

Vehicle Collision With Student Pedestrians Crossing
High-Speed Roadway to Board School Bus
Rochester, Indiana
October 30, 2018



Accident Report

NTSB/HAR-20/02
PB2020-100122



National
Transportation
Safety Board

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Notation 59830
Adopted March 31, 2020

Highway Accident Report

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National
Transportation
Safety Board

490 L'Enfant Plaza, SW
Washington, DC 20594

National Transportation Safety Board. 2020. *Vehicle Collision With Student Pedestrians Crossing High-Speed Roadway to Board School Bus, Rochester, Indiana, October 30, 2018.* Highway Accident Report NTSB/HAR-20/02. Washington, DC: NTSB.

Abstract: About 7:12 a.m., on October 30, 2018, a school bus, operated by Tippecanoe Valley School Corporation, was traveling north on State Route 25 (SR-25) in Rochester, Indiana, on its morning route. At this location, SR-25 is a two-lane highway with a posted speed limit of 55 mph. The school bus stopped at its designated location to pick up students, and the driver activated the bus's red warning lights and stop arm. Ten students and a parent were waiting for the school bus at a mobile home park on the other side of the road from the bus stop. After being signaled by the school bus driver to cross, four of the students entered the southbound roadway. A pickup truck traveling south on SR-25 failed to stop for the school bus and struck the four children. A 9-year-old female and two 6-year-old males were fatally injured. An 11-year-old male sustained serious injuries.

The National Transportation Safety Board (NTSB) identified the following safety issues:

- Deficiencies in establishing safe school bus routes and stop locations.
- Failure of other drivers to stop or otherwise respond safely when approaching a school bus that is stopped with its warning lights on and stop arm extended.
- Need for greater use of technologies to prevent collisions with, and mitigate injuries of, student pedestrians.

The NTSB makes safety recommendations to the National Highway Traffic Safety Administration; the 28 states (and District of Columbia) that do not have laws permitting use of stop arm cameras for enforcement purposes; the Indiana Department of Education; the National Association of State Directors of Pupil Transportation Services, National Association for Pupil Transportation, and National School Transportation Association; the International Association of Chiefs of Police, National Sheriffs' Association, and National Association of School Resource Officers; and the Tippecanoe Valley School Corporation.

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Acronyms and Abbreviations

AAA	American Automobile Association
ABS	antilock braking system
CDL	commercial driver's license
CFR	<i>Code of Federal Regulations</i>
DOT	US Department of Transportation
FCSO	Fulton County Sheriff's Office
FMVSS	Federal Motor Vehicle Safety Standard
GVWR	gross vehicle weight rating
IDOE	Indiana Department of Education
IIHS	Insurance Institute for Highway Safety
IMUTCD	<i>Indiana Manual on Uniform Traffic Control Devices for Streets and Highways</i>
INDOT	Indiana Department of Transportation
KSDE	Kansas State Department of Education
MS-370	Mississippi State Highway 370
MUTCD	<i>Manual on Uniform Traffic Control Devices for Streets and Highways</i>
NAPT	National Association for Pupil Transportation
NASDPTS	National Association of State Directors of Pupil Transportation Services
NCAP	New Car Assessment Program [NHTSA]
NCSL	National Conference of State Legislatures
NCST	National Congress on School Transportation
NHTSA	National Highway Traffic Safety Administration
NPRM	notice of proposed rulemaking

NSC	National Safety Council
NSTA	National School Transportation Association
NSTSP	<i>National School Transportation Specifications and Procedures</i>
NTSB	National Transportation Safety Board
PAEB	pedestrian automatic emergency braking
SR-25	State Route 25
TRB	Transportation Research Board
TVSC	Tippecanoe Valley School Corporation
V2I	vehicle-to-infrastructure
V2P	vehicle-to-pedestrian
V2V	vehicle-to-vehicle
V2X	vehicle-to-everything

Executive Summary

Crash Summary

About 7:12 a.m., on Tuesday, October 30, 2018, a 2015 Thomas Built school bus, operated by Tippecanoe Valley School Corporation, was traveling north in the 4600 block of State Route 25 (SR-25) in Rochester, Fulton County, Indiana, on its morning route. At this location, SR-25 is a two-lane highway with a posted speed limit of 55 mph. The school bus stopped at its designated location to pick up students, and the driver activated the bus's red warning lights and stop arm. At this location, an agricultural field is on the east side of SR-25 and a mobile home park is on the west side; 10 students and a parent were waiting for the school bus at the mobile home park on the other side of the road from the bus's pickup stop. A Watch For School Bus warning sign is posted for southbound traffic on SR-25 about 868 feet before the mobile home park. There is no roadway lighting at this location. Conditions were dark, the sky was cloudy, and the roadway was dry.

After being signaled by a wave from the school bus driver to cross the roadway, four of the students entered the southbound roadway. A 2017 Toyota Tacoma pickup truck traveling south on SR-25 failed to stop for the school bus and struck the four children. According to the vehicle's recorded data, the pickup truck struck the student pedestrians at 41 mph. As a result of the crash, a 9-year-old female and two 6-year-old males were fatally injured. An 11-year-old male sustained serious injuries. None of the other people waiting for the bus or any occupants of the pickup truck and school bus were injured.¹

Probable Cause

The National Transportation Safety Board determines that the probable cause of the Rochester, Indiana, crash was the pickup truck driver's failure to stop for the school bus for unknown reasons, despite its clearly visible warning lights and stop arm, as well as a roadway warning sign indicating an upcoming school bus stop. Contributing to the cause of the crash was the Tippecanoe Valley School Corporation's (1) inadequate safety assessment of school bus routes, resulting in the prevalence of bus stops that required student pedestrians to cross a 55 mph roadway to board a bus, increasing the risk of injury during a collision, and (2) failure to establish a clear policy regarding surrounding traffic for school bus drivers to follow in determining when it was safe to signal students to cross a roadway to board a school bus.

Safety Issues

The safety issues identified in this investigation include the following:

¹ For more information, see the Factual Information and Analysis sections of this report. Additional information about the investigation of this crash (National Transportation Safety Board [NTSB] case number HWY19MH003) can be found by accessing the [Docket Management System](http://www.nts.gov) at www.nts.gov. For more information on our safety recommendations, see the [Safety Recommendation Database](http://www.nts.gov) at www.nts.gov.

- **Deficiencies in establishing safe school bus routes and stop locations.** The school bus route for the bus involved in this crash required students to cross a 55 mph roadway to board the school bus in the dark, early morning hours. A safe school bus route should avoid requiring students to cross high-speed roadways. Creating safe routes requires that those who develop the routes be adequately trained to assess route safety. Moreover, school bus routes should be evaluated periodically for hazards, and when individuals familiar with the route identify hazards, there should be a mechanism by which the dangers can be reported and tracked. Finally, when students must cross a roadway to board a bus, drivers and students must know and use consistent procedures to reduce the risk of the crossing.
- **Failure of other drivers to stop or otherwise respond safely when approaching a school bus that is stopped with its warning lights on and stop arm extended.** Although motorists are required by law to stop for a school bus that is stopped with its warning lights flashing and stop arm extended, many motorists fail to do so; they drive past the school bus and create a dangerous situation for any student who might be crossing the roadway. Education and enforcement can be used to reduce motorists' illegal behavior.
- **Need for greater use of technologies to prevent collisions with, and mitigate injuries of, student pedestrians, including vehicle-to-everything (V2X), pedestrian automatic emergency braking, and school bus safety-enhancing technologies.** Although routes that require a student to cross a roadway to board a school bus (or to return home after disembarking) should be minimized, there will continue to be some routes where students will have to cross a roadway. In such cases, technology may help to prevent crashes or mitigate any injuries sustained by students.

Findings

1. None of the following were factors in this crash: (1) mechanical condition of the pickup truck or condition of the school bus warning light and stop arm systems; (2) school bus driver licensing; (3) pickup truck driver licensing, drug or alcohol impairment, medical condition, vision, or cell phone use; or (4) actions/behavior of the student pedestrians or the adult pedestrian.
2. There is insufficient information to determine whether the school bus and pickup truck drivers were fatigued in the period leading up to the crash.
3. The emergency response to the crash was timely and effective.
4. For reasons that cannot be determined from the available evidence, the pickup truck driver did not respond to the activated warning lights and stop arm of the school bus, and she did not attempt to stop her vehicle until she saw the students in the roadway.
5. Requiring students to cross a roadway, regardless of the number of lanes, presents a risk of pedestrian death or injury because motorists do not always stop, as required, for school buses, even when a bus is at a bus stop with its lights flashing and stop arm extended.

6. Periodically evaluating school bus routes and stops for hazards can reduce the safety risks to student pedestrians.
7. The existing Indiana Department of Education training for school transportation directors does not contain sufficient information on assessing the safety of school bus routes or identifying hazards at school bus stops.
8. The routing hazards evident in the recent Hartsfield, Georgia, and Baldwyn, Mississippi, crashes suggest that inadequate school bus routing may be a widespread problem.
9. The Tippecanoe Valley School Corporation's inadequate safety assessment of school bus routes resulted in bus stops that required students to cross a high-speed roadway, placing them at risk.
10. Creating a mechanism by which school bus drivers and parents (or caregivers) of student riders could report safety concerns about bus operations would provide an additional source of information that could be used to improve the safety of school bus routes and stops.
11. The Tippecanoe Valley School Corporation's policy at the time of the crash, which required school bus drivers to determine subjectively when surrounding traffic was "controlled," left its bus drivers with insufficient information to make a safe determination about when to signal students to cross a roadway to board a school bus, placing students at risk.
12. In circumstances when a student roadway crossing cannot be avoided, the school bus driver must be knowledgeable of, and consistent when making, crossing and warning signals, and students must be aware of, and understand, the crossing and warning signals the driver makes.
13. Although it is illegal in all 50 states, National Association of State Directors of Pupil Transportation Services data show that the passing of stopped school buses by other vehicles remains a pervasive and continuing safety issue in the United States.
14. Education materials informing the driving public of the illegality and dangers of passing a school bus that is stopped to load or unload passengers are widely available from a variety of sources.
15. Evidence suggests that coupling enhanced enforcement of no-passing laws with efforts to educate motorists about the dangers of passing a stopped school bus may reduce the incidence of illegal passings.
16. The use of stop arm cameras could deter drivers from illegally passing stopped school buses.
17. It remains a safety priority that school buses be included in performance standards for connected vehicle technologies.

18. [The Federal Communications Commission’s proposed rulemaking to reduce Intelligent Transportation System operations to the upper 30 megahertz of the currently assigned bandwidth while opening the remaining 45 megahertz to unlicensed devices would be detrimental to safety and set back advancements in transportation safety.](#)
19. [Because school buses and the children they carry are an integral part of the transportation system, it is imperative to transportation safety that the developers and manufacturers of advanced technologies create systems in which automated and connected vehicles respond appropriately to school buses.](#)
20. [Although there are limitations to the current pedestrian automatic emergency braking systems, these safety technologies can help the driver and prevent or lessen the severity of crashes involving pedestrians.](#)
21. [Because funding for school bus equipment is limited, to make the best use of their resources, school systems need more information on which technologies are most effective in reducing illegal school bus passings and protecting students from the risk of injury.](#)

Recommendations

New Recommendations

To the National Highway Traffic Safety Administration:

[When evaluating safety self-assessment reports from entities testing automated driving systems on public roads, evaluate how effectively the entities include school bus operations in their plans. \(H-20-10\)](#)

[Evaluate the effectiveness of technologies designed to reduce the incidence of illegal school bus passings, and publish and disseminate the evaluation results. \(H-20-11\)](#)

To the states of Alaska, Arizona, California, Colorado, Delaware, Florida, Hawaii, Iowa, Kansas, Louisiana, Michigan, Minnesota, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, North Dakota, Ohio, Oregon, South Dakota, Texas, Vermont, and Wisconsin; the commonwealths of Kentucky and Massachusetts; and the District of Columbia:

[Enact legislation to permit stop arm cameras on school buses to capture images, and allow citations to be issued for illegal school bus passings based on the camera-obtained information. \(H-20-12\)](#)

To the Indiana Department of Education:

[Supplement your training program for school transportation directors with a module on how to assess the safety and risks of school bus routes and stops, according to best industry practices. \(H-20-13\)](#)

Require local school transportation directors and others involved in evaluating school bus routes and stops in Indiana to complete the training module on the safety and risks of routes and stops recommended in Safety Recommendation H-20-13. (H-20-14)

To the National Association of State Directors of Pupil Transportation Services, National Association for Pupil Transportation, and National School Transportation Association:

Inform your members of the circumstances of the Rochester, Indiana; Baldwin, Mississippi; and Hartsfield, Georgia, crashes, and urge them to minimize the use of school bus stops that require students to cross a roadway (especially a high-speed roadway) and to, at least annually, and also whenever a route hazard is identified, evaluate the safety of their school bus routes and stops. (H-20-15)

Remind your members to ensure that school transportation directors and others involved in evaluating school bus routes and stops complete training on how to assess the safety of school bus routes and stops, according to best industry practices. (H-20-16)

Advise your members to train their school bus drivers and students on crossing procedures, including the crossing hand signal and the danger signal, which are to be used when a student roadway crossing cannot be avoided. (H-20-17)

Urge your members to continue to coordinate with local law enforcement agencies to conduct educational and enforcement activities aimed at reducing illegal school bus passings. (H-20-18)

To the International Association of Chiefs of Police, National Sheriffs' Association, and National Association of School Resource Officers:

Inform your members of the fatal Rochester, Indiana; Baldwin, Mississippi; and Hartsfield, Georgia, crashes, and encourage them to continue to work with local school districts to conduct educational and enforcement activities to reduce illegal school bus passings. (H-20-19)

To the Tippecanoe Valley School Corporation:

Implement a process to track school bus driver and parent (or caregiver) complaints regarding the safety of school bus routes and stops, as well as any other safety concerns about bus operations, from initial submission of an issue to its resolution. (H-20-20)

Train your school bus drivers and students on crossing procedures, including the crossing hand signal and the danger signal, which are to be used when a student roadway crossing cannot be avoided. (H-20-21)

Previously Issued Recommendations Reiterated in This Report**To the National Highway Traffic Safety Administration:**

[Develop minimum performance standards for connected vehicle technology for all highway vehicles. \(H-13-30\)](#)

[Once minimum performance standards for connected vehicle technology are developed, require this technology to be installed on all newly manufactured highway vehicles. \(H-13-31\)](#)

[Incorporate pedestrian safety systems, including pedestrian collision avoidance systems and other more-passive safety systems, into the New Car Assessment Program. \(H-18-43\)](#)

1 Factual Information

1.1 Crash Narrative

On Tuesday, October 30, 2018, the 57-year-old male driver of a 72-passenger 2015 Thomas Built school bus, operated by Tippecanoe Valley School Corporation (TVSC), was driving his normal route. He had picked up three students at designated school bus stops and, about 7:12 a.m., was traveling north in the 4600 block of State Route 25 (SR-25) in Rochester, Fulton County, Indiana. At this location, SR-25 is a two-lane highway with a posted speed limit of 55 mph. A mobile home park is located on the west side of the roadway and an agricultural field is located on the east side. (See figure 1.)¹ There is no roadway lighting at this location. Conditions were dark, the sky was cloudy, and the roadway was dry.



Figure 1. View of crash location on SR-25 in Rochester, Indiana. (Source: Google Earth 2020, modified by the National Transportation Safety Board [NTSB])

Before stopping the school bus in the northbound lane, the bus driver activated the bus's amber warning lights. As the bus came to a complete stop at the designated stop location, the driver activated the bus's red warning lights, which deployed the stop arm.² Ten students and a parent were waiting for the school bus at the mobile home park on the

¹ SR-25 generally runs northeast to southwest; however, it is usually referred to as a north and south highway. In the Rochester area, just north of the crash site, SR-25 curves so as to change the road's orientation to one that is essentially east-west. Just south of the crash site, SR-25 again resumes its more typical northeast-southwest orientation. To avoid confusion in this report, we generally refer to vehicles traveling northbound and southbound on SR-25 rather than providing strict compass directions at any location.

² See Title 49 *Code of Federal Regulations* (CFR) 571.131. The term "stop signal arm" is used in Federal Motor Vehicle Safety Standard (FMVSS) 131; however, the safety device is commonly referred to as a "stop arm." In this report, wherever possible, the term "stop arm" is used.

west side of the roadway, opposite the bus stop. The school bus driver said he saw the headlights of a vehicle approaching in the southbound lane in the distance, and he expected the driver of that vehicle to stop. The bus driver signaled with a wave of his hand for the students to cross SR-25 to board the school bus. Four of the students entered the southbound lane of SR-25 and began crossing the roadway. A few steps behind this group were three more students who had not yet begun to cross the roadway. The remaining three students had not reached the roadway.

The approaching vehicle was a 2017 Toyota Tacoma pickup truck operated by a 24-year-old female driver. The driver's brother and two children were seated, and restrained, in the rear seat. While traveling south on SR-25, the pickup truck driver passed a Watch For School Bus warning sign posted about 868 feet before the mobile home park. The driver of the pickup truck did not stop for the school bus, as required by Indiana state law.³ When the bus driver realized that the pickup truck was not going to stop, he honked the school bus's horn.

The pickup truck struck four student pedestrians. A 9-year-old female and two 6-year-old males were fatally injured. An 11-year-old male sustained serious injuries and was transported by medical helicopter to a medical facility in Fort Wayne, Indiana. The other people waiting for the school bus, as well as the occupants of the pickup truck and school bus, were not injured. The vehicle-recorded speed of the pickup truck several seconds before impact was 58–59 mph. The recorded data indicate that the pickup truck brakes were applied between 1.3 and 0.8 seconds before impact. At 0.8 seconds before impact, the vehicle speed was 55.9 mph. At the time of impact, the recorded vehicle speed was 41 mph. The pickup truck was not equipped with a pedestrian automatic emergency braking (PAEB) system.

1.2 Other Crash Information

1.2.1 Students

On the day of the collision, a parent waited at the mobile home park with 10 students, ranging in age from elementary to high school, for the school bus to arrive.⁴ The parent said she instructed all the students to remain behind the fence that was between the mobile home park and the roadway. The parent reported that she saw the white flashing light on top of the school bus from a distance as it approached from the south. As the school bus reached the designated stop location, she started to gather the students into one group to cross SR-25. She said that when the school bus stopped, the warning lights and interior light were on, and the stop arm was deployed. In preparation to cross the roadway, the 9-year-old female held hands with one of the 6-year-old males on her left side and the other 6-year-old male on her right side (as the children faced the roadway). The 11-year-old male student stood to the right of the 6-year-old male on the right. The parent said that the school bus driver signaled the children to cross the road. The parent said that, as the children began

³ See Indiana Code 9-21-8-52.

⁴ This information is summarized from NTSB investigators' interview with the parent and a student waiting for the school bus on the day of the collision. The interview occurred on February 12, 2019.

to cross the roadway, the pickup truck “appeared out of nowhere.” She said the school bus driver honked the bus’s horn.

1.2.2 Pickup Truck Driver

The pickup truck driver said that on the morning of the crash, she left her home in Rochester, Indiana, with her husband, their two children (ages 2 and 3 years old), and her 12-year-old brother. Her husband drove them to his job in Talma, Indiana, about 9 miles away, and they arrived at 7:05 a.m. After dropping off her husband, the driver began driving the pickup truck on a return trip back to Rochester, this time heading for her brother’s house (near her home) to get him ready for school.⁵ Her brother and the other children were seated in the rear seat of the pickup truck. She said she talked to her brother as she drove, and the younger children were asleep. She said that as she approached the stopped school bus, she saw a vehicle ahead but did not recognize what type of vehicle it was. She said she suddenly saw two children and tried to stop. She said that she did not realize that the vehicle was a school bus until seeing the children.

1.3 Injuries

As a result of this crash, three student pedestrians died, and another sustained serious injuries. The other student pedestrians and adult pedestrian were not injured. None of the pickup truck occupants sustained injuries. The school bus was not involved in the collision, and the school bus driver and the bus’s three passengers were not injured. (See table 1.)

Table 1. Injuries.

	Fatal	Serious	Minor	None	Total
Pedestrians	3	1	0	7	11
Pickup truck occupants	0	0	0	4	4
School bus occupants	0	0	0	4	4
Total	3	1	0	15	19

NOTE: Title 49 CFR 830.2 defines fatal injury as any injury that results in death within 30 days of the accident, and serious injury as any injury that: (1) requires hospitalization for more than 48 hours, commencing within 7 days from the date of injury; (2) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); (3) causes severe hemorrhages, nerve, or tendon damage; (4) involves any internal organ; or (5) involves second- or third-degree burns, or any burn affecting more than 5 percent of the body surface.

Figure 2 shows the positions of the student pedestrians after impact. The 9-year-old female was struck by the pickup truck and came to rest in the grassy area on the west side

⁵ Although the pickup truck driver was familiar with this route on SR-25, it was not usual for her to make an early morning trip to and from Talma. The circumstances of the trip will be discussed in section 1.6.1.

of the roadway about 79 feet south of the front bumper of the stopped school bus. She sustained multiple fatal blunt-force trauma injuries. The two 6-year-old males were also struck by the pickup truck and came to rest in the southbound lane next to the double yellow line, about 46 feet south of the bus's front bumper. Both of the 6-year-old males sustained fatal blunt-force trauma injuries. The 11-year-old male was also struck by the pickup truck and came to rest in the grassy area adjacent to the roadway, about 130 feet south of the bus's front bumper. He sustained serious blunt-force trauma injuries and was flown by medical helicopter to a medical facility in Fort Wayne, Indiana.

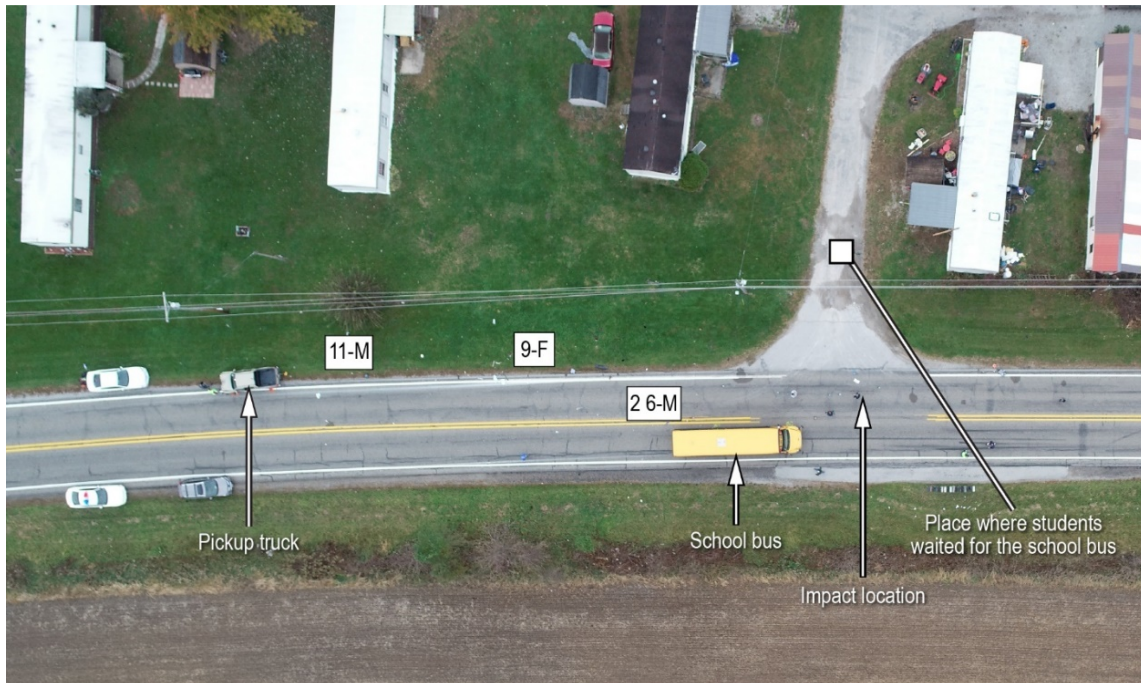


Figure 2. Postcollision site photograph showing the postcollision positions of the school bus, pickup truck, and four struck student pedestrians. (The students are indicated by age and gender (that is, “age-gender.”) (Source: Indiana State Police, modified by the NTSB)

The driver of the pickup truck was restrained with a lap/shoulder belt. The driver airbags deployed during impact.⁶ The driver's 2-year-old and 3-year-old children were restrained in child restraint systems in the rear passenger seat of the pickup truck, and the driver's 12-year-old brother was wearing a lap/shoulder belt in the center seating position of the rear seat.

⁶ The data downloaded from the airbag control module indicated that the driver-side frontal and knee, side, and side-curtain airbags all deployed. On the passenger side, the side and side-curtain airbags deployed; the frontal airbag for this seat did not deploy because the seat was unoccupied. The module had event data recorder functionality. The data were downloaded by the Indiana State Police.

1.4 Emergency Response

The Fulton County Sheriff's Office (FCSO) Emergency 911 Communications Center received its first call at 7:15:25 a.m.⁷ At 7:15:50, eight FCSO deputies were dispatched to the crash site. The FCSO emergency dispatcher also notified the Rochester Fire Department. The Rochester Fire Department informed Lutheran EMS that at least one medical helicopter, and potentially three, would be needed for the incident.⁸

A Lutheran EMS ambulance and a Rochester Fire Department truck were the first to arrive at the crash site at 7:21:47 a.m. The first FCSO deputy arrived shortly afterward, at 7:25:46 a.m. Two additional Lutheran EMS ambulances arrived at the scene at 7:29:30 a.m. and 7:36:17 a.m., respectively. A fire truck from the nearby town of Mentone also responded. The medical helicopter provided by Parkview Samaritan Medical Transport was requested at 7:22:13 a.m. and arrived at the scene at 7:49:06 a.m. The Indiana State Police was notified by the FCSO of the crash at 7:52:51 a.m.

1.5 Highway Information

1.5.1 General

The collision of the pickup truck with the student pedestrians occurred on SR-25, about 4.6 miles north-northeast of the city of Rochester. This segment of SR-25 has two opposing lanes of traffic delineated by solid white striping at the right-side lane edges and yellow centerline striping denoting where passing is permitted or restricted. In the southbound direction, passing is restricted beginning about 3,593 feet north of the collision area. The southbound lane at the crash site measures about 12.9 feet wide; the northbound lane at this location is about 11.9 feet wide. This segment of SR-25 is defined as a rural major collector.⁹ The highway approach to and through the collision area has no street lighting or other sources of supplemental roadway lighting. The speed limit is 55 mph, and the nearest speed limit sign in the southbound direction is about 2.46 miles before the collision site.¹⁰

The collision occurred along a 960-foot-long tangent (straight) segment of highway. The area of impact between the pickup truck and the students was near the center of the southbound travel lane, adjacent to the centermost (of three) paved access roadways for the mobile home park.

⁷ Interviews with witnesses indicated that several individuals unsuccessfully attempted to call 911 on their cell phones; however, cell phone reception in the area is unreliable.

⁸ Lutheran EMS is a private contractor that provides emergency medical services in Indiana.

⁹ "Collectors" are roads that connect local roads and streets with highways and similar higher-speed roadways. The posted speed limits on collectors are usually in the 35–55 mph range.

¹⁰ This location is just south of the unincorporated community of Talma, through which the highway speed limit is reduced.

The highway has curves on the northern and southern approaches to the tangent segment. One curve is about 890 feet north of the collision site.¹¹ A second curve begins about 2,164 feet north of the collision site.¹² Another curve begins about 70 feet south of the collision site.¹³ (Sightline information is discussed in the next section of this report.)

With respect to highway signage, a Watch For School Bus sign is positioned about 868 feet north of the collision site. A School Bus Stop Ahead sign is positioned 9,706 feet north of the collision site. Curve warning signs are located 667 feet north of the collision site (left curve warning sign), 1,747 feet north of the collision site (right curve warning sign), and 3,355 feet north of the collision site (right curve warning sign). (See figure 3 for roadway and signage information.)



Figure 3. Southbound approach to collision site and relative locations of signage along SR-25. (Source: Google Earth 2020, modified by the NTSB)

The *Indiana Manual on Uniform Traffic Control Devices for Streets and Highways* (IMUTCD) does not specify an application for the Watch For School Bus warning sign, but it states that the sign may be installed if the school bus stops at individual residences to pick up or discharge passengers, rather than at a single location where numerous passengers

¹¹ This is a rightward curve for vehicles traveling southbound on SR-25.

¹² This is a rightward curve for vehicles traveling southbound on SR-25.

¹³ This is a leftward curve for vehicles traveling southbound on SR-25.

are picked up or discharged.¹⁴ Further, the IMUTCD says that the Watch For School Bus signs are not intended for use everywhere a school bus stops to pick up or discharge passengers but are to be used where terrain and roadway features limit the approach sight distance and there is no opportunity to relocate the school bus stop location to another spot with adequate visibility.

According to the Indiana Department of Transportation (INDOT), in 2018, the estimated annual average daily traffic for SR-25 through the area of the collision was 2,953 vehicles.¹⁵ In all, 53 crashes were reported within 2 miles of the crash site from 2013 through 2018. In the area of the mobile home park (between the northern and southern access roadways), there was one single-vehicle crash, in addition to this collision.

1.5.2 Highway Sightline

INDOT personnel conducted a static line-of-sight measurement from the area of the collision northward. As a 6-foot-tall subject stood in the center of the northbound lane adjacent to the collision site, an approaching southbound observer was able to see the subject at a distance of 1,233 feet.¹⁶ This was consistent with an estimate made based on highway plans and collision site measurements, which projected a sight distance of 1,185 feet.

On the day of the crash, the students waited for the approaching school bus on an access road to the mobile home park at a short distance behind a chain link fence that ran parallel to the roadway, between the mobile home park and the SR-25 roadway. The fence was set back about 26 feet from the SR-25 pavement edge. Had those waiting for the bus stood any farther behind the fence, the mobile homes in their northward line of sight would have blocked their view of the road in that direction. An area of dense foliage was located along the fence line about 80 feet from the mobile home park access road and extended toward the highway from the fence. The clear zone from the foliage to the roadway was 13 feet. Considering these limitations, the northward (toward the pickup truck) sightline distance for those waiting for the bus at the mobile home park could have been as short as 265 feet.¹⁷ As the students moved toward the roadway, their northward line of sight would steadily improve. With respect to their south- and eastward sightlines, from their position behind the fence, the students had a clear line of sight of the school bus as it approached the mobile home park, as well as of the stop position of the bus. (See figure 4.)

¹⁴ By statute, Indiana Code section 9-21-2-1 through 9-21-2-4, Indiana Department of Transportation, adopts the IMUTCD with concurrence from the Federal Highway Administration. The IMUTCD conforms substantially with the federal MUTCD (FHWA 2009).

¹⁵ INDOT reported that the annual average daily traffic for SR-25 through the area of the collision was estimated from ground counts taken in June 2014 and April 2017.

¹⁶ The observation was conducted during daylight hours, with the observer likely aware of the purpose of the observation.

¹⁷ An unobstructed line of sight does not consider that light sources, such as approaching vehicle headlamps, could be visible through the foliage.

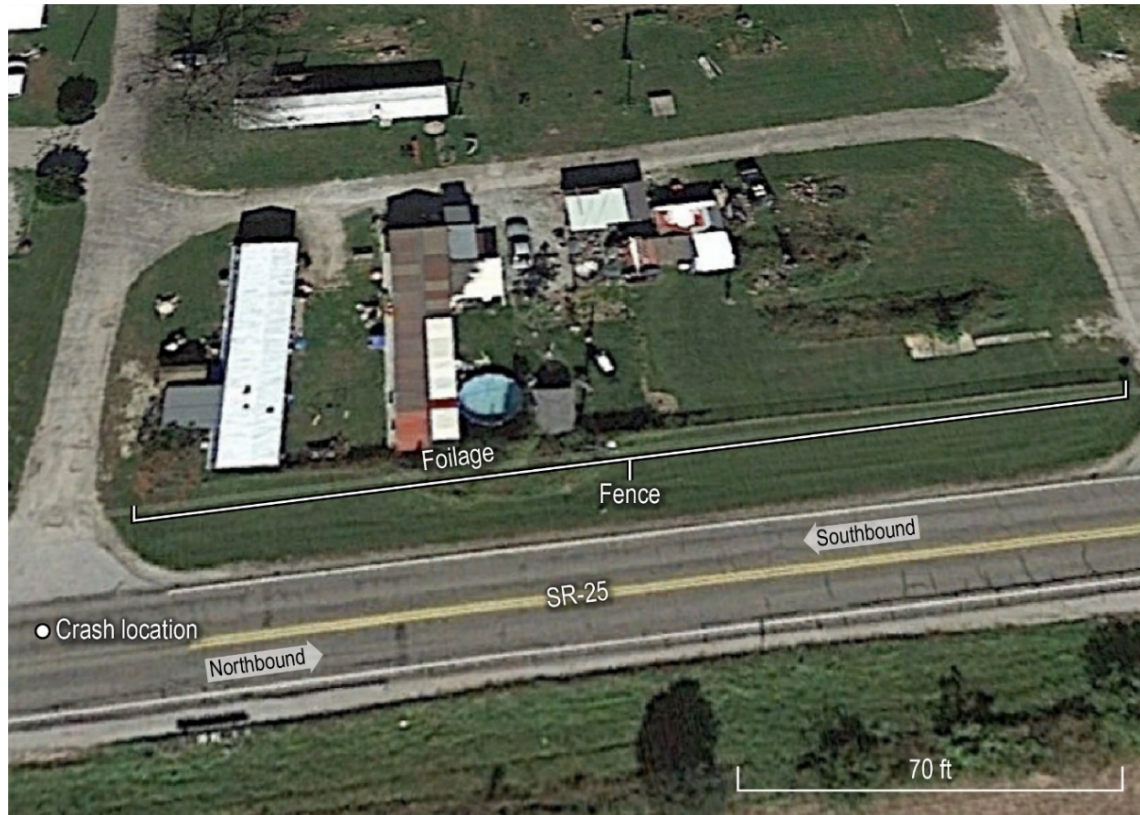


Figure 4. Crash location and SR-25 roadway. (Source: Google Earth 2020, modified by the NTSB)

1.5.3 Scene Evidence

When the crash occurred, the school bus was approximately centered within the northbound lane, with its front bumper about 11.5 feet south of the centerline of the access road into the mobile home park (where the children stood). The final rest position of the pickup truck after the crash was 170.6 feet south of the school bus, as measured from the two vehicles' bumpers. At final rest, the pickup truck was positioned off the right side of the southbound travel lane with its right-side wheels off the pavement.

In the southbound lane, beginning near the center of the intersecting access road, investigators found a tire friction mark on the pavement. The mark was just to the right of the lane center, and it exhibited a slight angular heading toward the southbound pavement edge. Investigators measured the tire mark as about 12 feet long.

1.6 Driver Information

1.6.1 Pickup Truck Driver

The pickup truck was driven by a 24-year-old female. Through her legal counsel, the driver declined to be interviewed by NTSB investigators. Information in this section is based on the Indiana State Police interview with the pickup truck driver, a forensic cell

phone examination, driver license records, and pharmacy and medical records.¹⁸ Additionally, NTSB investigators reviewed the driver's court testimony from an October 18, 2019, proceeding in the Fulton County Superior Court on this case.

1.6.1.1 License and driving history. The pickup truck driver obtained an Indiana operator's license on August 26, 2011. Her current driver's license was issued in 2016 and was valid until 2021. Her license history showed no record of traffic violations or license suspensions. The National Driver Register did not indicate that her driving privileges had been suspended, canceled, revoked, or denied.¹⁹ According to an insurance industry database, the driver was involved in a property-damage-only accident on July 9, 2014, in Rochester, Indiana.

The pickup truck driver had a corrective lens restriction on her Indiana operator's license, which required that she wear glasses or contact lenses when driving. According to her October 18, 2019, court testimony, she was wearing glasses at the time of the crash.

1.6.1.2 Medical and toxicology information. Medical and pharmacy records for the pickup truck driver showed no medical conditions that would have affected her performance in the crash. No chronic illnesses or routine medication use was documented.

Following the crash, the pickup truck driver consented to a toxicology test at the request of the Indiana State Police. The testing was performed by the Indiana State Department of Toxicology. The test results were negative for ethanol, drugs commonly used for abuse, and several sedating substances.²⁰

1.6.1.3 Activities in the days before the crash. No information was available on the pickup truck driver's daily activities or sleep schedule in the days preceding the crash. Table 2 shows her first and last cell phone activity each day.

¹⁸ The Indiana State Police interview was conducted on October 30, 2018.

¹⁹ The National Driver Register is a division in the National Center for Statistics and Analysis within the National Highway Traffic Safety Administration (NHTSA), which maintains the Problem Driver Pointer System database. The database contains records of drivers whose privilege to drive has been suspended, canceled, revoked, or denied or who have been convicted of serious traffic-related offenses.

²⁰ The substances tested for included the following: acetone, ethanol, isopropanol, methanol, 7-aminoclonazepam, alprazolam, clonazepam, desalkylflurazepam, diazepam, lorazepam, midazolam, nordiazepam, oxazepam, temazepam, zolpidem, a-hydroxyalprazolam, THC, THC-COOH, amphetamine, benzoylecgonine, cocaine, ephedrine, MDA, MDEA, MDMA, methamphetamine, phencyclidine, phentermine, phenylpropanolamine, and pseudoephedrine.

Table 2. Pickup truck driver's first and last cell phone activity, October 27–30, 2018.

Time	Driver Activity	Source
Saturday, October 27, 2018		
6:49 a.m.	Outgoing text message	Cell phone device
9:59 p.m.	Cell phone notes saved	
Sunday, October 28, 2018		
7:45 a.m.	Outgoing text message	Cell phone device
9:51 p.m.	Outgoing text message	
Monday, October 29, 2018		
6:46 a.m.	Incoming phone call	Cell phone device
10:28 p.m.	Outgoing phone call	
Tuesday, October 30, 2018		
7:02 a.m.	Outgoing text message (according to the driver interview, her husband was driving at this time)	Cell phone device
7:05 a.m.	Driver arrives in Talma, Indiana, and departs minutes later for Rochester, Indiana	Driver interview
7:12 a.m.	Crash occurred	-----

Cell phone records indicate no incoming or outgoing text messages or phone calls at the time of the crash. The FCSO conducted a forensic data extraction of the pickup truck driver's cell phone, which showed that an application was active but no conclusive indication that the phone was being manipulated at the time of the crash. In her interview, the driver said that the phone was in the center of the console and that a music application may have been playing.

1.6.1.4 Driver interview. Although the driver declined to be interviewed by NTSB investigators, she was interviewed by the Indiana State Police on October 30, 2018. She said that she left her house on the morning of the crash with her husband, two children, and brother. Her husband drove the pickup truck to his job in Talma, Indiana, and they arrived about 7:05 a.m. She said she had her 12-year-old brother with her for the night because her stepfather was in the hospital, and her mother was with him. She had planned to take her brother back to his house to get him ready for school, and then she was going to drive him to school. She said that while driving south on SR-25, she saw a vehicle but did not know what it was. She said she was trying to figure out “what heavy load it was.” She said, “I didn't see a stop sign—like usually when I see a bus, I like see a stop sign.”²¹ She said she suddenly saw children and tried to stop her vehicle. In her court testimony, she noted that the vehicle was in the “other lane,” and also confirmed that she saw the red flashing lights on the vehicle.

She recalled being by the mobile home park and described it as dark. She said she was using her “brights” until she saw another vehicle. When asked how fast she was

²¹ Based on the context of this statement, it appears that the pickup truck driver was referring to a stop arm on the bus, not a roadside stop sign.

driving, she stated that she was a slow driver and usually drives about 50 mph or slower, but she did not know how fast she was traveling when the crash occurred. She indicated that she was familiar with that roadway but was not usually on that road at that time of day. She said it was not usual for her to drive her husband to work; she was doing so this morning so that her husband could retrieve his car, which he had left at work the previous day.

She said she was not talking or texting on her phone. She said that, when the crash took place, her children were asleep, and she was talking with her brother about schoolwork. She replied “no” when asked if she had been drinking alcohol or using drugs that morning or the previous weekend.

1.6.2 School Bus Driver

1.6.2.1 License and driving history. The 57-year-old male school bus driver held a valid Indiana class B commercial driver’s license (CDL), with passenger transport and school bus endorsements, issued on March 4, 2016.²² According to the driver’s license record provided by the Indiana State Police, he had no prior license suspensions, convictions, or crashes. His medical certificate was valid, and there were no medical issues listed on his Commercial Driver Fitness Determination Report (Indiana Code 20-27-8-4). The driver’s record indicated that he had been subject to two preemployment and one random driver alcohol and controlled substance tests; all were negative for tested substances. According to US Department of Transportation (DOT) regulations (49 CFR Part 382), the school bus driver was not subject to postaccident controlled substance or alcohol testing following the October 2018 crash.²³

1.6.2.2 Employment history. The school bus driver was employed by the TVSC as of March 2016. Previously, he was a school bus driver for Greenfield Central School Corporation from March 2015 to January 2016. He had retired in February 2015 after working for a forklift company for 20 years.

1.6.2.3 Training. The school bus driver completed a 2.5-day-long basic bus driver training session as required by the Indiana Department of Education (IDOE) and received his certificate, which was valid until December 31, 2019. (Additional information on IDOE training requirements is provided in section 1.7.4.) The bus driver also completed an in-service safety class required to maintain his certification on August 1, 2018. When, in

²² (a) An Indiana class B CDL permits the operation of any single vehicle with a gross vehicle weight rating (GVWR) of 26,001 or more pounds, or any such vehicle towing a vehicle not in excess of 10,000 pounds GVWR. (GVWR is the total maximum weight that a vehicle is designed to carry when loaded, including the weight of the vehicle itself plus fuel, passengers, and cargo.) The license showed restrictions prohibiting the driving of manual-transmission-equipped vehicles. (b) The driver was operating under Indiana state laws because this trip was an intrastate commerce trip. The state of Indiana has adopted the *Federal Motor Carrier Safety Regulations*. The carrier/driver is subject to alcohol and drug testing requirements (49 CFR Part 382) and CDL requirements (49 CFR Part 383) but is exempt from hours-of-service regulations (49 CFR 390.3(f)(1)). See section 1.7.3 for more information.

²³ The NTSB was unable to determine whether the school bus driver underwent any type of postcrash controlled substance testing. The driver was not disciplined following this crash and remains a TVSC school bus driver.

April 2018, he took over the school bus route on which the crash occurred, he rode with the previous driver 3–4 days to learn the route.

1.6.2.4 School bus driver interview. During his postcrash interview with the state police, the school bus driver said that he was traveling north on SR-25 as usual for the route and when he reached the bus stop, it was like a normal day where “I pull up to my stop, put my stop sign on.”²⁴ He said that he saw a vehicle approaching at a far distance. The bus driver said that he thought the vehicle’s driver would stop; so, after a couple of seconds, he waved to the students waiting in the mobile home area to cross the roadway and board the bus. As the pickup truck got closer, the school bus driver realized that it was not going to stop, and he sounded the bus’s horn.

1.7 Motor Carrier Operations and Regulatory Oversight

1.7.1 Tippecanoe Valley School Corporation

The TVSC operated the school bus. The corporation serves more than 1,780 students at two elementary schools, one middle school, one high school, and one educational center. It operates its own transportation services with 44 active school buses and 26 full-time drivers providing transportation to students in 2 counties and 12 cities, including Rochester.

The TVSC superintendent/transportation director is ultimately responsible for school bus route planning. The TVSC transportation director at the time of the crash had been employed in that position since 2014. Records indicated that he attended a 3-day conference in December 2014 that addressed making safe stops, safe loading and unloading procedures, and school bus crash statistical data but provided little information on risk assessment of school bus stops. The transportation director also attended a school bus driver training course.

The TVSC held its 2018–2019 bus driver orientation meeting on August 1, 2018. The orientation material included information on the universal crossing signal, which the TVSC bus drivers are to use for any student who must cross the highway when getting on or off the bus.²⁵ If the driver perceives danger while students are in the road, the driver is to honk his horn and the students are to return to their original side of the road. Additionally, the orientation meeting detailed the dates for evacuation training and discussed the procedures for crossing a railroad crossing, using bus radio communications, reducing bus idling, and dealing with emergencies while driving, such as tornados or illness. The meeting also provided general school calendar information.

²⁴ NTSB investigators were unable to interview the school bus driver.

²⁵ The universal crossing signal refers to a signal the bus driver should use to signal student pedestrians that it is safe for them to cross the road. The signal used by the TVSC is a two-part gesture. First, the driver should use a thumbs-up to indicate that the situation is safe, and, second, the driver should use the index finger to point in the direction of travel. This signal (or versions with slight variants) is used in school districts across the nation.

The TVSC told NTSB investigators that it had no written policy about school bus drivers' reporting (or forms by which bus drivers could report) motorists who committed a stop arm violation. The TVSC expected drivers to report such violations verbally to the bus garage; however, the TVSC also noted that, if the incident description did not include the violating vehicle's license plate number, no official report could be filed with the sheriff's department. The TVSC also said that, although it had no written policy about reporting safety hazards identified along the school bus route or at a stop, it encouraged its school bus drivers to report such risks to the transportation department.

In her interview with NTSB investigators, the previous driver of the school bus route indicated that no formal system existed for TVSC bus drivers to report when vehicles illegally passed the school bus, or other hazards, such as a dark bus stop.²⁶ She said that some drivers might make a radio report to the garage of an incident, but no records were maintained on such reports. She recalled that, during her last year driving the route, there was one case in which a commercial vehicle had failed to stop for the bus, and the parent of the three children who were killed in the October 30, 2018, crash had complained about it to the school transportation director. The transportation director followed up with the company of the offending commercial driver and was told that the company would reprimand the driver. No route changes were made.

1.7.2 School Bus Route

At the time of the crash, the TVSC maintained 24 bus routes. The crash occurred on the route of school bus #36. Figure 5 shows the route that was to be taken on the day of the crash. The route began at the school bus garage (behind the high school) and then traveled along rural roads until it reached SR-25, where it continued in a northerly direction, making several stops. The bus stop where the crash occurred was number 5 of 18. Of the 18 stops on this route, 10 were at locations that required student pedestrians to cross the road to board the bus.²⁷ In all, 34 student pedestrians on this route were required to cross a road to board the school bus.

²⁶ NTSB investigators interviewed the previous driver of the school bus route on March 28, 2019. She retired in April 2018 after 20 years of driving the crash route.

²⁷ All these crossings, except those in the vicinity of Talma, were on high-speed roadways.

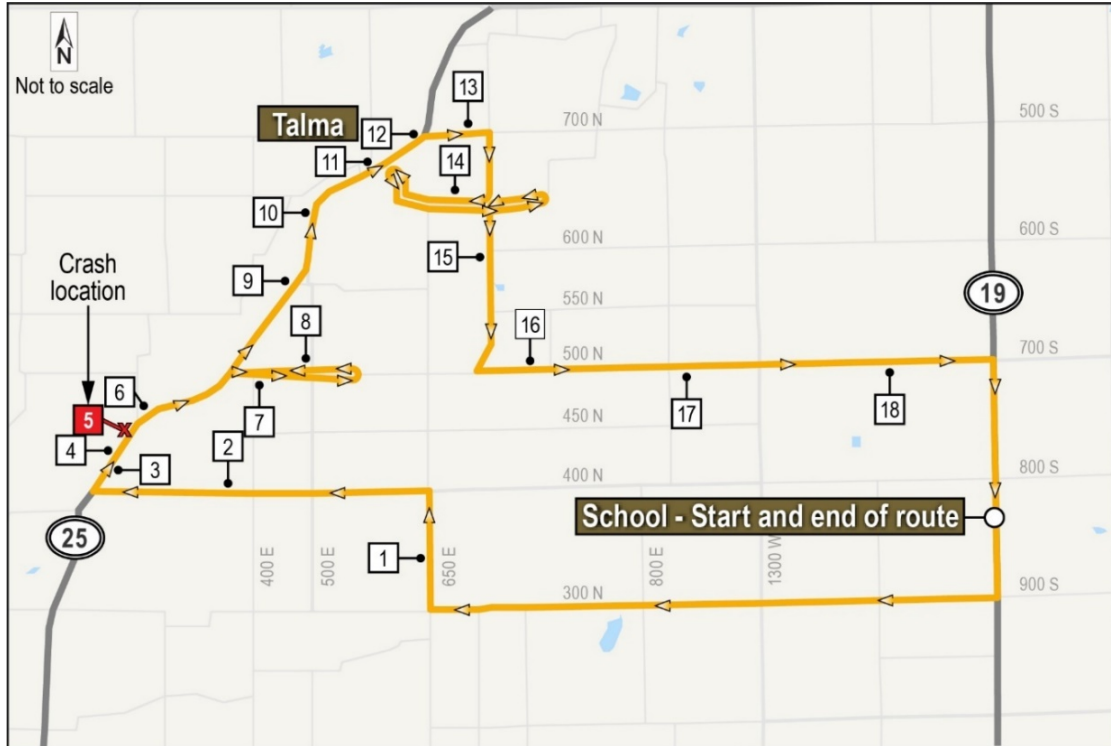


Figure 5. Route of school bus #36 at time of crash. The numbers enclosed in boxes indicate the order of the bus stops, and the dots off each box indicate the side of the road the students were on while waiting for the bus. The crash occurred at stop #5, which is marked in red. (Source: TVSC)

The previous driver of this bus route said that she had inherited the route without changes from the driver before her and that, when she retired, the route for bus #36 was passed to the crash bus driver. Other than changes to the stops required by the periodic changes in the student rider population, the route remained as it had been when the previous driver drove it. Neither the previous driver nor the current driver made any changes to the route. The TVSC told investigators that the school bus route drivers selected the bus stop locations. The previous driver said that, at the beginning of each school year, each driver presented the school corporation with a map of his or her route. According to her, the route map was devised by the drivers, and the school corporation was not involved in route planning or pickup scheduling, other than limiting the lengths of routes to about 25 miles. Alterations to routes were based on the locations of the students' homes and the students' need for school transportation. During her interview, the former bus driver did not clearly indicate whether the TVSC transportation director reviewed the route maps to assess risk.

When asked whether she had considered alternatives to the route to eliminate requiring students to cross the roadway to reach their bus stops, the previous driver explained that such changes would have required some students to board the bus earlier because she would have had to run the route twice—essentially driving the full route in both directions. She also said that she would not have been comfortable pulling into the mobile home park itself to pick up students, because the students would have been coming from their homes from multiple directions to board the bus.

The previous school bus driver and the crash driver similarly described how to stop at school bus stops. They said that the school bus driver should activate the bus's amber lights ahead of the stop and slowly come to a stop. After stopping and ensuring that all traffic was stopped or at such a distance that the vehicles had sufficient time to stop, the driver should activate the bus's red lights, which would automatically extend the stop arm. Once the driver had determined that the students could cross safely, the driver should turn on the bus's interior light and motion to the students to cross the roadway.

According to the TVSC, at the beginning of and throughout the school year, school bus drivers instructed student riders on how to conduct themselves on the bus and how to safely cross the roadway, which included making them aware of the universal crossing signal. The previous school bus driver said that each student was taught to respond to the driver's hand signal and was told not to cross the roadway without the driver's permission.

1.7.3 Indiana State Regulatory Oversight

The school bus trip was an intrastate trip involving the transportation of students from home to school. On this basis, the carrier fell under the jurisdiction of the state of Indiana, which has adopted the *Federal Motor Carrier Safety Regulations*.

Indiana requires all school bus drivers to obtain a physical examination certificate similar to the DOT-required medical exam and certificate required for commercial drivers. Additionally, Indiana school bus drivers must meet physical performance standards including the ability to (1) exit the bus through the service and emergency exit doors, (2) climb and descend the bus service doorsteps, (3) open and close the bus service door from a seated position, and (4) operate the hand controls and steering wheel. The driver of the crash-involved school bus met these standards.

Indiana conducts annual safety inspections of all school buses in the state. Before the crash, school bus #36 had passed a vehicle inspection conducted by the Indiana State Police on April 17, 2018. A postcrash vehicle inspection revealed minor defects, but none related to the operation of the warning lights or stop arm.²⁸

1.7.4 Indiana Department of Education Transportation-Related Training

According to the IDOE, all school bus drivers must complete a transportation basics training course consisting of 2.5 days of classroom training, 8 hours of behind-the-wheel driver training, and 4 hours of observed behind-the-wheel driver training. Upon completion of the course, the drivers receive their certificate, also known as a yellow card. To maintain their certification, drivers are required to complete a safety class annually.²⁹ The school

²⁸ According to the Indiana State Police inspection report, the following violations were found: (1) the trash container is greater than a 14-quart capacity, (2) the trash container is not secured to prevent movement and does not allow for easy removal and replacement, (3) antilock braking system warning light is illuminated, (4) first aid kit is not complete, (5) any front tire has less than 4/32-inch tread depth when measured in any two adjacent major grooves (right outside tread and adjacent tread was 3/32 inch), (6) there are loose items that would create a hazard, and (7) there is no brake certificate, or the certificate has expired or is not signed.

²⁹ The TVSC bus driver orientation meeting meets this requirement.

bus driver training course covers ways to safely serve the route, as well as positioning of vehicles and student management. It does not address school bus route planning or risk assessment of routes.

The IDOE offers training titled “Transportation 101,” which is designed for new school transportation directors. It covers a wide range of school transportation topics, such as school bus driver qualifications, school bus standards, statutes related to school bus transportation, and mechanic qualifications. With the exception of discussing the statutes related to the stop arm and divided highways, making a recommendation to load/unload students as close as possible to the right-hand curb or edge of the roadway, and advising that school bus stops should be reviewed annually, Transportation 101 does not address school bus route or stop risk assessment. According to the IDOE, few (about 1.5 percent) of Indiana’s school districts, charter and nonpublic schools, and Head Start programs requested the Transportation 101 course. There is no record of the TVSC transportation director having attended the course.

1.8 Vehicle Information

1.8.1 Toyota Tacoma Pickup Truck

1.8.1.1 General. The 2017 Toyota Tacoma pickup truck was manufactured in December 2016. Its GVWR was 5,600 pounds, and it had a six-speed automatic transmission and a 3.5-liter, V-6, 278-horsepower gasoline engine. It was equipped with hydraulically power-assisted steering gear. It had an independent suspension system on the steering axle and a non-independent suspension system on the drive axle. It was equipped with a hydraulic, antilock braking system (ABS).³⁰ The steering axle had disc brakes, and the drive axle had drum brakes. Postcrash visual inspection revealed that the brake linings, discs, drums, and ABS wiring were intact and without damage.

In accordance with manufacturer’s specification, the pickup truck was equipped with four 265/70R16 tires, mounted on 16x7J rims. All tread depths were within the minimums recommended for passenger vehicles.

Halogen projector headlamps were mounted on the pickup truck, and it was equipped with Toyota’s Star Safety System.³¹

According to the NHTSA recall database, no recalls had been issued for this vehicle.

³⁰ The pickup truck was not equipped with any automatic emergency braking systems, including PAEB.

³¹ The Toyota Star Safety System includes vehicle stability control, traction control, and an ABS with electronic brake-force distribution, brake assist, and smart stop technology (designed to assist with braking in the event of unintended circumstances, such as when, while driving, the brake and accelerator pedals are pressed at the same time).

1.8.1.2 Damage. The NTSB conducted a postcrash visual inspection and photographed the pickup truck on October 31, 2018. A detailed inspection was conducted on February 12, 2019, after the vehicle had been released by local authorities.

Figure 6 shows the damage the pickup truck sustained during the collision. The leading edge of the hood was displaced rearward, and the center was arched upward. The grille and much of the front bumper covering were missing. The hood was indented to the right of the left headlamp assembly. The left headlamp assembly was crushed. The left front fender was displaced rearward, and the trailing edge of the left fender was contacting the driver's door. The right headlamp assembly was displaced from its mounting location but remained attached to the vehicle. According to photographs taken at the crash site, the headlamps were working after the crash.



Figure 6. Frontal damage to pickup truck.

1.8.1.3 Event data recorder information. The pickup truck was equipped with an airbag control module with the capability to record “event” data and function as an event data recorder.³² According to the vehicle recorder, the pickup truck was traveling at a relatively constant speed of 58–59 mph beginning about 4.8 seconds before module wake-up.³³ (See table 3.) At 2.8 seconds before module wake-up, the accelerator pedal and engine throttle substantially decreased, and vehicle speed began to slightly decrease. Two

³² The term “event” refers to crash data related to activation of supplemental restraints (airbags and seat belt pretensioners).

³³ In this case, module “wake-up” refers to the activation of the restraint control algorithm and approximates the time of impact.

seconds later, at 0.8 seconds before module wake-up, the service brakes were reported as “ON,” and brake fluid pressure began to increase. The accelerator pedal and engine throttle percentages decreased to zero and a rightward steering input was recorded. The reported speed at this time was 55.9 mph. At 0.3 seconds before module wake-up, the brake fluid pressure was recorded at near maximum, the rightward steering input increased, and the vehicle speed decreased to 48.5 mph. At module wake-up, the vehicle speed decreased to 41 mph, the service brake was “ON,” and the rightward steering input decreased. Deployment of the airbags and seat belt pretensioners began 0.053 seconds after module wake-up.

Table 3. Event data recorder information.

Time (seconds before impact)	4.8	4.3	3.8	3.3	2.8	2.3	1.8	1.3	0.8	0.3	Wake-up
Speed (mph) ^a	58.4	59	58.4	58.4	58.4	57.8	57.2	57.2	55.9	48.5	41
Accelerator (percent) ^b	22.0	19.0	19.0	17.0	4.0	5.5	6.5	5.0	0.0	0.0	0.0
Engine throttle (percent) ^c	12.0	10.0	10.0	10.0	1.0	0.5	1.5	1.5	0.0	0.0	0.0
Service brake ^d	off	off	off	off	off	off	off	off	on	on	on
Brake oil pressure (megapascals) ^e	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.47	11.71	9.79
Steering input (degrees) ^f	3.0	4.5	6.0	7.5	7.5	3.0	9.0	9.0	-3.0	-18.0	-3.0

^a Resolution of 1 kilometer per hour (0.6 mph) with the value rounded down for reporting.

^b Percent of full application of the accelerator pedal with a resolution to the nearest one-half of a whole percent and rounded down for reporting.

^c Percent of full application of the engine throttle with a resolution to the nearest one-half of a whole percent and rounded down for reporting.

^d Indicates the status of the brake pedal as reported by the brake lamp switch with the possible values as “on” and “off.”

^e Reports the brake oil pressure at the master cylinder in megapascal units.

^f Measured rotational angle of the steering wheel between +375 degrees and -375 degrees at a resolution of 1.5 degrees with the value rounded down for reporting. Negative numbers indicate a right steering wheel input.

1.8.2 Thomas Built School Bus

1.8.2.1 General. At the time of the crash, the 2015 Thomas Built school bus was stopped at a designated school bus stop to pick up students with its red warning lights on and stop arm deployed.³⁴ The school bus was not involved in the collision.

1.8.2.2 Federal requirements. FMVSS 108 contains the requirements for vehicle lamps, reflective devices, and associated equipment.³⁵ School buses are required to be equipped with two red signal warning lamps on the front of the bus above the windshield, and two red signal warning lamps on the rear of the bus positioned at least above the top of any side window opening. These lights are to flash, and they are to be actuated by a manual switch. Additionally, optional amber lights may be placed at the same height and inboard of the red lamps. The amber lamps must also flash and may be activated by manual or foot operation. The amber lamps must be automatically deactivated and the red lamps automatically activated when the bus entrance door is opened.

FMVSS 131 sets the standards for the stop arm (49 CFR 571.131). It defines a “stop signal arm” (stop arm) as a device that can be extended outward from the side of a school bus to provide a signal to other motorists not to pass the bus because it has stopped to load or discharge passengers. The stop arm is to be installed on the left side of the bus and, when extended, is perpendicular to the side of the bus. Each side of the stop arm must have at least two red lamps, one at the top of the stop arm and the other at the bottom.

The *National School Transportation Specifications and Procedures* (NSTSP), developed by the National Congress on School Transportation (NCST), provide specifications for school buses and operational procedures for states to consider when establishing their standards, specifications, recommendations, and guidelines (NCST 2015). The FMVSSs are incorporated into the document and reiterate the regulations.

1.8.2.3 Exterior lights. NTSB investigators examined the exterior lights (signal warning lights, stop arm, headlamps, brake, and turn signals) of the school bus and found them operational. (See figure 7.) When the red signal warning lights are activated, the stop arm automatically extends from the left side of the bus, just behind and below the driver’s window. The red warning lights automatically turn on when the bus door is opened, or they can be operated manually when the bus door is closed. When the red warning lights are active and flashing, the headlamps alternately flash between high and low beam.

³⁴ The school bus was not equipped with a stop arm camera. A stop arm camera is a device attached to the side of a school bus that is used to photograph vehicles that pass the bus when it is stopped to load or unload passengers. The recorded information is often used to assess traffic citations. Since the October 2018 crash, the TVSC has installed stop arm cameras on its entire school bus fleet.

³⁵ Title 49 CFR 571.108 refers to the amber and red lights as “warning lamps.” Common terminology refers to these as “lights.” The terms “warning lamps” and “warning lights” are used interchangeably in this report.



Figure 7. On-scene postcrash view of school bus with lights in operation. (Source: Indiana State Police)

1.9 Weather and Astronomical Data

Weather data for October 30, 2018, were obtained from weather station KSBN in South Bend, Indiana, about 45 miles from the crash site. At 6:54 a.m., a few minutes before the pickup truck struck the students, the station reported a temperature of 49° F, cloudy conditions, winds from the south-southeast at 12 mph, and no precipitation. Astronomical data from the US Naval Observatory reported that, for that day, sunrise was at 8:13 a.m. and civil twilight began at 7:45 a.m.³⁶

1.10 Witness Statements

1.10.1 Occupants of Vehicle Behind Pickup Truck

The driver of a vehicle that was traveling south behind the pickup truck stated that, as she approached the crash location, she first observed the lights of the stopped school bus through a cluster of trees as she traveled through a curve. She said that she was driving about a car length behind the pickup truck, and no cars were behind her. She saw that the school bus was stopped with its red lights flashing, and several small children were crossing

³⁶ Civil twilight is the period preceding sunrise when the sun is about 6 degrees below the horizon but there is sufficient natural light to engage in typical outdoor activities without artificial lighting.

the road to board the bus. A passenger in her vehicle said that he had seen the bus's stop sign (stop arm) come out. The witness said that, upon seeing the stopped school bus, she slowed her vehicle to a stop, but the pickup truck did not appear as if it were going to stop.

She described the lighting conditions as dark. She said that she could see the children because they were illuminated by the headlamps of the pickup truck in front of her. The bus's red lights were flashing, and a white light was flashing on the top of the school bus. The driver indicated that, upon seeing the bus, she immediately recognized it as a school bus.

1.10.2 Driver of Vehicle Behind School Bus

The driver of a vehicle traveling north behind the school bus said that he had been following the school bus and that it had made a few stops before reaching the crash location. When the bus stopped, he stopped his vehicle behind it. He said that the stopped school bus had its red lights on and its stop arm extended. He said that he could see the pickup truck in the southbound lane traveling fast as it approached, and he saw it hit the children. He called 911.

1.10.3 Parent and Student at Bus Stop

The parent and one of the students who were waiting for the school bus said that the group was standing behind the fence that ran between the roadway and the mobile home park. They said that they identified the school bus from the bright white light on its roof, and that they could see the bus approaching from the right (south). They saw the bus stop with its red lights flashing and stop arm extended. They said that the bus's interior light was also on, and that they could see the driver wave from the driver's seat to signal the students to cross the roadway. They said that it was difficult for them to see traffic coming from the left (north) from where they were standing because a mobile home blocked the view. They said the southbound pickup truck "came out of nowhere." They recalled the school bus driver honking his horn but also noted that lots of horns are honked in the morning by motorists waiting for the stopped school bus to move.

1.11 Postcrash Actions

1.11.1 TVSC Postcrash Improvements

Following the collision, the TVSC altered the portion of the school bus route for school bus #36 on SR-25 to facilitate the loading and unloading of students on the right side of the bus, so that students would not have to cross the roadway to board the bus. A transportation safety review committee, consisting of members of three local school corporations (Rochester County, Kosciusko County, and Caston County), local law enforcement officials from the FCSO and the Kosciusko County Sheriff's Office, and personnel from the Kosciusko County Highway Department, was formed to discuss the safety issues regarding student transportation. The committee reviews local school bus routes and implements the new safety standards that were established as a result of the Rochester crash. Following the committee's recommendations, the TVSC modified its

school bus routes so that no student crosses a state highway to board a school bus. According to the TVSC transportation director, the TVSC has also reduced from 300 to 136 the number of school bus stops that require students to make any roadway crossing. In addition, the TVSC has purchased and installed stop arm cameras for its entire fleet of regular route school buses. The TVSC told the NTSB that its students' parents will receive a handout on the universal crossing signal.

1.11.2 Indiana Senate Bill 2

In May 2019, the governor of Indiana signed into law Senate Bill 2 (P.L. 144-2019), also known as the MAX Strong law), which contains many provisions to improve the safety of students when boarding or disembarking from a school bus. The new law makes the following enhancements to school transportation practices:

- Increases penalties for drivers passing a stopped school bus with the stop arm deployed.³⁷
- Prohibits school bus drivers, when operating on a US or state route (unless within the boundary of a city or town), from loading or unloading students at a stop which requires the student to cross a roadway unless no other safe alternatives are available.
- Authorizes schools to petition their counties for reimbursement of stop arm camera equipment.
- Requires school corporations to review school bus routes and school bus safety policies annually.
- Requires the state school bus committee to develop and post on the IDOE website school bus safety guidelines or best practices to include procedures to ensure that students do not enter a roadway until approaching traffic has come to a complete stop and information on how an individual or school may petition to reduce maximum speed limits to ensure student safety.³⁸

1.12 Other NTSB Investigations

The NTSB investigated two other fatal pedestrian crashes in 2018 involving illegal passings of school buses stopped to load or unload passengers. In both cases, the school

³⁷ Illegally passing a stopped school bus is now considered a class A misdemeanor (increased from a class B misdemeanor) punishable by up to 1 year in prison and a fine of up to \$5,000. Illegally passing a stopped school bus and injuring someone is a level 6 felony (increased from a class A misdemeanor), punishable by 6 months to 2.5 years in prison and a fine of up to \$10,000. Illegally passing a stopped school bus and killing someone is a level 5 felony carrying a 1- to 6-year prison sentence and up to \$10,000 in fines. Citations can be issued based on police witness or stop arm camera evidence.

³⁸ The information concerning the new law is from the following webpage: [Indiana Senate Bill 2 \(MAX Strong law\)](#), accessed January 27, 2020.

bus route required students to cross high-speed roadways to board the bus. These crashes occurred in Hartsfield, Georgia, and Baldwin, Mississippi.

1.12.1 Hartsfield, Georgia

On Thursday, October 25, 2018, at 6:45 a.m., a school bus operated by the Colquitt County School District was traveling north in the 1000 block of Thigpen Trail, also known as State Route 202, in Hartsfield, Colquitt County, Georgia. At this location, Thigpen Trail is a two-lane, two-way asphalt roadway bordered by farms and agricultural fields; it has a posted speed limit of 55 mph. The school bus driver stopped the bus at a designated student pickup location and activated the bus's warning lights, which deployed the stop arm. Two pedestrians, a 7-year-old male and a 10-year-old male, began to cross the roadway to board the stopped bus, which was on the opposite side of the road. At the same time, a 2008 Kia passenger car, operated by a 25-year-old female, was traveling south on Thigpen Trail. The Kia driver failed to stop for the school bus and struck both pedestrians while they were crossing the southbound lane. The 10-year-old pedestrian died. The 7-year-old pedestrian sustained serious injuries. The Kia driver was not injured.³⁹

1.12.2 Baldwin, Mississippi

On Wednesday, October 31, 2018, at 6:36 a.m., a school bus operated by Baldwin School District was traveling east on Mississippi State Highway 370 (MS-370) in Baldwin, Lee County, Mississippi. At this location, MS-370 is a two-lane, two-way roadway with a posted speed limit of 55 mph. The school bus driver stopped the bus, with its warning lights activated and stop arm extended, at a designated student pickup location. A 9-year-old male pedestrian entered MS-370 from the north side and began crossing the westbound traffic lane with the intention of boarding the stopped school bus, which was on the opposite side of the road from him. At the same time, a 2002 Toyota Tacoma pickup truck, operated by a 22-year-old male driver, was traveling west on MS-370. The pickup truck driver did not stop for the school bus and struck the pedestrian as he was crossing the westbound traffic lane. The student pedestrian died from injuries received during the collision. The pickup truck driver was not injured.⁴⁰

1.13 Data on School Transportation-Related Crashes and Illegal Passings

NHTSA reports that, from 2008 to 2017, a total of 264 school-age (18 and younger) children were killed in school transportation-related crashes (NHTSA 2019b). Ninety-seven (37 percent) of the school-age children were pedestrians, 61 (23 percent) were occupants of school transportation vehicles, 100 (38 percent) were occupants of other vehicles, 5 were pedalcyclists (2 percent), and 1 (<1 percent) was another nonoccupant.⁴¹

³⁹ Additional information about the investigation of the Hartsfield crash can be found by accessing the [Docket Management System](#) and searching for NTSB case number HWY19IH004.

⁴⁰ Additional information about the investigation of the Baldwin crash can be found by accessing the [Docket Management System](#) and searching for NTSB case number HWY19IH005.

⁴¹ The term "pedalcyclist" is synonymous with bicyclist or cyclist.

Of the 97 school-age pedestrians killed in a school-transportation-related crash, 53 (55 percent) were struck by school buses, 1 (1 percent) by vehicles functioning as school buses, and 43 (44 percent) by other vehicles involved in the crashes.

In all 50 states, it is illegal to pass a school bus that is stopped to load or unload passengers with its red lights flashing and stop arm extended. This law applies to traffic approaching from either direction on undivided highways. State laws vary about what action is required by motorists on a divided highway and what constitutes a divided highway.

Since 2011, the Kansas State Department of Education (KSDE), with assistance from the National Association of State Directors of Pupil Transportation Services (NASDPTS), has been collecting data through 1-day observational surveys to determine the prevalence of illegal passing of school buses (KSDE 2019). In the 2019 effort, 39 states participated, and they reported that 95,319 vehicles illegally passed school buses on a single day. Based on these numbers, the NASDPTS estimated that more than 17 million vehicles illegally passed school buses in a 180-day school year (NASDPTS 2019a).

For several years, the KSDE has been tracking school bus fatalities across the United States resulting from passenger loading and unloading (KSDE 2019). During the past 49 years, 1,252 students were killed while loading or unloading a school bus. Of these, 492 involved a motor vehicle passing a school bus and striking a student, 706 involved a school bus striking a student, and 54 were undetermined or due to “other” circumstances.

Seven loading/unloading school bus fatalities involving approaching vehicles occurred during the 2018–2019 school year. In addition to the three fatalities in Rochester, the fatality in Baldwin, Mississippi, and the fatality in Hartsfield, Georgia, the KSDE reported two additional fatalities involving oncoming vehicles, one in Maryland and one in Missouri. In the Maryland crash, a 16-year-old male student was running to catch a bus and was struck by an oncoming vehicle as he crossed the road. He died as a result of the crash. The school bus had its eight-way amber lights activated, but the stop arm was not extended. In the Missouri crash, an 8-year-old female was struck by an oncoming vehicle as she crossed the road to board a stopped school bus with its red lights activated and stop arm deployed. She died as a result of the crash.

2 Analysis

2.1 Introduction

A 2017 Toyota Tacoma pickup truck operated by a 24-year-old female driver was southbound on SR-25, a two-lane roadway, in Rochester, Indiana, at 58–59 mph. The pickup truck driver failed to stop for a school bus as required by Indiana state law and struck four children who were crossing the southbound lane to get to their waiting school bus on the opposite side of the road.⁴² The school bus was stopped in the northbound lane of SR-25 with its red lights flashing and stop arm deployed. As a result of the crash, three children died, and one child sustained serious injuries.

The analysis portion of this report first discusses factors that could be excluded as not causing the crash or contributing to the severity of its outcome. Then, it addresses the pickup truck driver's failure to respond to the warning cues of the stopped bus or to take action until it was too late to avoid striking the student pedestrians (section 2.2). The following safety issues are also discussed in the analysis:

- Deficiencies in establishing safe school bus routes and stop locations (section 2.3).
- Failure of other drivers to stop or otherwise respond safely when approaching a school bus that is stopped with its warning lights on and stop arm extended (section 2.4).
- Need for greater use of technologies to prevent collisions with, and mitigate injuries of, student pedestrians, including vehicle-to-everything (V2X), PAEB, and school bus safety-enhancing technologies (section 2.5).

As a result of its analysis, the NTSB established that the following factors did not cause or contribute to the crash:

- ***Mechanical condition of the pickup truck.*** Postcrash examination of the pickup truck did not reveal any preexisting mechanical defects or deficiencies in its mechanical and operational systems. The steering system, suspension system, braking system, and tires and wheels were operational at the time of the crash. The headlights of the pickup truck were operational and, according to the pickup truck driver and others in the vicinity, the lights of the pickup truck were on at the time of the crash.

⁴² The driver made a brake application between 1.3 and 0.8 seconds before impact. At 0.8 seconds before impact, the vehicle speed was 55.9 mph. At the time of impact, the recorded vehicle speed was 41 mph.

- ***Operation of the school bus warning lights and stop arm.*** Postcrash examination of the school bus and its maintenance records did not reveal any mechanical defects or deficiencies related to the operation of the bus's warning lights or stop arm. The warning lights and stop arm were in operating condition and in compliance with federal regulations. Witness statements from drivers of vehicles following the school bus, as well as those approaching the bus, indicated that its warning lights were on and its stop arm was extended.
- ***School bus driver licensing and training.*** The school bus driver held a valid CDL with the correct endorsements for passengers and school bus operations. The bus driver had received formal training for his school bus certification from the state of Indiana. Additionally, he had completed annual in-service training to maintain his certification. Before taking over this school bus route in April 2018, he drove the route with the previous driver. He had been driving for the TVSC since March 2016, and he had no crashes on his school bus driving record.
- ***Pickup truck driver licensing.*** The pickup truck driver had held a valid Indiana driver's license since 2011. Her current license was valid until 2021. Records indicate that the driver had been involved in a property-damage-only accident in 2014. She had no other records of traffic violations.
- ***Pickup truck driver alcohol and controlled substance impairment.*** Following the crash, the pickup truck driver underwent alcohol and controlled substance testing. Test results were negative for alcohol and all other drugs tested for.
- ***Pickup truck driver medical condition and vision.*** A review of medical records did not show any evidence of medical or vision conditions that would have negatively affected the driver's performance. The pickup truck driver had a corrective lens restriction on her license, and she testified that she was wearing glasses when the crash occurred.
- ***Cell phone use.*** The results of the FCSO's forensic examination of the pickup truck driver's cell phone and her cell phone records provided no evidence that she had been texting or talking on the phone at the time of the crash. The forensic examination found that an application on the phone was active, but there was no conclusive indication that the phone was being manipulated. The driver said the phone was on the center console at the time of the crash.
- ***Actions/behavior of the student pedestrians and the adult pedestrian.*** The student pedestrians remained behind the fence between the mobile home park and SR-25 until the bus arrived and stopped. The adult pedestrian gathered the student pedestrians together as the bus approached. The students did not begin to cross the roadway until waved onward by the school bus driver. Given the information that they had, they acted appropriately in crossing when they did.

On the basis of this information, the NTSB concludes that none of the following were factors in this crash: (1) mechanical condition of the pickup truck or condition of the school bus warning light and stop arm systems; (2) school bus driver licensing; (3) pickup truck driver licensing, drug or alcohol impairment, medical condition, vision, or cell phone use; or (4) actions/behavior of the student pedestrians or the adult pedestrian.

The NTSB considered whether fatigue on the part of the pickup truck driver or the school bus driver might have affected this crash. No information was available on the sleep histories of the two drivers. Only limited information was available concerning their daily activities. With respect to the pickup truck driver, her cell phone records showed that, in the 3 days preceding the crash, she did not send or receive any texts or calls during the nighttime hours. Just moments before the crash, the driver successfully navigated a curve in the roadway, and she applied the brakes before the collision. The driver of the vehicle traveling south behind the pickup truck did not report any unusual driving behavior on the part of the pickup truck driver before the crash. The available information concerning the school bus driver indicates that he was actively engaged with his driving and related tasks on the morning of the crash. Preceding the crash, he activated the bus lights and stop arm, and he waved the student pedestrians across the roadway. The NTSB concludes that there is insufficient information to determine whether the school bus and pickup truck drivers were fatigued in the period leading up to the crash.

The first 911 call reporting the crash was received at 7:15:25 a.m.; about 6 minutes later, the first medical help arrived on scene. The Rochester Fire Department, Lutheran EMS, Mentone Fire Department, and medical helicopters provided by Parkview Samaritan Medical Transport all assisted in the response. A medical helicopter transported the seriously injured student pedestrian to a medical facility in Fort Wayne, Indiana. The NTSB concludes that the emergency response to the crash was timely and effective.

2.2 Pickup Truck Driver Response

The pickup truck driver did not stop for the stopped school bus on SR-25, as required by state law. The school bus driver had stopped his bus in the northbound lane of SR-25, activated its warning lights, and extended its stop arm. As the pickup truck driver was traveling south on SR-25, she passed a Watch For School Bus sign, as well as signs warning of curves.

When speaking to the Indiana State Police after the crash, the pickup truck driver said she saw a vehicle ahead but did not recognize it as a school bus, despite the activated warning lights and extended stop arm. Specifically, in her interview with the police, she said, “I didn’t see a stop sign—like usually when I see a bus, I like see a stop sign.” She said she tried to stop her vehicle when she saw the children crossing the road to board the school bus.

Other drivers approaching the crossing area said that they saw the activated lights and stop arm on the school bus. The driver of the vehicle traveling south behind the pickup truck said that she saw the school bus with its flashing lights and stop arm. Her passenger indicated that he had seen the bus’s stop sign (stop arm) come out. A driver in a vehicle

traveling north behind the school bus recounted that he saw the bus's red lights and stop arm.

All available evidence shows that the school bus's headlamps and flashing red warning lights were on and would have been noticeable in the dark. Before exiting a curve north of the collision site, the pickup truck driver had an unobstructed sight distance of at least 1,185 feet in which to see the stopped school bus with its flashing red lights. If the pickup truck driver had maintained an average speed of 58–59 mph, as indicated by the recorded data, the school bus would have been within the driver's unobstructed line of sight for 14.0–14.6 seconds.

According to the parent who was waiting with the student pedestrians at the mobile home park before the crash, while waiting for the bus, the student pedestrians were standing in an unlit area away from the roadway. Dark conditions and their position off the roadway would have initially reduced the pickup truck driver's ability to see the pedestrians, until they approached the roadway. The pickup truck driver most likely did not become aware of the pedestrians until they were beginning to cross the roadway. This scenario is consistent with the recorded event data, which show that the driver began braking less than 1.3 seconds before impact, while the vehicle was less than 100 feet from the crash location.⁴³ The brake application made at this time and at this distance from the pedestrians could not stop the vehicle in time to avoid colliding with them.

The pickup truck driver failed to respond appropriately to the warning lights, or to the school bus itself; however, it is not clear why she failed to respond. With respect to the school bus, the driver reported observing the warning lights but said that she did not identify the vehicle as a school bus and that she did not see a stop sign (stop arm) on the bus, so she did not attempt to stop until she was about 100 feet from the crash location. There is no evidence that she was distracted at the time of the crash by cell phone use, her children asleep in her vehicle, or her conversation with her brother. It was early in the morning and dark when the crash occurred, which limited her ability to see the student pedestrians approaching the roadway. Her activities that morning were not routine, and, although she frequently drove on SR-25, she was not typically on the road in the morning hours, when school buses are on the road. The NTSB concludes that for reasons that cannot be determined from the available evidence, the pickup truck driver did not respond to the activated warning lights and stop arm of the school bus, and she did not attempt to stop her vehicle until she saw the students in the roadway.

2.3 Enhancing Safety of School Bus Routes and Stops

2.3.1 School Bus Routes and Stops

2.3.1.1 Crossing risks posed by high-speed roadways. In the Rochester collision, the school bus route included a bus stop that required the students to cross a roadway with a 55 mph posted speed limit to board the bus. Seconds before the pickup truck struck the student pedestrians, it was traveling at a speed of 58–59 mph. The students were waiting

⁴³ The event data recorder recorded data at intervals of 0.5 seconds.

for the bus in the dark, which is common in the United States, given that much of the school year takes place in months with fewer daylight hours. The 2018 collisions that the NTSB investigated in Baldwyn, Mississippi, and Hartsfield, Georgia, were similar in that they also occurred in the dark early morning hours and involved students crossing high-speed roadways to board a school bus.⁴⁴

In 1989, the Transportation Research Board (TRB) published a report on improving school bus safety (TRB 1989). In the chapter dedicated to “measures to prevent school bus and pedestrian accidents,” the TRB pointed out that the potential for pedestrian crashes can be reduced by improving the locations of school bus routes and stops. It also presented three basic principles that school districts should follow: (1) do not require school buses to back up on their routes, (2) locate stops to minimize traffic disruptions and give the driver a good field of vision, and (3) locate stops to minimize the need for students to cross in front of the bus, especially on busy highways.

The state of New York established route and bus stop guidelines in 1992 (Madison-Oneida Board of Cooperative Education Service 1992). The guidance included a discussion of the dangers of crossing a roadway to board a bus, recognizing that “Crossing the road is the most hazardous aspect of riding a school bus and it should be eliminated whenever and wherever possible.”

With funding from NHTSA, the National Center for Safe Routes to School and the Pedestrian and Bicycle Information Center (2010) developed a guide for determining school bus stop locations. The guide recommended that school bus stops be placed to “minimize the need for students to cross a road from the stop to the bus, regardless of the type of roadway.” The guide further suggested picking a bus stop location that offers adequate lighting whenever possible. The National Safety Council (NSC) also has noted that school bus routes should be planned to minimize walking across public highways and should enable the bus driver to pick up and drop off students on their own side of the street, if possible (NSC 2008).

In 1995, the NTSB investigated the collision of a train with a school bus that was stopped on a railroad/highway grade crossing in Fox River Grove, Illinois (NTSB 1996). The NTSB issued Safety Recommendation H-96-52 to the NASDPTS asking the organization to encourage its members to develop and implement a program for the identification of school bus route hazards and to routinely monitor and evaluate all regular and substitute bus drivers. The recommendation was “Closed—Acceptable Action.” With a grant from NHTSA, the NASDPTS generated a checklist of school bus route hazards,

⁴⁴ Information about the investigation of the Baldwyn crash can be found by accessing the [Docket Management System](#) and searching for NTSB case number HWY19IH005; the Hartsfield crash investigation is under NTSB case number HWY19IH004.

focusing on driving hazards (NASDPTS 1998).⁴⁵ The checklist has been adopted by the NCST and is included in the NSTSP (NCST 2015).

The NSTSP also contains a section on routing and scheduling that includes a list of factors (such as visibility) to consider when planning a school bus route and locating a stop. Specific information pertaining to highways divided into separate roadways and highways with three or more marked traffic lanes states that—

Fleet operators, schools and Head Start Centers should design bus routes that service each side of the highway so students do not have to cross the highway unless there is a traffic control signal or an adult crossing guard within 300 feet of the bus stop to assist students while crossing such multiple lane highways.

Based on longstanding safety guidance, as well as the crash investigations discussed in this report, the NTSB concludes that requiring students to cross a roadway, regardless of the number of lanes, presents a risk of pedestrian death or injury because motorists do not always stop, as required, for school buses, even when a bus is at a bus stop with its lights flashing and stop arm extended.

2.3.1.2 Assessing school bus routes and stops for risks. Following the passage of Senate Bill 2 in Indiana, the IDOE updated its *School Bus Safety Guidelines and Best Practices* (IDOE 2019). The document now states that, for bus stops on US or state routes (highways), outside the city limits, students will no longer be required to cross the street to board the bus, unless no safe alternatives are available. If no safe alternative exists and an elementary student must cross the highway to board the bus, the school board must approve having a crossing at that location. In compliance with Senate Bill 2, the TVSC changed the crash bus route and other school bus routes so that no student in the TVSC's jurisdiction must cross a state highway to board (or disembark from) a school bus. In addition, the number of roadway crossings (of any kind of road) within the TVSC jurisdiction decreased from 300 to 136.

Indiana's Senate Bill 2 also required school districts to review school bus routes and safety policies annually. It is common for school bus routes to be used year after year and passed on from driver to driver without being reassessed for safety. In the TVSC, the school bus route where the collision occurred had been in service for several years, although the individual stops may have changed due to student turnover. It should be noted that, although the route itself may not change, the specific stops and environments of the stops may change and become less safe. According to the NSTSP, routes should be reviewed periodically to identify factors that might necessitate a route change. The NTSB concludes that periodically evaluating school bus routes and stops for hazards can reduce the safety risks to student pedestrians. Therefore, the NTSB recommends that the

⁴⁵ The NASDPTS defined "driving hazards" as those hazards that are encountered while operating a school bus route, such as railroad grade crossings and industrial intersections. School bus loading zone hazards include hazards that are encountered at a school bus stop, such as a narrow, busy street without sidewalks or dangerous curves that do not provide the school bus driver, the students, or other motorists with an adequate view of the school bus loading zone.

NASDPTS, National Association for Pupil Transportation (NAPT), and National School Transportation Association (NSTA) inform their members of the circumstances of the Rochester, Indiana; Baldwyn, Mississippi; and Hartsfield, Georgia, crashes, and urge them to minimize the use of school bus stops that require students to cross a roadway (especially a high-speed roadway) and to, at least annually, and also whenever a route hazard is identified, evaluate the safety of their school bus routes and stops.

2.3.1.3 Training to reduce school bus route and stop hazards. The IDOE is the agency responsible for developing training for school bus drivers and transportation directors in Indiana. The IDOE course “Transportation 101” is designed to be taken by school transportation directors. This course covers a multitude of topics, including school bus driver requirements, school bus mechanic requirements, and various safe bus operating definitions, but it does not contain specific information about assessing the safety of school bus routes or identifying hazards at school bus stops. The NTSB concludes that the existing IDOE training for school transportation directors does not contain sufficient information on assessing the safety of school bus routes or identifying hazards at school bus stops. Therefore, the NTSB recommends that the IDOE supplement its training program for school transportation directors with a module on how to assess the safety and risks of school bus routes and stops, according to best industry practices. At present, only 1.5 percent of all Indiana school districts/charter schools and nonpublic schools/Head Start programs have requested the course Transportation 101 for their transportation directors. Consequently, the NTSB also recommends that the IDOE require local school transportation directors and others involved in evaluating school bus routes and stops in Indiana to complete the training module on the safety and risks of routes and stops recommended in Safety Recommendation H-20-13 (above).

The NTSB also concludes that the routing hazards evident in the recent Hartsfield, Georgia, and Baldwyn, Mississippi, crashes suggest that inadequate school bus routing may be a widespread problem. Further, the NTSB concludes that the TVSC’s inadequate safety assessment of school bus routes resulted in bus stops that required students to cross a high-speed roadway, placing them at risk. Therefore, the NTSB recommends that the NASDPTS, NAPT, and NSTA remind their members to ensure that school transportation directors and others involved in evaluating school bus routes and stops complete training on how to assess the safety of school bus routes and stops, according to best industry practices.

2.3.1.4 Evaluating and tracking safety risks associated with school bus routes and stops. Training school transportation personnel to assess routes and stops effectively is only the first step in improving their safety. To be of optimum value, assessments should take place recurrently, and all available information should be collected to make the assessments as comprehensive as possible. The TVSC had no written policy on when or how to report safety incidents, such as illegal passings, or identified route hazards, such as a dark bus stop. Although drivers could report incidents to the garage, no records of such reports were maintained. The NSC suggests that school bus drivers should examine their stops regularly and report unsafe conditions to the transportation supervisor (NSC 2008). Although school bus drivers are in the best position to identify any hazards associated with the routes they drive every school day, parents and caregivers who accompany their

children to a bus stop also have opportunities to observe risky behaviors or conditions. Therefore, the NTSB concludes that creating a mechanism by which school bus drivers and parents (or caregivers) of student riders could report safety concerns about bus operations would provide an additional source of information that could be used to improve the safety of school bus routes and stops. The NTSB recommends that the TVSC implement a process to track school bus driver and parent (or caregiver) complaints regarding the safety of school bus routes and stops, as well as any other safety concerns about bus operations, from initial submission of an issue to its resolution.

2.3.2 Roadway Crossing Procedures

The school bus driver said that, on the day of the collision, he pulled up to the stop with his bus's amber warning lights on, and he activated the bus's red warning lights, which extended the stop arm. He saw headlights in the distance but still waved the students on to cross the street, believing that the oncoming vehicle was sufficiently far away and expecting that it would stop before reaching the crossing area.

The students waited for the school bus behind the fence between the road and the mobile home park. From that location, they would have had a clear line of sight to the school bus's northbound approach on SR-25, as well as to the bus when it was stopped across the road. Their line of sight toward the southbound traffic and the approaching pickup truck, however, would have been restricted by the mobile homes and foliage north of their location until they had progressed through the clear zone and were nearer the roadway. Although their line of sight to the approaching pickup truck would have improved as they moved toward the highway, it is likely that, once near the highway, the students' focus would have been on the stopped school bus and its driver.

Although routes that require students to cross a road to board or disembark from a school bus create safety risks, there may be circumstances where alternative routes are not feasible. NHTSA maintains a *School Bus Driver In-Service Safety Series* training program designed for experienced school bus drivers (NHTSA 2011). The training module from this series on "Loading and Unloading for School Bus Drivers" says that students should wait for the driver to signal them to cross. When the driver signals that it is safe to cross, the student should first check for traffic, and then cross at a position in front of the bus and make eye contact with the school bus driver. NHTSA also suggests that drivers establish a special horn signal to be used to warn of danger and indicate that student pedestrians should "return to the side of the road [they] started from—AT ONCE." The NHTSA training further states that school bus drivers should ensure that student pedestrians know both the hand signal indicating that it is safe to cross and the horn signal indicating danger.

NHTSA's guidance is similar to the universal crossing signal guidance that the TVSC provided to its school bus drivers at the August 2018 driver orientation. The 2018 orientation training did not specify that all the traffic must be stopped before signaling students to cross; instead, it stated that, before signaling students to cross, the school bus driver should be sure that "traffic is controlled." Since this crash, in Indiana Senate Bill 2, Indiana has clarified its crossing safety policy to ensure that students crossing a roadway to board a stopped bus do not enter a roadway until approaching traffic has come to a

complete stop. The NTSB concludes that, the TVSC's policy at the time of the crash, which required school bus drivers to determine subjectively when surrounding traffic was "controlled," left its bus drivers with insufficient information to make a safe determination about when to signal students to cross a roadway to board a school bus, placing students at risk.

The school bus driver said that, on the day of the crash, when he perceived the pickup truck's approach as a hazard to the student pedestrians, he honked the school bus horn to warn them. This action is in accord with the universal crossing signal and NHTSA's guidance to indicate danger—intended to prompt student pedestrians to return to their point of origin on the side of the road. However, witnesses said that they frequently hear horns in the morning near the bus stop and did not necessarily associate the honking horn with danger, nor with the need for crossing students to return to the side of the road.

Although it appears from the circumstances of the crash that the student pedestrians were aware that they should wait until signaled by the school bus driver to cross the road, it is not clear whether they understood what to do when the driver sounded his horn. Also, although at the time of the crash, the driver was not trained to withhold the signal to cross until all approaching vehicles had stopped, since the adoption of Senate Bill 2, no Indiana school bus driver should now make the "safe to cross signal" until all vehicles have stopped. The NTSB concludes that, in circumstances when a student roadway crossing cannot be avoided, the school bus driver must be knowledgeable of, and consistent when making, crossing and warning signals, and students must be aware of, and understand, the crossing and warning signals the driver makes. Therefore, the NTSB recommends that the TVSC train its school bus drivers and students on crossing procedures, including the crossing hand signal and the danger signal, which are to be used when a student roadway crossing cannot be avoided. The NTSB further recommends that the NASDPTS, NAPT, and NSTA advise their members to train their school bus drivers and students on crossing procedures, including the crossing hand signal and the danger signal, which are to be used when a student roadway crossing cannot be avoided.

2.4 Modifying Driver Behavior Near School Buses

According to NASDPTS estimates, more than 17 million illegal school bus passings take place every school year. Even though it is illegal in all 50 states to pass a school bus that is stopped to load or unload passengers with its red lights flashing and stop arm extended, such illegal passings are taking place with dangerous frequency and putting children at daily risk.⁴⁶ Therefore, the NTSB concludes that, although it is illegal in all 50 states, NASDPTS data show that the passing of stopped school buses by other vehicles remains a pervasive and continuing safety issue in the United States.

A driver may fail to stop for a stopped school bus for many reasons, including not knowing the law, not knowing that it applies to traffic in both directions, being distracted

⁴⁶ Following the Rochester crash, the Stop for School Buses Act of 2019 was introduced into Congress in April 2019 (H.R. 2218 and S. 1254). It proposes that the Secretary of Transportation research the significant safety measures and programs to prevent the illegal passing of school buses.

while driving, being unaware of the potential risk of striking a child, or simple impatience. NHTSA is in the early stages of a demonstration project to prevent illegal passing of school buses. One of the objectives of the project is to assess drivers' levels of comprehension of state laws regarding passing of stopped school buses.⁴⁷

NHTSA suggests a two-pronged approach to reducing illegal passings of school buses: education and enforcement.

2.4.1 Education Efforts

There is no shortage of published service announcements or educational information on the dangers of illegally passing a stopped school bus, the state laws pertaining to illegal passings, and the penalties associated with such violations. For example, in October 2019, NHTSA issued a news release, "Back to School Safety Tips for All Drivers, Students and Parents," which included a video showing drivers how to slow with the amber lights, stop on the red lights, and, in general, be careful when driving near a school bus (NHTSA 2019a). NHTSA also maintains an electronic repository of school bus safety materials in its traffic safety "marketing" materials.⁴⁸ The NSC publishes a back-to-school safety tip sheet for drivers (NSC 2020). The American Academy of Pediatrics (2019) has a video on teaching children about safety on a school bus and reminds drivers to be cautious when driving near a school bus. Moreover, many school districts, law enforcement agencies, and state departments of education and transportation have developed public service announcements, posters, or other printed materials to inform motorists of the dangers of illegally passing a stopped school bus.⁴⁹

State driving manuals provide additional information. In Indiana, the driver's manual tells learning drivers that they must stop when approaching (from either direction) a stopped school bus with its red lights activated and stop arm extended. It warns drivers to be cautious when approaching a school bus and to stop to watch for children congregating near the stop or who may dart into the street to get on the bus. The driving manuals for Georgia and Mississippi contain similar information. At a minimum, state driving manuals provide basic information on state laws regarding the restrictions against passing a stopped school bus with its lights flashing and stop arm extended (NASDPTS 2019b). New York is revising its driver's curriculum to enhance its coverage of school bus safety.⁵⁰

Each year, National School Bus week is held in the third week of October, hosted by the NAPT, NSTA, and NASDPTS. Typically, there is a surge of activity during this

⁴⁷ The project is also intended to evaluate current stop arm violation initiatives at the state and local level, enhance the *Reducing the Illegal Passing of School Buses Best Practices Guide*, and test the comprehensive implementation of those best practices through a field study to examine the effectiveness of automated school bus camera enforcement.

⁴⁸ For more information, see [NHTSA safety marketing material](#) webpage, accessed January 27, 2020.

⁴⁹ For example, the Montgomery County, Maryland, Police Department and the KSDE have developed such items.

⁵⁰ In 2019, [New York State Senate Bill 2960B](#) amended [§502, Vehicle and Traffic Law](#) (both weblinks accessed March 26, 2020).

week on school bus safety. The theme for 2020 is “Red Lights Mean STOP!” Given this theme, the NTSB anticipates that, during this week in 2020, there will be increased opportunities to educate the public about the dangers of driving past a bus with its red lights on and stop arm extended.

The NTSB concludes that education materials informing the driving public of the illegality and dangers of passing a school bus that is stopped to load or unload passengers are widely available from a variety of sources. Unfortunately, despite the profusion of such information, crashes in which student pedestrians are struck by vehicles whose drivers do not stop for stopped school buses continue to occur; the Rochester, Baldwin, and Hartsfield crashes discussed in this report are only three examples of such tragic crashes. One approach to making these education materials more memorable and significant to drivers might be to combine education with enhanced enforcement of no-passing laws.

2.4.2 Enforcement Actions

Several states and local communities have been involved in programs that combine education and enforcement efforts to reduce illegal passings of school buses. Typically, these programs include participants from departments of education, student transportation agencies, law enforcement officers, and other parties involved in student transportation who work together to raise awareness of the potential consequences of illegal school bus passing.

During School Bus Safety Week in 2019, officers from the Sedgwick County Sheriff’s Office in Kansas and police departments in Wichita, Haysville, and Maize, Kansas, boarded school buses to watch for violators of school bus passing laws. These efforts were coupled with high-visibility enforcement using patrol cars (KAKE News 2019). New York State conducted its “Operation Safe Stop” day on May 2, 2019, during which 702 police officers from 75 law enforcement agencies wrote 646 tickets for drivers who passed stopped school buses and 1,991 tickets for other moving violations (New York State Governor’s Traffic Safety Committee 2019).

At the 2019 NAPT conference, during a session on illegal school bus passing, several attendees cited success stories of schools teaming up with local law enforcement to prevent violations of no-passing laws (Thompson 2019). A North Carolina study completed in 2000 noted that when school transportation staff and law enforcement worked together to reduce illegal school bus passings, convictions of reported violators increased, and the resulting publicity helped to decrease overall violations (North Carolina Department of Public Instruction 2000).

The NTSB concludes that evidence suggests that coupling enhanced enforcement of no-passing laws with efforts to educate motorists about the dangers of passing a stopped school bus may reduce the incidence of illegal passings. Therefore, the NTSB recommends that the NASDPTS, NAPT, and NSTA urge their members to continue to coordinate with local law enforcement agencies to conduct educational and enforcement activities aimed at reducing illegal school bus passings. Similarly, the NTSB recommends that the International Association of Chiefs of Police, National Sheriffs’ Association, and National

Association of School Resource Officers inform their members of the fatal Rochester, Indiana; Baldwin, Mississippi; and Hartsfield, Georgia, crashes, and encourage them to continue to work with local school districts to conduct educational and enforcement activities to reduce illegal school bus passings.

Although such high-visibility enforcement campaigns can be effective in raising awareness of the dangers of illegally passing a stopped school bus, they are expensive to conduct and limited in scope to a specific area and time period. As an alternative, some school districts are trying a more automated approach; they are installing cameras on school bus stop arms to record images of vehicles (and/or drivers) illegally passing the school bus when it is stopped to load or unload students.

According to the National Conference of State Legislatures (NCSL), 22 states explicitly permit local governments or school districts to use cameras to capture images and issue traffic tickets for illegally passing stopped school buses based on the images (NCSL 2020).⁵¹ The state laws differ in some details. Some states permit images to be taken only of the license plate of the offending vehicle and prohibit taking images of the driver and passengers. Several state laws define how the fines collected from stop arm camera violations may be used. For example, legislation (Senate Bill 2) passed in Indiana in April 2019 allows schools to petition counties for money to pay for stop arm cameras using funds collected from penalties. Connecticut, Illinois, Maine, and Rhode Island require school buses to be marked to alert drivers to the presence of a stop arm camera.

Some evidence suggests that use of stop arm cameras can improve compliance with no-passing laws. The firm Verra Mobility (formerly American Traffic Solutions) studied the citations resulting from 290 school bus safety cameras in 15 programs in Georgia, Maryland, Virginia, and Texas during the 2013–2014 school year.⁵² The results indicated that the use of the cameras resulted in a reduction in violations of almost 40 percent (Verra Mobility 2016). A 2013 study found that North Carolina's pilot program of issuing citations based on images of violations captured by stop arm cameras resulted in overall success in reducing the incidence of illegal passings (Cook and Tsai 2013). (NHTSA has conducted a study on the effectiveness of stop arm cameras, which is currently under internal review by the agency.)

The NTSB concludes that the use of stop arm cameras could deter drivers from illegally passing stopped school buses. Therefore, the NTSB recommends that the 28 states and the District of Columbia that do not currently have laws permitting the use of stop arm cameras on school buses for enforcement purposes enact legislation to permit stop arm

⁵¹ The 28 US states that do not have such laws are as follows: Alaska, Arizona, California, Colorado, Delaware, Florida, Hawaii, Iowa, Kansas, Kentucky, Louisiana, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, North Dakota, Ohio, Oregon, South Dakota, Texas, Vermont, and Wisconsin. The District of Columbia also does not have such a law.

⁵² The company develops, delivers, and operates road safety products and services intended to increase compliance with traffic laws addressing red lights, school zones, speed limits, and school bus safety.

cameras on school buses to capture images, and allow citations to be issued for illegal school bus passings based on the camera-obtained information.

At the time of the Rochester crash, the TVSC did not have stop arm cameras installed on its buses. The TVSC also told investigators that few school bus drivers had reported “near miss” incidents involving a vehicle illegally passing a school bus and that such reports were rarely communicated to local law enforcement. However, the TVSC has stated that, for the 2019 school year, it has purchased and installed stop arm cameras for its entire fleet of regular route buses, and that all future newly purchased buses will have cameras installed.⁵³ The images from the cameras can be used to enforce stop arm violations, and they can also provide additional information for assessing the safety of school bus routes and stops.

2.5 Using Technology to Prevent Collisions With Student Pedestrians and Mitigate Injuries

Requiring a student to cross an active roadway to board a school bus or to return home after disembarking from a bus is not a recommended safety option. Ultimately, the goal should be to eliminate school bus stops that require students to cross a roadway. However, where student crossings are not avoidable through route planning, technology may help to prevent a vehicle from striking a student or to mitigate the injuries sustained in a crash.

Advanced vehicle technologies are available that can assist drivers in avoiding or mitigating crashes with pedestrians and in recognizing stopped school buses that are loading or unloading students. These systems can respond to certain hazards when the driver does not take action, regardless of why the driver is not responding.

2.5.1 Connected and Automated Vehicles

The NTSB has long supported the development and use of vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and vehicle-to-pedestrian (V2P) technologies, which have the potential to reduce crashes, injuries, and fatalities on roadways. The comprehensive term V2X refers to V2V, V2I, and V2P technologies collectively. For implementing these technologies, the primary method is radio communication; however, there has been progress in using cellular communication (83 *Federal Register* 66338; also, NHTSA 2018).

Various V2X technologies may be applicable to school buses. For instance, a technology by which a school bus can trigger the activation (flashing) of a school bus stop warning sign on the road when the bus is approaching, or stopped at, a bus stop would help alert drivers of other vehicles and could lead to reductions in illegal school bus passings. There is some evidence that dynamic warning signs have the potential to reduce the

⁵³ Stop arm cameras have not been installed on older substitute buses.

incidence of vehicles illegally passing stopped school buses or to reduce their speeds (Carson and others 2005).

At one time, the Canadian province of Alberta allowed for the warning flashers on School Bus Stop Ahead signs to be activated by the school bus driver (Government of Alberta Transportation 2004). However, because drivers were inconsistent in when and how they activated the flashers, Alberta stopped installing the signs and recommended that those in use should be removed. Using V2I technology to activate the flashing lights would remove the element of driver inconsistency from the situation, because V2I technology would automatically activate the flashers, without human involvement.

Advanced technologies hold promise not just in alerting drivers to standard situations, such as a stopped bus, but in responding to dynamic ones, such as before an imminent crash. V2V technology could warn a driver of the presence of a stopped school bus with its warning lights on and stop arm extended; it could also (possibly) reduce vehicle speed to avoid a crash. The NTSB investigated a 2012 crash in Chesterfield, New Jersey, where a school bus drove into the path of a dump truck, resulting in the death of one child and the injury of several others (NTSB 2013). Had the truck and the school bus been equipped with connected technology, the school bus driver would have received a continuous warning as he began to cross the intersection. In the Chesterfield report, the NTSB concluded that connected vehicle technology could have provided active warnings to the school bus driver of the approaching truck and possibly prevented the crash. The NTSB issued Safety Recommendations H-13-30 and -31 to NHTSA, which read as follows:

H-13-30

Develop minimum performance standards for connected vehicle technology for all highway vehicles.

H-13-31

Once minimum performance standards for connected vehicle technology are developed, require this technology to be installed on all newly manufactured highway vehicles.

Because of NHTSA's lack of progress on these recommendations, they are currently classified "Open—Unacceptable Response." The NTSB continues to believe that, given their special operating features, which can involve safety vulnerabilities such as student pedestrians, school buses must be included in all plans to develop connected vehicle technology. Consequently, the NTSB concludes that it remains a safety priority that school buses be included in performance standards for connected vehicle technologies. Therefore, the NTSB reiterates Safety Recommendations H-13-30 and -31 to NHTSA.

The NTSB is concerned that the implementation of V2X technology could be negatively affected by a recent notice of proposed rulemaking (NPRM) issued by the Federal Communications Commission. The proposed rulemaking would reduce the radio bandwidth available for V2X applications. As the NTSB stated in its response to the NPRM, if the rulemaking is enacted, V2X applications would be functionally infeasible,

which would impede transportation safety advancements, including automated vehicle technologies (85 *Federal Register* 6841).⁵⁴

The school bus industry shares the NTSB's concern that the proposed rulemaking could negatively affect V2X capabilities. In its response to the NPRM, the NSTA noted that many of its members have incorporated the latest technologies onto their school buses and that these technologies depend on the success of high-speed safety communications. The NSTA stated that "Delays in a school bus receiving a crash-avoidance message due to signal interference can mean the difference between a catastrophic crash, and a narrow miss."⁵⁵ The NTSB concludes that the Federal Communications Commission's proposed rulemaking to reduce Intelligent Transportation System operations to the upper 30 megahertz of the currently assigned bandwidth while opening the remaining 45 megahertz to unlicensed devices would be detrimental to safety and set back advancements in transportation safety.

The NTSB recognizes that new automated vehicle technologies are rapidly being integrated into vehicles. SAE International defines six levels of driving automation that range from Level 0 (No Automation) to Level 5 (Full Automation) (SAE 2018). In recent years, the NTSB has issued major investigation reports on crashes involving partial driving automation as well as one involving the testing of higher-level automation systems (NTSB 2020, 2019a, and 2017). NHTSA has not established automated driving system safety standards or assessment protocols. It has published automated vehicle guidance and encouraged manufacturers and developers of automated driving systems to submit voluntary safety self-assessment reports describing the safety approach they are taking in the development of their systems. Underwriters Laboratories (with Edge Case Research) is developing UL 4600, *Standard for Safety for the Evaluation of Autonomous Products*, which proposes an extensive list of factors that should be considered when designing automated vehicles (Edge Case Research 2019). School buses and their passengers are identified as factors with which automated vehicles will interact and to which they will need to respond safely.

In its recent report on the collision between a vehicle operating with a developmental automated driving system and a pedestrian in Tempe, Arizona (NTSB 2019a), the NTSB recommended that NHTSA require entities that are testing or intend to test a developmental automated driving system on public roads to submit a safety self-assessment report (Safety Recommendation H-19-47). Additionally, the NTSB recommended that NHTSA establish a process for evaluating the safety self-assessment reports and determine whether the plans include appropriate safeguards for testing such

⁵⁴ See [NTSB's V2X radio bandwidth NPRM response](#) to view NTSB's response, accessed March 25, 2020. To view all of the comments on this NPRM, see [responses to bandwidth NPRM](#), accessed March 25, 2020.

⁵⁵ See [NSTA's V2X radio bandwidth NPRM response](#) to view the NSTA's response, accessed March 25, 2020. To view all of the comments on this NPRM, see [responses to bandwidth NPRM](#), accessed March 25, 2020.

systems on public roadways, including adequate monitoring of vehicle operator engagement, if applicable (Safety Recommendation H-19-48).⁵⁶

The unusual operating features of school buses should also be considered when developing such new technologies. School buses operate under conditions that do not apply to most other vehicles; they make frequent stops on highly active roadways in the morning and afternoon hours, they transport student passengers who will be boarding and leaving the bus; and they require other vehicles to stop when bus warning lights are active and the stop arm is extended. The NTSB concludes that, because school buses and the children they carry are an integral part of the transportation system, it is imperative to transportation safety that the developers and manufacturers of advanced technologies create systems in which automated and connected vehicles respond appropriately to school buses.

Therefore, in light of the special operating nature of school buses on public roadways, the NTSB recommends that NHTSA, when evaluating safety self-assessment reports from entities testing automated driving systems on public roads, evaluate how effectively the entities include school bus operations in their plans.

2.5.2 Pedestrian Automatic Emergency Braking

Although the 2017 Toyota Tacoma pickup truck involved in the Rochester crash was not equipped with a PAEB system, the 2020 model is equipped with one. PAEB systems are designed to automatically apply or supplement the vehicle's brakes to prevent a collision or reduce the severity of a collision between a vehicle and a pedestrian.⁵⁷ Usually, PAEB systems use camera or radar sensors to identify when a pedestrian is a potential hazard. Developing a system to detect pedestrians is challenging because pedestrians are smaller than vehicles; they may be present around vehicles, on sidewalks, in crosswalks, and on the roadside; and they often change trajectory quickly (Jermakian and Zuby 2011). In the Rochester collision, as well as in other school bus crashes, the pedestrians involved were children, who are smaller than the average adult, so when they cross the road in the dark, they are harder to see and may blend more fully into the environment.

NHTSA has not set performance standards for PAEB systems or required their installation on any vehicle. In its report on pedestrian safety (NTSB 2018b), the NTSB made the following recommendation to NHTSA:

⁵⁶ Both recommendations are currently in "Open—Await Response" status.

⁵⁷ An automatic emergency braking system engages dynamic brake support or crash-imminent braking to prevent or mitigate the severity of vehicle-to-vehicle rear-end crashes. A PAEB system assists the driver by automatically applying the brakes to avoid or mitigate a potential contact between the equipped vehicle and a pedestrian.

H-18-43

Incorporate pedestrian safety systems, including pedestrian collision avoidance systems and other more-passive systems, into the New Car Assessment Program [NCAP].⁵⁸

NHTSA responded that it had published an NPRM on the NCAP on August 3, 2018, and that one of the issues it raised was whether to incorporate pedestrian crash avoidance features into NCAP. NHTSA also held a public meeting on NCAP on October 1, 2018 (83 *Federal Register* 38201).⁵⁹

On November 21, 2019, NHTSA issued a request for comments on “Advanced Driver Assistance Systems Draft Research Test Procedures” (84 *Federal Register* 64405). PAEB systems are among those for which draft testing procedures were provided; one test condition for a PAEB system is its ability to detect and respond to a child pedestrian running from behind a parked vehicle into the path of a PAEB-equipped vehicle traveling at 10 or 25 mph.⁶⁰ In its response to NHTSA’s request for comments, the NTSB expressed its disappointment that the proposed testing procedures were for “research purposes only” and were not intended to be used to update the NCAP program. The NTSB urged NHTSA to incorporate advanced driver assistance systems and associated safety performance measures into its NCAP rating system.⁶¹

The Insurance Institute for Highway Safety (IIHS) has added PAEB testing to its passenger vehicle safety tests (IIHS 2019). Vehicles are rated as *basic*, *advanced*, or *superior*, based on their ability to avoid or mitigate a crash with pedestrian dummies in three different test track scenarios (parallel adult, perpendicular adult, and perpendicular child) conducted at different speeds. The parallel adult test simulates an adult pedestrian in the right lane near the edge of the road, facing away from traffic. Tests are run at 25 and 37 mph. The perpendicular adult scenario involves an adult pedestrian walking across the road; tests are run at 12 and 25 mph. The third scenario, and the one most relevant to the Rochester crash, is the perpendicular child test, which involves a child running into the road between parked vehicles; tests are run at 12 and 25 mph. To date, IIHS has rated 11 vehicles equipped with PAEB.⁶²

The American Automobile Association (AAA) tested midsize sedans that were equipped with pedestrian detection/mitigation systems under various scenarios, including

⁵⁸ NCAP is a 5-star safety rating program designed to provide consumers with information about the crash protection and rollover safety provided by new vehicles beyond what is required by federal law. In the NCAP rating system, one star is the lowest safety rating; five stars is the highest. More stars equal a safer car. See [NCAP ratings](#), accessed January 27, 2020.

⁵⁹ Safety Recommendation H-18-43 is currently classified “Open—Acceptable Response.”

⁶⁰ NHTSA proposed several test conditions under two general scenarios: (1) pedestrian crosses the road in front of the vehicle and (2) pedestrian walks along the side of the road in the path of the vehicle.

⁶¹ The NTSB’s response may be found at [NHTSA-2019-0102-0020](#), accessed January 27, 2020.

⁶² The IIHS ratings on PAEB systems were as follows: *superior*: 2018–2019 Honda CR-V, 2019 Subaru Forester, 2019 Toyota RAV4, and 2019 Volvo XC40; *advanced*: 2019 Chevrolet Equinox, 2018–2019 Hyundai Kona, 2019 Kia Sportage, 2018–2019 Mazda CX-5, and 2019 Nissan Rogue; *basic*: 2019 Mitsubishi Outlander; and *no credit*: 2018–2019 BMW X1.

one involving a child darting out between two parked cars (AAA 2019). In the AAA child pedestrian tests conducted at 20 mph, the system-equipped sedans avoided collisions 11 percent of the time; collisions were mitigated (at an average speed of 5.9 mph) 25 percent of the time. The pedestrian systems were found to be ineffective under nighttime testing conditions.

The pickup truck was traveling 58–59 mph moments before the Rochester crash, but at the time of the impact, the truck’s speed was 41 mph. Based on event recorder data, the driver began braking the vehicle less than 1.3 seconds before impact. The NTSB is encouraged that PAEB systems are being researched, developed, and tested; however, they are not yet proven to be capable of preventing collisions such as the Rochester crash. To date, most testing of PAEB systems has been conducted at much lower speeds than were involved in this crash. PAEB systems may be more effective in preventing crashes and mitigating injuries in lower-speed situations. In particular, they could have a more beneficial safety effect in preventing and mitigating crashes in cases where pedestrians are crossing low-speed roadways, such as in residential areas, where school buses commonly operate. Overall, the NTSB concludes that, although there are limitations to the current PAEB systems, these safety technologies can help the driver and prevent or lessen the severity of crashes involving pedestrians. Therefore, the NTSB reiterates Safety Recommendation H-18-43 to NHTSA.

2.5.3 Other Technologies to Prevent Illegal School Bus Passings and Increase Crossing Safety

Other technologies are available that could prevent crashes involving students crossing roadways, when changes to school bus routes are not possible. Some of these technologies are intended to make students more visible, while others are designed to help motorists recognize a stopped school bus.

Supplemental lighting systems can be attached to the school bus that would (1) enable the bus drivers to better see the pedestrian students; (2) provide a clear, distinct path for the students to walk, which would permit the bus driver to ensure that students are crossing the road in a safe area; and (3) enable motorists to see the students crossing the roadway from a distance. The NTSB is aware of 23 states that permit supplemental lighting on school buses.⁶³

Recently, Marion Community Schools in Marion, Indiana, field-tested a supplemental lighting system for its school buses.⁶⁴ The tested system was a light-emitting diode mounted on the bus’s left bumper at a 45-degree downward angle. The light projected a beam that extended 18–20 feet past the bus, illuminating the students’ path for both the

⁶³ The 23 states are Alaska, Arkansas, Arizona, Colorado, Delaware, Iowa, Idaho, Illinois, Maine, Michigan, Missouri, Mississippi, North Carolina, Nebraska, New Jersey, Nevada, New York, Ohio, Texas, Vermont, Wisconsin, West Virginia, and Wyoming.

⁶⁴ In 2013, Marion County was approved to test the Gardian (sic) Angel School Bus Lighting System.

bus driver and any other motorists. Despite positive feedback on the system, the Indiana School Bus Committee did not approve its use in the state.⁶⁵

The NTSB addressed student pedestrian conspicuity in its investigation of a 2016 collision in Thief River Falls, Minnesota, where a minivan struck and killed a 7-year-old male who was crossing a high-speed roadway to board a school bus. The NTSB recommended that NHTSA assess, and if necessary, update, the guidelines on pupil transportation to specifically address pedestrian issues related to conspicuity and route selection (Safety Recommendation H-18-50) (NTSB 2018a). In its March 2019 response to the recommendation, NHTSA stated that it will expand its Highway Safety Program Guideline no. 17, “Pupil Transportation Safety,” to address the issue of pedestrian conspicuity, such as through the use of retroreflective garments and route risk assessment strategies. Further, NHTSA indicated that it will seek discussions with national associations such as the NASDPTS, NAPT, and NSTA on identifying, promoting, and improving student pedestrian safety. Safety Recommendation H-18-50 is currently classified “Open—Acceptable Response.”

In its report on pedestrian safety, the NTSB recognized that one of the most straightforward approaches to make it easier for drivers to see and avoid pedestrians is to improve vehicle headlights (NTSB 2018b). In that report, the NTSB recommended that NHTSA revise FMVSS 108 to include performance-based standards for vehicle headlight systems correctly aimed on the road and tested on-vehicle to account for headlight height and lighting performance (Safety Recommendation H-18-39) as well as to allow use of adaptive headlight systems (Safety Recommendation H-18-40). These recommendations were reiterated in the NTSB’s Safety Research Report: *Bicyclist Safety on US Roadways: Crash Risks and Countermeasures* (NTSB 2019b). According to NHTSA, it is still working on the vehicle level headlight performance requirements, but it has published an NPRM for adaptive driving beam headlight systems. Safety Recommendation H-18-39 is currently classified “Open—Unacceptable Response,” and Safety Recommendation H-18-40 is currently classified “Open—Acceptable Response.”

In 2016, the IIHS released its first vehicle headlight ratings. The evaluations conducted by IIHS measure how far light is projected from a vehicle’s low- and high-beam headlights as the vehicle travels on straight roads and on curves. Although the headlights of the 2017 Toyota Tacoma pickup truck received a poor rating, in the IIHS tests, the 2020 Tacoma headlights, depending on type, received a rating of good or marginal. It should be noted that witnesses at the Rochester crash said that the pickup truck’s lights were on at the time of the crash, and that the student pedestrians could be seen in the beam.

⁶⁵ The committee could not agree on whether the supplemental lighting system should be “wired” into the current bus lighting system or a separate switch controlling the supplemental system should be installed.

To address motorists' failures to stop for school buses, extended stop arms have been designed to better communicate to oncoming drivers their responsibility to stop. Figures 8 and 9 show examples of extended stop arm systems. Pilot programs using extended stop arms have shown decreases in vehicles illegally passing stopped school buses.⁶⁶



Figure 8. Extended stop arm with two stop signs on school bus. (Source: Bus Safety Solutions)

⁶⁶ For example, a pilot program in Albemarle County, Virginia, used an extended stop arm system that lengthens the school bus's existing stop arm an additional 5–6 feet from the left side of the bus. During the test period, when the extended stop arm was installed on 10 buses in the county, an average of 0.81 daily violations took place for each of the equipped buses (118 total illegal school bus passings recorded over 15 days), compared with 1.79 daily violations for the buses without the extenders (268 total illegal school bus passings recorded over 15 days).



Figure 9. Close-up view of extended stop arm with single stop sign and horizontal stop bar. (Source: S.A.F.E. Gates)

Another new technology is the predictive stop arm. This safety feature uses radar technology and predictive analysis to monitor traffic approaching the school bus from either direction to assess the likelihood of illegal passings.⁶⁷ Each oncoming vehicle's speed, location, and acceleration/deceleration are used to determine whether the vehicle is likely to stop. When a risk is detected, the predictive stop arm provides an audible warning to the students and the bus driver.

As was noted at the outset of this section, the ultimate safety goal to prevent events such as the Rochester pedestrian crash is to eliminate the practice of having students cross roadways when boarding or leaving school buses, especially on high-speed roads. But because some students may still have to cross roadways when route planning cannot change the bus stop location, countermeasures to improve the safety of such crossings, including advanced technologies, must be evaluated. Because of their relative newness, the effectiveness of some such technologies is not yet established. The NTSB concludes that, because funding for school bus equipment is limited, to make the best use of their resources, school systems need more information on which technologies are most effective in reducing illegal school bus passings and protecting students from the risk of injury. Therefore, the NTSB recommends that NHTSA evaluate the effectiveness of technologies designed to reduce the incidence of illegal school bus passings, and publish and disseminate the evaluation results.

⁶⁷ Safe Fleet is manufacturing the predictive stop arm.

3 Conclusions

3.1 Findings

1. None of the following were factors in this crash: (1) mechanical condition of the pickup truck or condition of the school bus warning light and stop arm systems; (2) school bus driver licensing; (3) pickup truck driver licensing, drug or alcohol impairment, medical condition, vision, or cell phone use; or (4) actions/behavior of the student pedestrians or the adult pedestrian.
2. There is insufficient information to determine whether the school bus and pickup truck drivers were fatigued in the period leading up to the crash.
3. The emergency response to the crash was timely and effective.
4. For reasons that cannot be determined from the available evidence, the pickup truck driver did not respond to the activated warning lights and stop arm of the school bus, and she did not attempt to stop her vehicle until she saw the students in the roadway.
5. Requiring students to cross a roadway, regardless of the number of lanes, presents a risk of pedestrian death or injury because motorists do not always stop, as required, for school buses, even when a bus is at a bus stop with its lights flashing and stop arm extended.
6. Periodically evaluating school bus routes and stops for hazards can reduce the safety risks to student pedestrians.
7. The existing Indiana Department of Education training for school transportation directors does not contain sufficient information on assessing the safety of school bus routes or identifying hazards at school bus stops.
8. The routing hazards evident in the recent Hartsfield, Georgia, and Baldwyn, Mississippi, crashes suggest that inadequate school bus routing may be a widespread problem.
9. The Tippecanoe Valley School Corporation's inadequate safety assessment of school bus routes resulted in bus stops that required students to cross a high-speed roadway, placing them at risk.

10. Creating a mechanism by which school bus drivers and parents (or caregivers) of student riders could report safety concerns about bus operations would provide an additional source of information that could be used to improve the safety of school bus routes and stops.
11. The Tippecanoe Valley School Corporation's policy at the time of the crash, which required school bus drivers to determine subjectively when surrounding traffic was "controlled," left its bus drivers with insufficient information to make a safe determination about when to signal students to cross a roadway to board a school bus, placing students at risk.
12. In circumstances when a student roadway crossing cannot be avoided, the school bus driver must be knowledgeable of, and consistent when making, crossing and warning signals, and students must be aware of, and understand, the crossing and warning signals the driver makes.
13. Although it is illegal in all 50 states, National Association of State Directors of Pupil Transportation Services data show that the passing of stopped school buses by other vehicles remains a pervasive and continuing safety issue in the United States.
14. Education materials informing the driving public of the illegality and dangers of passing a school bus that is stopped to load or unload passengers are widely available from a variety of sources.
15. Evidence suggests that coupling enhanced enforcement of no-passing laws with efforts to educate motorists about the dangers of passing a stopped school bus may reduce the incidence of illegal passings.
16. The use of stop arm cameras could deter drivers from illegally passing stopped school buses.
17. It remains a safety priority that school buses be included in performance standards for connected vehicle technologies.
18. The Federal Communications Commission's proposed rulemaking to reduce Intelligent Transportation System operations to the upper 30 megahertz of the currently assigned bandwidth while opening the remaining 45 megahertz to unlicensed devices would be detrimental to safety and set back advancements in transportation safety.

19. Because school buses and the children they carry are an integral part of the transportation system, it is imperative to transportation safety that the developers and manufacturers of advanced technologies create systems in which automated and connected vehicles respond appropriately to school buses.
20. Although there are limitations to the current pedestrian automatic emergency braking systems, these safety technologies can help the driver and prevent or lessen the severity of crashes involving pedestrians.
21. Because funding for school bus equipment is limited, to make the best use of their resources, school systems need more information on which technologies are most effective in reducing illegal school bus passings and protecting students from the risk of injury.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the Rochester, Indiana, crash was the pickup truck driver's failure to stop for the school bus for unknown reasons, despite its clearly visible warning lights and stop arm, as well as a roadway warning sign indicating an upcoming school bus stop. Contributing to the cause of the crash was the Tippecanoe Valley School Corporation's (1) inadequate safety assessment of school bus routes, resulting in the prevalence of bus stops that required student pedestrians to cross a 55 mph roadway to board a bus, increasing the risk of injury during a collision, and (2) failure to establish a clear policy regarding surrounding traffic for school bus drivers to follow in determining when it was safe to signal students to cross a roadway to board a school bus.

4 Recommendations

4.1 New Recommendations

As a result of its investigation, the National Transportation Safety Board makes the following new safety recommendations.

To the National Highway Traffic Safety Administration:

When evaluating safety self-assessment reports from entities testing automated driving systems on public roads, evaluate how effectively the entities include school bus operations in their plans. (H-20-10)

Evaluate the effectiveness of technologies designed to reduce the incidence of illegal school bus passings, and publish and disseminate the evaluation results. (H-20-11)

To the states of Alaska, Arizona, California, Colorado, Delaware, Florida, Hawaii, Iowa, Kansas, Louisiana, Michigan, Minnesota, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, North Dakota, Ohio, Oregon, South Dakota, Texas, Vermont, and Wisconsin; the commonwealths of Kentucky and Massachusetts; and the District of Columbia:

Enact legislation to permit stop arm cameras on school buses to capture images, and allow citations to be issued for illegal school bus passings based on the camera-obtained information. (H-20-12)

To the Indiana Department of Education:

Supplement your training program for school transportation directors with a module on how to assess the safety and risks of school bus routes and stops, according to best industry practices. (H-20-13)

Require local school transportation directors and others involved in evaluating school bus routes and stops in Indiana to complete the training module on the safety and risks of routes and stops recommended in Safety Recommendation H-20-13. (H-20-14)

To the National Association of State Directors of Pupil Transportation Services, National Association for Pupil Transportation, and National School Transportation Association:

Inform your members of the circumstances of the Rochester, Indiana; Baldwyn, Mississippi; and Hartsfield, Georgia, crashes, and urge them to minimize the use of school bus stops that require students to cross a roadway (especially a high-speed roadway) and to, at least annually, and also whenever a route hazard is identified, evaluate the safety of their school bus routes and stops. (H-20-15)

Remind your members to ensure that school transportation directors and others involved in evaluating school bus routes and stops complete training on how to assess the safety of school bus routes and stops, according to best industry practices. (H-20-16)

Advise your members to train their school bus drivers and students on crossing procedures, including the crossing hand signal and the danger signal, which are to be used when a student roadway crossing cannot be avoided. (H-20-17)

Urge your members to continue to coordinate with local law enforcement agencies to conduct educational and enforcement activities aimed at reducing illegal school bus passings. (H-20-18)

To the International Association of Chiefs of Police, National Sheriffs' Association, and National Association of School Resource Officers:

Inform your members of the fatal Rochester, Indiana; Baldwin, Mississippi; and Hartsfield, Georgia, crashes, and encourage them to continue to work with local school districts to conduct educational and enforcement activities to reduce illegal school bus passings. (H-20-19)

To the Tippecanoe Valley School Corporation:

Implement a process to track school bus driver and parent (or caregiver) complaints regarding the safety of school bus routes and stops, as well as any other safety concerns about bus operations, from initial submission of an issue to its resolution. (H-20-20)

Train your school bus drivers and students on crossing procedures, including the crossing hand signal and the danger signal, which are to be used when a student roadway crossing cannot be avoided. (H-20-21)

4.2 Previously Issued Recommendations Reiterated in This Report

As a result of its investigation, the National Transportation Safety Board reiterates the following safety recommendations.

To the National Highway Traffic Safety Administration:

Develop minimum performance standards for connected vehicle technology for all highway vehicles. (H-13-30)

Once minimum performance standards for connected vehicle technology are developed, require this technology to be installed on all newly manufactured highway vehicles. (H-13-31)

Incorporate pedestrian safety systems, including pedestrian collision avoidance systems and other more-passive safety systems, into the New Car Assessment Program. (H-18-43)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

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Report Date: March 31, 2020

Appendix: Investigation

The National Transportation Safety Board was notified of the Rochester, Indiana, crash on October 30, 2018, and dispatched an investigative team to the site. The NTSB established groups to investigate human performance; motor carrier operations; and highway, survival and vehicle factors.

Parties to the investigation were the Indiana State Police, Fulton County Sheriff's Office, Tippecanoe Valley School Corporation, and Daimler Trucks North America.

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