

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

**TECHNICAL RECONSTRUCTION GROUP CHAIRMAN'S  
FACTUAL REPORT**

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**A. CRASH INFORMATION & CRASH SUMMARY**

Refer to the *Crash Information and Crash Summary Report* in the docket for this investigation.

**B. TECHNICAL RECONSTRUCTION GROUP**

Robert Squire – Highway Crash Investigator, Group Chairman  
NTSB Office of Highway Safety  
490 L'Enfant Plaza East, S.W., Washington, DC 20594

**C. DETAILS OF THE TECHNICAL RECONSTRUCTION INVESTIGATION**

The Technical Reconstruction Group was convened for this investigation to assist with providing on-scene documentation of the crash location and the involved vehicle, and to facilitate an analysis of collision events and causation factors. In support of these tasks the group relied upon information, data and documentation provided by Texas Department of Public Safety (TxDPS), Texas Department of Transportation (TxDOT) and the Hempstead Independent School District. Factual reports prepared by other NTSB investigative groups should be consulted for information related to other aspects of the investigation, including information referenced within this report.

The vehicle and highway were examined during the week of January 3, 2022.

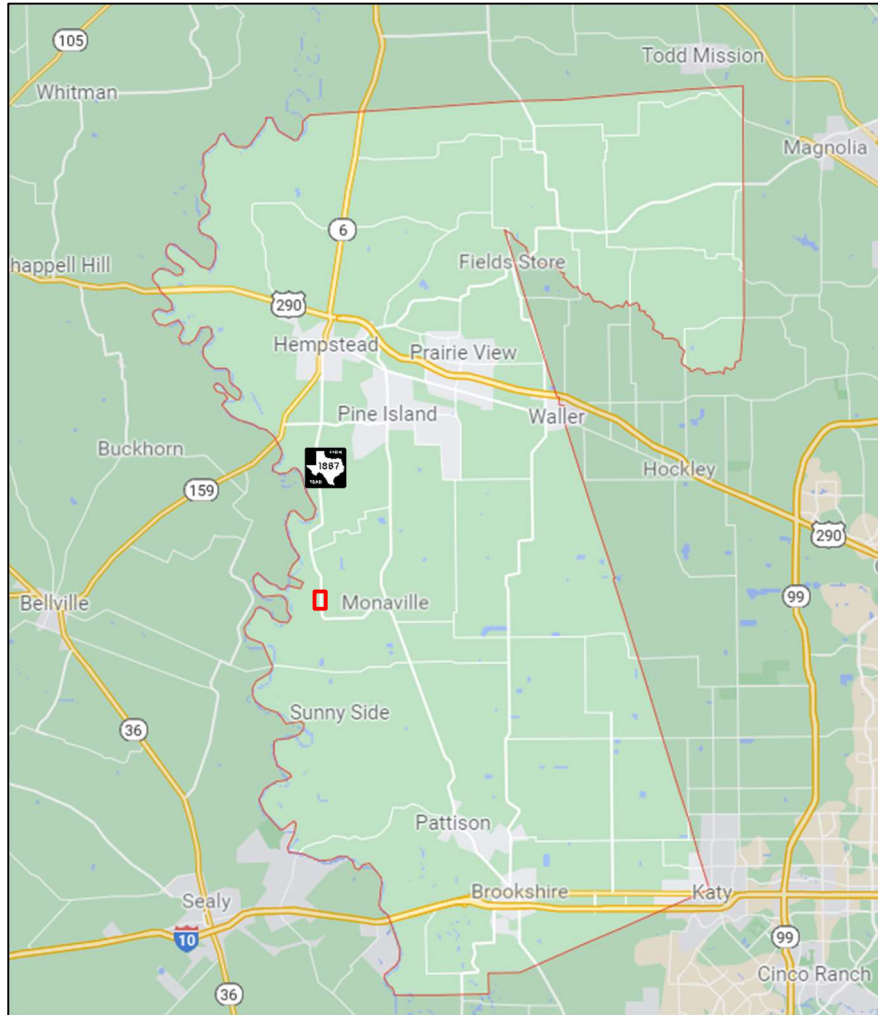
**1. Introduction and Highway Description**

The collision event occurred on Texas state route FM-1887, originating just north of the intersection with Holik Road and involved a single vehicle, a 2018 IC Bus CE model, Type-C, school bus. While traveling southbound on FM-1887 just south of the Irons Creek bridge the bus experienced a partial roadway departure along the west side of the highway followed by a driver induced serpentine movement during the attempt to return to the pavement. The bus ultimately entered a counterclockwise yaw, departed the east side of the highway, and rolled 360-degrees, coming to rest upright facing northward.

The crash occurred December 17, 2021, at about 12:10 p.m. CST under daylight and dry weather conditions. The vehicle's position of final rest was approximately located by GPS coordinates 29.94840701° north latitude and -96.080769° west longitude.

## 1.1. Crash Location

The crash site was located in Waller County between the towns of Hempstead and Monaville. As illustrated in **Figure 1**, the red rectangle marks the approximate crash location about 3.1 (road) miles west of Monaville.

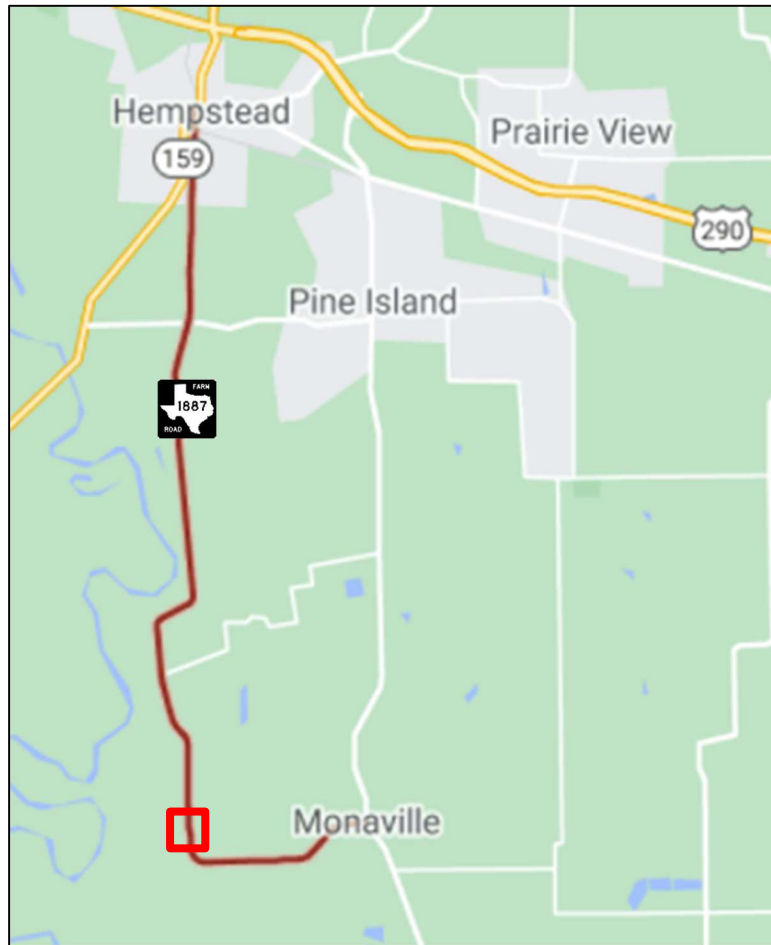


**Figure 1:** Area map depicting Waller County and the approximate location of the crash site (red box) on highway FM-1887.

## 1.2. Highway Data

Texas Department of Transportation (TxDOT) public data conveys that highway FM-1887 was designated in 1951 and covers a distance of about 13.69 miles between state highway 159 in

Hempstead and FM-359 at Monaville within Waller County.<sup>1</sup> The highway exhibits primarily a north-south orientation with several widely spaced curves leading southbound toward the crash site. Approximately 2.9 miles before its termination at FM-359, the highway exhibits a leftward curve that changes the heading from north-south to east-west. **Figure 2** depicts the orientation of FM-1887.



**Figure 2:** Depiction of FM-1887 (red highlight) atop a Google Maps image. The approximate crash site is outlined with a red box.

FM-1887 has a functional classification as a major collector. Information provided by TxDOT conveyed that in 2014 the highway underwent an overlay of the entire highway that included full-depth reclamation, seal coat and pavement markings.<sup>2</sup> The highway typical section

<sup>1</sup> Established in Texas through legislation in 1949, Farm to Market Roads exist as secondary state highway transportation systems connecting rural or agricultural areas to towns and city centers.

<sup>2</sup> As defined by the Federal Highway Administration, *Major collector roads* are routes that: (1) Provide service to any county seat not on an arterial route, to the larger towns not directly served by the higher systems, and to other traffic generators of equivalent intracounty importance, such as consolidated schools, shipping points, county parks, important mining and agricultural areas, etc. ; (2) link these places with nearby larger towns or cities, or with routes of higher classification; and (3) serve the more important intracounty travel corridors.

specifies 11-foot-wide travel lanes with approximately two-foot-wide shoulders within the area of the crash. The specified cross slope of the travel lanes was two-percent descending from the centerline toward the shoulders. These dimensions were corroborated by on-scene measurements that revealed 11-foot-wide travel lanes and shoulder widths of 24-30 inches adjacent the southbound lane and 24 inches adjacent the northbound lane.

The travel lanes and shoulders are clearly delineated by six-inch-wide painted striping. Through the area where the crash occurred, the north- and southbound travel lanes are delineated by double-yellow striping designating the area as a no-passing zone. The lateral separation of the double yellow striping was 12-inches.

Contiguous with the southbound right shoulder (west side of highway) was a 26 to 28-inch-wide area of compacted aggregate that likely supported the pavement edge. In many places this compacted aggregate had a thin asphalt overlay. While some areas of this asphalt overlay were fractured, it exhibited a descending slope that transitioned smoothly to the grass-covered foreslope. In areas where the overlay exhibited a drop at the edge, the vertical displacement did not exceed about 1.25 inches. At the other locations where there was less roadside aggregate or no overlay atop the aggregate, a slight edge drop could be present at the shoulder edge, although the vertical difference was found not to exceed two inches.

**Figure 3** is a photograph depicting the pavement edge near the area where the bus first began to depart the highway.



**Figure 3:** Photograph depicting southbound right roadway edge near area of bus roadway departure.

In the area where the bus initially departed the pavement, measurements of the roadside foreslope adjacent the southbound travel lane ranged from 7-17% (14:1 – 6:1), which was less than the 4:1 maximum cited in the 2014 TxDOT resurfacing/overlay plans for the highway. Those plans likewise indicate a 6:1 slope at the paved shoulder edge. The foreslope extended about 14.5 feet to level terrain. The entire clear zone width was approximately 24 feet then abutted a wooded area.

In the area of the final roadway departure before overturning, a wide ditch was present. While a (descending) foreslope was contiguous with the highway, the depth of the ditch and relative height of the backslope varied considerably throughout the area. Where the bus departed the pavement, the ditch appeared to be more prominent while at other locations there was no ditch or discernible backslope. Site measurements of the ditch revealed an overall width of 27-28 feet and approximate maximum depth of 35 inches. The fore slope exhibited a grade of about -16-17% (6:1), while the backslope was about +25-26% (4:1).

**Figure 4** is a photograph depicting a northward view of area where the bus departed the east side of the roadway and entered the roadside ditch.



**Figure 4:** Photograph depicting northward view of east roadside adjacent the northbound travel lane where the school departed the highway and overturned. Soil furrows (indicated by red arrows) from the bus tires are visible.

Site documentation by DPS investigators indicate the school bus initially departed the highway pavement toward the right roadside about 162 feet after the roadway transitioned from a tangent (straight) segment to a slight leftward curve. Highway design documentation provided by TxDOT indicate that the curve has a radius of 1,506.6 over a distance of 287.5 feet. The degree of curvature is specified at about  $3.8^\circ$  with a total change in heading of about  $10.93^\circ$ . The curve geometry does not warrant the installation of curve warning signs or advisory speed reduction.<sup>3</sup> Highway data indicate that the tangent segment traveled by the bus before the curve extended for a distance of about 5,294 feet (1.003 miles).

The highway curve began about 93.6 feet past the southern end of the Irons Creek bridge deck. The full length of the bridge measured 142 feet that included three 34-foot deck segments (102 feet) plus 20-foot-long concrete approach slabs at the northern and southern ends. The bridge deck generally exhibited 12-foot-wide travel lanes with shoulder widths of four feet seven inches.

FM-1887 exhibits several curves widely separated along its total length of 13.69 miles. Preceding the crash location, the more significant curves are located within approximately five miles north of the Irons Creek bridge. Four of those curves in the southbound direction exhibit curve warning signs and advisory speeds of 40 to 55 mph. **Figure 5** depicts a Google Earth overlay of FM-1887 with the relevant signage illustrated. While vertical alignment information was not

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<sup>3</sup> As no speed reduction was necessary or warranted for this curve, no horizontal alignment warning was necessary as referenced in Section 2C.06 of the FHWA *Manual on Uniform Traffic Control Devices for Streets and Highways*.

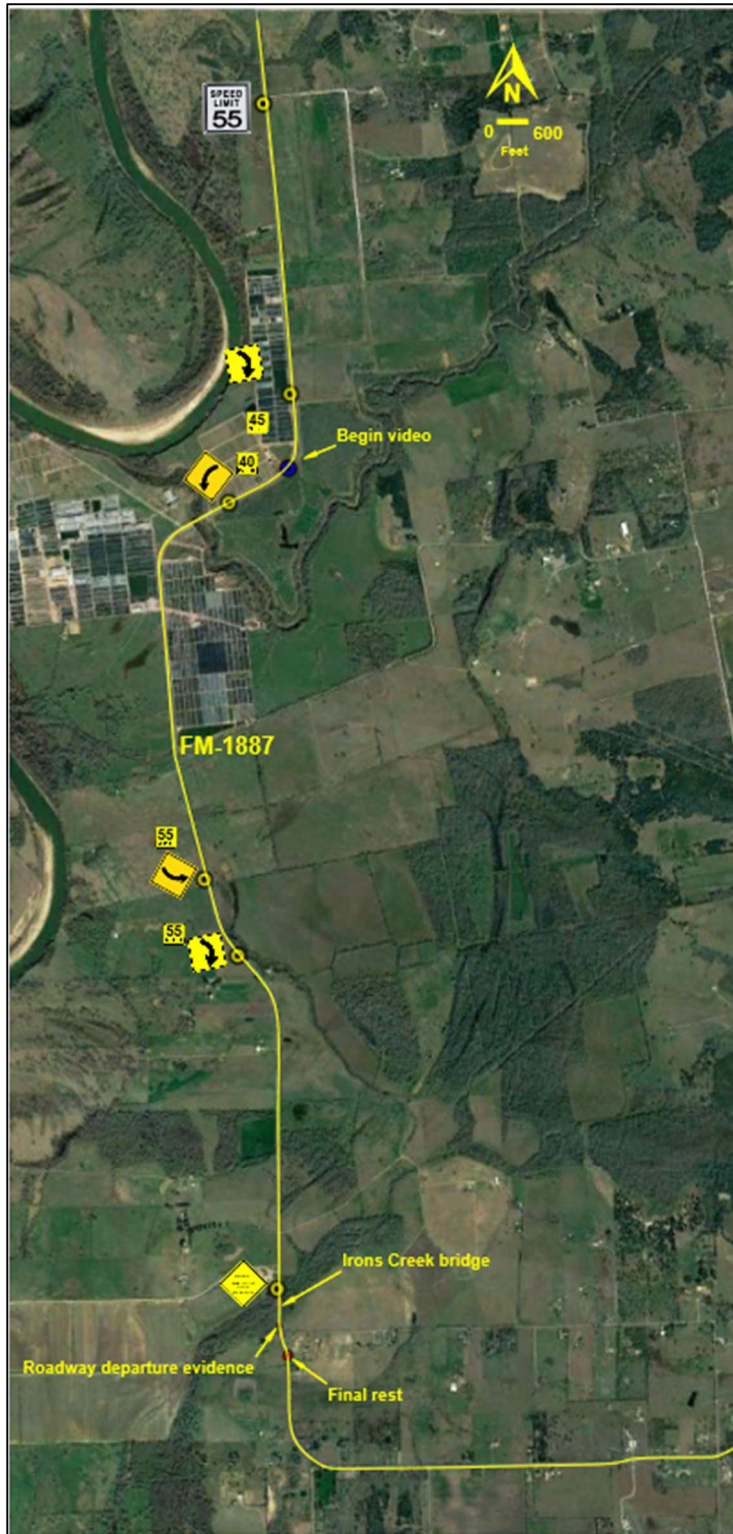
provided in the TxDOT documents, the highway generally appeared level with occasional minor changes in grade being discernible.

The highway speed limit was posted at 55 mph. Southward from state route 159, before the crash location two (2) signs are erected. The sign nearest to the crash site was positioned about 4.8 miles north of the Irons Creek bridge.

TxDOT data indicate a 2020 annual average daily traffic (AADT) count for FM-1887 of 1,092 vehicles as measured about 0.8 miles north of Addie Gee Road (2.9 miles north of the crash site).<sup>4</sup> Similarly, the AADT count was 1,141 vehicles near FM-359, south of the crash site. TxDOT reported only one other motor vehicle crash on FM-1887 south of Irons Creek and north of the left curve toward Monaville. That crash occurred in 2012 and involved a light duty truck traveling northbound that departed the highway and struck a fence. No injuries were reported.

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<sup>4</sup> Annual average daily traffic total traffic volume/days in a year



**Figure 5:** Google Earth overlay depicting southbound highway sign placement north of the crash site.



## 2. Highway Evidence Documentation

As documented by TxDPS investigators, evidence of the path of travel for the bus presented as tire scrubbing (i.e., surface cleaning) and friction marks atop the pavement surface, and impressions in the soil adjacent to the pavement edge. Upon examination of the highway by NTSB investigators, many of these marks were still visible. Documented evidence began about 328 feet north of the Holik Road intersection and continued about 415 feet to the south of the intersection. The approximate position of final rest for the bus was about 438 south of the Holik Road intersection.

DPS investigators documented the onset of tire impressions along the west roadside beginning about 154 feet north of Holik Road.<sup>5</sup> Parallel with the off-pavement tire impression path, tire marks atop the pavement were also documented beginning about 157 feet north of Holik Road. TxDPS scene photographs depict the initial onset of the pavement marks as a “cleaning” of the surface. The surface cleaning appeared to transition to black tire friction marks as they continued southward. The roadside wheel impressions exhibited the appearance of a dual tire assembly, such as was on the bus drive axle. Onset of the tire mark evidence exhibited an angular departure from the pavement of less than two degrees. As the tire path evidence continued southward, it began arcing leftward or eastward eventually returning to southbound travel lane. As the marks returned to the pavement the intensity of the marks increased, although as the marks reached the middle of the southbound lane at the Holik Road intersection, they were no longer visible. The maximum off-pavement distance of the roadside tire impression was measured at about 2.8 feet from the pavement edge.<sup>6</sup>

Beginning about 50 feet south of the Holik Road intersection arcing tire friction marks consistent with that of a set of dual tires were documented. The tire marks arced rightward or westward from the southbound travel lane across the highway centerline into the northbound travel lane and the returned to the southbound lane. As documented, the marks covered a distance of about 138 feet and exhibited a maximum intrusion into the northbound lane of about 5.5 feet.

The marks again faded from view with additional another set of tire marks appearing about 15 feet further south. The onset of these marks appeared about 200 feet south of Holik Road near the southbound lane road edge and exhibited a leftward or eastward arcing that extended about 217 feet across both travel lanes to the east side road edge. The tire marks exhibited significant striation patterns consistent with a tire that was rotating and sideslipping. As the tire marks arced from the west to east roadsides additional tire friction marks appeared that were indicative of having been created by tires on both the front and rear axles. As the tire marks crossed both roadway edges, loose surface aggregate was displaced. As the tire marks reached the east side pavement edge, soil furrowing was evident on the east side of the highway. The soil furrows descended the roadside foreslope with some terminating at the bottom of the ditch and others at the crest of the backslope. The longest visible soil furrow covered about 50 feet from the pavement edge.

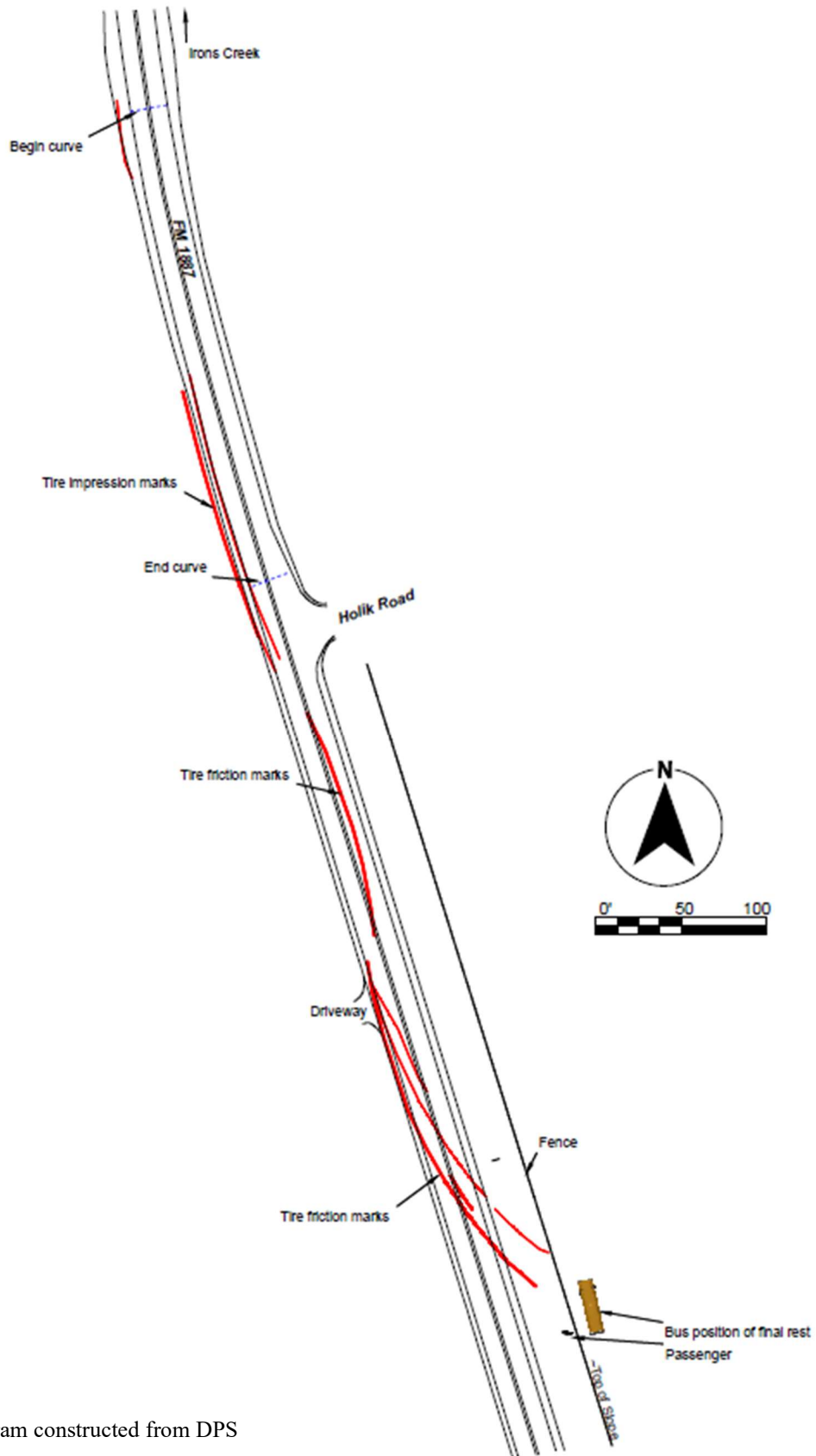
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<sup>5</sup> Another area of off-pavement evidence was documented about 168 feet further north, but this evidence was neither photographed nor consistent with other evidence related the bus path of travel.

<sup>6</sup> While some marks exhibited evidence of a dual tire assembly, a singular line of points was used to document both tires.

The overall distance from the onset of the tire marks to the area of final rest for the bus was about 599 feet. At final rest, the bus was about 40 feet off the highway pavement, upright and facing north parallel with the highway. A segment of wire fence that paralleled the highway along the crest of the backslope was toppled by the bus.

**Figure 6** is a diagram created from total station mapping data provided by TxDPS investigators.



**Figure 6:** Scene diagram constructed from DPS mapping data.

### 3. Vehicle Identification

The involved school bus was identified as a model year 2018 Type-C school bus manufactured by IC Bus, LLC. **Table 1** cites some general vehicle information.

Table 1: General Vehicle Data

Model	CE (PB10500)	
Date of manufacture	7/26/2017	
Engine	Cummins 6.7 L (diesel)	
Gross vehicle weight rating	29,800 lbs.	
Gross vehicle weight rating	29,800 lbs.	10,000 steer axle
Overall length	384.84 inches	19,800 rear axle
Wheelbase	217-218 inches <sup>7</sup>	
Wheel track (post-crash measurement)	78.1 inches	
Brake system	Pneumatic with ABS	

The vehicle primarily exhibited damage along the right (passenger) side roofline beginning at the rear corner and progressing forward. Damage was more significant at the rear of the vehicle. The left (driver) side roof exhibited areas of impact depression and paint scarring that was less substantial than damage on the right side. Seams along the roof exhibited entrapped dirt and some vegetation indicative of ground contact with a rear to front movement. The roof and support pillars above the lower windowsill were shifted toward the driver side about nine degrees. The upper half of the rear emergency exit door frame exhibited a similar lateral displacement. The greatest area of deformation appeared at the right rear corner roof line which in addition to the leftward displacement was vertically compressed about four inches. Soil debris embedded in areas of the body, primarily at the right rear, was indicative of vehicle motion and orientation during the roll event. There was no discernible reduction to the vehicle wheelbase or overall length.

Visual examination of the vehicle tires, suspension, steering, and brake components revealed no discernible deficiencies or crash-induced damage, excluding separation of the left-side outboard rear tire from the rim. The outboard facing tire bead/rim flange interface of both right- and left-side front and rear axles exhibited soil and vegetation entrapment consistent with soil furrowing. The right rear outboard tire exhibited shoulder scuffing that was consistent with the tire sideslipping on pavement. Overall, the tires and rims appeared satisfactory. Visible suspension and steering components remained intact and connected. Manipulation of the steering revealed no

<sup>7</sup> Specification varies by document reference.

looseness or excessive play. Brake system pneumatic lines and ABS sensor wires were present and connected. Visible brake friction material (shoe) material appeared satisfactory. As noted in their final investigative report, TxDPS investigators identified no pre-existing deficiencies during their post-crash vehicle inspection. **Figures 7 and 8** depict screen capture images of the three-dimensional point cloud rendering of the involved bus.



**Figure 7:** Screen capture image of the 3D point cloud rendering of the involved bus as observed from the right front of the vehicle.



**Figure 8:** Screen capture image of the 3D point cloud rendering of the involved bus as observed from the right rear of the vehicle.

While the involved model year bus was not equipped with driver assistance systems such as lane departure warning or electronic stability control, current IC Bus school bus models offer a range of driver assistance and collision mitigation features. Many of these features were introduced beginning with the 2018 model year vehicles. Current standard equipment features include electronic stability control (ESC), collision mitigation automatic emergency braking (AEB) and stationary object detection. Optionally available systems include features such as adaptive cruise control, lane departure warning and braking, overspeed alert and action, and stationary vehicle braking (expands on stationary object alert to automatic braking).

#### **4. Vehicle Onboard Video**

The bus was outfitted with a Safety Vision, LLC, Observer 4112 video recording system with four 41AHD Series cameras. As reported by Hempstead ISD transportation staff, the bus was purchased with the system installed. The system provided four video channels that included imagery from three interior facing and one forward exterior facing cameras. The video from each channel could be output as separate, synchronized, video files. Transportation staff provided NTSB investigators with copies of the four camera video files that included the crash event. Those files were approximately 19 minutes and 10 seconds in length. System specifications indicate that video is recorded at a rate of 30 frames per second at a resolution dependent upon the camera model.

Information provided by Hempstead ISD staff indicates that the video was a continuously recording and not subject to an event trigger or event recording feature. Displayed on the video image were geographic coordinates (internal GPS module), internally derived speed expressed in kilometers per hour, and a current date and time (hh:mm:ss).<sup>8</sup> The video recordings provided to

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<sup>8</sup> Time synchronization via GPS.

investigators began about 3.5 miles north of where the bus initially departed the highway. Beginning along the tangent that started just over a mile before the bus departed the highway, the forward-facing vehicle depicts the bus traveling within the southbound lane at speed between 102-104 km/hour (~63-64 mph) with the majority of the travel period at about 103 km/hour. The video data depict a constant speed of 102 km/hour (~63 mph) as the bus approaches and crossed the Irons Creek bridge up to the point of roadway departure.

#### **D. DOCKET MATERIAL**

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

- Highway plans highlighting typical section and horizontal alignment plans (dated 2014)

END OF REPORT

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Robert J. Squire  
Highway Accident Investigator