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Research on Best Practices for Winter Weather Operations

Technical Report 0-6669-1

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TEXAS A&M TRANSPORTATION INSTITUTE
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16. Abstract
There is a growing need to identify actionable practices relative to winter weather operations. Because of the potential and inherent hazards during cold weather, it has become increasingly important to ensure that these practices can be effectively employed as well as protect the health and safety of employees working in extreme conditions.

The research objective is to develop a winter weather operations manual for the Texas Department of Transportation (TxDOT) districts that are vulnerable to weather-related emergencies. A synthesis of the best practices related to winter weather operations and transferable best practices are documented in the operations manual to help maintenance crews better understand how to work in challenging weather-related events. In addition, a playbook for winter storms in Texas was developed to be used for general public awareness of winter storm operations.

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RESEARCH ON BEST PRACTICES FOR WINTER WEATHER OPERATIONS

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DISCLAIMER

This research was performed in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented here. The contents do not necessarily reflect the official view or policies of TxDOT.

This report does not constitute a standard, specification, or regulation, nor is it intended for construction, bidding, or permit purposes. The engineer in charge of the project was Judy A. Perkins, Ph.D., P.E.

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.

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CHAPTER 1: INTRODUCTION

BACKGROUND AND SIGNIFICANCE OF WORK

Adverse weather conditions have a major impact on the safety and operation of our roads, from signalized arterials to interstate highways. Weather affects driver behavior, vehicle performance, pavement friction, and roadway infrastructure. This is especially true for many drivers in Texas, who are unfamiliar with driving in winter road conditions.

Accurate weather information is a critical element in the daily lives of most Americans. In many cases, weather information helps determine when and if to take a trip, the route, and expected travel time. It guides the actions of state departments of transportation (DOTs) that maintain the interstates and state highways. It also affects how and when commerce is transported.

When weather turns wintry with snow and ice, it not only can change daily habits, it can be deadly. Over 70 percent of the nation's roads are located in snowy regions, which receive more than five inches (or 13 cm) average snowfall annually. Nearly 70 percent of the U.S. population lives in these snowy regions. Snow and ice reduce visibility, pavement friction and vehicle maneuverability, causing slower speeds, reduced roadway capacity, and increased crash risk. Over 17 percent of all fatal crashes occur during winter weather conditions. Of those, 60 percent happen in rural areas. Snow accumulation obstructs lanes and roads, further reducing capacity and increasing travel time delay.

Adverse Weather Impacts

Weather threatens surface transportation nationwide and impacts roadway safety, mobility, and productivity. It affects roadway safety through increased crash risk, as well as exposure to weather-related hazards. Weather impacts roadway mobility by increasing travel time delay, reducing traffic volumes and speeds, increasing speed variance (i.e., a measure of speed uniformity), and decreasing roadway capacity (i.e., maximum rate at which vehicles can travel). Weather events influence productivity by disrupting access to road networks, and increasing road operating and maintenance costs.

Weather acts through visibility impairments, precipitation, high winds, and temperature extremes to affect driver capabilities, vehicle performance (i.e., traction, stability, and maneuverability), pavement friction, roadway infrastructure, crash risk, traffic flow, and agency productivity.

STATE DEPARTMENT OF TRANSPORTATION RESPONSE ACTIONS

The benefits of improving road weather management include:

- Improved safety due to reduced crash risk.
- Increased mobility due to restored capacity, delay reductions, and more uniform traffic flow.
- Increased productivity due to reduced labor, treatment material, and equipment costs.

Despite the potential for benefit, there is a perception that transportation managers can do little in response to the weather. Contrary to this perception, three types of road weather management strategies may be employed in response to environmental threats (e.g., fog, high winds, snow, rain, ice, flooding, tornadoes, hurricanes, and avalanches):

- *Advisory strategies* provide information on prevailing and predicted conditions to both transportation managers and motorists. Posting fog warnings on Dynamic Message Signs (DMS) and listing flooded routes on web sites are examples of advisory strategies.
- *Control strategies* alter the state of roadway devices to permit or restrict traffic flow and regulate roadway capacity. Reducing speed limits with Variable Speed Limit (VSL) signs and modifying traffic signal timing based on pavement conditions are examples of control strategies.
- *Treatment strategies* supply resources to roads to minimize or eliminate weather impacts. The most common treatment strategies are application of sand, salt, and anti-icing chemicals to pavements to improve traction and prevent ice bonding. Many treatment strategies involve coordination of traffic, maintenance, and emergency management agencies.

These strategies often use various technologies intended to support surveillance, monitoring and prediction; information dissemination; and/or decision support, control, and treatment to help mitigate weather impacts on roads.

- Surveillance, Monitoring, and Prediction—Observing systems and forecast services that transportation managers can access to gather information on prevailing and predicted conditions.
- Information Dissemination—ITS and information technologies that transportation managers use to disseminate road weather information to travelers.
- Decision Support, Control, and Treatment—Decision support systems, control strategies, and treatment strategies that transportation managers employ to improve safety, mobility, and productivity.

Each state often has its own guidelines and policies that govern their operations during winter weather. In Texas, snow and ice control procedures are defined generally on a statewide basis; select districts have developed and maintain more detailed procedures. These guidelines and policies are likely borne from tradition rather than recent advances and science-driven decision making.

OBJECTIVES

The main research objective of this project was to develop a *Winter Weather Response Guide* (*1*) for the TxDOT districts vulnerable to weather-related emergencies. Researchers conducted a synthesis of the best practices related to winter weather operations, highlighted transferable best practices, and documented this information in a manual that will assist maintenance crews to better understand how to work in weather-related emergencies. In addition, researchers developed a

Playbook for Winter Storms in Texas, which will be used to provide information to the traveling public about TxDOT operations during winter storm events.

WORK PLAN

The work plan represented the tasks necessary to achieve the project objective and provide TxDOT with data and research findings that will enable TxDOT staff to explore strategies for dealing with winter weather operations. This plan was comprised of a number of tasks and subtasks including:

- Conduct project kick-off meeting with the project monitoring committee and critical TxDOT stakeholders.
- Conduct state-of-the-practice and literature review related to winter weather operations.
- Review TxDOT internal procedures for winter weather operations.
- Review weather patterns and identify asset requirements.
- Synthesize Best Practices in winter weather operations.
- Develop multi-district operational plans.
- Develop a *Winter Weather Response Guide*.
- Prepare project documentation.

CHAPTER 2: LITERATURE REVIEW AND STATE OF THE PRACTICE

BACKGROUND

Weather conditions can have a major impact on both the safety and operation of our roads, from signalized arterials to interstate highways. Adverse weather affects everything from driver behavior to vehicle performance, pavement friction, and roadway infrastructure. This is especially true for winter weather conditions in Texas as many drivers are unfamiliar with driving in winter road conditions. Texas is not alone in realizing the need to address these problems. In 2002, the Office of Federal Coordinator for Meteorological Services and Supporting Research (OFCM) completed a study examining the weather information needs for surface transportation. This study emphasized the need to utilize current technology to improve the production and delivery of road conditions and weather-related information about the nation's highways (*2*).

Winter weather conditions reduce the operating speeds and capacity on roadways, resulting in congestion and a loss of productivity. In a 2004 study, Cambridge Systematics and the Texas Transportation Institute (TTI) found that, nationwide, nearly a billion hours and 7000 lives are lost each year on roadways due to adverse weather (*3*). The following year, Iowa State University researchers released a study that quantified the impact of snow, extreme cold, wind, poor visibility, and adverse pavement surface conditions (*4*). They found that severe rain, snow, and low visibility all cause significant reductions in capacities and operating speeds, and that speed reductions due to heavy rain and snow were significantly lower than those specified in the *Highway Capacity Manual* (2000).

Winter weather conditions on roadways also compromise safety. In the 1960s, Clark University found that collisions increased by 200 percent on three to 12 snow days per year (*5*); in 1974, a British study (*6*) found that injury collisions increase as much as 50 percent under inclement weather conditions. In a 2006, Quinn, Noyce, and Lee (*7*) investigated the impact of snowstorms on crashes on the Wisconsin state highway system and the effect of winter maintenance efforts on mitigating that impact. The results of this study showed a mixed influence of both storm severity and winter maintenance investment on road safety. The severity and duration of the storm significantly influenced road safety, with a large percentage of crashes occurring during the initial stages of the snow storm. Storms that had freezing rain exhibited fewer crashes than storms that had only dry or wet snow. The researches hypothesized that fewer crashes occurred because of the more aggressive and proactive winter maintenance efforts for treating freezing rain along with raised public awareness and caution during freezing rain storms. However, the study also showed that a proactive winter maintenance effort will significantly improve traffic safety.

FEDERAL PLANS AND EFFORTS

The Road Weather Management Program (RWMP) is part of the Federal Highway Administration's (FHWA) Office of Operations. The RWMP works in conjunction with the Intelligent Transportation Systems (ITS) Office of the Research and Innovative Technology Administration (RITA) to addresses issues regarding road weather (*8*). The RWMP coordinates research, development, and implementation of systems to assist states in dealing with weather related issues. An example is the Clarus Initiative that was developed in 2004 to reduce the impact of adverse weather conditions on

surface transportation users by providing quality checked road weather observations to state DOTs and to the commercial and public sectors. The Clarus Initiative consists of two components: system development and information tailoring. The first component is the development of the Clarus System—a processing system for the collection, consolidation, quality control, and exchange of surface transportation weather data and related road and rail conditions. The second component is the development of tailored forecasts, models, and decision support tools, with which the surface transportation community can use the Clarus System and its processed data more effectively (*9*).

In the late 1990s, the FHWA recognized that there was no link between available weather forecasts and winter road maintenance decisions. This missing link led to the development of the winter Maintenance Decision Support System (MDSS) prototype (*10*). The winter MDSS is an integrated software application that provides users with real-time road treatment recommendations based on weather forecast information and predicted pavement conditions. These recommendations include guidance for material use (e.g., salt brine), application times, and rates. They help agencies minimize the amount of material applied to the roads while maintaining the highest level of service possible under given resource constraints. A winter MDSS can also be used for analyzing "what-if" scenarios and compare treatment alternatives using various material types, application times, and rates (*11*). It can also serve as a training tool for new and less experienced maintenance managers. After a winter season ends, conditions can be re-entered in the MDSS to determine if different courses of action would have proven more beneficial (*12*).

The FHWA Road Weather Management Program funded and directed the MDSS prototype project. The federal MDSS prototype software modules are available to private vendors who can utilize these to develop decision support applications specifically tailored to the needs of different state DOTs. Two winter MDSS development and deployment efforts were built on the technologies that the federal MDSS prototype provided. One of them was a pooled fund MDSS study that started in 2002, involved five state DOTs (South and North Dakota, Minnesota, Indiana, and Iowa), and enjoyed FHWA support. The other effort was the DTN-Meteorlogix Weather Sentry MDSS that was implemented and evaluated in 10 states during the winter of 2005–2006 (*13*).

Maine is one of the states that evaluated the DTN-Meteorlogix Weather Sentry MDSS (*13*). The MDSS that MaineDOT deployed was primarily used as a weather forecasting tool. Maine DOT decided to deploy the MDSS in a step-wise fashion without committing to a costly, fully evolved MDSS system initially. The MDSS offered a tool that helped Maine DOT integrate a variety of critical weather data (predicted precipitation type, quantity, start time, and duration) into a GIS platform. Next, Maine DOT used this platform to assist with the planning and timing of pretreatment decisions and determine the correct materials for the conditions they are going to face when a storm approaches. The overall experience with the MDSS was positive, though the available data were not adequate to support a more quantitative assessment of cost savings from the use of the MDSS (*14*).

Based on the savings that the states in the Pooled Fund MDSS had reported, several other states decided to implement and evaluate a winter MDSS. Indiana DOT decided to do a statewide implementation of MDSS during the winter of 2008–2009 (*15*). The field trials spanned over three winters, gradually adding more routes each year. During the field trials, the state reported a 10 to

30 percent savings in salt use. From 2008–2009, Indiana DOT realized savings of $12.1 million in salt use and $1.4 million in compensation for overtime (*15*) . After normalizing the savings to account for varying winter conditions, there were still almost $10 million savings in salt use and $1 million in overtime. In addition to these realized savings, some unexpected observations emerged. While MDSS was always considered a scientific tool, it also proved to be a powerful management tool. As managers became more accustomed to interpreting their treatment recommendations, they became more comfortable planning instead of reacting to conditions (*15*).

Several studies have evaluated the cost-effectiveness of MDSS. For example, Battelle performed a benefit-cost assessment (BCA) of the use of an MDSS by Colorado's City and County of Denver (*16*). The MDSS was used over two consecutive winters (2007–2009) and resulted in budget savings that exceeded costs of the system while maintaining the level of service on the road network. For every $1 that the City and County of Denver spent on the MDSS, it achieved $1.34 in return. Denver gained a net benefit of $24,304 per year from the use of the MDSS. Most of the savings are attributable to more effective tactical crew deployment decisions. While not insignificant, the percentage savings in supplies and materials is slightly less when compared with the overtime savings. Overall, the City and County of Denver management and staff were very satisfied with the utility and performance of the MDSS in supporting their maintenance decisions (*16*).

STATE PLANS AND EFFORTS

New Hampshire

The New Hampshire Department of Transportation's (NHDOT) snow removal and ice control policy has the goal of obtaining bare and dry pavements at the earliest practical time following the cessation of a storm. The policy clearly states that in the judgment of NHDOT, it is virtually impossible to provide bare pavements during a winter storm and the department does not attempt to do so (*17*). The primary factors that NHDOT used to determine the level of winter maintenance are traffic volume, posted speed, and highway grade. For example, the Interstate System, Turnpike System, and other heavily traveled highways are maintained in such a manner that bare pavements are produced as soon as practical after termination of a storm. However, on state highways with low traffic volumes, NHDOT attempts to provide some bare pavements—not necessarily from shoulder to shoulder, but rather within a day or two after a storm ends (*17*).

Minnesota

The Minnesota Department of Transportation (Mn/DOT) has a stated first priority of keeping the traveling public safe. The department has an active program to monitor the effectiveness of its fleet of over 800 snowplows and 1,500 snowplow drivers through performance targets based on public safety and driver expectations. Every year, Mn/DOT compares the winter severity to that of previous years using a Winter Severity Index. This process began in 2003 to simplify the comparison of winter severity, resulting in a single relative number for each district and a statewide average (*18*).

Mn/DOT also annually assesses the use of chemicals, training of maintenance personnel, and public satisfaction. In 1999, after an in-depth study of customer expectations, the Bare Lane Regain Time performance measure was introduced for snow and ice control operations. Bare Lane Regain Time is

measured from the time a winter event ends to when Mn/DOT's snow and ice operations regain bare-lane driving conditions. A "bare lane" is defined as the time when 95 percent of all driving lanes are free of snow and ice between the outer edges of the wheel paths and have less than 1 inch of accumulation on the center of the roadway. In the winter of 2009–2010, the Bare Lane Regain times were 6.9 hours statewide, down 31 percent from the prior winter's statewide average of 10 hours (*18*).

Wisconsin

Like other states, the goal for Wisconsin Department of Transportation (WisDOT) is to provide safe traveling conditions for the traveling public during the winter. One unique aspect of WisDOT winter weather operations is the use of county highway departments. To meet level of service goals in this area, WisDOT contracts with the state's 72 county highway departments for winter maintenance on these highways, resulting in a unique and mutually beneficial partnership. WisDOT receives the services of a skilled, experienced work force, and supports the counties through training, research initiatives, and facilitation of product testing (*19*). Like Minnesota, WisDOT uses a Winter Severity Index as a way to quantify overall winter severity with a single number that factors in number of snow events, number of freezing rain events, total snow amount, total storm duration, and total number of incidents. WisDOT uses this index as a management tool in evaluating materials, labor and equipment use across counties and from year to year (*19*). WisDOT also compiles two types of response time data—the time it takes a maintenance crew to get on the road after the start of a storm, and the time it takes the pavement to return to a bare condition after the end of a storm (*19*).

Utah

The policy of the Utah Department of Transportation (UDOT) to provide an appropriate level of service on state routes during adverse winter weather. The level of service is based on a number of factors including available resources, roadway functional classification, and importance to emergency services, importance to school bus routes, and importance to commerce. In each case, the primary objective is to keep at least one travel lane in each direction open to traffic and to provide intermittently a bare pavement as soon as practical (*20*).

In 2002, in preparation for the Winter Olympics, UDOT took the notable step of creating a Weather Operations/Road Weather Information System (RWIS) Program (*21*). This RWIS program is unique among state DOTs nationally, as it assists the UDOT operations, maintenance, and construction functions by providing detailed, often customized, area-specific weather forecasts. Staff meteorologists are stationed in the Traffic Operations Center (TOC), providing easily accessible weather information and quality control of weather forecasts. The study found that UDOT has realized significant cost savings (estimated at $5.9 to $13.3 million per year) by using weather forecasts to pursue anti-icing strategies. The study also found that UDOT's Weather Operations Program has helped to reduce labor and materials costs beyond what has been attained through the use of other weather forecast information services, and that there is potential for greater cost savings up to $0.5 to $1.2 million per year in the future based on increased usage of the Weather Operations Program (*21*).

Nevada

Like other DOTs, the Nevada Department of Transportation (NDOT) works hard to effectively clear Nevada roads for safe winter travel. Like Utah, NDOT employs an RWIS program to assist decision makers and maintenance personnel determine how to combat winter weather storms. NDOT's RWIS consists of a network of meteorological stations strategically located along state roadways. Specialized monitoring equipment embedded into the road makes detailed observations of air and pavement temperature on specific roadways, allowing NDOT to make informed snow removal decisions, from utilizing alternate de-icing chemicals and making optimal use of materials and staff to practicing anti-icing techniques developed through years of research. NDOT has approximately 35 strategically placed RWIS stations in northwest Nevada (*22*).

Washington State

The Washington State Department of Transportation (WSDOT) plan addresses two very diverse winter weather situations. Winter climates differ greatly between Eastern and Western Washington, so road treatment levels may vary on either side of the Cascades to match the ability to respond to expected conditions. Limited funding also requires prioritization of roads for snow and ice control, so that different levels of service will be employed for individual roads and sections of roads (*23*).

In Eastern Washington, periodic snowfall events are typical, and freezing temperatures and relatively drier conditions may persist for the duration of the winter season. The winter maintenance program (labor, equipment, and materials) is sized and developed to facilitate the movement and safety of traffic under normal expected winter conditions. The exceptional winter weather event in Eastern Washington is typically a widespread ice storm or a snowstorm of severe intensity and duration. The goal for Western Washington is substantially different as the winter season is generally cool and wet with only occasional ice or snow events. The expected winter conditions in Western Washington are for temperatures dropping to create black ice or frost conditions. A light to moderate snowfall event may also occasionally take place. These are typically characterized by localized events (*23*).

PUBLIC AWARENESS MATERIALS

In today's world of instant communications, it is crucial to connect with the community and the traveling public to keep them informed of the most current roadway condition. A Pew Research Center study (*24*) found that local television and the internet were the most relied-upon sources for information regarding weather, while radio was the most popular form of media for traffic information. It is also beneficial to educate both the media and the public on the capabilities of the local DOT offices so that there are realistic expectations regarding response to each approaching winter storm. Connecting with the community and increasing public awareness is a constant and ongoing task that utilizes multiple tools.

Many state DOTs, especially those for northern states, utilize a variety of ways to create public awareness of their snow and ice plans. Some states publish fact sheets, brochures, playbooks, and websites, while others have utilized public service announcements (PSAs) and YouTube videos.

All of these efforts have similar goals: educate the public, and encourage safety during winter weather events.

For example, WSDOT has a web page that features videos on winter driving, pictures, tips on winterizing your car, and safe driving tips (*25*). In Ohio, each district of the Ohio Department of Transportation has a video detailing Ice and Snow Operational Readiness or Snow Safety Tips. The Pennsylvania Department of Transportation (PennDOT) has developed a brochure called *PennDOT Playbook: Winter Operations Guide* (*26*). This trifold brochure provides the driving public with facts about PennDOT's winter operations, safe driving tips, and where to go to get more information.

The Internet has allowed transportation agencies to widely disseminate traveler information such as real-time traffic congestion, incidents, and updates on construction activities, as well as other transportation-related information to the public. The information is available 24 hours a day at a relatively low cost to the provider, and it can be accessed by users from home, from work, or en route if Internet access is available. The effectiveness of traveler information websites is dependent upon the nature and extent of, and level of effort expended to maintain, the traveler information provided on the website. The use of websites is effective; however, if websites are not maintained or kept current, the public trust in those websites will be severely diminished.

EMERGING ADVANCEMENT IN MATERIALS AND METHODS

Hot Water and Sand Mix (Norway)

Norway has developed and implemented a new method of sanding that is based on the use of a mix of hot water and sand. The most significant factors in this method are the sand quality, the amount of water, the spreading speed, and the water temperature. The sand should be of a specified quality corresponding to a 0 to 4-mm gradation. Hot water means that the water temperature is 90°C to 95°C (194°F to 203°F). The amount of water in the mixture of sand and water is approximately 30-weight percentage, and the normal dosage of sand used is equivalent to 200 g/m^2 as an average.[27]

Testing this new method against traditional sanding methods concluded that the warm wet sand method has a broad range of applications and therefore can be recommended as a supplement to existing sanding methods. It is important to emphasize that the wet-sand method can be used under conditions for which traditional methods have little or no effect. This method also makes it possible to maintain the friction standard under conditions for which it is normal to spread sand less frequently than necessary in order to maintain the friction standard. The new sanding method can be used under conditions under which traditional methods have little or no effect:

- Hard blue ice.
- Roads with a high percentage of heavy vehicles.
- Thin ice or frost on asphalt (*27*).

Agricultural By-Products (Michigan)

In response to the detrimental effects of deicing salt, ecosystem damage, and corrosion of metals, Michigan Department of Transportation (MDOT) began investigating alternative strategies for deicing and anti-icing. One of these strategies is the use of anti-icing compounds developed from animal by-products (ABP). Manufacturers claim that ABPs perform better, are environmentally friendly, and are less corrosive than conventional anti-icing and deicing materials. These products have shown promise in trial applications within Michigan and elsewhere in the nation. Their primary use is for anti-icing operations, but improved performance of deicing chemicals used in conjunction with ABPs has also been documented (*28*).

Michigan utilized ABPs from 1999 to 2002 in the southwest region of the state, which typically experiences heavy lake-effect winter precipitation. As more experience was gained, anti-icing methods became more efficient. Application rates for anti-icing were lowered to 25 gallons per lane mi. For the 2000–2001 winter season, the ABP used was a clear color, not the brown previously used; thus, the appearance as sprayed on the roadway did not resemble black ice and therefore prevented unnecessary applications of deicing salts. Overall, MDOT found that ABP liquids when used appropriately for anti-icing are powerful tools in providing safer roads at less cost (*28*). Equipment Advancements

Intelligent Spreaders GPS (Denmark)

Denmark has implemented two essential tools for winter maintenance: a road weather information system (RWIS) and Vinterman, a computer system that helps in decision making and winter operations (*29*). As a part of the Vinterman system spreaders are equipped with online data collection, which allows Vinterman to receive data on salting actions and equipment faults. As a result of the success of Vinterman, a project was initiated in 2003 to use Global Positioning System (GPS)-controlled spreading. The idea is that the road geometry, surface, and dosage are known before the action starts and should therefore be handled automatically without the need for the driver to adjust the control box. The driver is able to override the automatic adjustments: for example, changing of the spreading symmetry in windy situations. Further development of GPS-controlled technology is expected to improve the quality of winter service as well as reduce the environmental impact of salt usage (*29*).

Intelligent Spreaders GIS (Wisconsin)

Wisconsin Department of Transportation, in conjunction with eight Wisconsin counties and the University of Wisconsin-Madison has developed a geographic information system (GIS) application, called "Wiscplow" (*30*). Wiscplow combines vehicle data with manually entered data (e.g., storm durations, vehicle configurations, and labor and equipment cost rates) and with spatial data representing roadway centerlines attributed with functional class, number of lanes, patrol sections, and route systems. Outputs include reports on computed performance measures (e.g., cycle time and hourly average salt application rate by patrol section and storm) and decision management tools (charts, graphs, and maps) showing relationships among performance measures (e.g., salt application rate versus pavement temperature by patrol section and storm) .

The initial evaluation of Wiscplow shows promise; however, some technical issues concerning refinements to and effective use of Wiscplow, need to be addressed. These include questions about temporal identifiers, required spatial accuracies of both the DGPS and map data, optimal temporal resolution of the DGPS data, sensitivities of computed performance measures, and resolution of spatial ambiguities that cause vehicle data to be associated with the wrong roadways. Institutional issues that must be addressed before effective, long-term use of Wiscplow can be realized include responsibility for development and maintenance of accurate roadway centerline spatial databases, integration of Wiscplow and its databases with existing information technology environments at the county level, training and staffing, and long-term technical support and maintenance of the Wiscplow code (*30*).

TECHNOLOGY

In fall 2002, WSDOT embarked on a pilot project to collect and manage data from the snow and ice program more effectively (*31*). Previously, WSDOT did not have a universally applied standard for data collection, or for documentation of effort. The goal of the snow and ice program data collection project was to document where and when personnel applied material, how much material was applied, and to measure the outcome of the effort. A program was written to run on a PDA for download into a central database. Ease of use by the equipment operator and the collection of common data elements were the primary goals.

The initial implementation was limited in scope due to the limited number of PDAs available. WSDOT systematically began buying and deploying units every year until each employee had their own personal PDA, or access to a shared PDA. Replies to the following questions were answered with the data collection efforts:

- How much deicer has been applied within the last 24 hours on a specific section of highway?
- What resources are deployed for any given maintenance area?
- Is there a need to adjust or add resources?
- What were the road conditions over a given time period?
- Were operations effective in returning road surface to bare and wet?
- Is a consistent level of service being provided from area to area?
- Are service level goals being met? (*31*)

Using the PDA to document the use of materials and equipment has enhanced WSDOT's ability to effectively manage resources during storm events and plan for future events.

CHAPTER 3: WINTER WEATHER DATA TRENDS AND PATTERNS

WINTER WEATHER INFORMATION

Effective snow and ice control operations require a good understanding of state- and district level weather patterns and trends, access to reliable weather forecasts, and the availability of accurate real-time weather information. Knowledge of state- and district-level weather patterns and trends is useful in preparing long-term snow and ice control plans, effectively allocating available resources, and making purchasing decisions for anti- and deicing materials, major and minor equipment, and parts. This information can also be useful for district maintenance offices in coordinating the movement of personnel and equipment to areas that are expected to be the hardest hit based on historical storm data. This chapter provides information on available weather data sources, and state- and district-level winter weather trends and patterns.

WEATHER DATA SOURCES

Weather Forecast Information

Decisions to begin snow and ice control treatments require accurate weather forecast information. Access to reliable forecast is extremely important, because to a large degree it influences the treatment type, material choice, and application rate. There are a number of alternative sources for weather information, but the most up-to-date weather forecasts and real-time storm data can typically be obtained from the National Weather Service (NWS). The NWS is a good source for regional and national information on approaching adverse weather conditions. NWS data and products form a national information database and infrastructure that other governmental agencies, the private sector, the public, and the global community can use. The NWS Home Page (http://weather.gov) provides access to weather forecasts, radar and satellite images, and tabulated and graphical weather information. Weather information is also provided by, or can be gathered from, other sources such as the media, internet, law enforcement and/or other government agencies, and private forecasting services.

Archived Weather Data

To determine regional weather patterns as well as short- or long-term trends, historical weather data are needed. The research team used the National Climatic Data Center (NCDC) database, the most widely used source for historical weather events in the United States. The NCDC storm data, published by the National Oceanic and Atmospheric Administration (NOAA), documents:

- The occurrence of storms and significant weather phenomena having sufficient intensity to cause loss of life, injuries, significant property damage, and/or disruption to commerce.
- Rare, unusual, weather phenomena that generate media attention.
- Other significant meteorological events such as record maximum or minimum temperatures or precipitation that occur in connection with another event.

Note that storms are reported not by county, but weather zones that the NWS had defined. Texas has 254 counties and 262 weather zones. Although most weather zones follow county boundaries,

it is possible for a county (or a district) to be in multiple zones. Figure 3-1 shows that the largest variation between weather zone and county boundaries are found in the El Paso and Odessa Districts.

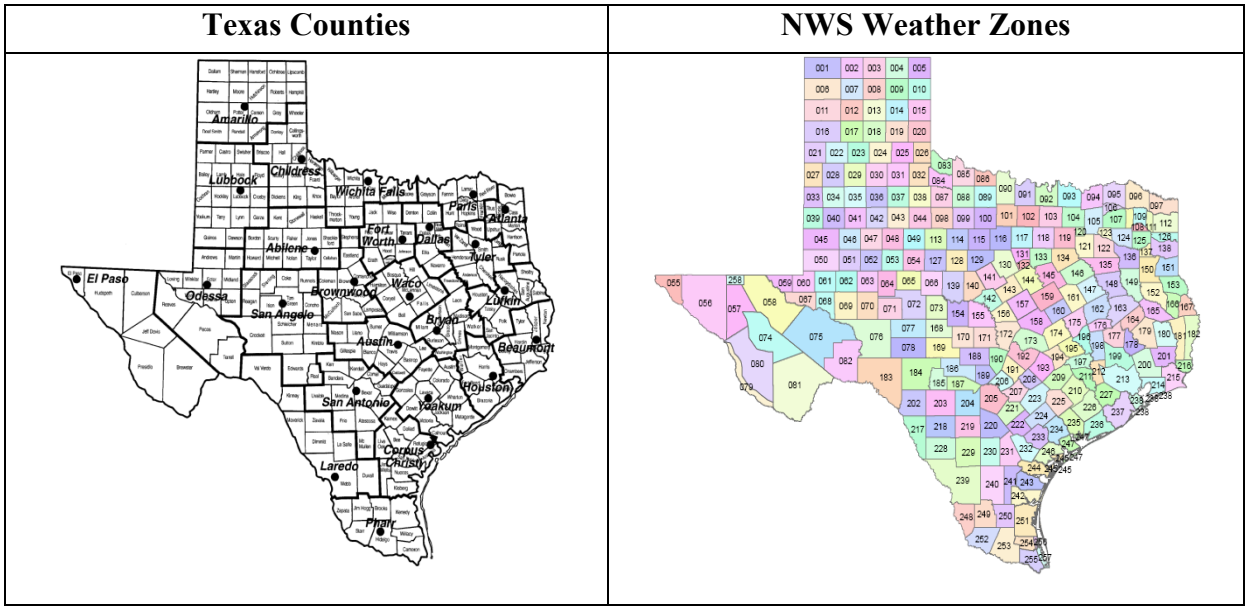

Figure 3-1. Comparison of NWS Weather Zones and Texas Counties.

The NCDC classifies winter storms and ice storms into 14 categories.

The following section provides recent information on state- and district-level weather patterns and trends determined from storms gathered from the NCDC database.

WINTER WEATHER TRENDS AND PATTERNS

Researchers reviewed an array of different storm events that occurred in Texas during the period 2000 through 2010. They performed a detailed analysis on the data to identify trends and patterns in terms of storm duration, storm frequency, time of day when storms began, and number of counties affected by the storms. This section discusses the state- and district-level results.

State-Level Trends and Patterns

Storm Distribution

During the period 2000–2010, a total of 642 winter weather events were recorded in the NCDC database for Texas. Figure 3-2 and Table 3-1 show the distribution of these events, and how these have the highest frequency followed by heavy snow. Winter weather, winter storm, and heavy snow events account for more than 80 percent of the total storms. Only one event was recorded in each of the freezing rain, freezing fog, sleet storm, and ice/snow categories; no freezing drizzle or glaze was reported. The very low percentages in these categories do not imply that, the state had none or only one of these storm types. Rather, it means that some events are either not reported or

reported in another storm category. For example, freezing rain may be incorporated into "winter weather" and "winter weather mix."

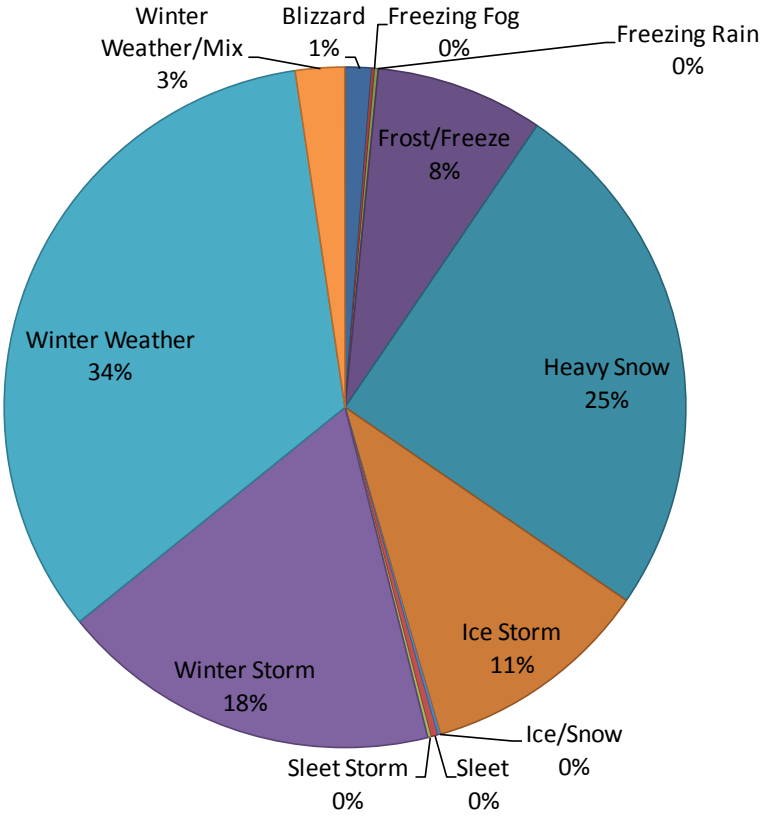

Figure 3-2. Distribution of Reported Winter Weather Events in Texas (2000–2010).

Table 3-1 presents the storm events distribution by year. Overall, winter weather events had the highest frequency, followed by heavy snow then winter storm. The year 2007 had the highest number of storm events. Most winter and ice storms were reported in 2007, whereas blizzard and winter weather were reported for 2009. The highest number of heavy snowstorms was recorded in 2010.

Table 3-1. Frequencies of Reported Winter Weather Events in Texas (2000–2010).

Storm Type	Year											Total
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Blizzard	0	0	0	0	0	0	1	0	0	7	0	8
Freezing Rain	0	1	0	0	0	0	0	0	0	0	0	1
Heavy Snow	5	7	4	2	20	7	28	24	2	9	53	161
Ice Storm	8	1	1	0	1	4	3	41	1	8	2	70
Ice/Snow	0	0	1	0	0	0	0	0	0	0	0	1
Winter Storm	7	6	6	3	6	6	11	35	8	24	4	116
Winter Weather	0	0	0	0	0	0	30	46	44	56	39	215
Winter Weather/Mix	0	0	0	1	10	2	2	0	0	0	0	15
Freezing Fog	0	0	0	0	0	0	0	1	0	0	0	1
Frost/Freeze	0	0	0	0	0	0	0	0	4	9	38	51
Sleet	0	0	0	0	0	0	0	1	0	0	1	2
Sleet Storm	0	0	0	0	1	0	0	0	0	0	0	1
Total	20	15	12	6	38	19	75	148	59	113	137	642

Time of Day when Storm Is Likely to Occur

Information on the time of day when different storm types are likely to occur is useful for maintenance supervisors who are responsible for making decisions on snow and ice control operations. If most storms occur during nighttime, then the district needs to prepare adequate visibility tools to ensure crew safety and proper operation. Further, this also helps determine the need and duration of shifts for maintenance crews.

Time of day can be categorized into early morning (12AM–6AM), mid-morning (<6AM–12PM), afternoon (<12PM–6PM), and night (<6PM–12AM). Storms can be classified by these four categories, depending on when the storm begins. Based on a review of the storm database for the period of 2000 through 2010, the researchers found that most storms are expected to occur in the morning. For example, 50 percent of blizzard events occurred in the early morning. In general, 60 percent of most storm types are likely to begin during the early or late morning.

Storm Duration Distribution

Expected storm duration is also important to both maintenance supervisors and crews. It helps supervisors in estimating the time that a crew may spend battling a storm within their own jurisdiction or helping other counties and districts. Further, it may help in planning for necessities that maintenance crews need while in the field battling storms. Figure 3-3 shows the average storm duration in descending order for the analysis period. The results indicate that ice storms have the longest expected duration (more than 31 hours) whereas sleet storm has the shortest (1 hour).

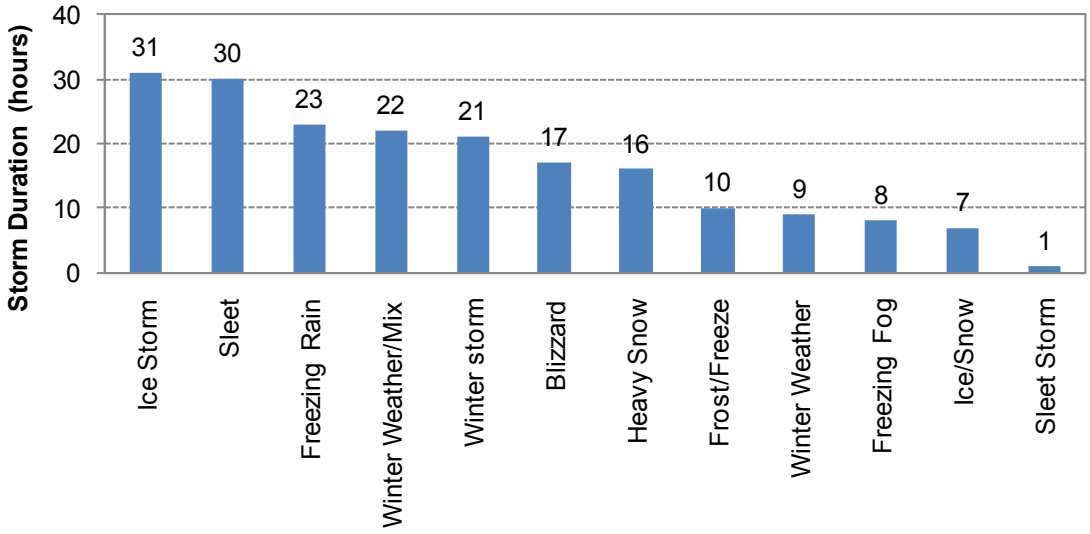

Figure 3-3. Average Storm Duration in Texas (2000–2010).

Number of Counties Affected

The number of counties affected by a storm is a data element that is available in the NCDC database. The researchers used it to estimate the expected spatial coverage of each storm type based on the analysis of historical storm data. This information may help TxDOT districts determine the appropriate or optimal allocation and positioning of winter weather equipment and materials. This may, in turn, save hauling time between storage and treatment areas. Figure 3-4 shows the average number of counties affected by each storm type based on storm data during the period of 2000 through 2010. These results indicate that winter weather mix is expected to have an impact on the largest area, whereas sleet storms are expected to affect the smallest area.

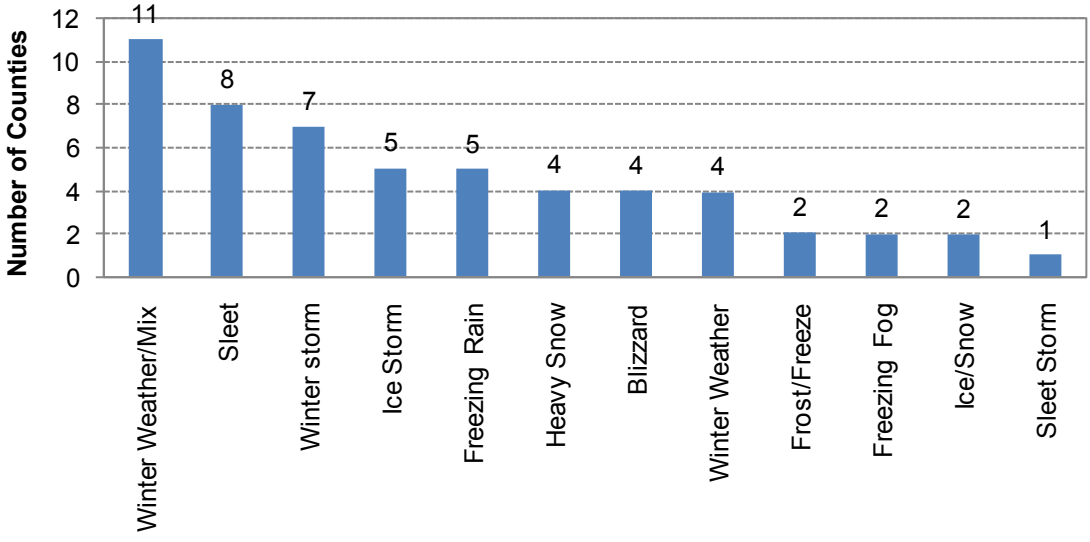

Figure 3-4. Average Number of Counties Affected by Storms in Texas (2000–2010).

District-Level Trends and Patterns

Storm Distribution by Districts

Researchers determined the relative frequencies of all storm types within each of the 25 TxDOT districts. The percentages previously mentioned in Table 3-2 can assist districts in developing plans for storm types that are most likely to impact their area, and identify the required resources to battle such storms. For example in Amarillo, heavy snow constitutes more than 60 percent of the total storm events for the analysis period. In Austin, winter storm constitutes more than 90 percent of the total storm events for the analysis period and more than 5 percent constitutes winter weather.

From a regional perspective, the west region accounts for more than 54 percent and the north region accounts for more than 33 percent of all storms in the state.

Winter Season by Districts

Researchers determined how winter seasons vary by districts, when these typically begin and end, and how long these last. The start of the winter season is defined by the date of the first fall freezing, and the end of the season is defined by the date of the last spring freezing. The length of the winter season is the number of days between these two dates. Reliable estimates on the expected length of a winter season as well as the dates of the first and last freezing days in the season are valuable information that can help TxDOT maintenance supervisors develop effective snow and ice control operations plans.

Winter seasons significantly vary by TxDOT districts, and also by years. To account for the stochastic nature of winter seasons, researchers determined probabilistic estimates for the first and last freezing dates, and the season length for all 25 TxDOT districts. The estimates shown in Table 3-3 are based on an analysis that Texas Tech University conducted using temperature time series covering the period from 1971 through 2000. The three columns under the "50 percent probability" heading include the median values for winter season length and boundaries. The estimates under the 10 percent probability are more conservative. These include the 90^{th} percentile winter season length (i.e., the probability of a longer season than the estimated length is 10 percent), and the 90^{th} percentile season boundaries (i.e., the probability of freezing before the estimated start date or after the estimated end date of the season is 10 percent). These probabilistic estimates on the onset and duration of winter seasons make it possible to develop effective snow and ice control plans with a specified level of risk tolerance (e.g., 10 percent risk of underestimating winter season length).

Spatial Distribution of Typical Winter Storms

Researchers visited all 25 TxDOT districts to discuss winter weather operations and management at the district level. Based on interviews with maintenance supervisors and personnel, they found that districts have to deal with the following typical storm categories:

- Mostly Snow.
- Snow and Ice.

- Mostly Ice.
- Ice and Freezing Rain.

Based on its characteristics, freezing rain can be treated as ice, and the last two storm categories may be combined as "Ice and Freezing Rain." The list in Table 3-4 and the map in Figure 3-5 show the spatial distribution of the resulting three typical storm categories among TxDOT districts. The map is useful for TxDOT maintenance personnel for planning, training, and strategizing for winter weather operations.

Table 3-2. Relative Frequencies of Storm Types in Percent (2000–2010).

	Winter Storm	Winter Weather Mix	Ice Storm	Heavy Snow	Freezing Rain	Blizzard	Winter Weather	Ice/Snow	Frost/Freeze	Sleet	Sleet Storm	Freeze Fog
Abilene	25	4	13	23			32				3	
Amarillo	12	5	13	63			4					3
Atlanta	2	14	37	11		5	32					
Austin	96						4					
Beaumont	38		3	10			48					
Brownwood	38	6	18	15			17				5	
Bryan	33	6	36	16			4				4	
Childress	23	3	9	25			38					1
Corpus Christi				36			54				11	
Dallas	39	9	16	19			17				1	
El Paso	17	8	25	50								
Fort Worth	49	7	15	12			16				1	
Houston	13	6	38	31			13					
Laredo	39			22			28				11	
Lubbock	22	1	7	22			48					
Lufkin		19	27	19			35					
Odessa	24	34	7	18			17					
Paris	41	6	23	17			13					
Pharr		9	1								89	
San Angelo	26	3	22	20			18				10	
San Antonio	80	2	2	9			4				2	
Tyler	27	11	19	27			16					
Waco	38	10	18	18			15				1	
Wichita Falls	31	7	19	14	4		23	1			1	
Yoakum	35		13	23			26				3	

Table 3-3. Winter Season Data Estimates by District (1971–2000).

TxDOT District	With 50% probability			With 10% probability		
	Length of Winter season exceeds (days)	First Fall freeze is before	Last Spring freeze is after	Length of Winter season exceeds (days)	First Fall freeze is before	Last Spring freeze is after
Abilene	133	Nov 12	Mar 24	167	Oct 26	Apr 10
Amarillo	181	Oct 20	Apr 18	211	Oct 3	May 1
Atlanta	127	Nov 14	Mar 20	166	Oct 27	Apr 10
Austin	73	Dec 6	Feb 17	121	Nov 15	Mar 15
Beaumont	85	Dec 2	Feb 25	134	Nov 11	Mar 24
Brownwood	135	Nov 11	Mar 25	167	Oct 26	Apr 10
Bryan	94	Nov 29	Mar 2	136	Nov 10	Mar 25
Childress	147	Nov 6	Apr 1	176	Oct 20	Apr 13
Corpus Christi	42	Dec 23	Feb 3	109	Nov 25	Mar 13
Dallas	99	Nov 25	Mar 3	145	Nov 4	Mar 28
El Paso	135	Nov 8	Mar 22	170	Oct 25	Apr 12
Fort Worth	128	Nov 14	Mar 21	163	Oct 28	Apr 8
Houston	92	Nov 30	Mar 1	146	Nov 5	Mar 30
Laredo	66	Dec 5	Feb 9	119	Nov 12	Mar 10
Lubbock	154	Nov 1	Apr 3	180	Oct 17	Apr 14
Lufkin	119	Nov 15	Mar 13	157	Oct 29	Apr 3
Odessa	139	Nov 12	Mar 30	172	Oct 26	Apr 15
Paris	125	Nov 14	Mar 18	161	Oct 28	Apr 6
Pharr	30	Dec 25	Jan 24	91	Nov 25	Feb 24
San Angelo	136	Nov 13	Mar 28	168	Oct 29	Apr 14
San Antonio	95	Nov 25	Feb 28	134	Nov 8	Mar 21
Tyler	146	Nov 7	Apr 1	182	Oct 20	Apr 19
Waco	115	Nov 19	Mar 13	157	Nov 1	Apr 6
Wichita Falls	140	Nov 9	Mar 28	172	Oct 23	Apr 12
Yoakum	87	Dec 2	Feb 27	138	Nov 8	Mar 25

Table 3-4. District-Level Storm Events for 2000–2011.

Mostly Snow	Snow and Ice	Ice and Freezing Rain
Atlanta (*Bowie*)	Abilene	Austin
Amarillo	Atlanta	Beaumont
Childress	Brownwood	Bryan
El Paso (*Brewster, Presidio*)	Bryan (*Freestone, Leon, Madison,*	Corpus Christi
Lubbock (*Parmer, Castro,*	*Milam, Robertson*)	Houston
Swisher)	Dallas	Laredo
Paris (*Grayson, Fannin, Lamar,*	El Paso	Lufkin
Red River)	Fort Worth	Odessa
Wichita Falls	Lubbock	Pharr
	Paris	San Antonio
	San Angelo	Tyler
	Waco	Yoakum

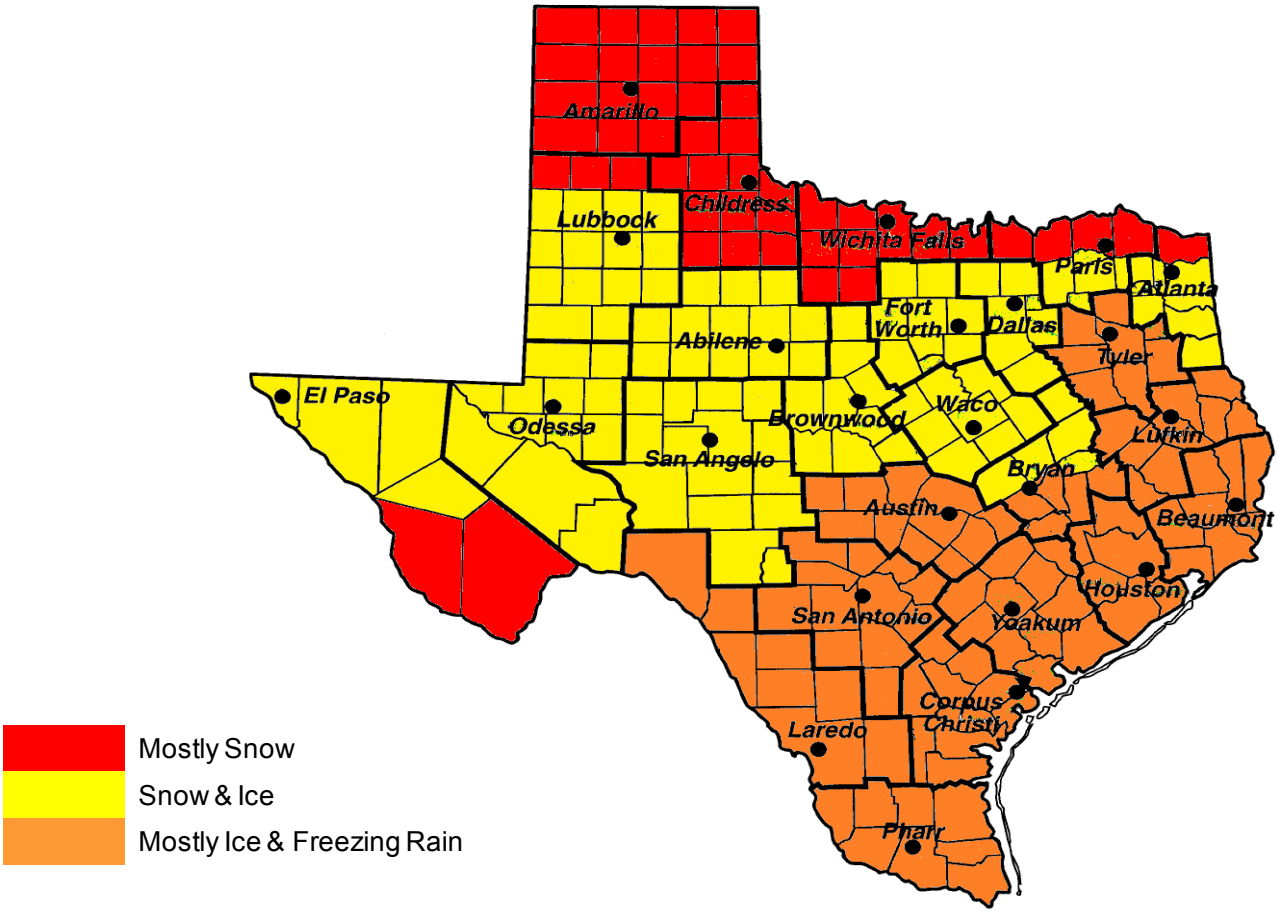

Figure 3-5. Texas Winter Storms Based on Site Visits Conducted in 2011.

CHAPTER 4: TXDOT INTERNAL PROCEDURES FOR WINTER WEATHER OPERATIONS

OVERVIEW

The winter weather response procedures within TxDOT vary widely from region to region in some aspects. Winter weather response seems to follow the pattern of winter weather across Texas. For instance, the response to winter weather in the south Texas district of Laredo is far removed from practices in the northwest Texas district of Amarillo. These differences are a result of both the frequency of winter weather as well as the type of winter weather that these two districts have experienced. Amarillo has frequent snowfall, with at least one snow storm experienced every winter season. In Laredo, winter weather seldom has any storm—whether ice or snow. Laredo does not experience snowfall, and ice storms are also rare events with, at most, one event each year. Thus, the two districts approach winter weather with vastly different objectives: preparing for winter weather is, as expected, a high priority in Amarillo, but the same cannot be expected in Laredo. In effect, the acquisition of winter weather equipment, materials, and development of winter weather documentation as well as the training of maintenance personnel in winter weather response are starkly different for these two districts.

The overall plans and procedures for winter storm responses are generally similar in structure (at least on paper), but the actual execution of these plans and procedures tend to be very different depending on the geographic location of a district. The discussions below provide a general overview of current trends in winter weather response procedures across the state. Some sections cite a brief discussion on observed differences among districts; others cite an example of a particular district or districts, to highlight certain practices.

METHODOLOGY

To obtain information on winter weather response practices across the state, researchers first obtained copies of available District Snow and Ice Control Plans. These plans, together with information obtained through a literature review of national practices in winter operations, formed the basis for the development of a questionnaire for use in discussions with TxDOT districts. See Appendix A for the list of questions used during discussions.

These discussions sought to provide information on the nature of winter weather response operations, the historical winter weather experience at that district, and district staff response to the development of the *Playbook for Winter Storms* brochure.

The research team held discussions with staff from all TxDOT districts between the months of April and July 2011. Meetings were held at the district offices with key staff involved with district ice and snow operations such as:

- Director of maintenance.
- District maintenance administrator.
- District emergency response coordinators.
- Maintenance section supervisors.
- Maintenance field staff.

In one case, the district engineer participated in the meeting and provided insight into the district's approach and policy toward winter weather operations.

DISTRICT ICE AND SNOW CONTROL PLANS

Documentation of District Plans

The *TxDOT Maintenance Operations Manual* indicates that each TxDOT district should have a plan for snow and ice control (*32*). The varying winter storm conditions require different snow and ice control plans for different areas of the state. Plans should be made for winter work so that equipment, operators, materials, and supplies will be ready for the first storm (*31*). As part of meetings with various TxDOT districts regarding their winter weather response procedures, researchers also gathered available TxDOT District Ice and Snow Control Plans (used interchangeably with Winter Weather Response Plan). Table 4-1 shows the availability of documented Ice and Snow Control Plans, as well as the level of detail provided in these plans.

Table 4-1 indicates that more than half (14 out of the 25) of TxDOT districts have documented ice and snow control plans available; however, the level of details provided in these plans may not provide the requisite information needed in an ideal Winter Weather (of Ice and Snow Control) Plan. Not surprisingly, districts further west and north, which deal with a lot more severe winter weather conditions, have well-established plans and procedures to combat winter weather. Districts further south, with rare winter events, typically have internal procedures that are not documented in such detail. Maintenance supervisors in such districts will generally have a list of crew members for each maintenance section and time slots for which these staff will be on duty for the approaching winter conditions.

Developing a Snow and Ice Control Plan is beneficial to all districts because it will help inform the district maintenance staff on the importance of responding in the right way to winter weather. If such a plan defines an objective that is communicated well to maintenance staff, they will focus on the overall goal(s) of their response. In addition, it provides maintenance supervisors with a document with which to formally provide training and information to their staff. The plan also serves as a reference guide for the crew and supervisor.

Researchers held discussions with all TxDOT districts and reviewed all available district-level documentation on winter weather control operations. The district-level snow and ice control plans can generally be grouped into five areas:

- District objectives.
- Pre-season activities.
- Event.
- Post-event activities.
- Attachments.

Table 4-1. Availability of District Snow and Ice Control Plan.

District	Ice and Snow Control Plan Document Availability	Level of Details Provided
Abilene	☑	High
Amarillo	☑	High
Atlanta		
Austin	☑	High
Beaumont		
Brownwood	☑	Moderate
Bryan		
Childress	☑	High
Corpus Christi	☑	Low
Dallas	☑	Moderate
El Paso	☑	High
Fort Worth	☑	High
Houston	☑	
Laredo		
Lubbock	☑	High
Lufkin		
Odessa		
Paris	☑	High
Pharr		
San Angelo		
San Antonio	☑	Moderate
Tyler		
Waco	☑	Moderate
Wichita Falls	☑	High
Yoakum		

District Objectives for Ice and Snow Control Plans

Across Texas, several districts have identified clear-cut objectives (or goals) for their winter weather response. The objectives are to provide guidance and purpose to the district staff involved with winter weather response. Traditionally, the use of Level of Service (LOS) has not been part of district response to winter weather. Typically, these objectives are stated in bulleted format at the beginning of the districts' Ice and Snow Control Plans; these are discussed with maintenance personnel prior to the start of winter weather.

District Example

The following example of District Objectives is provided in the Waco District Winter Weather Response Plan:

- Utilize all available resources to provide for the safety of the traveling public.
- Emergency removal of snow and ice takes precedence over all other work.
- Manage resources during extraordinary maintenance situations and minimize costs by prioritizing needs and planning for changing conditions.
- Minimize the accumulation of snow and ice on highways through continuous treatment operations during winter storms.
- Maintain open and minimize the disruption of travel on highways with concentrated efforts to remove snow and ice in a timely manner.
- Be prepared to temporarily close a highway or highways in case there are no other options. (Note: This will only be done after coordination with and direction from the DPS Disaster District Chairman or their designee as well as advance notice of District Management.)
- Keep the public informed through the use of the Highway Condition Reporting System (HCRS), telephone messages, and press releases. Coordinated messages on dynamic message signs and strategically placed portable changeable message signs, etc.
- Protect the state highway system through the timely removal of snow and ice.

Differences in Regions

As previously indicated, in discussions with district staff, it seemed the approach to winter weather operations varied from region to region. However, within the plans themselves, the objectives stated were quite similar for different districts. In fact, in some cases these were the same, word for word. The challenge is for each district to identify the objectives that fit their particular resources and address the particular needs of the district regarding winter weather response.

The objectives were not noticeably different for districts in different regions. Generally, most of the districts further north (with more severe winter weather) had stated objectives as part of their Ice and Snow Control Plans, while districts further south (with fewer winter weather events) omitted stated objectives altogether in their Plans.

PLANNING AND PREPARATION ACTIVITIES

Pre-season planning and preparation activities within various TxDOT districts generally take on a less formal process. Maintenance work on winter equipment is one of the main activities at the maintenance sections in preparation for the upcoming winter season. For most districts, typical pre-storm preparation begins around the end of October until the beginning of November. There is discussion at the maintenance section level on what equipment maintenance is required, what materials are needed to supplement the ones already in store, and how best to station equipment and materials for the upcoming season.

The maintenance supervisors are usually responsible for conveying information from their various sections on the status of equipment, materials, staff, and other tools for combating winter weather.

The West Region has a fleet management a manual entitled *Guidelines for Snowplow Maintenance* which provides helpful tips for maintaining and repairing snowplows and related winter equipment. Districts typically do not document firm deadlines by which time maintenance sections should have had pre-winter storm meetings to discuss the upcoming winter season and requirements to meet their response obligations.

District Meetings

Meetings within the District

The following meetings typically take place prior to an upcoming winter season.

- The maintenance section supervisor has regular meetings with maintenance staff to discuss the upcoming winter season and make adequate preparations for it. Discussions tend to address several issues including the following:
  - Winter equipment deployment plans, including potential for sharing and movement of equipment and personnel across county lines.
  - Materials inventory.
  - Personal ancillary equipment including communication apparatus.
  - Staff training.
  - Logistics for winter operations, including travel and lodging arrangements.
  - Communication protocols during winter events.
  - Equipment and material.
- The district director of maintenance (DOM) and district maintenance administrator (or designee) meets with maintenance section supervisors (MSS) to discuss the upcoming winter season. This meeting is usually held at the district office to discuss issues arising from previous winter seasons and any additional issues for the upcoming season. Discussion could include, but is not limited to the following:
  - Status of equipment and material supplies.
  - Logistics issues for upcoming season.
  - Training for maintenance personnel.
  - Communication protocols during winter events.

Meetings outside of the District

A few districts hold at least one meeting with other stakeholder agencies that are involved with winter weather operations, such as local law enforcement agencies, Emergency Management Services (EMS), Fire Service, Department of Public Safety (DPS), and other first responders. The meetings are typically held to provide an overview of the Emergency Operations Center (EOC) activities at the district in case of a significant winter weather event requiring the activation of the EOC. At the local level, maintenance supervisors can sometimes meet with local agencies involved in winter operations for updates on communication and cooperation during winter weather events.

Regional Meetings outside the District

In addition to the meetings held within the district's jurisdiction, informal meetings between neighboring districts also take place during the planning and preparation stages of a winter season. These meetings tend to discuss issues regarding the potential movement of personnel, equipment, and materials across district lines to combat larger scale winter events.

Equipment Maintenance

Equipment maintenance activities are carried over during the preparation stages for an upcoming winter season. TxDOT maintenance staffers have preset deadlines at the district for completing all major winter equipment repairs and test runs.

Deployment Plans

Equipment

During weather events, TxDOT utilizes various equipment to respond on short notice to adverse weather events. Such equipment includes dump trucks; motor graders; front end loaders, V-box and tailgate spreaders; snowplows, wings, and blowers; herbicide rigs, and pickup applicators. Supplemental equipment includes emergency traffic control trailers stocked with traffic barrels, cones, barricades, necessary signs and materials for road closures, and portable changeable message signs (PCMS). Such equipment may originate wholly within the affected TxDOT district or area, be "borrowed" from an adjacent TxDOT district or area, or be made available through a short-term lease from a non-TxDOT provider.

- Deployment and use of equipment available wholly within the affected TxDOT district or area requires only a basic understanding of the equipment's location, status, and point of contact for dispatch.
- Deployment and use of equipment from an adjacent TxDOT district or area may also be accomplished through this basic process, or it may require a formalized agreement that establishes a priority for equipment use (for significant weather events, adjacent TxDOT districts or areas may be reliant on this equipment to service their own roadways).
- In such instances, leased equipment may prove to be a viable option. Equipment can be leased either with or without an operator. Equipment may be leased with operator only to supplement state forces. In order for the lease to be considered a purchase of services, state forces must perform a minimum of 51 percent of the work. If the contractor performs work exceeding 49 percent, then this work must be performed under a routine maintenance contract. Standard terms and conditions that apply to the lease of equipment with and without an operator are available on the General Services Division (GSD) website. An alternative fuel waiver must be obtained prior to the lease of vehicle.

Materials and Supplies

Materials and supplies to support winter weather response commonly include replacement parts, ancillary personnel supplies, and anti- or deicing bulk materials. Districts usually acquire these

items for their maintenance sections as part of planning and preparation for an upcoming winter season.

Materials. TxDOT districts acquire anti- or deicing materials using a blanket bid master and the open-market method of purchase. GSD will survey districts and initiate annual statewide blanket purchases of anti/de-icing materials. Districts statewide blanket purchases include rock salt, calcium magnesium acetate (CMA) and magnesium chloride ($MgCl_2$, both liquid and solid). In situations where the open-market method of purchase is not appropriate, districts may use small purchase procedures. If an emergency situation requires the purchase of anti-/deicing material, districts follow the procedures for an emergency purchase.

Supplies. To support effective equipment operation, replacement parts and equipment may be required. District staff in charge of purchasing such supplies ensure that these are ordered and arrive in time for testing and subsequent use during winter weather operations. Additional ancillary personnel supplies intended to keep field crew safe and their equipment functional are also procured in preparing for winter weather response. The *Winter Weather Response Guide* outlines the procurement practices for ordering supplemental materials and supplies for the district.

Appropriate quantities of items such as gloves, storm suits, other personal protective equipment, flashlights and batteries, windshield deicer, and wiper blades should be kept on hand to adequately respond to each event. If a winter weather event is expected to result in TxDOT personnel working outside their area or in another district, maintenance supervisors will typically request a Department Advance Rapid Travel (DART) cards for their employees to pay for rooms and meals.

District Example of Planning and Preparation Activities

Childress District

The Childress District notes that the District Maintenance Office will schedule meetings and/or conference calls for area engineers, maintenance supervisors, and shop personnel to discuss preparations prior to each upcoming winter storm. Also, the district public information officer (PIO) will contact media outlets (radio, TV, newspapers, etc.) to ensure they are available and willing to broadcast road conditions.

When winter storms are approaching, the district encourages the following measures (and others) to be taken as part of their pre-winter storm activities:

- A safety meeting shall be held in each maintenance section prior to each storm event to discuss storm-related safety issues.
- Sections should predetermine and ensure that everyone knows their assignments.
- Discuss shifts to work.
- Ensure all equipment is in proper working order.
- Equipment components subject to deterioration and corrosion should be given particular attention, and high-wear replacement parts should be in stock.
- Discuss the application of chemicals and/or abrasives and recommended rates.
- Discuss how to assist handle stranded motorists.

- Maintenance sections should establish communications with key entities ahead of the storm.
- A test run of equipment should be completed by October 15th of each year and prior to each storm event throughout the winter.
- Pickups used for patrolling should be stocked with proper equipment and necessities to assist stranded motorists.
- Message boards and other traffic control devices should be prestaged at predetermined locations for alerting motorists to pertinent information.
- Supervisors may request permission to take their TxDOT vehicles home on a temporary basis if a winter storm is approaching.

Amarillo District

The Amarillo District emphasizes the need to enhance local coordination and notes the importance of keeping current department emergency numbers to communicate action plan activities for ice and snow control to local law enforcement and city officials.

Three areas of preparation include:

- Equipment—Detail preparation for all equipment. Fleet management has a manual entitled *Guidelines for Snowplow Maintenance*, which provides helpful tips for maintaining and repairing snowplows and related winter equipment.
- Materials—Need all materials to be ordered, tested and stored prior to freeze date.
- Personnel—Adequate training is recommended for all staff.

NOTIFICATION AND INSTITUTIONAL COORDINATION PROCEDURES

Weather Notification Procedures

There was no single or major source of weather information that all TxDOT districts had cited. Generally, districts use multiple sources for obtaining information on upcoming weather events. Districts preferred weather sources that are able to provide local weather information instead of more national weather patterns as this provided a better depiction of upcoming weather conditions. Districts obtain updated weather information regularly as the winter weather approaches. Some of the more common sources of weather information include the following:

- National weather service.
- National news channels.
- Local news channels.
- Internet weather sites such as www.weatherchannel.com.
- Eyewitness accounts.
- Information from law enforcement.
- Traffic Management/Operations Center (TMC) camera feeds.

The maintenance sections are usually responsible for monitoring the weather situation and making decisions as to when to start ice and snow response procedures and where within their section they can defer or not begin the process. During this time, they need to regularly and continuously monitor the weather so they can best decide how to allocate resources to provide the best response possible. This process is usually similar across all districts.

Incident Command and Organizational Structure

The FHWA defines the Incident Command System (ICS) as a standardized, on-scene all-hazards incident management concept and enables a coordinated response among various jurisdictions and agencies. It also allows for the establishment of common processes for planning and management of resources and, when performed well, for integration within a common organizational structure. Several TxDOT district staff recognized the importance of coordination between the various elements within the district and with other stakeholder agencies when dealing with major winter weather events.

In discussions with TxDOT districts, several staffers expressed a need for a more formal incident command system or structure to better organize the response to winter weather events. The need for better coordination and established operating procedures and organizational structure is alluded to in the TxDOT *Maintenance Management Manual,* which requires each district to develop and distribute standard operating procedures for emergency preparation, response, and recovery. The manual also indicates that all employees must be trained in the standard operating procedures (*33*). At the districts, the setup of any emergency operating center and subsequent incident command system is based on the threat level that a winter weather storm poses. Thus, the approach differs depending on whether a storm is "typical" (i.e., small scale) or "extreme" (i.e., large scale). The bigger the threat of a storm, the more centralized the ICS is likely to be.

Typical Weather Event

In discussions with districts, the research team noted that some have informal organizational structures for winter weather events that were local in nature. For instance, the Yoakum District has no regional or district-wide pre planning activities for an ice storm incident. Each county usually handles its own area. For further assistance, the county reaches out to the district and coordinates with their neighboring counties.

These weather events will typically affect only a few counties within the district and, hence, involve only a few maintenance sections. This is usually the most common weather event that a district will experience. Figure 4-1 illustrates a simple chain of command that is established during such instances; it is also a typical structure of operations at the maintenance sections. Figure 4-1 shows a typical structure of operations at the maintenance sections. The figure is modified from the Houston District example. Note that a critical element of the organizational structure is the interaction between the maintenance section supervisor and neighboring counties as well as with the district office.

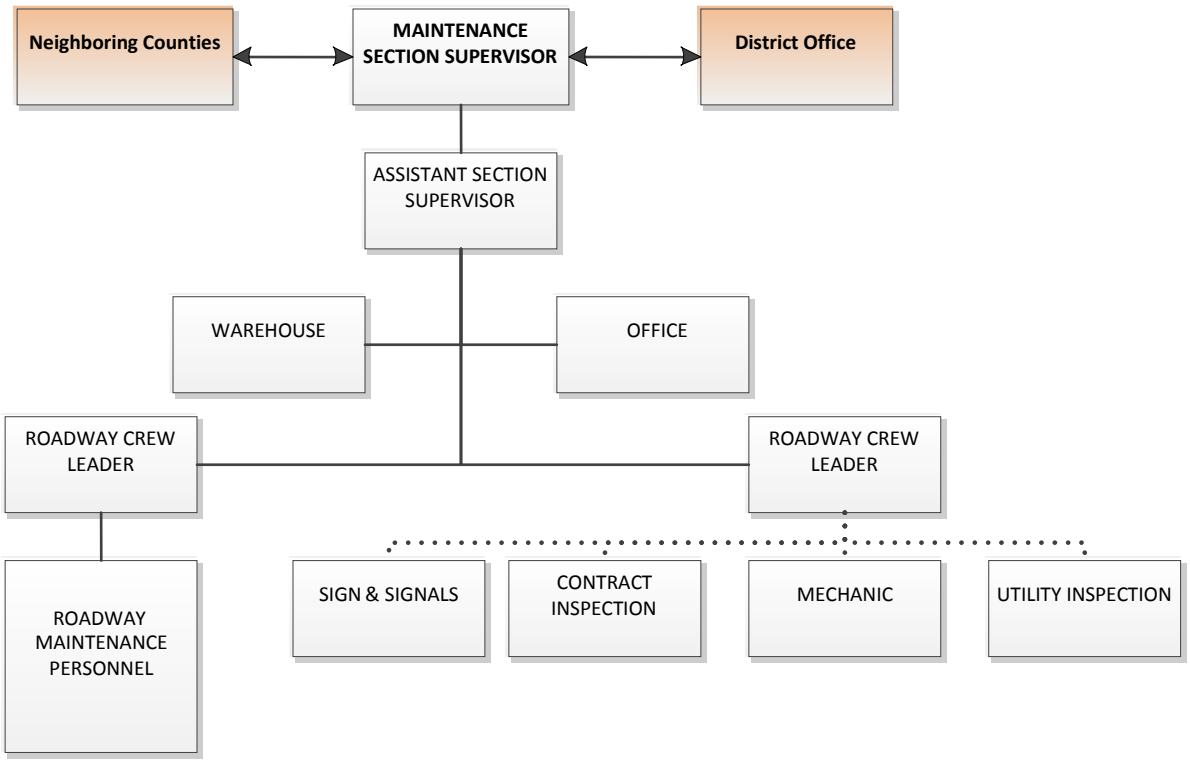

Figure 4-1. Maintenance Section Command Structure for Typical Scale Storm Event.

Emergency Operating Center. The size of the EOC is usually defined by the strength of the winter storm approaching a district. Usually, for the typical weather or adverse weather that is on a small scale, there is no formal EOC setup at the district. In such instances, the maintenance supervisors and maintenance field staff will coordinate communication efforts using cell phones and other mobile devices. Some communication might be required between the maintenance supervisors and the district office in the event of a request for more resources from other locations.

Extreme Weather Event

For winter weather events that are more widespread and involve the entire district or even the surrounding districts, a more formal organizational structure is necessary. Here, the involvement of the district engineer and other high-level district staff may be required. There is regular information exchange between maintenance supervisors and the district EOC. In addition, other stakeholder agencies will be included in the process.

Emergency Operation Center. For extreme weather events, a larger EOC is established at a neutral location (as is the case in Austin), or at one of the emergency stakeholder agencies (usually at the police department). Stakeholder agencies will send a representative(s) to the EOC who will serves as a liaison with their individual agencies. There is constant exchange of information at these EOCs that allows each agency to be involved in the decision-making process.

The combined resources and skills of the various agency staff allows for a better response to major winter weather events.

Figure 4-2 depicts an example of a general response and coordination processes among district, region, and division personnel for winter weather events and other planned or forecasted emergencies for the West Region Districts and West Region Support Center (*34*).

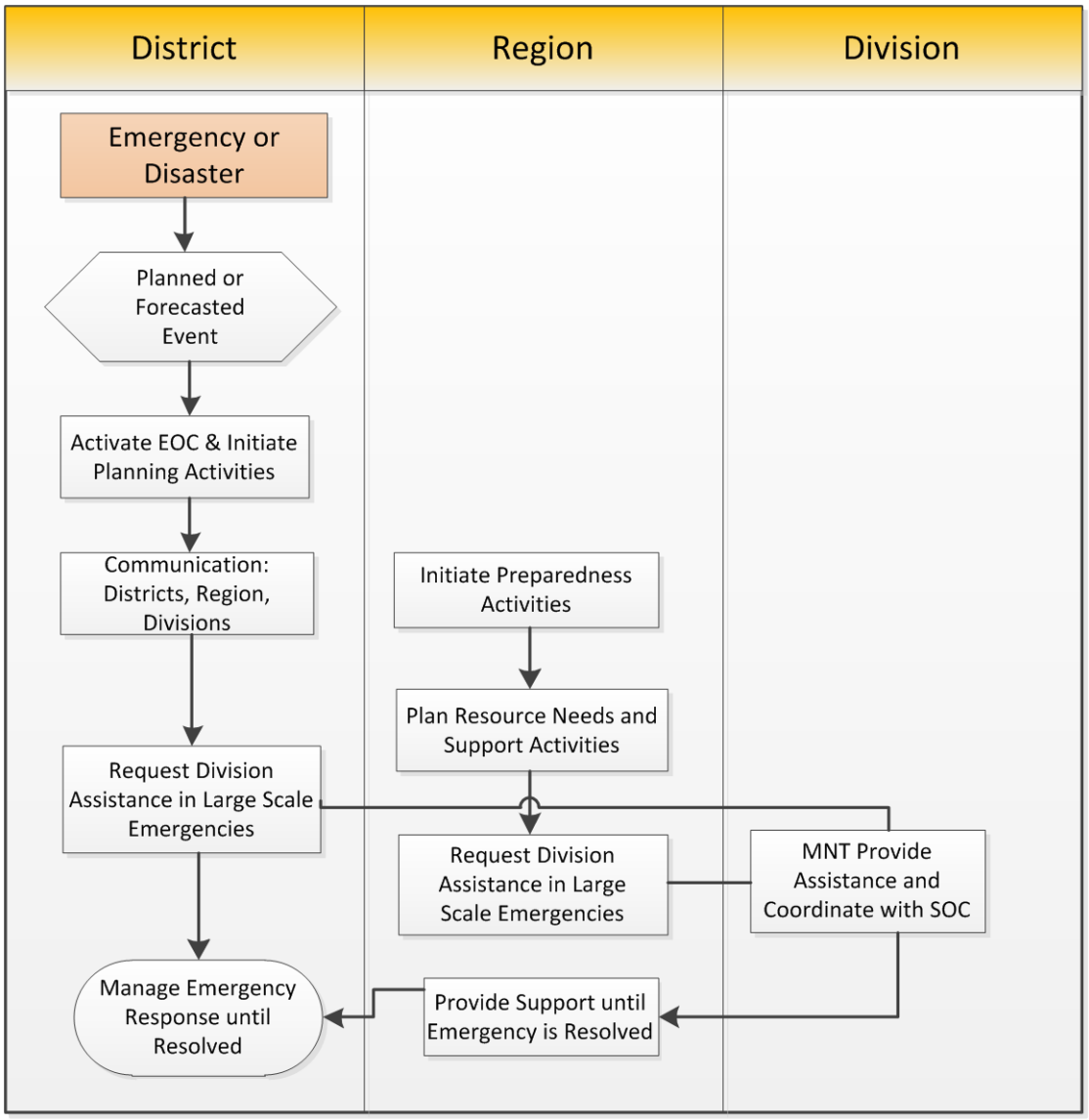

Figure 4-2. Response and Coordination Process among District, Region, and Division Levels (*34*).

District Example

Austin District

The Austin urban area operates a Combined Transportation Emergency Communications Center (CTECC) that stands as its own entity as a permanent facility that is always in operation. It is a joint venture comprising the Austin District, the City of Austin, Travis County, and the Capital Metropolitan Transportation Authority (CMTA). Each of these agencies has a representative staff at the permanent location of CTECC who will communicate to their corresponding agencies of any CTECC initiatives. Typically, during ice and snow storm events (or other emergencies), CTECC will inform the participating agencies upon activation of an Emergency Operations Center. Participating agencies send more high-level staff to the CTECC EOC location where they will be located for the entirety of the event and form the core of the command and control structure at the EOC. Outside the Austin metro area (outside the I-35 corridor), the Department of Public Safety takes the lead in activating the EOC.

Dallas District

The Dallas District Maintenance personnel are on duty in the EOC in the DalTrans Building at the Dallas District complex during a winter weather event. All Dallas District EOC personnel must prepare in advance to be available to make a timely response to snow and ice events. The district intends the Dallas EOC to be the central point for internal communication and coordination between maintenance sections, with other districts and Austin headquarters. The Dallas District EOC has a SharePoint site, which is the primary tool for such communications and coordination. District Maintenance EOC staff provide initial instruction on the content, features, and use of the site. It is the responsibility of all maintenance supervisors to assure that personnel trained and familiar with the site are available for all winter storm events.

Amarillo District

The Amarillo District has an incident command system structure as part of its Emergency Operations Center that details the roles and responsibilities of the various stakeholder agencies in their emergency operations. Figure 4-3 shows the structure of the Amarillo Incident Command System (ICS) that is in place for major winter weather events affecting a majority of the district. The ICS designates the district engineer as the head of the Incident Command System (*35*).

During major storms, Amarillo's EOC is activated and operates under the Incident Command System. The EOC will be open 24/7 or as necessary to coordinate district as well as out-of-district operations. Special Jobs equipment and personnel assist sections with plowing operations. Emphasis is also placed on the IH 40 corridor and on sections with decreased manpower and disabled equipment. Engineering personnel who do not possess a CDL may be utilized for non-driving operations such as dispatching, manning barricades, etc.

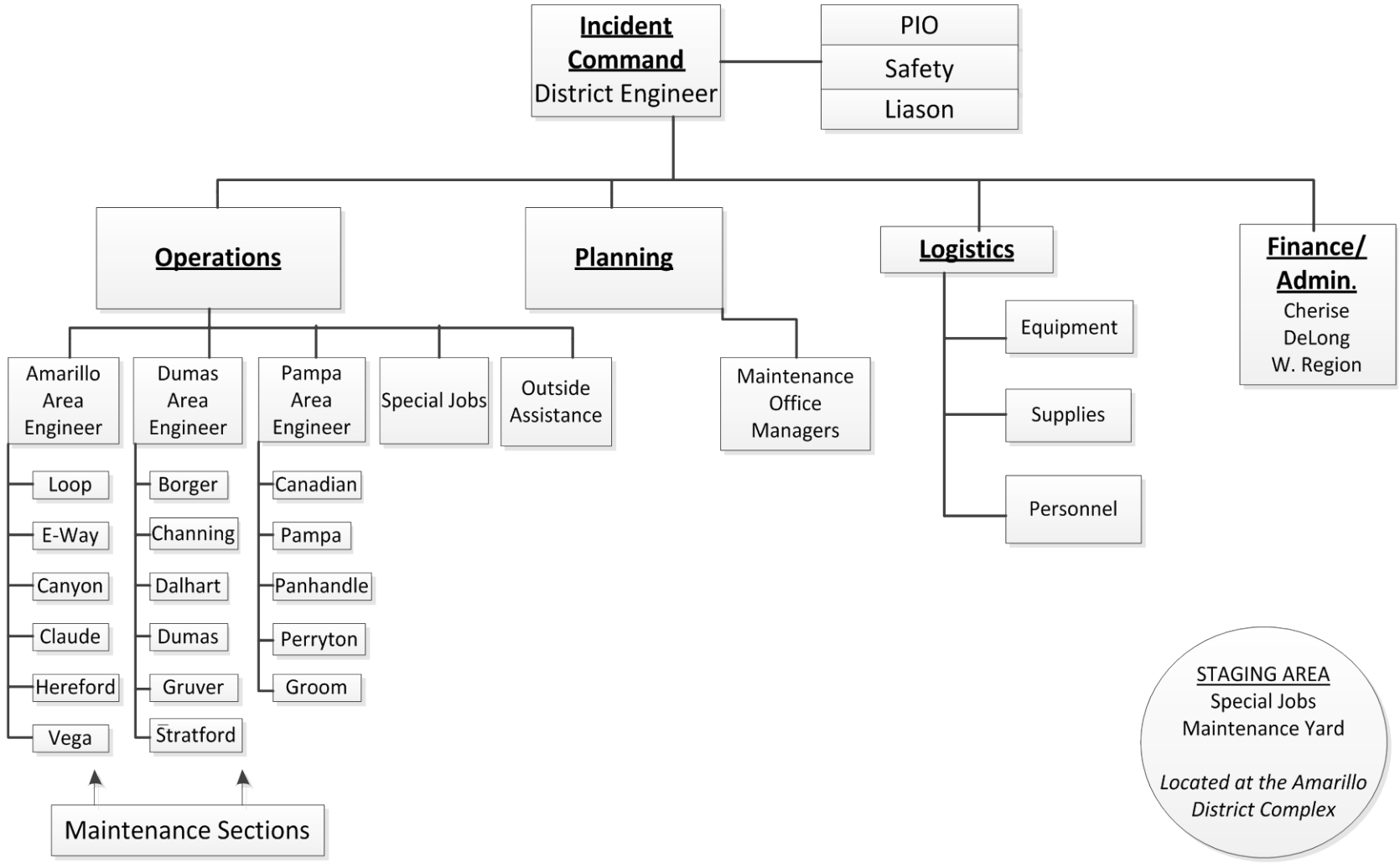

Figure 4-3. Incident Command Structure–Amarillo District Emergency Operations Center (*35*).

Regional Differences

The establishment of communication and coordination among various stakeholder agencies and within a district itself is not limited to winter weather response. Other weather events (particularly hurricanes) and other emergency management require such establishment of an EOC and ICS. Generally, districts located in major metropolitan areas (for instance, Dallas/Fort Worth, Austin, Houston, and San Antonio) have well-planned and documented ICS structures and EOC establishment procedures for emergency events that include a complex interaction between stakeholder agencies.

In addition, smaller districts located in sensitive locations have also developed their own ICS and EOC practices to help them better respond to their own emergencies. This includes districts located in the border regions such as El Paso, Laredo, and Pharr. In addition, Corpus Christi has well-established EOC practices that involve several stakeholder agencies including the Texas Department of Public Safety, local enforcement agencies and the TxDOT Corpus Christi District that is primarily set up to respond to hurricane events. However, the threat of winter weather is unique and requires specialized skill types that might not be evident in current established ICS and EOC practices at these districts.

The main emergency threat to the western region is generally a threat of severe winter weather, and the region has developed a tool for improving communication among partner agencies involved in winter weather (and other emergency) response. Known as the SNOWBOARD, this tool facilitates communication and EOC information sharing on weather severity, equipment, and personnel needs. SNOWBOARD members include key district maintenance staff and emergency response contacts from other stakeholder agencies such as the DPS, and other law enforcement agencies, TxDOT staff from all districts in the region and, in some instances, winter weather management staff from neighboring states. Discussion emails are circulated within the membership to quickly provide weather updates and ideas on improving response procedures to winter weather. In addition, the region partakes in a five-state conferences that are organized periodically to share ideas and concepts on winter weather response. These states include Colorado, Kansas, New Mexico, Oklahoma, and Texas.

ICE AND SNOW REMOVAL OPERATIONS

Initiation of Winter Weather Operations

Generally, the maintenance supervisors at the various TxDOT districts are responsible for initiating ice and snow response procedures and commanding such operations within each section. This is because they are best positioned to determine if conditions in their section warrant sending crews out to either pre-treat or deice the roadways and/or bridges. For winter weather events transcending several counties or the entire district, the district office serves as the center for coordinating the response. This allows the movement of manpower and equipment from one area of the district to the other. In such instances, the maintenance office is usually contacted and informed of the movement of such equipment and/or personnel. The director of operations (and director of maintenance in some districts) has the authority to activate the district's Emergency

Operations Center, when needed, to coordinate the movement of assets between sections and across district lines.

Communication and Coordination

Within TxDOT

Coordination and communication between response personnel within and outside of TxDOT is essential to the success of these winter weather response actions. To effectively coordinate winter weather response within the various TxDOT sections, areas, districts, divisions, and regions, several staff members hold key roles and responsibilities within the district.

- Maintenance supervisor—Activates and commands winter weather response within their section.
- Area engineer—Coordinates area response including movement of personnel and equipment as required and informs the director of maintenance when this is done.
- Director of maintenance.
    - Coordinates district response, including movement of personnel and equipment between areas (as required) and informs the district engineer when this is done.
    - Coordinates with other agencies and responds to requests for assistance under the direction of the Texas Department of Public Safety Disaster District Committee Chairman.
    - Activates and operates the District Emergency Operations Center when necessary.
- Director of transportation operations—Coordinates placement of portable changeable message signs (PCMSs) and appropriate messaging on PCMSs and Dynamic Message Signs (DMS) throughout the district.
- Public information officer—Responds to media requests, issues press releases, and distributes information via e-mail and other methods as appropriate.
- District engineer (or designee)—Coordinates with other districts including requesting or responding to requests for outside assistance (personnel, equipment, etc.).

The district EOC (often concurrent with Traffic Management Centers in urbanized areas) is usually the central point for internal communication and coordination between maintenance sections, with other districts, and with TxDOT headquarters, as required. Most districts do not initiate a formal EOC for typical winter weather that is handled at the local maintenance section offices. For more severe and widespread weather, the district EOC is established with participation from notable law enforcement agencies, first responders, and other stakeholder agencies that deal with winter weather operations. The EOC remains activated as long as is believed necessary to effectively respond to the winter weather event.

For significant winter weather events, district EOCs are used to support centralized communications within TxDOT as follows:

- Regular updates by Maintenance Section offices on their operational status including vehicular crashes or increased storm intensity.
- Periodic updates by Maintenance Section offices on shift rosters and equipment and materials inventory.
- Requests from Maintenance Section offices for additional materials, personnel, or equipment are made through the district EOC. The district EOC staff will locate whatever additional resources are necessary and task those resources with assisting the requesting maintenance office.
- The EOC is usually updated on any impending road closures due to unsafe weather related conditions. The Center will notify DPS or local law enforcement jurisdictions of the pending closure, and will also advise TxDOT's PIO.
- Each Maintenance Section office reports to the EOC when winter weather response operations have ceased in their area. Once all offices have ceased winter storm operations, the EOC will be deactivated.

Figure 4-4 shows an example of a typical communication flowchart that takes place within the district during winter storm operations.

Outside TxDOT

Outside of TxDOT, coordination and communication occurs with state and local law enforcement agencies, local fire and rescue agencies, local EMS agencies, local transportation agencies, private towing organizations, the news media, and other personnel involved in the management of or response to adverse weather events. TxDOT district staff recognize the distinctive role that each agency or organization can play in winter weather response activities.

Several districts made it a priority to update contact information (including after-hours emergency telephone numbers) of all external agencies involved in winter weather operations in advance of the winter season. This information is usually added as an attachment to the District Snow and Ice Control Plan (or other similar document).

In addition, TxDOT maintenance supervisors will establish a communications and coordination protocol with neighboring departments of transportation. Information on neighboring state DOTs is sometimes provided in the district Snow and Ice Control Plan (or similar document). This is particularly the case for the western region districts where they have a five-state emergency contact list included in the Amarillo District's Plan (*35*).

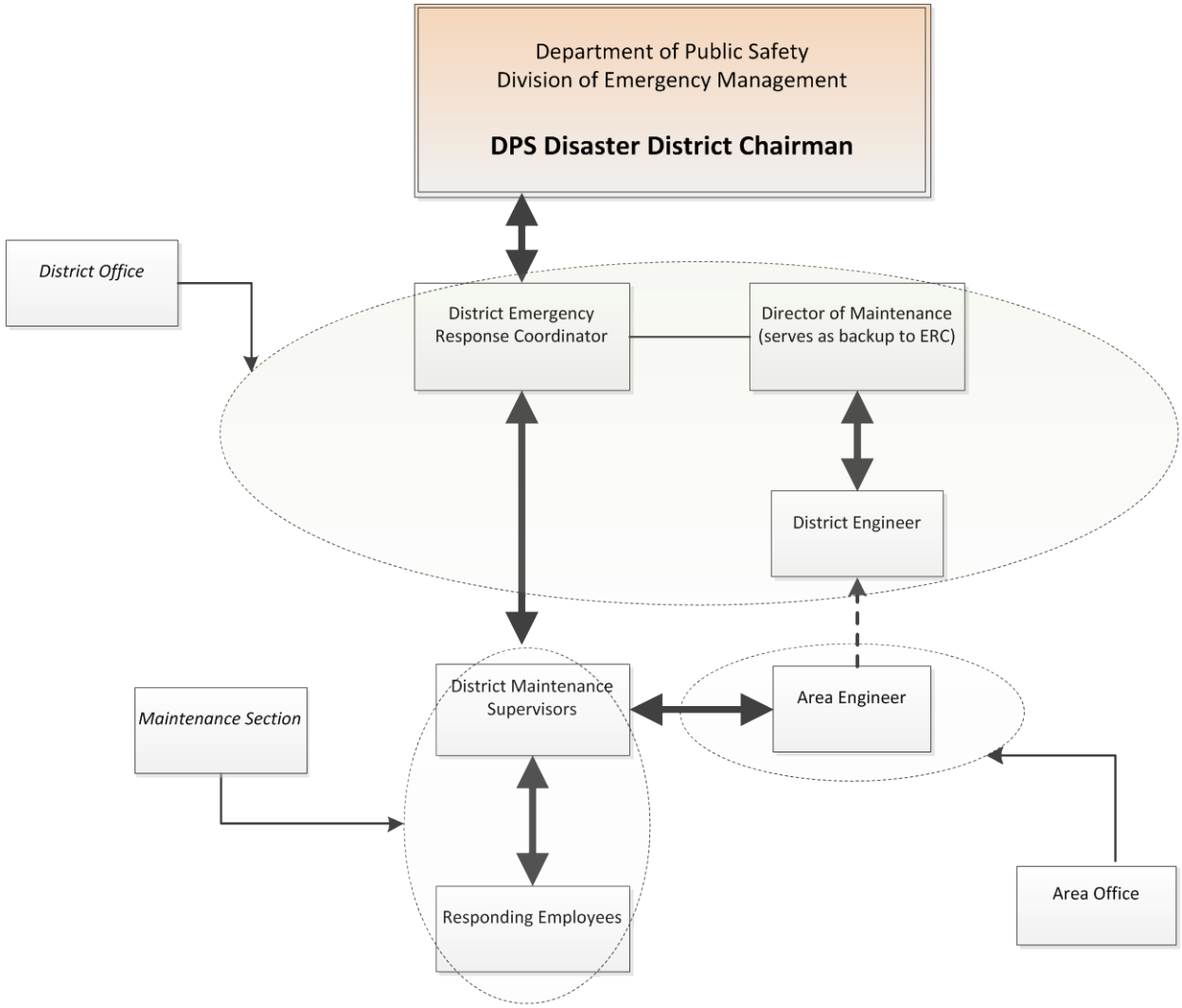

Figure 4-4. Communication Flow Chart during Typical Winter Weather Event.

District Example

Lubbock District

The Lubbock District has an example of their emergency response flowchart in their Ice and Snow Control Plan (*36*). Figure 4-5 shows the flow of information among key disaster management staff at the District. Note that the flowchart also includes information for the Disaster District Chairman for the neighboring Amarillo District.

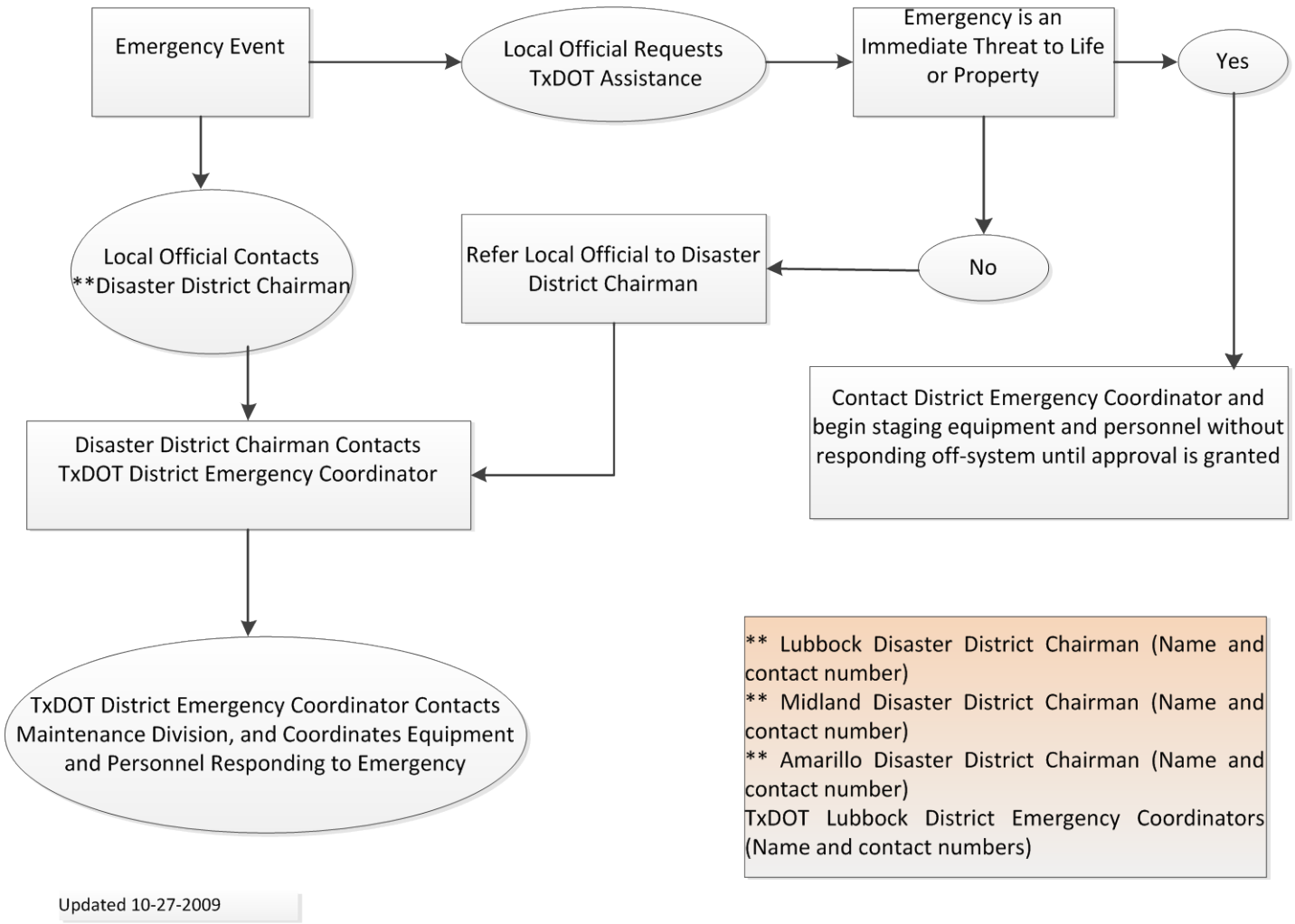

Figure 4-5. Lubbock District Emergency Response Flowchart for Emergency Response off TxDOT Right-of-Way (*36*).

Austin District

Each of the 15 maintenance sections in the Austin District has an area of responsibility as designated on a district map. If a maintenance office requires assistance or needs extra materials or equipment, the first action is for that section to request support from an adjacent maintenance office within the district. This is usually handled at the maintenance section level without involving the district office. However, if support cannot be found, the maintenance office will then submit this request to the district office or the Combined Transportation Emergency Communications Center (CTECC), the pre-eminent body responsible for coordinating winter weather response in the Austin metro area. Support can then be requested from other maintenance sections within the Austin District, from neighboring TxDOT districts or transportation of extra materials for the concerned section from storage facilities that the district office controlled. In extreme cases, additional material could be purchased to meet the request. Thus, while winter storm operations are directed locally from each individual maintenance office, coordination and communication between these offices is primarily facilitated through the Austin District representative at the CTECC/EOC floor.

Route Prioritization

Each TxDOT district designates selected routes as high priority when deploying treatment action. These roadways are typically selected based on the importance to the road network within the district and the economy. High-volume highways are usually prioritized including interstate highways, and major state highways. Typically, farm roads and local roads tend to be of the least priority. A proper prioritization ensures that there is no disruption to the traffic movement on major highways across the district. The roadway priority can be generally listed as follows:

- Priority 1—High-volume roadways such as interstates, U.S. highways, or other primary routes and known trouble spots such as bridges, steep grades, and sharp curves.
- Priority 2—State highways and high-volume farm-to-market (FM) roads.
- Priority 3—Low-volume FM roads (some FM roads may be of higher priority based on their importance to the local communities, such as being an emergency route to these sectors, etc.).

District Example

In the Pharr District, even though there is some prioritization of road treatment, there is also the lack of adequate winter weather response equipment and personnel to handle the occasional ice storm. Thus, in the event of a major ice storm, district staff in coordination with the Department of Public Safety will close down the highway main lanes first. The district will prioritize treating the frontage roads with sand and gravel and on the bridge structures as well. Hence, traffic is kept on the frontage roads instead of the main lanes.

Reporting Procedures

TxDOT provides regular updates of the weather effects on roadway conditions to the public to provide guidance on how drivers should proceed with their routes. This is a critical part of the ice and snow response procedures. When the relevant road information is delivered in a timely manner to the public, it has the potential to reduce accidents with more careful driving behavior. Public information, education strategies, and communications plans help ensure that numerous audiences receive timely, consistent messages about life-saving measures, evacuation routes, and threat and alert system notices. TxDOT districts use several avenues to disseminate information to the general public regarding winter weather road conditions.

Highway Condition Reporting System

The Highway Condition Reporting System (HCRS) is the primary avenue TxDOT districts use for reporting road conditions and weather updates to the public. District staffs are required to enter highway and weather conditions into the HCRS system every workday morning by 8:10 a.m. and update the information regularly throughout the day (preferably every 2 hours). According to the HCRS Manual (*36*), districts are required to report the following types of information:

- Local national weather service forecasts.
- Highway conditions that close travel in one direction for more than four hours or create hazardous travel.
- Weather-related events that may cause unsafe driving conditions such as ice, sleet, snow, floods, high winds, or hurricanes.

Some district personnel expressed dissatisfaction with the process involved in updating the HCRS system. TxDOT staff indicated that the requirement to input road conditions in detail, by road section, was time-consuming and suggested a need to allow for an option to provide road conditions for the entire county for instance with one button. Another challenge with the HCR system is that prior authorization is required to access the system; often, the person with that authorization may be required to be in the field monitoring the roadway response operations.

Local News Channels

The Public Information Officer at the district supports the Incident Command by releasing timely information to the general public through local TV and radio news channels. The popular news channels (both radio and TV) serve as an outlet for information on roadway and weather conditions and suggest routes for the traveling public.

Social Media

The current popularity of social media has led several TxDOT districts to use social media to provide roadway information. Several districts including San Antonio, Lubbock, Austin, Houston, Dallas, and Corpus Christi use social media as a means of communicating with the public. Typically, the PIO is responsible for this media outlet.

District Example

Amarillo District. The Amarillo District outlines their reporting procedures as follows:

- The Highway Condition Reporting System (HCRS) is to be updated according to the guidelines on the HCRS Manual, which can be found on the Crossroads under the Travel and Information Division heading.
- HCRS Capabilities should be verified as "Active" for each maintenance employee who has reporting responsibilities (primary and backup).
- Information provided to the District Maintenance Office is extremely important not only for the traveling public, but also for district-wide operations, which includes answering media requests.
- It may be important to keep a dispatcher on duty as a contact point for information requests and for the safety of the crew members. Using a dispatcher is at the maintenance supervisor's discretion.
- All storm activities are to be charged to Maintenance Function Code 811. Each storm is also to be tracked individually, using a task number that the DOO office established and set in advance.
- Each section will enter the information requested on the District's Storm Survey SharePoint Site pertaining to each storm into between 6–7 a.m. and between 4–5 p.m. daily and after any major incident.

Austin District. In Austin, all current roadway conditions and all reports from maintenance sections within the Austin Metro area are routed to the CTECC. In addition to this, the TxDOT Public Information Officer provides periodic information to media outlets for dissemination to the public. The PIO is also responsible for handling social networking sites and updating website information**.**

Materials Application

There are two main approaches in treating ice and snow on roadways: the anti-icing treatment approach and the deicing treatment. Almost all districts engage in deicing of roadways in their counties, but only a few districts in Texas do anti-icing (or pre-treatment) of roadway surfaces prior to the start of snowfall or ice formation. These two treatment processes are discussed briefly in the following section. Generally, all districts did not have any strong preference for a particular treatment material. The choice of ice and snow treatment material for districts is based on several factors including the purchase price, the general performance and ease of use, the corrosion potential to equipment and bridge structures, the storage and handling, and the experience of use by the district maintenance section.

Because some districts comprise of counties with varying winter weather, it is possible to have several material types being used within a particular district. Some districts use a combination of materials; for instance, the Brownwood District uses a combination of sand and salt to deice roadways to enhance their treatment process. This is supposed to provide the abrasiveness of the coarse sand with the chemical effects of the salt in melting the ice. Other districts have a primary use of one material, and have a secondary option only when the district runs out of the primary option.

Anti-Icing Treatment

The time and effort that is required to plow and clear roadways increase after the snow and ice are bonded to the roadway surface. In the immediate moments before a winter storm hits, some districts pre-treat the roadways with chemicals that prevent the bonding of snow and/or ice with road surfaces. The most commonly applied pre-treatment chemical used at the districts is the liquid magnesium chloride solution (liquid $MgCl_2$). The application of this chemical creates a layer of briny slush that separates the snow and ice from the pavement. Anti-icing requires a greater attention to application rates, and this requirement makes it less appealing to some districts. However, with precise applications; it does have the potential to reduce overall costs associated with roadway snow and ice treatment.

Districts usually prioritize what roadways will get pre-treated (usually the higher priority routes) and send crews out to disperse the chemical on the roadways just prior to the first ice/snow hits. The maintenance supervisors are responsible for determining which roadways are likely to be impacted by winter weather and implement the anti-icing treatment accordingly. In discussions with the various districts, pre-treating of road surfaces seemed to be more prevalent in districts located in areas with more severe winter weather events and in larger metropolitan areas, where there seems to be a greater desire to "get out in front of the storm" and reduce the impact of the winter weather in disrupting traffic conditions.

Deicing Treatment

Various districts use different chemicals and corrosives as part of their roadway deicing efforts. From discussions with the various TxDOT districts, several districts are increasingly using granular magnesium chloride (also referred to as Meltdown 20) in the treatment of ice and snow on road surfaces. This is a result of the concern for the damage to bridge structures due to road salt (sodium chloride), which is the most commonly used chemical for roadway treatment of ice and snow in the United States according to a National Cooperative Highway Research Program Report (NCHRP) report on Guidelines for the Selection of Snow and Ice Control Materials to Mitigate Environmental Impacts (*37*).

Some districts such as San Antonio prefer the use of abrasives to any liquid application. It appears to improve friction and thus creates a better grip that drivers feel while driving on the road. Even though the use of abrasives typically provides only temporary relief (before being swept off the roadway lanes), the district perceives that the driving public is not confident about the application of liquid chemicals on roadways and bridges. The district also cites the costs associated with purchasing application materials for these liquid chemicals, the chemicals themselves, and the storage challenges involved.

Pre-Wetting

Pre-wetting of dry ice and snow treatment material before application on the road surface reduces the scattering of the dry materials off the roadway lanes. This can improve the effectiveness of treatment materials. If the material is chemical, it increases the potential for the material to stay on the road surface and remove the bonding between the ice/snow to the road

surface. Secondly, it increases the friction that abrasive materials cause, thus further reducing the vehicles' potential for skidding.

District Example

Lubbock District. The Lubbock District is an example of a district that uses a variety of materials in their ice and snow treatment. For instance, some maintenance section supervisors use regular road salt ($NaCl_2$) in their jurisdiction partly because of the ease of acquiring this substance. Other locations apply both the liquid and granular magnesium chloride (Meltdown 20) in roadway surface treatment. There has been some concern discussed at the district about the damage to valves on the spray systems that the salt chlorides (sodium and magnesium chlorides) have apparently caused. To minimize the damage to these spray systems, other sections use organic material such as potassium acetate. The granular magnesium chloride is typically used on the overpasses and bridge structures, while road salt is typically applied on other roadway surfaces.

Corpus Christi District. The Corpus Christi district primarily uses road salt in the deicing treatment of roadway surfaces and even on bridge structures. In discussions with the district representatives, they indicated that due to the rarity of ice events within the district, the application of the corrosive road salt is limited and is likely not to have a drastic short-term effect on these structures. In their opinion the potential for damage is in line with the normal life cycle of a bridge structure.

Austin District. The maintenance sections within the Austin metro area uses granular $MgCl_2$ as the primary chemical material for deicing roadway surfaces during winter weather events. This is due to the cost of cleanup associated with the use of sand and/or *chat rock* (rock aggregates). The aggregates end up in drainage systems in the metro area and a resulting substantial effort in time and personnel to clean up. Currently, the district uses the granular $MgCl_2$, in more urban locations and even in counties further away from the metro area. In some rare cases, when the more rural counties run out of the $MgCl_2$, they resort to using chat rock. The threat of drainage blockage that this material posed is far less in those counties.

San Antonio District. The district previously used the chemical calcium acetate (referred to as CF7) for deicing. However, the product is currently not one of the TxDOT-approved materials. The district is ending its usage of this chemical because it requires a different nozzle and application rate. In contrast, magnesium chloride is on the state contract, is used statewide, and can be bought in pallet or liquid form. The city prefers the psychological idea of using rock to treat the ice instead of liquid ("Why would you place liquid over ice?"). Nevertheless, the main challenges to purchasing these materials and equipment are storage, and the purchase cost itself. Due to the low frequency of use, it is unjustifiable to make such a high purchase.

Regional Differences

As noted, the TxDOT west regional districts are at the forefront of pre-treatment activities within the state. The practice of anti-icing or pre-treatment of roadway surfaces require a substantial amount of pre-planning staging of equipment, materials, and personnel. It requires districts to be proactive in sending maintenance personnel out to the roadways and ensuring the roadway

surfaces are pre-treated. In addition, it requires the acquisition of additional anti-icing material. According to the districts that experience few winter weather events (such as Pharr and Laredo), these concerns have made the anti-icing treatment option impractical for them to implement.

On the other hand, for districts further north and west of the state (geographic zones from IH 20 north, for instance), anti-icing practices could be helpful in reducing the amount of time, personnel and money spent to deice frozen and snow-piled roadways. Several of these districts currently practice anti-icing treatment as part of their response to ice and snow winter conditions. Some districts—for instance, Abilene District—had concerns with using the granular $MgCl_2$ as the effectiveness diminished at extremely low temperatures below 15 degrees Fahrenheit.

In Table 4-2, the number "1" indicates the primary material that the district used, while the number "2" denotes the secondary material used. In some districts the secondary material(s) is only used when the district runs out of the primary material(s); however in other districts both (or several) materials may be used interchangeably, in which case both (or all) materials will be denoted as primary. A blank (shaded) cell denotes that the district does not use that particular material for treatments of ice and snow on its roadways. The following materials are commonly used across the state:

- Road salt ($NaCl_2$)—both liquid and granular.
- Magnesium chloride ($MgCl_2$)—both liquid and granular.
- Calcium chloride ($CaCl_2$).
- Organic products (e.g., CMA [Calcium Magnesium Acetate] and KA [Potassium Acetate]).
- Abrasives—rock aggregates, sand and other abrasives.

Table 4-2 shows that the most common treatments currently being used are the $MgCl_2$ and abrasives (specifically sand and chat rock).

Table 4-2. Materials Used by Various TxDOT Districts for Anti-Ice Treatmentof Roadways.

District	Anti-Icing Treatment	Deicing Material Used*				
		Chloride Salts$^{\beta}$			Organic Products	Abrasives
		$NaCl_2$	$MgCl_2$	$CaCl_2$	CMA/KA	
Abilene		1	1			1
Amarillo	☑	2	1		1	1
Atlanta			1			1
Austin		2	1		2	2
Beaumont			1			1
Brownwood			1			1
Bryan			1			1
Childress	☑		1			1
Corpus Christi		1				1
Dallas						
El Paso	☑					
Fort Worth						
Houston						
Laredo						1
Lubbock	☑	1	1		1	1
Lufkin			1			1
Odessa						
Paris			1			1
Pharr						1
San Angelo						
San Antonio	☑		1			1
Tyler						
Waco						
Wichita Falls	☑	1	1			1
Yoakum			1			1

1–Primary chemical; 2–Secondary chemical
β–Liquid and/or granular forms

Equipment Use

Equipment type and usage varies by region in Texas. Some basic equipment types are used in all districts across the state. These basic equipment types include v-box spreaders and dump trucks for use in dispensing granular chemical materials, pickup trucks that maintenance personnel use in inspecting roadway surfaces (and other uses), and motor graders. Some districts convert other equipment for use as part of their winter weather response fleet. For instance, the San Antonio District utilizes herbicide/vegetation trucks to assist with the dissipation of liquid $MgCl_2$ during pre-treatment of roadways and bridges.

Regional Differences

The difference in equipment usage across various regions in Texas is a result of the differences in winter weather events across the state. For instance, Amarillo experiences at least one snow event every winter season. San Antonio District experiences snow conditions once every few years. Thus, for Amarillo District, snowplows are a necessity while in San Antonio, they are not. Table 4-3 shows a list of typical winter weather equipment that each district has been using.

CONTROL ACTIONS

Control actions during adverse weather events include road closures, use of alternate routes, and modification of traffic signal systems.

Road Closure Procedure

TxDOT's objective is to keep all state roads open to the traveling public. In the event that local authorities request closure of a state-maintained roadway, the following procedures are usually followed.

- Roadway segments that will be given first consideration for closure are those that have redundancy or easily accessible alternatives. For example, elevated direct connector ramps or bridges may be considered for closure if frontage road or at-grade alternatives are readily available.
- The request for road closure must come from state or local law enforcement authorities.
- The closed roadway will usually begin and end within city limits or at major intersections to ensure that motorists are not stranded within the limits of the closed roadway.
- Maintenance section personnel continually patrolled, plowed, and salted the roadway according to established priorities, and with the goal of reopening it as soon as possible.
- Plow truck drivers are not to be taken away from plowing duties to set and/or man barricades at locations that have been officially closed. TxDOT non-CDL personnel, local volunteer organizations, or contract barricade companies should be used.
- Road closures are noted on HCRS and removed when the roadway is reopened.

Road closure procedures are similar for most districts. However, several factors were noted to dictate when and how often road closures occur within a particular district. These factors are briefly described below.

- District resources to combat winter weather: If a district has inadequate resources to combat ice and snow weather events, they are less likely to be successful in either pre-treating roadways prior to the icing of roadways or deice roadways. Such districts are likely not to attempt to keep roadways open in that scenario. Most of the smaller districts in the south (e.g., Pharr and Laredo) fall under the category of TxDOT districts where this factor is critical.

Miles of roadway affected by winter weather: The more miles of roadway a district has to cover, the more resources and funds are required to adequately treat iced roads or plow

Table 4-3. Equipment Types Used at TxDOT Districts.

District	Equipment Type							
	V-Box Spreaders	Pickup Trucks*	Rear-Mounted Drag Blades	Motor Graders	Snowplows (front mounted)	Loaders	Herbicide Trucks[b]	Dump Trucks (6-CY/10-CY)
Abilene	☑	☑	☑	☑	☑	☑		☑
Amarillo	☑	☑	☑	☑	☑	☑		☑
Atlanta	☑	☑						
Austin	☑	☑	☑	☑		☑	☑	☑
Beaumont		☑						
Brownwood		☑						
Bryan	☑	☑						
Childress	☑	☑	☑	☑	☑	☑		☑
Corpus Christi	☑	☑						☑
Dallas	☑	☑		☑				☑
El Paso	☑	☑						☑
Fort Worth	☑	☑						☑
Houston	☑	☑						☑
Laredo		☑						
Lubbock	☑	☑	☑	☑	☑	☑		☑
Lufkin		☑						☑
Odessa		☑						☑
Paris		☑						☑
Pharr		☑						☑
San Angelo		☑						☑
San Antonio	☑	☑					☑	☑
Tyler		☑						☑
Waco	☑	☑						☑
Wichita Falls		☑						☑
Yoakum	☑	☑		☑				☑

*—Sometimes used with spreaders/plows

b—Used for spreading liquid chemical material

snow from roadways. Some districts end up spot treating specific sections of the roadways (e.g., bridges or high accident locations for instance, or under overpasses)

- Severity of storm: A severe storm poses several challenges to district maintenance staff. Oftentimes, these storms may last longer than your typical one-day winter storm and put additional stress on maintenance staff. With limited maintenance staff now available at most districts, the needed treatment might not be administered to all sections of roadways and/or bridges. This makes it more likely for the district to suggest road closure procedures due to potential for increased accidents on untreated roadways.
- The objective of a district for ice and snow control: Some districts are making it an objective to keep the roadways open for as long as is possible. This involves an aggressive strategy of pre-treatment of high-volume/high-priority roadways and bridges, regular deicing treatment and/or snowplowing during the winter weather, and active monitoring of roadway conditions in the immediate aftermath of the storm. These districts are more likely to keep roadways open longer compared to other districts without any such goal or policy. Usually, such an objective will require the district to have adequate resources to combat winter weather.
- History with winter weather: Districts with a long history of winter weather including ice and snow (e.g., Amarillo, Lubbock, and Childress) have more staff experienced in dealing with such weather. These districts are more likely to be prepared (in terms of staff, materials, and equipment) to adequately pre-treat roadways before the storm arrives, as well as deice and plow snow during and immediately after the storm, thus increasing the chances of keeping roadways open. In contrast, districts with little experience (due to having very little history of ice and snowfall), are more likely to suggest road closures in the event of even a moderate winter storm.
- Impact to local economy: There is an increasing awareness among several TxDOT districts of the negative effect of road closures on the local economy. This means that such districts are likely to make a more proactive stance on winter weather response and keep roadways open for as long as manageable. As an example, the Laredo District recognizes the impact that closing access to Interstate Highway 35 has to the trucking industry and attempts to minimize such closures by treating bridges leading up to the highway. More urban districts (for example San Antonio) are also making a more aggressive push to keep roadways open and limit the impact that winter weather has on their local economies.

Some of these factors are interrelated. For instance, a district that has a long history of adverse winter weather conditions is likely to have the equipment and manpower required to combat winter weather.

In a winter storm with widespread impact, several districts face the major challenge of driver violations of road closure barricades while trying to ensuring an effective road closure. When drivers perceive a road to be passable, they will maneuver around unmanned road closure barriers and access the highway. Several districts noted this as a particularly difficult issue to tackle: it can lead to unnecessary accidents and subsequent expended resources in emergency responders, and a general ineffectiveness in any road closure plan.

Alternate Routes

Oftentimes, adverse winter weather affects a broad geographic area, limiting the availability of safe alternate routes. Certain roadway geometric design features, however, can make select roads in a region impassable during a winter weather event while others may continue to be safe. For example, at-grade roadway alternatives may be favored over routes with elevated direct connector ramps or bridges under adverse weather conditions.

TxDOT district staff acknowledged the challenges involved in providing appropriate alternate routes for public use. Some districts identify and require associated diversion plans mainly based on previous experience with winter weather and traffic patterns in the area. In selecting appropriate alternate routes, district staff also consider the ability of selected routes to accommodate all traffic types—for instance, truck traffic requires sufficient infrastructure that can support heavy loads and accommodate larger vehicle dimensions. Bridge and overpass structures are commonly limiting factors along potential alternate routes. In such instances, distinct alternate routes may be identified for passenger car and truck traffic. The designation of alternate routes can be politically charged; buy-in from all affected jurisdictions is required.

Traffic Signal Systems

To accommodate detoured traffic along alternate routes, districts use responsive traffic signal control (RTSC) systems or modified traffic signal timing plans. RTSC systems use algorithms that perform real-time optimization of traffic signal splits, offsets, phase lengths, and phase sequences based on current traffic conditions, demand, and system capacity to minimize delay and reduce the number of vehicle stops. The effectiveness of RTSC systems depends on the geographic extent of the system, the performance of the algorithms in responding to real-time traffic conditions, and the effort expended in maintaining the system to ensure ongoing functionality.

In the absence of RTSC systems, the use of alternative or modified traffic signal timing plans during winter weather events can effectively improve traffic flow by providing additional green time along designated alternate routes. Most traffic signal controllers allow multiple programs to be set. Response personnel can override the normal program manually or, in some cases, the timing may be set remotely from a TMC. For a more coordinated response to traffic changes, some districts developed alternate route signal timing plans in conjunction with alternate route plans.

District Examples

Districts generally have road closure procedures that differ based on the previously outlined factors. Because the outlined factors dictate what a district might want to do, it does not mean that other districts not following suit do not have a best practice. However, some helpful practices were identified at several districts that could potentially improve the coordination and practice of road closures across the state.

Communication and Coordination. As part of the Texas Disaster Emergency Management Plan the Department of Public Safety is responsible for road closures across the state. Thus, several districts defer road closures to the DPS. It is important that districts

coordinate with the DPS and be in continuous communication on issues such as accident updates, road surface condition, traffic status around the district, availability of TxDOT crew to respond to spot ice treatments, availability of DPS patrols to man barricades at road closure points, and relevant messaging on Dynamic Message Signs (DMS).

Input from TxDOT District. An interesting contrast was observed in interviews with the various Districts. While some districts (for instance, Yoakum and Laredo) deferred completely to the DPS and local law enforcement agencies for road closures, other districts had a more active input on when and how road closures were made. In several urban counties, TxDOT districts have access to a network of CCTV camera feeds on several major highways across the county. This places TxDOT in a unique position to identify patterns in traffic accidents. It is important that TxDOT have some role as an example:

Reporting. The use of social media was highlighted as an effective means of communicating with the traveling public. Outlets such as Facebook, Twitter, and the TxDOT website provide a quick way for people to access current weather and road conditions as they plan their routes to and from work or home.

Driver Education. The Amarillo District probably does the best with driver education to inform the general public about driving behavior in snowy conditions. They do this through a TV campaign that also includes information on safe driving around snowplows.

PERSONNEL SAFETY AND TRAINING

Effective personnel training and safety programs are integral to winter weather response operations.

Training

Training of maintenance staff is important in ensuring that staff are adequately prepared to handle winter weather response duties. The recent weather storms in the Dallas area required both staff and assets to be sent to that region from areas as far west as El Paso and San Angelo. This asset sharing and the concept of a "One DOT" may require maintenance staff to receive training on how to combat various winter weather types. For instance, even though some districts rarely encounter snow, it might be beneficial to have some maintenance staff train occasionally on snowplows with districts more accustomed to such weather.

This has two almost competing benefits. Firstly, this increases the versatility of maintenance staff and makes them more readily able to assist other districts in other regions of the state with different winter weather events than what is typically experienced in their local districts. Secondly, it will limit the need for staff to travel over excessive distances in order to help districts that are not accustomed to dealing with a particular type of winter event. For instance, as was the case in Dallas, there was a request for staff from other districts who were more familiar with combating snow to travel over several hours (in some case, over 10 hours) in order to assist the Dallas region combat the snow and ice. If maintenance staff in that district had undertaken adequate training in snow (which is rare in Dallas, for instance), it might have made them more prepared to handle the recent storm. Certainly, for this to be effective, some districts

might have to commit to purchasing limited quantities of equipment types that are different from what they are used to having.

At several TxDOT districts, it was quite evident that there were no formal training procedures or routines for maintenance staff. Most training for new maintenance staff is done on the job. Typically, during a winter event, more seasoned maintenance operators are teamed with newer staff to provide experience and guidance. Such on-the-job training might involve showing the staff how to spread chemical deicing agents such as Meltdown 20 or what are the right portions of salt to use on a bridge. Typically, the more experienced staff drive trucks during winter events as this task is too critical for a novice to do.

Maintenance supervisors are responsible for the proper training of all crew members. TxDOT employees have varying degrees of experience with snow winter weather response. In addition to formalized training, TxDOT staff engage in on-the-job training practices specific to winter weather response including the following:

- Pair experienced and inexperienced personnel to give time to the latter to become familiar with winter weather response operations.
- Allow new personnel to inspect their route prior to a winter weather event to note any hazards or changes to the roadway that may not be visible during a winter storm.
- Allow new operators to become familiar with a piece of equipment—this can be beneficial during night operations, blowing snow, and other low-visibility conditions.
- Operating a snowplow is a unique activity for even the most experienced truck drivers who may be new to TxDOT. New operators should complete orientation training prior to being assigned plowing duties, with an emphasis on proper plowing techniques, operating speed, plowing in high-volume traffic, and plowing near railroad crossings.

Unfortunately, aside from on-the-job training, there is very little formal training available to update staff knowledge or expose them to more recent developments in equipment or technology in combating winter weather. This is typical for many districts, particularly those that experience infrequent winter weather events.

Safety Measures

The safety of all crew members and the traveling public is the highest priority during a winter weather event. Work during periods of adverse weather is, by nature, a potentially hazardous operation, but the districts undertake various safety measures to protect response personnel.

- Prior to a winter weather event, supervisors hold a safety meeting in every maintenance section to discuss weather-related safety issues. The meeting addresses new and refresher training topics for equipment operators and standard operating procedures during a winter weather event.
- During adverse weather, employees communicate periodically with the dispatcher during operations and relay their location, especially when changing roads.

- As noted previously, operator fatigue is a significant safety concern. The maintenance supervisor relieves any employee who notifies him about needing temporary respite from the job.
- Maintenance supervisors and the district maintenance administrator evaluate the potential risk or benefit of the winter weather response and conduct operations accordingly. When conditions are so severe (e.g., extremely high winds with whiteouts) that attempting to improve road conditions is hazardous for both the public and equipment operators, response operations may be suspended temporarily until conditions improve.

District Examples

Some districts in the western region (for instance, Lubbock) have initiated formal training on a snowplow simulator. This simulator training has received extremely positive feedback from staff in Lubbock. While this training has been on a voluntary basis, it might be beneficial to require all staff at each district to undergo this training. Similar training should be encouraged for other forms of equipment and material usage to ensure that district maintenance staff are well-prepared to combat different types of winter weather. This will make them more of an asset not only to their district but across the state. The National Highway Safety has specific training programs targeting staff involved in winter weather response (*39*).

Regional Differences

As expected, districts with more severe winter weather may attach more importance to pre-winter storm winter activities than regions that rarely have winter weather events. There are minor differences in the approach that districts take with their pre-storm activities. Districts to the north and west of the state (i.e., those with more severe winter weather) tend to have relatively more formal meetings at the maintenance section level to discuss the upcoming winter season and outline activities that need to be completed prior to specific dates. On the other hand, districts with less winter weather events tend to have more informal meeting sessions to discuss, among other things, the equipment needs for the upcoming winter season.

POST-EVENT ACTIVITIES

Overview

In discussions with TxDOT districts, the research team found it challenging to identify clear post-storm activities. It appeared that most districts seldom have formal meetings to discuss the events of a just-passed winter storm or a winter season that had recently ended. In most districts, informal post-storm meeting discussions (either through phone conference or emails) do take place, even if they typically occur only after a significant winter storm event. For all other winter events, most discussions of the past storm actually occur during pre-storm activities prior to the start of the next winter season. In such cases, it is likely that recalling details of the recent winter weather might be sketchy and the district loses vital information that could be helpful in improving the response to future winter events. For some districts with multiple winter storm events, there are post-winter activities for each winter storm

Post-storm activities at the districts include an after-actions review to discuss the challenges and lessons learned from the previous storm or season. There is also likely to be a documentation of all equipment status and material status (this oftentimes takes place much later during preparations for the following winter season).

After-Action Review

Following each significant winter weather event, the director of maintenance calls a meeting of all maintenance supervisors and other key personnel shortly after the event to discuss procedures that worked and identify those that did not, so that changes may be implemented prior to the next winter weather event.

Follow-up reviews or assessments of winter weather response operations after their occurrence are important to districts because these enable district staff to discuss what went well and what actions could be improved. Ideally, after-action reviews would occur immediately after the winter weather event has ended (to ensure that details and procedures of the response effort are not forgotten) but following the necessary data collection. The main goals of these meetings are to constructively critique the procedures used and any decisions made, and to determine whether future winter weather response could be improved in any way (e.g., by restructuring the procedures, adding extra resources). Personnel in attendance should include each of the responders who participated in the response effort, as well as those from outside of TxDOT. If necessary, the director of maintenance will initiate an after-action conference call with all offices.

A typical after-action review contains the following topics for discussion:

- A description of the winter weather event, including the timeline, geographic extent, and any available pictures and/or video.
- A review of winter weather response objectives.
- A discussion of response outcomes (what was accomplished versus original intent).
- A discussion of lessons learned (sustain versus improve).
- An identification of future actions needed to correct any problems.

Important lessons learned, as well as other useful outcomes from the after-action review are documented and shared with other maintenance sections.

District Example

The Dallas District has several post storm activities that take place in the aftermath of all winter storm events. They include the following:

After-Action Report

Each office will prepare a brief "after-action report" and submit it to the director of maintenance and PIO no more than five working days after the end of the latest event. The report should include total man-hours worked, total overtime hours paid, total overtime cost, total labor cost,

and any specific or unusual problems and suggestions for improvement. If necessary, the director of maintenance will initiate an after-action conference call with all offices.

Aggregate Removal

As soon as excess ice aggregate is dry enough to remove with vacuum sweepers, all TxDOT and contractors' sweepers will be utilized continuously until cleanup is complete.

Equipment Cleanup, Inspection, and Repair

All equipment used during the storm event will be thoroughly washed and inspected to determine if any repairs are required. Repairs shall be promptly completed to ensure equipment is ready for the next storm event.

Resource Updates

Each office will be responsible for accurate updating of their shift roster, and equipment and materials inventory spreadsheets on the EOC SharePoint site.

Regional Differences

Generally, there are only slight differences in the post-storm activities in districts with respect to winter weather response. Almost all districts have post-storm and post-winter season activities, the magnitude of which may vary based on the amount of winter weather activity that the district typically experienced. For instance, in Laredo and Pharr, there might not be a formal review of the winter weather season unless there is an actual significant winter event. In contrast, in the west regional districts such as Amarillo, this process is more detailed and involved, with the participation of all maintenance supervisors and district emergency coordinators.

CHAPTER 5: LEVEL OF SERVICE VS. SERVICE LEVELS FOR DISTRICT OPERATIONS

OVERVIEW

Winter storms bring constant challenges to maintenance, safety, and operations of roadways. One aspect is the idea of level of service during winter weather operations. Unfortunately, traffic analysis and operational tools (simulation models) as well as standards for traffic performance generally assume clear conditions. Transportation managers are left with only their own experience to manage and control the transportation system when faced with inclement weather of varying intensities. For example, the *Highway Capacity Manual* states that "base conditions assume good weather, good pavement conditions, user familiarity with the facility, and no impediments to traffic flow" (*40*).

LEVEL OF SERVICE

Level of Service (LOS) is an assigned qualitative measurement that describes traffic operations of a given roadway. The *Highway Capacity Manual* (*40*) and the American Association of State Highway and Transportation Officials (AASHTO) Geometric Design of Highways and Streets (*41*) define six levels of service for road transportation. These levels of service range from free flow, level A, to congestion, level F. In order to achieve and sustain these levels, a myriad of factors and conditions must be present including optimal weather conditions.

SERVICE LEVELS

The concept of service level is what may be more appropriate than level of service for winter weather storm conditions. Simply put, service levels are the implementation of the goals and objectives as defined in a Snow and Ice Plan. It is an outcome-based approach to winter weather maintenance.

Goals and Considerations

Safety is the prime goal and consideration during winter weather maintenance. Other goals and considerations that affect service levels include:

- District priorities set for road clearance.
- Goals for treatment levels (bare pavement goals).
- Route specific goals. Each route may have differentiations of service levels at "trouble spots" such as bridges, overpasses, steep inclines, etc.
- Availability of personnel and equipment.
- Severity of the storm.

Several states have adopted the concept of winter service levels. A survey conducted for the Clear roads Pooled Fund Study (*41*) found that the majority of the states surveyed based service

levels on priority routing and performance measures. The performance measures varied from state to state. Many of the states defined performance measures based on the following:

- Bare pavement.
- Bare lane.
- Bare wheel paths.
- Clear condition.
- Roadway cleared shoulder-to-shoulder.

Other measures included customer feedback, return to near normal winter conditions, movement of traffic at a restricted rate, and enhanced traction.

Examples from Other States

Maine

Maine DOT established four corridor priorities that are used to define service levels during winter storm events. For each service level, target route lengths dictate the normal cycle times that can be expected based on average conditions. Local geographic and/or geometric factors are considered when determining route length. The plan also notes that during a winter storm event, there will typically be reduced levels of service for all routes during night hours. The performance goals for each priority corridor are:

- Priority I Corridors—Following the winter event, these are the first to be cleared and bare travel lanes are provided as soon as practical.
- Priority II Corridors—These are plowed to bare travel lanes as soon as practical and after Priority I corridors are cleared.
- Priority III Corridors—After the winter storm, one-third bare pavement, middle of the road, clearance is provided as soon as practical.
- Priority III Corridor Sand Routes—These are Priority III corridors that have a deicing strategy used for snow and ice control due to low traffic volumes, poor pavement conditions, low average temperatures, or have gravel surfaces. After the storm, one-third bare pavement, in the middle of the road, is provided as soon as practical (*42*).

Missouri

Missouri DOT classifies roads during winter weather events using four service level classifications: clear, partly covered, covered, and closed. They also classify routes for clearance using the following priorities:

- First Priority Routes (Continuous Treatment Routes)—This designation encompasses all major highways, urban and community routes, including all designated incident bypass routes.
- Second Priority Routes—This classification includes all minor highways not designated as First Priority.

The service level performance measures that Missouri DOT has designated are that First Priority routes are to be returned to clear conditions as soon as possible after the end of a winter storm, while Second Priority routes are plowed open for two-way traffic and treated with salt and/or abrasives on hills, curves, intersections and other areas as needed as soon as possible (*42*).

Recommendation

It is recommended that each district consider defining service levels for winter weather conditions. The district should determine goals and objectives based on safety, equipment, personnel, financial constraints, and previous winter weather experience. The service levels adopted should be both desirable and achievable. Once adopted, these service levels should be conveyed to the traveling public prior to winter storm events.

CHAPTER 6: FISCAL YEAR 2011 STATEWIDE INVENTORY OF EQUIPMENT, CHEMICALS, MATERIALS, AND SUPPLIES

To effectively respond to winter weather events, the TxDOT should have visibility over the necessary assets that will be used in winter weather operations for a given district. These assets include equipment, chemicals, materials, and supplies. In addition to having visibility of the district-level assets, it is also important to have knowledge of all availability of resources throughout TxDOT as well as procedures in place for accessing additional resources when needed.

REGIONAL SUPPORT SERVICES

A few years ago, TxDOT created the following four regional service centers to provide administrative and project management support to the department's 25 districts (*43*).

- West Region: Abilene, Amarillo, Childress, El Paso, Lubbock, Odessa, and San Angelo.
- North Region: Atlanta, Brownwood, Dallas, Fort Worth, Paris, Tyler, Waco, and Wichita Falls.
- South Region: Austin, Corpus Christi, Laredo, Pharr, San Antonio, and Yoakum.
- East Region: Beaumont, Bryan, Houston, and Lufkin.

This layer of TxDOT's organizational structure also provides internal support that includes facilities management, information technology, purchasing, accounting, and fleet management (*42*). For project management, the regions aid in environmental planning, project scheduling, metropolitan planning organization coordination, administering the Transportation Improvement Plan (TIPP, and right-of-way (ROW) acquisition. With regard to winter weather assets (equipment, chemicals, material, and supply) considerations, the Fleet Manager and Purchasing Manager are the key personnel that should be contacted. The Fleet Manager is responsible for securing equipment and the Purchasing Manager is responsible for securing materials and supplies for each district. Both also assist districts locate and acquire additional assets (equipment, chemicals, materials, and supplies), which is vital to the overall success of an asset visibility program.

EQUIPMENT

During weather events, TxDOT utilizes a variety of equipment to respond on short notice to adverse weather incidents. Such equipment includes dump trucks; motor graders; front-end loaders, V-box and tailgate spreaders; snowplows, wings, and blowers; herbicide rigs and pickup applicators. Supplemental equipment includes emergency traffic control trailers stocked with traffic barrels, cones, barricades, necessary signs, and materials for road closures and portable changeable message signs (PCMS). Table 6-1 provides a snapshot of the winter weather equipment inventory that the Regional Service Centers reported for their respective districts as of September 2011. However, pickup trucks that are traditionally used for shadowing are not included in this table.

Table 6-1. Fiscal Year 2011 Inventory of Winter Weather Equipment.

Equipment Description	Districts																							
	ABL	AMA	ATL	AUS	BMT	BWD	BRY	CHS	CRP	DAL	ELP	FTW	HOU	LRD	LBB	LFK	ODA	PAR	PHR	SJT	SAT	TYL	WAC	WFS	YKM
Grader, Motor, Class I, Up to 109 H				X							X						X				X				X
Grader, Motor, Class II, 110 TO 13	X		X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X	X	X	X	X	X
Grader, Motor, Class III, 135 TO 14	X		X	X		X	X	X	X	X		X	X	X		X	X	X	X	X	X		X		X
Grader, Motor, Class IV, 150 H.P.		X					X	X			X	X		X	X	X	X	X		X		X		X	X
Snow Blower, for Mounting on Pneum		X						X							X										
Snow Plow, High Speed Express Way	X	X						X			X	X			X			X						X	
Snow Plow, Rotary Type, Carri								X																	
Snow Plow, Straight Moldboard,10 FT	X	X				X		X			X	X			X					X				X	
Snow Plow, V-Type															X										
Sprayer, Herbicide/Insectioned Truck	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Truck, Dump, Single Rear Axle, 29000	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Truck, Dump, Tandem Rear Axle, 43000	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Moreover, the deployment and use of equipment available within the district requires only a basic understanding of the equipment's location, status, and point of contact for dispatch. Deployment and use of equipment from an adjacent district may also be accomplished through this basic process, or may require a formalized agreement that establishes a priority for equipment use for significant weather events since districts may be reliant on this equipment to service their own roadways. In such instances, leased equipment may prove to be a viable option. Equipment can be leased either with or without an operator; however, leasing with an operator is allowed only to supplement state forces. In order for the lease to be considered a purchase of services, state forces must perform a minimum of 51 percent of the work. If the contractor's performed work will exceed 49 percent, then it must be done under a routine maintenance contract. Standard terms and conditions that apply to the lease of equipment with and without an operator are available on the General Services Division (GSD) website. An alternative fuel waiver must be obtained prior to the lease of vehicle.

Based on field data gathered during this research project, the typical winter storm events that occur in Texas can be placed into three categories: 1) mostly snow; 2) snow and ice; or 3) mostly ice and freezing rain. Table 6-2 provides an overview of which districts as well as district county or counties are affected by typical winter storm events. Table 6-3 gives information on the type of equipment traditionally used when battling each of the three types of winter storm events. In combining Tables 6-1 through 6-3, both the districts and Regional Service Centers have visibility of the equipment that may originate wholly within their area, can be "borrowed" from an adjacent district, and know the equipment type most suited for battling winter storm events. Lastly, proper maintenance of all equipment before, during, and after a winter weather event is important to ensure readiness for future storms. Specific equipment maintenance tasks to be performed at each stage of responding to an event can be found in Chapter 7 of the *Winter Weather Response Guide* (*1*).

Table 6-2. Winter Storm Events per District.

Mostly Snow	Snow and Ice	Mostly Ice and Freezing Rain
Atlanta (*Bowie*) Amarillo Childress El Paso (*Brewster, Presidio*) Lubbock (*Parmer, Castro, Swisher*) Paris (*Grayson, Fannin, Lamar, Red River*) Wichita Falls	Abilene Atlanta Brownwood Bryan (*Freestone, Leon, Madison, Milam, Robertson*) Dallas El Paso Fort Worth Lubbock Paris San Angelo Waco	Austin Beaumont Bryan Corpus Christi Houston Laredo Lufkin Odessa Pharr San Antonio Tyler Yoakum

Table 6-3. Equipment Requirements for Winter Storm Events.

Mostly Snow	Snow and Ice	Mostly Ice and Freezing Rain
Motor Graders *Snowplows* *Snow Blowers* *Herbicide Sprayers* Dump Trucks Pickup Trucks	*Motor Graders* *Snowplows* *Herbicide Sprayers* Dump Trucks Pickup Trucks	*Motor Graders* *Herbicide Sprayers* *Dump Trucks* Pickup Trucks

DEICING CHEMICALS

The different types of chemicals used in responding to winter weather are discussed in this section. Chemical treatment methods generally involve the use of chemicals to "deice" or speed the melting process after snow pack or ice has formed on a road. The types of chemical products used, as well as their recommended uses and application methods, are described below. In addition, potential concerns related to environmental and bridge infrastructure impacts are identified. The appropriate testing procedures for chemical products and anti-icing applications are described as well.

Deicing Chemical Types

Sodium Chloride ($NaCl_2$)

Sodium chloride has been used as an ice-control chemical on roads since early in the previous century. It is produced by three processes:

- Rock salt is mined using conventional hard rock mining equipment and techniques.
- Solar salt is produced by the evaporation of sea water and may contain only a small amount of impurities.
- Evaporated, solution, or vacuum salt is a very pure form made by drying under vacuum the solution resulting from injection of water into deep underground deposits.

Most salt used for highway applications in the United States is rock salt, though some solar salt is produced in several western states and some is imported into the eastern states. Naturally occurring rock salt is the mineral halite, which usually contains between 1 percent and 4 percent impurities, mostly gypsum, shale, dolomite, and quartz.

Magnesium Chloride ($MgCl_2$)

The principal source of this ice control chemical is brine from the Great Salt Lake. Though it is available in solid (flake) form, it is used in liquid form for ice control. The lowest temperature at which MgC_{l2} can melt snow or ice (eutectic temperature) is about −28 degrees Fahrenheit at a concentration of 21.6 percent. Its ice melting capacity is about 40 percent greater than calcium chloride ($CaCl_2$). Proprietary mixtures are available containing 20–25 percent $MgCl_2$ with various corrosion inhibitor additives. One proprietary compound reportedly has a eutectic temperature of −4 degrees Fahrenheit. These solutions are effective ice-melting agents at temperatures above 19 degrees Fahrenheit.

With its competitive price and low freezing point, magnesium chloride works well as both a deicer and anti-icer. It contains a corrosion inhibitor, making it less damaging to concrete and steel than other products, and it is less harmful to the environment than calcium chloride and sodium chloride.

Calcium Magnesium Acetate (CMA)

Currently there is only one commercial source for CMA, using the reaction of acetic acid with dolomitic limestone for production. Acetic acid, the costly component of the compound, is manufactured from natural gas or petroleum, though small quantities have been produced by biodegradation of agricultural wastes. The compound is available as pellets or powder. Though not as soluble in water as $NaCl_2$ and $CaCl_2$, CMA solutions can be made for use as a pre-wetting agent or straight chemical application. CMA is not a highly effective deicing chemical in solid form because of its affinity for water and its light particle mass. Its benefit is that it makes snow mealy so that it does not compact.

CMA is primarily a mixture of calcium and magnesium acetates, produced with a 3:7 Ca/Mg ratio that was found to be optimum in previous Federal Highway Administration (FHWA) studies. The eutectic temperature is about −18 degrees Fahrenheit at a concentration of 32.5 percent. When CMA degrades, the calcium and magnesium elements are said to actually improve the water and air permeability of the soil by restoring sodium-compacted soils. Since acetate degrades into carbon dioxide and water and is a natural component of plant decay, CMA is appropriate where roadside vegetation, crops, or ground water are especially vulnerable. Because it is less corrosive than salt, some agencies prefer CMA for use on bridges, parking structures, sidewalks, and certain road surfaces (Caution: It does cause major scaling). The pellet form of CMA is usually preferable to the powdered form, since the powder dust is less

controllable. The pellet form of CMA does not bounce off the road before melting and its residual action can reduce reallocation frequency.

CMA costs approximately $600 per ton, whereas salt generally costs $20–$40 per ton. Some advocates of CMA argue that the initial costs may be misleading because replacement costs for roads and bridges damaged by chloride-related corrosion should be factored into the overall figures.

Potassium Acetate ($KC_2H_3O_2$)

Potassium acetate, or KAc as it is commonly known, is produced by the reaction of acetic acid with potassium carbonate. The sources of acetic acid are the same as in the production of CMA. Potassium carbonate is one of the groups of salts commercially known as potash. Potassium carbonate was originally obtained by running water through wood ashes and boiling the resulting solution in large iron pots. The substance that formed was called potash.

Potassium carbonate is currently produced by one of several processes that use potassium chloride, another salt of the potash family. The compound, potassium acetate, is a white, crystalline, deliquescent powder that has a saline taste. It is soluble in water and alcohol. Solutions are alkaline under a litmus test. The dry compound is combustible, but is used as a dehydrating agent, a reagent in analytical chemistry, and in the production of synthetic flavors, in addition to other uses. The eutectic temperature of a KAc and water solution is −76 degrees Fahrenheit at a concentration of 49 percent. A commercial form of liquid KAc, containing a 50 percent concentration by weight plus corrosion inhibitors, has been used as a pre-wetting agent with dry salt or as a straight chemical application.

Sand

The most economical material used in snow and ice control is sand. The price of sand ranges from $6–$16 per ton. However, sand on the road must be removed—sweeping is costly and the combined product and cleanup costs can well exceed the cost of other chemical products. Sand can cause damage to windshields and auto body paint. The use of sand also creates silting problems in bridge joints and storm sewer systems, which undoubtedly leads to environmental concerns in the nearby streams, rivers, and other water bodies. In areas where only ditch cross sections exist (no curb and gutter and storm sewer system exists to trap the sand), sand is favored for use. In these areas, the sand can blow off the pavement and be absorbed into the surrounding ground surface so additional cleanup costs are minimized. Salt should be mixed with sand at the approximate rate of 50 lb per cubic yard to prevent the sand freezing in the truck and to melt ice on which sand is applied.

Recommended Uses

Where anti-icing operations are conducted to prevent the formation or development of bonded snow and ice for easy removal, deicing operations are performed to break the bond of already bonded snow and ice. It is important for maintenance personnel to understand the uses and limitations of each of the materials and techniques. Table 6-4 presents key distinctions between the use of dry or solid chemicals and liquid chemicals.

Various additional factors should be taken into account when deciding on a course of action to treat roadways during a winter weather event. Product application combinations are chosen after maintenance personnel have evaluated many factors including, but not limited to:

- Air temperature.
- Pavement temperature.
- Humidity levels.
- Dew point temperatures.
- Exposure to solar radiation.
- Type and rate of precipitation.
- Weather forecast.
- Weather radar data.

Table 6-4. Distinctions between Dry/Solid and Liquid Chemical Use.

CHEMICAL FORM	RECOMMENDED USE
Dry/Solid Chemicals	**Timing is Critical**—Timing of an initial dry solid chemical application for snowstorm events is critical. The application should be made as soon as possible after sufficient precipitation has fallen to prevent loss, but before ice bonds to the pavement. **Do Not Use As Pretreatment**—Application of dry solid chemical onto dry pavement is not recommended, and therefore should not be used as a pretreatment.
Liquid Chemicals	**Don't Use During Ice Storms**—Liquid chemicals are not recommended during a freezing rain or sleet storm because of the large quantity needed to retain an effective concentration. The application rates are the equivalent dry chemical rates suggested by the manufacturer. **Using for Snow Storms**—For snowstorms, initial liquid applications can be made either as a pretreatment in advance of the storm or as an early-storm treatment, (i.e., soon after snowfall has begun and/or when the pavement temperature is dropping toward freezing). **Pretreatment**—A pretreatment can be made prior to a storm, as long as the storm does not start out with above freezing temperatures and rain, washing the chemical away. Benefits from liquid pretreatments can include higher friction and better pavement conditions early in a storm. These benefits are generally short-lived. Subsequent chemical applications should be made as soon as conditions begin to deteriorate. Pretreatments can be thought of as "buying time" in the early stages of a storm until subsequent chemical applications become effective. **Early-Storm Treatment**—In the case of early-storm treatment, the application may be made onto dry, wet, light slush, or lightly snow covered pavement. Late applications onto pavements with more than a light covering of slush or snow can result in excessive dilution of the chemical, lowering its effectiveness. **Preventing Black Ice**—To prevent the formation of frost or black ice (caused by radiation cooling of the pavement in the presence of high humidity) the chemical should be applied before ice is expected to form so the water component of the chemical will evaporate or be removed by traffic action. This will leave only the chemical on the road surface and result in the greatest concentration when frost or black ice conditions occur.

Chemical treatments should be continuously evaluated and modified before, during, and after a winter weather event, depending on careful analysis of intensity, duration, and type of precipitation.

Recommended Application Procedures

Recommended application procedures for dry/solid chemical, pre-wetted dry/solid chemical, and liquid chemical (chemical solution) application procedures are described below.

Dry/Solid Chemicals

The use of dry solid chemicals as an anti-icing treatment can be effective in many circumstances, but only where there is sufficient moisture or accumulation of snow or ice on the pavement. Moisture must be present for two reasons: 1) to prevent loss of material from dry pavement; and 2) to trigger the chemical into solution.

For initial operations, solid chemicals will be effective when maintenance forces have the operational resources available to apply the chemical soon after sufficient precipitation has fallen, but before ice bonds to the pavement. For subsequent operations, solid chemical treatments will usually be effective when there is adequate moisture or accumulation of snow or ice during later periods of storms. For either initial or subsequent operations, when there is not enough moisture or accumulation of snow or ice on the pavement there is likely to be loss of the chemical from the pavement. This may be caused by the blowing action of traffic, especially from high speed and commercial vehicles, or by particles bouncing off the pavement during spreading.

Pre-Wetted Dry/Solid Chemicals

The pre-wetting of a solid chemical prior to spreading can improve the effectiveness of the solid chemical in many situations. A solid chemical requires energy to go into solution, and a dry solid chemical particle will remain inert until a liquid film forms. The solution process will be accelerated if pre-wetting is performed to the solid material. This is only one of the benefits of pre-wetting. Other advantages include:

- The solid chemical is spread more uniformly because of less waste from bouncing or traffic action (although not all waste is eliminated).
- Wet granules adhere to the road surface better than dry granules.
- There is a faster and longer-lasting effect.
- Spreading speed can be increased.
- In some cases, the road surface dries more quickly.

The practical result is a reduction in the resources necessary for maintaining the highway since a lower application rate translates into a spreader load covering more area, often requiring less deadheading (returning to the barn empty or making a return trip without a load) to obtain material.

Liquid Chemicals

Liquid chemicals applied with spray equipment can be used for deicing, provided these can be applied at sufficient pressure to cut though the ice or snow pack. Caution must be exercised during de-icing since spraying liquids on top of the pack may cause the road to become slick.

The use of dry solid chemicals and pre-wetted abrasives in conjunction with deicing will speed the melting of the snow and ice pack. This practice will improve the deicing process and reduce the time it would take to melt naturally. There are advantages for using liquids at pavement temperatures of 23°F and above. These include:

- The ability to apply a chemical uniformly over the pavement.
- The ability to place a chemical onto dry pavement as a pre-storm treatment to prevent bonded snow or ice from forming. However, this means putting the chemical down before enough snow has accumulated to prevent the chemical from reaching the pavement or from being excessively diluted. In some situations, it may be beneficial to remove snow and slush from the road using traditional mechanical methods.

Liquids can be used at pavement temperatures below 23°F by following the manufacturer's suggested rate of application for varying conditions. The cost effectiveness of using liquid chemicals at lower pavement temperatures needs to be evaluated on a case-by-case basis.

Environmental Considerations

Much is written and said each winter about the effects of anti-icing and deicing chemicals on the environment, but little is said of their benefits to the traveling public. The truth is that anti-icing and deicing chemicals are essential to the safe transportation of goods and people. When applied heavily and frequently, chemicals can pollute receiving waters, but the degree of their damage largely depends on the type and designated use of the receiving waters, and on the drainage system used to discharge the runoff. Surface waters are not as vulnerable to chemicals as ground waters because their turbulent actions blend and dilute plumes of incoming liquids almost immediately after the chemicals enter the mainstream. Ground waters, on the other hand, are more susceptible to pollution since there may be no turbulent actions to dissolve the chemicals when the runoff percolates through the soil and enters the water table.

CMA and KAc are chemicals most benign to the environment because they contain weak biodegradable acids. NaCl, $CaCl_2$, and $MgCl_2$, on the other hand, leave residues of chloride ions on the highway surface that may not only contaminate surrounding ground waters, but they may also corrode motor vehicles and bridge structures. The effect of chemicals on receiving waters may vary with the specific use and overall ecological health of each body of water. In some cases, water with elevated concentrations of sodium may be suitable for some uses, but undesirable for certain industrial purposes. For example, high concentrations of sodium in water for human consumption are harmful to people with certain types of heart or kidney diseases, but the major objection comes from taste preferences. The effect of high salinity on fish life varies with the tolerance of individual species. Some fish cannot tolerate a salt level as low as 400 parts per million (ppm), while others are able to live with levels higher than that of seawater (30,000 ppm). Salt levels in highway runoff vary with the amount of chemicals applied and the intensity of subsequent rainstorm events. Highway runoff can contain salt levels as low as 10 ppm,

particularly in areas where chemicals are not used. Recent studies on the migration paths of chemicals have indicated that, in places where highway runoff is discharged through open-drainage systems, as is typically done in many highways, concentrations of deicing chemicals tend to be substantially higher down gradient than up gradient from the highway. Chemicals are often combined with other substances to prevent caking or inhibit corrosion. These substances may be toxic to human, animal and fish life. For instance, sodium ferrocyanide is often used to prevent caking but, unfortunately, it releases cyanide ions that are extremely toxic to fish. Corrosion inhibitors may contain phosphorus compounds that, in turn, stimulate the growth of undesirable aquatic plants, weeds, and algae in freshwater lakes.

Chemicals in highway runoff are not the major sources of chloride contamination of waters. Sewage discharges and runoff from industrial waste and agricultural products also contain high concentrations of chloride that may affect receiving waters as well. Rain and snow may deposit as much as 35–40 lb of chloride per acre annually even without the presence of deicing chemicals. Areas that are geographically located along coastal waters also experience high chloride concentrations since chloride occurs naturally in sea water, natural brines, and water that passes through salt-bearing strata. Liquid anti-icer and deicer chemicals are much better for the environment than other alternatives, including sand and salt. While some sand and salt use is still necessary, increased use of liquids has drastically reduced air pollution associated with sand use, and has reduced the amount of sand runoff that endangers roadside plants

Bridge Infrastructure Considerations

Bridge decks typically are the first transportation structures to freeze during cold weather. The greatest risks associated with chemical use on bridges are corrosion of embedded steel and concrete deterioration. TxDOT allows each district to use commercially available chemical products. Corrosion potentials vary with each material. Bridges are composed of substructures (caps, columns, foundations) and superstructures (beams, bridge deck, and rail). Each respective structural element has an associated risk created by the use of deicers and the related destructive forces created by the corrosive nature of the agents. Review of bridge components that exhibit the most risk and damage are contained in the following sections.

Decks

Bridge decks, especially overhangs and joints, are at great risk of incurring deicer related damage. When evaluating design loads, overhangs exhibit the greatest levels of stress in the deck design. Overhangs also store snow pushed by plows. The snow pushed by plows is typically laced with deicers, possibly saturating our high-stress areas with corrosive chemicals. Steel under stress corrodes at an accelerated rate, so storing snow on overhangs is not an ideal situation. The damage begins when the snow melts and concentrates the corrosive forces in the deicing agents in the overhangs. To prevent as much damage as possible, wash the deck when the temperatures rise and snow season is over. Washing helps in two ways: 1) It physically removes remaining chemicals; and 2) It dilutes any chemical residues, reducing their corrosion potential.

Joints

These are positions in the deck that allow thermal contraction and expansion to occur. If joints are not maintained, then runoff will fall through them. Typically, snow melt runoff is

concentrated on the low side of the structure. Snow melt is particularly brutal because it is laced with chemical agents concentrated in one area and flows for extended periods of time (length of meltdown). This combination of concentrated flow combined with corrosive agents subjected to extended exposure allows for corrosion damage to initiate and progress. TxDOT prefers bridge joint inspection and cleaning to be performed in the spring and reinspection to occur prior to the beginning of snow season. This fulfills the six-month bridge inspection criteria requirement in accordance with the *Maintenance Operations Manual*.

Beams

These exhibit increased risks to corrosion due to cover reductions, high-stress steel design, and concentrated chemical solution saturating end zones when joint seals are broken. Maintenance personnel should repair and maintain joint systems ensuring the protection that the sealed joint systems had created.

Caps

Bridge caps support the superstructure and are the elements on which the beams are supported. Chemical damage occurs to caps when the sealed expansion joints fail and the concentrated chemical solution either falls from the deck through the joint to the cap, or it travels through the joint down the beam to the cap. Contamination and damage to the cap can be accelerated when caps are finished flush and the chemical solution is allowed to pond on the cap. Maintenance personnel should take care of the joint systems, eliminating the possibility of chemical solution saturating this structural element. If joint systems have failed, or are designed as an open system, caps should be washed at the end of snow season.

Columns

These attach the foundations to the cap that support the beams. Chemical damage occurs when expansion joints fail and chemical solution flows through the expansion joint, down the beam, down the face of the cap, and down the column. If chemical stock piles are stored next to bridge structures, the corrosive forces of the chemicals will induce damage to the columns. To eliminate chemical damage to columns, do not store chemical materials next to columns and maintain and repair bridge joints.

Testing

TxDOT developed the *Departmental Material Specification DMS-6400,* modeled after the Pacific Northwest States specification, to ensure the quality of chemical treatment products (anti- and deicers). *DMS-6400* describes the requirements, testing methodology, and a Quality Monitoring Program (QMP) for $MgCl_2$ and $NaCl_2$. CMA and KAc are used in Texas in smaller quantities. These and other materials must be tested prior to use, in accordance with TxDOT standards.

To be considered for inclusion in the department's QMP, a producer of $MgCl_2$ and $NaCl_2$ products must contact the Materials and Pavement Section of the Construction Division (CSTM) and submit a sample for evaluation. The sample must include test results from an independent laboratory indicating compliance with the requirements set forth in *DMS-6400*. After evaluation

and specification compliance, the producer and material will be included on the Material Producer List (MPL). A district may purchase any product listed on the MPL with only verification sampling advised. Those products not on the list will require full independent lab testing and CSTM verification before application. The following properties are verified at the CSTM laboratory:

- Corrosion.
- Sulfate.
- Percent total settleable solids.
- Percent solids.
- Specific gravity.
- pH.

These tests were developed to ensure an environmentally sound material. Results from chemical properties are to be submitted every time material is ordered and delivered. All material supplied must include the following documentation:

- Current, clearly legible Material Safety Data Sheet (MSDS).
- Clear documentation of its percentage of concentration of $MgCl_2$.
- An application rate table that clearly states the manufacturer/vendor/supplier recommended rate for the various conditions of use at the place of delivery.
- Shelf life of material.
- A Friction Analysis Report on all products.

Any certified lab that is set up to run the test as a function of humidity and for the type of roadway [asphalt or concrete] specified may perform the test. Required information includes:

- Hard data.
- Graphical analysis.
- A write-up about the product, typically with comparison information.
- Information on how low temperatures will affect storage of liquid material.
- Clear documentation on proper storage.
- Certification that any $MgCl_2$ supplied meets test methods shrp-h-205.2 for effectiveness (strategic highway research program handbook of deicer test methods).

When materials are delivered, it is very important that a TxDOT representative visually inspect the load for any obvious reasons for rejection. For example, no precipitates in liquid products are allowed in excess of the specification limits. Material portraying these or other uncharacteristic traits when delivered may be immediately rejected at the option of the engineer or representative at the delivery location. In addition to verifying that a delivered liquid chemical meets the current specification, the inspector can have two additional simple and inexpensive tests (viscosity and specific gravity) done at the district level to determine whether the right liquid chemical is delivered. The *viscosity test* provides useful information that clearly indicates the chemical concentration of the liquid chemical. *Specific gravity* is a quick and

simple verification acceptance test. For more information on quality control testing, contact the Materials and Pavement Section of the Construction Division (CSTM).

ANTI-ICING CHEMICAL AND APPLICATION

Unlike deicing operations that are performed following a winter weather event to break the bond of snow and ice and eliminate the buildup on the roads, anti-icing operations are conducted to prevent the formation or development of bonded snow and ice for easy removal. Anti-icing involves pre-treating a road **before** the freezing weather or storm arrives with the goal of limiting or preventing the buildup of ice. Successful anti-icing efforts require accurate timing and good judgment about when and where to treat, relying on weather forecasts, field sensors, and in-field measurements or observations to predict when a storm will hit and its severity.

TxDOT commonly uses MeltDown 20™ to prevent ice from forming on bridges and overpasses. Recommended application practices include the following:

- When moisture is present and freezing temperatures are possible, MeltDown 20 should be applied to bridges and overpasses. Make applications **prior** to the temperature reaching freezing to prevent ice forming.
- If the temperature drops below freezing point, begin treatment applications at steep grades, sharp curves, intersections, and other points where the hazard is greatest.
- Treatment should continue as long as precipitation continues to fall. The interval allowable between treatments will vary, depending on the rate of precipitation and traffic, but should be not be longer than 4 hours.

Anti-icing can be more effective when coupled with the Roadway Weather Information System (RWIS). An RWIS helps to make informed decisions about when and where to deploy materials, crews, and equipment. While an anti-icing strategy coupled with an RWIS can be beneficial, there are some drawbacks associated with RWIS:

- High initial cost.
- Potential for premature and/or unnecessary application of materials.
- Insufficient sensors/stations and the incompatibility of RWIS platforms.
- Over-application of chloride-based chemicals can result in slick pavement.
- High maintenance and upkeep costs.

Anti-icing application systems can be either mobile truck-mounted spray rigs, capable of covering large areas where needed, or fixed spray systems that will treat specific problem locations. Both use a chemical that can lower the freeze point of water, requiring a storage tank for the chemical. Although personnel generally use a 6,000-gallon capacity tank with agitation and circulation capabilities, they also accept other sizes, depending on specific local needs and conditions.

The equipment for a mobile system consists of a truck-mounted tank with a spray boom and controls for accurate calibration. Cost-effective dual herbicide/anti-icing spray units have been

designed and built. In such dual-use systems, note that the chemicals used for anti-icing can be corrosive, thus requiring thorough cleaning of the system in between seasons. Commercial vendors can supply a large variety of types and size rigs suitable to the section's needs. GSD purchases major equipment for all snow and ice control methods.

MATERIALS AND SUPPLIES

Materials and supplies to support winter weather response commonly include replacement parts, ancillary personnel supplies, and anti- or deicing bulk materials. To support effective equipment operation, replacement parts and equipment may be required. When immediate repairs are needed and new parts are not readily available, districts may purchase used repair parts under small purchase or emergency authority (as appropriate).

Additional ancillary personnel supplies intended to keep them safe and their equipment functional should not be overlooked when preparing for winter weather response. Appropriate quantities of items such as gloves, storm suits, other personal protective equipment, flashlights and batteries, windshield deicer, and wiper blades should be kept on hand to adequately respond to each event. If a winter weather event is expected to result in TxDOT personnel working outside their area or in another district, maintenance supervisors should request DART cards for their employees to pay for rooms and meals.

Anti- and deicing materials are obtained using a blanket bid master and the open-market method of purchase. GSD will survey districts and initiate annual statewide blanket purchases of anti- and deicing materials. Statewide blanket purchases include rock salt, CMA, and magnesium chloride (liquid and solid). In situations where the open-market method of purchase is not appropriate, districts may use small purchase procedures. If an emergency situation requires the purchase of anti-/deicing material, districts will follow the procedures for an emergency purchase. Table 6-5 provides a snapshot of the winter weather chemicals and materials inventory that the regional service centers have reported for their districts as of September 2011.

Table 6-5. Fiscal Year 2011 Inventory of Winter Weather Chemicals and Materials.

Chemicals & Materials	Districts																								
	ABL	AMA	ATL	AUS	BMT	BWD	BRY	CHS	CRP	DAL	ELP	FTW	HOU	LRD	LBB	LFK	ODA	PAR	PHR	SJT	SAT	TYL	WAC	WFS	YKM
Aggregate: Bottom Ash; Pit Run (Fine)	X	X																							
Aggregate; Bottom Ash; Pit Run, (Coarse), ASTM C 136-92		X						X																	
Aggregate; Concrete; I#421, Fine, Grade 1				X							X				X		X		X	X	X	X	X		
Aggregate; Concrete; I#421, Fine, Grade 1 (2004 Spec)	X			X			X				X		X				X		X	X			X		
Aggregate; Ice Control; Coarse Btm Ash and Salt Mixed F		X																							
Aggregate; Ice Control; Fine BTM Ash and Salt Mixed F/I		X													X										
Aggregate; Ice Control; Remixed Sand/Chloride Mix												X													
Aggregate; Ice Control; Remixed Sand/Grade 5 Aggregate																							X		
Aggregate; Ice Control; Remixed Sand/Salt								X			X	X	X												
Aggregate; Sinter Material; By Product from Crushed Stone						X																			
Aggregate; Surface; Crushed Limestone Screening Material		X													X					X					
Aggregate; Surface; I#302, Blotter Sand, Grade-Spec									X																
Aggregate; Surface; I#302, Type A, Grade 5 S, (2004 Spec)																						X			
Aggregate; Surface; I#302, Type B, Grade 5-Mod	X		X																		X	X			
Aggregate; Surface; I#302, Type B, Grade 5 (2004 Spec)	X	X	X	X				X	X					X	X	X		X	X		X	X	X		X
Aggregate; Surface; I#302, Type B, Grade Special	X									X		X												X	
Aggregate; Surface; I#302, Type B, Grade Special (2004 Spec)	X								X	X	X	X		X			X						X	X	X
Aggregate; Surface; I#302, Type E, Grade 5-Mod			X	X	X				X				X								X	X			
Aggregate; Surface; I#302, Type E, Grade 5 (2004 Spec)	X			X			X		X				X	X	X	X				X	X				X
Aggregate; Surface; I#302, Type L, Grade 5 (2004 Spec)					X	X	X	X		X				X		X		X				X		X	
De-Icer; Liquid Solution, 50% Potassium Acetate																		X							
De-Icer; Roadway; 100% Calcium Mag Acetate, 2205 LB/Bag		X		X						X										X		X	X		
De-Icer; Roadway; 100% Calcium Mag Acetate, 55 LB/Bag	X					X	X			X								X		X		X	X		
De-Icer; Roadway; 40% Calcium Mag Acetate-60% Salt, 2250 LB																					X		X		
De-Icer; Roadway; 89% Mag Chloride, 11% Corrosion & Dus	X	X		X		X	X	X		X	X	X	X		X		X			X	X	X		X	
De-Icer; Roadway; 89% Mag Chlorine, 11%, 50LB/Bag, Corr	X	X		X				X		X	X	X			X		X	X		X				X	
De-Icer; Roadway; Complex Chloride with Corrosion and D	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X		X		X	X	X	
De-Icer; Roadway; Crystals, 20lb Moisture Proof Bag								X																	
De-Icer; Roadway; Liquid Magnesium Chlorine w/Corrosion	X	X	X					X		X	X	X	X		X					X	X			X	
De-Icer; Roadway; Liquid Solution, 50% Potassium Acetat																					X				
De-Icer; Roadway; Liquid Solution, Magnesium Chloride									X			X													
Salt; Sodium; Chloride, 50 LB. Bag, Road Maintenance	X			X		X		X		X	X	X			X		X							X	
Salt; Sodium; Chloride, for Highway Maintenance		X	X					X		X		X			X		X	X						X	

REPORTING EQUIPMENT, CHEMICALS, MATERIALS AND SUPPLIES

Maintaining accurate inventories of equipment, chemicals, materials, and supplies is challenging, but extremely necessary in order to have an adequate level of readiness during the winter weather season. To facilitate achieving this level of readiness, is the research team recommends that maintenance sections report their equipment, chemicals, materials, and supplies status to the districts and their respective regions on a periodic basis. The proposed systematic reporting of equipment, chemical, material, and supply inventories provides visibility of these assets to all levels within the organizational structure. As a general guideline, researchers recommended that the maintenance sections report inventory information at least three times a year (e.g., prior to, during, and after the winter weather season). Although the length of winter season may vary greatly by geographical regions within Texas, the reporting periods should be consistent across the different districts. Table 6-6 provides guidance on the submission of equipment, chemical, and material and supplies inventory data both within the district and to the region.

Table 6-6. Recommended Equipment, Chemical, Material and Supply Inventory Reporting Schedule.

Item	Report From	Report To	Due Dates
Equipment Inventory	Maintenance Section Supervisor	Director of Maintenance	October 1 January 1 April 1
	Director of Maintenance	Region Fleet Manager	
Chemical Inventory	Maintenance Section Supervisor	Director of Maintenance	October 1 January 1 April 1
	Director of Maintenance	Region Fleet Manager	
Materials Inventory	Maintenance Section Supervisor	Director of Maintenance	October 1 January 1 April 1
	Director of Maintenance	Region Purchasing Manager	
Supplies Inventory	Maintenance Section Supervisor	Director of Maintenance	October 1 January 1 April 1
	Director of Maintenance	Region Purchasing Manager	

CHAPTER 7: MULTI-DISTRICT AND SELECT METROPOLITAN OPERATIONAL PLANS

INTRODUCTION

Management of winter weather operations and resources from a regional or large metropolitan area perspective requires a significant amount of coordination to occur within and across district boundaries. The nature of these operations can involve two or more districts within the same region, across different regions, or across different metropolitan areas. Also, these operations will require utilizing a common operating framework that is supported by combining facilities, equipment, personnel, procedures, and communications capabilities. The remaining sections of this document will describe the five key management functions vital to multi-district and metropolitan operational plans, response activities that are useful during and immediately after the storm event, and provide a capitulation of the operational plans implement in five metropolitan areas (Austin, Dallas, Fort Worth, Houston, and San Antonio).

FIVE MAJOR MANAGEMENT FUNCTIONS

Engaging in a multi-district and metropolitan operational plan for winter weather operations begins when one district engineer (DE) informs another that assistance (personnel and resources) is needed in battling a winter storm event. The winter storm event escalates to this level because of its intensity, duration, or both. Once it has been established that assistance from a "call up" is confirmed, at this point the DE that initiated the notification assumes the role of the host (supported) district and the DE (or Des) that agrees to assist will assume the role of the visiting (supporting) district. Establishing this chain of command is important because it helps to further define the roles, responsibilities, and functions of all components associated with responding to multi-district and metropolitan-level operations. Below are five major management functions vital to having the operational chain of command integrate into a unified organizational structure for coordinating and supporting large scale winter weather events (*44*, *45*).

- **Incident Commander (Host/Supported DE).** Establishes command, works to protect life and property, sets objectives and priorities, and directs overall management of emergency response activities. The Incident Command role can be transferred to another individual (e.g., director of maintenance) depending on the event as they arrive on the scene.
- **Planning.** In small emergencies, the incident commander (IC) is responsible for leading the planning effort; in a larger emergency, the IC establishes a Planning Section. Planning develops the action plan to accomplish the objectives, collects and evaluates information as related to the development of an incident, and maintain status of resources.
- **Operations.** Directs all resources and are usually the respective area offices and maintenance sections responsible for carrying out response activities according to established district snow and ice control plans.
- **Logistics.** Is responsible for communications, as well as securing and providing needed materials, resources, services, and personnel. This section may take on a major role in extended storm events.

- **Administration/Finance.** The Administration/Finance section is critical for tracking storm event costs, providing procurement assistance, performing cost analysis, and for reimbursement accounting. This is especially important in tracking costs where a state or federal "disaster area" may be declared.

Figure 7-1 shows that, once these five management components are in place, it is imperative for the chain of command to establish a common operating framework that is responsive to combining facilities, equipment, personnel, procedures, and communications capabilities. In some ways, this is similar to that of a single district operation involving multiple maintenance sections. The major difference is that the span of command and control is now extended to include the assignment of additional temporary forces and resources that may or may not be familiar with the area they have been deployed to as well as personnel they will work with. With this said, the next step is to employ response activities geared toward ensuring that multi-district and metropolitan winter operations during and immediately after the winter storm event subsides.

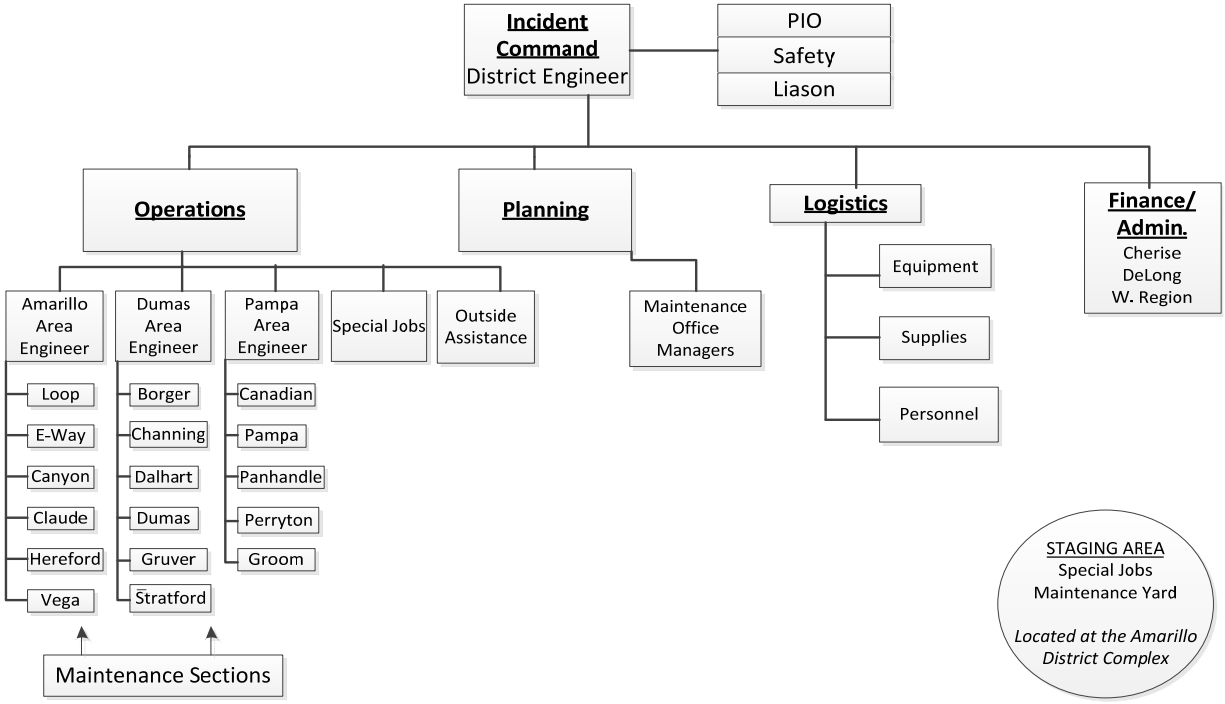

Figure 7-1. Management Functions for Multi-District and Large Metropolitan Operational Plans–Amarillo District (*35*).

RESPONSE ACTIVITIES

Command and Control

For winter storm events that have grown to the point of having forces and resources to be deployed in to fight it, the main command structure will now involve both the host (supported) district and the visiting (supporting) district personnel. The host (supported) district DE will command, control, manage, and be responsible for all resources and personnel operating in his/her respective district. The host (supported) district DE will activate a district-level emergency operating center (EOC) and will include key district staff involved with winter weather response. This district-level EOC is at a lower level than regional EOCs. At a minimum, the EOC should involve the director of maintenance, director of operations and the district maintenance administrator or other designated staff involved in the high levels of maintenance operations at the district. The host (supported) district EOCs should serve as the central point for communication and coordination between TxDOT, regional, state and local law enforcement agencies, local fire and rescue agencies, local emergency medical services (EMS) agencies, local transportation agencies, private towing organizations, the news media, and other state DOTs during a winter weather event. Representatives from each of the various primary response agencies should report to this EOC, thus enhancing the host (supported) district's ability to have decisions made in coordination with the local agencies as well as quickly respond to trouble spots. Lastly, the public information officers (PIOs) from the host (supported) district should coordinate a rotating shift schedule so that at least one PIO is available at all times during a storm event to conduct media interviews (*46*).

Moreover, the host (supported) maintenance section EOC will activate and become operational under the guidance of the maintenance section supervisor. When it becomes necessary to move manpower and equipment from one supervisor's area to another, the director of maintenance should be contacted to coordinate the movement of equipment from one area to another with the input from the maintenance section supervisors. The maintenance section supervisor will take the request for personnel tasking, coordination, and communication guidance from the host (supported) district DE or director of maintenance and use it to establish both a district-wide coordination and district-wide tracking effort for where equipment and manpower should be located. As a rule of thumb, the district and maintenance section EOCs remain activated as long as necessary to effectively respond to the winter weather event.

At a regional level, an EOC should be set up to help direct large scale winter weather response operations that affect multiple districts and large metropolitan areas. At a minimum, the following individuals should be actively involved in the EOC:

- Regional key personnel (e.g., fleet managers, purchasing manager) involved with winter weather equipment, chemicals, materials, and supplies.
- Directors of maintenance of various districts within and across regional boundaries.
- Directors of transportation operations of various districts within and across regional boundaries.

The Regional EOC should be held at a facility that provides capabilities for communication among all stakeholder agencies in emergency winter operations.

Coordination and Communication

The coordination and communication that must take place between response personnel internal and external to TxDOT is essential to the success of these winter weather response actions. During multi-district and large metropolitan operations, the host (supported) district EOC will serve as the central point for internal communication and coordination between maintenance sections, with other districts, with regional service centers, and with TxDOT headquarters, as required. Also, the host (supported) district EOC will communicate and coordinate between TxDOT and external agencies involved with winter weather management. For significant winter weather events during multi-district and large metropolitan operations, the research team recommended that coordination procedures internal and external to TxDOT use the host (supported) district EOC to support centralized communications. Figure 7-2 is an example of the communication flow proposed for multi-district and large metropolitan winter weather operations.

Internal to TxDOT

- Maintenance supervisor—Activate and manage winter weather response within their section.
- Area engineer—Coordinates area response including movement of personnel and equipment as required and informs the director of maintenance when this is done.
- Director of maintenance—
  - Coordinates district response including movement of personnel and equipment between areas as required and informs the district engineer when this is done.
  - Coordinates with other agencies and responds to requests for assistance under the direction of the Texas Department of Public Safety (DPS) Disaster District Committee Chairman.
  - Activates and operates the District Emergency Operations Center (EOC) when necessary.
- Director of transportation operations—Coordinates placement of portable changeable message signs (PCMSs) and appropriate messaging on PCMSs and Dynamic Message Signs (DMS) throughout the affected district.
- Public information officer—Responds to media requests, issues press releases, and distributes information via email and other methods as appropriate.
- District engineer (or designee)—Coordinates with other districts including requesting or responding to requests for outside assistance (personnel, equipment, etc.).

Other recommended coordination procedures internal to TxDOT are:

- Four hours prior to the anticipated winter weather event and subsequent compromise in public safety (e.g., onset of freezing pavement conditions), the host (supported) EOC should be fully staffed and equipped to perform its role in coordinating winter weather response operations.
- All Maintenance Section offices should update their operational status at least every 4 hours or as major events (such as vehicular crashes or increased storm intensity) result in significant changes to their planned operations.
- At each 12-hour shift change, each Maintenance Section office should update their shift

roster and equipment and materials inventory. It is understood that during the winter weather event, the accounting for materials used will be estimated; however, an accurate accounting will be made as part of post-storm procedures.

- If at any point during the response, any Maintenance Section office needs additional materials, personnel or equipment, they must submit a request to the EOC. The host (supported) district EOC staff, with the assistance of their respective Regional Service Centers, will locate whatever additional resource necessary and task those resources with assisting the requesting maintenance office.
- The host (supported) EOC should be contacted when it becomes apparent that a road section will need to be closed because of unsafe weather-related conditions. The host (supported) EOC will then notify DPS or local law enforcement jurisdictions of the pending closure. The host (supported) EOC will also advise TxDOT's PIO. For highways crossing district lines, the closure should be coordinated with the appropriate neighboring district counterparts.
- Each Maintenance Section office should report to the host (supported) EOC when winter weather response operations have ceased in their area. As each office reports the cessation of winter weather operations, the host (supported) EOC will determine if the reporting office's resources are needed in another location. If not, the reporting office will be authorized to stand down. Once all offices have ceased winter storm operations, the host (supported) EOC will be deactivated.
- When possible, use one point of contact for communication with maintenance sections to provide better coordination of information across the district.

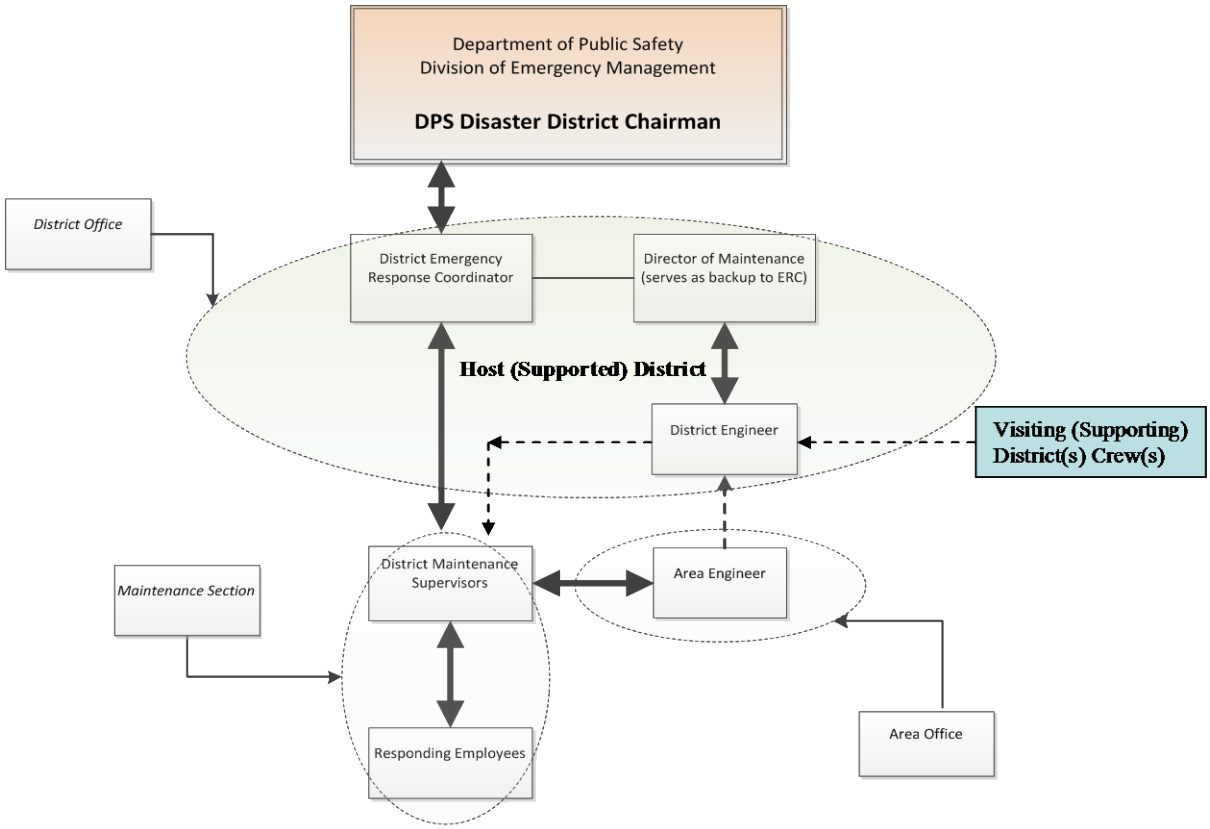

Figure 7-2. Communication Flow Chart for Multi-District Winter Weather Operations.

External to TxDOT

Several key steps should be taken to improve the communication and coordination between TxDOT and external agencies involved with winter weather management.

- Activate visiting (supporting) district and/or regional EOCs and implement ICS involving stakeholder agencies involved with winter weather operations management.
- Activate visiting (supporting) maintenance section EOCs and implement ICS at the maintenance section.
- Initiate communication protocol between maintenance section and local law enforcement and other local stakeholder agencies involved with winter weather operations management.
- Maintain communication with key stakeholder agency representatives throughout the duration of winter storm event.

Moreover, incoming weather information is critical to the success of winter weather operations, particularly during an ongoing winter storm event. The various sources of information should be monitored regularly to ensure that all decision makers and personnel participating in winter weather operations are armed with the latest weather forecasts to make the best decisions regarding the use of equipment, materials, and personnel. Also, this will allow for any control actions such as road closures to be considered at the appropriate time. A brief explanation of advisory actions, response personnel, motorist notification, and the role of TxDOT's PIO is provided.

Advisory Actions

When all available preventative measures have been taken and the winter weather event still threatens public safety, notification or advisory actions are required. Providing a common set of definitions and terminology to ensure a consistent understanding of the severity of the event, the National Weather Service distinguishes the following severity levels for winter weather event notification:

- Winter Storm Watch—Issued when conditions are favorable for developing hazardous winter weather; usually issued 24–48 hours in advance. These conditions may occur singularly, or in combination with others.
- Advisory—A weather condition that is an inconvenience to people outdoors or can produce difficulty in travel.
- Winter Weather Advisory—Issued for sleet, snow, freezing drizzle/rain or blowing snow, sleet accumulations are expected to be less than one half of an inch snowfall of two to five inches in 12 hours, light accumulations of freezing drizzle or freezing rain blowing snow intermittently reducing visibility to one quarter of a mile.
- Warning—A weather condition that is life-threatening to those caught outdoors.
- Blizzard Warning—Sustained wind or frequent gusts of 35 mph or more, considerable falling snow, and blowing snow frequently reducing visibility to one-quarter mile or less, conditions last three hours or more.
- Winter Storm Warning—Issued when life-threatening winter weather conditions are

imminent or very likely includes the occurrence of combinations of snow, ice, wind, and cold.

Notification or advisory actions are directed toward 1) other personnel involved in the management of or response to adverse weather events, including state and local law enforcement; and 2) the motoring public. These two audiences require different procedures, sets of information, and levels of detail regarding the winter weather event to appropriately respond.

Response Personnel

The first responder made aware of an observed or anticipated winter weather event is responsible for notifying or advising response personnel from other agencies. For example, if a DPS officer discovered an icy bridge deck or a low water crossing that was at or near flood-stage, the officer would notify DPS dispatch who, in turn, would notify TxDOT's dispatch and other affected agencies. Notification methods among field response personnel generally include the use of radios, pagers, facsimiles, or landline, cellular, or satellite telephones. To respond more effectively to a winter weather event, field response personnel internal and external to TxDOT rely on detailed information regarding the nature and extent of the event, involvement of other response personnel and agencies, and the current status of the event.

Additionally, winter weather notification among response agencies can improve access to the affected area for field responders, support appropriate personnel and equipment dispatch, and improve responder safety by alerting them to potentially dangerous conditions. During larger winter weather events, agency administrators should also be notified and notification priorities consistent with the severity and extent of the winter weather event should be established. For example, localized winter weather events may require notification of only lower level administrators from TxDOT, DPS or local law enforcement agencies, and local fire and rescue agencies. As the severity and extent of the winter weather event increases, the involvement of higher level administrators may be required. Telephone contact lists for first (low-level administration), second (mid-level administration), and third (high-level administration) priority notifications are recommended.

Motoring Public

Notification or advisory actions are also required to ensure the safety of the motoring public. To ensure motorist cooperation, notification or advisory actions should:

- Advise motorists of the nature and extent of the problem so that they may make intelligent choices about alternative routes or delayed trip departures.
- Provide information on possible courses of action such as alternative routes.
- When motorists are required to take certain actions (e.g., change lanes, reduce speed, or divert), describe those actions clearly.

Target audiences include motorists who are in the affected area, approaching the affected area, or not yet departed from work, home, or other location. Table 7-1 presents a number of different traveler information tools and strategies that are available to relay critical winter weather event advisories to each of these audiences.

TxDOT's PIO will be responsible for managing all communications with the media and the public. Traveler information should be provided as early in the winter weather event process as possible and should continue until the threat has cleared.

Table 7-1. Traveler Information Tools and Strategies by Audience.

TRAVELER INFORMATION TOOL/STRATEGY	MOTORISTS		
	In the Affected Area	Approaching the Affected Area	Not Yet Departed
Static Signs with Flashers	X		
Dynamic Message Signs (DMS) or Portable Changeable Message Signs (PCMS)	X	X	
Highway Advisory Radio (HAR)	X	X	
Telephone Hotlines	X	X	X
Highway Condition Reporting System (HCRS) Website	X	X	X
Commercial Media Broadcasts	X	X	X
Social Media (Facebook, Twitter)	X	X	X

Implement Deployment and Redeployment Plans

When engaging in multi-district and large metropolitan operations, employing a "just-in-time" philosophy is ideal to ensuring your resources will be where and when they are needed most. Also, synchronizing the deployment and redeployment forces will ensure that the operation has the necessary "footprint" to be effective in responding to the winter weather event. Table 7-2 shows the layout of actions needed for establishing a foundation on which the multi-district and large metropolitan operational structure can successfully work. Also, it can serve as a general checklist for districts and their respective maintenance sections to use when having to respond to multi-district and large metropolitan winter weather operations.

As the operation progresses and the additional forces are integrated under the host (supported) district command, the responsibilities and functions of the host (supported) maintenance supervisors and district director of maintenance (or director of operations) will follow the guidance outlined below:

- Maintenance supervisors are responsible for coordinating all activities within their geographic area of responsibility, including the scheduling, dispatch, and care of qualified personnel.
- In anticipation of a winter weather event, appropriate personnel should be placed on "On Call" or "May-Call" status. All personnel vacations will be canceled, as required.
- During an event, rotation of crews is recommended and is left to the maintenance

supervisor's discretion as to how shifts will be divided. Whenever possible, use a continuous operation with two crews rotating every 12 hours until all roadways are clear. As a safety precaution, no employee should work more than 16 hours without a minimum of 8 hours of rest to avoid becoming fatigued. Exceeding the 16-hour threshold is occasionally allowed for non-driving duties and the area engineer may authorize and approve more than 16 hours of shift time by submitting a detailed exception report, in writing, to the district engineer after the event has ended.

- The location, arrival, and departure times of field employees should be tracked to ensure their safety and gain adequate response time to potentially unsafe conditions. If pre-assigned routes are in place, personnel dispatch can be expedited and accomplished without a supervisor giving individual assignments with each event.
- When maintenance crews are unable to cover all roadways and additional manpower is needed, use the resources within the area or district first. TxDOT Area Office personnel who do not possess a Commercial Driver's License (CDL)—including engineers, inspectors, designers, and support staff—can assist with dispatching, manning barricades, or riding with operators during nighttime operations. The area engineer shall coordinate with the maintenance supervisor for the use of area office personnel needed to work during winter weather response operations. If additional personnel within the district are required, the District Maintenance Office must be contacted and informed about the movement of equipment and/or personnel from one maintenance section to another.
- Contact the district director of operations (or director of maintenance) if additional assistance is needed, which requires moving personnel and/or equipment into or from another district. The director of operations or director of maintenance may move equipment and personnel both within and out of the district to concentrate clearing efforts of higher priority routes. The movement of TxDOT assets must be a district-wide and/or region-wide coordinated effort. This includes tracking weather event movement, areas of least and greatest impact, and the location of the needed resources. The director of operations or director of maintenance can activate the local EOC, when necessary, to coordinate the movement of assets between sections and across district lines. During major storms, the EOC will be activated and operate continuously through the duration of the winter weather event under the ICS.
- In extreme instances, it may be necessary to outsource winter weather response activities to supplement TxDOT forces. In these instances, consider using the routine maintenance contracts or purchase of services. Consult the appropriate district and/or division personnel early in the process for these methods of outsourcing to be in effect in a timely manner.

Also, in order for the host (supported) district to maintain the integrity of their organic assets as well as the visiting (supporting) district or maintenance section asset, it is recommended that the host (supported) district lead the field operations activities. This would include being responsible for establishing the lines of communication (LOCs), crew sizes and composition, equipment distribution, safety, control actions, treatment actions, risk assessment, and reporting requirements.

Table 7-2. Deployment and Redeployment for Multi-District and Metropolitan Operations.

Phases / Responsible	Deployment	Field Operations	Redeployment
Host (Supported) District	• Initiate notification and "On-Call" or "May-Call" to personnel • LOCs • Coordination and communication • Risk management	• Prioritize roadways • Determine crew sizes and rotation cycles • LOCs • Equipment • Safety • Control actions • Treatment actions • Risk management	• Safety • Risk management • Reporting
Visiting (Supporting) District	• Initiate "On-call" or "May-Call" to personnel • LOCs • Coordination and communication • Equipment, materials and supplies (if necessary) • Safety • Logistics • Risk management	• LOCs • Equipment, materials and supplies (if necessary) • Safety • Employ control and treatment actions • Risk management	• Excess Equipment, materials and supplies (if necessary) • Safety • Logistics • Risk management • Reconstitute assets • Reporting

Crew Sizes

Determine the crew sizes to use based on the following conditions:

- Type of storm (ice, snow, freezing rain, etc.).
- Travel distances for crew (critical for multi-district, multi-county, and large metropolitan operations).
- Available personnel.
- Experience of personnel (with equipment, materials, and general winter weather response process).

When determining crew makeup and sizes, consider the following:

- Pair experienced staff with inexperienced operators.
- Include equipment technicians with crews for long distance travel.
- For cross district travel (or other long distance travel), reduce convoy sizes to improve response time.

At a minimum, consider the issues discussed above in determining crew sizes. If the intensity of a storm increases, additional steps can be taken regarding crew.

- Contact district administration coordinator to request district emergency staff to support maintenance section operations.
- Coordinate with the district to determine additional crew support from neighboring districts.

Equipment

Maintenance supervisors are responsible for deploying winter weather equipment as needed. Their deployment decision should be based on local weather conditions, including:

- Current and predicted weather conditions.
- Equipment type and quantities.
- Available personnel including experience of personnel in various aspects of winter storm. operations.
- Personnel.

The area engineer coordinates movement of equipment between maintenance sections. However, input from the district is required for any movement of equipment and personnel to neighboring districts and counties.

Safety

The two groups of people to be considered during safety checks are the maintenance crew (including other agency staff involved in winter weather response process) and the traveling public. The following measures should be taken to ensure the safety of maintenance staff as during any response process to winter weather events.

- In adverse weather, employees should communicate periodically with the dispatcher during operations and relay their location, especially when changing roads.
- As noted previously, operator fatigue is a significant safety concern. The maintenance supervisor will be responsible for determining when an employee is to be relieved. The maintenance supervisor shall immediately relieve any employee that notifies him that he is tired and needs to be relieved. Employees are expected to be honest in assessing their ability to continue to work safely, prior to the beginning of and for the duration of response.

Moreover, the maintenance supervisors and district maintenance administrator should evaluate the potential risk or benefit of the winter weather response and conduct operations accordingly. When conditions are so severe (e.g., extremely high winds with whiteouts) that attempting to improve road conditions is hazardous for both the public and equipment operators, response operations may be suspended temporarily until conditions improve.

Control Actions

Control Actions are designed to provide the district maintenance staff with a means of maintaining drivability on roadways while ensuring the safety of both first responders and district staff as well as the traveling public. Control actions include route prioritization, deploying alternate routes, and ensuring traffic signal operations are altered to accommodate re-routed traffic patterns.

Road Closures. The host (supported) districts should aim to keep the roadways open for as long as possible. Coordination between host (supported) district and DPS and local law enforcement is crucial in ensuring successful road closure actions and in reducing the threat of accidents due to slick roadway surfaces. In the event that local authorities request that a state maintained roadway be closed, the following procedures should be considered:

- DPS or local law enforcement with jurisdiction should be responsible for closing a roadway with significant input from the host (supported) district or maintenance section supervisors. In situations where TxDOT disagrees with the DPS or local law enforcement on the road closure, DPS will make the final decision.
- For highways crossing district(s) or state line(s), the closure should be coordinated with the appropriate counterparts *in advance* of the storm and during winter weather response.
- The closed roadway should begin and end within city limits or at major intersections to ensure that motorists are not stranded within the limits of the closed roadway.
- Where practical, signs should be erected to advise traffic
- The closed roadway section should continue to be patrolled, plowed, and salted by maintenance section personnel according to established priorities and with the goal of reopening the roadway as soon as possible. This will also help ascertain that no one is stranded in the closed section.
- Give notice to all news media and appropriate officials.
- The road closure should be noted on HCR and removed when the roadway is reopened.

Alternate Routes. Oftentimes, adverse winter weather affects a broad geographic area, limiting the availability of safe alternate routes. Certain roadway geometric design features, however, can make select roads in a region impassable during a winter weather event while others may continue to be safe. For example, at-grade roadway alternatives may be favored over routes with elevated direct connector ramps or bridges under adverse weather conditions.

Appropriate alternate routes intended for public use are often difficult to identify, and require associated diversion plans to be effective. During a winter weather event, motorists may self route or be directed to an alternate route by response personnel. Not all routes may be able to accommodate all traffic types; in particular, heavy truck traffic can be a problem. The designation of alternate routes can be politically charged; buy-in from all affected jurisdictions is required. When county or city roadways are utilized as alternate routes, appropriate jurisdictions should be notified immediately so that they may adjust to accommodate the additional traffic flow.

When available, alternate routes have the potential to reduce traffic demand and subsequent crash exposure along affected routes and maintain mobility and reduce frustration for the motoring public. As part of the planning for winter weather response, districts should designate appropriate alternate routes should there be a need for road closures and plan for associated diversion plans.

In considering alternate routes, the following should be noted:

- For interstate highway section closures, consider treating frontage roads and using them as alternate routes for highway travel.
- Consider at-grade roadway alternatives if elevated direct connector ramps or bridges are not adequately treated.
- Truck traffic requires sufficient infrastructure that can support heavy loads and accommodate larger vehicle dimensions. Bridge and overpass structures are commonly limiting factors along potential alternate routes. In such instances, distinct alternate routes may be identified for passenger car and truck traffic.

Traffic Signal Systems. To accommodate detoured traffic along alternate routes, responsive traffic signal control (RTSC) systems or modified traffic signal timing plans can be used. RTSC systems use algorithms that perform real-time optimization of traffic signal splits, offsets, phase lengths, and phase sequences based on current traffic conditions, demand, and system capacity to minimize delay and reduce the number of vehicle stops. System technologies "sense" the increased traffic demand using electronic loops, video imaging, or microwave sensors and automatically adjust the signal timings to improve traffic flow. The effectiveness of RTSC systems is dependent on the geographic extent of the system, the performance of the algorithms in responding to real-time traffic conditions, and the effort expended in maintaining the system to ensure ongoing functionality.

In the absence of RTSC systems, the use of alternative or modified traffic signal timing plans during winter weather events can effectively improve traffic flow by providing additional green time along designated alternate routes. Most traffic signal controllers allow multiple programs to

be set. Response personnel can override the normal program manually, or in some cases the timing may be set remotely from a TMC. Alternate route signal timing plans can be developed in conjunction with alternate route plans.

Treatment Actions

There are two distinct snow and ice control strategies that have been gaining popularity and show promise in making use of chemical freezing-point depressants: deicing and anti-icing. Anti-icing operations are conducted to prevent the formation or development of bonded snow and ice for easy removal, while deicing operations are performed to break the bond of snow and ice and eliminate the buildup on the roads.

Pre-Wetting. Pre-wetting of dry ice and snow treatment material before application on the road surface reduces the scattering of the dry materials off the roadway lanes. This can do two things:

- If the material is chemical, it increases the potential for the material to stay on the road surface and remove the bonding between the ice/snow to the road surface.
- Prewetting increases the friction that abrasives have caused by allowing these materials to remain longer on the road surface. As a result, it also reduces the potential for skidding of vehicles.

Anti-Icing. Anti-icing involves pre-treating a road **before** the freezing weather or storm arrives with the goal of limiting or preventing the buildup of ice. Successful anti-icing efforts require accurate timing and good judgment about when and where to treat, relying on weather forecasts, field sensors, and infield measurements or observations to predict when a storm will hit and its severity.

Deicing. Deicing methods generally involve the use of chemicals to speed the melting process after snow pack or ice has formed on a road. Liquid chemicals with similar spray equipment can be used for deicing, provided they can be applied at sufficient pressure to cut though the ice or snow pack. Caution must be exercised during deicing since spraying liquids on top of the pack may cause the road to become slick. Using dry solid chemicals and pre-wetted abrasives in conjunction with deicing will speed the melting of the snow and ice pack. This practice will improve the deicing process and reduce the time it would take to melt naturally.

Moreover, both the host (supported) and visiting (supporting) districts and maintenance sections are responsible for performing a risk assessment for any work activity that engages their employees. The factors to consider are discussed, and submitting a risk assessment analysis for each phase of the deployment and redeployment plan is necessary.

Risk Management

This is the process of identifying, assessing, and controlling risks arising from operational factors and making decisions that balance risk costs with mission benefits. A preliminary risk assessment should be performed to identify any risks associated with the group of individuals involved in responding to the storm event or affected by the storm event.

- **Level of risk to traveling public:** Outline the level of risk that an incoming storm posed to the safety of the traveling public.
- **Level of risk to safety of maintenance crew**: Outline the level of risk an incoming storm posed to the safety of maintenance field crew. Include the potential for handling hazardous materials.
- **Level of risk to safety of other emergency personnel:** Outline the level of risk that an incoming storm posed to the safety of first responders. Include the potential for handling hazardous material.
- **Level of risk to economy:** Outline the level of risk an incoming storm posed to the local economy of the region, district, or county.
- **Level of risk to environment:** Evaluate the potential impacts to the environment that not only a particular storm posed, but also the response operations, particularly the use of chemical materials and abrasives.

The steps to employ when assessing risks are:

- **Step 1. Identify hazards**: Outline the hazards that the incoming winter storm posed. Each type of winter storm will have its own hazards. For instance, the hazards associated with snow weather is different from one associated with sleet.
- **Step 2. Assess hazards to determine risks**: Outline the risks associated with each hazard. For instance, the risks that snow weather posed vary significantly in a district that is unfamiliar with snow weather as compared to one that regularly deals with snow.
- **Step 3. Develop controls and make risk decisions**: Identify the controls (tools) available to the district to deal with the incoming weather. Again, this depends on several factors including the number, skill, and expertise of personnel; the available winter weather equipment; and the communication sophistication of the EOCs.
- **Step 4. Implement controls**: This involved deploying the planned winter weather management procedures in the District Snow and Ice Control Plan.
- **Step 5. Supervise and evaluate**. Constant monitoring of winter weather operations is critical in ensuring the success of the response operations to winter weather.

Reporting

Reporting is an important but often overlooked component of a good overall winter weather response plan. Effective reporting procedures help to accomplish several goals that are important to TxDOT:

- Providing timely and accurate information to the public—public awareness of current roadway conditions can be a potentially life-saving service.
- Providing a basis for departmental actions when responding to the media, public complaints, or litigation.
- Supporting efforts of TxDOT supervisors and managers to plan for future winter weather events or obtain assistance in repairing damage to roadways as a result of winter weather events.

Reporting should occur at the federal, state, district, multi-district, and local levels, depending on the nature and severity of the winter weather event.

Federal Reporting of Storm Damage Costs

For significant and severe winter weather events (with damages typically in excess of $1 million,) districts may seek reimbursement through the Federal Emergency Management Agency (FEMA). Federal reimbursement is limited to damages from severe ice storms; damages due to snow storms are not eligible.

Statewide Reporting

Reporting at the state level is normally accomplished through the Highway Condition Reporting System (HCRS). The roadway condition information entered into the HCRS is directly relayed to the traveling public through the TxDOT's Internet site and the statewide toll-free number for highway conditions. Because this information is not edited prior to being released to the public, it is extremely important that the information be accurate and current.

The District HCR Coordinator (or designee) should enter weather conditions in HCRS and update conditions every 4 hours during winter weather events. Maintenance sections should also enter roadway conditions to HCRS and update every 4 hours—or as conditions change—during winter weather events. If maintenance section personnel are unable to access the HCRS due to a loss of power or other constraint, they should contact the neighboring sections or the district HCRS coordinator for data entry support. The HCRS coordinator or their backup will monitor the HCRS data for the district to ensure that it is kept up to date and accurate.

Conditions should be entered within 30 minutes of occurrence when inclement weather strikes, and deactivated within 30 minutes after occurrence ceased. During normal business hours, personnel should enter the conditions by 9:00 am and update these prior to 4:00 pm. This will provide sufficient information to allow motorists to react appropriately.

District Reporting

District-level reporting may vary because of unique conditions within area. A typical district level report includes detailed information from each maintenance section that the district maintenance office can use to coordinate the movement of personnel and equipment to areas experiencing the greatest impact, and to respond to public complaints and requests for information during a winter weather event. For extended winter weather events, anticipated manpower or equipment needs should also be reported.

District Reporting from Each Maintenance Section. It is the responsibility of the maintenance section supervisor (or his designee) to contact the district maintenance administrator by phone or pager when snow or ice control measures begin. The maintenance section supervisor (or his designee) should provide periodic updated reports on control operations to the district maintenance administrator or designated district contact at the EOC. The frequency and detail of these reports will depend on the severity and nature of the winter storm.

Multi-District Reporting

Multi-district or metropolitan-level reporting will require each host maintenance section to submit information to the hosting district maintenance office. A typical multi-district or metropolitan-level report includes detailed information to coordinate the movement of personnel and equipment (from both the hosting and visiting districts) to areas experiencing the greatest impact and to respond to public complaints and requests for information during a winter weather event.

Local Reporting

Reporting requirements at the local maintenance section level should include all routine reports in addition to any district, state, and/or federal reports. A well-organized system for local reporting can make responding to district, state, and federal inquiries much easier.

Local Status Reports: It is the responsibility of the maintenance section supervisor (or his designee) to ensure that field crew shall provide status reports on items such as pre-trip inspection reports for trucks, snowplows, spreaders, motor graders, etc. Such reports include daily activity reports tracking shift hours, mileage, equipment usage hours, and materials applied during treatment operations.

Recovery Activity

After Action Review—Multi-District and Metropolitan Level Operations

Following each winter weather event, the host (supporting) director of maintenance as well as the respective visiting (supporting) districts should call a meeting of all maintenance supervisors and other key personnel shortly after the event to discuss procedures that worked and identify those that did not, so that changes may be implemented prior to the next winter weather event. These meetings should occur after those at the maintenance section level are completed. The after action reviews at the district level will follow those discussed at the maintenance section level, but will include additional items specific to district input in winter weather operations, such as the following:

- Sharing of maintenance personnel, equipment, and material resources across different districts and sections.
- Communication and coordination between the host (supporting) district and maintenance sections and the visiting (supporting) district and maintenance sections.
- Support by host (supported) and visiting (supporting) district maintenance staff to winter weather operations.

For very active winter seasons, an in-depth host (supported) district-level meeting may not be feasible and can be conducted at the end of the winter season instead of immediately after each winter storm event.

SELECTED METROPOLITAN OPERATIONAL PLANS

In the attached operational plans of the five metropolitan areas—Austin, Dallas, Fort Worth, Houston, and San Antonio—there were two key observations made: 1) they were state-of-the-art facilities; and 2) available communication systems that are vital for carrying out the principles of emergency preparedness, emergency management, or disaster management functions. The two basic requirements existing in the available communication systems operating at the metropolitan level during winter weather events are:

- **Interoperability—**the ability of public safety service and support providers to communicate with staff from other responding agencies and to exchange voice and/or data communications on demand and in real time (*5*). To determine the interoperability requirements for setting up communication at an EOC:
  - Identify communication requirements by function or position, not by name.
  - Consider communications needs both inside and outside of the EOC.
  - Prioritize information sensitivity based on routine information, priority information, and classified or sensitive information.
  - Consider all types of communication (e.g., radio, telephone, fax, and pager).
- **Redundancy—**this ensures that a backup is available if the primary means of communication breaks down. The need to consider redundancy is critical especially when weather can easily disrupt communication lines.
  - All agencies involved in the response should be able to switch to a backup system when required.
  - A system may work in one situation, but not in another; hence, the need to plan for multiple backup systems. Thus, the agencies involved need to design a proper procedure for switching to the backup systems to ensure that everyone who needs to communicate can do so.
  - Backup systems must accommodate secure communications where necessary.

Moreover, the uniqueness of each metropolitan area is their type and size of cutting-edge facilities that can be utilized for conducting EOC operations, depending on the scale and type of winter storm event encountered. For large-scale events that affect a significant portion of the metropolitan area or region, these cities have access to physical facilities with more sophisticated communication equipment availability. Such facilities can operate through combining resources of cooperating agencies involved with incident response (such as the Combined Transportation, Emergency, and Communications Center [CTECC] in Austin, DalTrans Transportation Management Center in Dallas, TransVISION Traffic Management Center in Fort Worth, Houston TranStar in Houston, and TransGuide Advance Transportation Management System in San Antonio).

While each plan covers its respective district area of responsibility, the access to state-of-the-art facilities and available communication systems affords them opportunities to be a model for best practices in overall emergency planning, preparation, response, and recovery. Appendix D has copies of the plans for Austin, Dallas, Fort Worth, Houston, and San Antonio.

CONCLUSIONS

Multi-district and metropolitan operational plans must use the creative thinking of key personnel internal and external to TxDOT to organize, employ, and manage forces and resources. It also requires maintenance sections, districts, and regional service centers to have a broad vision, the ability to anticipate, and the skills to plan, prepare, execute, and assess. This blending of elements in a complementary manner can potentially produce the type of proactive plans that will drive the operation.

CHAPTER 8: CONCLUSION

OVERVIEW

Weather conditions can have a major impact on both the safety and operation of our roads, from signalized arterials to interstate highways. Winter storms are unpredictable and each storm brings its own challenges and problems. As the various state plans have shown, there is no cookie-cutter approach to dealing with winter storm maintenance issues. It is important to have a readiness plan, especially at the district level. Keeping the public aware of those efforts and plans are a critical key to success.

EMERGING TECHNOLOGY

There are a number of initiatives utilizing emerging and current technology. There are innovations in utilizing both GPS and GIS as tools for winter weather plowing, new products and approaches for anti-icing and deicing materials as well as developing software such as MDSS. The winter MDSS is an integrated software application that provides users with real-time road treatment recommendations based on weather forecast information and predicted pavement conditions. These recommendations include guidance for material use (e.g., salt brine), application times, and rates. The software helps agencies minimize the amount of material applied to the roads while maintaining the highest level of service possible under given resource constraints. A winter MDSS can also be used for analyzing "what-if" scenarios and compare treatment alternatives using various material types, application times, and rates (*11*). It can also serve as a training tool for new and less-experienced maintenance managers. The MDSS effort is especially promising and is currently being used in a number of states including Kansas, Nebraska, Indiana, Maine, Colorado, Minnesota, Maryland, Idaho, Pennsylvania, New York, North Dakota, South Dakota, and New Hampshire. If used properly, this tool could assist in saving both money and manpower.

COMMUNICATIONS

In today's world of instant communications, it is crucial to connect with the community and the traveling public to keep them informed of the most current roadway condition. A Pew Research Center study (*24*) found that local television and the internet were the most relied-upon sources for information regarding weather, while radio was the most popular form of media for traffic information. It is also beneficial to educate both the media and the public on the capabilities of the local DOT offices so that there are realistic expectations regarding response to each approaching winter storm. Connecting with the community and increasing public awareness is a constant and ongoing task that utilizes multiple tools. The effectiveness of traveler information websites is dependent on the nature and extent of, and level of effort expended to maintain, the traveler information provided on the website. Using websites is effective; however, if these are not maintained or kept current, the public trust in those websites will be severely diminished.

WINTER WEATHER RESPONSE

Researchers discovered that winter weather response appears to follow after the winter weather patterns across Texas. For instance, the response to winter weather in the south Texas district of Laredo is far removed from practices in the northwest Texas district of Amarillo. These differences are a result of both the frequency of winter weather as well as the type of winter weather that these two districts have experienced. Snowfall occurs frequently and is the primary winter weather experienced in Amarillo; in Laredo, winter weather is seldom accompanied by any storm—whether ice or snow. Thus, the two districts approach winter weather with vastly different objectives. While preparing for winter weather is, as expected, a high priority in Amarillo; the same cannot be expected of preparations in Laredo. Districts such as Austin and Dallas, while encountering more winter weather than Laredo, only contend with ice storms and seldom encounter snow. Thus, their approach to winter weather response might be more involved than Laredo, but focused more on dealing with ice events.

These differences in weather severity and patterns among districts and regions influence decision making concerning winter weather resource allocation, planning and preparation procedures for winter weather operations, depth and organization of coordination and communication during winter response, and the prevention and control actions taken to combat winter weather. In addition, the acquisition of winter weather equipment, materials, and development of winter weather documentation as well as the training of maintenance personnel in winter weather response are different for districts in different regions.

Adopting a systematic approach for reporting equipment, chemical, material, and supply inventories will provide visibility and control of key assets needed to effectively respond to winter weather events. Also, this approach will help facilitate integrating the business practices of the maintenance sections, districts, and regional service centers in a manner that will provide accurate and timely information to TxDOT decision makers involved in winter weather operations. Lastly, it is extremely important to have knowledge of the availability of resources and procedures in place for accessing them when needed.

Multi-district and metropolitan operational plans must use the creative thinking of key personnel internal and external to TxDOT to organize, employ, and manage forces and resources. It also requires maintenance sections, districts, and regional service centers to have a broad vision, the ability to anticipate, and the skills to plan, prepare, execute, and assess. This blending of elements in a complementary manner can potentially produce the type of proactive plans that will drive the operation.

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APPENDIX A: TALKING POINTS/DISCUSSION ITEMS WITH DISTRICTS

General Ice and Snow Operations Plans

1. Do you currently have an Ice and Snow Operations Plan? If yes, can we have a copy? If not, why? Future plans of implementing such a plan?
2. Plans are updated annually - what changes are made from year to year, why they are made and the process for making those changes.

Guidelines:

3. How do they differ from the detailed plans (do you see any benefit in having guidelines)?
4. What would you like to see in a set of guidelines? (including content and whether you want it short and easy to read, longer with more details, etc.)

Pre-Storm:

5. What deicing materials do you use and why? (e.g., Meltdown 20, Bottom Ash)
6. Do you consider other materials better?
7. Why are you not using such materials, if better?
8. What is the source of an initial weather report? (e.g., National Weather Service, Weather sensors, etc.)
9. What challenges do you face during Pre-Storm activities?

Ice and Snow Removal Operations

10. Who is primarily responsible for initiating ice and snow operations response?
11. Who is primarily responsible for initiating and coordinating the movement of assets between sections and across district lines? What are the specific agencies to be included in such an event (e.g., is there a regional Emergency Operations Center that is at the center of such coordination efforts)?
12. Is there an Emergency Response Flowchart available and in your estimation is it followed strictly?
13. Prioritization of road de-icing routes—what guides it?
14. What are some of the challenges you face during your ice and snow removal operations including institutional and operational?

Reporting Procedures

15. What reporting procedures exist for reporting storm activities during removal operations?
16. Do you use the Highway Condition Reporting System during emergency response operations? How effective is the HCRS? Any suggestions on improving its use?

17. Do you use dispatchers during ice and snow removal operations? Who makes the decision to use a dispatcher?
18. What challenges do you face during your reporting procedures?

Safety and Training

19. What kind of training exists (or is required) for new staff?
20. What kind of training exists (or is required) for existing staff?
21. Are there issues with staff turnover at your district? If yes, why do you think there is—what can be done to keep staff longer? If no, what have you been doing to keep staff?
22. What other challenges do you face with your Safety and Training procedures?

Road Closure

23. Who makes the decision to close a road? Why that person or agency?
24. What criteria are used to initiate road closure?
25. How do you communicate road closure information to public?
26. What challenges do you face during road closure procedures? (includes institutional as well as operational issues)

Other Items

27. Contact information—which agencies are critical to include in such a list?
28. Do you have a district map with road prioritization and spray routes?
29. Have you explored innovative procedures (e.g. Twitter/Facebook) to disseminate information (such as road closures) to the public?
30. What items would you include in a Winter Weather Response Manual that has not yet been discussed?
31. Any other thoughts on what you think will work best (allow district staff to discuss what they think will help optimize process—and note items that have not been discussed previously).

APPENDIX B: SUMMARY OF PROJECT PRODUCT P1

The Texas Department of Transportation (TxDOT) is responsible for the planning, design, construction, operation, and maintenance of the state highway system. With few new highways being constructed, the operation and maintenance of existing facilities has become more important. Increasing traffic volumes and higher public expectations challenge effective highway operations and maintenance in Texas. That being said, the *Winter Weather Response Guide* (*1*), which is the project's product P1, is intended to encourage consistent, cost-effective practices that proactively respond to dynamic weather conditions and maximize the use of the state's limited assets.

Moreover, the purpose of the guide is to develop consistent practices that focus on a proactive approach to snow and ice control across the state. In addition to responding in a timely manner to a snow and ice event, best management practices highlighted in the guide will aid maintenance personnel in developing the best snow and ice control strategies.

APPENDIX C: SUMMARY OF PROJECT PRODUCT P2

This appendix highlights the statewide "playbook" brochure that was developed in English and in Spanish. Examples of both the English and Spanish versions are shown on the following pages and are represented by two different backgrounds. The purpose of the "playbook" is to comprehensively describe the TxDOT winter weather operation practices and disseminate it to the public in order to raise their awareness and understanding of important information needed to protect the safety of the motorists. The brochure fulfills the requirements for the project's product number P2.

Moreover, a district-level "playbook" brochure template is attached. The individual districts will have to customize this template in order to highlight their respective winter weather operations.

Providing Safe, Effective, and Efficient Movement of People and Goods

Texas Department of Transportation

PLAYBOOK FOR WINTER STORMS IN TEXAS

Texas Winter Storm Events

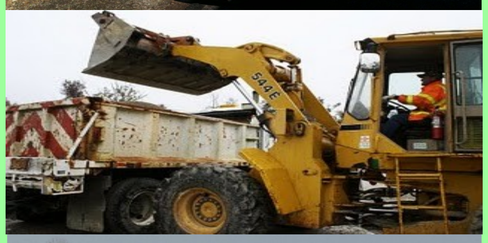
Snow

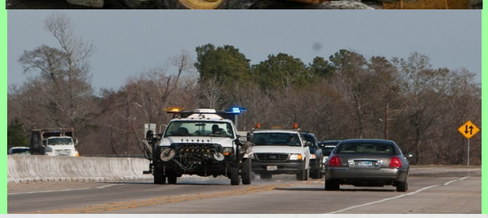
Ice

Freezing Rain

How TxDOT Responds to Winter Storm Events

- Supervisors continually monitor weather and road conditions, traffic cameras, road sensors, hotlines, and management reports.
- Personnel and equipment adjustments are made as needed.
- Crews spread sand and anti-icer or de-icer materials along assigned routes.
- Work continues 24/7 to keep roadways passable.
- Public Information Officers work with the media (newspapers, radio, TV) and through social media networks (Twitter, Facebook, Youtube) to get road conditions information out to the public.
- Road conditions are updated on TxDOT's Web site.





Winter Storm Treatments

Anti-icing

Liquid magnesium chloride is primarily sprayed on bridges and overpasses before a storm to help prevent a hard bond of ice, reduce snow buildup, and to speed snow and ice breakup.

De-icing

Granular magnesium chloride pellets are mixed with sand to help remove thick layers of ice already on the road. Granular magnesium chloride is made with natural sea salt and is less corrosive than rock salt and more environmentally friendly than baking soda.

Sand (Chat Rock)

Used to improve traction and as a mixing agent for granular magnesium chloride or road salt.

Salt

Still preferred in some situations because it is very fast acting. Sometimes used to free up stalled trucks on icy roads.

Priority Treatment Strategy

TxDOT's mission is to keep roadways open. Roads are prioritized and crews work to address them in the order listed

Type of Roads

- Interstates
- US Highways
- State Highways
- Farm-to-Market Roads

Type of Road Structures

- Bridges
- Overpasses
- High traffic interchanges
- High traffic intersections

Local authorities are responsible for city and county roads.

Maintenance crews moving supplies and manpower where most needed

Roadway Closures

TxDOT's first priority is always the safety of the traveling public. To ensure the safety of the traveling public, TxDOT works in collaboration with the Department of Public Safety and local law enforcement officials to close sections of inter-states and major highways during winter storm events.

How You Can Prepare

Winter Survival Checklist

Keep the following items in your vehicle

- Blankets and Warm Clothes
- Shovel and Scraper
- Flashlight and Batteries
- Lighter and Matches
- First-Aid Kit
- Booster Cables
- Chain/Tow Strap
- Non-Perishable Food and Water

Auto Safety Checklist

Check and maintain these vehicle components

- Ignition
- Battery
- Headlights and Taillights
- Brakes
- Wiper Blades
- Antifreeze Level
- Fuel Level and Exhaust Systems
- Heater/Defroster
- Tires

For More Information

Texas roadway conditions are available by calling the Texas Road Condition and Travel Information Line at (800) 452-9292 and for current road conditions: www.txdot.gov/travel/road_conditions.htm

Find out more at: www.txdot.gov
Find us on Facebook: www.facebook.com/txdot
Follow us on Twitter at: www.twitter.com/txdot
Check us out on Youtube at: www.youtube.com/user/TxDOTpio

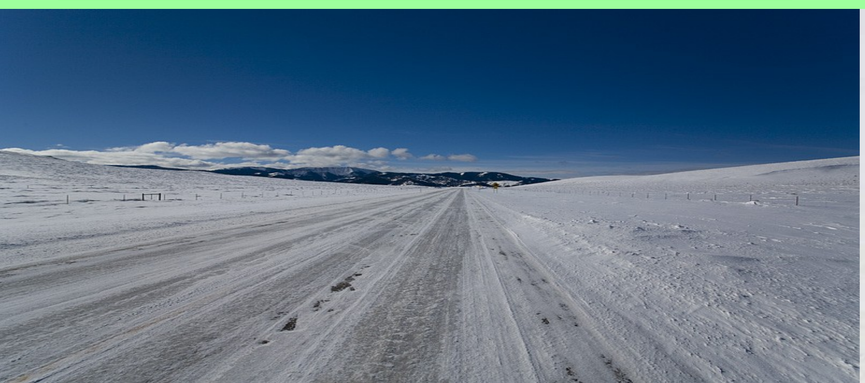
Winter Weather Driving Tips

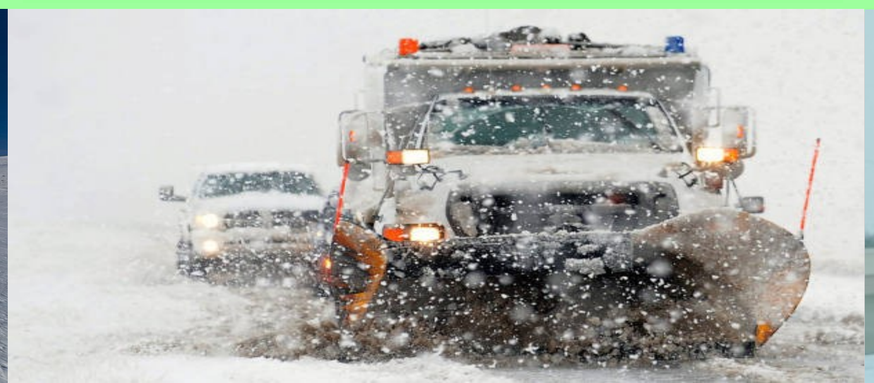
Remove snow and ice from your vehicle before you drive and make sure the headlights and taillights are visible.

- Use caution when driving due to the variations in weather conditions (snow, black ice, etc.) throughout the state of Texas.
- Accelerate slowly.
- Increase your following distance.
- Brake gently using slow, steady strokes to see how much traction you have and begin braking early when approaching stops or intersections.
- Approach bridges, shaded spots, overpasses, and turns slowly
- Never use cruise control in winter driving conditions.
- Use non-freezing windshield washer liquid.
- Use snow tires and/or chains (as needed).
- If stranded, call the Texas Department of Public Safety's stranded motorist hotline toll free number (800) 525-5555.

Driving Behind Winter Weather Equipment

- Never drive through a snow cloud or whiteout conditions. You can't be sure if such conditions are caused by crosswinds or by a snowplow, so be patient.
- Watch for snowplows and other winter weather equipment on interstate ramps and "authorized vehicle only" turnarounds.
- Drive slowly and be cautious when driving near winter weather equipment (snowplows, spreaders, graders, etc.).





Proporcionando Movimiento Seguro, Efectivo, y Eficiente de Personas y Mercancías

OPERACIONES PARA TIEMPO DE INVIERNO

Eventos de Tormentas de invierno en Texas

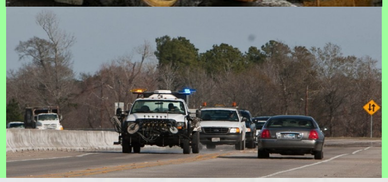
Nieve

Hielo

Lluvia Congelada

Como TxDOT Responde Eventos de Tormenta del Invierno

- Supervisores continúan monitorizando el tiempo y condiciones de carreteras, cámaras de tráfico. Sensores de carretera, líneas gratuitas, y reportes de administración.
- Ajustes de personal y equipo son hechos como se necesitan.
- Equipos riegan la arena y pri- o des – congelan materiales sobre recorridos asignados.
- El trabajo continúa 24/7 para mantener las carreteras transitables.
- Oficiales de Información Publica trabajan con los medios (periódicos, radio, TV) y través de medios de red sociales (Twitter, Facebook, Youtube) para conseguir información de condiciones ase el publico.
- Condiciones de carreteras son corrientes en la pagina web de TxDOT.



Tratamientos Tormentas Invierno

Contra-Hielo

El liquido de cloruro de magnesio es principalmente rociado en puentes y pasos elevados antes de una tormenta para prevenir una unión de Hielo macizo, reduce la aumentación de nieve, y apura nieve y hielo para que se deshace.

Des-Hielo

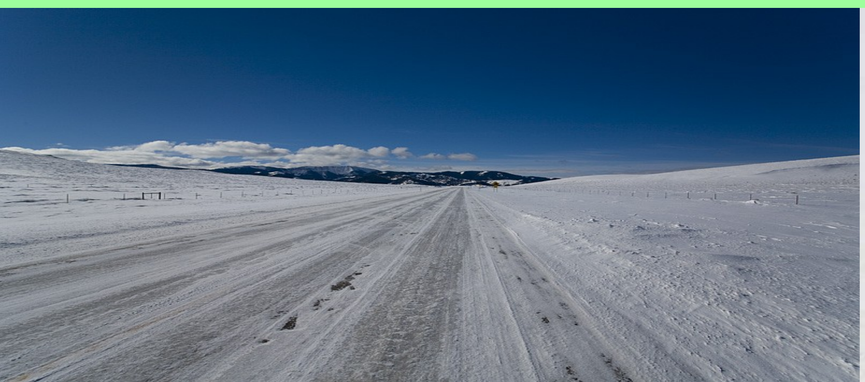
Grano de cloruro de magnesio son mescladas con arena para ayudar a remover capas gruesas de hielo que ya están en la carretera. Cloruro magnesio es hecho con sal del mar natural y hace menos corrosión que sal de piedra y es más agradable medioambiental que bicarbonato de soda.

Arena (Roca de Chat)

Se utiliza para mejorar la tracción y como un agente de mezcla de cloruro de magnesio granular o la sal del camino.

Sal

Es todavía preferida in algunas situaciones porque actúa rápidamente. Y es a veces usado para librar camionetas en carreteras heladas.



Estrategia Tratamiento Prioridad

La misión de TxDOT es mantener las carreteras abiertas. Carreteras son ordenadas en niveles y los equipos trabajan en la orden enlistada

Tipos de Caminos

- Interestatales
- E.E.U.U. Autopista
- Autopista de estado
- Granja-a- Mercado (Farm-to-Market)

Tipos de Estructuras Viales

- Puentes
- Paso a desnivel
- Intercambios de alto tráfico
- Intersecciones de alto tráfico

La autoridad local es responsable por carreteras de ciudad y del condado.

Equipo de mantenimiento viajan y mueven material, Mano de Obra donde más se necesita

Cerradas de Carreteras

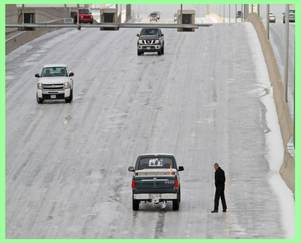
Primera prioridad de TxDOT es siempre la seguridad de los viajeros. Para asegurar la seguridad del publico que viaja, TxDOT trabaja en colaboración con del Departamento de Seguridad publica y oficiales de la ley local para cerrar secciones de interestatales y Autopistas principales durante eventos de tormenta de invierno.

Como Te Puedes Preparar

Lista de supervivencia para Invierno
Mantengan los siguiente artículos en su vehículo

- Sábanas y ropa cálida
- Pala y raspador
- Linterna y baterías
- Encendedor o fósforos
- Botiquín
- Cables para cargar
- Cadena/lazo para remolcar
- Comida que no perecedera/Agua

Lista de seguridad para el Automóvil
Vigila y mantengan estos componentes de Vehículo



- Ignición
- Batería
- Luces de enfrente y luces de atrás
- Frenos
- Limpiaparabrisas
- Nivel de Antifreeze
- Nivel de Combustible y sistema de escape
- Calefacción/descongelador Llantas
- Llantas

Para más información

Información sobre condiciones de carreteras en Texas está disponible por llamar La Condición de Carretera de Texas y La Línea de información para Viajar, 1-800-452 -9292 Para saber las corrientes condiciones de las carreteras: www.txdot.gov/travel/road_conditions.htm

Descubre más en: www.txdot.gov
Encontrarnos en Facebook: www.facebook.com/txdot
Síguenos en Twitter en: www.twitter.com/txdot
Visítenos en Youtube en: www.youtube.com/user/TxDOTpio

Tiempo de Inverno Consejos Conducir

Quite la nieve y el hielo sobre su vehículo antes de conducir, asegurase que las luces de atrás y adelante estén visibles.

- Tenga cuidado al conducir debido a las variaciones en las condiciones de invierno (nieve, hielo negro, etc) en todo el estado de Texas.
- Aceleré lentamente.
- Aumente su siguiente distancia.
- Enfrene suavemente y lentamente, continuando despacio para ver cuanta agarre tienes, y comienza a enfrenar en aproximación de las intersecciones o señas de Alto.
- Aproxima puentes, lugares con sombra, pasos elevados, y vueltas lentamente.
- Nunca use el control crucero para conducir durante el invierno.
- Use líquido para limpiar que no se congelé.
- Use llantas de nieve y/o cadenas (a como se necesite).
- Y si se encuentra atrapado o tirado en el borde de la carretera, llame el Departamento de Seguridad Pública de Texas tele comunicadora gratuita al (800) 525-5555.

Conducido Atrás de Equipo de Nieve

- Nunca maneje a través de una nube de nieve o condiciones blancas. No puedes estar segura si las condiciones son causas de vientos que cruzan o una camioneta de nieve, así que tengan paciencia.
- Fijase si ay Camionetas de Nieve y otros tipos de equipos in la rampas interestatales y “autoridad solo de vehículos” vueltas.
- Conduce lentamente y cautela cuando maneje cerca de equipo de tiempo de invierno. (camionetas de nieve, regaderas, graduadores, etc.).

Winter Weather Driving Tips

Remove snow and ice from your vehicle before you drive and make sure the headlights and taillights are visible.

- Accelerate slowly
- Increase your following distance
- Brake gently using slow, steady strokes to see how much traction you have and begin braking early when approaching stops or intersections
- Approach bridges, shaded spots, overpasses, and turns slowly
- Never use cruise control in winter driving conditions
- Use non-freezing windshield washer liquid
- Use snow tires and/or chains (as needed)
- If stranded, call the Texas Department of Public Safety's stranded motorist hotline toll free number (800) 525-5555

Driving Behind Winter Weather Equipment

- Never drive through a snow cloud or white-out conditions. You can't be sure if such conditions are caused by crosswinds or by a snowplow, so be patient.
- Watch for snowplows and other winter weather equipment on interstate ramps and "authorized vehicle only" turnarounds.
- Drive slowly and be cautious when driving near winter weather equipment (snowplows, spreaders, graders, etc.).

How You Can Prepare

Check winter weather conditions before you travel. Monitor TxDOT website for current road condition:
www.txdot.gov/travel/road_conditions.htm

Winter Survival Checklist

Keep the following items in your vehicle

- Blankets and Warm Clothes
- Shovel and Scraper
- Flashlight and Batteries
- Lighter and Matches
- First-Aid Kit
- Booster Cables
- Chain/Tow Strap
- Non-Perishable Food and Water

Auto Safety Checklist

Check and maintain these vehicle components

- Ignition
- Battery
- Headlights and Taillights
- Brakes
- Wiper Blades
- Antifreeze Level
- Fuel Level and Exhaust Systems
- Heater/Defroster Tires

For More Information

- List numbers to call for District road conditions
- List social media links (if any) to the District such as Twitter, Facebook, Youtube, etc.
- List local TV stations, news and weather contact information

Texas Department of Transportation
Providing Safe, Effective, and Efficient Movement of People and Goods

District Name
[*insert District Office address*]

WINTER WEATHER OPERATIONS

[*suggest inserting a picture of District battling a storm event*]

Typical Winter Storm Events for [*insert District Name*]

- List of winter storm events

Winter Facts

[*list of suggestions*]

- List District counties covered
- List lane miles District is responsible for maintaining or covering during winter storm events
- List approximate number of District personnel that participate in fighting winter storm events
- List quantity and type of equipment used by District
- List approximate quantity and type of chemicals and materials used by the District for winter storm events
- List time versus miles covered
- List average cost of winter storm per mile treated

Preparing for Winter Storm Events

[*suggest inserting a bulletized list of your pre-storm activities*]

Responding to Winter Storm Events

[suggest *inserting a bulletized list of your storm and post-storm event activities]*

[*suggest inserting a picture of equipment, treatment techniques, or equipment being used to implement the treatment technique*]

Priority Treatment of District Roads

[*suggest* d*escribing how the District prioritizes roads for winter storm treatment. Suggest providing a list or map to showcase District prioritization*]

[*suggest inserting a picture showing a road or location affected by one of the District's winter storm events*]

APPENDIX D: METROPOLITAN SNOW AND ICE PLANS

Snow and ice plans for Austin, Houston, Dallas, Fort Worth, and San Antonio are included in this appendix.

2010-2011 AUSTIN DISTRICT WINTER STORM PLAN

District Objective

The Austin District's objective in any winter storm event is to respond to the road conditions in an expedient manner and to maintain the highways in a condition that is accessible to public travel as is feasible and reasonable. It is the District's intention to keep all State highways open throughout the duration of the winter storm event as long as there is a sufficient inventory of deicing materials and as long as personnel are able to safely reach and apply the deicing agents to the road surface.

However, if the duration of the storm event exhausts the inventory of deicing agents, or if the resources of responding State or local assisting personnel can no longer provide reasonably safe public travel, then a decision to close some segments of roadways will be considered. Roadway segments that will be given first consideration for closure are those which have redundancy or easily accessible alternatives. For example, elevated direct connector ramps or bridges may be considered for closure if frontage road or at-grade alternatives are readily available.

It is also the Austin District's intention to work closely with local governments and their law enforcement and public works agencies. In particular, the Austin District will actively work with all partners in the Combined Transportation Emergency Communication Center (CTECC).

CTECC (Combined Transportation Emergency Communications Center)

CTECC is a joint venture between the Austin District, the City of Austin, Travis County, and the Capital Metropolitan Transportation Authority. This operation is housed in a facility located just east of IH 35 along 51st St. CTECC accommodates not only the 911/311 operations of the Austin area law enforcement and fire fighting services, but it also serves as the base for the emergency operations of the partnering entities. During region-wide emergency incidents (such as winter ice storms, flooding events, coastal evacuations, etc.) the partnering entities send representatives to work in the CTECC Emergency Operations Center (EOC). The CTECC/EOC remains activated as long as is believed necessary to effectively respond to the incident event.

While on-going winter storm operations are directed locally from individual Austin District maintenance offices, coordination and communications between these offices is primarily facilitated through the Austin District's representative on the CTECC/EOC floor. By having a representative on the CTECC/EOC floor, the Austin District also remains in constant contact with both City and County transportation representatives as well as representatives from law enforcement and fire fighting. Particularly during winter storm events, this level of coordination greatly enhances the District's ability to quickly respond to trouble spots. This centralized communication also allows for decisions to be made in coordination with the local agencies.

Through direct conversation with representative from law enforcement and fire fighting we have made it clear to them that we make every effort to keep all roads and bridges open at all times throughout the winter storm events.

Austin District Winter Storm Response

Winter storm response operations are primarily directed from the local maintenance office level. Each of the 15 maintenance sections in the Austin District has an area of responsibility as shown by the District map in Exhibit 1. Each maintenance supervisor has an inventory of equipment and materials at their disposal as is detailed in Appendix A. In some cases the supervisor has created a specific predetermined schedule that section employees are expected to follow. In other cases the supervisor determines their employee's work schedule at the onset of the winter storm event. The scheduling method used by each section is up to the discretion of the maintenance supervisor and the corresponding area engineer and is generally determined by what has historically worked best in their local situation.

The decision as to when to begin application of pretreatment or anti-icing agents is left in the hands of each local maintenance supervisor at the onset of the winter weather event. Supervisors rely on a combination of several factors when making this decision: current weather forecast information, on-going discussions with the CTECC/EOC representative or District Maintenance management, pavement temperature readings on bridge decks by infrared thermometers, reports from their personnel in the field, and/or field reports from local law enforcement officers. There is always a risk of applying anti-icing agents too soon and having them washed off the pavement surface. But supervisors are encouraged to error on the side of caution when making this decision. It is the Austin District's position that we would prefer to have anti-icing agents washed off by the rain rather than have traffic caught on highways that have not been pretreated.

While maintenance section autonomy in winter storm events is deemed most effective for handling local operations, central communication is critical for maintaining a district-wide response. As previously discussed, the Austin District representative on the CTECC/EOC floor serves a critical role in fostering this communication.

In the event that additional support is needed at a local maintenance section, the first tier of response will be looked for the needed support from an adjacent maintenance office within the Austin District. Frequently, this communication is handled at the maintenance section level without involvement from the District Maintenance Office or the EOC floor representative. If the support needs cannot be satisfied by the neighboring maintenance section, then the maintenance section request should be forwarded to the District Maintenance Office or the EOC floor representative. Support can then be sought from other sections within the Austin District, from neighboring districts, or through the acquisition of materials.

The contact information for Austin District Maintenance Office personnel who serve in the CTECC/EOC or are available to assist the maintenance offices during winter storm events is shown in Exhibit 2.

Winter Storm Response on Austin District Toll Roads

The Austin District has approximately 690 lane-miles of highway on the toll road system. This system includes SH 130, SH 45 North, SH 45 Southeast, Loop 1 North, and US 183A. At the present time the winter weather response on these highways is handled by contracted maintenance forces. The direct winter weather response for the toll road

system is coordinated through the mainline plaza facility located on Loop 1 North. These efforts are made in coordination and communication with the Austin District representative at the CTECC/EOC. The resources available for winter weather response on the toll roads are summarized in Appendix A. Contact information for those involved in toll road response is shown in Exhibit 2.

Winter Storm Preparations

Each year in the early fall months, the District Maintenance Office queries the maintenance sections about their inventory of aggregates, anti-icing, and deicing agents. It is the responsibility of each maintenance section to maintain an adequate inventory of necessary materials and to be sure their equipment is in operational condition. In addition to operational V-box spreaders, it is also necessary for the sections to have their herbicide trucks properly prepared for applying liquid magnesium chloride for pretreatment (anti-icing) operations. When believed necessary, the District will request assistance from the Vegetation Management Section of the Maintenance Division to help properly calibrate the herbicide trucks for winter operations.

The quantities of stockpiled winter storm response agents is best determined by each maintenance section and is based on historical experience. Generally, each section is expected to maintain an inventory sufficient to handle an event lasting two to three days.

There is also an annual winter storm preparation meeting held at the CTECC/EOC. This meeting is usually held in October and involves all the partner agencies. During this meeting each participating agency gives an overview of their winter storm objective and level of inventory preparedness.

Materials Used in the Austin District

In recent years the Austin District has adopted an operational strategy of trying to use only chemical anti-icing and deicing agents in the Austin metro area. The primary anti-icing agent used is liquid Magnesium Chloride (MgCl), and our primary deicing agent is granular MgCl. This strategy has evolved from the experience of excessive clean up costs and environmental impacts caused by using aggregates in response to winter storm conditions. Following past winter storm events when aggregates have been deployed on the urban highway system, the costs associated with sweeping and clean up have far exceeding the cost of using straight deicing agents. Not only are the clean up costs nearly eliminated, but there is no post-storm build up of aggregates sitting on our bridges and curb and guttered sections of highway. The use of aggregates also creates silting problems in our bridge joints and storm sewer systems, which undoubtedly leads to similar environmental concerns in the nearby streams, rivers, and other water bodies. In the event that a winter storm lasts longer than two or three days then we will use aggregates on the road surface, but we try to refrain from that option as long as possible.

Outside of the Austin metro area we use deicing agents in combination with aggregate. In these areas the highways are primarily a ditch cross section so there is no curb and gutter and storm sewer system to trap the aggregate. In these areas the aggregate can blow off the pavement and be absorbed into the surrounding ground surface so additional clean up costs are minimized.

Austin District Winter Storm Response Resources

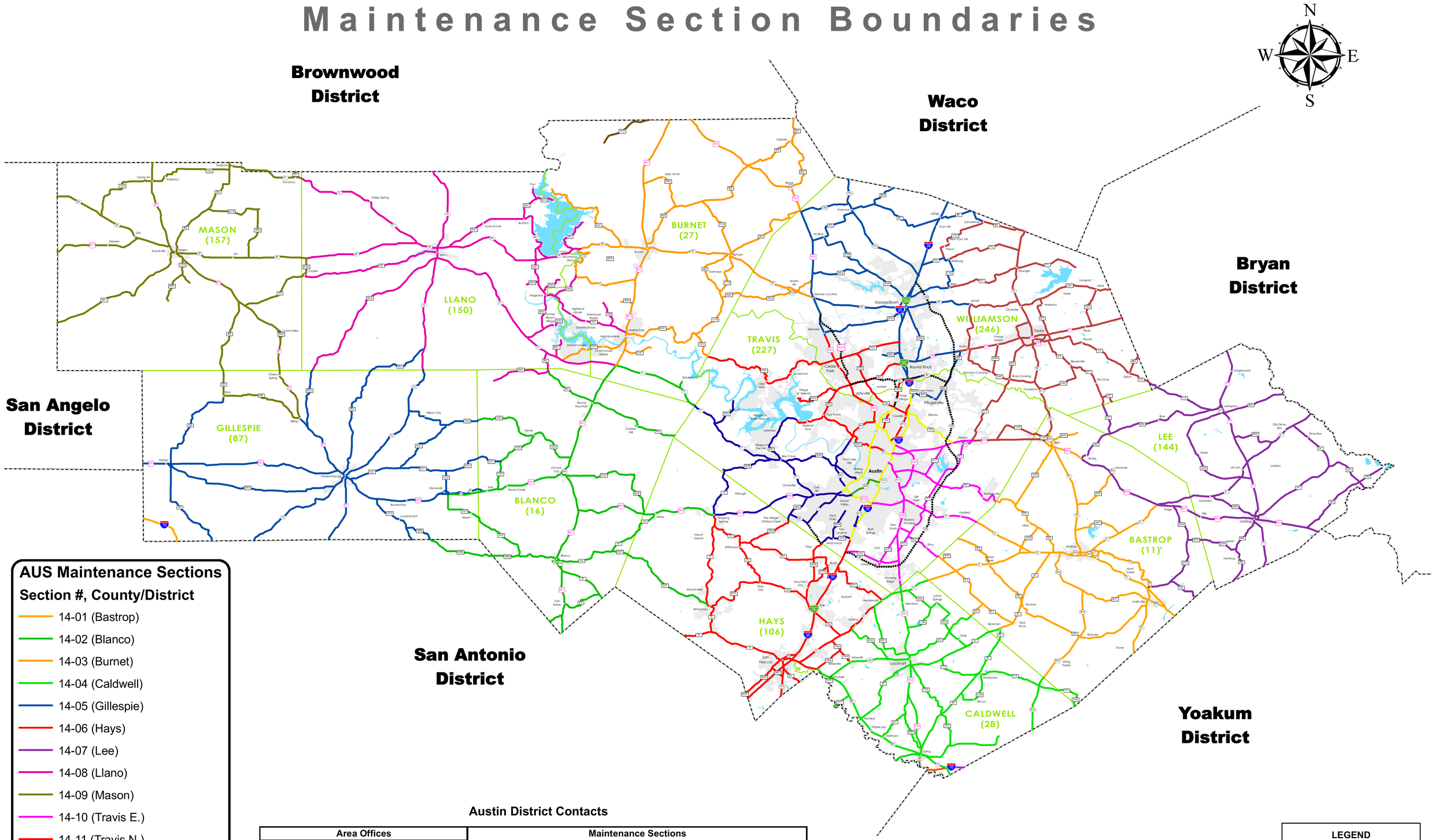
As previously stated, the Austin District Maintenance sections are fairly autonomous in their winter storm response. This is because throughout the eleven county area there is a wide variety of highway types, levels of adjacent development, and highway geometry. For this reason it is most effective if each maintenance section can tailor their response to fit their local conditions. See Appendix A for a summary of each section's response resources.

It should also be noted that personnel from the Austin District's Special Crews are also a resource for the maintenance section supervisors. Special Crews personnel are generally deployed to the maintenance sections in the Travis, Williamson, and Hays County areas as needed.

EXHIBIT 1

DISTRICT MAINTENANCE BOUNDARIES MAP

TxDOT - Austin District
Maintenance Section Boundaries



AUS Maintenance Sections

Section #, County/District

- 14-01 (Bastrop)
- 14-02 (Blanco)
- 14-03 (Burnet)
- 14-04 (Caldwell)
- 14-05 (Gillespie)
- 14-06 (Hays)
- 14-07 (Lee)
- 14-08 (Llano)
- 14-09 (Mason)
- 14-10 (Travis E.)
- 14-11 (Travis N.)
- 14-12 (Williamson W.)
- 14-13 (Williamson E.)
- 14-14 (Travis C.)
- 14-15 (Travis S.)
- 13-04 (Yoakum Dist.)
- 15-06 (San Antonio Dist.)
- 15-13 (San Antonio Dist.)
- 23-05 (Brownwood Dist.)
- COA (City of Austin)

Austin District Contacts

Area Offices			Maintenance Sections			
No.	Area Office	Area Engineer	No.	Section	Supervisor	
050	BASTROP	Daniel L Smith	01	BASTROP	Reginald (Reggie) Woods	(512) 321-2221
		(512) 332-7006	04	CALDWELL	James Petty	(512) 398-2412
			07	LEE	Eric Goertz	(979) 542-5568
051	BURNET	Howard Lyons	02	BLANCO	Terry Brussel	(830) 868-7166
		(512) 715-5701	03	BURNET	Anthony (Tony) Reitan	(512) 715-5720
			05	GILLESPIE	Daniel (Danny) Crenwelge	(830) 997-4362
			08	LLANO	Kenneth Shaffer	(325) 247-5146
			09	MASON	Elba Nail	(325) 347-6447
053	NORTH AUSTIN	Terry G McCoy	10	TRAVIS - EAST	Charles Vaughn Sr.	(512) 929-7221
		(512) 997-2202	14	TRAVIS - CENTRAL	Clint Dube	(512) 997-2266
055	GEORGETOWN	John R Wagner	11	TRAVIS - NORTH	Samuel (Sam) Holguin	(512) 331-5361
		(512) 930-5402	12	WILLIAMSON - WEST	Travis Remmert	(512) 930-6017
			13	WILLIAMSON - EAST	Paul Michalk	(512) 365-5254
056	SOUTH AUSTIN	Donald E Nyland	06	HAYS	Vacant	(512) 353-1061
		(512) 282-2113	15	TRAVIS - SOUTH	Jose (Joe) Sustaita	(512) 288-4761

Texas Department of Transportation

SOURCE DATA : TxDOT - TP&P Div. - FY 2006
MAPPING : TxDOT - AUSTIN DISTRICT MAINTENANCE
REVISION DATE : 25 - SEPTEMBER - 2007

LEGEND

- Interstate Highway
- US Highway
- State Highway
- Farm and Ranch to Market Road
- Loop and Spur
- Toll Road
- TxDOT District Boundaries
- County Boundaries
- Cities
- City Boundaries
- Streams
- Lakes

0 5 10 Miles

EXHIBIT 2

DISTRICT CONTACT LISTS

Austin District Maintenance Operations Contact Information

Lowell D. Choate, P.E.	Director of Maintenance	(512) 832-7030 (office) (512) 585-4601 (mobile) (512) 992-0840 (home) (512) 779-3919 (personal cell) lowell.choate@txdot.gov
Wayne L. Rehnborg, P.E.	Assistant Director of Maintenance	(512) 832-7019 (office) (512) 965-2468 (mobile) (512) 837-1570 (home) (512) 914-3055 (personal cell) wayne.rehnborg@txdot.gov
Jamie Witten	District Maintenance Administrator	(512) 832-7099 (office) (512) 585-4678 (mobile) (512) 864-4441 (home) jamie.witten@txdot.gov
Paul Michalk	Tollroad Maintenance Contract Inspector	(512) 365-5254 (office) (512) 745-4114 (mobile) (512) 470-9033 (home) paul.michalk@txdot.gov

AUSTIN DISTRICT AREA ENGINEER & MAINTENANCE OFFICES

(50) BASTROP A.E.
174 SH 21 East, Bastrop TX 78602
Radio Base: 96R

Area Engineer: Danny Smith, P.E.
(512) 304-8119 *Cell Phone*
(512) 321-2195 *Office Phone*
(512) 321-3343 *Fax*

(01) BASTROP MAINT (Bastrop Co)
174 Hwy 21, Bastrop TX 78602
Radio Base: 96M

Supervisor: Reggie Woods
(512) 304-8854 *Cell Phone*
(512) 321-2221 *Office Phone*
(512) 321-3343 *Fax*

(51) BURNET A.E.
3029 E. Hwy 29, Burnet TX 78611
Radio Base: 97R

Area Engineer: Howard Lyons, P.E.
(830) 798-3762 *Cell Phone*
(512) 756-2316 *Office Phone*
(512) 756-4251 *Fax*

(02) JOHNSON CITY MAINT (Blanco Co)
608 Hwy 281 S, Johnson City TX 78636
Radio Base: 101

Supervisor: Terry Brussel
(512) 585-4129 *Cell Phone*
(830) 868-7166 *Office Phone*
(830) 868-0853 *Fax*

(55) GEORGETOWN A.E.
2727 S. Austin Ave, G'town TX 78626
Radio Base: 99R

Area Engineer: John Wagner, P.E.
(512) 585-4637 *Cell Phone*
(512) 930-5402 *Office Phone*
(512) 869-1419 *Fax*

(03) BURNET MAINT (Burnet Co)
3029 E. Hwy 29, Burnet TX 78611
Radio Base: 97

Supervisor: Anthony "Tony" Reitan
(830) 798-3761 *Cell Phone*
(512) 756-2315 *Office Phone*
(512) 756-4251 *Fax*

(53) NORTH A.E.
1001 E. Parmer Ln, Ste. B, Austin TX 78753
Radio Base: 453

Area Engineer: Terry McCoy, P.E.
(512) 470-6788 *Cell Phone*
(512) 997-2200 *Office Phone*
(512) 997-2280 *Fax*

(04) LOCKHART MAINT (Caldwell Co)
1315 N. Blanco, Lockhart TX 78644
Radio Base: 102

Supervisor: James Petty
(512) 376-8050 *Cell Phone*
(512) 398-2412 *Office Phone*
(512) 398-2788 *Fax*

(56) SOUTH TRAVIS / HAYS A.E.
9725 S. IH 35 Austin, TX 78744
Radio Base: 456

Area Engineer: Don Nyland, P.E.
(512) 585-3358 *Cell Phone*
(512) 282-2113 *Office Phone*
(512) 282-2362 *Fax*

(05) F'BURG MAINT (Gillespie Co)
1623 E. Main, Fredericksburg TX 78624
Radio Base: 98

Supervisor: Danny Crenwelge
(830) 739-7222 *Cell Phone*
(830) 997-4361 *Office Phone*
(830) 990-8137 *Fax*

AUSTIN DISTRICT AREA ENGINEER & MAINTENANCE OFFICES

(06) SAN MARCOS MAINT (Hays Co)
1710 Hwy 21, San Marcos TX 78666
Radio Base: 105

Supervisor: Joe Sustaita
(512) 585-3170 *Cell Phone*
(512) 353-1061 *Office Phone*
(512) 353-1117 *Fax*

(07) GIDDINGS MAINT (Lee Co)
1975 N. Main, Giddings TX 78942
Radio Base: 100

Supervisor: Eric Goertz
(979) 540-6398 *Cell Phone*
(979) 542-5568 *Office Phone*
(979) 542-9713 *Fax*

(08) LLANO MAINT (Llano Co)
2504 S. Hwy 16, Llano TX 78643
Radio Base: 103

Supervisor: Ken Shaffer
(512) 585-4182 *Cell Phone*
(325) 247-5146 *Office Phone*
(325) 247-2230 *Fax*

(09) MASON MAINT (Mason Co)
2424 E. Hwy 29, Mason TX 76856
Radio Base: 104

Supervisor: Elba Nail
(325) 347-2049 *Cell Phone*
(325) 347-6447 *Office Phone*
(325) 347-5661 *Fax*

(10) TRAVIS EAST MAINT
8902 F.M. 969, Austin TX 78724
Radio Base: 150

Supervisor: Charles Vaughn
(512) 585-6318 *Cell Phone*
(512) 929-7221 *Office Phone*
(512) 928-2090 *Fax*

(11) TRAVIS NORTH MAINT
2001 W. Whitestone, Cedar Park TX 78613
Radio Base: 288

Supervisor: Sam Holguin
(512) 585-3064 *Cell Phone*
(512) 331-5361 *Office Phone*
(512) 335-0869 *Fax*

(12) GEORGETOWN MAINT (Wmson Co)
2727 S. Austin Ave, G'town TX 78626
Radio Base: 99M

Supervisor: Travis Remmert
(512) 585-4617 *Cell Phone*
(512) 930-4700 *Office Phone*
(512) 869-5590 *Fax*

(13) TAYLOR MAINT (Williamson Co)
3101 W. Second St, Taylor TX 76574
Radio Base: 106

Supervisor: Deral Milliken (acting)
(512) 585-4692 *Cell Phone*
(512) 365-5254 *Office Phone*
(512) 352-6401 *Fax*

(14) TRAVIS CENTRAL MAINT
1001 E. Parmer Ln, Ste B, Austin TX 78753
Radio Base: 425

Supervisor: Clint Dube
(512) 585-3084 *Cell Phone*
(512) 832-6676 *Office Phone*
(512) 997-2281 *Fax*

(15) TRAVIS SOUTH MAINT
12315 W. Hwy 290, Austin TX 78737
Radio Base: 427

Supervisor: Joe Sustaita
(512) 585-3170 *Cell Phone*
(512) 288-4761 *Office Phone*
(512) 301-3053 *Fax*

(440) Special Crews
9725 S. IH 35 Austin, TX 78744
Radio Base:

Supervisor: Jamie Witten (interim)
(512) 585-4678 *Cell Phone*
(512) 832-7099 *Office Phone*
(512) 832-7390 *Fax*

Weather Emergency Contact List
ML1 Phone: 874-9205

NAME	TITLE	PHONE	EMAIL
DPS			
Vacant	DPS-THP Captain	997-4101 ofc cell	
Lt. Victor Taylor	DPS-THP Lieutenant	997-4104 ofc 496-4328 cell	
Sgt. Kelly Wilkison	DPS-THP Sergeant	874-9264 ofc 486-0447 ofc	kelly.wilkison@txdps.state.tx.us
DPS Communications	Communication Department	424-7391 ofc	
TxDOT			
Linda Sexton	Toll Operations Program Coordinator	874-9177 ofc 853-0441 BB 658-0323 cell	Linda.sexton@txdot.gov
Erica Ramirez	Marketing and Communications	874-9713 ofc 563-0098 cell	Erica.ramirez@txdot.gov
JD Witten	Transportation Specialist	585-4678 cell 864-4441 cell	Jamie.witten@txtdot.gov
Paul Michalk	Transportation Specialist	745-4114 cell 470-9033 cell	Paul.milchalk@txdot.gov
Lori Wagner	Transportation Specialist	745-4115 cell	Lori.wagner@txdot.gov
CTRMA			
Chuck Murphy		413-5258 cell	cmurphy@ctrma.org
PBS&J			
Allen Beck	Consultant	874-9720 ofc 739-5333 cell	abeck@pbsj.com
WGI			
Perry Kirby	Project Manager	874-9171 ofc 407-491-3711 cell	Perry.kirby@wgint.com
David Stephenson	Toll Operations Manager	874-9168 ofc 426-2006 cell	David.stephenson@wgint.com
WP Engineering			
Tom Frank	Central Texas Manager	874-9245 ofc 203-0608 cell	tfrank@txtag.org
CTECC			
	TxDOT Line Duty Officer	974-0883 974-0600	Wayne.rehnborg@txdot.gov
EMERGENCY AGENCY			
	Austin Police Dept.	974-5750	
	Round Rock Police Dept.	218-5515	
	Pflugerville Police Dept.	251-4004	
	Williamson County Sheriff Dept.	943-1389	
	Hutto Police Dept.	846-2017	
	Travis County Sheriff Dept.	974-0854	
	Cedar Park Police Dept.	258-2800	

Date_____ Time_____

ICE CONTROL SCHEDULE

Winter 2010

Travis Central Maintenance

NIGHT CREW	CALL #	EQUIPMENT	DAY CREW	CALL #	EQUIPMENT	AREA
Rusty Davenport	3485-1	5344-J	Clint Dube	3485	4151-J	Travis Central
Teresa Resendez	580	Office	Rosalinda Gamez	580	Office	Maintenance Section
Cesar Garcia	3584-8	6675 (loader)	Dale Turner		6675 (loader)	Travis Central Stock Pile
VACANT		6849-A (loader)	VACANT		6849-A (loader)	LP1 / US 183 Stock Pile
VACANT		Borrow loader	VACANT			LP 1 / SW Parkway Stock Pile
John Taylor (JT)	3485-5	5249-H (10cuyd)	Daniel Mendez	3485-14	5249-H (10cuyd)	IH 35 (FM 1327 to 51st)
						No sand on PFC (Riverside to BW)
Ed Seale	3485-18	3876-G (10cuyd)	Amado Samora	3485-19	3876-G (10cuyd)	IH 35 (51st to SH 45)
Bill Lantz	3485-13	4213-J (6cuyd)	David Browning	3485-11	4213-J (6cuyd)	IH 35 (US 290 to SH 71)
						SP 69 (IH 35 to RR xing)
Gary Atwood	3485-21	3337-H (10cuyd)	Jacob Wells	3485-3	3337-H (10cuyd)	LP 1 (FM 734 to FM 2222)
Dustin Armstrong	3485-17	5472-F (10cuyd)	Gregory Stephens	3485-7	5472-F (10cuyd)	LP 1 (FM 2222 to Barton Creek)
						No sand on PFC (RM 2222 to 1st/5th)
Jay O'Donald	3485-2	4732-F (10cuyd)	Carmelo Reyes	3485-4	4732-F (10cuyd)	US 183 (IH 35 to LP 360)
						No sand on fingerjoint segments
VACANT		4885-D (6cuyd)	Santos Almaguer	3485-15	4885-D (6cuyd)	US 183 ramps (IH 35 to LP 360)
						No sand on fingerjoint segments
VACANT		4121-E (6cuyd)	VACANT		4121-E (6cuyd)	FM 734 (US 290 to IH 35)
Jonnie Perrine	3485-12	7571-G	Ronald Crawford	3485-20	7571-G	IH 35 (FM 1325 to FM 1327)
VACANT		7573-B	VACANT		7573-B	US 183 / LP 1 Flyover
						LP 1 (Parmer Ln to Barton Creek)
VACANT		7567-C (Giddings)	VACANT		7567-C (Giddings)	IH 35 (FM 1325 to FM 1327)
						US 183 (IH 35 to LP 360)

Material On Hand:			
Cal.Mag. Acetate	150611	Maint Yard	19 bags
Mag.Chloride	165612	Maint Yard	86 bags
Mag.Chloride	150669	US 183/LP 1	50 bags
Liquid Mag Chloride	157072	Dist. Yard	12,500 gal
Liquid Mag Chloride	157072	Maint Yard	6200 gal
Sand	11542	Maint Yard	260 cuyd
Sand	11542	US 183/LP 1	237 cuyd
Chat Rock	88375	Maint Yard	379 cuyd

Equip On Hand:	
10 cuyd Dump Trucks	5
6 cuyd Dump Trucks	3
Front End Loaders	2
Liquid De-icing Trucks	3
Motor Graders	2
Sweeper	1
Trk Attenuators	2

Clint Dube	585-6318wk	mbl,923-4389mbl	
Rusty Davenport	585-3778	CTECC	974-0883
Jay O'Donald	585-3104	Travel Division	512-921-6213
Jacob Wells	585-3084	Roadway Info	1-800-452-9292
G'town Remmert	585-4617	Terry McCoy	819-9985hm,818-9554mbl, 470-6788wkmbl
G'town Stacy	569-0681	Mike McKissick	585-3237
S.M. Sustatia	585-3170	Dale Turner	569-7021wk, 272-8643hm, 921-1338mbl
S.M. Leclerc	557-3047	Clint Best	762-5571
T.South Sustatia	585-3170	Rosie Gamez	796-2213
T. South Rice	585-3571	Chris Green	992-5003
T. North Holguin	585-3064	Renell Springer	762-4374
T. North Brown	585-3045	Lanny Hall	689-4050wk
T.East Vaughn	585-3043	Teresa Resendez	771-5834
T. East Schulze	585-3751	Lowell Chaote	585-4601
Toll Rd. Michalk	745-4114	Jamie Witten	585-4678
	Reserve:	Daniel Bridges	422-2574, hm 992-2500, 809-9025wk
	Reserve:	Chad Franks	227-1181
	Reserve:	Steve Schmidt	585-3283

Date_____ Time_____ **ICE CONTROL SCHEDULE** **Winter 2010/2011**

Travis East Maintenance

NIGHT CREW	EQUIPMENT	CALL #	DAY CREW	EQUIPMENT	CALL #	AREA
Ronald Schulze	4416-H	3421-1	Charles Vaughn	4417-H	3421	Travis East
Patti Perez	Office	150	Carol Jarosek	Office	150	Maintenance Section
Slade Harris	Yard		J.Copenhaver	Yard	3421-6	4875-H/6614-A
Mike Jones	4729-F	3421-12	Robert Salas	4729-F	3421-10	SH 71 (IH 35 to Co. Line)
			Eddie Cooper			FM 812
Michael Salas	3873-G	3421-8	Paul Galvan	3873-G	3421-9	US 183 (IH 35 to Col. River)
						LP 111
Vacant			Vacant			FM 973
						LP 212
						*help US 183 south
Vacant	4124-E		Victor Herrera	4124-E	3421-4	FM 969
						FM 3177
						*help US 183 south
Jayme Holmes	4212-J	3421-7	J. Zaragoza	4212-J	3421-11	US 183 (Col. River to Co. Line)
						FM 1327
						FM 1625
Josh Wilson	5475-F	3421-2	Felix Zapata	5475-F	3421-3	US 290 (IH 35 to FM 973)
Chad Robinson	7518-G	3421-5	M.Dube	7518-G	3421-13	US 290 **(Includes CTRMA US 183 overpass)**
						US 183 (Col. River Interchange)
Lowell Choate	**Off.-512-832-4601**		**Charles Vaughn**	**585-3043**		SH 71 & US 183 Interchange
Jamie Witten	**Off.-512-832-7099**		**Ronny Schulze**	**585-3751**		SH 71 (ABIA Bridges)
Paul Michalk/Toll Roads	**Mb.-512-745-4114**		**Terry McCoy**	**470-6788-TxDOT Mb**		**Neighboring Sections and Supvisors:**
				819-9985-Home		**Travis South:Joe Sustaita**
Travel Division	**512-921-6213**			**818-9554-Mb**		Off-512-288-4761
Roadway Info	**1-800-452-9292**		**Mike McKissick**	**512-585-3237Mb.**		Mb.-512-585-3170
CTECC	**512-974-0883**		**Eddie Cooper**	**W-585-3931**		Gene Rice Maint.Asst.
				C-297-5467		Mb.-512-585-3571
			Slade Harris	**W-784-8627**		**Bastrop Mo: Reggie Woods**
				C-844-3006		Off.-512-321-2221
			Patti Perez	**C-589-4302**		Mb.-512-304-8854
			Equipment:			Celso Harper Maint.Asst.
Material on Hand:			**2 ea-Front End Loaders**			Mb.-512-304-8122
Mag.Chloride 150669 Maint.Yard 44 bags			**2 ea-MotorGrader**			**Lockhart MO:James Petty**
Mag.Chloride 150669 Old Special Crews Yard 68 bags			**3 ea-10yd Dumps w/V-Box Spreaders**			Off.-512-398-2412
Sand 11542 Maint.Yard 350 tons			**2 ea-6yd Dumps w/V-Box Spreaders**			Mb.-512-376-1118
Salt 88bags Maint.Yard (Use w/Sand as last resort)			**1 ea-Herbicide Unit to apply Liquid De-Icer**			Cody Chambliss Maint.Asst.
Liquid MagChloride 157072 11000 gals.			**1 ea-Rotary Broom**			Mb.-512-376-8095

SAN MARCOS ICE CONTROL PLAN 2011

DAY CREW SUPERVSOR	DAY CREW OFFICE	DAY CREW TRUCK/SANDER	DAY CREW SHADOW		LOCATION		NIGHT CREW SUPERVSOR	NIGHT CREW OFFICE	NIGHT CREW TRUCK/SANDER	NIGHT CREW SHADOW
				1	**BEN WHITE ML: from Lamar Blvd to woodward Ave. N&W direct connects**					
				1A	**BEN WHITE FRONTAGE: from Lamar Blvd to IH 35, and LP 275**					
				2	**LOOP 1: from Barton Skyway to William Cannon**					
				3	**LOOP 360: from Lamar Blvd to Pennybacker bridge**					
				4	**US 290: from sh 71 west to Westgate Blvd**					
				5	**LOOP 1: from William Cannon to SH 45, and FM 2304**					
				6	**HILL COUNTRY: SH 71, US 290, RM 12 (SH 71 IS PFC, use liquid/melt down 20 only)**					

EMERGENCY NUMBERS

JOE SUSTAITA (3422)	**512/585-3170**
GENE RICE (3422-1)	**512/585-3517**
ROLAND MANCHA (3422-2)	**512/619-6176**
OFFICE	**512/288-4761**
BASE STATION	**427**

SHIFTS ARE FROM 9:00 AM - 9:00 PM

APPLICATION RATES FOR "V" BOXES

1. **MELT DOWN 20 BY ITSELF:** SET GATE @ 1/2" - 1" SET VALVE @ 5-8 ON DIAL
2. **SAND/ GRADE #5, MELT DOWN 20:** SET GATE 1 1/2" - 3" DEPENDING ON MOISTURE
3. **LIQUID DE-ICER: PRE-TREAT**

MIX RATIOS ALL TRUCKS

1. 3 LOADER BUCKET GRADE #5, 1 LOADER BUCKET SAND, 4 BAGS SALT
2. 3 LOADER BUCKETS SAND, 1 BAG MELT DOWN 20
3. MELT DOWN BY ITSELF - 1 BAG PER TRIP

EMPLOYEES	EQUIPMENT	MATERIAL IN STOCK
JOE SUSTAITA	10-YD 4731-F	GRADE #5 MODIFIED - 320 CUYD
GENE RICE	10-YD 3335-H	LIQUID DE-ICER MAG CHLORIDE - 5100 GALS
ROLAND MANCHA	10-YD 3870-G	MAG CHLORIDE (MELTDOWN 20) - 109 BAGS
ALBERT BRIENO	6-YD 4890-D	MAG ACETATE - 18 BAGS
SALVADOR CALZONCIT	6-YD 4127-E	
JOE JIMENEZ	6-YD 4024-E	
BEJAMIN YOUNG	6-YD 4116-E	
BLAYNE BIRCK	BACKHOE- 6584-A	
EDUARDO CALZONCIT	LOADER 6648-G	
RICARDO CALZONCIT	UNI-LOADER 6760-A	
LARRY CLEMENTS	BLADE 1142-A	
CLINTON DOWDY	BLADE 1750-B	
ROLAND MANCHA	HERBICIDE - 7571-B	
BRAD PHIPPS		
TROY PHIPPS		
LYDIA RAMIREZ		
GLEN SANDERS		

MEMORANDUM

Texas Department of Transportation

TO: North Travis Maintenance Employees **DATE:** December 17, 2010

FROM: Sam Holguin

SUBJECT: Schedule for Inclement Weather for 2010-2011

6am to 6pm		6pm to 6am	Roadway
Tom Brown		Sam Holguin	Monitor all roadways and assist as needed
Tommy Frierson	Shop		Load and repair equipment as needed
David Bauer	Office	Steve Sylvester	Monitor all roadways and assist as needed
William Bonnell	4118E	David Williams	RM1431: Lime Creek-IH35, & FM734
Phillip Morris	3878G	James Sites	RM620 & RM2222
Jimmy Holland	3879G	Gary Gietl	US183: RM620-LP360, FM1325, & LP275
Ben Parada	4730F	Eric Buchhorn	US183: RM620-LP360, FM1325, & LP275
Tim Parlak	4896D	Cody Lewis	US183: RM2243-RM620, RM1431
Jamie Atencio	7517G	Danny Hudson	US183 Main Lanes & OCP

Equipment Available for Incident Management Response:

- 2) Loaders
- 1) Motor Grader
- 1) Rotary Sweepers
- 1) Vacuum Broom
- 5) Arrow Boards
- 3) 10 CY Dump Trucks
- 3) 6 CY Dump Trucks
- 1) 2 CY Dump Truck w/arrowboard
- 1) Herbicide Truck
- 2) Haul Trailers
- 2) Truck Mounted Attenuators
- 1) Fork Lift
- 4) Pickups (2 w/Arrow Boards)

Material on Hand

Liquid De-icer	12,000 Gal
Granular De-icer	41 Bags (2205/Bag)
Grade 1 Aggregate	233 CY
Grade 5 Aggregate	114 CY

All material equipment and personnel will be based at maintenance yard. All seventeen employees at TNMO have a CDL and will assists as needed. We will operate on a rotating 12 hour shift to keep all roadways opened and assist emergency response personnel and stranded motorist.

Winter Weather Plan (Georgetown Maintenance)

1st Response	Equipment	Area to Maintain
Travis Remmert	Pick-up	Supervisor
Tisha Lyda		Office
Timmy Stacy	Pick-up	Asst. Supvr. (Check Area roads / Assist w/ Operations as needed)
Anthony Paidle	Pick-up	Crew Chief (Check Area roads / Assist w/ Operations as needed)
Douglas Havins	10 Yd Dump	IH 35 (ML/FR) - Bell Cty Line to SH 130 (Assist each other as needed)
Roland Thompson	10 Yd Dump	IH 35 (ML/FR) - SH 130 to RM 2338 (Assist each other as needed)
Jeremy Mikes	10 Yd Dump	IH 35 (ML/FR) - RM 2338 to Inner Space Caverns, Spur 158, Spur 26 (Assist w/ Eastern Roads)
Richard parker	10 Yd Dump	IH 35 (ML/FR) - Inner Space Caverns to SH 45, FM 3406, BI 35 L (Assist w/ Eastern Roads)
Charlie Havins	6 Yd Dump	All roads West of IH 35 - US 183, FM 487, FM 2843, FM 970, SH 195, SH 138, FM 3405, RM 2243, SH 29 W
Steve Kelley	6 Yd Dump	All roads West of IH 35 - US 183, FM 487, FM 2843, FM 970, SH 195, SH 138, FM 3405, RM 2243, SH 29 W
Mike Walton	6 Yd Dump	All roads East of IH 35 - FM 971, FM 1105, FM 487 E, US 79, SH 29 E, FM 685, FM 1825
Jeff Snider	Liquid Truck	IH 35 - Bell Cty Line to Lakeway (Assist Sanding Operations as needed)
Cub Brundige	Liquid Truck	IH 35 - Lakeway to SH 45 (Assist Sanding Operations as needed)
Guy Freeman	TMA	Assist w/ one of the Liquid Trucks as needed

Mixing Materials / Load Trucks

Espirio Puga
Harold Buchhorn
Elton Copeland

Materials On Hand

Material	Location	Quantity
Melt Down 20	Yard	124 bags
Mag Chloride (Liquid)	Yard	6800 gal
Sand	Yard	549 cuyd
Grade 5 Aggregate	Yard	500 cuyd

AE Personnel available to assist Maint. Operations

Jason Hudson	Shadow Vehicle
Sherman Coots	Shadow Vehicle
John Peters	Shadow Vehicle
Gerald Pohlmeyer	Shadow Vehicle
Mark Olson	Shadow Vehicle

Equipment On Hand		Location
10 Yd Dump Trucks	4	Yard
6 Yd Dump Trucks	3	Yard
Front End Loaders	2	Yard
Motor Graders	1	Yard
Skid Loader	1	Yard
Sweeper	1	Yard
Crash Cushion Truck	1	Yard
Backhoe	1	Yard
Liquid De-Icing Trucks	2	Yard

*****Available CDL Operators in Maint. 16**
*****Available CDL Operators in AE Office 0**

Note:
Everyone is listed as 1st Response due to not enough CDL Operators to keep all necessary equip. on the road or man the Office for a 2nd shift

Note:
Pre-treating Operations will be performed prior to the event if applicable using a slow moving operation w/ 2 liquid trucks and 3 shadow vehicles for IH 35 ML

SAN MARCOS ICE CONTROL PLAN 2011

DAY CREW SUPERVSOR	DAY CREW OFFICE	DAY CREW TRUCK/SANDER	DAY CREW SHADOW	LOCATION	NIGHT CREW SUPERVSOR	NIGHT CREW OFFICE	NIGHT CREW TRUCK/SANDER	NIGHT CREW SHADOW
				1 **HILL COUNTRY: RM 12, RM 150, RM 1826, RM 3237**				
				2 **IH 35 NORTH: from Blanco river to Onion creek(main lanes) no sand…PFC**				
				2A **IH 35 NORTH: from Blanco river to onion creek(all bridges), FM 1626, RM 967**				
				3 **IH 35 TOWN: from Blanco river to Hays county line (main lanes) no sand…PFC**				
				3A **IH 35 TOWN: from Blanco river to Hays county line, all bridges. Assist main lanes**				
				4 **IH 35 TOWN: from Blanco river to Hays county line RM 12 to city limit, SH 123, SH 80**				
				5 **EAST: SH 21, FM 2001, FM 1984, assist location 6 as needed**				

EMERGENCY NUMBERS

JOE SUSTAITA	**3422**	**512/585-3170**
DONALD LECLERC	**3435**	**512/557-3047**
HENRY RAMIREZ	**3435-1**	**512/557-3046**
BASE STATION		**105**
OFFICE		**512/353-1061**

SHIFTS ARE FROM 6:00 AM - 6:00 PM

APPLICATION RATES FOR "V" BOXES

1. **MELT DOWN 20 BY ITSELF:** SET GATE @ 1/2" - 1" SET VALVE @ 5-8 ON DIAL
2. **SAND/ GRADE #5, MELT DOWN 20:** SET GATE 1 1/2" - 3" DEPENDING ON MOISTURE
3. **LIQUID DE-ICER: PRE-TREAT**

MIX RATIOS ALL TRUCKS

1. 3 LOADER BUCKET GRADE #5, 1 LOADER BUCKET SAND, 4 BAGS SALT
2. 3 LOADER BUCKETS SAND, 1 BAG MELT DOWN 20
3. MELT DOWN BY ITSELF - 1 BAG PER TRIP

EMPLOYEES	EQUIPMENT	MATERIAL IN STOCK
JOE SUSTAITA	**10-YD 3333-H**	**GRADE #5 MODIFIED - 320 CUYD**
DONALD LECLERC	**10-YD 3875-G**	**SAND - 682 CUYD**
HENRY RAMIREZ	**10-YD 5474-F**	**LIQUID DE-ICER - 7939 GALS**
DALE BLUME	**10-YD 4237-J**	**MAG CHLORIDE (MELTDOWN 20) - 120 BAGS**
JOHN BUCKLEY	**10-YD 3304-K**	**MAG ACETATE - 16 BAGS**
SUZIE DOUGLAS	**6-YD 4210-J**	
DAVID DREW	**6-YD 4014-E**	
JOE GARZA	**BACKHOE- 6596**	
BENNY GAY	**LOADER 6828**	
JOE HENNIG	**LOADER 6756-A**	
MICKEY JOHNSON	**BLADE 1062-G**	
TIM MCDONALD	**BLADE 1140-A**	
MICAHEL MCNABB	**HERBICIDE SAN MARCOS - 7505-G**	
RENE PINALES	**HERBICIDE LOCKHART - 7574-B**	
JASON RODRIGUEZ		
MIGUEL RUIZ		
JESSE SERNA		
EDWARD TILL		

MEMORANDUM

Texas Department of Transportation

TO: Law Enforcement Officials – Bastrop County **DATE: November** 19, 2010

FROM: Texas Department of Transportation (Bastrop County)

SUBJECT: Ice Control

This is to inform you of the "Ice Control" efforts which are currently in place by TxDOT's, Bastrop Maintenance office. We will be using a de-icing material called Meltdown 20 and this product will perform more effectively than just using sand and salt. Attached is a list of characteristics of this product. In brief, once the Meltdown 20 has been applied to a frozen surface, the ice will melt leaving only a wet surface. Meltdown 20 is most effective on wet pavement. The product will present a certain sheen resembling black ice but in fact the surface is only wet not frozen. Should Bastrop County experience ice conditions, our intention is to initiate a control plan providing safer roadways for the traveling public.

Please inform all personnel of this new method of controlling frozen roadway surfaces.

For question or concerns please call our office at 512-321-2221.

Ice Control Plan for Winter - 2010/2011
Bastrop Maintenance Section

Maintenance personnel will be divided into two - 12 hour shifts. When ice is anticipated by local weather reports, the beginning shift will standby at the warehouse. All sanding trucks will be prepared with V-box sanders and fueled. Personnel shifts and truck assignments are listed below:

Day Shift: (6:00 a.m. – 6:00 p.m.)

Reggie Woods/Paulette Goertz: Office
Paul Shirocky: 4467-H – *Route 2 (*[redacted])
Angel Beltran 3871-G – Route 3 ([redacted]
Willie Thomas: 3366-J – Route 4 (Yellow)
Marvin Burgess: 3332-J – Route 1 ([redacted]
Vacant Loader/Road Monitor/Back-up Driver

Night Shift: (6:00 p.m. – 6:00 a.m.)

Celso Harper: Office
Pete Peterson: 4467-H – Route 2 ([redacted])
Kip Adams: 3871-G – Route 3 ([redacted])
Bob Kempf 3366-J – Route 4 (Yellow)
Scott Burdette: 3332-J – Route 1 ([redacted])
Vacant Loader/Road Monitor/Back-up Driver

Ice Control Routes – Winter 2010/2011

Route 1- Blue 12,964' = 2.55 mi. = 613.82lbs. (Equip.: 1 ea. 6 yard dump)

Routing:
SH 21/71 – from SH 304 to SH 95N – 5 bridges
SH 21 east – from SH 95 to US 290 – 2 bridges
Loop 150 – from SH 21/71 to Main St. (Bastrop) – 2 bridges

Route 2 – Orange 15,166' = 2.87mi. = 717.50lbs. (Equip.: 1 ea. 10 yard dump)

Routing:
SH 71 from LP 150(Bastrop) to Fayette County Line - 7 bridges
SH 95S from SH 71 to Fayette County Line – 4 bridges
FM 2571 from SH 95 South to SH 304 – 2 bridges
SH 304 – 1 bridge -
FM 535 east from SH 304 – 2 bridges

Route 3 – Green 8,233' = 1.56mi. = 390lbs. (Equip.: 1 ea. 10 yard dump)

Routing:
FM 20 from SH 71 to Caldwell County Line – 6 bridges
FM 535 from FM 20 to SH 21- 2 bridges
FM 535(Pearce Lane) from SH 21 to second bridge – 2 bridges
FM 812 from FM 20 to SH 21 – 2 bridges
FM 672 from FM 812 to county line – 1 bridge
SH 21 from SH 71 to FM 812 – 5 bridges

Route 4 – Yellow 6,124' = 1.16mi. = 290lbs. (Equip.: 1 ea. 10 yard dump)

Routing:
SH 71 from FM 20 to Travis County Line – 4 bridges
FM 969 from SH 71 to Travis County line – 2 bridges
FM 1704 from FM 969 to US 290 – 1 bridge
US 290 (Elgin) – 1 bridge
FM 3000 (Elgin) – 1 bridge
FM 1100 (Loop 109) – 1 bridge
SH 95 from US 290 to SH 21 – 2 bridges
FM 1441 from SH 95 to first bridge – 1 bridge

Route 1 – 9 bridges
Route 2 – 17 bridges
Route 3 – 18 bridges
Route 4 – 13 bridges
57 bridges = 42,487' =8.05mi. = 2011.71lbs. = 1 coverage @ 250lb/lane mile

Bastrop Ice Control Bridge Lengths

Route 1 - Blue			
220	4	880	
220	4	880	
1202	4	4808	
480	4	1920	
1300	2	2600	
126	4	504	
128	4	512	
215	4	860	
		12964/2.4	**615 lbs.**

Route 2 - Pink			
162	4	648	
190	4	760	
1177	4	4708	
370	4	1480	
215	4	860	
303	4	1212	
82	4	328	
1124	2	2248	
155	2	310	
80	2	160	
85	2	170	
110	2	220	
156	2	312	
130	2	260	
		13676/2.5	**647 lbs.**

Route 3 - Green			
522	2	1044	
125	2	250	
530	2	1060	
150	2	300	
526	2	1052	
150	2	300	
120	2	240	
182	2	364	
95	2	190	
170	2	340	
208	2	416	
200	2	400	
290	2	580	
80	2	160	
58	2	116	
133	2	266	
90	2	180	
95	2	190	
460	2	920	
110	2	220	
205	2	410	
		7646/1.45	362 lbs.

Route 4 - Yellow			
100	4	200	
188	4	752	
65	4	260	
90	4	360	
569	2	1138	
86	2	172	
284	2	568	
365	4	1460	
128	2	256	
100	2	200	
290	2	580	
129	2	258	
225	2	450	
		6654/1.26	**315 lbs.**

Route 1	*2.46 mi*	*615 lbs.*
Route 2	*2.59 mi*	*647lbs.*
Route 3	*1.39 mi*	*348 lbs.*
Route 4	*1.26 mi*	*315 lbs.*
Total	**7.98 mi.**	**1996 lbs.**

1 lane mile = approx. 250lbs. - "meltdown 20"

Refer to Ice Control Map for Route Locations

Winter Weather Plan
Taylor Maintenance Section

We watch the weather and if there is a chance of Ice or Snow we split the crew into two groups, 7 people during the day and 5 people at night.

Day Crew 7:00 AM to 7 PM.
Deral Milliken- CDL
Randy Nelson -Office no CDL
Jackie Volek-CDL
Fred Wilson-CDL
Jeremiah Boehme-CDL
Vacant- CDL
Vacant- CDL

Night Crew 7:00O PM to 7:00 AM.
James Henderson-CDL
Clinton Anderson-CDL
James Cole-CDL
Mike Schneider-CDL
Vacant-CDL

Equipment
3 each-10 Yard Dump Trucks with V-Box Spreaders.
2 Each- 6 Yard Dump Trucks with V-Box Spreaders.
2 each- front end loaders.
1 each- Fork Lift.
1 each-TMA.
1 each- Herbicide Truck

Deicing Agents
3,810 Gallons of Liquid Magnesium Chloride.-Taylor Maintenance Yard
43 Super Sacs of Meltdown 20. - Taylor Maintenance Yard
400 CY of Sand. - Taylor Maintenance Yard

From: Terry Brussel
To: Wayne Rehnborg
Date: 12/21/2010 3:40 PM
Subject: Fwd: Re: Winter Weather Plan

>>> Terry Brussel 12/16/2010 10:02 AM >>>

The Johnson City Maintenance Section does not have a formally written winter weather response plan. We operate on a case by case basis utilizing our resources available at the time.

We have 12 employees other than myself. (total 13) We will work shifts as directed by me.

Equipment Inventory:

Loader 1
Skid Steer 1
2- 6 yards with V-Boxes
3- 10 yards with V-Boxes

Materials Inventory:

Sand- 400 cubic yards
Grade 5-150 cubic yards
15-2000# bags of Mag Chloride

From: Anthony Reitan
To: Wayne Rehnborg
Date: 12/17/2010 9:17 AM
Subject: Re: Winter Weather Plan

Here is Burnet Maintenance plan:
12 people working 12 hour shifts with 6 people per shift. (the A/E Office has 3 people if needed.)
Equipment : 6 -V-Box Spreaders 2-6 yard
3-10 yard
1-1/2 yard
3-Front end loaders
2-Graders
2-Drag type snow plows
1- Sweeper with plow blade

Anthony J. Reitan
Texas Department of Transportation
Burnet Maintenance Section Supervisor
PH# (512)-756 -2315
Fax#(512)-756-4251
Anthony.Reitan@txdot.gov

From: Anthony Reitan
To: Wayne Rehnborg
Date: 12/22/2010 9:09 AM
Subject: Fwd: Re: Winter Weather Plan

>>> Anthony Reitan 12/22/2010 8:56 AM >>>

Burnet Winter Weather Materials Inventory: All materials located in maintenance yard

48 super sacks of deicer
50-50 lbs bags of deicer
400 tons of sand
500 tons of grade 5 rock.

Gillespie County Maintenance
Winter Weather Plan

Available Employees:

Employee	Position	Office	CDL	HCRS Input
Daniel Crenwelge	Maint. Supv.	Maint.	√	√
Doyle Moellering	Asst. Maint. Supv.	Maint.	√	√
Kristi Koch	Office Manager	Maint.		√
Karl Wilke	Crew Chief	Maint.	√	
Russell Hartmann	Sign Tech	Maint.	√	
Dennis Segner	Maint Tech	Maint.	√	
Will Weidenfeller	Maint Tech	Maint.	√	
Randy Kalka	Maint. Tech	Maint.	√	
Lonnie Hohmann	Maint. Tech	Maint.	√	
David Wiemers	Maint. Tech	Maint.	√	
Dennis Behrends	Sign Tech	Maint.	√	
Girard Behrends	Maint. Tech/Office Backup	Maint.	√	√
Denzal Wright	Maint. Tech	Maint.	√	
Keith Schneider	Mechanic	Region	√	
Stevie Kothe	Eng. Tech	AE		

Available Equipment:

Equipment No.	Description	Sander Available
1350	John Deere motor grader	
3330-J	Ford 6 cy dump truck	√
3343-K	Ford sign truck	
4027-J	Chevrolet pickup	
4128-E	GMC 6 cy dump truck	
4129-E	GMC 6 cy dump truck	√
4413-H	Ford pickup	
4553-H	Chevrolet field mechanic truck	
4871-H	Chevrolet pickup	
4898-D	Ford 6 cy dump truck	
4730-G	International 10 cy dump truck	√
5445-D	Chevrolet 6 cy dump truck	√
5585-F	Ford 10 cy dump truck	√
5678-H	Ford pickup	
5575-J	Ford baby dump truck	
6114-B	GMC bucket truck	

6559-G	New Holland backhoe	
6693-G	Case loader	
6847-A	Case loader	
8368-K	Broce road sweeper	
8420-A	Equipment trailer	
8707-G	Equipment trailer	
8037-L	Electronic Changeable Message Trailer	
####	Cone/sign trailer	

Available de-icing materials/aggregates:

Description	dht #	Quantity	unit	Location
De-icer; MeltDown 20	150669	37	3000 lb bag	Fredericksburg maintenance yard
Salt	11563	506	50 lb bag	Fredericksburg maintenance yard
Sand	11542	165	cubic yards	Fredericksburg maintenance yard
Aggregate; gr. 5-mod	88375	202	cubic yards	Fredericksburg maintenance yard

From: Lana Nickel
To: Wayne Rehnborg
Date: 12/21/2010 3:08 PM
Subject: Fwd: Re: Winter Weather Plan

>>> Lana Nickel 12/20/2010 10:20 AM >>>

The Giddings Maintenance Section has 9 employees that will be doing shift work and that have their cdl's. At present we have not ask for anyone from AE office.
We have: 4 pick up trucks, 2 loaders and 4 spreaders for 10 yard dump trucks.
We also have 19 bags of deicer stockpiled in the maintenance yard.

Lana S. Nickel
Giddings / Lee County
Office manager
Ph: 979-542-5568
Fax: 979-542-9713

Llano Maintenance
Winter Weather Plan

# Of Employees with CDL	Equipment Available	Materials Available
13	Three 10 yard dump trucks with sanders.	20 bags of melt down 20 (approx. 2000#'s per bag) DHT# 150669
	Two 6 yard dump trucks with sanders.	168 CY of Sand (DHT# 162218)
	Two rubber tired loaders.	177 CY of Grade Special Aggregate (DHT# 162058)
	One maintainer.	
	One skid steer loader.	
	One rotary broom.	
	One Herbicide truck for spraying liquid de-icer.	

From: Elba Nail
To: Wayne Rehnborg
Date: 12/16/2010 9:43 AM
Subject: Re: Winter Weather Plan

Personnel available with CDL: Elba Nail, Randy Stockbridge, Chris Ake, Jared Carter, Cole Farmer, Terry Geistweidt, Joey Ingracia, Sean Reardon, Dennis Simon, Charles Schmidt and Rick Smith. Gwen Stockbridge (no CDL)is available for office

Equipment available: (10 cy. trucks-- 5586-F, 4732-G) (6 cy. dump trucks-- 4130-E, 3360-H, 3326-J) (Loaders-- 6848-A, 6776, 6517-A) (Broom--8390-H) (maintainer-- 1031-A) (pickups-- 4908-H, 4407-H, 4291-F, 5324-J, 4555-H) (V-box sanders-- 10 yd (2), 6yd (3),) (pickup sanders (4) (sm. truck (1))

Materials and quantities: Sand-- 330cy, gr. 5-- 80cy, gr.4 lw-- 333 cy. meltdown 20-- 14 bags. (each bag is 3000 lb)

Don't have any written plan, shifts are split with half of employees on nights and half on days, 7pm to 7AM

Austin District Toll Road Winter Weather Plan

- **ISI (maintenance contractor) has 9 V-BOX spreaders 4 of these are on dump trucks and 5 are mounted on flat bed trucks that do not require CDL drivers. All spreaders are manufactured by Bonnell and have a 6 yard capacity. ISI has a total of 9 CDL drivers. The plan is to have 32 contract employees to work split 12 hour shifts with 16 working each shift. ISI also has 7 liquid applicators to spray Mag-Chloride. ISI has one loader and will rent another as soon as winter weather forecasted**

- **Once winter weather is eminent ISI will be out on stand by. We will begin pre-treatment depending on moisture on pavement will determine if we will use liquid or granular. Once ice has formed we will treat pavement with both liquid and granular de-icier. We also will before storm stage barrels at key ramps and other areas that ice over more incase we need to close these areas.**

- **We have in stock 134 bags of granular de-icier and 9200 gallons of liquid de-icier. These are stock piled in two locations. One is at LP 1 and SH 45 and the other is on SH 130 at Greg/ Manor Road. Each location has 62 bags of granular and 6000 gallons at the LP1/ SH 45 site and 3200 gallons at the SH 130 site. The plan is to order 4500 more gallons for the SH 130 site.**

Houston District

Freeze Response Plan
2010-2011

The Houston District provides services for more than nine thousand lane miles of roadways within a six-county area. The size of this investment and the importance of transportation in Houston and the surrounding area, compel us to ensure that we meet our responsibilities and effectively respond to freeze conditions.

The following individuals are responsible for securing the work force, materials and equipment to respond to freezing/icing conditions:

FIELD OFFICES

See the Highway Condition Report (HCRO) access list. For updates contact the Public Information Office, at 713-802-5076.

PRE-FREEZE INITIATIVES

A. Area engineers will be responsible for performing, annually, the following tasks by November 24:
   1. Determine number of hours needed to cover all roadways in area of responsibility so that anti-icing material can be placed prior to icing. Check herbicide trucks to ensure their readiness to apply this material.
   2. Verify that sufficient quantities of anti-icing and de-icing materials are on hand to support a freeze response. Procurement of these materials may take two months, so plan ahead.
   3. Conduct meeting with local law enforcement. Solicit their support and assistance during freeze response periods.
   4. Open all "Watch for Ice on Bridge" sign. Close signs after March 8.

B. The District Emergency Operations Center (EOC) will be responsible for performing, annually, the following tasks by November 24:
   1. Determine that all telephone lines into the EOC are operational. The EOC is located at 7600 Washington Avenue, room 122.
   2. Conduct meeting with Police Chief of local area law enforcement agencies. Brief them on our freeze plan strategy and solicit their support.

FREEZE RESPONSE INITIATION

A. Each area engineer will be responsible for monitoring road conditions in their area of responsibility. When freezing conditions are forecast, the area engineer will:

   1. Coordinate with adjacent maintenance offices or districts.
   2. Mobilize manpower and materials.
   3. Coordinate assistance from local law enforcement and emergency management partners.

4. Notify the EOC of initial activities and complete resource survey at 11:00 A.M. and 4:00 P.M. through EOC website until the freeze response is over.

B. The EOC will be responsible for:
   1. Monitoring weather throughout district with assistance of National Weather Service (NWS).
   2. Tracking the freeze response efforts of each maintenance office.
   3. Securing additional personnel to assist sections.
   4. Coordinate assistance from local law enforcement and emergency management partners.
   5. Informing freeze response activities to:
      a. District Engineer
      b. EOC Staff
      c. Public Information
      d. East Region Service Center
      e. Houston TranStar

WORK FORCE, MATERIALS & EQUIPMENTS

Each area engineer will be responsible for identifying the resources that they need to keep their roadways open during freezing conditions. Staffing will also include office personnel to answer phones, monitor radio, monitor EOC SharePoint and update (HCR). If additional personnel are needed, notify the EOC.

Anti-icing and de-icing materials are stored at each maintenance site and the district office. Storage tank locations for the liquid anti-icing material are as follows:

LOCATION	TANK CAPACITY
Central Houston	21,000 gallons
North Harris Maintenance	12,000 gallons
East Harris Maintenance	9,000 gallons
West Harris Maintenance	15,000 gallons
South Harris Maintenance	3,000 gallons
Montgomery Maintenance	6,000 gallons
Waller Maintenance	6,000 gallons
Fort Bend Maintenance	3,000 gallons
Brazoria Maintenance	6,000 gallons
Galveston Maintenance	6,000 gallons

No special equipment is required for application of the anti-icing and the de-icing materials. Granular material will be applied with V-box spreads and the liquid will be applied by herbicide sprayers. Additional equipment can be obtained by contacting the DEC.

In the event that anti-icing and de-icing material supplies run out, we will use aggregate as our alternate response material. This measure is labor intensive and will require shifting of various roadways to different maintenance offices for handling.

Materials are procured to cover treatment of structures only. When icing occurs on the roadway, plans and coordination with local law enforcement should be made so that roadways can be closed to traffic.

SUPPORT OPERATIONS AT DISTRICT HEADQUARTERS

The EOC will be responsible for coordinating all activities at the district level. The EOC will secure additional manpower and materials for maintenance offices when needed. The EOC will coordinate all requests for services that involve Houston TranStar.

The East Region Service Center Shop will be open to repair equipment throughout the duration of the freeze response. The Equipment Administrator will be responsible for keeping adequate staff on hand to repair equipment.

The District Warehouse will be open to procure additional supplies throughout the duration of the freeze response. The Warehouse Supervisor will be responsible for keeping adequate staff on hand to purchase needed supplies.

The District Public Information Office will be responsible for handling all road condition calls at headquarters and responding to all media inquiries. Highway condition reporting will be as outlined in the Highway Condition Reporting Plan. A copy of this plan is provided in the Appendix of this document.

LONG RANGE PLANS

Continue to establish a weather information system strategically located in the district to assist in forecasting severe and/or changing weather conditions.

Conduct annual training on the Freeze Response Plan.

DALLAS DISTRICT WINTER STORM PLAN

District Objective

TxDOT Dallas District's objective is to always provide motorists with a safe travel way through the Dallas District, even during inclement winter weather events. Maintaining traffic flow on our roadways, bridges and overpasses is accomplished through the strategic use of the limited available resources at our disposal as well as the dedication, determination and teamwork of the men and women of the Dallas District.

Maintenance of the Dallas District roadways has become more challenging due to higher public expectations, increasing traffic volumes and a maintenance restructuring program that has streamlined day to day maintenance operations by redistributing personnel and equipment to maintenance sections outside of the metropolitan area. To maintain satisfactory levels of service, the district must continue to strive for maximum effectiveness from its crews, equipment and materials.

District Maintenance, with assistance from District Transportation, District Public Information Office and all Maintenance Sections throughout the Dallas District, will coordinate and develop a Dallas District Snow and Ice Control Plan. The plan will establish priorities, resource management, communications and operational procedures and protocols in order to make the most effective use of limited resources.

Advance winter storm preparations

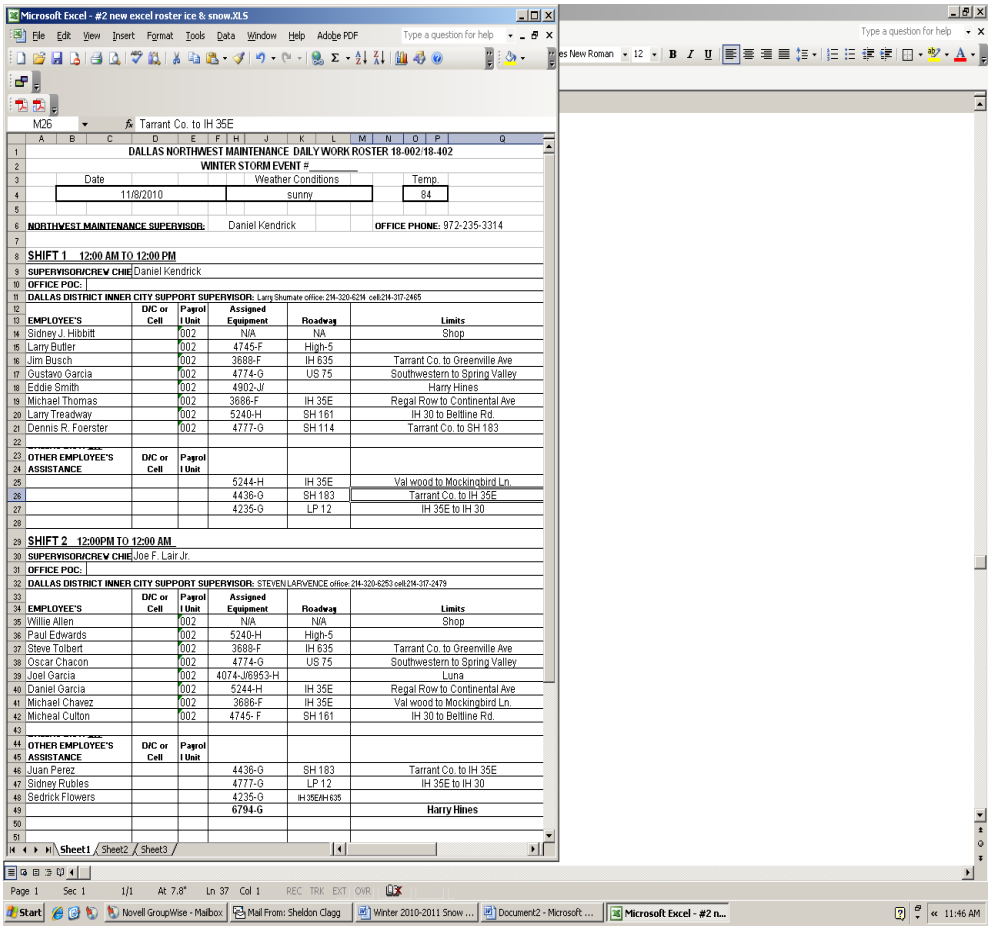
Each year prior to the 15th of November, all supervisory personnel responsible for winter storm operations will work collaboratively to complete preparation for winter storm operations and the update the district's winter storm plan. The main aspects of this effort are as follows:

- General
  - To effectively maintain the metropolitan area in Dallas County and the surrounding counties, resources will be pooled, personnel will be redistributed and maintenance sections will assist neighboring sections. Maintenance sections will focus on preparation and staging of our work forces and equipment.
  - A color-coded district map will be updated each year indicating material stockpile locations and routes (by priority) to be covered by each maintenance office. This map will be available on the EOC SharePoint site.

- Personnel
  - The Dallas District Maintenance Sections and District Maintenance will identify qualified personnel and utilizing a 'Buddy System' will shift employees where needed to accomplish the District's objectives. It is also required that supervisors pre-determine work crews if shift work becomes necessary during an extended storm event. Work crews should be a mix of experienced and inexperienced crew members. Maintenance supervisors will maintain a list of names and home phone numbers for these employees. To field the most experienced crew possible, every

attempt should be made to utilize the same personnel each year.

- Employees stationed at the district campus (Bridge Crew, Heavy Equipment Crew and Sign Crew) will be assigned to the various maintenance sections to assist in winter storm operations for the duration of each event,
- CDL operators will be assigned to dump trucks. Follow vehicles and pickup spreaders may be operated by non-CDL employees.
- To ensure maintenance personnel will be well rested and alert during a snow/ice event, each maintenance section will operate two shifts (beginning at 12 a.m. and ending at 12 p.m.).
- Each Maintenance Section will complete and maintain updates of the standard shift roster provided located in that office's section of the District's EOC SharePoint site. The roster will include the names and payroll units of all employees, their direct connect or cell phone number the equipment assigned to each employee and their duty location (route, stockpile location or office) for each of two twelve hour shifts beginning and ending from 12:00 am to 12:00 pm.



Microsoft Excel - #2 new excel roster ice & snow.XLS

DALLAS NORTHWEST MAINTENANCE DAILY WORK ROSTER 18-002/18-402

WINTER STORM EVENT #_____

Date	Weather Conditions	Temp.
11/8/2010	sunny	84

NORTHWEST MAINTENANCE SUPERVISOR: Daniel Kendrick OFFICE PHONE: 972-235-3314

SHIFT 1 12:00 AM TO 12:00 PM

SUPERVISOR/CREW CHIE Daniel Kendrick

OFFICE POC:

DALLAS DISTRICT INNER CITY SUPPORT SUPERVISOR: Larry Shumate office: 214-320-6214 cell:214-317-2465

EMPLOYEE'S	D/C or Cell	Payroll Unit	Assigned Equipment	Roadway	Limits
Sidney J. Hibbitt		002	N/A	NA	Shop
Larry Butler		002	4745-F	High-5	
Jim Busch		002	3688-F	IH 635	Tarrant Co. to Greenville Ave
Gustavo Garcia		002	4774-G	US 75	Southwestern to Spring Valley
Eddie Smith		002	4902-J/		Harry Hines
Michael Thomas		002	3686-F	IH 35E	Regal Row to Continental Ave
Larry Treadway		002	5240-H	SH 161	IH 30 to Beltline Rd.
Dennis R. Foerster		002	4777-G	SH 114	Tarrant Co. to SH 183
OTHER EMPLOYEE'S ASSISTANCE	D/C or Cell	Payroll Unit			
			5244-H	IH 35E	Val wood to Mockingbird Ln.
			4436-G	SH 183	Tarrant Co. to IH 35E
			4235-G	LP 12	IH 35E to IH 30

SHIFT 2 12:00PM TO 12:00 AM

SUPERVISOR/CREW CHIE Joe F. Lair Jr.

OFFICE POC:

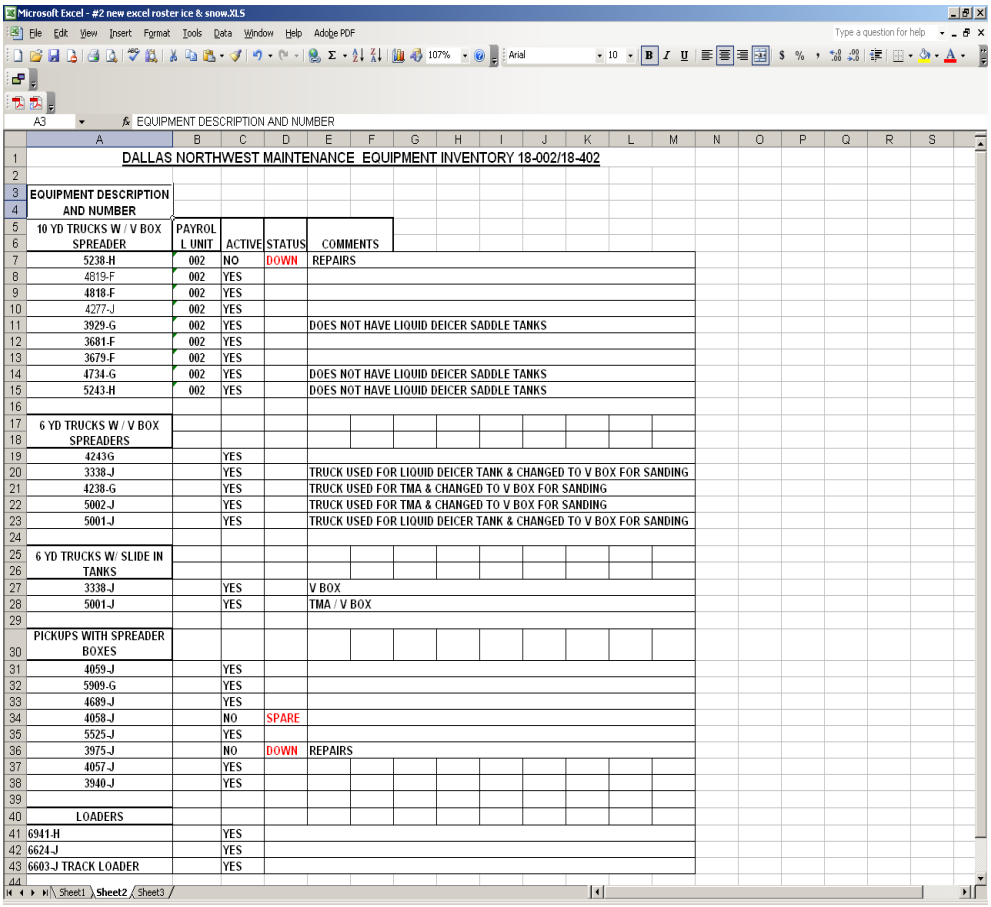
DALLAS DISTRICT INNER CITY SUPPORT SUPERVISOR: STEVEN LARVENCE office: 214-320-6253 cell:214-317-2479

EMPLOYEE'S	D/C or Cell	Payroll Unit	Assigned Equipment	Roadway	Limits
Willie Allen		002	N/A	N/A	Shop
Paul Edwards		002	5240-H	High-5	
Steve Tolbert		002	3688-F	IH 635	Tarrant Co. to Greenville Ave
Oscar Chacon		002	4774-G	US 75	Southwestern to Spring Valley
Joel Garcia		002	4074-J/6953-H		Luna
Daniel Garcia		002	5244-H	IH 35E	Regal Row to Continental Ave
Michael Chavez		002	3686-F	IH 35E	Val wood to Mockingbird Ln.
Micheal Culton		002	4745- F	SH 161	IH 30 to Beltline Rd.
OTHER EMPLOYEE'S ASSISTANCE	D/C or Cell	Payroll Unit			
Juan Perez			4436-G	SH 183	Tarrant Co. to IH 35E
Sidney Rubles			4777-G	LP 12	IH 35E to IH 30
Sedrick Flowers			4235-G	IH 35E/IH 635	
			6794-G		Harry Hines

Equipment

- All necessary equipment for a snow/ice event will be thoroughly inspected and must complete a test run prior to November 15 of each year.
- Each Maintenance Section will complete and maintain updates of the

standard equipment spreadsheet located in that office's section of the District's EOC SharePoint site. The spreadsheet will include the equipment number, equipment type and status (active, idle or down for repair) of all equipment either engaged in or available for use in winter storm operations.



Microsoft Excel - #2 new excel roster ice & snow.XLS

A3: EQUIPMENT DESCRIPTION AND NUMBER

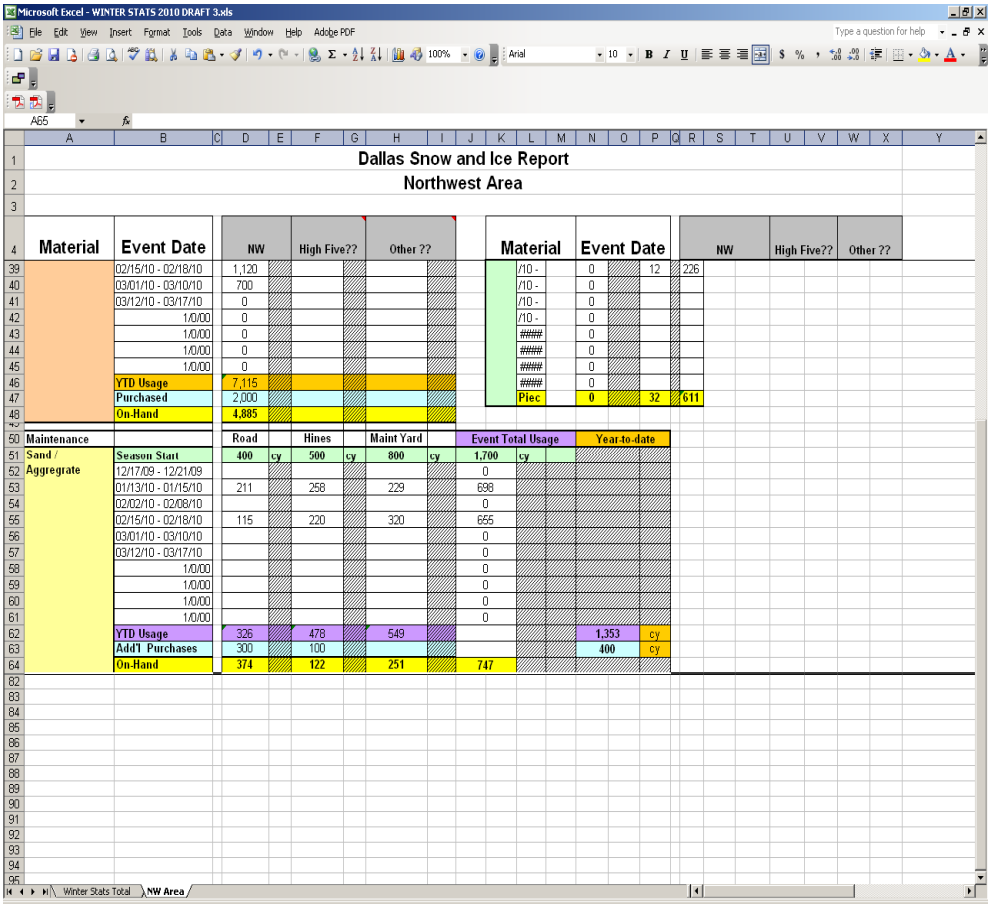
DALLAS NORTHWEST MAINTENANCE EQUIPMENT INVENTORY 18-002/18-402

EQUIPMENT DESCRIPTION AND NUMBER	PAYROLL UNIT	ACTIVE	STATUS	COMMENTS
10 YD TRUCKS W / V BOX SPREADER				
5238-H	002	NO	DOWN	REPAIRS
4819-F	002	YES		
4818-F	002	YES		
4277-J	002	YES		
3929-G	002	YES		DOES NOT HAVE LIQUID DEICER SADDLE TANKS
3681-F	002	YES		
3679-F	002	YES		
4734-G	002	YES		DOES NOT HAVE LIQUID DEICER SADDLE TANKS
5243-H	002	YES		DOES NOT HAVE LIQUID DEICER SADDLE TANKS
6 YD TRUCKS W / V BOX SPREADERS				
4243G		YES		
3338-J		YES		TRUCK USED FOR LIQUID DEICER TANK & CHANGED TO V BOX FOR SANDING
4238-G		YES		TRUCK USED FOR TMA & CHANGED TO V BOX FOR SANDING
5002-J		YES		TRUCK USED FOR TMA & CHANGED TO V BOX FOR SANDING
5001-J		YES		TRUCK USED FOR LIQUID DEICER TANK & CHANGED TO V BOX FOR SANDING
6 YD TRUCKS W/ SLIDE IN TANKS				
3338-J		YES		V BOX
5001-J		YES		TMA / V BOX
PICKUPS WITH SPREADER BOXES				
4059-J		YES		
5909-G		YES		
4689-J		YES		
4058-J		NO	SPARE	
5525-J		YES		
3975-J		NO	DOWN	REPAIRS
4057-J		YES		
3940-J		YES		
LOADERS				
6941-H		YES		
6624-J		YES		
6603-J TRACK LOADER		YES		

Sheet1 Sheet2 Sheet3

- Materials
  - All snow and ice control materials (aggregate, salt, liquid MgCl, granular MgCl chloride etc.) will be ordered, and appropriately stored/stockpiled prior to November 15 of each year. Sufficient materials will be stocked for a minimum of two to three day snow/ice event. Materials to replenish depleted stock will be ordered immediately after each winter event.
  - Each Maintenance Section will complete and maintain updates of the standard materials spreadsheet located in that office's section of the District's EOC SharePoint site. The spreadsheet will include stockpile or material storage locations of all available ice and snow control materials and the quantity in inventory.

DALLAS DISTRICT WINTER STORM PLAN



Microsoft Excel - WINTER STATS 2010 DRAFT 3.xls

Dallas Snow and Ice Report

Northwest Area

Material	Event Date	NW	High Five??	Other ??
	02/15/10 - 02/18/10	1,120		
	03/01/10 - 03/10/10	700		
	03/12/10 - 03/17/10	0		
	1/0/00	0		
	1/0/00	0		
	1/0/00	0		
	1/0/00	0		
	YTD Usage	7,115		
	Purchased	2,000		
	On-Hand	4,885		

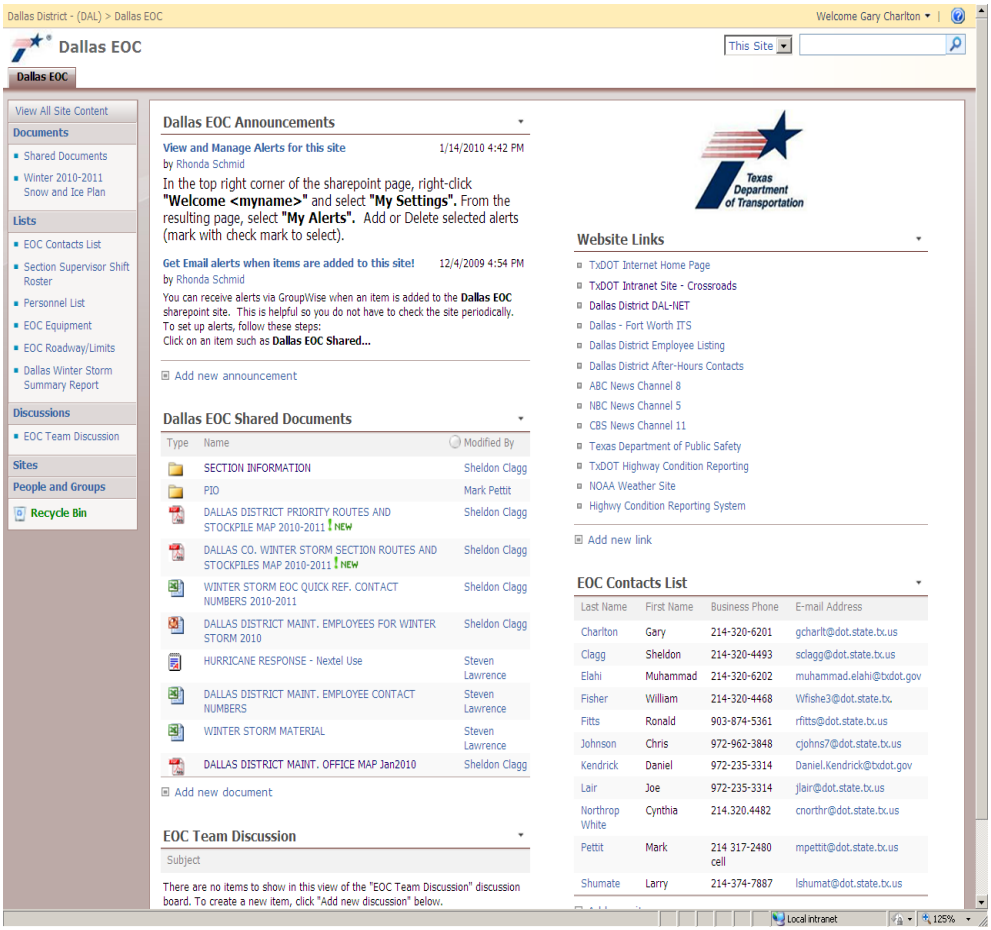
Material	Event Date	NW	High Five??	Other ??
	/10 -	0	12	226
	/10 -	0		
	/10 -	0		
	/10 -	0		
	#####	0		
	#####	0		
	#####	0		
	#####	0		
	Piec	0	32	611

Maintenance		Road		Hines		Maint Yard		Event Total Usage		Year-to-date	
Sand / Aggregate	Season Start	400	cy	500	cy	800	cy	1,700	cy		
	12/17/09 - 12/21/09							0			
	01/13/10 - 01/15/10	211		258		229		698			
	02/02/10 - 02/08/10							0			
	02/15/10 - 02/18/10	115		220		320		655			
	03/01/10 - 03/10/10							0			
	03/12/10 - 03/17/10							0			
	1/0/00							0			
	1/0/00							0			
	1/0/00							0			
	1/0/00							0			
	YTD Usage	326		478		549				1,353	cy
	Add'l Purchases	300		100						400	cy
	On-Hand	374		122		251		747			

Winter Stats Total | NW Area

- ## Communications
  - District Maintenance personnel will be on duty in the EOC (Emergency Operations Center) in the DalTrans Building at the Dallas District complex during an event. All Dallas District EOC personnel must prepare in advance to be available to make a timely response to snow and ice events.
  - It is the intent that the Dallas EOC be the central point for internal communication and coordination between maintenance sections, with other districts and Austin headquarters. The Dallas districts EOC SharePoint site shall be the primary tool for such communications and coordination. District Maintenance EOC staff will provide initial instruction on the content, features and use of the site. It will be the responsibility of all supervisors to assure that personnel trained and familiar with site are available for all winter storm events.
  - The Public Information Office (PIO) will be responsible for managing all communications with the media and the public.

DALLAS DISTRICT WINTER STORM PLAN



- <u>Pre-storm procedures</u>
  - The safety of TxDOT personnel and the traveling public is of the utmost importance. Prior to deployment for a storm event, all maintenance section supervisors will conduct a safety meeting with their section personnel to discuss storm-related safety issues.
  - Prior to an apparent storm event snow and ice control equipment shall be mounted and made ready for rapid response.
  - Approximately 12 hours prior to an imminent winter storm event the District EOC will issue an activation notice in the form of a SharePoint discussion item. This notice will designate winter storm event number, the expected progress of freezing precipitation impacts on the district's roadways, any special instructions and a check list of standard instructions and procedures.
  - Four hours prior to the anticipated onset of freezing pavement condition the EOC will be fully staffed and equipped to perform its role in coordinating winter storm operations.
  - The task numbering convention for winter storms will be "Y*S###" where * is the first digit of the fiscal year (0 for 2010, 1 for 2011 etc.) and ### is the storm sequence number for the fiscal year (001 first storm, 002 second storm etc.).

- Example: the task number for the first winter storm of fiscal year 2011 would be Y1S001.

- Each Maintenance Section Supervisor (or designated shift supervisor) will be responsible for monitoring local weather conditions prior to the onset of freezing precipitation and reporting their operational status at least every 4 hours and at the point at which personnel begin pre treatment operations.
- Pre-treatment application is encouraged to prevent hazardous conditions and should be implemented whenever rain prior to freezing conditions would negate its effectiveness. Bridges, overpasses, steep inclines, known trouble spots should be pretreated using liquid anti-icing material. If time permits, all lanes at these locations should be pretreated, but at the very least, one lane (far right) will be pretreated.

Winter storm operations

- **De-icing**
  - Materials such as granular Magnesium chloride will be applied to roadways in order of their pre-established priority using conventional spreaders or pickup spreaders.
  - The primary priority will be to de-ice the right lane of all priority routes. This process will be repeated as necessary. If conditions allow additional lanes will be treated to increase traffic flow. A sand/salt mixture should be applied for traction when needed.
- **Snow and ice removal**
  - Motor graders should be used to remove accumulations of snow to prevent melting and refreezing and ice damming of melt water on the travel way.
  - Slushing with dump trucks should begin as soon as possible to accelerate melting of snow and/or ice particularly on outside shoulders where ice damming may occur.
- **Communications**
  - All Maintenance Section offices will update their operational status at least every four hours or as major events such as accidents, increased storm intensity and the like result in significant changes in their operational circumstances.
  - At each 12 hour shift change each office will be responsible for updating their shift roster, equipment and materials inventory spreadsheets on the EOC SharePoint site. It is understood that during the storm the accounting for materials used will be estimate only. An accurate accounting will be made as part of post-storm procedures.
  - EOC staff will post all HCRS notices based on the status updates provided by each office.
  - A request in the form of an EOC SharePoint discussion item will be submitted to the EOC if at any point in a winter storm event any office is in need of additional materials, personnel or equipment. The district EOC staff will locate whatever additional resource necessary and task those resources with assisting the requesting maintenance office.
  - The EOC should be contacted when it becomes apparent that a road section

will need to be closed because of snow or ice. The EOC will then notify the Department of Public Safety (DPS) or local law enforcement jurisdictions of the pending closure. The EOC will also advise PIO. For highways crossing district lines the closure should be coordinated with the appropriate neighboring district counterparts.

- Each office will report to the EOC via SharePoint when winter storm response operations have ceased in there area of responsibility. As each office reports the cessation of winter storm operations in there area the EOC will make a determination if the reporting office's resources are needed in another location. If they are not, the reporting office will be authorized to stand down. Once all offices have ceased winter storm operations The EOC will post a deactivation notice via SharePoint.

Post-storm procedures

- **After action report**
  - Each Office will prepare a brief "after action report" and submit it to the Director of Maintenance and PIO no more than 5 working days after the end of the latest event. The report should include total man-hours worked, total overtime hours paid, total overtime cost, total labor cost and any specific or unusual problems and suggestions for improvement.
  - If necessary an after action conference call will be initiated with all offices by the Director of Maintenance.
- **Aggregate removal**.
  - As soon as excess ice aggregate is dry enough to remove with vacuum sweepers, all TxDOT and contractors' sweepers will be utilized continuously until cleanup is complete.
- **Equipment cleanup, inspection and repair**
  - All equipment used during the storm event will be thoroughly washed and inspected to determine if any repairs are required. Repairs shall be promptly completed to ensure equipment is ready for the next storm event.
- **Resource updates**
  - Each office will be responsible for accurate updating their shift roster, equipment and materials inventory spreadsheets on the EOC SharePoint site

Fort Worth District
Snow & Ice Plan
FY 11

District Objective

Keep all district-maintained roadways, bridges and overpasses open during snow and ice events by using anti-icing chemicals prior to the event and deicing chemicals during the event while limiting the use of sand/salt mixture as much as possible due to environmental concerns, potential damage to bridge structures and large cleanup costs. Entire roadway lengths will not be treated, only bridges, overpasses, steep inclines, known trouble spots and roadways leading to the DFW Airport entrances. PIO staff will assist with providing information to motorists of hazardous driving conditions through the use of overhead electronic message boards, media interviews, TV and radio news stations, and various internet web sites.

Maintenance Section Plan

Each maintenance supervisor will prepare/update a Snow and Ice Control Plan and submit it to the Director of Maintenance by September 15 of each year. This plan will include:

1. Color-coded section map indicating routes to be covered by each crew.
2. Listing (by location) of stockpiled materials to be used.

Resources

Personnel – Each maintenance section will operate two twelve hour shifts during a snow and ice event so that employees will be rested and alert. Commercial Driver License operators will be assigned to dump trucks. Follow vehicles and pickup spreaders may be operated by non-CDL employees. Each maintenance section supervisor will contact his/her area engineer to acquire available personnel to man the follow vehicles. Additional follow vehicle employees may be obtained from the Signal Shop and District Lab. Maintenance supervisors will maintain a list of names and home phone numbers for these employees. To field the most experienced crew possible, every attempt should be made to utilize the same personnel each year. All employees will be trained in the use of their assigned equipment. Only the most experienced employees will be assigned on the major interchanges as these are the most difficult and dangerous to maintenance during snow and ice events.

Equipment – All necessary equipment for a snow and ice event will be thoroughly inspected and must complete a test run prior to October 1 of each year and again just prior to each storm event.

Materials – All snow and ice control materials (aggregate, salt, liquid MgCl, and Meltdown 20) will be ordered, tested and appropriately stored/stockpiled prior to October 15 of each year. Sufficient materials will be stocked for a week-long ice/snow event. Materials to replenish depleted stock will be ordered immediately after each storm.

Operations

Safety – A safety meeting will be held in every maintenance section prior to each storm event to discuss storm-related safety issues.

Weather Forecasting – Maintenance supervisors will be responsible for monitoring the local forecast and calling employees to work based upon the forecast.

Storm Event – All bridges, overpasses, steep inclines, known trouble spots and roadways leading to the entrances of the DFW Airport will be pretreated using liquid anti-icing material. If time permits, all lanes at these locations will be pretreated, but at the very least, one lane will be pretreated. When precipitation begins to fall, apply Meltdown 20 (granular) using conventional spreaders or pickup spreaders to create a solution that will delay freezing. Repeat this process as necessary. A sand/salt mixture can be applied for traction when necessary, but the granular MgCl applications should continue. Use motor graders during a snow event to remove the snow and prevent melting and refreezing on the roadways. Slushing with dump trucks should begin as soon as possible to accelerate melting of snow and/or ice. HCRS will be updated by each Maintenance Section on an as needed basis. Conference calls will be held as needed. The conference calls will be held at least every twelve hours with all maintenance sections in attendance as well as PIO. The host will always be District Maintenance. A District EOC is only opened during an extreme event, primarily an extended storm. The EOC will be manned by District Maintenance and PIO staff. PIO staff will be updated through out the entire event via phone calls, e-mails, and text messages, if the EOC is not opened.

Post-Storm Review – The Director of Maintenance shall call a meeting of all maintenance supervisors and other key personnel shortly after the storm event to discuss procedures that worked and identify those that did not so changes may be implemented prior to the next storm event.

Post-Storm Cleanup – Aggregate used for snow and ice control creates an undesirable condition on the roadways after a storm event due to decreased traction and dust; therefore, use of this aggregate should be kept to a minimum. Aggregate needs to be removed as soon as practical. All TxDOT and contractors' sweepers will be utilized continuously until cleanup is complete. All equipment used during the storm event will be thoroughly washed and inspected to determine if any repairs are required. Repairs shall be promptly completed to ensure equipment is ready for the next storm event.

Post-Storm Reporting – Immediately after a storm event, each maintenance section will report the following information to the Director of Maintenance:

- total man-hours worked
- total overtime hours paid
- total overtime cost
- total labor cost
- ice aggregate used (cy)
- salt used (lbs)
- liquid MgCl used (gal)
- granular Meltdown 20 used (lbs)

Snow & Ice Phone Numbers

Fort Worth District Contacts

Office	Title	Name	Office	Mobile	Home
District Maintenance	Director of Maintenance	Richard Schiller	817-370-6521	817-821-7212	817-581-6540
	Maintenance Administrator	Alan Easterling	817-370-6746	817-584-4753	817-447-6371
Hood, Erath, & Somervell Counties	Supervisor	James Hand	254-897-2647	817-713-5248	817-558-7926
	Assistant Supervisor, Erath County	Albert Ray	254-965-3511	817-368-5830	254-968-3465
	Assistant Supervisor, Hood & Somervell Counties	David Moore	254-897-2647	817-917-4117	817-279-0473
Jack & Wise Counties	Supervisor	Ricky Tompkins	940-626-3400	817-235-3411	940-627-7295
	Assistant Supervisor, Jack County	Ronnie Abernathie	940-567-6611	817-313-4129	940-567-3408
	Assistant Supervisor, Wise County	Juan Flores	940-627-2545	817-205-7208	940-626-1576
Johnson & South Tarrant County	Supervisor	Ralph Garza	817-370-6903 or 817-202-2900	817-235-3416	817-483-9573
	Assistant Supervisor	Scott Jones	817-275-1921	817-235-3393	817-447-1267
	Assistant Supervisor	Recco Chazarreta	817-370-6904	817-235-3392	817-297-4572
	Assistant Supervisor	Jack Hobson	817-202-2900	817-235-3413	817-373-2921
North Tarrant County	Supervisor	Smokey Phillips	817-399-4350	817-235-3394	817-297-4374
	Assistant Supervisor	Mike Sepeda	817-232-1304	817-239-5689	817-385-4549
Parker & Palo Pinto Counties	Supervisor	Alan Donaldson	817-594-5626	817-304-2105	817-613-9388
	Assistant Supervisor, Parker County	Justin McKinley	817-594-5626	817-205-8249	817-594-5123
	Assistant Supervisor, Palo Pinto County	Jerry Vandivere	940-325-2414	817-235-3395 (m)	

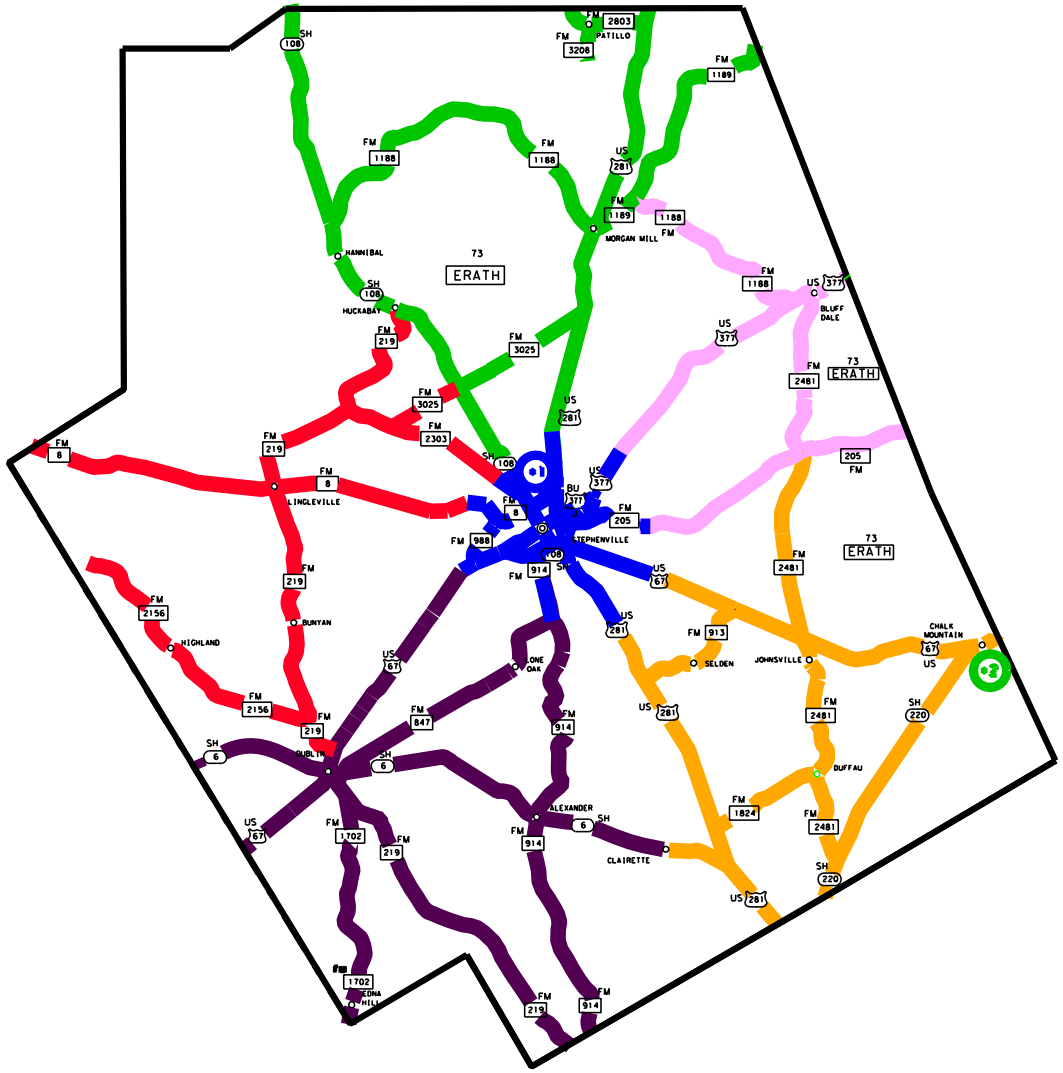
Adjacent District Contacts

Dallas District				
District Maintenance	Maintenance Engineer	Gary Charlton	214-320-6201	214-317-2425 (cell)
Ellis County	Supervisor	Hank Campbell	972-938-2960	
West Dallas County	Supervisor	Travis Bartlow	972-263-1387	
Denton County	Supervisor	Keith Nabors	940-387-1324	
Wichita Falls				
District Maintenance	Director Of Operations	Tim Hertel	940-720-7721	940-867-2216 (cell)
Cooke County	Supervisor	Bob Walker	940-665-5312	
Montague County	Supervisor	Tony Woods	940-825-3158	
Archer County	Supervisor	Shan Slaggle	940-574-2507	
Young County	Supervisor	Jeffrey Parker	940-549-0676	
Brownwood District				
District Maintenance	Director Of Operations	Gary Humes	325-643-0416	512-965-2574 (cell)
Stephens County	Supervisor	Keith Munden	254-559-8203	
Eastland County	Supervisor	Travis Rogers	254-629-3845	
Comanche County	Supervisor	Efrain Almodova	325-356-7507	
Waco District				
District Maintenance	Director of Maintenance	Mike Heise	254-867-2816	254-405-2673 (cell)
Hamilton County	Supervisor	Carroll Starkey	254-386-5512	
Bosque County	Supervisor	Hal Bateman, Jr.	254-435-2258	
Hill County	Supervisor	Hal Bateman, Jr.	254-582-5411	

Regional Contacts

North Regional Office	Assistant North Region Director for Support Services	Mark Bradshaw	817-370-3676	512-517-8246 (cell)	
	North Region Fleet Manager	Dalton Pratt	817-370-3681	214-317-2421 (cell)	
	North Region Fleet Administrator Fort Worth/Wichita Falls	Keith Harris	817-370-6655	817-313-1401 (cell)	817-295-6014 (home)
	Fort Worth	Thomas Moore	817-370-6654	817-690-1283 (cell)	
	Wichita Falls	Curtis Jordan	940-720-7786	866-638-7903 (cell)	940-766-3952 (home)
	North Region Fleet Administrator Brownwood/Waco	Lloyd Garrett	254-867-2810	254-867-2810 (cell)	
	Waco	Fred Husak	254-867-2818	254-855-8974 (cell)	254-662-6643 (home)
	Brownwood	Joe McKee	325-643-0083	325-647-3901 (cell)	325-641-0720 (home)
	North Region Fleet Administrator Dallas/Paris	Royce Trojacek	214-324-6211	214-686-0619 (cell)	972-875-0377 (home)
	Dallas	Melvin Harris	214-320-6213	972-571-6751 (cell)	
	Paris	John Chandler	903-737-9260	972-464-6140 (cell)	
	North Region Fleet Administrator Atlanta/Tyler	Keith Young	903-799-1370	no cell	
	Tyler	Clint Costner	903-510-9257	903-539-2628 (cell)	903-894-7815 (home)
	Atlanta	Keith Cook	903-799-1373	903-756-3791 (home)	

Other Important Phone Numbers			
Name	**Title**	**Office**	**Cell**
Tim Powers	North Region Director	817-370-3675	214-317-2464
Gus Khanharli	Assistant North Region Director for Project Delivery Support	817-370-3677	214-317-2486
Leigh Bailey	NRC Purchasing Manager	817-370-3692	817-565-0946
Ron Nodine	Purchaser	817-370-6665	817-233-9491
Oscar Chavez	Acting NTC AE	817-370-4301	
Greg Cedillo	STC AE	817-370-6640	
David Neeley	STC Assist. AE	817-370-6803	817-709-6918
Ronald Robinson	Johnson Co. AE	817-202-2900	
Randy Bowers	Johnson Co. Assist. AE	817-202-2900	512-934-2166
Bill Nelson	Wise/Jack County AE	940-626-3400	817-235-3412
Marc McEndree	Hood, Erath, & Somervell AE	254-965-3511	817-235-3417
John Cordary	Parker & Palo Pinto Co AE	682-229-2800	817-372-4283
Lt. Alan Troup	Wichita Falls DDC (Jack Co.)	940-851-5521	
Capt. Bryan Rippee	Hurst DDC (All others)	817-299-1311	
Lanita Magee	RLO (Tarrant, Johnson, Hood, Somervell, & Erath Co)	817-538-0164	
Sherri Copeland	RLO (Wise, Parker, & Palo Pinto Co)	940-452-7757	
Becky Pursur	RLO (Jack Co)	940-882-4030	
Jimmey Bodiford	Traffic Operations Director	817-370-6615	817-235-3409
Billy Manning	Traffic Systems Supervisor	817-370-6745	817-239-7024
J.D. Gore	Traffic Systems Supervisor	817-370-6942	817-205-7303
Mark Fox	NWS Fort Worth, Warning Coordination Meteorologist	817-831-1574	682-429-7874
Jodi Hodges	PIO-FTW-TxDOT	817-370-6737	817-235-5335
Michael Peters	PIO-FTW-TxDOT	817-370-6846	817-2057176
Val Lopez	PIO-FTW-TxDOT	817-370-6630	817-205-7174
Holly Hughes	PIO-FTW-TxDOT	817-370-6744	817-247-5794
Ed Bodiford	Safety Office-FTW-TxDOT	817-370-6709	817-584-4659
Larry Long	Safety Office-FTW-TxDOT	817-370-6717	



ROUTE LOCATIONS DENOTED

- #1
- #2
- #3
- #4
- #5
- #6

Maintenance Section 05 - Erath County

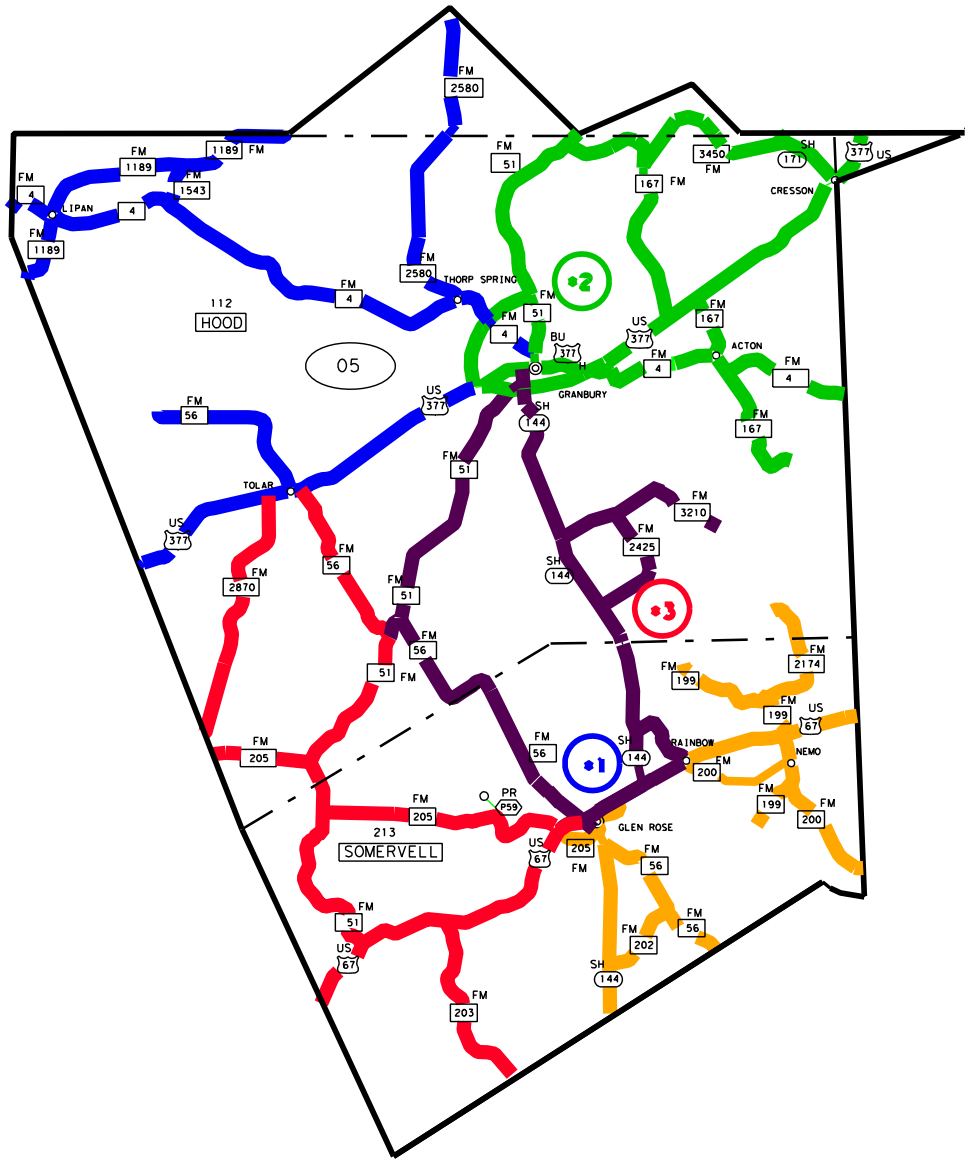
SNOW & ICE ROUTES

Fort Worth District

STOCKPILE DENOTED

#1 STEPHENVILLE YARD

#2 US 67 @ SH 220



ROUTE LOCATION DENOTED

- #1
- #2
- #3
- #4
- #5

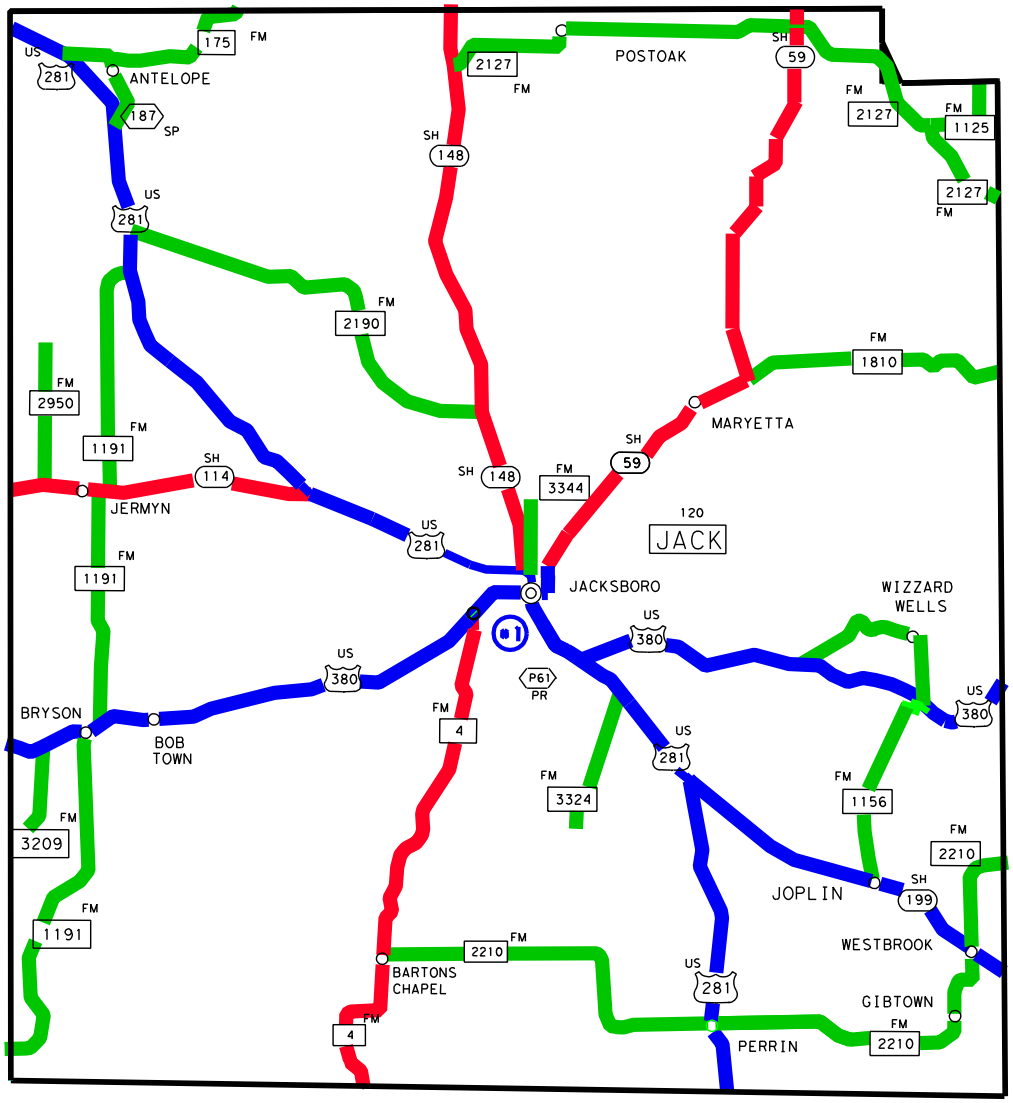
Maintenance Section 05 - Hood & Somervell County

SNOW & ICE ROUTES

Fort Worth District

STOCKPILES DENOTED

- #1 GLENROSE YARD
- #2 FM 51 IN GRANBURY
- #3 SH 144 @ COUNTY LINE



ROUTE LOCATIONS DENOTED

- PRIMARY
- SECONDARY
- TERTIARY

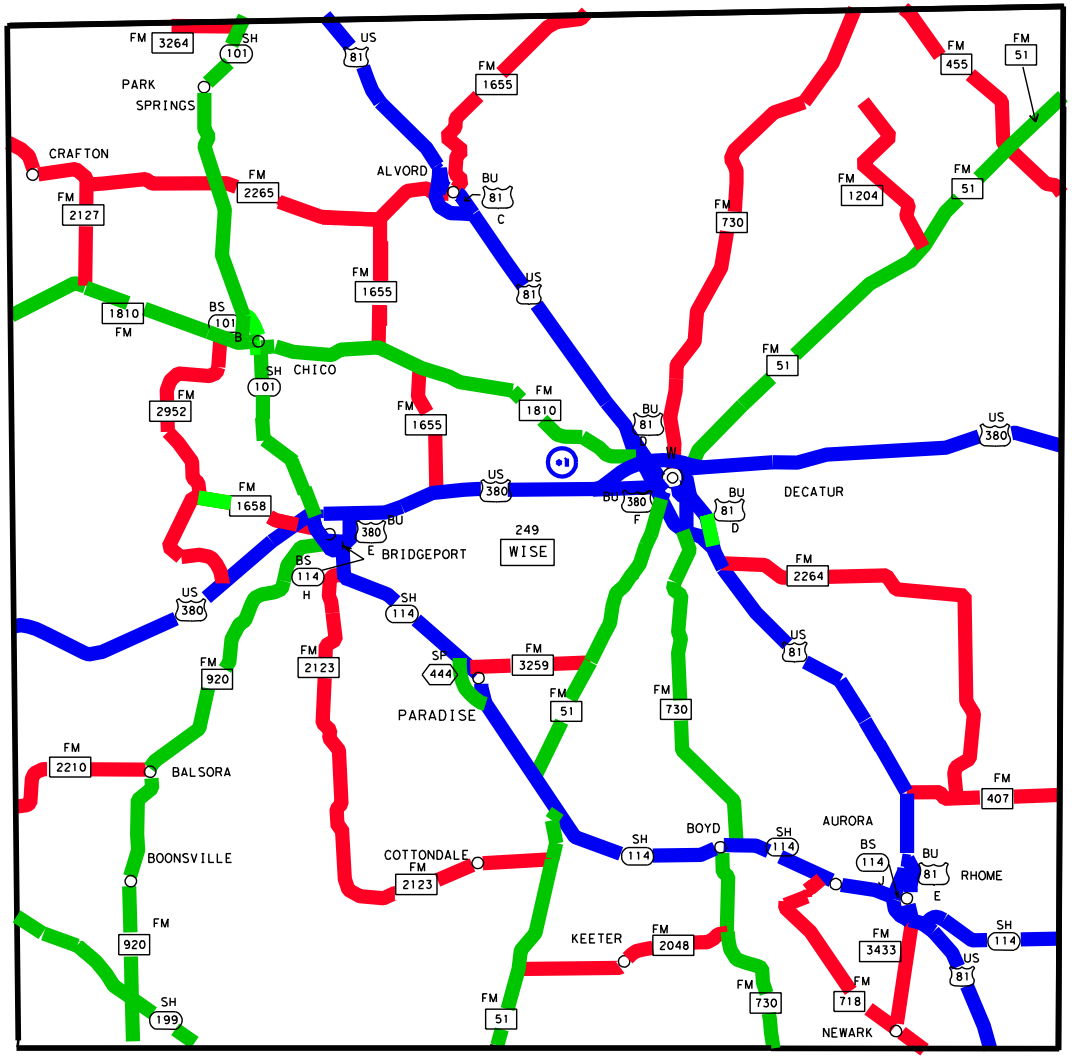
Maintenance Section 02 - Jack County

SNOW & ICE ROUTES

Fort Worth District

STOCKPILE DENOTED

*1 JACKSBORO YARD



ROUTE LOCATIONS DENOTED

- PRIMARY
- SECONDARY
- TERTIARY

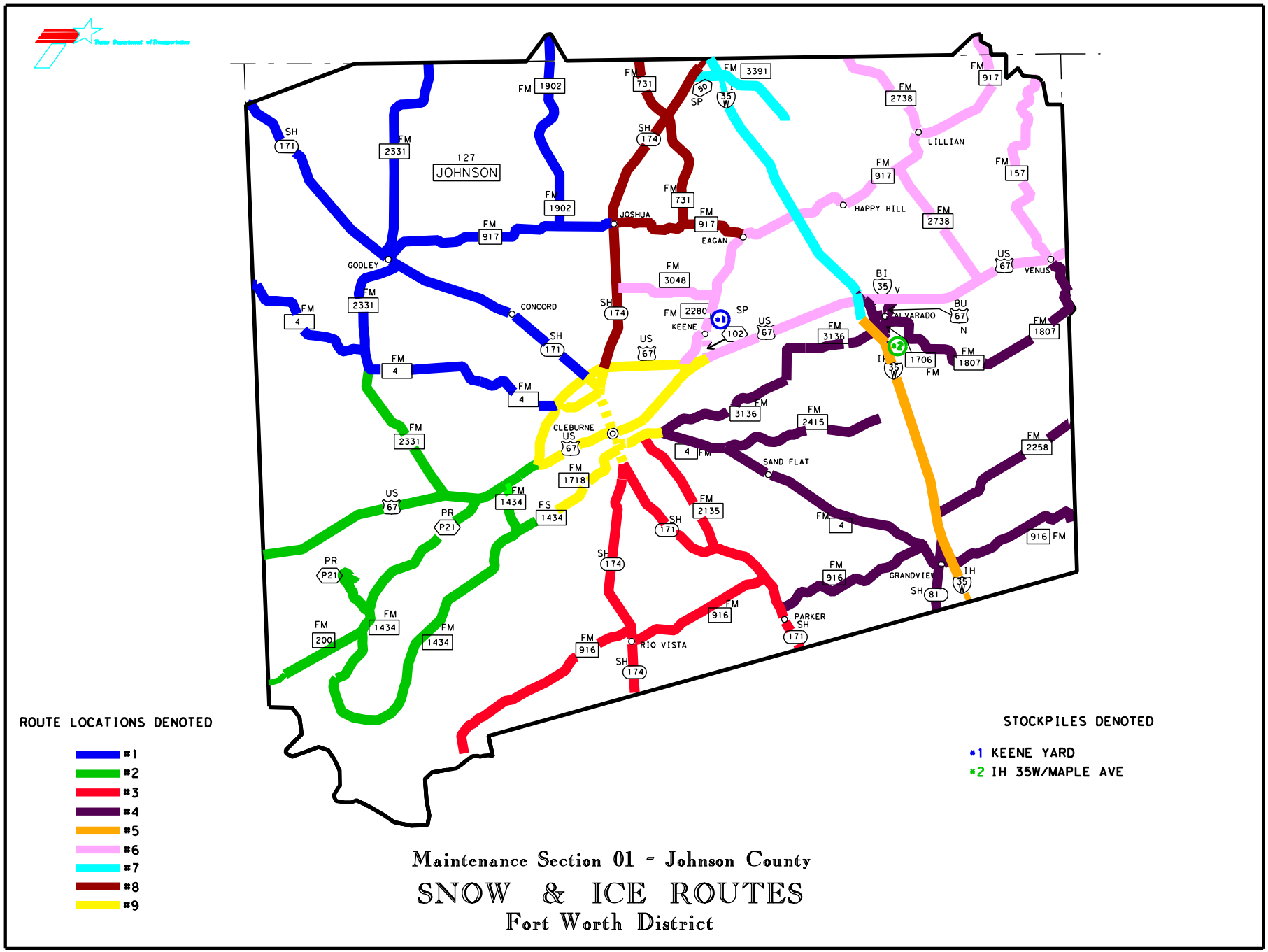
Maintenance Section 02 - Wise County

SNOW & ICE ROUTES

Fort Worth District

STOCKPILE DENOTED

*1 DECATUR YARD



ROUTE LOCATIONS DENOTED

- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9

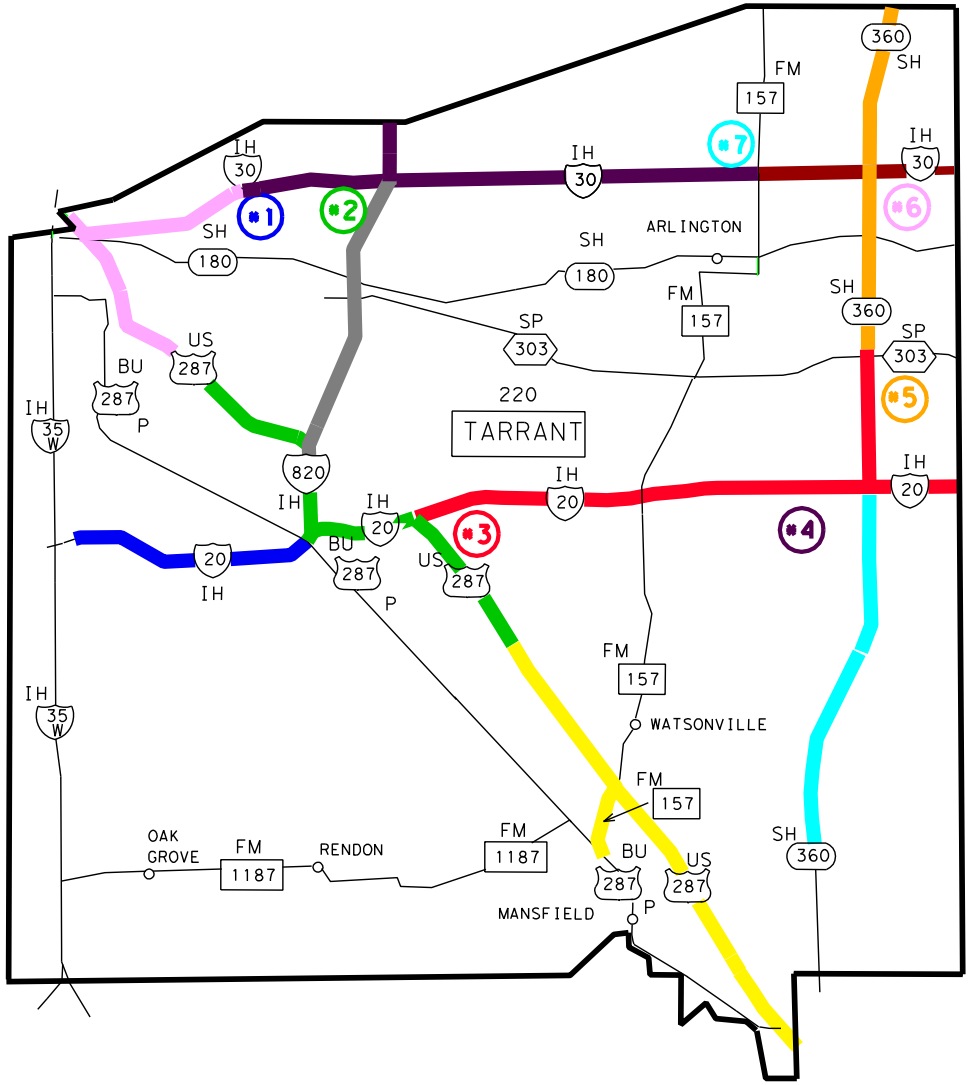
STOCKPILES DENOTED

- #1 KEENE YARD
- #2 IH 35W/MAPLE AVE

Maintenance Section 01 - Johnson County

SNOW & ICE ROUTES

Fort Worth District



ROUTE LOCATIONS DENOTED

- #1
- #2
- #3
- #4
- #5
- #6
- #7
- #8
- #9
- #10

STOCKPILES DENOTED

- #1 IH 30/OAKLAND BLVD
- #2 IH 30/BRIDEGEWOOD DR
- #3 IH 20/LITTLE ROAD
- #4 IH 20/NEW YORK AVE
- #5 SH 360/SP 303
- #6 IH 30/SH 360
- #7 IH 30/COLLINS

Maintenance Section 03 - Southeast Tarrant County

SNOW & ICE ROUTES

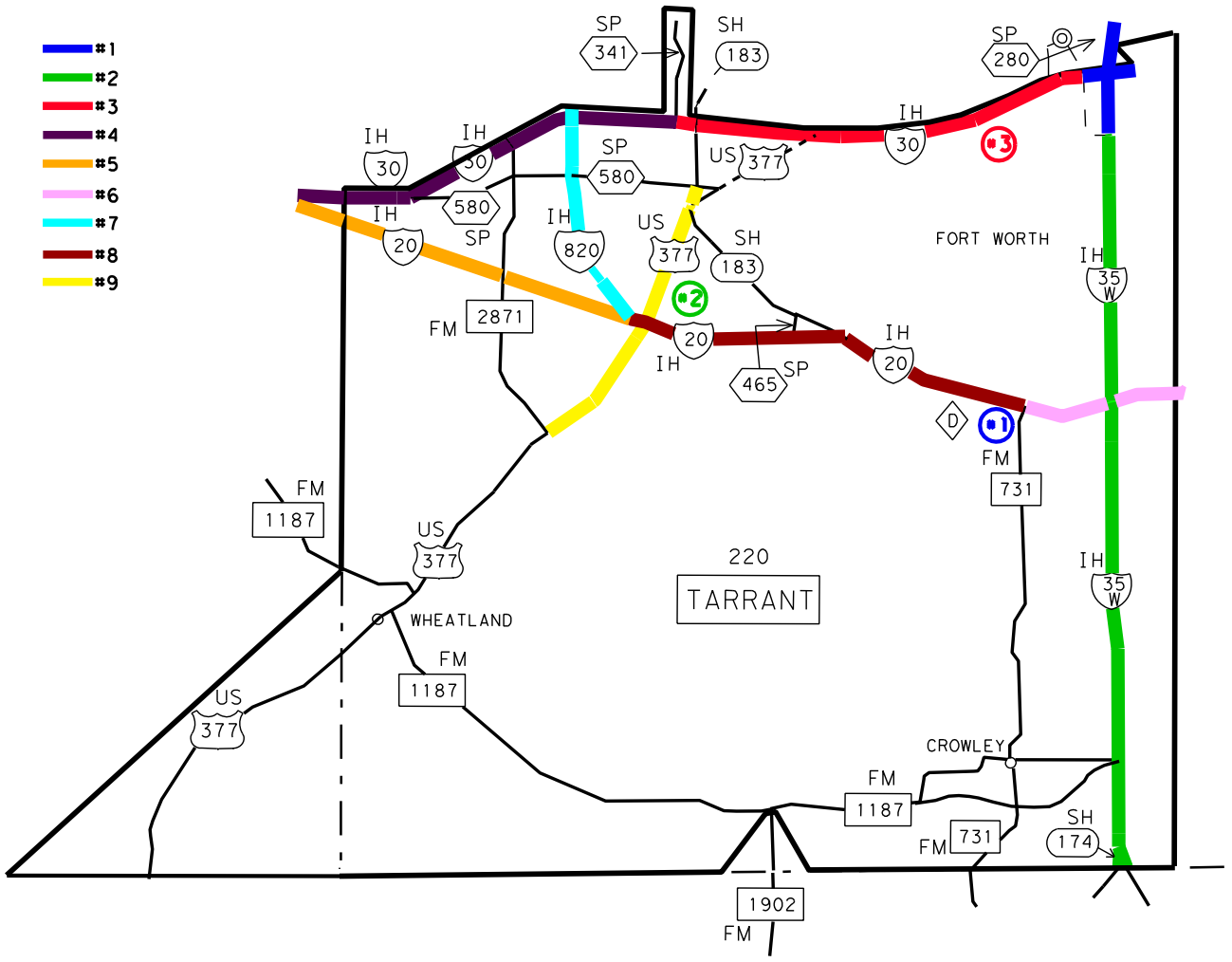
Fort Worth District

ROUTE LOCATIONS DENOTED

#1
#2
#3
#4
#5
#6
#7
#8
#9

STOCKPILES DENOTED

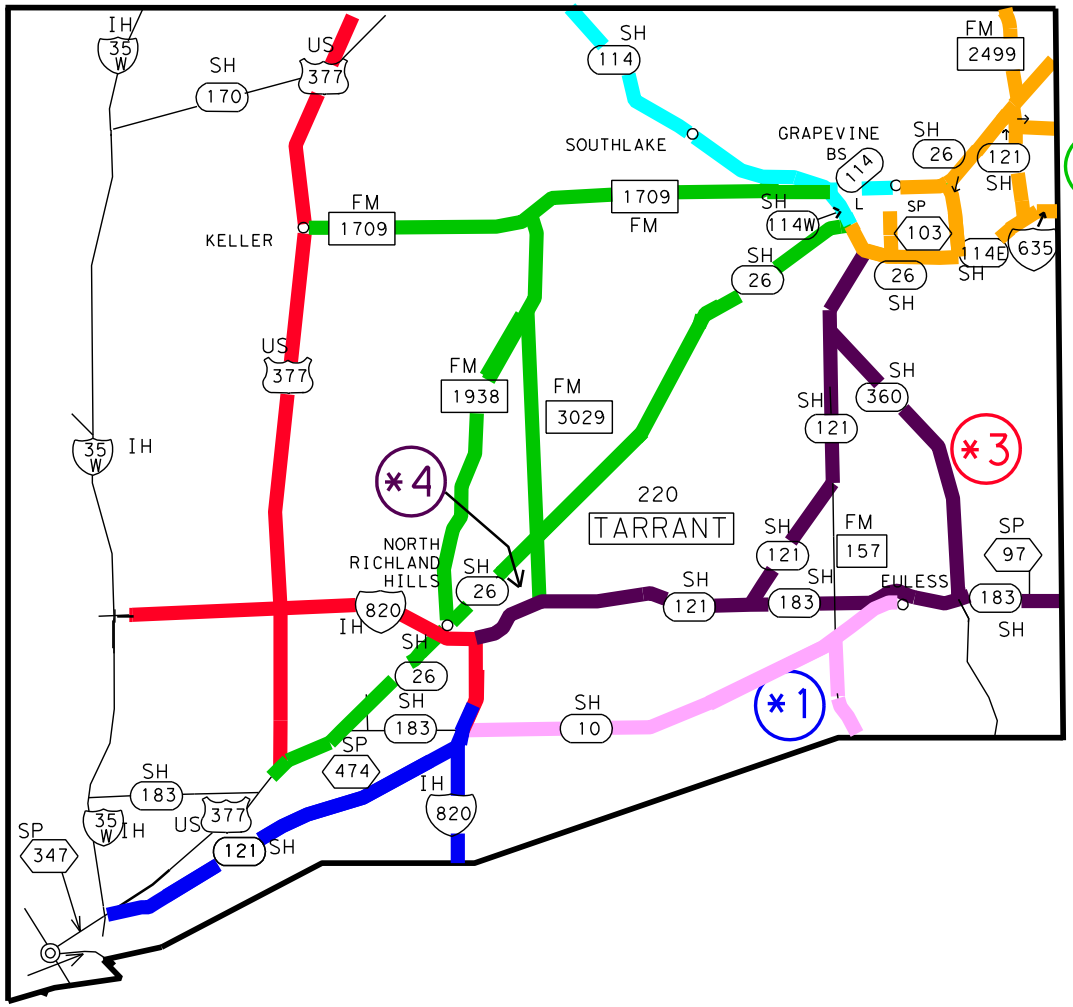
*1 McCART YARD
*2 US 377 / IH 20
*3 IH 30 / FOREST PARK



Maintenance Section 03 - Southwest Tarrant County

SNOW & ICE ROUTES

Fort Worth District



ROUTE LOCATIONS DENOTED

- #1
- #2
- #3
- #4
- #5
- #6
- #7

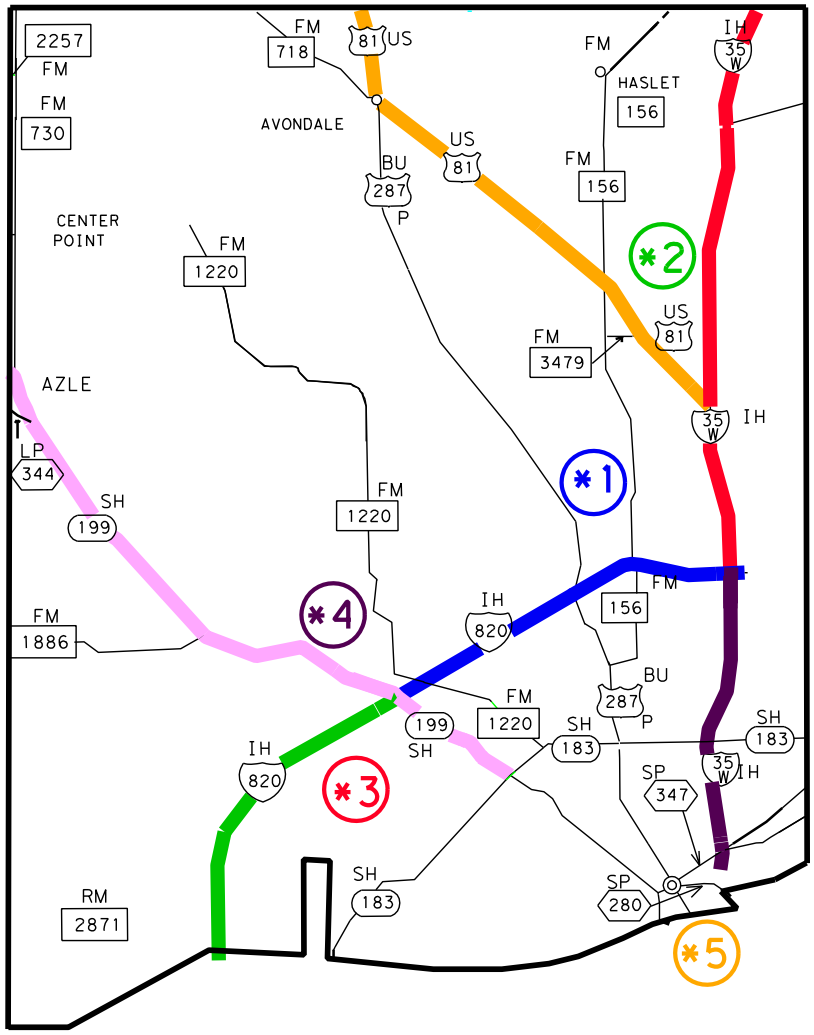
STOCKPILES DENOTED

- *1 EULESS YARD
- *2 IH635/SH121/BASS PRO
- *3 SH360/SH121@STONE MYER
- *4 IH 820/SH 26 @ RED LOBSTER

Maintenance Section 10 - Northeast Tarrant County

SNOW & ICE ROUTES

Fort Worth District



ROUTE LOCATIONS DENOTED

- #1
- #2
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- #4
- #5
- #6

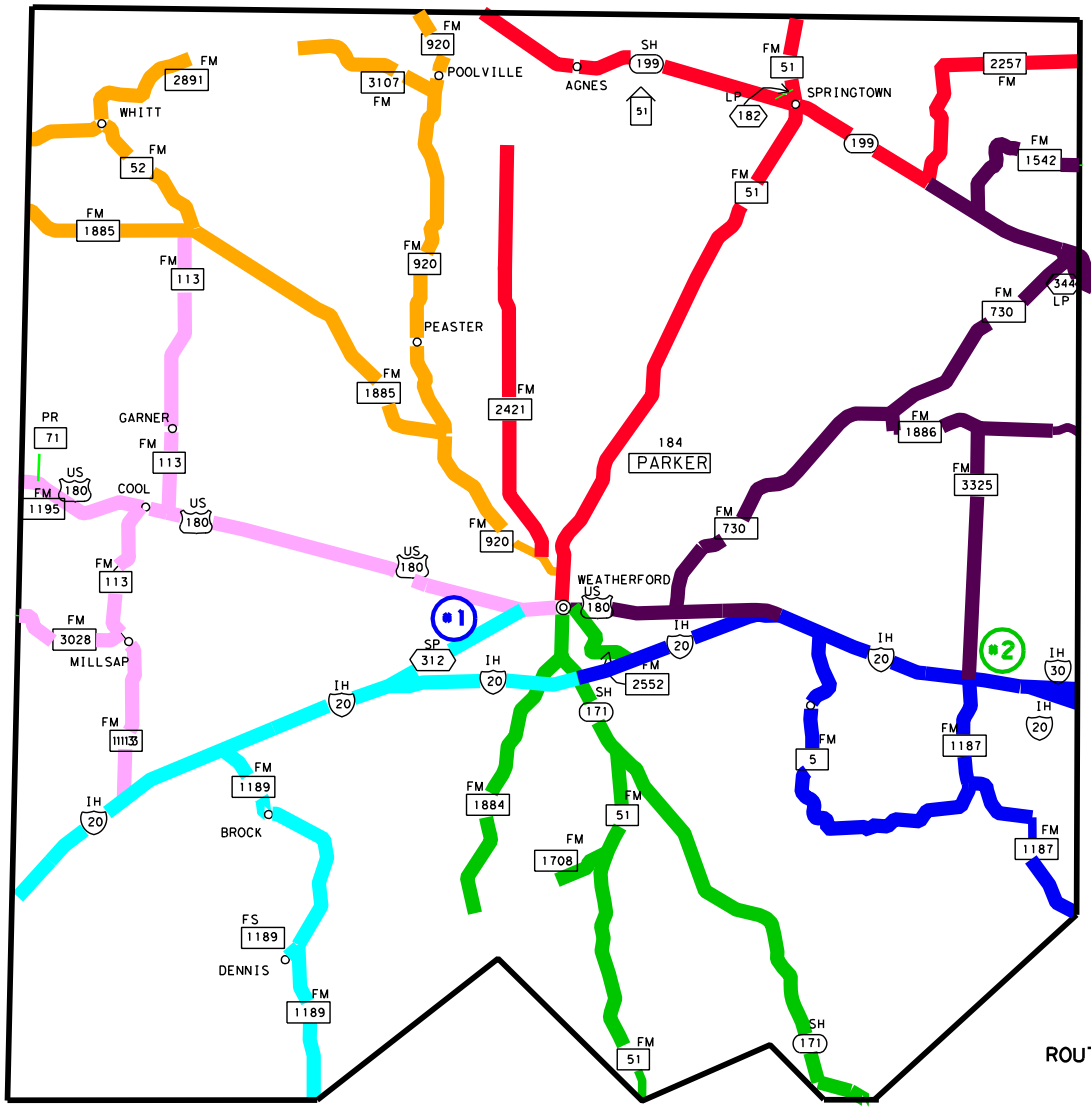
Maintenance Section 10 - Northwest Tarrant County

SNOW & ICE ROUTES

Fort Worth District

STOCKPILES DENOTED

- #1 SAGINAW YARD
- #2 HARMON@US81/287
- #3 LAKEWORTH BRDG UNDER IH820
- #4 SH 199 NW OF IH-820
- #5 IH-30 @ FOREST PARK



ROUTE LOCATIONS DENOTED

- #1
- #2
- #3
- #4
- #5
- #6
- #7

ROUTE LOCATIONS DENOTED

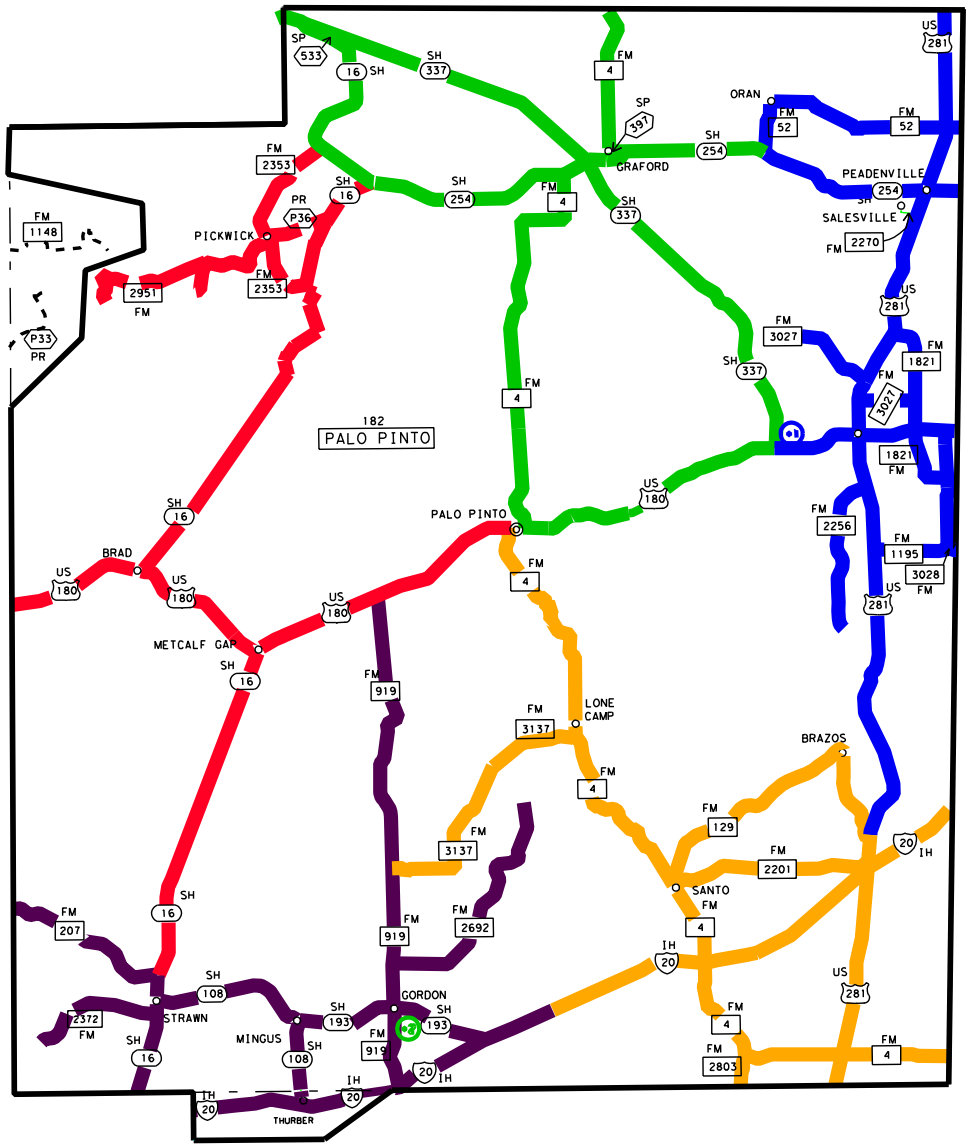
#1 IH 20 / FM 1187

#2 WEATHERFORD YARD

Maintenance Section 09 - Parker County

SNOW & ICE ROUTES

Fort Worth District



ROUTE LOCATIONS DENOTED

#1
#2
#3
#4
#5

Maintenance Section 09 - Palo Pinto County

SNOW & ICE ROUTES

Fort Worth District

STOCKPILES DENOTED

*1 MINERAL WELLS YARD
*2 FM 919 (OLD GORDON YARD)

Fort Worth District Snow and Ice Plan FY 11

Quantities Needed For A Three Day Snow & Ice Event

Maint. Sect.	# V-Bottom Sanders	# Pick-Up Sanders	# CDL Drivers	# of Vehicles for Liquid	Salt Bags	Salt/Sand Mix, Cubic Yards	Sand, Cubic Yards	Meltdown 20			Liquid Mag-Chloride, Gallons	# of Herb. Trucks	# of Snow Plows	# of Loaders
								50 lb Bags	Bulk	Super Sack				
Wise	4-10 and 4-6	4	22	2	0	120	0	150	40		300	1	2	2
Jack	3-10 and 3-6	2	12	1		80		125		10	100	1	2	2
Erath	4-10 and 4-6	3	12	1	250	300	1000	200	0	5	150	1	0	2
Somervell	5-10 and 3-6	3	14	2	350	450	1200	300	0	7	250	1	0	3
South Tarrent	11-10 and 6-6	7	31	2	1782	680	5261	1000	150000	61	4150	3	0	3
Johnson	4-10 and 3-6	4	17	1	735	398	3394	400	0	13	700	1	0	2
Euless	6-10 and 4-6	4	10	2	700	1000	3500	750	200	30	4,000	1	0	2
Saginaw	7-10 and 5-6	5	20	2	700	1000	2500	750	200	30	3,000	1	0	2
Parker	4-10 and 5-6	8	18	2	140	200	300	50	175	n/a	150	2	1	2
Palo Pinto	4-10 and 4-6	6	20	2	100	175	300	50	100	n/a	150	2	2	2

Fort Worth Equipment & Materials FY 11

Current Inventory

Location	V-Bottom Sanders	Pick-Up Sanders	CDL Drivers	Liquid De-icier Vehicles	Salt	Salt/ Sand Mix	Sand	Meltdown 20	Liquid Mag-Chloride	Snow Plows	Number of Blades
Wise	4-ten and 4-six yard inserts	2-insert and 2 tailgate	22	1-one ton pick-up and 1-3/4 ton mounted	609 bags	75 cubic yards	551 cubic yards	42 cubic yards	530 gallons	2	2
Jack	3-ten yard and 3-six yard inserts	2-insert	13	1-one ton pick-up	422 bags	94 cubic yards	527 cubic yards	1-2,500 lb bag	500 gallons	2	2
Erath	4-ten and 4-six yard inserts	3-insert	12	1-one ton pick-up	462 bags	0	759 cubic yards	512-50lb bags and 7 bags of 3000 lbs	220 gallons	0	2
Somervell	5-ten yard and 3-six yard inserts	3-insert	14	1-one ton pick-up and 1-herbicide truck	141 bags	0	1,231 cubic yards	721-50lb bags and 5 bags of 3000 lbs	315 gallons	0	1
South Tarrant	11-ten yard and 6-six yard inserts	7-insert	31	2-250 gl. pick-up units	900 bags	680 cubic yards	4,261 cubic yards	1,100-50lb bags and 23 bags of 3000 lbs	4,150 gallons	0	3
Johnson	4-ten and 3-six yard inserts	4-insert	17	1-250 gl. pick-up units	735 bags	398 cubic yards	3,094 cubic yards	400-50lb bags and 13 bags of 3000 lbs	700 gallons	0	2
Euless	6-ten yard and 4-six yard inserts	4-insert	10	2-one ton pick-up	1176 bags	394 cubic yards	4,129 cubic yards	413-50lbs bags and 33 bags of 3000 lbs	4,050 gallons	0	2
Saginaw	7-ten yard and 5-six yard inserts	5-insert	20	2-one ton pick-up	650 bags	18 cubic yards	1,492 cubic yards	780-50lb bags and 12 bags of 3000 lbs	1,425 gallons	0	2
Parker	4-ten yard and 5-six yard	8-insert	18	2-one ton pick-up	466 bags	0	1,210 cubic yards	96-fifty lbs bags and 233 cubic yards of bulk	485 gallons	1	2
Palo Pinto	4-ten yard and 4-six yard	6-insert	20	1-one ton pick-up and 1-three quarter ton mounted	408 bags	0	850 cubic yards	846- fifty lbs bags and 69 cubic yards of bulk	800 gallons	2	2
Gordon	0	0	0	0	442 bags	0	657 cubic yards	416-fifty lbs bags and 73 cubic yards of bulk	0	0	0

Texas Department of Transportation

SAN ANTONIO DISTRICT

ICE PLAN STANDARD OPERATING PROCEDURES (SOP)

(Updated: Nov. 2010)

GENERAL GUIDANCE

Introduction

Coordination of effort between offices of the San Antonio District is critical during a disaster. This standard operational procedures (SOP) document with specific action steps, will serve as a guide for the San Antonio District on what actions should occur between the District Emergency Operations Center (SAT-EOC) and the various offices of the district during a winter weather event.

This SOP will serve as a framework for the preparation, mobilization, and implementation of the District's response for any winter weather event. It shall be the responsibility of the San Antonio District to act in the best interests of the State of Texas and its citizens in accordance with the information contained in this emergency operation plan.

General Operations

This SOP accounts for the preparation, mobilization, and deployment to counter severe winter weather occurrences. The San Antonio District will take a pro-active approach to any inclement weather event. Operations will require that personnel are pre-staged prior to the event to maximize their effectiveness during the period of extreme winter weather. The District's primary objective will be to utilizing all resources to ensure a safe highway for the traveling public.

In Texas, initial emergency response is generally the responsibility of local jurisdictions (city and county governments). State law requires that all local jurisdictions have their own emergency management program. All requests for state emergency response assistance are submitted by local governments to the local Disaster District Committee (DDC). If additional help is needed, the DDC will coordinate with the State Operations Center (SOC) in Austin.

Generally, for severe winter weather events, TxDOT Districts will cooperate with local cities and counties in coordinating their response efforts as the situation dictates. The SAT-EOC will work closely with the City of San Antonio (COSA) to ensure the freeway system in Bexar County is made as safe as possible for travel. Area Offices and Maintenance Sections outside of Bexar County will coordinate as needed with local counties and municipalities.

COMMAND AND CONTROL

Incident Command

Coordination and cooperation between the San Antonio District Headquarters, Area Offices and the various Maintenance Sections is imperative during any emergency operation. The primary figure in this coordination will be our *District Incident Commander*. The presumed incident commander for the District, unless otherwise appointed by the District Engineer, will be the Director of Operations. The District Incident Commander will coordinate operations within the district and will act as the point of contact for coordination with the TxDOT-EOC (MNT) in Austin, the DDC (if activated) and the City of San Antonio (COSA) EOC at Brooks City Base in San Antonio.

SAT Emergency Operations Center

The SAT-EOC here in San Antonio, will operate from Transguide during Winter Weather Events. During emergencies, the SAT-EOC will function as the hub for all activities related to the San Antonio District; coordinate all taskings from the TxDOT EOC in Austin and the DDC in San Antonio.

Particularly during Winter Weather Emergencies, the SAT-EOC will co-ordinate activities with the COSA-EOC in relation to keeping the highway system operational for the traveling public in Bexar County. This co-ordination will include the decision for implementing anti-icing / de-icing operations and closures of the highway system.

The staffing of the SAT-EOC will primarily come from the District Maintenance Office, District Traffic Operations Office, and Public Information Office.

The SAT-EOC staff will include the following positions:

District Incident Commander (Director of Operations)
Assistant District Incident Commander (State Forces Engineer)
Operations (Contracts/Permits Engineer)
Operations (Transportation Operations Engineer)
Operations (District Maintenance Manager)
Public Information Officer (Public Information Personnel)

SAT-EOC duties will include:

Serve as the point of contact between the District and other TxDOT Divisions and Districts, the regional DDC, MNT EOC, SOC, etc.
Coordinate anti-icing and de-icing operations with the City of San Antonio
Track any tasks from the MNT EOC and DDC.
Coordinate any DE Conference Calls for the San Antonio District personnel to coordinate taskings and to pass on pertinent information.

District Personnel

ALL PERSONNEL in the San Antonio District may be called upon for additional duties during any winter weather emergency. Personnel not specifically indentified in this plan should not assume that they are excused from duty; *all personnel, regardless of normal duties, can be given emergency duty assignments as the situation or need arises during a disaster.*

Maintenance Sections should work closely with their Area Offices before events begin to supplement staffing needs. As the winter weather event progresses and a better determination can be made as to additional needs for personnel, the EOC will coordinate the use of non-maintenance employees from District offices to supplement the maintenance and area office personnel.

Communication

The SAT-EOC will serve as the hub for all communications concerning winter related emergency activities for the San Antonio District.

Conference Calls will be utilized as needed to coordinate actions and pass information. They will include the District Engineer, Directors, Area Engineers, EOC staff, Maintenance Supervisors and designated personnel.

Phones, both cell and land lines, are to be monitored for the duration of the event. All offices should ensure that phones are manned and messages are forward to the specific individual. Once 24 hour operations begin, those offices involved in the emergency operation need to ensure that their office phones are covered around the clock.

Phone lines and cell phone service can quickly become overwhelmed, so all avenues of communication need to be monitored.

TxDOT - San Antonio District	(210) 615-6000
TxDOT - Statewide information	(800) 452-9292
TxDOT - Transguide Web Page	www.transguide.dot.state.tx.us/Traffic/lclist.php
TxDOT - Statewide Web Page	www.dot.state.tx.us/hcr/main.htm
City Street Closure Information	311
San Antonio PD Web Page	www.sanantonio.gov/sapd
Bexar Cnty Road Closures Web Page	www.bexar.org/webapps/html/roadclosures.asp

SPECIFIC OPERATIONS AND TASKINGS

Watch for Ice on Bridge Signs

WFIOB signs will be displayed according to the “Signs Display Schedule”. Signs will remain displayed throughout the cold weather season, and will not be removed from view until the recommended removal date. If inclement weather requires opening of the sign before the recommended display date, the sign should be bolted in place and should remain displayed throughout the cold weather season. Conversely, if inclement weather prevents removal until after the recommended date, the sign should remain displayed until no longer applicable.

Sign Display Schedule:

	From	To
Atascosa	December 09	February 21
Bandera	November 24	March 23
Bexar	November 24	March 08
Comal	November 24	March 23
Frio	December 09	February 21
Guadalupe	November 24	March 08
Kendall	November 09	March 23
Kerr	November 09	April 07
McMullen	December 09	February 21
Medina	November 24	March 23
Uvalde	November 24	March 23
Wilson	November 24	February 21

Liquid De-Icier Spray Equipment

In November of each year, those herbicide trucks designated to be move to Bexar County will be identified. Coordination will take place between the maintenance section sending the vehicle and the receiving maintenance section for timely movement of equipment into Bexar County when needed.

Calibration of Spraying Equipment (Revised 12-28-10)

All maintenance sections will ensure that their equipment used in spraying of liquid chemicals is checked prior to the winter season and properly calibrated.

With a few exceptions, all SAT equipment is capable of spraying 1, 2 or 3 travel lanes with one pass down the roadway. A data base with the calibration information is kept by the District Maintenance Office and updated annually. If pumps or pump motors are changed after the annual calibration, recalibrate the equipment and notify Marvin Hatter so the data base can be updated. The following steps should be followed to properly calibrate the equipment for the anti-icing (pre-ice) rate of application:

1. Fill the tank with plenty of water (not the ice control material). The calibration process sometimes requires three to four hundred gallons of water.

2. Fill the pump motor with an adequate amount of fuel.

3. Clean all filters.

4. Make sure the correct nozzles are installed on the equipment. The solid stream nozzles for the MgCl APEX product and the CF-7 product look alike except the size of the orifice is different for each material. Refer to the EQUIPMENT FOR APPLICATION OF LIQUID DE-ICER sheet to determine the correct nozzles for the material you are spraying.

5. Assure all nozzles and swivel attachments are clear of obstructions and operating properly with no leaks. Debris will make a solid stream nozzle spray like a fan.

6. Turn on all 3 spray booms (left, back and right as if you were driving the truck) and adjust the pressure. The desired pressure is 30 psi for herbicide trucks and 40 psi for slide-in units.

7. Determine the gallons per lane mile (GPLM) for a scenario in which you would be spraying only the back lane (the lane you are driving in). Without adjusting the pressure that was set in Step 6, turn off the left and right spray booms and collect the water from all nozzles on the back boom for 10 seconds.

8. There are 60 seconds in a minute so multiply the sum of all gallons from Step 7 by 6 to get the gallons per minute (GPM).

9. Plug the GPM from Step 8 into this formula, $GPLM = \frac{60 \times GPM}{MPH}$ to get GPLM at 30 mph for an anti-icing (pre-ice) application. The number 60 in the formula is a constant.

10. If the GPLM for the back boom as determined in Step 9 is 18-20 GPLM for MgCl Apex (or 36-60 GPLM for CF-7), proceed to Step 11. If the rate is higher than these numbers, lower the pressure by 5 psi and start again with Step 6. If the rate is lower than these numbers, raise the pressure by 5 psi and start again with Step 6.

11. Turn on all 3 booms again (do not change pressure from previous setting and leave all booms turned on) and catch the water from each nozzle on the left boom for 10 seconds to determine the GPLM as described in Steps 8 and 9. Perform the same calculations for the back boom and the right boom.

12. If the GPLM is not within 15-20 for MgCl or 25-60 for Cf-7, raise or lower the pressure as required by 5 psi and begin again with Step 7. Continue pressure adjustments until the back boom spraying alone (determined in Steps 6-9) and all 3 booms spraying at once (determined in Step 11) will apply a GPLM rate that is within these limits.

13. During de-icing (after ice forms) operations, the only adjustment should be to drive at 15 mph instead of 30 mph. Driving at 15 mph will double the GPLM that are applied.

Additional information:

Some pump motors may pulsate as rpm is reduced. This needs to be corrected by raising the operating pressure in 5 psi increments or by other means. A pulsating motor will affect the output of the system.

The pressure gauge line from the system to the cab may be obstructed with air or other debris if the pump motor is running at a high rpm but the pressure gauge reads low. Disconnect the pressure gauge line in the cab of the vehicle and flush out the obstruction if this occurs.

Adjustment of the left and right boom nozzles to spray into a collection bucket may be necessary to facilitate collection of the water from all the nozzles during calibration.

Adjust the left and right boom nozzles to spray the adjacent lanes. Keep in mind that there will be significant blowing of the material due to the 30 mph travel speed. Because the equipment is sitting still during the calibration/nozzle adjustment process, this may require adjustment of the nozzles to a point in which some are spraying the shoulder. The blow back of the material at 30 mph should compensate for this and ensure the material is applied to the adjacent lane as intended.

Be certain to drain the water from the system components to protect the system from freeze damage.

Wear rubber gloves and boots instead of leather when working with ice control materials. It will remove the moisture and quickly distort and destroy leather items.

Public Awareness Measures

Once a winter weather event is forecasted, the SAT PIO will work closely with local media in informing the public of TxDOT preparations. Once the SAT-EOC has been activated, the PIO will send out hourly updates to the local media sources.

Transguide Operations will post the following message on all Dynamic Message Signs once it has been determined to put the District Ice Plan into effect. The DMS message display should read;

WATCH FOR ICE ON BRIDGE USE CAUTION

DMS messages will also place a downward yellow "X" on all Lane Control Signals.

Responsibility for Bridge Structures Over The Freeway System in COSA

The San Antonio City Public Works Department will be responsible for maintaining all bridge structures that cross over the freeway system within the city limits of COSA. TxDOT will be responsible for maintaining access to the City of San Antonio Fleet Yard (Tool Yard) on Wurzbach Parkway between Perrin Beitel and Thousand Oaks

STRUCTURE	RESPONSIBILITY		STRUCTURE	RESPONSIBILITY
IH 10			IH 410	
Spur 53	City		Cherry Ridge	City
Ramsgate	City		NW Military Hwy. (FM 1535)	City
Medical Drive	City		Blanco Rd. (FM 2696)	City
Callaghan	City		McCullough	City
Fredericksburg Rd.(Lp 345)	City		Jones-Maltsberger	City
Woodlawn	City		Airport Blvd.	City
Cincinnati	City		Starcrest	City
Culebra (Spur 421)	City		Goliad	City
Colorado	City		South Presa (Spur 122)	City
Martin	City		Espada Road	City
New Braunfels	City		Valley Hi Drive	City
Gevers	City		Fredericksburg Rd. (Lp 345)	City
Walters	City			
Roland (US 87)	City		US 90	
Foster	City		Hunt Lane	City
Graytown	City		Old Hwy. 90	City
FM 1518	City		Acme Road	City
IH 35			US 281	
Judson	City		Sonterra Blvd.	City
O'Connor	City		Henderson Pass (Closed)	City
George Beech Ave.(BAMC)	City		Donella	City
Walters	City		Winding Way/Oak Shadows	City
New Braunfels	City		Nakoma	City
Pine	City		Sandau/Rhapsody	City
Brooklyn	City		San Pedro (Spur 537)	City
McCullough	City		Isom	City
Lexington	City		Terminal	City
Main	City		Airport Blvd.	City
San Pedro	City		Hildebrand	City
Alamo (Spur 536)	City		Stadium	City
Nogalitos (Lp 353)	City			
Fischer	City		SPUR 371	
			Kirk	City
IH 37			Old Frio City	City
Hot Wells	City		Quintana	City
Southcross	City		Cupples	City
New Braunfels	City			
			LOOP 1604	
SH 151			Tradesman	City
Wiseman Blvd.	City		Bitters	City
Westover Hills	City		Huebner	City
Military Dr. W.	City		Blanco Rd. (FM 2696)	City
			Gold Canyon	City
			Redland Rd.	City
			Green Mountain Rd.	City
			Nacogdoches (FM 2252)	City

Ice Plan Implementation

- Mobilization
    - National Weather Service issues a Winter Weather Advisory for the San Antonio District area of responsibility.
    - SAT-EOC will make the determination to activate the District Ice Plan after consultation with the District Engineer and COSA-EOC.
    - Maintenance Sections will mobilize crews and equipment. “Stand by” status may be utilized with the authorization of the SAT-EOC.
    - Maintenance Sections will prepare alternate plans for the use of 12 hour shifts if they become needed due to an extended event.
    - Maintenance Supervisors will ensure that all employees under their responsibility received a safety and operational brief for ice operations in their sections. This brief should include what steps to take for employees involved in accidents during the performance of their duties.
    - Employees delegated to spraying liquid anti-icing agents should be given additional instructions on procedures for spraying, route assignments and equipment assignments.
- Anti-Icing Operations
    - Upon notification from the SAT-EOC, maintenance crews will begin spraying designated routes with liquid chemicals such as Magnesium Chloride at the anti-icing rate.
    - Chat trucks will be readied and placed in strategic locations within the sections.
- Monitoring & Reporting to SAT-EOC
    - Maintenance Sections will report to the SAT-EOC upon the completion of anti-icing spraying of specified routes.
    - Maintenance Sections will monitor all bridges for effectiveness of anti-icing operations and the need for de-icing operations or chatting requirements.
    - Maintenance Sections will update their operational status every four hours or as events such as major accidents / highway shutdowns occur. During extended operations and the use of shifts are employed, the Maintenance Section will notify the SAT-EOC of a shift change and status at that time of the section, its personnel, equipment resources and highway conditions.
- De-Icing Operations
    - If the winter weather event is sever enough to cause the forming of ice on bridge decks and elevated areas of the highway system, Maintenance Sections will proceed into De-Icing Operations as needed.
    - Maintenance Sections will take necessary steps to maintain safe driving conditions on all state highways with additional applications of liquid chemicals at the de-icing rate or with sanding / chatting of roads and bridges.

Maintenance Sections in Bexar County

Bexar County Maintenance Sections will coordinate their actions with the SAT-EOC to ensure a uniform response over the entire City of San Antonio and Bexar County.

Marked SAPD police units, as designated below, will be sent to each of the following TxDOT Maintenance Yards to escort TxDOT trucks for application of anti-icing liquid on designated highway bridges in Bexar County. Each marked SAPD police unit will be assigned a spray route to shadow the spray trucks during the application of the liquid chemical.

SAPD units will be assigned as follows:

4 units to	9320 SE Loop 410 (East Bexar)
4 units to	6550 Walzem (East Bexar)
4 units to	7395 Pearsall Rd (West Bexar)
4 units to	4615 NW Loop 410 (West Bexar)

Maintenance Sections outside of Bexar County

All Maintenance Sections adjacent to another TxDOT District will contact the adjoining TxDOT section to coordinate any actions that may effect the movement of the traffic across district boundaries. This includes any highway shutdowns in the District that could significantly impact the movement of traffic.

All Sections will ensure their area of responsibility is covered and perform their anti-icing / de-icing operations independently from other sections depending on the conditions in their respective areas. The EOC will provide guidance but sections are expected to take appropriate actions dependent upon current weather conditions in their areas and coordinate as needed with adjoining sections.

Sections will update the SAT-EOC frequently as to conditions in their respective areas and operations being conducted.

Requests for additional personnel or resources should be coordinated through the SAT-EOC.

Freeway Closures (Worst Case)

The consensus of TxDOT and SAPD is required prior to the closing / opening of any particular part of the Main Lanes of the Expressway System within the City of San Antonio. If it is determined that the majority of the Expressway Main Lanes are to be closed or if the closure will create a significant inconvenience to the public, the Incident Commander will notify the District Engineer.

Due to the absence of continuous frontage roads, detours and lane restrictions within current construction projects, and the lack of sufficient alternate routes, closure of Expressway main lanes are only permitted as shown on the "Worst Case" Main Lane Closure Map.

All Maintenance Sections are responsible for updating the Highway Condition Report (HCR) for any long term closures.

APPENDIX A: SAN ANTONIO DISTRICT EMERGENCY OPERATIONS
WINTER WEATHER CHECKLIST

TIME LINE	ACTION REQUIRED	RESPONSABLE OFFICE
October	Review plans, equipment needs and personnel. Update District Ice Plan as needed.	District Operations
October	Check section equipment, spreaders, v-box, spray rigs, material on hand / order if needed.	Maintenance Sections
November	Send out memo for lowering Watch For Ice on Bridge Signs.	District Operations
November	Pre-stage barricades and barrels on highway.	Maintenance Sections
November	Move Herbicide Rigs from outlying sections into Bexar County.	Bexar Cnty coordinates with rural sections.
November	Send out memo on Personnel Response for Emergency Operations	District Operations
November	Coordinate Ice Plan Meeting with COSA / SAPD	District Operations
Winter Weather Advisory	Monitor conditions, contact NWS for updates. Make preliminary plans for skeleton crews to monitor roads.	District Operations Maintenance Sections
Winter Weather Advisory	Notification to contractors of possible event	Responsible Area Offices
Likely Event in Hill Country	Take necessary steps to monitor roads and perform ice operations if needed.	Effected Maintenance Sections / Area Office
Likely Event in Bexar	SAT EOC will be activated in conjunction with COSA EOC	SAT EOC Bexar County Sections
Likely Event Over District	SAT EOC will be activated in conjunction with COSA EOC. Take necessary steps to monitor roads and perform ice operations.	SAT EOC Maintenance Sections / Area Offices

APPENDIX B: SAT MAINTENANCE SECTION ICE PLANS

BANDERA MAINTENANCE SECTION EMERGENCY ICE PLAN					
Route 1	**From:**	**To:**	**Equipment:**	**#**	**Personnel**
SH 173 N	City of Bandera	Kerr C/L	10 cy dump truck with V-box spreader	3835-G	
SH 16 N	City of Bandera	Kerr C/L			
RM 337	SH 16 in Medina	Vanderpool			
FM 470	SH 16				
Route 2					
SH 16 S	City of Bandera	Bexar/Medina C/L	10 cy dump truck with V-box spreader	3388-J	
SH 46	SH 16	Kendall C/L			
FM 1283	SH 16	FM 471			
PR 37	SH 16	County Park			
Route 3	SH 173	Medina C/L	6 cy dump truck with V-box spreader (loaner with operator to Kerrville)	5154-G	
various	bridges around town that require monitoring				
Route 4					
various	deicer applied to roadways and bridges		herbicide truck applying deicer	7550-G	
De-Icer	1800 gallons of CF-7 deicer				
Graders	two motor graders	(1 loaner with operator to Kerrville if conditions warrant)		1033-A	
				1173-G	
Material	120 cy grade 5 chat rock in stock				

BOERNE MAINTENANCE SECTION EMERGENCY ICE PLAN					
Route 1	**From:**	**To:**	**Equipment:**	**#**	**Personnel**
IH10	Camp Bullis Rd.	Waring/Welfare Exit	10 yd dump w/10yd v-box	5260-H	
Route 2					
IH10	Waring/Welfare Exit	Kerr Co. Line	10 yd dump w/6yd v-box	5467-F	
US87	IH10 (Comfort)	Gillespie Co. Line			
SH27	Kerr Co. Line	IH10 (Comfort)			
FM1621	IH10	Waring			
Route 3					
US281	Bexar Co. Line	Blanco Co. Line	10 yd dump w/10yd v-box	3512-H	
SH46	Bergheim	US281			
FM473	Kendalia	Blanco Co. Line			
FM3351	Kendalia	Bergheim			
Route 4					
FM3351	Bergheim	IH10	6 yd dump w/6yd v-box	5569-H	
SH46	Bergheim	Bandera Co. Line			
US87B	IH10 (s/o Boerne)	IH10 (n/o Boerne)			
Route 5					
FM474	Boerne	FM473	6 yd dump w/6yd v-box	4189-E	
FM1376	Boerne	Gillespie Co. Line			
FM473	Kendalia	Comfort			
De-Icer					
IH10	Boerne	Comfort	1250gal. Herbicide Truck	7501-H	
Graders					
	For Heavy Snow & Ice		MG Class II	1059-G	
			MG Class I	1138-A	
Material					
	De-Icer (MG/CL)	Boerne Maint Yd	2650 Gallons		
	Pellets	Boerne Maint Yard	4 totes		
	Chat Rock Stock Pile	Boerne Maint Yard	315 CY (Backhoe)	6522-G	
	Chat Rock Stock Pile	IH10/Guadalupe R.	100 CY (Loader)	6872-H	
	Chat Rock Stock Pile	SH46/Blanco Rd.	as needed (Loader)	6946-H	

FLORESVILLE MAINTENANCE SECTION EMERGENCY ICE PLAN					
	STRUCTURE NAME:		**Equipment:**	**#**	**Personnel**
Route 1					
US 87	ECLETO CREEK		10 YD DUMP W/ V-BOX	4389-J	
US 87	SH 123 OVERPASS				
US 87/ SH97	CIBOLO CREEK				
SH 119	ECLETO CREEK				
FM 1347	ECLETO CREEK				
FM 1681	WEST ECLETO CREEK				
FM 1681	EAST ECLETO CREEK				
FM 537	CIBOLO CREEK				
FM 539	CIBOLO CREEK				
FM 2772	ELM CREEK				
FM 775	CIBOLO CREEK				
Route 2			10 YD DUMP W/ V-BOX	4827-F	
US 181	KICASTER CREEK				
US 181	PAJARITO CREEK				
US 181	OVERPASS POTH				
US 181	BURKOWSKI CREEK				
SH 97	SAN ANTONIO RIVER				
SH 97	PICOASA CREEK				
SH 97	BARREGO CREEK				
FM 541	CIBOLO CREEK				
FM 541	MARCELINAS CREEK				
FM 541	SAN ANTONIO RIVER				
FM 775	SAN ANTONIO RIVER				
LP 181	KICASTER CREEK				
LP 181	SEGUIN BRANCH				
FM 536	SAN ANTONIO RIVER				
Graders					
	For Heavy Snow & Ice		MG Class II	1032-A	
			MG Class II	1238-G	
Material					
	Chat Rock Stock Pile	MAINT. YARD	250 TON / LOADER	6811-A	

HONDO/DEVINE MAINTENANCE SECTION EMERGENCY ICE PLAN					
Route 1	**From:**	**To:**	**Equipment:**	**#**	**Personnel**
US 90 W			10 yd dump w/10yd v-box		
US 90 E			10 yd dump w/10yd v-box		
SH 173 N			Herbicide Truck		
Route 2					
SH 173 S			10 yd dump w/10yd v-box		
IH 35 N			10 yd dump w/10yd v-box		
IH 35 S			Herbicide Truck		
Route 3					
SH 132			6 yd dump w/10yd v-box		
FM 462					
FM 472					
Route 4					
FM 1796			6 yd dump w/6yd v-box		
FM 1957					
FM 2200					
FM 2504					
FM 2676					
FM 3176					
Material	De-Icer (CF-7)	Hondo Maint Yd	1250 Gal		
	De-Icer (CF-7)	Devine Maint Yd	325 Gal		
	Chat Rock Stock Pile	Hondo Maint Yd	500 CY		
	Chat Rock Stock Pile	Devine Maint Yd	400 CY		

KERRVILLE MAINTENANCE SECTION EMERGENCY ICE PLAN					
Route 1	**From:**	**To:**	**Equipment:**	**#**	**Personnel**
IH10	Kimble County Line	RM 479	10 yd dump w/10yd v-box	4828-F	
SH 27	At Rough Hollow				
SH 41	At Johnson Creek				
Route 2					
IH 10	RM 479	SH 16	10 yd dump w/10yd v-box	5186-G	
FM1338	At Goat Creek		Motor Grader	1151-G	
RM 783	IH 10	Gillespie County Line			
Route 3					
IH 10	SH 16	Kendall County Line	10 yd dump w/10yd v-box	4494-H	
			Loaner Motor Grader	1033-A	
Route 4					
SH 16	Gillespie County Line	FM 1273	6 yd dump w/6yd v-box	5152-G	
SH 27	LP 534	SH 16			
SH 173	LP 534	SH 16			
Route 5					
LP 534	SH 16	SH 173	6 yd dump w/6yd v-box	3598-G	
FM 1341	At Quinlan Creek				
SH 27	LP 534	City of Comfort			
FM 1350	At Guadalupe River				
RM 480	SH 27	SH 173			
SH 173	LP 534	RM 480			
Route 6					
SP 98	At Guadalupe River		6 yd dump w/6yd v-box	3599-G	
FM 394	At Guadalupe River				
SH 27	SH 16	SH 39			
SH 39	SH 27	FM 1340			
De-icer					
IH10	Kimble County Line	Kendall County Line	1250gal. Herbicide Truck	7500-H	
Various	As needed				
Material	De-Icer (MG/CL)	Kerrville Maint Yd	795 Gallons		
	Pellets	Kerrville Maint Yd	15 bags (Backhoe)		
	Chat Rock Stock Pile	Kerrville Maint Yd	39 CY (Loader)		
	Chat Rock Stock Pile	LP 534 @ river bridge	165 CY (Loader)		

NEW BRAUNFELS MAINTENANCE SECTION EMERGENCY ICE PLAN					
Route 1	**From:**	**To:**	**Equipment:**	**#**	**Personnel**
IH35	Solms Rd.	Cilbilo Creek	1250 gal. Hebicide Deicer	7509-G	
			10 yd dump w/10yd v-box	3836-g	
FM 2252	Cilbilo Creek	Cibilo Creek			
Route 2					
IH 35	Rueckle Rd.	York Creek	250 gal. slide in Deicer	5778-J	
			10 yd dump w/10yd v-box	5223-J	
Route 3					
FM 306	MM 514	US 281	10 yd dump w/10yd v-box	5261-H	
FM 32	Hays Co. Line	Blanco Co. line			
Route 4					
FM 2673	FM 2722	End of Maint.	6 yd dump w/6yd v-box	4187-E	
FM 2722	FM 2673	SH 46			
Route 5					
Lp 337	IH 35	SH 46	6 yd dump w/6yd v-box	4769-G	
SH 46	Lp 337	IH35			
SH 46	Lp337	US 281			
Graders					
	For Heavy Snow & Ice		MG Class III		
			MG Class II		
Material					
	De-Icer (MG/CL)	New Braunfels, yard	4200 Gallons		
	Chat Rock Stock Pile	New Braunfels, yard	649 CY		

PLEASANTON MAINTENANCE SECTION EMERGENCY ICE PLAN					
Route 1	**From:**	**To:**	**Equipment:**	**#**	**Personnel**
IH 37	Atascosa/Live Oak C/L MM 84	Atascosa/Bexar C/L MM 119	10 CY Dump Trk. with 10 CY V-box	5184G	
	Includes Tilden Section		6 CY Dump Trk. with 6 CY V-box	5153G	
Route 2					
US 281 LP 242 FM 3006	Leming Pleasanton City Limits IH 37	Pleasanton US 281	10 CY Dump Trk. w/ Spreader	5705E	
Route 3					
SH 16	Bexar C/L	FM 140	10 CY Dump Trk. w/ Spreader	5183G	
SH 173	SH 16	Frio C/L			
FM 476	Pleasanton	Poteet			
SH 97	Wilson C/L	Charlotte			
Route 4					
FM 140	US 281A	SH 16	6 CY Dump Trk. w/ Spreader	5522D	
Graders					
	For Heavy Snow & Ice		Class II	1057G	
			Class III	1030A	
Material					
	Chat Rock Stock Pile	Pleasanton Maint. Yard	59 CY Loader	6605J	
	Chat Rock Stock Pile	US 281A & FM 140	105 CY Loader	6808A	

SEGUIN MAINTENANCE SECTION EMERGENCY ICE PLAN					
Route 1	**From:**	**To:**	**Equipment:**	**#**	**Personnel**
IH10	SH123	US183	10 yd dump w/v-box		
Route 2					
IH10	SH123	Cibolo Creek	10 yd dump w/v-box		
Route 3					
SH123	US90	Hays Co. Line	10 yd dump w/v-box		
Route 4					
FM78	SH46	Cibolo Creek	6 yd dump w/v-box		
Route 5					
SH123	US90A	Wilson Co. Line	6 yd dump w/v-box		
Route 6					
SH46	FM758	SH123	6 yd dump w/v-box		
Route 7					
IH10	US90	US90	De-Icer Trk 1500 gallon		
SH46	FM78	UPRR			
IH10	e/o US90	w/o US90			
SH123 B	IH10	Guadalupe River			
US90	in Seguin				
Graders					
	For Heavy Snow & Ice		MG		
			MG		
Material					
	De-Icer	Maint Yard			
	Chat Rock Stock Pile	Seguin Maint Yard			

TILDEN MAINTENANCE SECTION EMERGENCY ICE PLAN					
Route 1	**From:**	**To:**	**Equipment:**	#	**Personnel**
S.H. 72	S.H 16	SH 97	10yd w tailgate spreader	5263H	
S.H. 97	S.H 72	CHARLOTTE			
S.H. 16	F.M. 140	TILDEN			
Route 2					
F.M 3445	S.H. 16	Maint. Ends			
S.H. 16	TILDEN	Duval Co. Line	10 yd w tailgate spreader	4490-J	
F.M. 624	S.H. 16	LaSalle Co. Line			
Route 3					
F.M. 99	S.H 72	Live Oak Co. line	6 yd w tailgate spreader	5570-H	
U.S281A	Live Oak co. line	F.M. 791			
F.M 791	U.S. 281A	S.H 16			
Graders					
	For Heavy Snow & Ice		MG Class II	1058-G	
			MG Class III	1108-A	
Material					
	Chat Rock Stock Pile	TILDEN Yard	239 cyds		
			backhoe	6579-A	
			Loader	6999-H	

UVALDE MAINTENANCE SECTION EMERGENCY ICE PLAN					
Route 1	**From:**	**To:**	**Equipment:**	**#**	**Personnel**
SH 55	US 83 N. Intersection	Edwards County Line	6 Yrd Dump Trk with V-Box Spreader & Shadow Vehicle. Broom w/blade	5518-E 5777-J 8365-J	3
RM 334	SH 55 Inters.	Kinney County Line			
Route 2					
US 83 N.	Uvalde N. City Limits	Real County Line	10 YRD. Dump Truck with V-Box Spreader and Shadow Vehicle	5221-J 5775-J	3
RM 1050	US 83 North	RM 187 N. Utopia			
SH 127	US 83 N Concan	RM 187 N. Inters.			
RM 2690	US 83 North	SH 127			
FM1049 N	US 90 East	SH 127			
FM 1051	US 83 North.	End of State Maint.			
FM 30	SH 127 Inters.	US 90 E.			
Route 3					
US 90 E.	US 83 Getty St. Inters.	Medina County Line	10 YRD. Dump Truck with V-Box Spreader and Shadow Vehicle w/arrow board.	3309-K 4739-H	3
RM187 N.	US 90 in Sabinal	Bandera County Line			
RM187S.	US 90 in Sabinal	Zavala County Line			
FM 2730	US 90 E.	SH 127			
FM1049 S	US 90 in Knippa	FM 1023 S. Inters.			
FM 1796	RM 187 N.	Medina County Line			
Route 4					
US 90 W.	US 83 Getty St.	Kinney County Line	6 YRD. Dump Truck with Whirled type Applicator and Shadow Vehicle	4273-J 4811-H	2
RM 1022	US 90 W	Vulcan Mines Plant			
FM 481	US 90 W	Zavala County Line			
US 83 S	FM 117 Inters.	Zavala County Line			
FM 117	US 83 S. Inters.	Zavala County Line			
FM 140	FM 117 Inters.	Zavala County Line			
Scouts	Roads North of US 90	Roads South of US 90			2
Radio	Office				2
Graders (2 Ea.)	For Ice & Snow Removal	Staging Areas-1 US 83 North & 1 US 90 E.	Class II 14' (Ft.) Blade	1307 1214-G	
Loaders/Backhoe (3 Ea.)	Loading Material	Assist in Removal of Ice & Snow Buildup on Roads & Bridges.	Staging Areas – 1 in Maint. Yard, 1 US 83 North & 1 US 90 East	6875-A 6922-H 6554-A	
Materials	Chat Rock & Deicer (CF-7)	Uvalde Maint Yard.	124 C.Y. 505 Gallons		

EAST BEXAR MAINTENANCE SECTION EMERGENCY ICE PLAN					
Route 1	**From:**	**To:**	**Equipment:**	**#**	**Personnel**
IH410			1 x 1250 Gal Herb Trk		1
IH35					
Route 2					
IH35			1 x 550 Gal Herb Trk		1
LP1604					
Route 3					
IH410			1 x 550 Gal Herb Trk		1
IH35					
Route 4					
IH37			1 x 500 Gal tank on Trk		1
Route 5					
IH 10 Downtown			1x 1250 Gal Herb Trk		1
			1 x 550 Gal Herb Trk		1
Route 6					
IH 10 Downtown			1 x 1250 Gal Herb Trk		1
			1 x 550 Gal Herb Trk		1
			1 x 500 gal tank on Trk		1
Route 7					
LP1604 SE			1 x 125 gal tank on PU		1
Route 8					
LP1604 NE			1 x 125 Gal Tank on PU		1
Route 9					
Wurzbach Pkwy			1 x 125 Gal Tank on PU		1
NE Bexar					
			7 x 10 Yd Dumps w/v-box		7
			1 x 6 Yd Dump w/v-box		1
SE Bexar					
			6 x 10 Yd Dumps w/v-box		6
			1 x 6 Yd Dump w/v-box		1
Materials	Chat Rock & Deicer				

WEST BEXAR MAINTENANCE SECTION EMERGENCY ICE PLAN					
Route 1	**From:**	**To:**	**Equipment:**	**#**	**Personnel**
IH410			1 x 125 Gal Tank on PU		1
FM2790					
SH16					
Route 2					
IH35			1 x 300 Gal Tank on Trk		1
Route 3					
IH410			1 x 500 Gal Herb Trk		1
Route 4					
US90			1 x 125 Gal Tank on PU		1
Route 5					
SH151			1x 500 Gal Herb Trk		1
US90					
Route 6					
LP1604 NW			1 x 125 Gal Tank on PU		1
Route 7					
IH10			1 x 125 gal tank on PU		1
LP1604 N					
Route 8					
IH10			1 x 1500 Gal Herb Trk		1
IH410			1 x 500 Gal Herb Trk		1
Route 9					
US281			1 x 500 Gal Herb Trk		1
			1 x 500 Gal Tank on Trk		1
Route 10					
US281/IH410	Interchange		1 x 125 Gal Tank on PU		1
			1 x 500 Gal Tank on Trk		1
Route 11					
IH10/IH410	Interchange		3 x 125 Gal Tank on PU		3
Route 12					
LP1604 SW			1 x 125 Gal Tank on PU		1
SH16 S					
SH211 S					
Route 13					
SH16 N			1 x 125 Gal Tank on PU		1
SH211 N					
NE Bexar					
N Bexar	US281 Area		2 x 10 Yd Dumps w/v-box		2

			2 x 6 Yd Dump w/v-box		2
NW Bexar	IH10 Area		3 x 10 Yd Dumps w/v-box		3
			1 x 6 Yd Dump w/spinner		1
W Bexar	US90 Area		2 x 10 Yd Dump w/v-box		2
			2 x 6 Yd Dump w/v-box		2
SW Bexar	IH35 Area		2 x 10 Yd Dump w/spinner		2
			1 x 6 Yd Dump w/spinner		1
Materials	Chat Rock & Deicer				