



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Highway Safety
Washington, D.C. 20594

October 14, 2022

Group Chairman's Factual Report

HIGHWAY FACTORS

HWY22FH001

A. ACCIDENT

Location: Big Spring, TX
Date: November 19, 2021
Time: 4:01 p.m. CST

Vehicle: 1 2016 Ford F-350 Pick Up Truck. Private Owner.
Vehicle: 2 2005 MCI Motorcoach. Andrews Independent School District.
Vehicle: 3 2018 Freightliner Bus. Andrews Independent School District.

HIGHWAY FACTORS GROUP

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B. SUMMARY

For a summary of the crash, refer to the Crash Summary report, which can be found in the NTSB public docket for this investigation.

C. DETAILS OF THE HIGHWAY FACTORS INVESTIGATION

The Highway Factors Group obtained information related to the design, maintenance, and operation of the highway environment to establish a foundation for evaluating whether the condition, design, or operation of the highway facility contributed to or caused the crash. Information was obtained from the Texas Department of Transportation (TXDOT) that provides a general description of the highway location. Highway information obtained documented the geometric design, and traffic metrics, including vehicle speeds and volumes, and crash history. In addition, construction plans, and policies were obtained on the Test-level-4 (TL-4) High-tension Cable Median Barrier (HTCB).¹ Focus areas included examining the signage installed to deter wrong-way drivers on the eastbound 179 exit ramp.

1. GENERAL INFORMATION

The crash was located on Interstate Highway 20 (I-20), 159 feet west of eastbound mile marker 179. The GPS coordinates for this location are 32.26640 latitude and -101.46660 longitude. Highway design plans indicate the crash occurred near station number 826+67.² See **Figure 1** and **2** for overhead Google images and **Figure 3** a crash scene photo by the Texas Department of Public Safety (TXDPS).

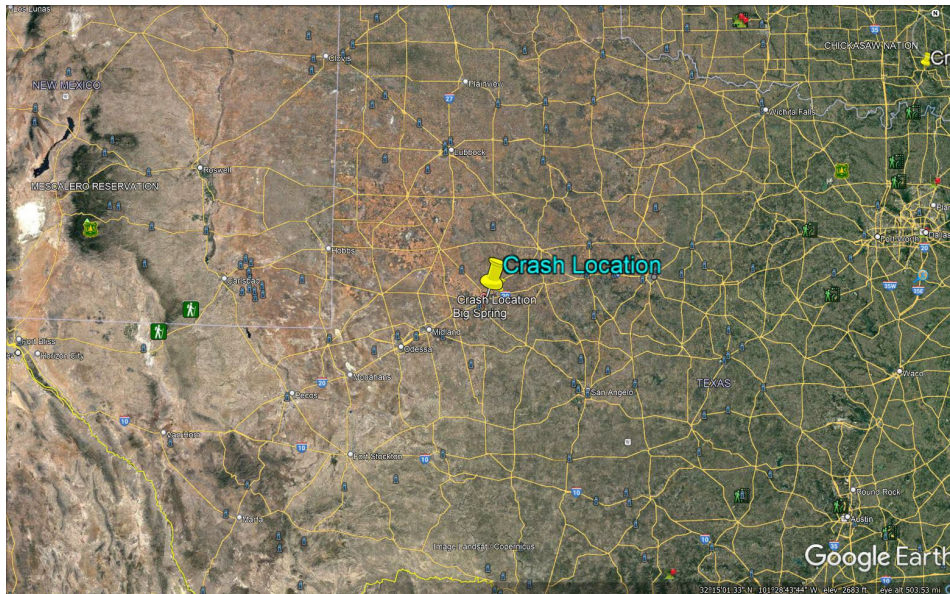


Figure 1. View of crash location, approximately 225 miles west of the Dallas-Fort Worth area.

¹ The high-tension cable barrier met TL-4 crash test requirements from NCHRP 350, which require the HTCB to safely re-direct a 19,700-pound straight truck striking the barrier at 50 mph and a 15-degree encroachment angle. See Highway Attachment Cable Barrier Plans and Construction Plans and Highway Attachment TXDOT Cable Barrier Installation Policies.

² See Highway Attachment Cable Barrier and Construction Plans for project CSJ0005-06-033 for station numbers that give dimensional information on the highway.

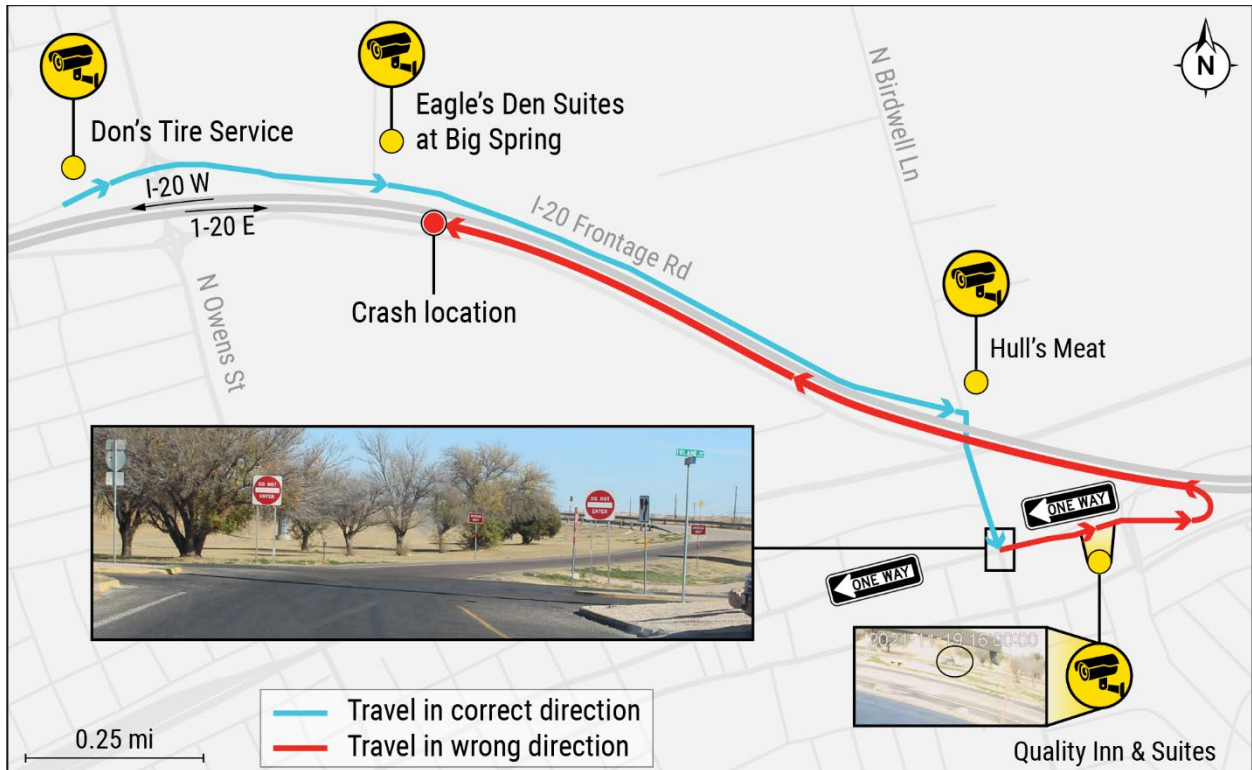


Figure 2. This figure shows a Google image annotated with four yellow circles and a red circle. The yellow circles show where security video cameras documented the Ford pickup driver's route of travel. The circle on the lower right and red line show where the wrong-way driver entered I-20 and the red circle indicates the crash area. The inset shows the signage, and the video screenshot shows the wrong-way driver entering the exit ramp.



Figure 3. View of impact area near mile marker 179 with motorcoach at final position in the median and the pickup in the right-hand eastbound traffic lane.

In this area I-20 is a four-lane rural interstate highway with two lanes in the eastbound and two lanes in the westbound direction that are divided by a depressed earthen median protected by a TL-4 HTCBB installed on a 6:1 slope. I-20 was constructed between 1957-1965 and runs from Kent, Texas near the interchange with I-10 east through west and north central Texas to the Louisiana border; 636 miles.

The pavement was resurfaced in 2004 with Asphaltic Concrete Pavement (ACP), and in 2020 the surface was planed with a cold planer (surface texturing, or grooving) to improve skid resistance.³

Near the crash area I-20 had 12-foot-wide lanes with 10-foot-wide right-hand shoulders and 4-foot-wide median shoulders. The right-hand shoulder was delineated from the travel lanes by a solid white pavement stripe and the median shoulder was delineated from the travel lanes by a solid yellow pavement stripe. Both shoulders had rumble strips milled into the shoulder surface to alert errant drivers departing the travel lanes. The dual east and westbound lanes were delineated by a dashed 10-foot-long white pavement stripe spaced at 30-foot gaps. The earthen median was 40-foot wide. A Gibraltar TL-4 HTCBB was installed 12-feet from the westbound shoulder stripe, and it had three high-tension cables installed at 39-inch, 30-inch, and 20-inch mounting heights. The cable posts were located at 19-foot intervals. Scene measurements showed that the bus impacted the HTCBB at a 14-degree encroachment angle. The location was

³ Road planning is usually used as an alternative to the complete removal of the road surface.

equipped with highway safety lighting. The high-pressure sodium vapor lights were mounted on 40-foot-high poles at 200-foot spacings.

1.1 Traffic Metrics

The Average Annual Daily Traffic (AADT) in 2020 on I-20 near the crash site was 20,030 vehicles per day. Heavy truck and bus traffic comprised approximately 41 percent of that volume. The design speed is 70 mph. The speed limit on I-20 was posted at 75 mph. A speed study was performed by TXDOT District 8 on I-20 between mile marker 178-179 on December 6, 2021. The study showed the average speed was 74.8 mph.⁴ See Table 1 for traffic classification counts.

Table 1: Vehicle Classification Counts.

Vehicle Classification	Volume	Percent	Bus and Truck Traffic Volume	Bus and Truck Traffic Percent
Class 1 - Motorcycles	23	0.1%		
Class 2 – Passenger Cars	6,702	33.5%		
Class 3 – Other Two-Axle, Four-Tire Single Unit Vehicles	5,085	25.4%		
Class 4 - Buses	23	0.1%	23	0.1%
Class 5 – Two-Axle, Six-Tire, Single-Unit Trucks	1,254	6.3%	1,277	6.4%
Class 6 – Three-Axle Single-Unit Trucks	352	1.8%	1,629	8.2%
Class 7 – Four or More Axle Single-Unit Trucks	12	0.1%	1,641	8.3%
Class 8 – Four or Fewer Axle Single-Trailer Trucks	171	0.9%	1,812	8.39%
Class 9 – Five-Axle Single-Trailer Trucks	5,699	28.5%	7,511	36.89%
Class 10 – Six or More Axle Single-Trailer Trucks	226	1.1%	7,737	37.99%
Class 11 – Five or Fewer Axle Multi-Trailer Trucks	325	1.6%	8,062	39.59%
Class 12 – Six-Axle Multi-Trailer Trucks	158	0.8%	8,220	40.39%
Class 13 – Seven or More Axle Multi-Trailer Trucks				
Class 14 – Five-Axle Truck and Trailer Combinations				
Class 15 – Errors/Unknown	0	0%		
Totals	20,030	100%	8,220	41%

⁴ See Highway Attachment TXDOT Speed Study and Highway Attachment TXDOT Procedures for Establishing Speed Zones.

1.2 Roadway Geometry

The crash was in a 4,230 foot-long, right-hand horizontal curve that had a radius of 1-degree or 5,229.58-feet and sloped downward on an approximate 2.8 percent downgrade. The impact area (station number 826+67) was approximately 2,990-feet from the beginning of the curve at station number 796+77.06. The crash location was also located east of an 1,100-foot crest vertical curve.⁵ The vertical curve began at station number 818+50 or approximately 817 feet before the impact area. See Figure 4 showing a view of the curved eastbound approach.



Figure 4. View of eastbound I-20 showing the horizontal and crest vertical curve on the approach to the crash location.

1.3 Crash History

Records provided by TXDOT showed that in the preceding five-year-period in Howard County, Texas along I-20, seven other wrong way crashes occurred. Four of the crashes occurred on Business I-20. Three of those crashes were on 4th Street, one crash was on 3rd Street, and three crashes were on the main lanes of I-20 at mile markers 192, 193, and 176.⁶ Since 2012, there have been 13 fatal wrong way crashes in TXDOT Abilene District, with 6 of these crashes occurring in the past two years. Five of the 13 fatal crashes involved alcohol impaired drivers.

⁵ A crest vertical curve is a curve that connects inclined sections of roadway, forming a crest. A sag vertical curve is a curve that connects descending sections of roadway, forming a sag.

⁶ See Highway Attachment Wrong Way Crash History Reports for more information.

TXDOT studied the crashes on 3rd and 4th streets in Big Spring since 2012 and found that 10 were attributable to wrong-way drivers. However, only two of the 10 crashes on these one-way city streets resulted in injuries. As a result of increases in these types of crashes, TXDOT has begun to assess the wrong-way driving problem in the Abilene District.⁷ For more information see section 1.7 in this report.

1.4 Wrong-Way Signage Near the Crash Location

The security video from Hull Meat Company on Birdwell Lane showed the pickup truck driver departed the business and traveled to 3rd St. where he turned left on the one-way street. TXDOT indicated 3rd Street had been a one-way street for at least the preceding 34 years. See Figure 5 for a view of the one-way signage on 3rd St. and Figure 6 for the additional WRONG WAY sign on 3rd St. The one-way sign had a mounting height of 13.5-feet and was 36-inches by 12-inches in dimension. The wrong way sign had a mounting height of 7-feet and was 36-inches by 24-inches.



Figure 5. View of ONE-WAY sign on 3rd St. where the pickup driver turned left traveling east on the westbound one-way road.

⁷ See Highway Attachment TXDOT Wrong-Way Crash Analysis and Countermeasures in the TXDOT Abilene District.



Figure 6. View of WRONG-WAY sign on 3rd St. viewed from Birdwell Lane.

There was an additional One-Way sign posted on the right-hand side of 3rd St., approximately 155-feet east of the Birdwell intersection that preceded the WRONG WAY sign. After the pickup driver turned left onto 3rd St. it was approximately 0.25-mile to where 3rd St transitioned to the exit ramp for the I-20 exit 179. Figures 7 and 8 show the signage on the exit ramp to deter wrong-way entry.



Figure 7. View of DO NOT ENTER signs followed by WRONG WAY signs on the exit ramp where the pickup driver traveled to enter I-20.



Figure 8. View of WRONG WAY signs posted 150-feet after the DO NOT ENTER signs.

The following dimensions were measured for the lateral placement, mounting height, and dimensions of the signage. The DO NOT ENTER signs were located 53-feet east of the Tulane St. intersection. They were posted on both the left and right sides of the exit ramp. The 48-inch square signs were located 14-feet from the road edge and had a 7-foot mounting height from the pavement to the center of the sign.

The WRONG WAY signs were located 150-feet past the DO NOT ENTER signs. The 36-inch-wide by 24-inch-tall signs were located 14-feet from the pavement line and mounted 7-feet above the pavement to the center of the sign.⁸ The sign pole had a 12-inch-tall red reflective tape located 57-inches above the pavement. Traveling the wrong way, the yellow shoulder stripe was on the right and the white shoulder stripe was on the left, opposite as it would appear to a driver driving the correct direction.

Figure 9 below depicts the Texas Manual on Uniform Traffic Control Devices (TXMUTCD) Figure 2B-18, which shows an example application of signage at an exit ramp to deter wrong-way entry.

⁸ See Table 2B-18 TXMUTCD 2011 Edition Revision 2 for sign dimensions for a single lane ramp. [Texas MUTCD \(txdot.gov\)](https://www.txdot.gov/publications/texas-manual-on-uniform-traffic-control-devices-txmucd) Page 83.

Figure 2B-18. Example of Application of Regulatory Signing and Pavement Markings at an Exit Ramp Termination to Deter Wrong-Way Entry

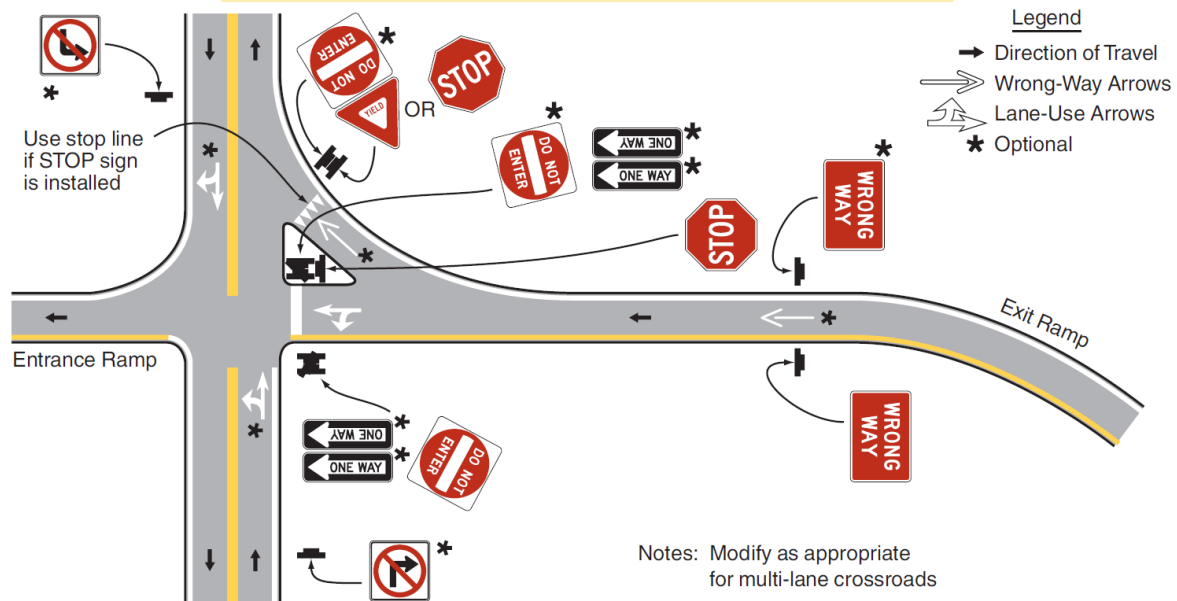


Figure 9. View of TXMUTCD figure 2B-18 which provides example applications on signing exit ramp termination to deter wrong-way entry.

Only one DO NOT ENTER sign and one WRONG WAY sign are required to be installed on the right-hand side of the road. The additional DO NOT ENTER sign and WRONG WAY sign that were installed on the left-hand side of the road were optional features that TXDOT chose to install.⁹

1.5 Vehicle Damage and Cable Barrier Damage

The frame on the right side of the 2005 MCI motorcoach was displaced inward 7-feet over a 42-inch-wide area. The wheelbase on the right-hand side was reduced 42-inches. The right side of the motorcoach had contact and intrusion damage along a 26-foot-long area to the rear of the baggage compartment. See Figure 10 for a view of the motorcoach damage. Three of the cable barrier posts were bent over at the base to the ground from the impact. None of the three steel wire ropes were fractured.

⁹See Highway Attachment Excerpts from Texas MUTCD.



Figure 10. View of frontal damage to the 2005 MCI motorcoach.

The Ford F-350 pickup truck was destroyed by impact and the postcrash fire. The 2018 Freightliner bus had sideswipe damage beginning at the front of the bus body and running the length of the bus. See figure 11 and 12 for view of sideswipe damage. See Figure 13 for a view of pickup truck damage.



Figure 11. View of damage to left forward edge of the bus body.



Figure 12. View of sideswiped damage along the left side of the 2018 Freightliner bus body.



Figure 13. View of damage to the Ford F-350 pickup truck.

1.6 Line of Sight Testing

On December 22, 2021, I-20 was closed by TXDOT and TXDPS to conduct line-of-sight testing with an exemplar MCI motorcoach and an exemplar Ford F-550 pickup truck. The pickup was placed in the eastbound right-hand lane of I-20 facing westbound, approximately 400-feet east of where the impact occurred. The motorcoach was driven east on I-20 until the driver could discern the pickup truck. This distance was measured 1,335 feet or 935 feet from the impact location. The motorcoach was then moved forward an additional 280 feet or 1,055 feet from the pickup truck. The testing motorcoach driver said his view was clearer from this position. Still photographs were taken, and then a drive through was performed at 75 mph with the motorcoach approaching the stopped pickup truck. The drive through was documented with a GoPro video recording. Next a drive through GoPro video recording documented the pickup truck driver's route of travel from Hull's Meat Company to where he turned left onto 3rd street going the wrong-way and continuing wrong-way onto the I-20 exit 179 ramp and continuing onto I-20 to the impact location. See Figure 14 and 15 for motorcoach driver's view of the pickup truck.



Figure 14. Test motorcoach driver's view of Ford pickup in right-hand lane at the bottom of the hill in the right center of the photograph.



Figure 15. Test motorcoach driver’s view of Ford pickup truck located 1,055 feet ahead.

1.6.1 Sight Distance and Stopping Sight Distance

Sight distance is the length of the roadway ahead that is visible to the driver. The available sight distance on a roadway should be sufficiently long to enable a vehicle traveling at or near the design speed to stop before reaching a stationary object in its path. Stopping sight distance includes reaction time and braking distance. Design reaction time is established at 2.5 seconds which exceeds the 90th percentile of reaction time for all drivers.

Braking distance is determined from a recommended deceleration rate of 11.2-feet per second squared or .34 g’s. Table 3-2 Stopping Sight distance on Grades in the American Association of State Highway and Transportation Officials (AASHTO) *A Policy on Geometric Design of Highways and Streets* indicates that a stopping sight distance of 866-feet should be provided for 75 mph speeds on a three-percent downgrade in new construction projects.¹⁰ Prior to 1984 the AASHTO text indicated the object target height was 6-inches-high and the deceleration rate was .28 g’s.¹¹ At the crash location an 1,100-foot vertical curve preceded the impact area. AASHTO design calculations showed that 1,273-feet sight distance was available to the

¹⁰ AASHTO design criterion provides for a 2.5 second reaction time, a deceleration rate on .34 g’s on wet pavement, a seated eye height of 3.5 feet and an object target height of 2.0 feet.

¹¹ 1984 AASHTO Policy on Geometric Design that quoted the 1965 determinations of object height and deceleration rates. Table III-1 in the 1984 version of the AASHTO manual indicated a stopping sight distance of 910-feet was recommended on highways with a design speed of 70 mph on a three percent downgrade.

motorcoach driver on this crest vertical curve.¹² In the line-of-sight testing, the pickup truck was placed forward from the bottom of the crest vertical curve resulting in more line-of-sight distance.¹³

1.7 TXDOT Assessment of Wrong Way Crashes and Post-Crash Improvements

There are 660 lanes miles of interstate highway in the Abilene District of TXDOT that are configured with 191 entrance ramps and 206 exit ramps. Also, the district operates 704 lane miles of other divided highways that have approximately 304 crossover access locations.

The TXDOT Abilene District conducts monthly meetings to review and address fatal crashes within the district. As part of this process police reports, Google imagery, photos from county maintenance supervisors, and the Texas Crash Record Information System (TCRIS) is studied to look for trends on a particular segment of roadway. From these analyses immediate improvements can be recognized and countermeasures implemented. Also, areas for further study can be selected.

As indicated earlier, the increase in wrong-way driving crashes in the district has resulted in the TXDOT Abilene District undertaking an initiative to evaluate and improve traffic operations and signing at all ramp connections and at-grade crossovers on four-lane divided highways. All ramps and crossovers are being inspected by the 3 area engineers to ensure that the proper signing is in place conforming to the TXMUTCD standards. In addition to the required signage, all ramps will have the Wrong-Way Arrow installed that includes the raised, retro-reflective pavement markers that display reflected red light to wrong-way drivers. The projects to inspect, add signing, and new pavement markings is projected to be complete by the end of calendar year 2023.

Additionally, a separate initiative is underway on 3rd and 4th Streets in Big Spring. An engineering study is being performed to study these routes and inventory all street, alleyway, and driveway connections, existing signage, and pavement markings. The results of the study will provide TXDOT with recommendations to improve and enhance the conspicuity of the traffic operation elements so that wrong-way driving can be reduced or eliminated in this area before wrong-way drivers reach the connections with ramps leading to the main-line lanes of I-20. As of July 2022, the following improvements have been completed: at all signalized intersections, DO NOT ENTER and WRONG WAY signs have been installed along 3rd and 4th Streets; additionally, WRONG WAY signs have been installed every other block, with WRONG WAY pavement marking arrows placed on the roadway pavement at intermediate intervals between the signs; and, ONE WAY signs are placed on all traffic signals and stop signs.

Work is still in progress for the placement of ONE WAY signs at all street and alleyway intersections. TXDOT is also planning on placing ONE WAY signs at some private drives where vehicles can enter the property from more than one direction. For example, if a business has a driveway that enters/exits 3rd or 4th streets, but also has access from a side street or alley, a ONE WAY sign will be placed in front of the driveway on 3rd/4th streets.

¹² The motorcoach driver's seated eye height was 7.75-feet and the height of the object was the center of the windshield on the Ford pickup truck measured at 5.83-feet.

¹³ See Highway Attachment Sight Distance Calculations.

Possible improvements will include more frequent installation of “Do Not Enter” signs, “WRONG WAY” signs, movement prohibition signs, and the use of lane arrows and pavement markings at strategic locations. The results of the study and implementation of the recommended improvements is anticipated to be complete by the end of 2023.

The major signs will be completed by the end of the 2022 fiscal year, and the remaining signs will be completed in FY 2023.

1.8 National Transportation Safety Board Wrong-Way Driving Special Investigative Report.¹⁴

Several safety improvement recommendations were made to the Federal Highway Administration (FHWA) in the Safety Board’s *Special Investigation on Wrong-Way Driving Report*. FHWA provided information to the states on countermeasures to deter wrong way driving and the status of the NTSB recommendations as of this report are “Open -Acceptable Action” based on steps taken by FHWA.¹⁵

D. Docket Material

LIST OF ATTACHMENTS:

- Highway Attachment - Excerpts TXDOT Cable Barrier Plans and Construction Plans.
- Highway Attachment - TXDOT Cable Barrier Installation Policies.
- Highway Attachment – TXDOT Speed Study.
- Highway Attachment – TXDOT Procedures for Establishing Speed Zones.
- Highway Attachment – Wrong way Crash History Reports.
- Highway Attachment – Wrong way Crash Analysis and Countermeasures in the TXDOT Abilene District.
- Highway Attachment – Excerpts from the Texas MUTCD.
- Highway Attachment – Sight Distance Calculations.

Submitted by:

David S. Rayburn
Highway Factors Group Chairman

¹⁴ National Transportation Safety Board *Wrong-Way Driving Special Investigative Report* (SIR) (2012) NTSB/SIR-12/01.

¹⁵ FHWA’s final rule on MUTCD revisions will be issued in May 2023.