3.3 WEATHER IMPLICATIONS FOR URBAN AND RURAL PUBLIC TRANSIT

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1. INTRODUCTION

Over the past five years or so, the meteorological and public transit communities have made a concerted effort to document the intuitive thesis that there are real direct and indirect relationships between weather and the operations, maintenance, and utilization of public transit systems of all types. A seminal work, *Weather Information for Surface Transportation (WIST) - National Needs Assessment Report,* prepared by the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM 2002) provides that first important effort. That report covers all modes of surface transportation including public transit systems, identifying particular weather elements and their impacts on the varied transit activities and required action/decision responses. The reader is referred to the URL cited in the reference with particular attention to Appendix B-5 therein.

This paper will summarize the highlights of these findings and discuss the impacts affecting two major stakeholders: 1) management, and 2) users.

2. Weather Elements of Concern

Appendix B-5 lists no fewer than sixty (60) separate weather or weather related elements. However, only those having a substantial impact on the delivery or use of public transit are discussed here.

In summary, weather and weather-related elements are grouped into major categories with indications of how each impacts specific public transit operations or access by the public. Those categories are:

- Freezing Precipitation
- Frozen Precipitation
- Liquid Precipitation
- Severe and Major Storms
- Temperature - Air and Surface
- Visibility
- Wind Speed
- Miscellaneous Phenomena

a. Freezing precipitation in any amount or rate of fall adversely affects surface friction for both transit and transit users. It also negatively impacts electrical conductivity of traction and power rails or guideways. Further, it increases safety risks for provider personnel and transit users.

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b. Frozen precipitation affects transit at different levels of accumulation or rate of fall. It primarily poses safety related concerns as well as schedule delays, possible detours, and system access impediments for users. Maintenance issues also arise. Drifting snow can cause similar problems.

c. Liquid precipitation impacts transit providers and users in a similar manner as frozen precipitation to an extent depending on amounts and rate of fall. Flooding can adversely affect routing, rail infrastructure integrity, and access to transit stations and stops by users.

d. Severe major storms include local severe storms such as thunderstorms and tornadoes; hurricanes and other intense cyclonic disturbances; and blizzards. Each of these impacts transit providers and users to different extents. Safety of operation is of paramount importance. Destruction of assets is possible. Major schedule upheavals are usual.

e. Temperature extremes, both air and surface (roadway and rail) can wreak havoc with vehicle operations and infrastructure, health and safety of transit workers and users alike, and serve as a precursor or adjunct to more severe weather phenomena.

f. Visibility includes such restricting conditions as fog, haze, smoke, dust, and glare. Safety concerns and schedule delays are the major impacts of these parameters.

g. Wind speeds of 30 miles per hour and above primarily pose safety and operational issues. Direct infrastructure damage and damage caused by flying debris are of major concern. Bridge closings and/or vehicle restrictions are implemented. Wind chill effects are problematic for transit users accessing station or bus stops.

h. Miscellaneous phenomena include such elements as storm surges, air quality, and geophysical events such as seismic activity, tsunamis, and effects of solar storm activity. Each have different impacts on providers and users with respect to safety concerns, operational issues, and infrastructure damage potential.

3. Management Decision Requirements

Most transit providers have developed storm or

incident management plans which are structured to their specific operational and physical characteristics. (The aforementioned WIST Assessment Report (OFCM 2002) tabulates the lead times necessary to take actions in advance of threatening weather or related events.) For example, electrified rail operators can plan to run their trains on a non-scheduled basis in freezing rain situations to keep catenary power lines and rails free of ice buildup. Bus operators can plan to install chains on their buses prior to dispatching them in heavy snow events. Rural transit operators can rearrange schedules adjusting to road conditions.

The primary directive of transit managers is to keep the service "on the road" without jeopardizing safety, keeping operating costs down, and protecting physical assets from damage. While it is often possible to plan for synoptic scale weather events, it is a challenge to plan for and react to meso-scale or very localized situations. For example, if "snow" is forecast for the afternoon, do maintenance managers install chains on buses in the morning causing wear and tear and operational slowdowns before the storm arrives or do they wait it out and only install chains on buses as needed during the event as needed? Each alternative has significant financial and operational considerations. Flash flooding and drifting snow can also cause "real-time" operational problems requiring managers to make on-the-spot decisions without much warning or weather information support.

Even with the availability of meso-scale forecasts, it may be difficult for managers to make operational decisions. For example, in hilly terrain, the difference of a few hundred feet of altitude may make the difference between a wet or an icy surface during precipitation in a temperature regime hovering around zero degrees Celsius. In a severe storm advisory or warning situation, managers do not generally alter service until an actual event takes place locally. Then it may be difficult or impossible to operate safely or at all in that environment.

Quite often, vehicle or train operators serve as weather observers and report back to their managers seeking guidance. At this juncture, most transit vehicles do not have mobile weather sensors and transmitting devices which would certainly assist managers in making critical operating decisions. If communications are impaired, it could fall on the transit operators' shoulders to make operational decisions that often have significant operational, safety, and financial implications.

Clearly, there is much research (as described later) to be done to develop industry standards and guidelines to deal with such real-time management weather-related issues.

4. User Issues and Decisions

There are several issues and related decisions involved with respect to transit users' interactions with current and forecast weather. For those users who are transit dependent and live in an urban area, the impacts of weather primarily affect the walk to and from transit services. Transit service delays, detours, or cessation of service are key factors in their planning. Appropriate dress and skin protection are also important factors for them to consider. These users rely heavily on the morning weather forecast and 511 reports where available.

For those users who have access to or require the use of automobiles for a portion or all of their trips, a more complicated decision matrix is employed. Some users will only use transit during foul weather to avoid driving; and, others will only use transit during fair weather to minimize their exposure to the elements. Both types of users need road condition reports as well as current and forecast weather and/or 511 reports to aid them in making their choices.

Others may select from several existing alternative transit modes in response to the weather. Underground rail (subway) systems are often chosen in inclement weather as opposed to surface bus or light rail lines as the former are less prone to weather-related delays and have more protected waiting areas. These users rely mostly on current weather and 511 reports in making their decisions.

5. Future Research and Direction

a. Management perspectives. The weather-related challenges facing transit managers and users alike will not be solved entirely by improved weather information and forecasts. Management decisions are made at several levels by individuals who have varying degrees of understanding of meteorological processes. Those decisions have operational, safety, and financial implications which are specific to individual transit systems.

Standardized, sample decision matrices need to be developed for transit systems similar to those contained in the Management Decision Support System developed for the roadway networks by the Federal Highway Administration. Individual transit organizations can then modify the matrix to fit their own specific needs assuring some uniformity in decision-making processes for given weather events.

It would also be important to share implementing weather-related experiences and procedures among transit systems as backup guidance for their own decision processes. Having standardized formats will aid in this endeavor. It is not clear at this point how the above program would be developed. Two committees, the Surface Transportation Committee of the American Meteorological Society and the Weather Implementation Applications Special Interest Group of the Intelligent Transportation Society of America, have focused on this

issue and are defining research projects to deal with this important problem.

b. User perspectives:

Clearly, much of the user decision-making processes are subjective and site specific making it challenging to develop a formal decision matrix incorporating weather elements. One approach is to upgrade weather information through 511 transit information systems now being deployed around the country. Weather reports and forecasts can be incorporated in automated telephone messages along with relevant transit information. Feedback from users will be important during this process to learn of users' needs and the effectiveness of the messages they receive.

The Intelligent Transportation Society of America is spearheading the above effort through its 511 Deployment Program which has a weather element advisory group actively contributing to this important initiative.

REFERENCE:

Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM), 2002: Weather Information for Surface Transportation (WIST) - National Needs Assessment Report. FCM-R18-2002. http://www.ofcm.gov/wist_report/wist-report.htm