North Tarrant Express Mobility Partners Segments 3 LLC Party Submission

Fort Worth, TX

HWY21FH005

(22 pages)

North Tarrant Express Mobility Partners Segments 3 LLC

Proposed Findings & Recommendations

NTSB Accident File:	WHY21FH005
Incident:	Multi-Vehicle Crash
Date of Incident:	February 11, 2021
Location of Incident:	Fort Worth, TX
Date of Submission:	May 10, 2022

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Introduction

North Tarrant Express Mobility Partners Segments 3 LLC (NTEMP S3) participated as a party to this National Transportation Safety Board investigation of a multi-vehicle crash in Fort Worth, Texas, on February 11, 2021.

The April 21, 2021 Preliminary Report announced that the NTSB would be "conducting a focused investigation to examine the road treatment strategies used to address the freezing conditions."

The NTSB Highway Factors Group Chairman's Factual Report announced that the scope of the investigation had been broadened to include "pretreatment of roadways; ice treatment strategies for roadways, bridge structures and sections of roadway; and training to detect moisture and icy road conditions."

NTEMP S3 would like to thank the NTSB and the other parties to the investigation for their diligence and commitment to investigating the February 11, 2021 accident.

NTEMP S3 offers the following analysis based upon the information that was provided during the course of the NTSB investigation. To the extent that the NTSB's analysis differs, and particularly if any differences are based upon information not available to, or considered by, NTEMP S3, we welcome the opportunity to discuss those differences.

Broad Overview of Accident Being Investigated

On Thursday, February 11, 2021, shortly after 6:00 a.m. central standard time, a multivehicle crash occurred in the southbound toll lanes of Interstate 35 West (I-35W), at milepost 53.5 in Fort Worth, Tarrant County, Texas. The crash occurred after ice formed on a bridge near the exit to Northside Drive and involved about 130 vehicles.[1]

In the days before the crash, the area had experienced 36 consecutive hours of dry, below-freezing temperatures.[2]

The crash involved a combination of commercial and passenger vehicles and covered a segment of roadway approximately 1,100 feet long. As a result of the crash, 6 people were fatally injured.

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1 This count is based on the Fort Worth Police Department's investigation.

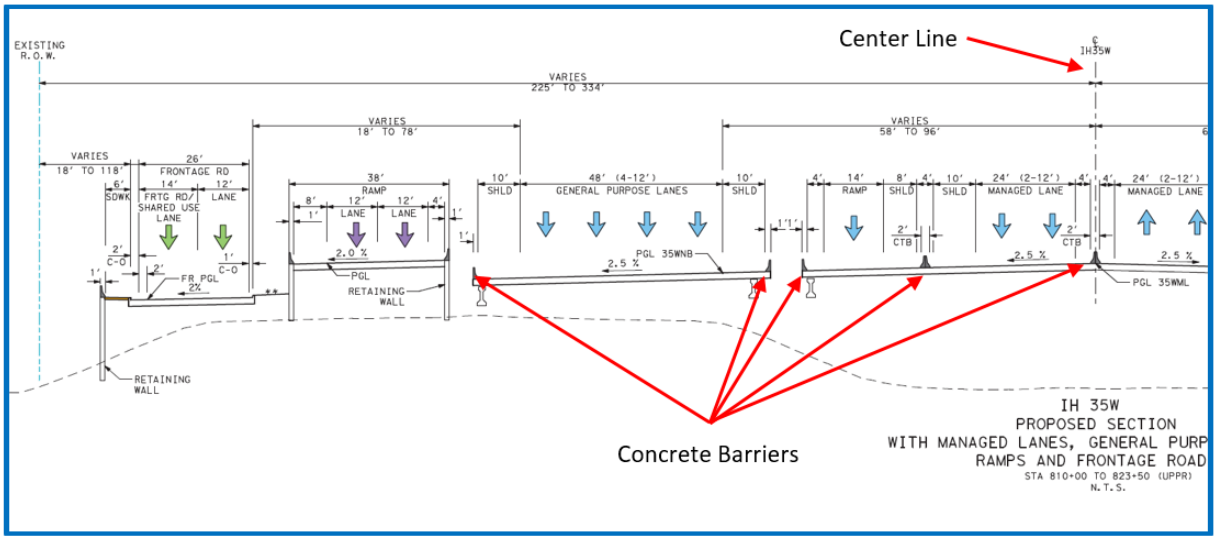
2 Appendix D, Local Climatological Data Daily Summary for February 2021, published by U.S. Dep't of Commerce, Nat'l Oceanic & Atmospheric Admin., Nat'l Env. Satellite, Data, and Information Service, generated on Feb. 17, 2021 (reflecting no precipitation on February 1–10, 2021).

Schematic of Relevant Portions of I-35W

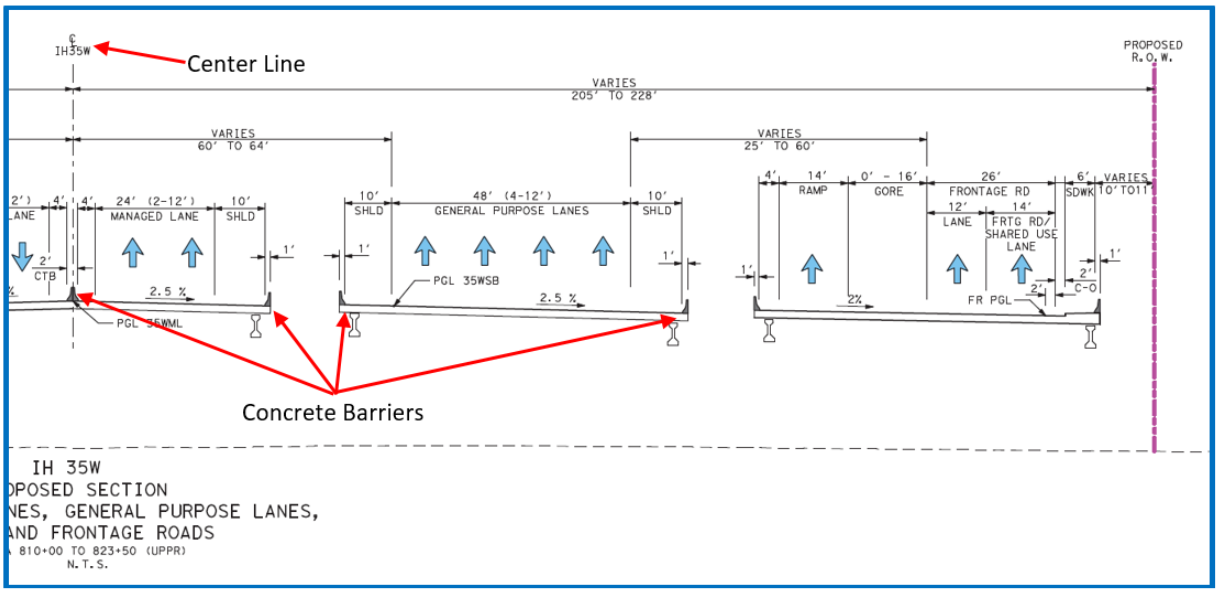
The Interstate 35W improvement project spans 17 miles in Fort Worth and was built in segments. NTEMP S3 constructed Segment 3A, which is 6.20 miles long, from north of I-30 to north of I-820 (shown in blue below), including the I-35W/820 interchange. Segment 3A, where the accident occurred, opened partially in April 2018 and fully in July 2018.

Design of the Road

The basic design of the roadway in the area of the accident was provided by TxDOT within the procurement process. That design required three separate bridge decks in the area of the accident: one for the northbound general purpose lanes, one for the managed lanes and one for the southbound general purpose lanes:[3]



Left hand side of roadway.



Right hand side of roadway.

[3] NEPA Evaluation Schematics.

The design of the roadway required concrete barriers, including specifically in the area of the accident which is comprised of three separate bridge decks. The roadway in the area of the accident consisted of two lanes, approximately 24-feet-wide (12-feet-wide per lane), bordered by a left paved shoulder, approximately 4-feet-wide, and a right paved shoulder, approximately 10-feet-wide. At the edge of the left and right paved shoulders are concrete barriers, 42 and 36 inches high, respectively. This design was submitted to the Federal Highway Administration.[4]

Shortly before the area of the accident, the managed lanes go over railroad tracks and have a 3% upgrade slope followed by a 3% downgrade slope.[5]

NTEMP S3's Operation and Maintenance of the Road

NTEMP S3, under its Facility Agreement with TxDOT, is responsible for the operation and maintenance of the toll lanes, general use lanes, and frontage roads in the section of I-35W near the crash.

Through its Traffic Management Center ("TMC"), NTEMP S3 monitors the road 24 hours a day, 7 days a week, 365 days a year. TMC operators monitor live feed from more than 200 fixed, pan-tilt-zoom and toll rate cameras.

Customer Assist vehicles can be dispatched to assist stranded motorists, and the TMC works closely with local courtesy patrols and other emergency agencies when additional assistance is needed. TMC operators also activate Dynamic Message Sign ("DMS") boards to warn the vehicle operators of potential hazards, such as traffic incidents, congestion, road work, and weather conditions.[6]

Maintenance technicians perform daily inspections of various portions of the road, noting areas that may require repairs or cleaning. They are also trained every year on snow and ice control. When Snow and Ice Mode is activated, shifts are extended and the company provides food and lodging to maximize the availability of both maintenance technicians and TMC operators.

The average traffic count on the southbound managed lanes, where this accident occurred, regularly exceeds 20,000 per day,[7] and can exceed 25,000 per day.[8] Since opening, many millions of drivers have safely travelled in the southbound managed lanes where this accident occurred.[9] Since Segment 3A fully opened in July 2018, there were two previous fatality accidents in the area.[10] These occurred in May of 2019 and April of 2020, and neither involved icy road conditions.[11] No accidents were

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4 The I-35 Study from SH 114 to I-820 includes the statement, "All of the concurrent managed (toll) lanes would be separated from the general purpose lanes (non-toll) by concrete traffic barriers." (p. 11). The I-35W Study from I-820 to I-30 also states, "All of the concurrent managed lanes would be separated from the general purpose lanes by concrete traffic barriers." (p. 21).

5 TxDOT design parameters for the roadway allow for such slopes as this up to 3%. Facility Agreement, § 11.2.2., NTE3-NTSB-00423.

6 High-level overview of TMC Operations, provided at NTE3-NTSB-RFI4-00005 – NTE3-NTSB-RFI4-00006. "NTE3-NTSB-RFI[#]-XXXXX" indicates materials that were submitted to the NTSB by NTEMP S3 in response to requests for information. The final five digits indicate the page number of the submission being referenced.

7 NTE3-NTSB-RFI2-01175; Annex H4. "Annex XX" indicates materials that were submitted to the NTSB by NTEMP S3 as "Annexes to Answers" provided in response to requests for information.

8 NTE3-NTSB-RFI2-01175; Annex H4.

9 NTE3-NTSB-RFI2-01178; Annex H4.

10 Per the NTSB's request, this was a 3-mile radius. NTE3-NTSB-RFI2-01174 and Annex H3 (accident information).

11 NTE3-NTSB-RFI5-00002. Police Reports and corresponding Code Sheet, NTE3-NTSB-RFI5-00022-28, reflect that neither accident occurred when it was raining or snowing, and that the road did not have snow, slush, or ice on

logged in icy conditions between July 2018 and December 2020—whether on the managed lanes or the general purpose lanes—in the area of the accident.[12]

Despite the unusual aspects of this accident, NTEMP S3 has embraced the opportunity to study the accident and enhance its ongoing commitment to developing best-in-class transportation solutions.

Recommended Strategies to Mitigate Snow and Ice Formation

There are two distinct snow and ice control strategies that make use of chemical freezing-point depressants. Anti-icing is the snow and ice control practice of preventing the formation or development of bonded snow and ice to pavement with the use of a chemical freezing-point depressant, like brine. Anti-icing is a *proactive* strategy.[13] Expected weather conditions can and do change, and pretreatment will not necessarily prevent all snow and ice formation. Firsthand monitoring of the road and weather conditions in real time is required.[14] De-icing is the practice of destroying the bond between snow and ice and pavement. It is employed after snow or ice is detected and is a reactive strategy.[15] It is not recommended to apply granular de-icing product to dry roadways.[16]

There are no regulations requiring a particular type of pretreatment to minimize snow and ice from forming on a roadway or to treat it where it occurs. NTEMP S3 performs its winter maintenance obligations in accordance with its contractual obligations to TxDOT and regional standards.

Brining as a Pretreatment

At the time of the accident, NTEMP S3 used a product called IceSlicer NM to create a 23.3% salinity brine solution to pretreat dry roads.[17] Pretreating with brine is an effective and recognized tool in ice mitigation efforts. Application of brine as an anti-icing strategy is consistent with the approach of other road operators in this region, like TxDOT and the North Texas Tollway Authority, national guidance such as the National Cooperative Highway Research Program (NCHRP) Report 526 Snow and Ice Control: Guidelines for Materials and Methods, AASHTO[18] guidance, and the approach of several other state and local governments, many of whom experience far more severe winter weather.

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it during either accident. This information is reflected in numbered fields 38 (Weather Condition) and 43 (Surface Condition).

12 NTE3-NTSB-RFI2-01174.

13 Manual of Practice for an Effective Anti-icing Program: A Guide for Highway Winter Maintenance Personnel, Report No. FHWA-RD-95-202, June 1996, at Section 2.3, Deicing and Anti-Icing.

14 *Id*. at Section 3.2.5 (stating there is "no substitute" for visual observation of weather conditions and conditions of the pavement surface).

15 *Id.* at Section 2.3.

16 Annex P11, Snow and Ice Control Operations Manual, TxDOT, January 2017, Chapter 2, Section 6.

17 Other similar products have since been used, including Torch RT and Torch Red Plus.

18 AASHTO is the American Association of State Highway and Transportation Officials. AASHTO is a nonprofit, nonpartisan association representing highway and transportation departments in the 50 states, the District of Columbia, and Puerto Rico. It represents all transportation modes including: air, highways, public transportation, active transportation, rail, and water. Its primary goal is to foster the development, operation, and maintenance of an integrated national transportation system. AASHTO, in conjunction with the Snow and Ice Pooled Fund Cooperative Program (SICOP) and the Transportation Curriculum Coordinating Council (TC3,) developed and distributed training series for winter maintenance operations. This training, now provided to NTEMP S3 maintenance employees, is consistent with and complimentary to the training received in years prior to the accident.

The TxDOT Snow and Ice Control Operations Manual includes this discussion of pretreating with liquid chemicals:[19]

> **Section 5 – Recommendations for Use of Liquid Chemicals**
>
> **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 and should not be expected over a long period. 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.

The National Cooperative Highway Research Program (NCHRP) Report 526 Snow and Ice Control: Guidelines for Materials and Methods advises:[20]

> **Pretreating for and Treating Frost, Black Ice, and Icing with Liquid Chemicals**
>
> A 23-percent solution of liquid NaCl applied at 40 to 60 gal/LM (or equivalent effective amount of other chemical) has proven to provide protection from these conditions that are non-precipitation events … In the absence of precipitation, these treatments are effective for at least 3 days and possibly up to 5 days depending on traffic volume. If the liquid treatment is allowed to dry before the event, it will be slightly more effective.

Last, AASHTO materials similarly recommend that the use of liquid chemicals for anti-icing is an appropriate proactive approach to winter maintenance that can improve service and result in clearer roads.[21] Consistent with TxDOT and the NCHRP, AASHTO recognizes that using brine as a pre-treatment or anti-icing treatment allows a roadway operator to attempt to prevent the bond of snow and ice to the pavement by taking action prior to, or at the beginning of a winter storm event, and potentially prevent the need to apply abrasives to the roadway to provide traction.[22]

Many other state and local authorities use brine in this manner as well.[23]

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19 Annex P11, Snow and Ice Control Operations Manual, TxDOT, January 2017, Chapter 2, Section 5, p. 2-7.

20 Snow and Ice Control: Guidelines for Materials and Methods, National Cooperative Highway Research Program (NCHRP) Report 526, Robert R. Blackburn and Karin M. Bauer, Midwest Research Institute, Kansas City, MO; Duane E. Amsler, Sr., AFM Engineering Services, Slingerlands, NY; S. Edward Boselly, Weather Solutions Group, Olympia, WA; and A. Dean McElroy, Consultant, Overland Park, KS; 2004, page 21.

21 Anti-icing/RWIS – Winter Road Maintenance Management, AASHTO Training Materials.

22 Anti-icing/TWIC – An Introduction to Anti-icing and Winter Maintenance, AASHTO Training Materials.

23 Examples include: North Carolina, Tulsa, Oklahoma, Omaha, Nebraska, and local authorities in New Jersey. See https://www.ncdot.gov/travel-maps/traffic-travel/severe-weather/Pages/treating-roads.aspx (North Carolina); https://www.government-fleet.com/137859/fleets-prepare-for-snow-with-vehicle-upgrades (Tulsa, Oklahoma); https://omaha.com/weather/if-snow-and-ice-come-omaha-city-crews-are-ready-to-hit-streets/article_13b9bf0f-309a-51ba-8284-eb7efec97a16.html (Omaha, Nebraska); https://www.northjersey.com/story/news/passaic/hawthorne/2017/01/13/science-perfect-timing-keep-winter-roads-clear/96401382/ (various boroughs and counties in New Jersey).

Firsthand Observation During a Winter Weather Event

The Federal Highway Administration notes in its Manual of Practice for an Effective Anti-icing Program: A Guide for Highway Winter Maintenance Personnel, Report No. FHWA-RD-95-202, June 1996, that "real time knowledge of pavement surface state is necessary for making an informed decision on [road] treatment." Recommended strategies include monitoring pavement and air temperature as well as observation of pavement conditions by maintenance personnel.

Specifically, the FHWA notes:

> There is no substitute for visual observation of weather conditions and conditions of the pavement surface. Observations remain an important tool for making operational decisions even when an agency has access to and experience with new technology such as RWIS. Use of patrols for this purpose can be highly effective. Though the State or local highway patrol can fulfill this role, trained maintenance personnel are better prepared to judge the severity of conditions and to make or recommend corrective action.[24]

In February 2021 NTEMP S3 employed both of these recommended strategies: (1) monitoring pavement and air temperature in real time and (2) observing weather and road conditions firsthand in real time.

To obtain weather information in real time, one of NTEMP S3's maintenance technicians drove the road with a handheld infrared thermometer to obtain actual readings of the pavement temperature. When in Snow and Ice Mode, the NTEMP S3 maintenance technicians would also look for ice and physically test areas where ice was likely to form by aggressively braking their vehicles. Physically patrolling the road allowed for real-time information about road conditions.[25]

De-Icing with Granular IceSlicer NM

Once ice has formed, de-icing strategies can still be employed. For example, TxDOT indicates that the use of solid chemical treatments is usually effective when there is adequate moisture or accumulation of snow or ice during alter period of storms.[26] NCHRP guidance is more pointed stating unequivocally, "Solid chemicals, particularly those with a 'coarser' gradation or particle size distribution, are well suited to deicing operations."[27] The NCHRP specifically states that solid chemicals are the most effective treatment for packed or bonded snow and ice. Accordingly, NTEMP S3 follows these recommendations. At the time in question, NTEMP S3 treated areas where moisture was detected and where ice had formed with granular IceSlicer NM.

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[24] FHWA's Effective Anti-Icing Program, at Section 3.2.5.

[25] FHWA's Effective Anti-Icing Program, at Section 3.2.5.

[26] Annex P11, Snow and Ice Control Operations Manual, TxDOT, January 2017, Chapter 2, Section 2, p 2-3.

[27] Snow and Ice Control: Guidelines for Materials and Methods, National Cooperative Highway Research Program (NCHRP) Report 526, at p. 14.

NTEMP S3's Winter Maintenance Preparation and Resources

NTEMP S3's preparation for snow and ice control begins well before the start of the winter season. This preparation includes annual training, equipment maintenance, stocking of de-icing product and anti-icing material, and coordination with agencies such as TxDOT and local cities like Fort Worth.[28]

NTEMP S3 Training

NTEMP S3's annual Snow & Ice Training is completed by November 30 of each year.[29] This training includes all snow and ice operations, equipment, special safety procedures, job hazard analysis, communications, and routes for the roadway. It serves as both an introduction and refresher training event for new and seasoned technicians, who review the importance of winter maintenance operations for roadway safety.

The training event consists of approximately six hours of classroom and practical training, which includes:

1. Principles and guidelines on the safety of both the public and maintenance staff;
2. Loading and unloading equipment safely;
3. Brine making and storage;
4. Proper operation of the winter equipment;
5. Performing any preventative maintenance in the equipment (if needed);
6. Application of brine and de-icing salts;
7. Dry run of routes;
8. Radio communication techniques; and
9. Monitoring and reporting roadway conditions.[30]

NTEMP S3's training is consistent with AASHTO's training which encourages a general preparation for winter storm events that includes the following:

1. Development of anti-icing plan, including stockpiling of materials, proper use of chemical application systems, use of technology, roadway communications, and training of personnel;
2. Brine production and storage;
3. Weather monitoring, including use of technology, communications with local government personnel (including police and other first responders), and use of maintenance personnel who are monitoring the roadway weather conditions in real-time;
4. Proper use, calibration, cleaning, and storage of winter maintenance equipment; and,
5. Real-time monitoring by maintenance personnel of roadway conditions before, during, and after a winter storm event.[31]

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28 Annex P11, OP-OM-LBJ_NTE-12, Snow and Ice Control Procedure ("Snow and Ice Control Procedure"), p. 2.
29 Snow and Ice Control Procedure, p. 2.
30 Snow & Ice Rodeo Agenda, NTE3-NTSB-RFI1-00020.
31 See, e.g., Anti-icing/TWIC – An Introduction to Anti-icing and Winter Maintenance, AASHTO Training Materials.

The annual Snow & Ice Training was attended by each of the 14 maintenance personnel who were patrolling on the night of February 10 and/or morning of February 11, as well the maintenance technician who brined the area where the accident occurred on February 9.[32]

Resources

The following vehicle and equipment resources for snow and ice control were available in February 2021 for use based on actual need along the 23.5 miles of the North Tarrant Express[33]:

1. Three dump trucks;
2. Ten pickup trucks,
3. Twelve spreaders,
4. Eleven plows,
5. Six sprayers, and
6. Three brine mixers.[34]

To pretreat and treat for ice, NTEMP S3 purchased and employed IceSlicer NM (also known as "IceSlicer CB").[35] According to the TxDOT-approved supplier, EnviroTech Services, Inc.:

- IceSlicer NM is about 20-30% less corrosive than Sodium Chloride.
- IceSlicer NM also melts 2-3 times faster than Sodium Chloride and is effective for temperatures as low as 5°F, while Sodium Chloride is recommended to 15°F to 20°F only.

The brine mixture was prepared on site using IceSlicer NM. IceSlicer NM is comprised of Sodium Chloride (90-98%) Magnesium Chloride (0.30-3.0%), Potassium Chloride (0.30%-3.0%) and Calcium Chloride (0.30-3.0%). IceSlicer NM has been in the market for approximately 25 years and has been widely used for highway maintenance.

To stay abreast of expected weather conditions, NTEMP S3 received weather forecasts and updates from the National Weather Service, and also consulted local weather stations.

Coordination with adjacent local and State authorities

In order to share and monitor adverse winter weather and travelling conditions, NTEMP S3 liaises closely with TxDOT, the police department, and adjacent local road and highway authorities.[36] For

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[32] Snow and Ice Control Procedure, p. 2; NTE3-NTSB-RFI2-01857 – NTE3-NTSB-RFI2-01876.

[33] This includes Segment 1 (6.4 miles), Segment 2 (6.9 miles), and Segment 3A, where the accident occurred (6.2 miles miles), and Segment 3B (4.0 miles).

[34] NTE3-NTSB-RFI3-00002 reflects the type, VIN and license plate numbers for the vehicles and type, manufacturer and serial number for the equipment.

[35] Both the product and its manufacturer were approved by TxDOT. Archived publications of TxDOT-approved products and manufacturers are available at https://www.txdot.gov/inside-txdot/division/materials-and-tests/producer-list-archive.html. For the relevant time period and product type, see https://ftp.txdot.gov/pub/txdot-info/cmd/mpl/archive/deicer-120820.pdf.

[36] Winter Maintenance Plan; 2.14, page 13.

example, NTEMP S3 attends TxDOT's snow and ice coordination meeting.[37] Prior to the storm, NTEMP S3 also let TxDOT know how it planned to prepare its roadways for the week of February 8, 2021.[38]

On the night of February 10 and the morning of February 11, NTEMP S3 communicated with TxDOT to ensure consistent messaging on the area's Dynamic Messaging Signs[39] and NTEMP S3 maintenance and road crews observed and communicated with TxDOT maintenance personnel performing ice mitigation activities overnight on areas of the NTEMP S3 roadway that abutted TxDOT maintained roadways. In the days following the accident, TxDOT and NTEMP S3 continued to coordinate road maintenance and snow and ice mitigation activities as Winter Storm Uri pummeled North Texas.[40]

NTEMP S3's Pre-Treatment of the Road

On February 8, 2021, at approximately 10:32 a.m., NTEMP S3 received the following alert from the National Weather Service:

> A cold front will move slowly through North Texas starting tonight and Tuesday and continuing south into Central Texas on Tuesday and Tuesday night. Temperatures near or below freezing across northern and northwestern parts of the area are possible, mainly for the nighttime and morning hours. Behind the front, light precipitation may occur. Precipitation chances are highest on Wednesday and Thursday. Most of this precipitation will be in the form of light rain, but where and when temperatures are below freezing, some light freezing drizzle or freezing rain may occur. Some pockets of light sleet may also occur. Any impacts from icing are highly dependent on how far south the freezing line gets and that remains very uncertain at this time, but confidence increases in light accumulations farther to the northwest one goes.[41]

With no major precipitation predicted for Wednesday or Thursday, a pretreatment with brine was deemed to be the best anti-icing precaution. Among several benefits, a brine solution:

- Sticks to dry roads, so there is no need for any moisture for effectiveness;
- Prevents snow and ice from bonding with the road's surface; and
- Is more effective and coats roadways better than plain salt or sand for the envisioned conditions.[42]

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37 North Tarrant Winter Weather Operations, December 2020 (reflecting attending offices).

38 February 9, 2021 email between Michael Gage (TxDOT) and Francisco Galdeano (NTEMP S3).

39 February 10, 2021 email confirmation from Mary Thompson, TMC Operator, regarding activation of DMS.

40 In the wake of Winter Storm Uri, Texas was the subject of disaster declarations by both the Texas Governor and President Biden. Official press releases regarding both declarations are available at https://gov.texas.gov/news/post/governor-abbott-issues-disaster-declaration-in-response-to-severe-winter-weather-in-texas and https://www.whitehouse.gov/briefing-room/statements-releases/2021/02/20/president-joseph-r-biden-jr-approves-texas-disaster-declaration/.

41 Annex P1, email NWS UPDATE_Winter Precipitation Potential Midweek.msg; NTE3-NTSB-RFI2-01853 – NTE3-NTSB-RFI2-01856.

42 Manual of Practice for an Effective Anti-icing Program: A Guide for Highway Winter Maintenance Personnel ("Effective Anti-icing Program"), Report No. FHWA-RD-95-202, June 1996, at Sections 3.1.1-3.1.3.

On February 9, 2021, at approximately 10:12 a.m., NTEMP S3 pretreated the traffic lanes where the accident occurred with an IceSlicer NM brine solution at an application rate of 44 gallons per lane mile.[43] This is within industry recommendations of 40-60 gallons per lane mile.[44]

NTEMP S3 Firsthand Observation and Treatment on February 10–11

At the time this accident occurred, NTEMP S3 was in Snow and Ice Mode. In this operational status, the maintenance crews and TMC operators worked 12-hour shifts.

As has been noted by the Federal Highway Administration, "[t]here is no substitute for visual observation of weather conditions and conditions of the pavement surface."[45] Throughout the night and into the early morning hours, a night crew of 14 maintenance personnel patrolled the 23.5 miles of road in twelve vehicles to identify areas where ice might have formed despite the previous brine application.[46] The technicians traveled pre-determined routes to ensure that all areas of the roadway were patrolled, with an emphasis on areas such as bridges that were more likely to ice. Special attention was paid to the managed lanes and general purpose lanes.

While patrolling, the maintenance technicians were not relying solely on visual observation to detect ice. The technicians repeatedly tested areas likely to freeze (such as bridges) by braking to determine whether there was ice that would cause their vehicles to skid. This practice is called "brake-checking" and allows for the detection of ice even when it may not be visible.[47]

During their patrols, if moisture or ice was detected, visually or through brake-checks, NTEMP S3 maintenance technicians treated the area with granular IceSlicer NM. This included the area of the road near the Basswood exit at approximately 3:00 a.m. This exit is approximately 6 miles from the area where the accident occurred.

The area where the accident occurred was patrolled by one of NTEMP S3's maintenance technicians. He did not detect any moisture or ice there during his shift.[48] Another pair of technicians drove through the area where the accident occurred at approximately 5:15 a.m. and they also did not observe any rain, freezing rain, sleet, or ice in the area.[49]

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[43] This application rate was calculated by video analysis of one technician's spreading of 1,800 gallons of the brine solution on approximately 41 lane miles in the area of the accident. Confirmed by video camera located north of Northside Drive/Yucca Avenue pointing towards the crash site. The start point of brining on SBML - STA 614+00 (Mile Marker: 57.48). The end point of brining on SBML - STA 924+30 (Mile Marker: 51.61).

[44] Snow and Ice Control: Guidelines for Materials and Methods, National Cooperative Highway Research Program (NCHRP) Report 526.

[45] Effective Anti-icing Program at 3.2.5.

[46] NTE3-NTSB-RFI3-000006; FHWA, Effective Anti-Icing Program, at 3.2.6 (noting visual observation is one way to evaluate the effectiveness of previous treatment).

[47] Effective Anti-icing Program, at Sections at 3.2.6 (noting that the measurement of frictional resistance to sliding—one test for which is hard braking—is another way to evaluate the effectiveness of previous treatment).

[48] NTEMP S3 Maintenance Technician Interview Transcript (DR), 9:9–20 (indicating he drove through the area all night and did not detect any moisture in that location).

[49] NTE3-NTSB-RFI3-00007; also see NTEMP S3 Maintenance Technician Interview Transcript (JE), 9:11–10:11 (indicating that, toward the end of his shift, he drove through the area where the accident occurred on the general purpose lanes and did not detect any moisture.

The observations of NTEMP S3 maintenance technicians is consistent with video footage showing that it began to rain in the area of the accident at approximately 5:57 AM.[50]

5:51 a.m.:

5:57 a.m. (Note halo effect of rain on camera lens):

[50] Accident video 1559_5229_20210211_0550-610.mp4. Camera is north of Yucca/Northside facing the stretch of road of the incident (SBML towards the camera). A halo effect on camera lens (indicating rain) starts at 5:57:19; slippery pavement confirmed by a spinning semi-truck at 6:00:16 (SB GPL); a semi-truck fish tails at 6:01:25 (SB ML); car fishtails at 6:04:07, 6:04:21, 6:06:54, etc.

The February 11, 2021 Multi-Vehicle Crash

As earlier noted, the crash occurred in the southbound toll lanes of I-35W at milepost 53.5, Fort Worth, in Tarrant County, Texas.

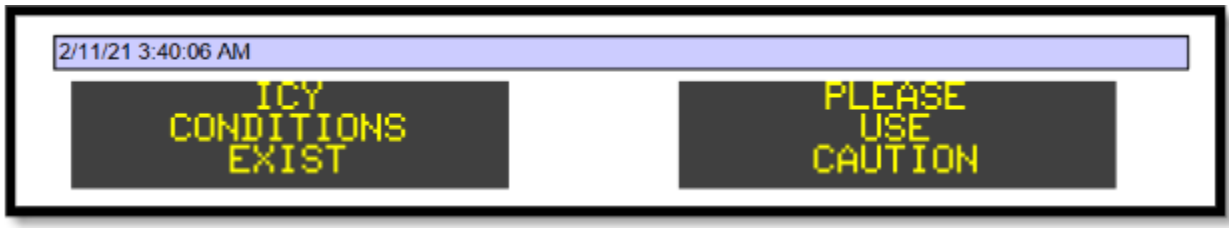
Warnings to Vehicle Operators

On the morning of the accident, southbound vehicle operators on the five miles of roadway approaching the accident site were repeatedly advised to exercise caution due to the weather conditions they were likely to encounter.

First, there were three fixed 4-feet-by-4-feet diamond-shaped yellow signs in the five miles prior to the accident warning motorists that "BRIDGE MAY ICE IN COLD WEATHER." These signs are as recommended in section 2C.32 of the Texas Manual on Uniform Traffic Control Devices (TMUTCD Rev2, October 2014).

NTEMP S3 also employs Dynamic Message Signs ("DMS"). During this weather event, NTEMP S3 coordinated with TxDOT to ensure that consistent signage was being displayed in the area. Following a call from TxDOT, at 8:20 p.m. on February 10, these signs displayed the cautionary message "WINTER WEATHER ADVISORY" and "DRIVE WITH CAUTION."

At approximately 3:40 a.m., more than two hours before the accident, the DMS boards for the south-bound tolled lanes displayed the message "ICY CONDITIONS EXIST" and "PLEASE USE CAUTION."



Three of these DMS messages were displayed along the southbound toll lanes of I-35W in the five miles prior to the accident.[51]

Thus, in the five minutes before the accident, a vehicle operator going 60 mph (or one mile per minute) on the morning of February 11, 2021 would have been cautioned up to three times that "Bridge May Ice in Cold Weather" and three additional times that "Icy Conditions Exist".

Posted Speed Limits & Texas Law

The express toll lanes have a posted speed limit of 75 mph, and the general purpose lanes have a posted speed limit of 65 mph.[52]

NTEMP S3 does not have the authority to lower the posted speed limit. The Facility Agreement with TxDOT provides:

> **Nothing in the FA Documents authorizes Developer to adjust posted speed limits on the Managed Lanes,** General Purpose Lanes, Frontage Roads or other lanes of the Facility, except temporary reductions during construction with TxDOT's written approval as set forth in Section 18.3.1 of the Technical Provisions. **Such authority is reserved solely to TxDOT and applicable Governmental Entities.**[53]

Vehicle operators are obligated to slow down when conditions require it. The Transportation Code, Chapter 545, Subchapter H, "Speed Restrictions", are, collectively, referred to as the "basic speed law." Speed zone regulations are based on Section 545.351, which states in part:

> An operator may not drive at a speed greater than is reasonable or prudent under the circumstances then existing.
>
> …
>
> (c) **An operator shall**, consistent with Subsections (a) and (b), **drive at an appropriate reduced speed if**:
>
> (1) the operator is approaching and crossing an intersection or railroad grade crossing;
> (2) the operator is approaching and going around a curve;
> (3) the operator is approaching a hill crest;
> (4) the operator is traveling on a narrow or winding roadway; and
> (5) ***a special hazard exists with regard to*** traffic, including pedestrians, or ***weather or highway conditions***.[54]

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[51] NTE3-NTSB-RFI2-01849 – NTE3-NTSB-RFI2-01851 (SB 35W @ Western Center, 5 miles to crash; EB 820 @ Mark IV, 4.6 miles to crash; SB35W @ Meachum, 3.4 miles to crash; SB 35W @ Long Ave., 2.3 miles to crash).

[52] NTE3-NTSB-RFI 2-01180

[53] Facility Agreement, § 8.1.7.3, NTE3-NTSB-00639 (emphasis added).

[54] Acts 1995, 74th Leg., ch. 165, Sec. 1, eff. Sept. 1, 1995 (emphasis added). Amended by Acts 1997, 75th Leg., ch. 165, Sec. 30.109, eff. Sept. 1, 1997." NTE3-NTSB-RFI2-01181. The Texas Transportation Code has been included in Annex H8.

Additionally, the Texas Department of Public Safety Driver Handbook advises vehicle operators about winter driving safety tips, including the need to increase the distance from the next vehicle and reducing speed:

Winter Driving

Most drivers realize winter creates additional hazards, but many drivers don't know what to do about it. Here are a few precautions you should follow during winter.

Table 25: Winter Driving Safety Tips

Safety Tip	Explanation
Maintain a safe interval	Increase the distance from the vehicle ahead of you according to the conditions of the pavement. Many rear-end collisions occur on icy streets because drivers don't leave space to stop. Snow tires will slide on ice or packed snow. To keep safe you must keep your distance.
Reduce speed to correspond with conditions	There is no such thing as a "safe" speed range at which you may drive on snow or ice. You must be extremely cautious until you are able to determine how much traction you can expect from your tires. Avoid locking of brakes on ice as it will cause a loss of steering and control. Every city block and every mile of highway may be different, depending upon sun or shade and the surface of the road.
Keep windows clear	Remove snow and ice before you drive, even if you're just driving a few miles. Make certain the windshield wipers and defroster are working properly.
Watch for danger spots ahead	There may be ice on bridges when the rest of the pavement is clear. Snow melts more slowly in shady areas. Take precautions when approaching turns.
Get a feel for the road	Start out very slowly. It is useless to burn the rubber off your tires by spinning the wheels. Test your brakes gently after the car is in motion to determine how much traction you have. Start slowing down before you come to a turn.
Equip your vehicle with chains or snow tires	Chains are the most effective and should be used where ice and snow remain on the road. One word of caution, neither chains nor snow tires will permit you to drive on slick pavement at normal speeds so don't get a false feeling of security.

Weather & Road Conditions

Maintenance technicians who were patrolling for moisture and ice at approximately 5:15 on February 11 did not detect any moisture or ice in the area where the accident occurred.[55]

Video analysis confirms that, prior to 6 a.m., traffic was unimpeded. As earlier noted, video footage further confirms that it only began to rain in the area of the accident at approximately 5:57 AM.[56]

The same video confirms that very soon thereafter, the pavement becomes slippery:

1. Video shows semi-truck spinning in southbound general purpose lanes at 6:00 a.m.

2. Video shows semi-truck fishtailing in southbound general purpose lanes at 6:01 a.m.

3. Video shows car fishtailing in southbound general purpose lanes at 6:04 a.m.

Microwave Vehicle Detector Average Speeds

NTEMP S3 had deployed Microwave Vehicle Detectors (MVDs) that detected average vehicle speeds along the corridor in the southbound toll lanes before (MVD Up) and after (MVD Down) the crash location as follows:

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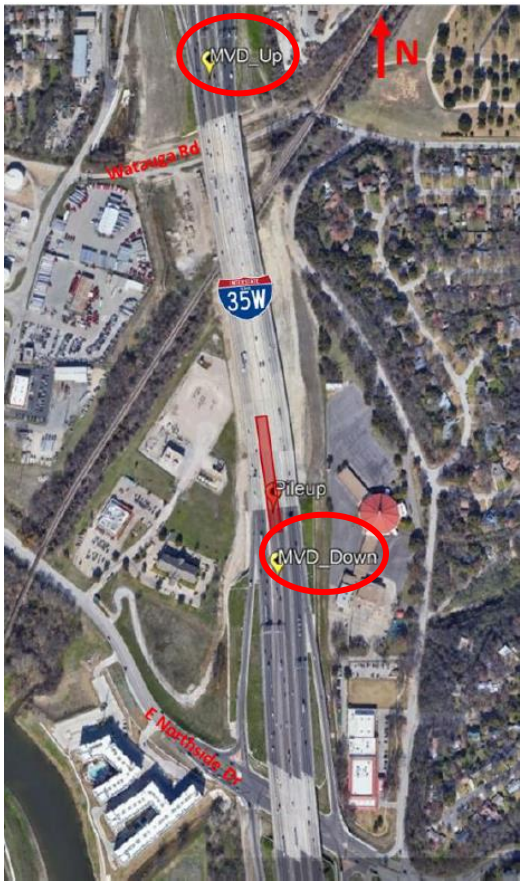
55 NTE3-NTSB-RFI3-000007

56 Accident video 1559_5229_20210211_0550-610.mp4. Camera is north of Yucca/Northside facing the stretch of road of the incident (SBML towards the camera). Halo effect (indicating rain) starts at 5:57:19; slippery pavement confirmed by semi spins 6:00:16 (SB GPL); SBML at 6:01:25 semi fish tails; 6:04:07 car fishtails; 6:04:21, 6:06:54, etc.



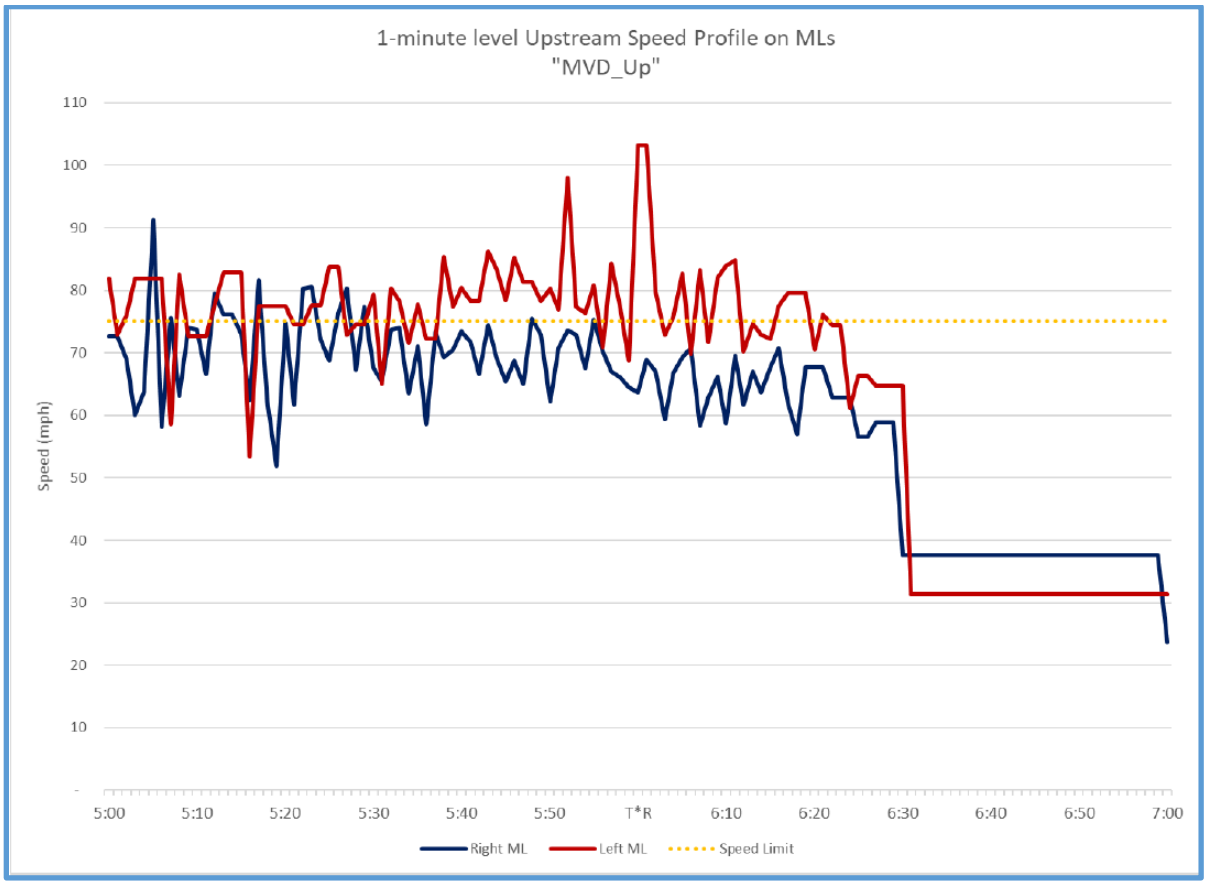
The MVD Up data reveals the following average speeds in right and left southbound managed lanes as the traffic was approaching the area of the accident in 15-minute intervals for the one hour preceding the 6:11 AM accident:

AVERAGE SPEEDS

	Right ML	Left ML
15 mins up to 6:11	65	82
30 mins up to 6:11	68	81
45 mins up to 6:11	69	79
60 mins up to 6:11	69	79

In the below graph of this data, the 1-minute average speeds in the left lane, as the traffic was approaching the area of the accident, significantly exceeded the 75 mph posted speed limit. The average

speed in the left lane at one point less than 15 minutes before the accident, just as it started to rain, exceeded 100 mph.[57]



Collisions Begin

Video footage confirms that the first collisions began to occur at approximately 6:11 a.m. Initially, some motorists were able to slow down sufficiently and navigate around and past the earlier collisions. Other drivers were unable to slow and/or navigate sufficiently to do so and additional collisions occurred. Ultimately approximately 130 vehicles were involved in the collision.[58]

Post-Accident Initiatives

Independent of the cause or causes of this particular accident, the winter maintenance equipment and strategies have been examined and improved.

1. The fleet of maintenance vehicles that are equipped for winter maintenance has been increased. The inventory of dump trucks is being increased from three to six. The

[57] The right and left lane MVD sensors are approximately 1400 feet (about ¼ mile) from the accident location. As the accident begins at approximately 6:11 a.m., the sensors begin recording slowing traffic speeds. As the traffic backs up at the sensors at approximately 6:30 a.m., the sensors record constant speeds of approximately 38 mph and 32 mph for several minutes. These constant readings reflect the speeds of the last cars with active readings once the traffic has stopped.

[58] This count is based on the Fort Worth Police Department's investigation.

number of pick-up trucks has been increased from ten to thirteen. While previously three pick-up trucks were outfitted to spray brine, now ten pick-up trucks can do so. These vehicles are still shared for use along Segments 1–3 of the road.

2. Salt storage has been increased by over 400 tons.

3. National Weather Service continues to be used for weather forecasting, in addition to local weather stations. A new weather forecast vendor, DTN,[59] that provides more localized and customized forecasts and alerts, has been added. This vendor also provides 24/7 access to a meteorologist and pavement temperature forecasting.

4. Eighteen weather sensors from Frost Technologies have been added.[60] These weather sensors capture air and pavement temperatures, as well as relative humidity. Photographs of the road are also transmitted. The weather sensors have been strategically placed in areas where freezing is more likely to occur. These sensors also trigger real-time alerts via email to designated employees when certain conditions are detected on the road.

5. Maintenance vehicles have been equipped with infrared thermometers and with GPS devices and controllers from Force America (dump trucks only) linked to the sprayers and spreaders.[61] Data can be captured electronically that previously had to be captured manually and make them real-time accessible through a computer dashboard. It also allows the technicians to obtain pavement temperature readings without having to stop and exit the vehicles.

6. Training materials have been updated to include the new technologies and processes that have been implemented. On-line AASHTO training has also been adopted.

Proposed Findings

1. The TxDOT road design required concrete barriers.

2. The TxDOT road design required the road to go over a rail line, thus requiring the bridge on which the accident occurred.

3. The 3% slope of the bridge was within allowable TxDOT standards.

4. At approximately 10:12 a.m. on February 9, 2021, NTEMP S3 treated the roadway at the area of the accident with a 23% solution of IceSlicer NM at an application rate of 44 gallons-per-lane-mile.

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59 Information about DTN's transportation solutions is available here: Transportation - DTN.

60 Information about Frost Technologies' weather stations is available here: Advanced Infrared Site Monitoring | Frost Technologies (frostcontrolsys.com).

61 Specifically, NTEMP S3 is using the ARC Air and Conditions System (infrared thermometer), the IX-402-G (GPS) and 5100 EX (dump truck controller).

5. This road treatment was within guidelines specified by the National Cooperative Highway Research Program and the TxDOT Snow and Ice Control Operations Manual and the best practices for roadway maintenance in general.

6. In the early morning hours of February 11, 2021, there were 12 vehicles patrolling its roadways for moisture and ice. These patrols included the area of the accident.

7. Video confirms that rain started in the area of the accident at approximately 5:57 a.m.

8. Video confirms that in the southbound general purpose lanes in the area of the accident a semi-truck was spinning at 6:00 a.m., a semi-truck was fishtailing at 6:01 a.m. and a car was fishtailing at 6:04 a.m.

9. There were three permanent yellow, diamond-shaped warning signs "BRIDGE MAY ICE IN COLD WEATHER" in southbound toll lanes in the five miles prior to the area of the accident.

10. There were three Dynamic Message Signs displaying the message "ICY CONDITIONS EXIST" and "PLEASE USE CAUTION" in the southbound toll lanes in the five miles prior to the area of the accident.

11. While the posted speed limits were 65 mph and 75 mph in the general purpose and toll lanes, respectively, Texas law mandates that operators do not drive at a speed greater than is reasonable or prudent under the circumstances, including special weather hazards or highway conditions.

12. Microwave vehicle detectors revealed that the average speeds in the left southbound toll lane, as the traffic was approaching the area of the accident, significantly exceeded the 75 mph posted speed limit. The average speed in the left lane at one point less than 15 minutes before the accident, just as it started to rain, exceeded 100 mph.

Proposed Recommendations

1. Recommend that AASHTO commission a study of strategies for highway operators to encourage motor vehicle operators to reduce their speeds in response to hazards and other adverse weather or roadway conditions.

2. Recommend that AASHTO commission a study of utilization of technology to encourage motor vehicle operators to reduce their speeds in response to hazards and other adverse weather or roadway conditions.

3. Recommend that AASHTO commission a study regarding the use of technology for forecasting and detection of rapid changes in roadway conditions.