NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF HIGHWAY SAFETY
WASHINGTON, D.C.

HIGHWAY FACTORS GROUP CHAIRMAN'S FACTUAL REPORT

A. CRASH INFORMATION

Location:	Northbound US Highway 83 (US-83) near milepost 553.4 in Uvalde County, 6.5 miles north of Concan, Texas
Vehicle:	2007 Dodge Ram quad-cab 3500 pickup truck
Operator:	Private owner
Vehicle:	2004 Ford E350 cutaway chassis with a 13-passenger Turtle Top Vanterra medium-size bus body
Operator:	First Baptist Church of New Braunfels
Date:	Wednesday, March 29, 2017
Time:	Approximately 12:20 p.m. CDT
NTSB #:	**HWY17MH011**

B. HIGHWAY FACTORS GROUP

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C. CRASH SUMMARY

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

D. DETAILS OF THE HIGHWAY FACTORS INVESTIGATION

In this crash, the pick-up truck driver crossed the double yellow center line before colliding head-on into the Ford Turtle Top bus.[1] The crash location was in a work zone where the work had not yet begun.

The highway group examined the highway traffic metrics including the traffic volumes, posted speed limits, design speeds, and speed studies performed in 2010 and 2014. Next, the construction and design documents were examined along with pavement skid data and plan and profile sheets. The accident history was examined for similar head-on collisions. The scene was examined and photographed, and supplemental measurements were made as well as a complete three-dimensional scanning was performed by the Technical Reconstruction Group.

1. Crash Location

The crash site was located on U.S. Highway 83 about 6.5 miles north of Concan, Texas. The Texas Department of Public Safety Report indicated the location was .6 miles north of milepost 554. In the northbound direction, the milepost signs (MP) are decreasing in number so the location was MP# 553.4. The construction design plans from 1935 indicate the location was near station number 1469 +20.[2] The Global Positioning Satellite (GPS) coordinates were 29° 34' 49" N by 99° 45' 07" W. See **Figures 1 and 2** below for Google Earth views of the crash site.

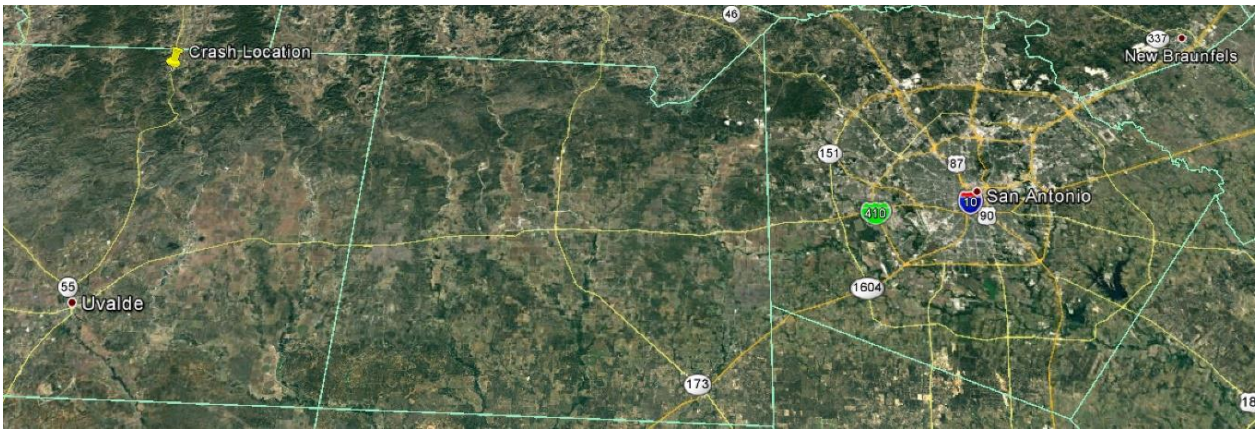

Figure 1- 11/22/2014 Google image showing crash location in relation to Uvalde, San Antonio, and New Braunfels, Texas.

[1] See Texas Transportation Regulations TRC 545.055, which prohibits passing or driving left of center in a no passing zone marked by signs or appropriate markings.
[2] Station numbers are numbers showing official dimensional locations along a project.

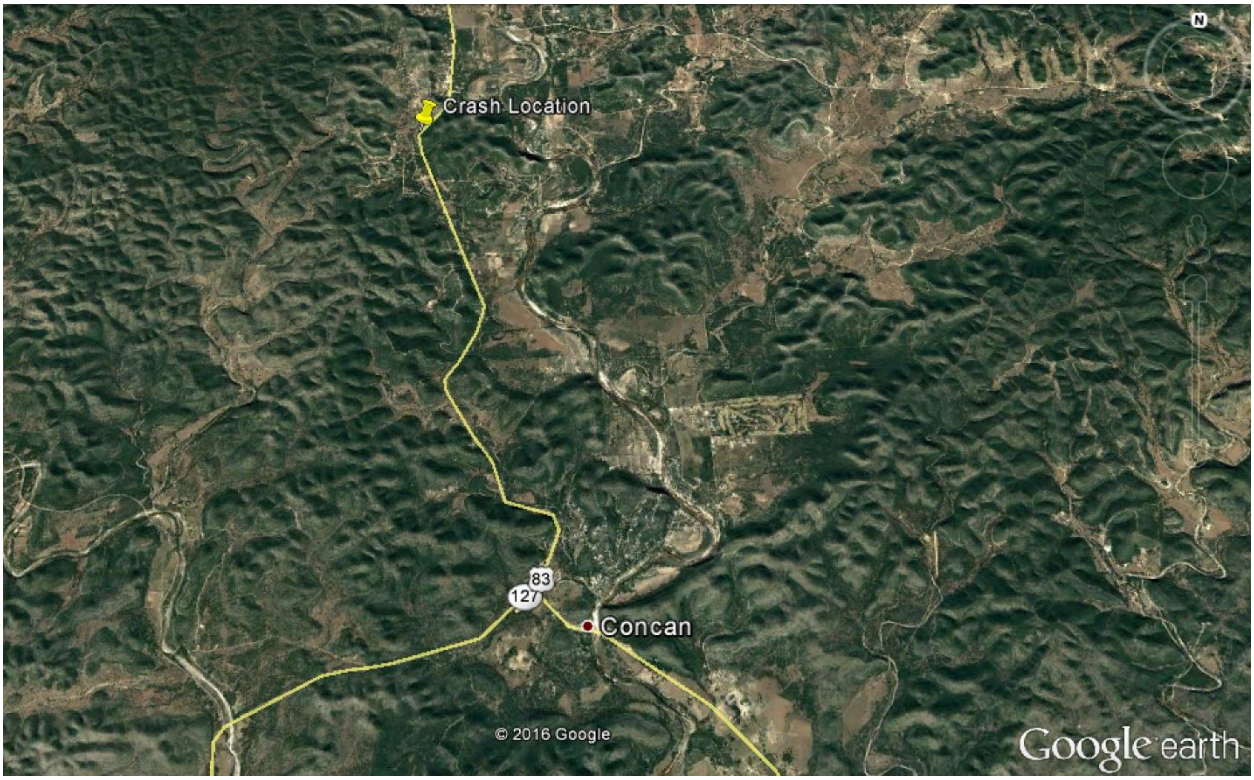

Figure 2 – 11/22/2014 Google image showing crash location in relation to Concan, Texas.

2. Traffic Metrics

At the time of the crash, the posted speed limit for US 83 in the accident curve was 70 mph. Approximately 250 feet south of the accident site a 60-mph warning sign was posted warning northbound motorists that the speed limit ahead was reduced to 60 mph. The speed limit for northbound traffic reduced to 60 mph approximately 700 feet north of the area of impact. A speed study was performed at several locations along US 83 in 2014. See locations and 85th percentile speeds below:

Location:	85th percentile Speed, North/South:
2.6 miles south of Ranch Road 1050	67/71 mph
0.3 miles north FM 127	61/65 mph
2.0 mi. north of FM 127	71/71 mph
3.1 mi. north of FM 127	70/75 mph

The 2016 Average Daily Traffic (ADT) was 2,726 vehicles per day. Truck traffic accounted for approximately 15 percent of that total or approximately 408 trucks per day.[3]

3. General Highway Information.

US 83 is a two-lane roadway with an 11.5-foot-wide travel lane in each direction. In the vicinity of the cash, the lanes are separated by a double, yellow pavement stripe, indicating it is a no passing zone.[4] Raised yellow thermoplastic pavement markers are located between the double yellow pavement stripes; they are spaced at 42-foot intervals. The right-hand shoulders for the north and southbound lanes are approximately 8 feet wide. There were no alert grooves or longitudinal rumble strips on the shoulders in the vicinity of the crash. Also, there were no centerline rumble strips. In other areas along US 83 there were both center-line and longitudinal edge-line rumble strips. TXDOT indicated the other nearby areas had accident problems that were mitigated by the edge-line and center-line rumble strips, adding that the area of this accident did not have a serious accident problem in the past.

4. Accident Curve Stopping Sight Distance and Horizontal Alignment

The Dodge pickup truck was traveling uphill on an approximate 4 percent grade traveling through the right-hand curve to the impact area. The Ford Econoline 350, Turtle Top bus was traveling downhill on the 4 percent grade entering the left-hand curve. Design plans showed the curve had a radius of 1,432.7 feet or approximately 4 degrees and was 1,445 feet long. Supplemental measurements indicated that the superelevation or bank of the curve was 9.5 percent. In the northbound direction, the curve ended near station number 1472 and the impact area was near station number 1469+20, so the pick-up was nearly out of the curve and the bus was just entering the curve when the crash occurred.[5]

The horizontal offset dimension or distance from the northbound edge-line perpendicular to the cut slope and vegetation on the slope was approximately 20 feet. The vegetation and cut slope limited the horizontal stopping sight distance to northbound traffic to approximately 615 feet. This dimension was determined graphically by TXDOT by surveying the line of sight dimensions and measuring along the road-path for northbound traffic along the travel lane.

Both stopping sight distance and horizontal alignment are design control criteria. Federally funded highway construction and reconstruction projects must either meet established design criteria for these elements or a formal design exception must be prepared and approved.

The design stopping sight distance for a 70-mph design speed on a four percent upgrade is 706 feet.[6] Stopping sight distance is a required design control feature and must be maintained. Since the horizontal sight distance was limited by vegetation and the cut slope to less than the

[4] See Texas Manual on Uniform Traffic Control Devices (TMUTCD) Section 3B.02 No Passing Zone Markings and Warrants, which indicates that a double yellow centerline should be used to prohibit passing in both directions, Texas Department of Transportation 2011, Revised 2009 FHWA MUTCD.

[5] See Attachment 2 - Plan and Profile Sheets and superelevation for more detail

[6] See Table 3-2 Stopping Sight Distance on Grades on page 3-5 of the 2011 6th Edition "A Policy on Geometric Design of Highways and Streets", American Association of State Highway and Transportation Officials, (AASHTO) Stopping Sight Distance is the distance required for a vehicle with a drivers' eye height of 3.5 feet to detect and object 2.0 feet tall in the lane and to brake to a stop on wet pavement. The perception reaction time is calculated at 2.5 seconds and the deceleration rate is assumed to be .34 g's. In this accident, the stopping sight distance was not an issue because the driver was not trying to stop for any object in his travel lane.

required stopping sight distance, TXDOT indicated it would post a 60-mph advisory speed warning sign, and on May 10, 2017 the work order was sent to maintenance engineers directing the installation of the sign.[7] See **Figure 3 for the sight distance diagram.** The recommended stopping sight distance for a 60-mph design speed on a 4 percent upgrade is 535 feet.

Additionally, horizontal alignment is a design- criteria. The design documents did not list the design speed for this roadway segment but TXDOT indicated the design speed for this segment of roadway was 70 mph. Horizontal alignment or roadway curvature is limited by side friction factors, superelevation and curve radius for design speeds. The TXDOT Roadway Design Manual refers designers to the AASHTO Geometric Design Manual when superelevation rates exceed 8 percent. The AASHTO Policy on Geometric Design provides tables that show minimum values of radius for various combinations of superelevation and design speeds.[8],[9]

The tables shown that the design speed would need to be reduced to 65 mph since the accident curve radius was 1432 feet. The table shows that the minimum radius for a 70mph design speed is 1630 feet.

5. Crash History

TXDOT provided the NTSB with a list of all the crashes along a six-mile segment of US 83 including three miles north and south of the crash site for the five- year-period between 2012 and 2016. A total of 31 crashes occurred; 22 were property damage only, 8 were injury crashes and one crash was a run off the road fatal crash. No other fatal head-on collisions occurred during this time-period.

6. Maintenance and Construction

In 1935 US 83 was reconstructed from the previously existing Texas State Highway 4.[10] Next the pavement was re-graded and seal coated in 1962.[11] In 2000-2001 the road was rehabilitated.[12] In 2005-2008 flashing beacons were installed at the intersection of Ranch-to-Market (RM) road 1050, and in 2010, advance-warning flashers and rumble strips were installed at RM 1050.[13] Also in 2010 the pavement was seal-coated and pavement markings were installed.[14] During the week after the accident another seal coat project began near the accident area.[15] The accident location was located within a work zone but the actual work in the accident area had not begun at the time of the accident. Additional high-friction treatments are scheduled

[7] See Attachment 3-TXDOT E-mail and work order for advisory speed sign.
[8] Table 1 is copied from AASHTO Table 3-11b on page 3-49, "A policy on Geometric Design of Highways and Streets", 6th Edition 2011, American Association of State Highway and Transportation Officials, Washington, D.C.
[9] The measured .096 percent superelevation was rounded up to .010 percent to account for any variations in measurement.
[10] See Project Plans 0036-07-026
[11] See project plans 0036-07-014
[12] See project plans 0036-07-0026
[13] See Project Plans 0036-07-030
[14] See Project Plans 0016-19-022
[15] See Project Plans 0017-14-018

for April 2017 in the curves on US 83 near Park Road 29 at the entrance to Garner State Park.[16] And in 2018 edge-line rumble strips will be installed to aid in preventing run off the road crashes.

7. Highway Signage

Table 1 shows the highway signs on northbound US 83 on the approach to the impact area in the accident curve.

Table 1

Sign Type	MUTCD Code	MUTCD Sign Symbol	Condition	Sign Size	Distance to Crash
Stay Alert Talk or Text Later Sign	G20.10T		Good	48 inch X 60 inch	3000 feet south of impact area
Begin work Zone Traffic Fines Double When Workers Are Present	G20.5AP R20-5T R205aTP		Good	24 inch X 24 inch 24 inch X 30 inch 24 inch X 12 inch	1,500 feet south of impact area

[16] See Project Plans 0036-07-036 See Attachment 4 - Highway Plans for more detail

Warning for speed reduction ahead	W3-5 **(60mph)**	 W3-5	Good	30 inch x 30 inch	250 feet South of impact area
Speed Limit 60	R2-1	 R2-1	Good	30 inch x 36 inch	750 feet past impact area

8. Skid Data

Wet Pavement skid testing in the crash area that was performed on 03/31/2016 showed that the pavement had skid number scored readings of 45-62 at 47-49 mph skid tests.[17] These values equate to longitudinal friction readings of approximately .45-.62 g's.

9. Scene Information

There were gouges and scrapes in the southbound lane of US 83 marking the impact location. Laterally, the gouges were located about 8.3 feet west of the double yellow center-line, indicating the pick-up had encroached over half way halfway into the opposing traffic lane at impact. There were tire friction marks in the southbound lane from a witness traveling behind the bus. The witness indicated they skidded to a stop behind the bus after witnessing the impact. At impact, both the bus and pick-up rotated counterclockwise with the bus coming to a final position facing east and the pickup facing west.

Evaluation of the witness video recorded by witnesses behind the pick-up showed that the pick-up was traveling an average speed of 69 mph +/- 2mph in the last several miles before the impact. For details see the *NTSB Video Study*.

10. Testing and Research

On Monday April 3, 2017 TXDOT performed ball-bank testing on the accident curve using a digital test device. This device reads a driver's comfort level driving through the curve at the posted speed limit of 70 mph. Generally, the readings must exceed 12 degrees to warrant posting an advisory speed on a curve. The testing showed a reading of - 0.41 degrees on the left and +

[17] See Attachment 5 - Skid Testing for more detail

1.74 degrees on the right traveling at 70 mph northbound in the curve. In the southbound direction, the readings were -2.57 degrees left and +0.05 degrees right. This information is characteristic of a curve that is well banked and an advisory speed is not warranted.

Additional information on guidelines for posting advisory speed warnings on horizontal curves is found in Section 2C.08 of the Manual on Uniform Traffic Control Devices (MUTCD). As part of the standard the MUTCD requires the posting of an advisory speed shall be determined by an engineering study that follows established engineering practices. In support information for this section the MUTCD indicates that among the established engineering practices that are appropriate for the determination of the recommended advisory speed for a horizontal curve are the following:

1. An accelerometer that provides a direct determination of side friction factors
2. A design speed equation
3. A traditional ball-bank indicator using the following criteria:
    a. 16 degrees of ball-bank for speeds 20 mph or less
    b. 14 degrees of ball-bank for speeds 25 mph to 30 mph
    c. 12 degrees of ball bank for speeds of 35 mph or higher.

DPS conducted skid testing on the pavement in the southbound direction at the accident site in a Chevrolet Tahoe equipped with anti-lock brakes. The dry pavement friction was .86-.89 g's at 40-45 mph.

E. DOCKET MATERIAL

The following attachments and photographs are included in the docket for this investigation:

LIST OF ATTACHMENTS

Highway Attachment -	Plan and profile sheets with curve data and superelevation,
Highway Attachment -	TXDOT work order for installation of 60-mph warning sign on the accident curve.
Highway Attachment -	TXDOT wet pavement skid scores
Highway Attachment -	TXDPS police accident report

LIST OF PHOTOGRAPHS

Highway Photo 1 –	Southbound view on US 83, showing the final positions of both accident vehicles. Note the scrapes and tire friction marks leading away from the impact area. **Highway photos 1-11 are provided courtesy of the Texas Department of Public Safety Highway Patrol**
Highway Photo 2 –	Northbound view on US 83 showing impact area and final vehicle positions.
Highway Photo 3 –	Southbound view of tire friction marks from a witness vehicle that skidded to a stop behind the bus.
Highway Photo 4 –	View of both vehicle's final positions in the southbound lane.
Highway Photo 5 –	Additional view of impact area
Highway Photo 6 –	Additional Southbound view of both vehicles final positions in the southbound lane
Highway Photo 7 –	From of vehicle positions from southbound shoulder, showing the back on the bus on the metal beam guardrail.
Highway Photo 8 –	View of bus impact with wooden guardrail post
Highway Photo 9 –	Aerial view of impact area and vehicle positions.
Highway Photo 10 –	Closer view of scrapes on the pavement and tire friction marks leading away from the impact area.
Highway Photo 11 –	View of vehicle final positions with the end of the curve in the background.
Highway Photo 12 –	View of advance work zone warning sigh on US 83, approximately 3200 feet from the impact area.
Highway Photo 13 –	View of Texas G20.10T sign warning motorist to stay alert and not to text in work zones. The accident curve can be seen beginning approximately 1500 feet away in the photo background.
Highway Photo 14 –	View of where the work zone began at the beginning of the accident curve.
Highway Photo 15 –	View of northbound US 83, approximately 1400 feet from the impact area.

Highway Photo 16 –	Continued view of accident curve about 1300 feet from the impact area.
Highway Photo 17 –	Note how the forward sight distance in the curve is limited by the cut slope and vegetation on the hill side.
Highway Photo 18 –	Continued northbound view around the accident curve approximately 1200 feet from the impact area.
Highway Photo 19	Continued northbound view approximately 1100 feet from the impact area.
Highway Photo 20 –	Northbound view of 4-degree right-hand curve on the uphill grade.
Highway Photo 21 –	Continued view of accident curve, approximatelyy 1,100 feet from the impact area.
Highway Photo 23 –	Northbound view of curve approximately, 900 feet from the impact area.
Highway Photo 24 –	Continued view of accident curve.
Highway Photo 25 –	View of advance warning sign for speed limit change ahead on US 83 from 70 mph to 60 mph.
Highway Photo 26 –	Closer view of speed limit change warning sign.
Highway Photo 27 –	View of work zone warning sign. Note the impact area can be seen by the pavement discolored by fluid debris on the opposite side of the road across from the sign.
Highway Photo 28 –	Northbound view of impact area in the southbound lane.
Highway Photo 29 –	Closer view of the impact location.
Highway Photo 30 -	View of impact area marked by fluid stains and paint markings.
Highway Photo 31 –	Close-up view of impact area in the southbound lane of US 83.
Highway Photo 32 –	View of northbound curve ending in the photo background.

Highway Photo 33 –	Continued view on northbound US 83 where the speed limit changes to 60 mph, approximately 750 feet past the impact area.
Highway Photo 34 –	Southbound view (direction of bus) of US 83 where the speed limit in the southbound direction changes from 60 mph to 70 mph for the bus.
Highway Photo 35 –	Beginning of the accident curve in the southbound direction. The impact area is approximately 350 feet ahead.
Highway Photo 36 –	View of witness vehicle tire friction marks in the southbound lane that skidded to a stop behind the accident bus. Fluid stains marking the impact area are just ahead of the tire marks in the photo.
Highway Photo 37 –	Southbound view of the impact area in the southbound lane.
Highway Photo 38 –	Additional close-up view of pavement gouges and tire friction marks in the impact area.

END OF REPORT

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