 'Advisory' level notifications are the "trigger-point" thresholds to the WisDOT STOC as described in the following sections.

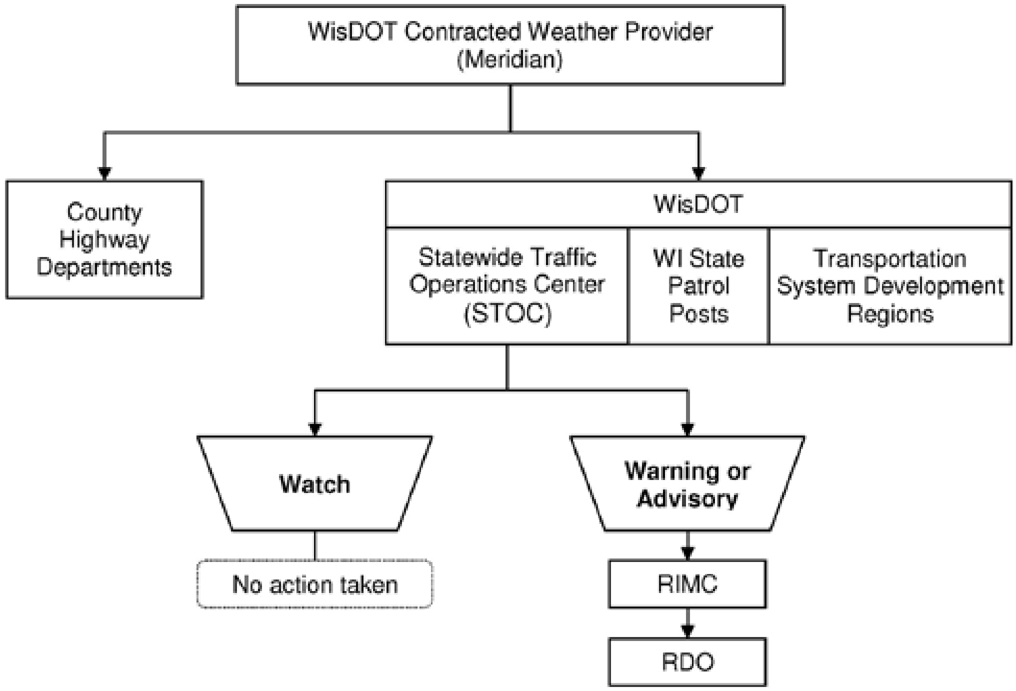
5.1.1. Flow Chart – Notification of an Adverse Weather Event

The flow chart for Notification of an Adverse Weather Event is provided in Figure 5.1.

5.1.2. Checklist – Notification of an Adverse Weather Event

- ❑ NWS issues a weather 'Warning' and/or 'Advisory'.
- ❑ The WisDOT weather subscription provider (Meridian) sends an e-mail to the STOC. The weather subscription provider also notifies the affected county highway departments, State Patrol communication centers and the WisDOT Region offices.
- ❑ No action will be taken in the event of a weather 'Watch'.
- ❑ For NWS 'Warnings' and/or 'Advisories', the STOC documents the notification and sends an e-mail notification to the Regional Incident Management Coordinator (RIMC).
- ❑ If warranted, the RIMC will contact the Regional Duty Officer (RDO).

Figure 5.1: Flow Chart – Notification of an Adverse Weather Event



5.2 County Request for Assistance

In the event that a county requires assistance, the counties will first utilize any existing mutual aid or assistance agreements before contacting WisDOT. This procedure is not intended to supplant any existing mutual aid arrangements, but rather to provide an additional resource from which a county can request support prior to ceasing operations.

Whether or not they are successful in procuring mutual aid assistance, the counties will inform WisDOT of their request for assistance through the Area Maintenance Coordinator or the STOC. If the call is received during normal business hours, typically the WisDOT Area Maintenance Coordinator will be the initial contact; if the call is received after business hours the contact will be the STOC.

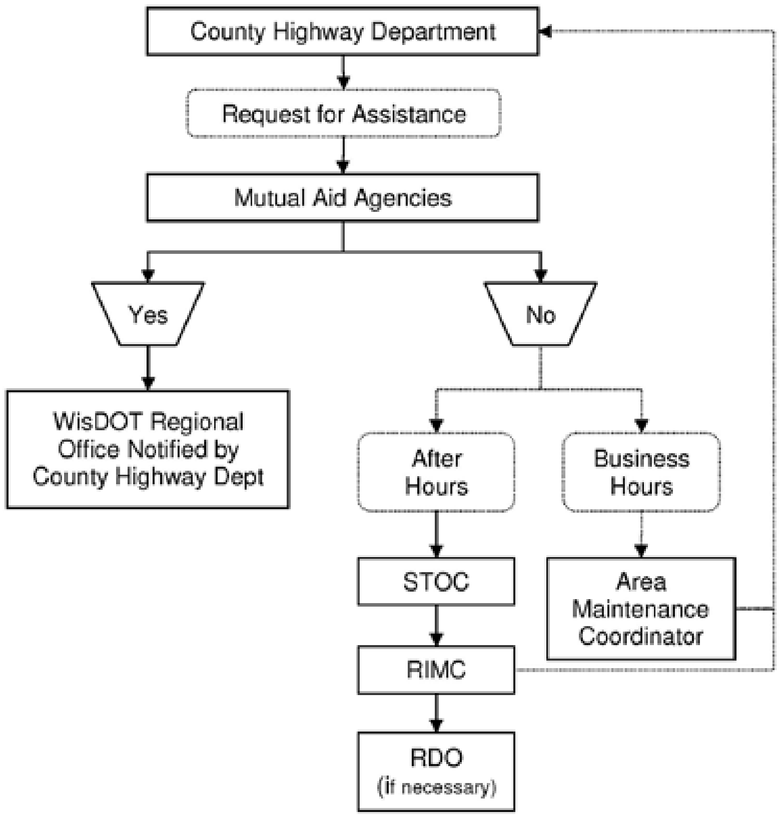
Examples of situations in which the county highway departments may use this notification procedure include, but are not limited to:

- Snow plow driver hours being exhausted and plowing operations may need to halt.
- Road treatment material is out or running low.
- Maintenance issues have exhausted snow plow reserves (e.g., plow break downs).
- Ice has created a situation worse than county resources can handle.
- Flooding situation requires additional sandbags, signage, and traffic control equipment.

5.2.1. *Flow Chart - County Request for Assistance*

The flow chart for County Request for Assistance is provided in Figure 5.2.

Figure 5.2: Flow Chart – County Request for Assistance



5.2.2. *Checklist – County Request for Assistance*

- ❑ The county highway department contacts its existing mutual aid neighbors for assistance.
- ❑ If mutual aid assistance is provided by a neighboring county, the county highway department will inform the WisDOT regional office, usually through the Area Maintenance Coordinator.
- ❑ If assistance was not provided by any of the neighboring counties, the county highway department will contact the regional WisDOT Area Maintenance Coordinator during regular business hours (or the STOC if after regular business hours) and advise that they were not able to procure assistance.
- ❑ The STOC will contact the RIMC.

- ❑ The STOC will also contact the STOC supervisor during regular business hours or the Bureau of Traffic Operations (BTO) on-call supervisor if after regular business hours.
- ❑ The RIMC will contact the county highway department and the WisDOT Area Maintenance Coordinator (if available) to evaluate the situation and arrive at a solution.
- ❑ If unsuccessful at arriving at a solution, the RIMC will contact the RDO to inform them of the situation and attempt to locate assistance.
- ❑ If the situation appears to be escalating to a multi-region or Area (Statewide) level event, the RDO will contact the DTSD Division Administrator's Office.
- ❑ The DTSD Division Administrator's Office will follow the ETO Plan procedures and initiate an internal Incident Command System (ICS) response.

5.3 Potential Interstate Restriction or Closure

This will occur when WisDOT, the county highway department, or law enforcement determines that adverse weather, traffic incidents, or any other event threatens to make travel on the Interstate 'Not Advised', 'Restricted' or 'Closed'. Examples of times when WisDOT, the county highway department or law enforcement may use this notification include, but are not limited to:

- Whiteout Conditions
- Snow Plow Driver Hours Exhausted
- Heavy Snow and/or Ice Conditions
- Travel Not Advised
- Travel Restricted
- Highway Closed

5.3.1. Checklist – Potential Interstate Restriction or Closure

- ❑ A law enforcement, highway or county highway department contacts the STOC to inform them that a segment of the Interstate is in danger of being restricted or closed due to adverse weather conditions.
- ❑ The STOC contacts the RIMC, the DSP post communication center, the affected county emergency communication center, and the Wisconsin Emergency Management (WEM) Duty Officer.
- ❑ The RIMC coordinates with DSP and/or local law enforcement and the county highway department.
- ❑ The RIMC and DSP will determine if the situation appears to be escalating or if more than a local response is required. If the situation appears to be escalating or if the situation appears to be out of the control of on-site personnel, the RIMC will contact the WisDOT Regional Duty Officer.
- ❑ The WisDOT RDO and DSP supervisor will follow the ETO Plan protocols and initiate an internal ICS response.
- ❑ If the event appears to impact multiple WisDOT regions or has an impact beyond regional control, the WisDOT Regional Duty Officer will contact the DTSD Division Administrator's Office and the STOC. The DSP post supervisor will contact the DSP Superintendent's Office.

- ❑ The DTSD Division Administrator's Office, with the assistance from the RDO and DSP, will follow the ETO Plan procedures and initiate an Area (Statewide) internal ICS response.
- ❑ In the event WEM activates the state Emergency Operations Center (EOC) Level 1 (full activation) or Level 2 (partial activation), the on-call WisDOT WisHELPer and State Patrol representative will be contacted by WEM to report to the state EOC. A state EOC activation at Level 3 (minimal activation) will only require a WisDOT State Patrol representative to report.

6 | PRE-EVENT AND OPERATIONAL BRIEFINGS

To facilitate consistency, a standard set of guidelines were developed for regional and statewide pre-event and operational briefings that take place during the duration of an incident. Statewide briefings are intended to provide situational awareness updates to the DOT Secretary's Office. Briefings are arranged at the direction of the Administrator/Superintendant's offices. They are not to replace the regional or statewide incident command response. In regard to adverse weather, consideration to conducting a pre-event briefings should occur when one or more of the following threshold trigger-points are met:

(1) Adverse weather event predicted to last 15 hours or more
(2) Winter storm warning
(3) Blizzard warning
(4) Flood warning

6.1 Checklist – WisDOT Regional or Statewide Pre-Event or Operational Briefings

- ❑ The National Weather Service (NWS) regional office affected by an impending severe weather event announce a scheduled on-line weather webinar.
- ❑ WisDOT and county representatives attend the weather webinar.
- ❑ Initial considerations for conducting an internal WisDOT regional or statewide teleconference are:
  - Two or more regions involved
  - Resource allocation being a major concern for more than one region
  - A single significant event that impacts our state
  - NOAA/NWS forecast of blizzard conditions
  - Forecasts of imminent large scale flooding
- ❑ Pre-Event or Operational briefing attendees:
  - Division of State Patrol (DSP) – Statewide
  - Superintendent, Colonel, Majors, STOC Lieutenant
  - Division of Transportation System Development (DTSD) – Statewide
  - Administrator, Deputy Administrators, freight representative
  - Office of Public Affairs (OPA)
  - Statewide RCM group representative
  - DTSD and DSP – Regions
  - Incident commander or unified commander, DTSD region directors, DSP Captain and Lieutenant, DTSD on-call RDO
  - Statewide Bureau Duty Officer (SWBDO) on-call
  - WisHELPer on-call
  - DTSD Bureau of Highway Maintenance (BHM)
  - Director, engineer chief, meteorologist
  - DTSD Bureau of Traffic Operations (BTO)
  - Director, operations manager, state traffic operations supervisor, ETO manager, support staff, control room manager or supervisor
- ❑ Briefings will be scheduled for a targeted 30-45 minutes, and all attendees will strive to provide concise regional or assignment briefings.

- ❑ There may be more than one regional or statewide briefing scheduled during an operational period. The frequency will be determined by senior DTSD and DSP staff.
- ❑ Discussion leading to additional planning or tactics should generally be refined off-line at statewide or regional planning meetings.
- ❑ All regional or statewide briefings will be facilitated by the STOC and conducted on a taped telephone line.
- ❑ Agenda Items
    - Roll Call
    - Secretary's Office and/or DTSD and DSP Administrators remarks
    - Regional DTSD and DSP briefings
        - Review current incident objectives
        - Provide resource status report
        - Discuss current strategies
        - Identify safety concerns and mitigation measures
        - Planning efforts for next operational period
    - Bureau briefings (BTO, control room, BHM)
    - News release – statewide vs. Regional
    - State EOC briefing, if activated
    - Schedule next briefing
    - Secretary's Office (closing remarks)
- ❑ A briefing summary will be shared with all attendees via e-mail within one-hour of the conclusion of the briefing.
- ❑ Briefing summaries are classified as "FOR OFFICIAL USE ONLY" (FOUO) and will be handled as sensitive information that is not to be publicly disclosed.
- ❑ The initiation of the Event Plan is the responsibility of the incident commander.
- ❑ The Event Plan is a joint effort between DTSD and DSP.
- ❑ An updated Event Plan will be prepared prior to the beginning of each new operational period by the outgoing incident commander.

7 | FLOODING ALERT PROCEDURE

7.1 Purpose

A procedure designed to proactively alert WisDOT regions of flooding threats that can negatively impact the safety and mobility of the motoring public on 33 predefined highway segments and 24 bridge segments of Wisconsin's Interstate highway system.

7.2 Procedure

- ❑ When a Flash Flood, Flood, or Areal Flood 'Warning' is received from iNWS (interactive National Weather Service) via the STOC E-mail, the control room will review the 'Warning' as it relates to the location of the pre-defined at-risk Interstate highway/bridge segments.
- ❑ The control room will notify the affected State Patrol post and request that a trooper be dispatched to that segment of Interstate highway to determine if flooding is occurring over the roadway.
- ❑ If flooding is occurring, the STOC control room will contact the on-call Regional Incident Management Coordinator (RIMC) with the details and request that they contact the WI State Patrol post and provide DTSD assistance.
- ❑ The STOC control room will contact the affected county emergency communications center.
- ❑ If flooding is not already occurring, the DSP post will be requested to continue to periodically monitor that segment of the highway until the threat diminishes.
- ❑ The control room will provide the DSP and RIMC with iNWS documentation that supports the Flash Flood, Flood, or Areal Flood warning.
- ❑ The STOC control room will log the incident into SINS (Statewide Incident Notification System).
- ❑ The STOC control room will contact the DSP and/or RIMC with any updates to or cancellation of the Flash Flood, Flood, or Areal Flood warnings and will make the appropriate comments in the SINS.

8 | PUBLIC INFORMATION

During adverse weather events, communication with the public is vital. To organize and execute an effective and efficient response to adverse weather incidents, WisDOT will follow the principles of the National Incident Management System (NIMS) and the Incident Command System (ICS). ICS recognizes the important role of the Public Information Officer (PIO).

8.1 Overall Public Information Objectives

When a weather emergency event occurs, WisDOT must be able to quickly share information internally and externally. WisDOT has several broad objectives when providing public information to various audiences, including the news media, during incidents:

- Provide accurate information
- Provide timely information
- Eliminate or minimize confusion
- Establish and maintain good relationships with the public, media representatives, stakeholders and all responding personnel and agencies

WisDOT media releases must be used anytime travel on the Interstate is not advised, when travel is restricted, or when the highway is closed. Example media releases can be found in *Appendix A*.

If more than one region is affected, the public information effort needs to be coordinated between the regional communication managers.

If an adverse weather event escalates to a statewide event, a Public Information Officer (PIO) needs to be identified and work closely with the incident commander, per ICS guidelines.

8.2 Dynamic Message Signs and Portable Changeable Message Signs

There are times when the STOC is requested to place messages on Dynamic Message Signs (DMS) or Portable Changeable Message Signs (PCMS) to alert motorists to adverse driving conditions. Operators will consider the following information before requesting approval to place the message from the STOC Control Room manager, on-call STOC supervisor, or STOC manager:

1. Did the STOC receive a request for signing from a law enforcement agency or county highway department?
2. Is a Winter Storm Warning in effect for the county or area? If so, use the warning's expiration time as a guide for how long to place the message on the DMS/PCMS units.
3. Has there been a significant increase in the number of traffic incidents in that county? In particular, is the number of incidents unusually high for the time of day?

If all three criteria are met, notify the STOC Control Room manager and the on-call STOC supervisor and request to display the following message on any available DMS and PCMS units in the affected county until the Winter Storm Warning expires:

- Phase One: Adverse Conditions Reduce Speed
- Phase Two: Travel Times

Note: Use of a DMS or PCMS unit to notify drivers of an incident will take priority over a cautionary adverse conditions message.

8.3 Floodgate Messages on 5-1-1

A STOC Control Room operator may request to put either a statewide or county-level floodgate message on 5-1-1 if the following criteria are met:

1. A weather Warning and/or Advisory has been issued, and/or:
   a. The 5-1-1 Winter Road Conditions Map for the corresponding area indicates that a majority of the highways are either: *Snow Covered*, *Ice Covered*, or *Travel Not Advised*.
   b. There is a significant increase in the number of traffic incidents (even if not blocking traffic).
   c. State Patrol or other law enforcement agency requests a floodgate message and one or more of the above criteria are also met.

Note: Because of the frequency of lake effect snow warnings for the Lake Superior south shore snow belt, floodgate messages for that area will be placed at the county level of all counties identified in the warning, and will show either: *Snow Covered*, *Ice Covered*, or *Travel Not Advised* highway conditions on 5-1-1.

Floodgate Template: *"As of (time/date) law enforcement is reporting adverse road conditions in (much of the state, northern/southern part of the state, etc.). Motorists are encouraged to slow down and avoid travel when possible."*

The audio and text floodgate messages should be taken down when the Winter Storm Warning expires or when DSP reports that conditions have improved.

8.4 Highway Advisory Radio

The Highway Advisory Radio (HAR) is intended to provide travelers with current traffic conditions and alert them of any special events or incidents that are impacting traffic. Only the STOC is authorized to place recorded messages on the HAR.

8.5 STOC Contact Information

STOC Control Room, 800-375-7302 *(Note:This phone number is not for public use.)*

WISCOM: DOTSTOC

9 | ROLES AND RESPONSIBILITIES

The following sections describe the specific roles and communications expectations in the event of an adverse weather event for these parties:

- County Highway Department
- WisDOT Statewide Traffic Operations Center (STOC)
- WisDOT Area Maintenance Coordinators (AMC)
- WisDOT Regional Incident Management Coordinator (RIMC)
- WisDOT Regional Duty Officer (RDO)
- Wisconsin State Patrol Communications Center
- Wisconsin Highway Emergency Liaison Personnel (WisHELPer)
- WisDOT Statewide Bureaus Duty Officer (SWBDO)
- WisDOT Public Information Officer (PIO)

9.1 County Highway Department

Role During Adverse Weather Events:

The County Highway Department is under contract to WisDOT to provide Interstate highway maintenance and snow/ice removal. Specifically:

- Monitor materials
- Monitor driver hours
- Receive direction from WisDOT Area Maintenance Coordinators
- Coordinate with the STOC

Communication Expectations

County highway departments will communicate with WisDOT about Interstate conditions. WisDOT requires that the following information be provided:

- Interstate roadway conditions
- Road treatment supplies status
- Road clearing equipment status
- Driver hours/availability status

The two primary points of contact for the counties are the WisDOT Area Maintenance Coordinators during regular business hours and the STOC after regular business hours.

The county highway department will contact the Area Maintenance Coordinators and/or the STOC when additional resources are required or if conditions are deteriorating on the State highway system.

The county highway departments will continue to inform law enforcement dispatch and the STOC about conditions that threaten State highway operations. The STOC will contact the RIMC, if necessary. Examples of conditions warranting coordination and communication include:

- Extensive black ice
- Ramp closures
- Snow drifts

- Blowing snow and/or whiteout conditions
- Flooding
- Dense fog
- Freezing fog

9.2 WisDOT Regional Area Maintenance Coordinator

Role During Adverse Weather Events

During an adverse weather event, the WisDOT Regional Area Maintenance Coordinators (RIMC) provide direction to the county highway departments.

Typically, Area Maintenance Coordinators work during normal business hours.

WisDOT Area Maintenance Coordinators are also in contact with the STOC and the State Patrol when conditions warrant.

Communication Expectations

WisDOT Area Maintenance Coordinators are WisDOT's primary communications contacts with the county highway departments.

WisDOT Area Maintenance Coordinators are responsible for contacting and coordinating with the county highway departments prior to an adverse weather event.

WisDOT Area Maintenance Coordinators are expected to relay information to the STOC as soon as possible if conditions are deteriorating.

The WisDOT Area Maintenance Coordinators monitors the adequacy of county resources and reports any deficiencies to the WisDOT STOC.

9.3 WisDOT Regional Incident Management Coordinator (RIMC)

Role During Adverse Weather Events

The WisDOT Regional Incident Management Coordinator is to be WisDOT's first responder during severe weather events affecting the state highway system.

RIMCs are the STOC liaison to the WisDOT Region office during adverse weather 'Warnings' and 'Advisories'.

RIMCs attend National Weather Service (NWS) webinars for impending severe weather.

The RIMC will coordinate with county highway departments after regular business hours if the counties need additional assistance or resources.

The RIMC will contact the Regional Duty Officer (RDO) if it appears that an incident requires more than a local response.

The RIMC will collaborate with county highway departments and with the State Patrol and/or local law enforcement when considerations are being made to restrict or close segments of the Interstate.

Communication Expectations

RIMCs are the primary communications contact for WisDOT during non-business hours and serve as WisDOT's first responder from DTSD in the field.

The RIMCs are responsible for being the primary WisDOT Region office point of contact for an adverse weather event.
RIMCs are responsible for relaying information to WisDOT Regional Duty Officers and the STOC to inform them of problems or to help manage additional resources.

9.4 WisDOT Statewide Traffic Operations Center (STOC)

Role During Adverse Weather Events

The STOC provides timely and accurate information to travelers using field devices (DMS, PCMS and HAR) and the 5-1-1 traveler information system.

The STOC:

- Receives weather Warnings and Advisories from the WisDOT weather subscriber, Meridian
- Participates in the National Weather Service (NWS) weather webinars
- Attends regional and statewide WisDOT pre-event and operational briefings for impending adverse weather events.
- Monitors the WisDOT closed circuit television (CCTV) cameras during adverse weather events for quick identification of trouble areas.
- When appropriate, places advisory messages on DMS, PCMS and HAR.

Communication Expectations

STOC Control Room operators will monitor e-mails received from the WisDOT weather subscriber (Meridian) and iNWS.

Weather Warnings and Advisories that impact the state highway system will be forwarded via e-mail to the appropriate WisDOT Region RIMC e-mail list, and will be retained at the STOC. *(Note: State Patrol communications centers independently receive NWS Warnings and Advisories.)*

STOC will notify the appropriate State Patrol post when flood warnings received from iNWS impact pre-identified Interstate and bridge segments.

The STOC control room, after regular business hours, will receive requests from counties needing assistance during adverse weather events. The STOC will subsequently contact the on-call RIMC to provide the requested assistance.

When a decision to restrict or close a segment of the Interstate system is made, the STOC will contact the RIMC, State Patrol communication center, county emergency communication center, and the WEM Duty Officer.

The STOC facilitates communication among the:

- STOC Control Room Manager
- On-call BTO staff
- WisDOT Regional Incident Management Coordinators (RIMCs)
- State Patrol and other local law enforcement agencies
- WisDOT Area Maintenance Coordinators
- WisDOT Office of Public Affairs (OPA)
- Regional Communications Managers (RCMs)
- Wisconsin Emergency Management
- Media outlets
- Bordering state transportation departments (as appropriate)
- Federal transportation agencies (as appropriate)

9.5 WisDOT Regional Duty Officer (RDO)

Role During Adverse Weather Events

During adverse weather events, RDOs are responsible for conducting regular status check-ins with the Area Maintenance Coordinators, Regional Incident Management Coordinators (RIMCs), and the Statewide Traffic Operations Center (STOC).

RDO's will assist in locating additional resources, as needed.

The RDO communicates situation status to the DTSD Division Administrator's Office, as identified in the existing Administrators' Office Notification Procedure outlined in Section 4.2 (page 16) of the RIMC/RDO Response Guidelines dated June 1, 2012.

Communication Expectations

During an adverse weather event, the WisDOT RDO, if activated, will be in contact with the WisDOT Area Maintenance Coordinators and with the RIMC to monitor Interstate highway conditions.

The RDO will communicate with the DTSD Division Administrator's Office when conditions are deteriorating to the point of impacting multiple regions or require a statewide response.

The WisDOT RDO will do the following:

- Work with the WisDOT Area Maintenance Coordinators and RIMC to ensure that the information needed to maintain the Interstate system is being communicated.
- Contact the STOC and the DTSD Division Administrator's Office if the WisDOT Area Maintenance Coordinator and/or the RIMC reports a resource problem.
- Request additional resources within the region and coordinate assistance with the county.
- Coordinate with the DSP post supervisor on the WisDOT response.
- Manage the WisDOT internal Incident Command System (ICS) response.

9.6 WisDOT State Patrol Communications Center

Role During Adverse Weather Events

Receives winter roadway condition reports from State Patrol troopers and populates the 5-1-1 Traveler Information system map.

Communication Expectations

The State Patrol has seven communication centers at posts throughout Wisconsin. Each communication center is responsible for coordinating communications between the State troopers and the counties in their region. During adverse weather events, the State Patrol Communication Center will communicate with the WisDOT STOC, the Area Maintenance Coordinator, and county sheriff and/or local law enforcement, as necessary.

9.7 WisDOT Wisconsin Highway Liaison Personnel (WisHELPer)

Role During Adverse Weather Events

The on-call WisHELPer will:

- Participate in WisDOT regional or statewide pre-event or operational teleconference briefings during adverse weather events
- Report to the state Emergency Operations Center if it has been activated at Level 1 or Level 2
- Assist WEM staff and other state EOC representatives by providing highway-related information such as road closures, road damages, available routes for emergency response personnel, and oversize-overweight permitting details
- Coordinate with the STOC to ensure that proper and consistent messaging is being provided to the public

Communication Expectations

Perform under the direction and authority of the Statewide Bureaus Duty Officer (SWBDO)

Work directly with the state EOC State Patrol representative to relay and confirm road closure information.

WisHELPers communicate primarily with the state EOC structure, SWBDO, the WisDOT Regional Duty Officer, the activated county EOC's, and the STOC.

Document WisDOT's activities into E-Sponder when assigned to the state EOC.

9.8 WisDOT Statewide Bureaus Duty Officer (SWBDO)

Role During Adverse Weather Events

The on-call Statewide Bureaus Duty Officer (SWBDO) will:

- Participate in WisDOT regional or statewide pre-event or operational teleconference briefings during adverse weather events
- Supervise and coordinate with the on-call WisHELPer assigned to the state Emergency Operations Center (EOC)

- Marshal statewide resources and technical expertise as needed
- Assist with managing the WisDOT internal Incident Command System (ICS) response

Communication Expectations

Coordinate with the on-scene WisDOT Regional Duty Officer.

The SWBDO will contact the STOC and the DTSD Administrator's Office if the WisHELPer reports a resource problem.

9.9 WisDOT Public Information Officer (PIO)

Role During Adverse Weather Events

The PIO will:

- Participate in regional or statewide pre-event or operational teleconference briefings.
- Issue WisDOT media releases anytime travel on the Interstate is 'not advised', 'travel is restricted', or the 'highway is closed'. (See sample media releases in 11.0.)
- Monitor media coverage and analyze public information needs.

Communication Expectations

Timely dissemination or vital information to WisDOT's internal and external stakeholders.

If more than one WisDOT region is affected the public information effort needs to be coordinated between the Regional Communication Managers (RCM).

If an adverse weather event escalates to a WisDOT statewide response, a Public Information Officer (PIO) needs to be identified and work closely with the incident commander per the guidelines of the Incident Command System.

Write and distribute media advisories, media releases and situation reports.

Organize media conferences.

Record radio actualities/audio messages for telephone hotlines.

Handle media interviews and arrange for escort of reporters to restricted areas when such visits are authorized.

APPENDIX A – MEDIA RELEASE SAMPLES

Travel Not Advised

Traffic Alert

Wisconsin Department of Transportation

Northwest Region Eau Claire Office
718 W Clairemont Avenue • Eau Claire, WI 54701
(715) 836-2891 • Fax (715) 836-2807
eauclaire.dtd@dot.state.wi.us

Northwest Region Superior Office
1701 N 4th Street • Superior, WI 54880
(715) 392-7925 • Fax (715) 392-7863
superior.dtd@dot.state.wi.us

December 11, 2010
FOR IMMEDIATE RELEASE

For more information, contact:
State Patrol Regional Post (listed on WisDOT Web site) at
http://www.dot.wisconsin.gov/about/locate/sp/offices.htm

Travel not advised tonight through Sunday in the entire state of Wisconsin
Heavy snow and high winds significantly impacting travel

MADISON - The Wisconsin Department of Transportation along with the State Patrol is advising motorists not to travel on any Wisconsin highway now through Sunday, unless absolutely necessary.

The National Weather Service has issued Winter Storm and Blizzard Warnings in most counties around the state until Sunday morning. Heavy snow combined with high winds and dangerous wind chills, has led to white-out conditions in many areas, limiting visibility for motorists. This storm will continue to move through the state, with areas in the south and east expected to be impacted throughout the night and day on Sunday.

"Conditions continue to deteriorate and it is becoming critically important for vehicles to stay off the roadways," said State Patrol Superintendent David Collins. "We continue to monitor the highways, and will make determinations on whether to keep them open to ensure the safety of the motoring public."

Providing safe and efficient transportation in Ashland, Barron, Bayfield, Buffalo, Burnett, Chippewa, Clark, Douglas, Dunn, Eau Claire, Jackson, Pepin, Pierce, Polk, Rusk, Sawyer, St. Croix, Taylor, Trempealeau, and Washburn counties

- Motorists who must travel are advised to monitor weather and road conditions before leaving.
- To check on the latest winter road conditions, call 5-1-1 or view this information on the Web at 511wi.gov. Dial 911 only for emergency situations.
- Leave at least 500 feet of distance between your vehicle and a snowplow or salt truck.
- Make sure your gas tank is full and you have some food, warm blankets and clothing in the vehicle in case of emergency. If you have a cell phone, make sure it's fully charged and working.
- Tell others about your travel route and itinerary, so that if you don't arrive at your destination, they can contact law enforcement officers and inform them where to look.
- Keep others informed if you're going to be late or encounter problems so they won't worry needlessly.
- It's safer to travel with passengers and convoy with other vehicles than it is to drive alone.
- Remember, the speed limit is based on clear roads and dry pavement—don't drive too fast for conditions.
- Watch for slippery spots on bridges and overpasses.
- Take note of mileposts, exit numbers or crossroads in case you slide off the road or are involved in a crash so that law enforcement officers and tow truck operators can find you.
- If the storm makes driving too hazardous or if your car breaks down, stay in the vehicle. Run your engine and heater for short intervals to stay warm. Be sure to crack the window to avoid carbon monoxide build-up.

###

NOTE: News releases can be viewed on the Web at: www.dot.wi.gov/news/index.htm.

Travel Restricted

Traffic Alert

Wisconsin Department of Transportation

Northwest Region Eau Claire Office
718 W Clairemont Avenue • Eau Claire, WI 54701
(715) 836-2891 • Fax (715) 836-2807
eauclaire.dtd@dot.state.wi.us

Northwest Region Superior Office
1701 N 4th Street • Superior, WI 54880
(715) 392-7925 • Fax (715) 392-7863
superior.dtd@dot.state.wi.us

Date:
FOR IMMEDIATE RELEASE

For more information, contact:
Chris Ouellette, WisDOT Communication Manager 715-828-9471

I-94 Travel Restricted
Heavy snow and high winds significantly impacting travel

MADISON - The Wisconsin Department of Transportation along with the State Patrol is restricting traffic from entering I-94 between Hudson and Tomah.

Motorists attempting to use the interstate should make alternate plans, however all highways are in hazardous condition. WisDOT will begin restricting access to the interstate immediately and will continue until it is deemed safe to travel.

Motorists on the interstate at this time should begin to consider exiting and finding safe shelters for the night.

WisDOT continues to advise against any travel on any Wisconsin highway now through Sunday, unless absolutely necessary.

###

NOTE: News releases can be viewed on the Web at: www.dot.wi.gov/news/index.htm.

Providing safe and efficient transportation in Ashland, Barron, Bayfield, Buffalo, Burnett, Chippewa, Clark, Douglas, Dunn, Eau Claire, Jackson, Pepin, Pierce, Polk, Rusk, Sawyer, St. Croix, Taylor, Trempealeau, and Washburn counties

Interstate Closed

Traffic Alert

Wisconsin Department of Transportation

Northwest Region Eau Claire Office
718 W Clairemont Avenue • Eau Claire, WI 54701
(715) 836-2891 • Fax (715) 836-2807
eauclaire.dtd@dot.state.wi.us

Northwest Region Superior Office
1701 N 4th Street • Superior, WI 54880
(715) 392-7925 • Fax (715) 392-7863
superior.dtd@dot.state.wi.us

February 20, 2011
FOR IMMEDIATE RELEASE

For more information, contact:
State Patrol Regional Post 715-839-3800
Chris Ouellette, NW Region Communication Manager 715-828-9471

Mutli vehicle crash on I-94 in Eau Claire County
Heavy snow and high winds significantly impacting travel

EAU CLAIRE – A multi vehicle crash on I-94 in Eau Claire between WIS 37 and WIS 93 has closed the interstate in that area.

The State Patrol and other emergency crews are responding to the crash and motorists are being diverted off of the interstate. Eastbound traffic will exit at WIS 312 to eastbound US 12 back to I-94. Westbound traffic will exit at US 53 to westbound US 12 to I-94.

Motorists attempting to use the interstate between now and Monday afternoon should make alternate plans, however side roads are also in hazardous condition.

Heavy, blowing snow has reduced visibility on the highways and WisDOT is encouraging no travel unless absolutely necessary as the storm moves through the area.

###

NOTE: News releases can be viewed on the Web at: www.dot.wi.gov/news/index.htm.

Providing safe and efficient transportation in Ashland, Barron, Bayfield, Buffalo, Burnett, Chippewa, Clark, Douglas, Dunn, Eau Claire, Jackson, Pepin, Pierce, Polk, Rusk, Sawyer, St. Croix, Taylor, Trempealeau, and Washburn counties

Road Condition Report

Traffic Alert

Wisconsin Department of Transportation

Northwest Region Eau Claire Office
718 W Clairemont Avenue • Eau Claire, WI 54701
(715) 836-2891 • Fax (715) 836-2807
eauclaire.dtd@dot.state.wi.us

Northwest Region Superior Office
1701 N 4th Street • Superior, WI 54880
(715) 392-7925 • Fax (715) 392-7863
superior.dtd@dot.state.wi.us

December 12, 2010
FOR IMMEDIATE RELEASE

For more information, contact:
State Patrol Region Posts
Chris Ouellette, WisDOT Communication Manager 715-828-9471

Road conditions remain poor across Wisconsin
Travel still not advised across the state

MADISON - The Wisconsin Department of Transportation along with the State Patrol would like to remind motorists that state highways remain in hazardous condition.

While the roads may appear clear in places, they may be covered with ice or ice packs. Also, due to the dropping air and road temperatures the remedies used on the roads may not be as effective in keeping them clear.

Dangerous wind chills, and white-out conditions in open areas, along with the snow and ice covered roads will continue to make driving very difficult. WisDOT advises against travel on any Wisconsin highway through the remainder of the day, unless absolutely necessary.

To check the latest winter road conditions, call 5-1-1 or visit 511.wi.gov. Dial 9-1-1- only for emergency situations.

###

NOTE: News releases can be viewed on the Web at: www.dot.wi.gov/news/index.htm.

Providing safe and efficient transportation in Ashland, Barron, Bayfield, Buffalo, Burnett, Chippewa, Clark, Douglas, Dunn, Eau Claire, Jackson, Pepin, Pierce, Polk, Rusk, Sawyer, St. Croix, Taylor, Trempealeau, and Washburn counties

Travel Restriction Lifted

Traffic Alert

Wisconsin Department of Transportation

Northwest Region Eau Claire Office
718 W Clairemont Avenue • Eau Claire, WI 54701
(715) 836-2891 • Fax (715) 836-2807
eauclaire.dtd@dot.state.wi.us

Northwest Region Superior Office
1701 N 4th Street • Superior, WI 54880
(715) 392-7925 • Fax (715) 392-7863
superior.dtd@dot.state.wi.us

December 12, 2010
FOR IMMEDIATE RELEASE

For more information, contact:
State Patrol Region Posts
Chris Ouellette, WisDOT Communication Manager 715-828-9471

I-94 entrance restrictions lifted
Travel still not advised across the state

MADISON - The Wisconsin Department of Transportation along with the State Patrol is removing the restrictions to entering I-94 between Hudson and Tomah effective immediately. However, high winds continue to cause drifting and icing conditions on many roadways across the state.

With the dangerous wind chills, white-out conditions in open areas, and snow and ice covered roads, WisDOT continues to advise against travel on any Wisconsin highway through the remainder of the day, unless absolutely necessary.

To check the latest winter road conditions, call 5-1-1 or visit 511.wi.gov. Dial 9-1-1- only for emergency situations.

###

NOTE: News releases can be viewed on the Web at: www.dot.wi.gov/news/index.htm.

Providing safe and efficient transportation in Ashland, Barron, Bayfield, Buffalo, Burnett, Chippewa, Clark, Douglas, Dunn, Eau Claire, Jackson, Pepin, Pierce, Polk, Rusk, Sawyer, St. Croix, Taylor, Trempealeau, and Washburn counties

Abbreviations used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation

TRANSPORTATION RESEARCH BOARD
500 Fifth Street, N.W.
Washington, D.C. 20001

ADDRESS SERVICE REQUESTED

ISBN: 978-0-309-27117-2
90000
9 780309 271172