Planning for Severe Weather Events in Public Transit Operations

An analysis of current planning efforts and recommendations for beginning and improving the planning process.

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Abstract

Weather inherently has an effect on the usability of the surface transportation network. Those who drive regularly can tell the difference between the ease of maneuverability when weather is pleasant as opposed to when it is inclement. In addition, extremely severe weather events have been on the rise (MacCracken 2002). These events, such as flooding in Nashville, Tennessee in May 2010 and Southern California in December 2010 as well as the snowstorm in the Northeast during the busy Christmas holiday travel season, cripple the surface transportation system during and after the catastrophic weather. Nevertheless, little is known about the effects of extreme weather events on public transit operations. This project intends to utilize literature and plan reviews as well as interviews with various transit agencies throughout the country in order to make recommendations a severe weather planning process directed to agencies considering development of a new plan, or considering evaluations and updates to an existing plan.

Acknowledgements

Introduction

In developing a planning process for a severe weather plan geared toward transit operators, several steps needed to be taken. The first section of this report contains a literature review covering a combination of aspects. Part one of the literature review discusses general literature regarding weather impacts on surface transportation. Additionally, it includes what potential impacts climate change may have upon the surface transportation network. Part two of the literature review discusses research and general guidelines for hazard mitigation and emergency planning as well as continuity of operations planning. The following section encompasses feedback from transit agencies throughout the United States, all of various sizes, regarding their procedures and policies utilized during a severe weather event or general emergency. Using both the literature review and agency reflections, section three describes recommendations for a complete severe weather planning process. While many of the concepts of general emergency planning and severe weather planning overlap, some portions of the recommended process do deal with issues found only in relation to weather events.

Literature Review

Weather, Climate Change and Transportation

Weather and Surface Transportation

Standard transportation analysis and modeling tools assume clear weather conditions when providing output. Unfortunately, this leaves transportation operations managers only able to utilize their previous experience when dealing with inclement weather. Maze, Agarwal and Burchett (2006) reviewed previous research and literature in regards to impacts of weather on traffic demand, safety and flow. Upon their review, the authors found that the literature indicated traffic volumes and capacity generally decline during inclement weather. There was a general agreement within the literature that there are more crashes during wet or snowy weather, however, some studies indicated that crashes during winter storms were less severe.

Because of their impervious nature, rainstorms in urban areas tend to cause larger problems than in rural areas given the same amount of rainfall. Changnon and Westcott (2002) explain that flooding is a common problem in large cities and discuss Chicago as a case study. Chicago is typically plagued with flooding of street and rail viaducts as well as business and residence basements during heavy rainstorms. Because of the city's national transportation hub status, flooding can disrupt not only passenger transport but commercial traffic as well. The authors discuss several severe storms that happened in 2001. The most overpowering storm occurred on August 2, crippling commuter travel after just one hour of heavy rain. Additionally, in the Chicago region, Class I railroads were prompted by the 1999 blizzard to look for more coordination opportunities during severe winter weather. Representatives from Burlington Northern Santa Fe, CSX Transportation, Canadian National, Canadian Pacific, Norfolk Southern and Union Pacific as well as other railroads formed the Chicago Transportation Coordination Office (CTCO) in 2000. The CTCO, located at Metra's dispatch center, allows for viewing of current train flows which is used to manage operating difficulties and reduce dwell times for freight trains. Additionally, the office's efforts are used to reduce freight interference with passenger trains (Judge 2001).

To address the issues surrounding weather predictability, the National Weather Service (NWS) and the Federal Highway Administration (FHWA) developed the Cooperative Program for Operational Meteorology, Education and Training (COMET) in 2001. The joint program evaluates data from Environmental Sensor Stations (ESS) in order to better understand and inform the relationship between surface transportation and weather. The ESS equipment measures factors which include road temperature, road surface conditions, driving visibility and chemical concentrations that depress road freezing points. The equipment also measures wind, temperature, pressure, precipitation amounts and humidity. Pisano, Spangler and Hardesty reviewed projects implemented with the help of the COMET program, including the New York Integrated Weather Data Network (NYIWDN). The network has been developed through a partnership between the State University of New York at Albany (SUNYA), the New York State Department of Transportation (NYSDOT) and the NWS, and funded by the FHWA. The project intends to create a mesonet – a connected network of weather sensors – with which the team will integrate the data into NWS operations, archive the data and ultimately provide improved weather prediction (Pisano, Spangler, Hardesty).

Weather and Public Transit

The breadth of literature regarding weather and transportation tends to relate only to automobile traffic or aviation. Nevertheless, there are some articles that specifically discuss public transportation. Hofmann and O'Mahony (2005) studied the impact of inclement weather on bus performance measures in Dublin, Ireland. The authors found that the frequencies of both inbound trips and average daily frequencies are both higher on days when it is not raining, which they attributed to a possible increase in congestion. Travel times increased on rainy days. Oddly enough, however, they found that service is more regular during rainy days and bus bunching occurs less often.

Guo, Wilson and Rahbee examined how weather impacts ridership on the Chicago Transit Authority (CTA) system. Transit riders are not only exposed to weather elements while waiting or walking to the bus or train, but weather elements may also negatively impact service while riding. Their analysis indicated that rain reduces ridership in all seasons on bus and rail, and wind speed also has a significant negative impact. However, they found that fog has a consistently positive impact on ridership, with a stronger effect on rail, which could indicate that such weather increases the amount of people choosing to use transit (Guo, Wilson, Rahbee 2007).

Climate Change and Transportation

In 2007, Koetse and Rietveld performed a literature survey of climate change, inclement weather conditions and transportation. Through their review they found that adverse weather leads to increased average travel times, increased spread of travel times and increased probability of accidents. Under inclement weather, people may cancel trips depending on its purpose. Trip distribution may be altered during adverse weather when travelers decide to shop closer to home than further away due to the weather. Mode choice may be changed due to weather. Slow traffic and congestion may make travelers consider public transport. However, the authors found that other researchers, including Aaheim and Hauge found that this mode shift is relatively small. Additionally, the authors emphasize that much of the research does not focus on seasonal level impacts or long range effects of climate and weather (Koetse, Rietveld 2007).

Prior to Koetse and Rietveld's review, in October 2002, the U.S. Department of Transportation's (USDOT) Center for Climate Change and Environmental Forecasting held a workshop on the potential impacts of climate change on transportation in the U.S. The workshop featured several papers regarding the climate change topic. MacCracken gave a scientific overview global warning (or climate change). Climate change may include more frequent extreme rainfall, which was evident during the 20th century in the U.S., as well as more frequent and intense hurricanes and changes in location and intensity of snowfall. All of these factors could adversely impact air, truck and passenger transportation (MacCracken 2002). Mills and Andrey indicate that climate change may impact transportation operations in terms of safety, mobility and economic efficiency (Mills and Andrey 2002).

Pisano, Goodwin and Stern further discussed safety and operations in the context of climate change. The authors discuss various scenarios that may happen with climate change related events. Weather impacts productivity of the transportation system through an increase of operating and maintenance costs as well as delay to transportation networks. They also echoed many of the sentiments of MacCracken. Because of a potential of more severe convective storms, transportation managers may need to focus more on handling these storms and resulting funding. An increase in frozen precipitation would also need to be accommodated by traffic managers. Congestion impacts of these adverse weather events could be somewhat counteracted by traffic signal timing and more frequent road weather information (Pisano, Goodwin, Stern 2002).

Lockwood also discussed operational responses to climate change in 2008. Because of changes in frequency, intensity and distribution of severe weather events due to climate change, Lockwood states that more weather events may not only become part of routine operations, but more may be considered general emergencies due to their impacts. Transportation managers will need to scale up and tailor preparations, which includes longer lead times. Due to this new situation, there should be a convergence of more organized system management and a greater integration of weather into routine management. While weather is a part of the national Intelligent Transportation System (ITS) architecture, it still must be implemented in many more locations. Also, institutional environments can challenge transportation operations and emergency response. Information needs to be shared with all institutions involved with a weather emergency. Because of all these factors, Lockwood recommends that operations should be mainstreamed. This can include adopting an integrated, all-emergency hazard approach for operations, developing interagency protocols and procedures for emergency situations, increasing training internally and through interagency exercises, adopting cost-effective technology, introducing performance measures, formalizing emergency transportation operations and an aggressive communication of weather information (Lockwood 2008).

Types of Emergency Plans and Practices

Hazard Mitigation and Emergency Planning

In a 2004 brief, the Federal Highway Administration surveyed state, local and regional emergency management plans and found that few fully integrated transportation into their plans. Less than 50% discussed evacuation routes or media coordination, traveler information and protection of assets. Just as troubling, only two-thirds of state and one third of municipal plans include any sort of transportation contacts. The brief also

enumerated several goals which should be considered by state, local and regional agencies when crafting emergency plans. These include an accurate reflection of how transportation will work during the emergency, while transportation agencies need to discuss management of the emergency. Also, transportation agencies must have working relationships and communication with other responders, as well as implement a communications system compatible with several transportation modes as well as the other responding agencies. Evacuation models and traffic response scenarios must be developed and tested (FHWA 2004).

Public transportation can play an integral role in emergency management, according to the report by Higgins, Hickman and Weatherby. The authors mention several examples of transit agencies' collaboration with other agencies in order to manage a disaster. During a flood in 1996, C-TRAN of Vancouver detoured routes to continue service as well as increased commuter service in order to allow customers to get home. Buses were used for emergency evacuations and transporting emergency and recovery personnel. In both Orlando and Nashville, buses and company cars were used to rescue tornado victims. The authors discuss what transit agencies can do to prepare and operate during an emergency in the context of the Federal Emergency Management Administration's (FEMA) Comprehensive Emergency Management, which emphasizes mitigation, preparedness, response and recovery during and after an emergency.

Mitigation is actions taken that may minimize possible risks and hazards. In the case of transit agencies, this may include design consideration for both vehicles and facilities as well as training of safety procedures and standards for both staff and passengers. Preparedness includes facets such as risk assessment, responsibilities and communications within and between organizations as well as emergency procedures and training. Agencies should assess types of emergencies that could happen in the community and within the transit system, as well as resources and activities they can provide in emergency response. Written procedures and a communication structure should be developed. Response may occur when the emergency has happened or when warnings indicate an emergency will happen. Clear and continuous communication and coordination of activities – not only within the agency, but also with other agencies and the public – is critical when handling an emergency response. Recovery happens after the emergency situation and consists of repairing damage and restoring regular operations. (Higgins, Hickman, Weatherby 1999).

Continuity of Operations Planning

A Continuity of Operations Plan (COOP) is a plan put into place by an agency – in this case, a transit agency – that will allow them to provide essential services following an emergency or natural disaster. The American Public Transportation Association (APTA) released "Recommended Practice for a Continuity of Operations Plan" in 2008. The document outlines necessary steps a transit agency should undertake when developing such a plan. Executive management should define the planning process as well as when it should be reviewed and revised. Elements of the COOP should include the identification of essential functions and resources as well as actions to be taken in order for the functions to perform adequately. Part of this implementation may include identifying alternative operating facilities to maintain the essential functions. These facilities should be able to accommodate the agency restoring its essential functions within 12 hours and potentially run the agency for up to 30 days. The communication system is a critical support for a transit agency during and after an emergency. The agency should examine what links must be established, including those between internal departments, field personnel, outside agencies, law enforcement and the public. Another critical portion of this plan should

include what staffing needs will be necessary to perform the plan. The transit agency should also identify a chain of command, training methods, contact lists and a backup plan for vital records and databases (APTA 2008). Lawyer echoed many of these sentiments in his paper, but also emphasized the need to keep the COOP as a "living document," updated and practiced at least once a year (Lawyer 2005).

Current Agency Practices

In order to create a more robust set of recommendations, it was essential to discuss policies, planning processes and past actions with transit agencies that have experienced severe weather events. Contacting and interviewing agency representatives directly not only added more breadth to information regarding transit operations during inclement weather, but the process also addressed issues that individual agencies encountered that a highly technical report may have not discussed.

Utilizing the National Oceanographic and Atmospheric Administration database of weather events (NCDC), transit agencies of several different sizes throughout the United States were selected to be contacted. Searching for weather events between January 1, 2005 and October 31, 2010 that caused more than $10 million in property damage yielded 60 different transit agencies that experienced these severe weather events (please see Appendix 1). Primary weather events utilized in this study included flooding, winter storms and ice storms. Secondary events examined included hurricanes and tornadoes.

The transit agencies were contacted and with their consent were asked several questions regarding their plans and procedures regarding their operating practices during severe weather events (please see Appendix 2). These questions addressed emergency planning in general and how the agencies function during a severe weather event. They addressed communication, collaboration and planning update policies. Furthermore, the questions addressed a particular severe weather event in order to determine how the agency handled such an event and what could be done differently. Ultimately, 12 transit agencies were interviewed, ranging from 108,000 to 436 million annual riders. The following section outlines plans and procedures used by these agencies.

Basic Agency Information

Rochester City Lines (RCL) in Rochester, MN runs 17 weekday routes, 4 weeknight routes and 6 Saturday routes as well as run paratransit service. They do not run on Sundays or Holidays, and carry approximately 1.7 million riders annually. The transit service is part of the city's department that also performs snow removal and street repairs.

The Greater Attleboro Taunton Regional Transit Authority (GATRA), in Taunton, MA is operated by several service contractors in an area encompassing 27 municipalities, and John Greene represents one of them. Greene said his firm's ridership is approximately 550,000 annually on both fixed route and paratransit.

Space Coast Area Transit (SCAT) in Cocoa, FL has a fleet of approximately 61 buses that runs 15 fixed routes, paratransit and van pools for an annual ridership of approximately 2.25 million in the Brevard County area.

The agency is a unit of county government.

Omnitrans is a bus system based in San Bernardino, CA with a yearly ridership of approximately 13 million on 27 fixed routes and paratransit.

The Lafayette (LA) Transit System (LTS) runs 12 daytime routes, serving approximately 884,000 passengers per year. Nighttime service and paratransit service is contracted out.

Reno County Area Transit (RCAT), an agency in Hutchinson, KS provides approximately 108,000 rides per year on 5 city routes as well as paratransit and intercounty transit.

Tulsa (OK) Transit serves approximately 2.7 million riders per year on 22 fixed routes and paratransit. Niagra Frontier Transportation Authority (NFTA) runs both rail and bus, and also runs two airports. The agency moves approximately 29 million people annually.

Metra, commuter rail in Chicago, serves approximately 80 million riders per year on 12 train lines, which includes the South Shore Line to Indiana.

The Washington (DC) Metropolitan Area Transit Authority (WMATA) serves 436 million passengers per year on its Metro Rail, Metro Bus, and Metro Access demand response service.

Pace Suburban bus in suburban Chicago serves approximately 35 million passengers per year on 217 fixed routes as well as ADA paratransit service and vanpool service.

Key West Transit (FL) operates services in the city of Key West, which serves nearly 260,000 annual passengers on 4 routes, as well as in the lower keys of Monroe County, which serves102,500 passengers on two routes.

Figure 1 shows a graphic representation of the interviewed agencies. Table 1 addresses how the agencies answered various categories of questioning. While some agencies addressed all topics during the interviews, others did not. For instance, those agencies with no plan at all would not be able to address a question about updates and evaluations. Also, hard copies of three plans were obtained. These included the SCAT Hurricane Evacuation Manual, WMATA's Emergency Operations Plan and the LTS Hurricane Evacuation Plan. Combining these three plans with answers from the agencies provides a well-rounded perspective of transit emergency planning in the States.

The following sections discuss individual agency responses in more detail, arranged by these subjects:
  ‣   Planning Process
  ‣   Agency Preparedness
  ‣   Collaboration with Other Agencies
  ‣   Internal and External Communications
  ‣   Service Changes due to Weather
  ‣   During Event Procedures
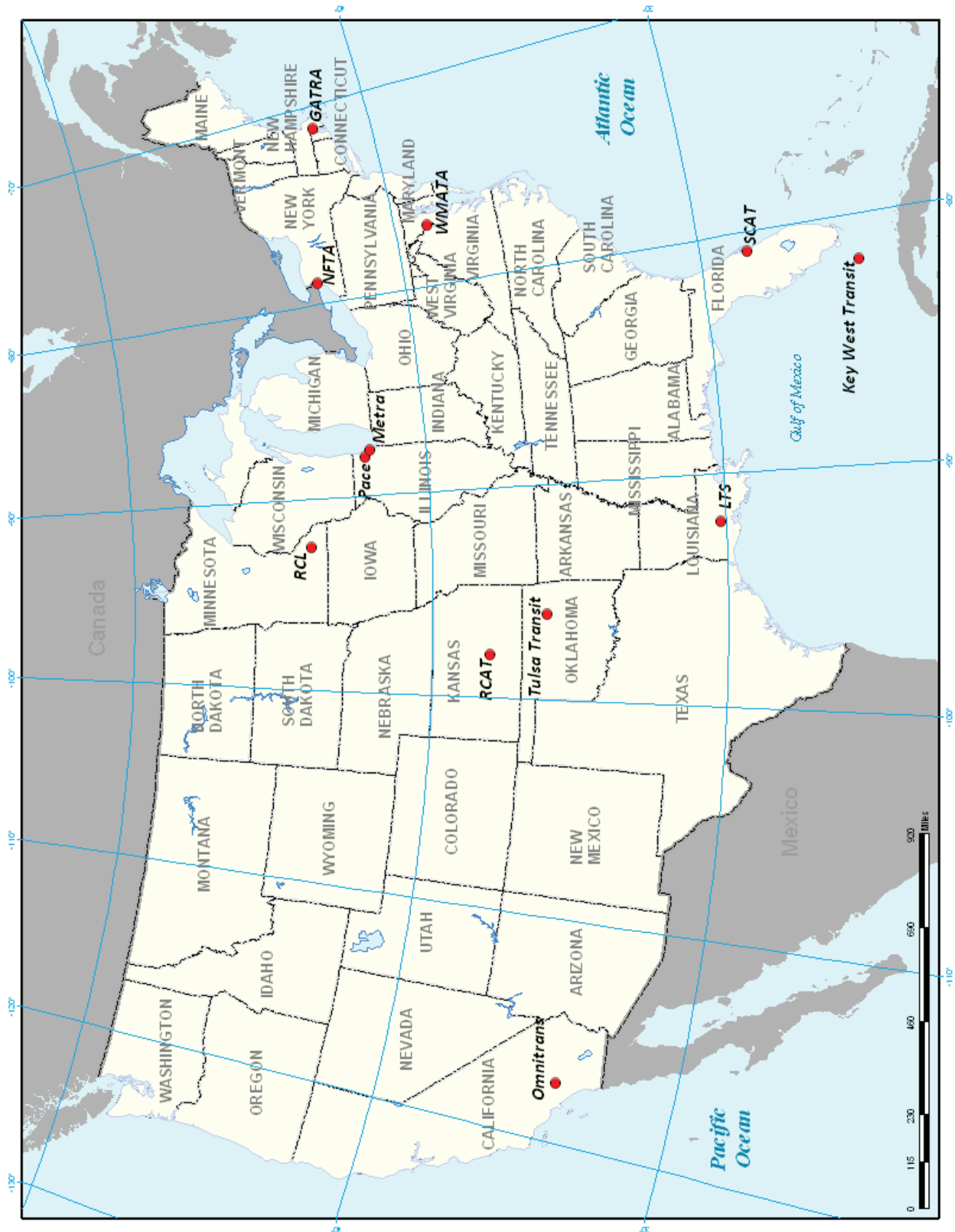
Figure 1: Map showing locations of interviewed transit agencies. Compiled by author, March 31, 2011.

Agency	Has related plan	Type(s)	Preparedness	Collaboration	Addressed Communications	Addressed Service Changes	Addressed During Event Procedures	Addressed Updates and Evaluations
RCAT	N				Y	Y	N	
GATRA	N				Y	Y	Y	
LTS	Y	Hurricane Evacuation		911 (Emergency Management), state agencies	Y	Y	Y	
RCL	N		FEMA, NIMS training, drills	part of city's EMS, police, fire, public health, utilities	Y	Y	Y	
SCAT	Y	Hurricane Evacuation & System Hazard and Security Plan			Y	Y	Y	annually
Tulsa	Y	Emergency & Weather		City of Tulsa	Y	N	Y	as needed
Omnitrans	Y	All Hazards Plan & Hazard Mitigation Plan	NIMS, California's Incident Management System, drills, tabletop exercises, CA Transportation Safety and Security Forum	San Bernardino County	Y	N	Y	annually & as needed
NFTA	Y	Snow Plan & Security and Safety Plan	security and safety training	emergency transportation	Y	Y		regularly
Metra	Y	Operating Plan encompassing General Emergencies, Severe Weather and COOP		Chicago's OEMC	Y	Y	Y	annually
WMATA	Y	Emergency Operations Plan & COOP strategies	NIMS training, interagency drills, tabletop exercises	EMS, various EOCs, NGOs, medical services	Y	Y	Y	annually at minimum & as needed
Pace	Y	System Security & Emergency Preparedness Plan, includes former Continuity Plan for Recovery	FTA emergency preparedness classes, rented four-wheel drive vehicles	emergency transportation, Chicago's OEMC	Y	Y	N	annually & as needed
Key West	Y	Evacuation Plan	practice plan during large special events	part of EOC, communicate with state and county officials	Y	Y	Y	annually

Table 1: Summary of question responses

Planning Process

RCL

While the agency does not have a formal plan, they do have policies in place concerning shutting down service, sending employees home or advising them not to check in.

GATRA

GATRA does not have a formal plan but a line of procedures to follow.

SCAT

While the previous two agencies operate under procedures and guidelines rather than a formal plan, SCAT not only operates under its own Hurricane Plan (called "Hurricane Evacuation Manual"), it is also mandated by the Florida Department of Transportation (FDOT) to comply with their System Hazard and Security Plan. Although the Hurricane Evacuation Manual specifically addresses hurricanes, it can also be useful in other severe events the county encounters such as forest fires and flooding. SCAT's motivation behind this manual was that the agency felt it needed a checklist due to the regular occurrence of hurricanes in the area. The hurricane manual is part of the county's comprehensive EMS plan and is updated yearly. While forming the Hurricane Plan, the agency does not utilize direct public involvement; however, the county has a special needs advisory group, which represents that portion of the public. In terms of the System Hazard and Security Plan, SCAT simply uses a template provided by the state. According to a review document provided by FDOT, the plan should include several facets of bus safety and security.

Omnitrans

Omnitrans utilizes a disaster plan based on an all hazards plan. These hazards may include floods, wildfires and earthquakes. This plan is evaluated annually and updated on an as needed basis. The agency also has a stand-alone Information Technology COOP plan as well as a hazard mitigation plan. The hazard mitigation plan is required by California's Hazard Mitigation Law, and must be revised every five years. Omnitrans does not have any specific quantifiable performance measures in their plan.

LTS

In the wake of Hurricane Katrina, LTS, in coordination with the city's emergency management department (911) and the Louisiana Department of Transportation, created a hurricane evacuation plan for the city as a whole.

RCAT

RCAT does not have a formal plan. However, the agency will be part of a COOP that the county is currently devising. The agency is also exploring the feasibility of developing a plan to illustrate the point where service

should be discontinued. On previous occasions, there have been situations where inclement weather such as ice and snow has started in the late afternoon where it created a situation with residents still at work. Conditions were very slick, but the objective was to get people home. If this weather service plan comes to fruition, the agency wants to take several steps in developing the plan, including identifying stakeholders and developing a marketing program. RCAT's bus operators would be critical for input on possible snow routes.

Tulsa Transit

Tulsa Transit has an emergency plan as well as a weather plan. Their plans assume an evacuation and include important contacts as well as how to mobilize resources to react to the situation. The plans also include information about typical emergencies and events that occur during revenue hours as well as after hours. When developing the plan, all departments wrote elements specific to their operations, mainly contact information. Then the various sections were combined into an overall plan. The plan is updated as needed, generally when contacts change.

NFTA

NFTA does not have a severe weather plan per se, however, they do have a snow plan. The agency also utilizes a safety and security plan. The safety and security plan has recently been altered due to a change on the rail side in the Code of Federal Regulations (CFR). When updating its plan, the agency's safety staff is responsible for any revisions, however, NFTA works with state and local police and fire officials for training purposes. The largest cost to the agency when updating its security and safety plan is man hours. The plan is regularly updated for conformity with CFR and audited throughout the year by New York's Public Transportation Safety Board (PTSB).

Metra

Metra has operating plans encompassing general emergencies, severe weather and COOP. Its weather plan is annually updated and evaluated by past events. The agency examines whether certain trains or interlocking signals experienced problems during events and evaluates how to remedy the situation, as well as whether more staff may be needed for future events. Developed at an internal level, the plan does not have input from the public or other agencies.

WMATA

WMATA's Emergency Operations Plan (EOP) discusses three strategic goals. These include limiting risk to protect and save lives, preserving continuity of essential functions and minimizing service disruption and economic loss. It addresses several assumptions as well as important critical considerations that should be taken into account about the metropolitan Washington D.C. area. Additionally, it lists authorities, policies and references important to formulating the plan. The plan is annually updated (at a minimum) by applicable WMATA departments and reviewed by the Office of Emergency Management, however, changes may be recommended at any time and changes in personnel and resources should be continually be updated. When an event occurs that activated the EOP, an after event report is filed which discusses findings, recommendations and corrective actions. This report is used as a baseline for plan changes.

Another part of WMATA's plan discusses steps in COOP planning. It includes strategies for the agency's primary mission essential functions. The plan recommends a three-deep order of succession to take responsibility if a COOP is activated, methods for choosing alternative operating facilities, remote location capabilities, identification of necessary records and databases and personnel issues that may arise. (WMATA 2010).

Pace

Pace has a System Security and Emergency Preparedness Plan (SSEPP), which includes the agency's prior Continuity Plan for Recovery (CPR) The CPR has a section regarding weather. The weather guidelines advise the agency on how to respond to weather events such as tornadoes and blizzards, which can cause damage to facilities and assets. The agency has always had some form of emergency plans, however, with the SSEPP; all potential emergency guidelines – from bomb threats, to weather, to personnel issues – are in one document. The agency does not directly utilize public input for its planning process; however, they do have an ADA advisory board that addresses issues within the disabled and special needs community. The plan was developed utilizing knowledge of past experiences and is generally updated once a year. Before a predicted event, such as the 2011 blizzard, the agency holds a pre-planning meeting. Additionally, after incidents they try to debrief to review the event and what can be improved.

Key West Transit

Key West Transit has an Emergency Operations Plan which is updated yearly at a minimum. The agency collaborates with local fire and police to update it, and also uses large special events in order to practice the plan and review how well it works. Also, after an emergency event, the agency contacts social service agencies for whom they provide transportation services to find out the agencies' opinion on how Key West Transit performed during the event. The agency participates in a general debriefing with other EOC members after an event to find areas of improvement. Key West Transit does not have formal performance measures in its plan, but the agency internally considers the costs and service provided during an evacuation. In addition, the agency also incorporates best planning practices from state and federal sources into its plan.

Agency Preparedness

RCL

As a part of preparedness planning, all RCL management has gone through FEMA training in National Incident Management System (NIMS) procedures. NIMS was mandated by Homeland Security Presidential Directive 5 as a consistent approach to emergency planning (WMATA 2010). The agency also performs drills as a training exercise. To see how many people the bus system could get from downtown to a city hospital, the agency performed two "inoculation" drills, and moved 1,200 people within a certain time frame. The agency also participated in a terrorist drill at the Rochester airport, where they used buses for staging in order to get people in and out. While these drills are useful for preparedness purposes, such staff time and training time use the most resources.

Omnitrans

Omnitrans prepares by utilizing NIMS policies as well as California's State Incident Management System. For preparedness, the agency works closely with the fire and police departments as well as the Transportation Security Administration (TSA) and Department of Homeland Security (DHS). In fact, Omnitrans recently received a grant from the Transit Security Grant Program, which funds activities such as emergency drills and table top exercises. The agency also is part of the California Transportation Safety and Security Forum, which meets every other month.

SCAT

The agency utilizes table top exercises for preparedness as well as involvement in radiological, airport and space launch drills.

NFTA

As mentioned above, NFTA works with local authorities for security and safety training. In order to get its fleet up to speed, any changes in design or maintenance of its vehicles must be submitted to the agency's change control review board.

WMATA

WMATA incorporates NIMS in its training and planning. The agency holds a minimum of one large interagency drill per year. However, if there is a serious incident in which the full EOC is activated, that event is considered the yearly exercise (WMATA 2010). An agency-wide tabletop exercise is also conducted at least once a year.

Pace

Pace prepared for the 2011 blizzard in advance by renting four-wheel drive vehicles in case personnel needed to be collected from trapped vehicles, or picked up to make runs when service was restored. The agency does occasionally participate in emergency preparedness classes offered by the FTA.

Key West Transit

Key West Transit uses its yearly Fantasy Fest as a way to examine its ability to move large numbers of people and evaluate its performance. In addition, the agency takes other steps to prepare. A public service announcement is released every May 1 to encourage residents to preregister for an evacuation ride, which the system provides for residents of Monroe County. The preregistration allows the agency to determine an estimated capacity in the event of an evacuation. They have two satellite phones for communication during an emergency that are tested twice a year. Hotel contracts and interlocal agreements are reviewed and renewed well before hurricane season. Furthermore, Key West Transit utilizes NIMS principles for training and recovery purposes.

Collaboration with Other Agencies

RCL

RCL is also a part of Rochester's Emergency Management Services (EMS) in which they can intervene in transit service in an emergency and use the agency's assets. Knauer said the EMS is currently in the process of reexamining its plan, which includes sections on all departments. The agency generally works with police, fire, health, EMS and utilities during severe events.

Omnitrans

Okamura said that in most natural disaster incidents, Omnitrans will receive requests from other municipalities for vehicles to assist in the emergency situation. However, such moves must be coordinated through San Bernardino County in order to effectively receive FEMA reimbursements for the added service. FEMA has a public assistance program in the event that will provide reimbursements to transit agencies for damaged assets or emergency transportation provided during the severe weather event (FEMA 1999). While Omnitrans can be an asset for municipalities, Okamura added that the cities have other options such as charter buses and school buses to move people during an emergency. The agency ran into a problem during wildfires in 2004 when they used assets in cities and schools that had contacted them directly, when the county was unaware of the situation and the vehicles and drivers were needed elsewhere.

LTS

Prior to Hurricane Gustav, Dana McPherson-Gradney said LTS sat with 911 and other state agencies and discussed what each agency's role would be. Then the evacuation plan was followed. She said some adjustments could be made in the event of another hurricane. Coordination of transportation services was not ideal, with McPherson-Gradney having to supervise getting residents to the central location rather than concentrate on transit operations that were still occurring.

Tulsa Transit

Tulsa Transit communicates with the city of Tulsa during a severe weather event to determine whether the agency's assets are needed during an emergency or severe weather event.

NFTA

While NFTA generally does not cancel service, at times the agency's fleet is called in to assist other motorists. Queeno recalled when a snow storm crippled traffic on the Thruway (Interstate 90), and buses were deployed to the area to assist trapped motorists.

Metra

During the 2011 blizzard, Metra had representation from its police force stationed at Chicago's Office of Emergency Management and Communications.

WMATA

WMATA's plan makes assumptions for public safety, police, fire and emergency medical services. The agency will work with fire and EMS based on jurisdiction. Some staff may not be available. All operating actions will comply with laws and regulations. Coordination with other agencies and WMATA is challenging because of the number of jurisdictions, multiple EOC's, offices and authorities in the metro area. Additionally, WMATA may need to work with non-governmental organizations such as the Red Cross, Salvation Army and local food banks, depending on the emergency. WMATA may also work with the private sector for medical or messaging purposes (WMATA).

Pace

Pace has agreements with approximately 70 communities in their service area to provide emergency transportation. When a community needs this service, it is coordinated through Pace's corporate office in order to authorize the movement of assets. Occasionally, McIntyre said Metra also uses this service. Pace is part of the city of Chicago's OEMC. The agency may also provide equipment as requested to local emergency agencies.

Internal and External Communications

RCL

All RCL buses are equipped with AM/FM radio capability that can broadcast weather warnings to customers and drivers. Additionally, the city's downtown transfer station has electronic signs that can display important emergency messages. The agency is currently in the process of remodeling its web site to enable real-time announcements.

GATRA

If the decision is made to cancel service at GATRA, the Rhode Island Broadcasters Association will be notified, as much of the news media in the area is from Rhode Island.

SCAT

Recently, a forest fire spread through the SCAT service area and the county utilized Twitter to disseminate information about affected bus routes to the public. The information quickly made it to traditional news media. SCAT anticipates that social media will have a larger impact during future emergency and severe weather events. Other ways the agency communicates is through telephone calls and press releases. Additionally, SCAT notifies its paratransit contractors so they are able to inform their clients. The agency is also part of a radio system in which they can communicate with all agencies involved with emergency management.

Omnitrans

Omnitrans conducts a public awareness campaign about emergencies through information booths at terminals or bus stops. During a severe weather or emergency event, areas to avoid and emergency numbers are posted on their web site.

LTS

In Lafayette, the agency contacts local media via press releases in order to inform customers of any changes. If daytime service is altered, the contracted agencies for night and paratransit service are contacted regarding any changes.

RCAT

Some resources and procedures RCAT uses in the event of inclement weather include radios in each bus for communications with drivers and reserve buses that can be used to create a command post. The agency hopes to begin utilizing a laptop computer in order to receive continuing updates from emergency management services. During an event, the agency communicates with its customers via radio and television.

Tulsa Transit

Tulsa Transit communicates with customers via television, their web site and radio.

NFTA

NFTA uses local news media as well as its customer service hotline in order to communicate any service changes to its customers. In the future, the agency plans to electronically post service changes as well as implement an email alert program for customers. Any service changes are communicated to operators by the control center.

Metra

Metra communicates with its riders through radio, television and its web site. Additionally, riders have the ability to sign up for mobile or email alerts regarding service on a particular line.

WMATA

WMATA's plan makes assumptions when it comes to external public communications. These include operating status messaging both within the Metro system as well as local media outlets. The agency will include alternate messaging formats for those customers with limited English proficiency, special needs or disabilities. Customers may also use kiosks at stations as well as web site or Metro Line to get service information. Furthermore, internal communication and sharing information with other authorities is equally important. Additionally,

personnel should have OEM information shared with them. Radios and telephones should be used for internal communication, and back up communications systems should be identified (WMATA 2010).

Pace

In the event of inclement weather such as a tornado, Pace can communicate with drivers via their Intelligent Bus System (IBS), which will send a message to drivers instructing them to cease driving and not let any passengers off the bus. Additionally, because some paratransit service is contracted out, Pace must ensure that service changes and situations are adequately communicated to the contractors. The agency uses its web site as well as press releases to local television and radio stations in order to communicate with its customers. Unfortunately, the IBS estimator for bus arrival times on the agency's web site goes into default scheduled times when there are no buses, which should be addressed by the agency in the future. Additionally, during the 2011 blizzard some customers encountered problems when checking the agency's web site. While the site did have a pop up announcement about service cancellation, those accessing the site via a mobile device may not have seen it.

Key West Transit

Internally, the operations manager has a laminated contact card with staff names and contact information. Nevertheless, communication among field supervisors during an emergency situation is an ongoing issue that could continually be improved. When supervisors become occupied with their own duties, they sometimes neglect to debrief with other divisions of the transit agency as well as the EOC. This can cause mixed signals to drivers at a time when they need up to date information the most. Key West Transit utilizes television as well as its real time transit site to communicate with customers. Because the real time information site is web based, it can be accessed from any computer in the world to alert customers of any changes.

Service Changes due to Weather

RCL

RCL has closed one day due to snow. More than 20 inches of snow fell and on a Saturday, the agency closed down at 4 pm. In general, however, bus reroutes will depend on the street situation and usually involves police, fire and other emergency management personnel. After an emergency, the agency will assess service, and will reroute as necessary depending on what percent of their assets are damaged.

GATRA

Many of the severe weather events experienced in the GATRA area are snow storm-related, however, the agency did not cancel service during the most recent snow storms in December 2010. Management will continue as many paratransit routes as possible but begin sending drivers home as necessary. Fixed routes usually continue to run at all times, since transit in the area is the recommended mode of choice during severe weather. Reroutes depend on the exact situation, but when routes mainly serve school children or must climb steep hills, they may be curtailed before the end of the route.

SCAT

Continuation of service in the SCAT service area depends on the severity of a weather event. Generally service is not completely shut down, but situations are watched closely. For example, Hurricane Charlie only affected the northern end of Brevard County, which caused a shut down in service; however, service in the southern portion of the county still ran. On the other hand, Hurricane Wilma caused a complete shutdown of fixed route service. Nevertheless, there are customers in the service area that require certain medical transportation on a regular basis, such as dialysis. In this case, SCAT tries to continue that service for as long as possible. Additionally, since Wilma, if an event begins occurring in the midday period, the agency has learned that it is best to try to get everyone home safely.

LTS

At LTS any rerouting of service depends on advisory from either 911 or media about road closures. Besides hurricanes, the city does not experience many other severe events that may impact service.

RCAT

RCAT has spoken with other transit agencies that have said they discontinue service when the major school district closes. Nevertheless, on some occasions when the local school district has closed due to weather, transit service could still be provided. When rerouting, RCAT tries to keep service that is close to major arteries while attempting to avoid hazardous intersections and potentially slick, dangerous overpasses.

NFTA

Rarely does the agency cancel service; roads must be closed and completely impassable in order to curtail service.

Metra

Metra tries to never completely discontinue service; however, in some events certain trains are canceled. Canceling trains during rush may help keep the other service on schedule. Nevertheless, a snowball effect can occur depending on which trains are canceled. If a train that typically runs express through certain stops must end up making every local stop, other trains will experience further delay. Thus, the agency must be equipped to strike a balance. As the 2011 blizzard began to set in, Metra implemented an early quit schedule, assuming many passengers would leave work early. Later service was canceled in order to handle the earlier crowds. The next day, Metra was forced to run a Sunday schedule. Although several personnel had been stationed in hotels, other crews were unable to get to trains due to road closures in outlying suburbs.

WMATA

WMATA's plan calls for a continuation of core service if possible during an emergency event. The agency has identified pre-determined triggers to implement service cancellation and station closure. Additionally, if a severe weather or emergency event closes or cancels public events, the agency needs to anticipate crowds overwhelming the system.

Pace

Pace tries to always run service, however, weather events may cause runs to be late or intermittent. Service restoration after an emergency can also depend on EMS input. For instance, after a tornado, the agency's fleet was not damaged heavily and could have been run; however, EMS would not allow personnel into the damaged building. When there is a severe weather event, Pace evaluates its ability to run service on a garage by garage basis by assessing the amount of manpower and resources available, as well as condition of the roads. During the 2011 blizzard, Pace ended service early during the first night of the storm, a Tuesday. On Wednesday, once most of the snow had ended, the agency decided to curtail service for the day. Although there was some service running in the southern suburban area, various factors, including accidents that would block buses, eventually caused running routes to become so short that continuing service was no longer a good idea. In this situation, drivers were told to take people where they could then return to the garage. Additionally, some counties and municipalities throughout the area had declared snow emergencies in order to get all vehicles off the roads. Of course, this included buses. By Thursday, Pace was operating at full capacity.

During Event Procedures

RCL

During an emergency or severe weather event, RCL has a representative in the EMS command room. All service is directed by the EMS incident commander.

GATRA

The agency will assess the severe weather situation beginning at 4 am to determine whether there will be service or not.

SCAT

During an emergency, SCAT is known as Emergency Support Function (ESF) #1. This means the agency is responsible for coordinating county-wide transportation as a support function to both government agencies and social service or volunteer organizations. The agency's Hurricane Evacuation Manual lists five alert phases that describe the evacuation process, as well as recovery operations and call down procedures. To assist with evacuating special needs residents, the county has a registry, which currently includes 2,800 residents. However, evacuation of this population can be difficult if they are not registered for any type of social services or feel that they do not need the assistance the registry can provide. SCAT would like to examine a more automatic

and faster way to track evacuations. In the past, the agency has tried to work with the homeless population by setting up pick up points to take them to shelters, however, very few homeless residents take advantage of the program. After an event, SCAT examines how to get service restored, and the county's chain of islands usually has service restored last. Agency representatives ride along fixed routes to assess their facilities and ability to restore service. Because the agency is number one in the EOC, they are still needed for disaster recovery until deactivated. In addition, the EOC representatives hold an "after event" meeting in which they review what happened and what could be done differently (SCAT 2010).

Omnitrans

During an emergency, Omnitrans is responsible for transporting people as required by San Bernardino County. This may include moving emergency responders or volunteers during evacuation situations. The agency also provides retired buses to create a mobile command center, particularly after earthquake events.

LTS

LTS's main objective during a hurricane or other natural disaster requiring evacuation is to transport its transit dependent citizens to a central pick up location. At this location, workers gather information about evacuees and provide medical services (if necessary) before transporting the residents to a safe place further inland. The evacuation plan outlines a procedure timeline. Annually, LTS takes an inventory of its fleet and updates operator contacts as necessary. Five days prior to an event, the agency contacts local broadcast media to inform them of pickup locations in the event of an evacuation. Finally, three days before the event, evacuation routes are determined and operators are notified of them. Also, bus and operator assignments are organized in order to implement the evacuation (LTS). The evacuation plan does not always go flawlessly – accurate tracking of evacuees can be an issue.

Tulsa Transit

During an ice storm in 2007, Tulsa Transit performed several evacuations of populations from apartment residents to nursing homes. The agency noticed emergency shelters were inconveniently located. Thus, the agency recommended that the city examine placing emergency shelters in closer proximity to fixed route service. This change would allow Tulsa Transit to evacuate residents more quickly and efficiently.

Metra

When there is an anticipated severe weather event, such as the 2011 blizzard, Metra will provide hotel accommodations for trainmen and engineers. The agency will also station extra maintenance personnel at interlocking signals. Additionally, management remains fully staffed, creating a command center until the event is over. Nevertheless, improvements could be made to the timing of decisions during severe weather events. Of course, weather cannot be fully predicted and it is difficult to determine exactly how an event will occur.

WMATA

The agency differentiates between a routine response to an incident versus a major emergency. When an incident occurs, the initial response is considered a departmental issue and may not have to involve the agency as a whole; this is considered a "routine response." A routine response also rarely needs assistance from first responders. A larger emergency may require activation of the EOC. This activation includes the agency as a whole, and encompasses management, operations, planning, administration/finance and logistics. The plan specifically delineates the command structure for both a routine response and a major emergency. Additionally, the plan outlines responsibilities of each department during a routine response or activation of the EOC. The plan also recommends a narrative log of any incident as well as any expenditures necessary during an emergency situation (WMATA 2010).

Key West Transit

If a tropical storm may hit the Keys, the agency, as well as other city departments, begins watching weather reports on a regular basis. Representatives of the EOC have informal conference calls to discuss possible situations. Additionally, the agency communicates with county and state level officials at this time. If the situation intensifies, a memo to internal employees will go out to advise them to decide whether they want to evacuate as a driver or leave at another time. The agency holds mini drills and briefings in order to prepare. An evacuation will be called by the county and non-residents and visitors are evacuated in the first phase. Approximately six hours before the brunt of the storm, the drivers take the buses and evacuees to hotels to the agreed to hotels. This arrangement allows both personnel and assets to be safe. After an evacuation emergency, the city EOC goes back into the area to assess damage and whether it is safe to allow evacuees back into the area. The analysis is reported to the county and state levels. If approved, evacuees may return in the opposite order in which they left.

Recommendations

The survey of transit agencies indicated that procedures during a severe weather event or emergency vary throughout the country, based upon agency size, region and potential weather events. While some agencies, such as those in California and Florida, are required by law to provide some sort of plan, others choose to plan upon their own desire. Additionally, some agencies, such as Pace, mentioned a planning need for compliance with more stringent FTA and DHS regulations.

By reviewing prior literature, including sample severe weather and emergency plans, as well as information gleaned from the interviewed transit agencies, recommendations were developed. These recommendations may be useful for agencies in both categories – for those that have not created their own plans (while they may be a part of other participating agency plans) as well as for agencies that may be evaluating and updating current plans. Figure 2 illustrates a flow chart for a complete severe weather planning process.

Assessments

- ✔ Weather events
  - ▶ National Weather Service
- ✔ Assets
  - ▶ Revenue & Non Revenue Fleet
  - ▶ Facilities
  - ▶ Communications
  - ▶ Records & Archives
- ✔ Personnel
  - ▶ Training Programs
  - ▶ Contact Information
- ✔ Community
  - ▶ Emergency Shelter Locations
  - ▶ Vulnerable Populations
- ✔ Regulations
  - ▶ Changes at all government levels

Identify Stakeholders

- ✔ Government
  - ▶ Local
  - ▶ State
  - ▶ Federal
  - ▶ Emergency Management & Law Enforcement
- ✔ Non-Government Organizations
  - ▶ Red Cross
  - ▶ Salvation Army
  - ▶ Food banks
- ✔ Private
  - ▶ Major employers
  - ▶ Medical service
  - ▶ Human services
- ✔ Public
  - ▶ General
  - ▶ ADA/Special Needs
  - ▶ When and how to interact with the public

Identify Emergency Role

- ✔ Providing Emergency Transportation vs. Essential Transit Service

Communications Plan

- ✔ Internal
  - ▶ Within agency
  - ▶ Other government agencies
  - ▶ Paratransit contractors
  - ▶ Evaluate and consider current alternate or backup communications systems
  - ▶ Identify command structure
- ✔ External
  - ▶ How and when
  - ▶ Traditional and Social Media
  - ▶ Marketing program for severe weather, safety or other emergencies

Service Strategies

- ✔ Identify routes in relation to common weather events
- ✔ Identify current routes, ridership and physical barriers
- ✔ Identify service cancellation point
- ✔ Identify alternative facilities for continuation of service

Evaluations & Updates

- ✔ Perform basic annual evaluation
- ✔ Perform debriefing meeting after severe weather events that impact service
- ✔ Develop performance measures
  - ▶ Travel delays
  - ▶ Asset performance
  - ▶ Effective evacuation measures
- ✔ Consult with stakeholders, especially after an event
- ✔ Consult with other agencies
  - ▶ Before and after a predicted event
  - ▶ Before severe weather seasons (i.e. hurricane, tornado, winter)
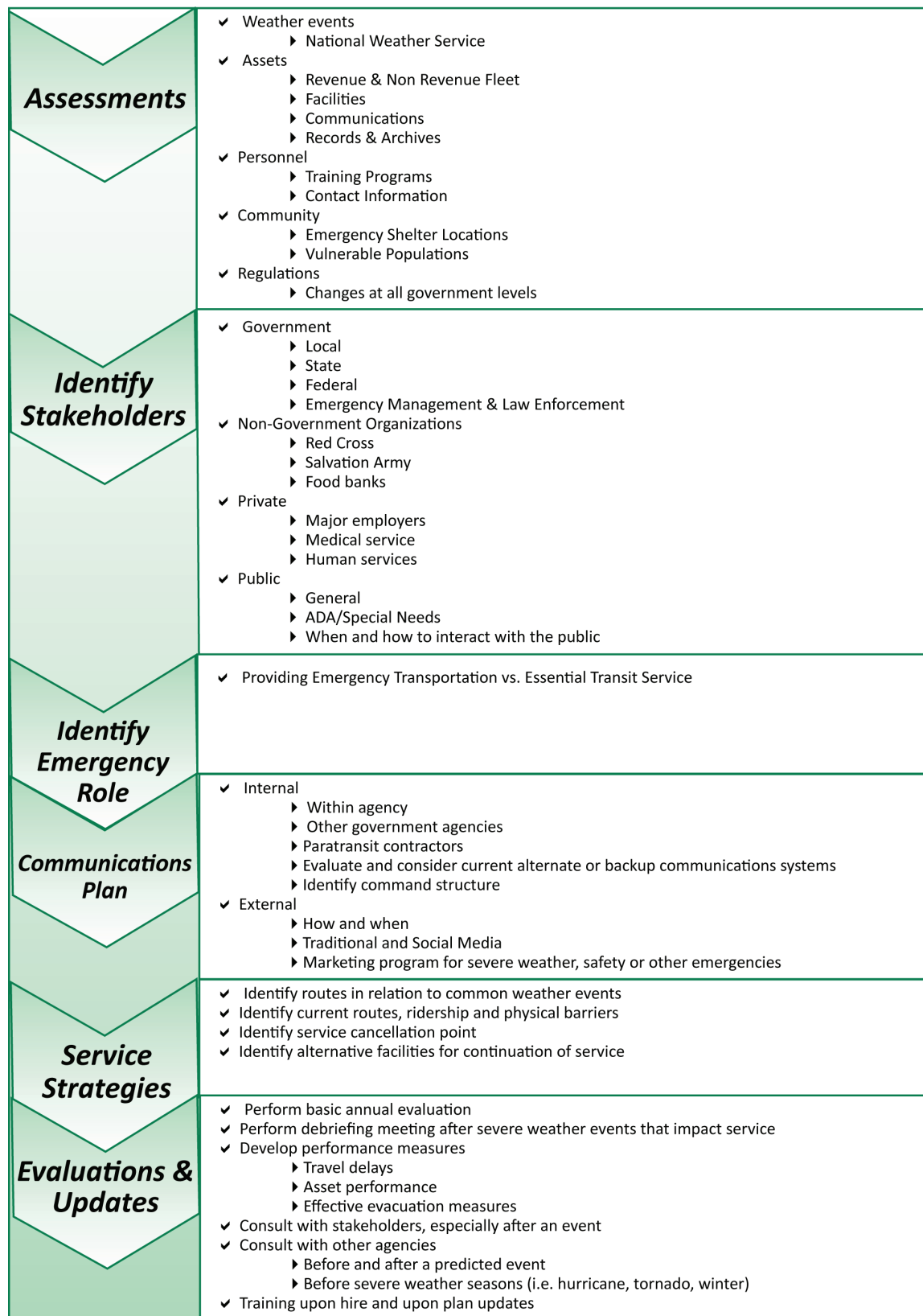- ✔ Training upon hire and upon plan updates

Figure 2: Severe Weather Planning Process

Agencies creating a new plan

Assessments

Agencies prone to severe weather events should perform several assessments before beginning to formulate a severe weather plan. First, an agency should assess what types of weather events may occur in their areas. Areas that experience frequent snow storms will have to plan differently than those who endure regular flooding or hurricanes. One way to do this is to contact the local branch of the National Weather Service, who will have data on past events likely to occur again in the future. Similar to the LTS evacuation plan, agencies should assess their assets, including revenue and non-revenue fleet, facilities and necessary records and archives. Such an assessment can be useful to determine whether assets are adequate to help set up mobile command centers or alternate facilities, as well as mobilize and evacuate residents.

An agency may want to produce uniform design and maintenance standards in order to have a more effective fleet. Personnel contact information and evaluation of employee training should also be part of this assessment process. Agencies may also want to work with the municipality or county to map potential emergency shelter locations and vulnerable or transit dependent populations. Collaborating on emergency shelter locations can allow the transit agency to encourage shelter locations near already established fixed routes, enabling them to more quickly bring residents to the shelters. Mapping vulnerable or transit dependent residents will allow an agency to see which areas they should focus evacuation efforts. Agencies should also be mindful of recent changes and additions to any local, state and federal regulations in regards to safety and security.

Stakeholders

A transit agency should identify all important stakeholders that may be involved in the severe weather planning process, including public, private and other government agencies. In many cases, which can be seen by the above survey results, transit agencies may already closely collaborate with municipal or county government as well as emergency management departments. Agencies may also closely work with police and fire departments. An agency should examine these collaborative relationships and be sure to include them in their own plan.

Private stakeholders include local businesses and major employers. These can include hospitals, nursing homes and human service agencies. As most transit agencies are charged with running paratransit service for special needs populations, agencies should gather input from businesses and agencies that serve the special populations, as Key West Transit regularly does after an emergency event. Additionally, agencies may want to collaborate with major employers to discuss what procedures may be effective if a severe weather event begins during the work day.

Besides SCAT with its special needs advisory board and Pace with its ADA advisory board, surveyed agencies did not indicate any public participation within the emergency or weather planning process. Agencies may want to consider forming a general citizens' advisory board, which can include representatives of different areas of the population, if they have not yet done so. Alternately, an agency may rather hold public workshops and meetings discussing severe weather events and transit service. This approach would more than likely be most effective immediately after a severe event. A paper by Godschalk, Brody and Burby (2003) noted that in some cases in Flor-

ida, interest in hazard mitigation was low during public participation in comprehensive planning. On the other hand, they found much greater interest in Issaquah, which had recently experienced flooding.

Agency's Role During Emergencies

A transit agency may already participate in emergency management within their municipality or county. This level of collaboration should be assessed and included in any individual agency plan. In particular, an agency should assure that their involvement with other agencies does not impact essential transit service. Additionally, past cooperation during inclement weather events should be evaluated for effectiveness. This may be a formal meeting or an informal debriefing immediately after an event, as some agencies mentioned in their interviews.

Communications Plan

Agencies must consider both internal communication, which can include communication with other collaborating agencies, as well as external communication to customers. After evaluating current internal communication capabilities, which may range from special radio frequencies to the internet, an agency should explore ways to improve internal communications. An agency should also identify a chain of command for communication with internal stakeholders. An adequate evaluation and implementation of a communications structure can help agencies avoid problems such as mixed messages to drivers who are in the field during an emergency event. Most transit agencies hire contracting companies that provide paratransit service. Additionally, if resources allow, an agency should examine the possibility of collaborating on electronic mapping resources that may include emergency shelters, hospitals, schools, nursing homes and their relation to transit routes.

External communication to customers is essential during severe weather events. The agency should include a policy for announcing service changes or evacuations. Traditional media includes television and radio. They may have a marketing program in regard to safety and emergencies. Many agencies also use their web sites to publicize such alerts. With constantly changing technologies, agencies should also examine how to more effectively utilize social media such as Twitter and Facebook, as well as beginning a program of mobile text alerts. Any public engagement should include a discussion of effective communications during inclement weather. Agencies should also decide when and how they should publicize alternate routes, which will be discussed below.

Service Strategies

Transit agencies should identify routes in relation to common weather events in their areas. Areas prone to snow should designate snow routes according to major arterials already used in fixed route services. Agencies subject to flooding incidents should compare their route maps to flood plain maps. As mentioned previously, an agency should collaborate with its local emergency management department when developing evacuation routes as well as when locating shelters. This will allow the agencies to efficiently assist in evacuation during an emergency and avoid communication difficulties. Agencies may choose to shorten routes or cancel routes altogether. They should evaluate current fixed routes and their primary ridership, as well as physical barriers that could impact vehicle operation. GATRA has curtailed service to an area that primarily served a school, whose route was shortened.

Several agencies mentioned that transit service is generally thought of as a way for passengers to travel during a severe weather event, agencies should examine at what point service should be canceled. While RCAT has spoken with agencies that have a policy to close when the major school district closes, such a decision really depends on each agency's situation. While a large region like Chicago would more than likely require at least some basic services, an area similar to Reno County may not need to continue service during a severe weather event. Additionally, flood-prone agencies should locate ideal places to store assets as well as alternative facilities in case current garages and facilities become flooded. Something similar happened in Nashville during the 2010 flooding, and transit agencies from other parts of the country donated vehicles to the agency in order to restore service (Metro Magazine 2010).

Evaluations and Updates

A severe weather plan should be updated at least annually, and evaluated soon after any event in which the plan is utilized. The plan should include performance measures for evaluation. These may include measuring travel delays during inclement weather, measuring asset performance, and measuring effectiveness of evacuation measures. They may also include costs incurred by the agency during Of course, because of the wide variety of weather types found throughout the country, such measures may only be utilized once every few years, while in other areas they may be used more than once a year.

Stakeholders should be consulted regularly. Businesses and public advisory representatives should especially be consulted after a severe weather event in which the plan is used. Other agencies should be consulted with both after an event and before important weather seasons begin – for example, winter or hurricane season. Similar to Key West Transit, any contracts or agreements that are important during severe weather should be reviewed before weather seasons begin. In order to avoid gaps in training due to turnover, new hires should be trained on the plan and given a copy of it upon hire. Additionally, when the plan is updated, all personnel should be reminded of the plan and trained on any new aspects.

Agencies reviewing current plan

Some agencies may already have a planning process, however, there are some ways that they may want to improve the plans they already have. Agencies should find ways to engage the public. At the very least an advisory committee should be formed that represents special populations such as aging and disabled communities. Additionally, because cities change, ranging from land use to road construction, agencies should make an effort to review their service routes at least quarterly. This may make designating snow or flood routes easier. Agencies should keep pace with evolving technology. As mentioned above, inexpensive ways to keep in touch with customers can include utilizing social media such as Facebook or Twitter. Also, agencies should evaluate how they utilize technology to communicate internally – are smartphones or radios more effective for their situation? Training should happen yearly, and updating of training programs should be evaluated after severe weather events. Additionally, personnel and asset information should continually be updated. As mentioned above, agencies with plans may want to create performance measures when updating their plans.

Conclusions

With the potential of more frequent severe weather events occurring in the U.S. due to climate change, transit agencies throughout the country may want to evaluate the feasibility of developing a severe weather operations plan. Although an agency may already play a large part in emergency planning and evacuation with local emergency management, officials may want to create its own plan for even more comprehensive preparedness. All transit agencies have differing needs. Rural agencies will react differently to a severe weather event than a large urban system. Additionally, with such a large country, agencies in one part of the nation will experience vastly different weather events than in others. When developing a severe weather plan, transit agencies must assess their particular situations to create the most effective plan.

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Appendices

1. Transit agencies contacted and/or interviewed

State	Agency	Weather Event	Contacted	Interviewed
AL	The Wave (Mobile)	Hurricane Katrina	X	
AR	Central Arkansas Transit Authority (Little Rock)	Ice Storm	X	
CA	Victor Valley Transit Authority (Victorville)	Flash Flood	X	
CA	Sonoma County Transit	Flood	X	
CA	Vallejo California Municipal Transit Services	Flood	X	
CA	Riverside Transit Agency	Flood	X	
CA	San Francisco Municipal Transportation Agency	High Surf	X	
CA	Contra Costa Transit	Flood	X	
CA	Omnitrans (San Bernardino)	Flood	X	X
CA	Marin Transit	Flood	X	
DC	Washington Metropolitan Area Transit Authority	Flash Flood/Blizzard	X	X
DE	Delaware Transit Corporation	Coastal Flood	X	
FL	Miami Dade Transit	Hurricane Katrina	X	
FL	Key West Transit	Hurricane Wilma	X	X
FL	Space Coast Area Transit (Palm Bay)	Hurricane Wilma	X	X
GA	Metropolitan Atlanta Rapid Transit Authority	tornado	X	
IA	CyRide (Ames)	Flood	X	
IA	Iowa City Transit	tornado	X	
IL	Chicago Transit Authority	Flash Flood/Blizzard	X	
IL	Metra Rail	Flash Flood/Blizzard	X	X
IL	Pace Suburban Bus	Flash Flood/Blizzard	X	X
IN	Metropolitan Evansville Transit System	Tornado	X	
IN	Terre Haute Transit Utility	Flood	X	
KS	Wichita Transit	Winter Storm	X	
KS	Reno County Area Transit (Hutchinson)	Ice Storm	X	X
KY	Owensboro Transit	Tornado	X	
KY	Henderson Area Rapid Transit	Flash Flood	X	
LA	Alexandria City Transportation	Flash Flood	X	
LA	Lafayette Transit System	Hurricane Gustav	X	X
LA	Regional Transit Authority (New Orleans)	Hurricane Katrina		
MA	Greater Attleboro Taunton Regional Transit Authority	Flood	X	X
ME	Greater Portland Metro Bus	Coastal Flood	X	
MN	Rochester City Lines	Flash Flood	X	X
MS	Coast Transit Authority (Biloxi)	Hurricane Gustav	X	
MS	JaTran (Jackson)	Hurricane Katrina	X	
NC	The Wave (Wilmington)	Hurricane Ophelia	X	
ND	Bis-Man Transit (Bismarck)	Winter Storm	X	
NH	Nashua Transit System	Ice Storm		
NJ	New Jersey Transit	Flood/Snow	X	
NY	Suffolk County Transportation	Coastal Flood	X	
NY	NFTA-Metro (Erie County/Buffalo)	Lake Effect Snow	X	X
NY	NYC MTA	Snow		
OH	LakeTran (Lake County)	Flash Flood	X	
OH	Toledo Area Regional Transit Authority	Flash Flood	X	
OH	Greater Cleveland Regional Transit Authority	Flood	X	
OK	Metro Transit (Oklahoma City)	Winter Storm	X	
OK	Cleveland Area Rapid Transit (Norman)	Winter Storm	X	
OK	Tulsa Transit	Ice Storm	X	X
OR	Tillamook County Transportation District	Flood	X	
PA	Lehigh and Northampton Transportation Authority (Lehigh County)	Winter Storm	X	
PA	Luzerne County Transportation Authority (Wilkes-Barre)	Flood	X	
RI	Rhode Island Public Transit Authority	Flood	X	
TN	Knoxville Area Transit	Flash Flood	X	
TN	Metropolitan Transit Authority (Nashville)	Flood	X	
TX	Amarillo City Transit	Flash Flood	X	
TX	Dallas Area Rapid Transit	Snow	X	
WA	Community Transit (Lynnwood)	Heavy Rain	X	
WI	Kenosha Area Transit	Flash Flood	X	
WI	Metro Transit (Madison)	Flash Flood	X	

2. Questions asked to transit agencies

1.   Basic agency info
    a.   Fleet size
    b.   Modes
    c.   Ridership
    d.   Routes
2.   Emergency/Weather/COOP
    a.   Do you have a general emergency plan?
    b.   Do you have an operating plan for severe weather in particular?
    c.   Do you have a Continuity of Operations Plan, or have you considered taking steps to create one?
    d.   (Yes to any of these go to Q4, No to all go to Q3... then all answer 6-10)
3.   If you do not have a full severe weather or emergency plan, what are some guidelines you use while operating as a severe weather event is occurring?
    a.   Communications with agencies/customers?
    b.   Rerouting or suspension of service?
4.   What are the main elements of your plan?
    a.   Mitigation
        i.   Design, maintenance, safety, security?

    b.   Preparedness
        i.   Disaster assessment, command communication structure, written procedures
    c.   Response
        i.   Communication with other agencies and the public? Continuation of service?
    d.   Recovery
        i.   Methods for restoring service? Role in helping other agencies with disaster recovery?
5.   What process did you undertake to create your plan?
    a.   Motivation/Needs
        i.   Particular weather and/or events
        ii.   Regulations – federal, state, local?
    b.   Participants
        i.   Internal
        ii.   Public
        iii.   Other Agencies
    c.   Resources needed and used
        i.   Costs incurred
    d.   Methodology/data
    e.   Updates and Evaluations
        i.   How often is it updated and evaluated?
        ii.   What are your performance measures?
6.   What actions did your agency take during (weather event)?
7.   How did you collaborate with other government agencies?
8.   How did you communicate service information to customers?
9.   What do you think could be handled differently?
10.   How did your approach to dealing with severe weather events change after (weather event)?