TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER

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VERIDIAN ON-SITE AIR BAG RELATED DRIVER FATALITY INVESTIGATION
SCI TECHNICAL SUMMARY REPORT

VERIDIAN CASE NO. CA00-060

SUBJECT VEHICLE - 1994 FORD F-150 4X2 PICKUP TRUCK

LOCATION - STATE OF NEW YORK

CRASH DATE - DECEMBER 2000

Contract No. DTNH22-94-D-07058

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

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16. *Abstract* This on-site investigation focused on a two-vehicle crash that involved a 1994 Ford F-150 county highway-owned pickup truck and a 1997 Dodge Grand Caravan. The Ford F-150 was equipped with a driver's air bag that deployed as a result of head-on collision with the Grand Caravan. The Ford pickup truck was occupied by an unrestrained 40-year-old male driver. Impact resulted in moderate damage to both vehicles. The driver of the Ford pickup truck was probably out-of-position forward and was struck by the deploying driver's air bag. He initiated a forward trajectory in response to the frontal impact and loaded through the air bag, compressing the steering column and upper portion of the steering wheel rim. He sustained facial abrasions, conjunctiva injuries, an upper lip contusion, a subgaleal forehead contusion, a right arm contusion, and bilateral chest contusions from air bag contact. He was redirected rearward by the expansion of the air bag. The rearward acceleration of his head resulted in brain swelling/cerebral edema and bilateral uncal grooving and tonsillar coning. The driver came to rest on his back in the front-right seat area. The Medical Examiner stated that the cause of death was asphyxia due to blood aspiration due to facial injuries. The driver was transported by ambulance to a local hospital where he expired. The driver of the Dodge Grand Caravan was restrained by the available 3-point lap and shoulder belt system and initiated a forward trajectory in response to the frontal impact. He loaded the manual restraint and the deployed driver's air bag which provided additional protection from the frontal crash forces. He had a police-reported complaint of neck pain and indicated to police that he would seek medical treatment on his own.			
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BACKGROUND

This on-site investigation focused on a two-vehicle crash that involved a 1994 Ford F-150 county highway-owned pickup truck **(Figure 1)** and a 1997 Dodge Grand Caravan. The Ford F-150 was equipped with a driver's air bag that deployed as a result of head-on collision with the Grand Caravan. The Ford pickup truck was occupied by an unrestrained 40-year-old male driver. Impact resulted in moderate damage to both vehicles. The driver of the Ford pickup truck was probably out-of-position forward and was struck by the deploying driver's air bag. He initiated a forward trajectory in response to the frontal impact and loaded through the air bag, compressing the steering column and upper portion of the steering wheel rim. He sustained facial abrasions, conjunctiva injuries, an upper lip contusion, a subgaleal forehead contusion, a right arm contusion, and bilateral chest contusions from air bag contact. He was redirected rearward by the expansion of the air bag. The rearward acceleration of his head resulted in brain swelling/cerebral edema and bilateral uncal grooving and tonsillar coning. The driver came to rest on his back in the front-right seat area. The Medical Examiner stated that the cause of death was asphyxia due to blood aspiration due to facial injuries. The driver was transported by ambulance to a local hospital where he expired. The driver of the Dodge Grand Caravan was restrained by the available 3-point lap and shoulder belt system and initiated a forward trajectory in response to the frontal impact. He loaded the manual restraint and the deployed driver's air bag which provided additional protection from the frontal crash forces. He had a police-reported complaint of neck pain and indicated to police that he would seek medical treatment on his own.

Figure 1. 1994 Ford F-150 pickup truck

The Veridian SCI team identified this crash from the local television news. The notification was forwarded to NHTSA and an on-site effort was assigned to the Veridian SCI team on Monday, December 11, 2000. The on-site inspections of both vehicles were completed on December 15, 2000.

Crash Site

Figure 2. Northbound view of the crash site

This crash occurred on a north/south rural county roadway in the dawn hours. At the time of the crash, it was snowing and the asphalt roadway surface was snow/ice covered. According to the National Weather Service weather history, the temperature was approximately -9 degrees Celsius (16 degrees Fahrenheit) and the wind was 13 km/h (8 mph) at the time of the crash. The crash occurred on a curved portion of a two-lane roadway that measured 6.2 m (20.3') wide and was bordered by dirt shoulders. The crash site was approximately 50.0 m (164.0') north of a hillcrest that was located at near the apex of the curve. The northbound grade was approximately 3.0 percent on the south side of the hillcrest, and -5.0 percent on the north side. Due to the slope and curvature of the roadway, the sight distance around the curve was obscured in both directions. The roadway was bordered by fields, scattered trees, and utility poles **(Figure 2)**.

Pre-Crash

The 40-year-old male driver of the county-owned Ford F-150 pickup truck was checking road conditions at the time of the crash. Based on a brief interview with his wife, he was not scheduled to work at the time of the crash, but was called in to work due to weather conditions. She indicated that he had four hours of sleep prior to going to work, and that he was not used to working that particular time frame. She indicated that he had called home prior to the crash and seemed to be awake and alert. She said that she thought he should have made a left turn at a previous intersection, and was not sure why he was driving on the road where the crash occurred. He was operating the vehicle northbound on the two-lane county roadway on approach to a hillcrest with a curve to the right **(Figure 3)**. As he traveled over the hillcrest and into the curve **(Figure 4)**, he relinquished control of the vehicle for unknown reasons. The pickup truck drifted in a straight trajectory in a tracking mode across the centerline and into the opposite lane **(Figure 5)**.

Figure 3. Northbound approach for the Ford F-150 pickup truck

Figure 4. Approach #2 for the Ford pickup truck near the hillcrest

Figure 5. Approach #3 for the Ford pickup truck where it drifted across the centerline

The driver of the 1997 Dodge Grand Caravan was operating the vehicle southbound toward the hillcrest **(Figure 6)** when he detected the Ford pickup truck approaching in the same lane in the opposite direction from around the curve. Due to the curve and hillcrest, the driver's vision was obscured and he did not detect the approaching Ford pickup truck until the collision was imminent.

Figure 6. Southbound approach for the Dodge Grand Caravan

Crash

The front of the Ford pickup truck impacted the front of the Dodge Grand Caravan in a head-on configuration. Impact resulted in moderate damage to both vehicles. The direction of force was in the 12 o'clock sector for both vehicles. The damage algorithm of the WinSMASH program computed velocity changes of 17.2 km/h (10.7 mph) for the Ford F-150 pickup truck based on the documented crush profile. The longitudinal and latitudinal components were -17.0 (-10.5 mph) and -3.0 km/h (-1.9 mph), respectively. The damage algorithm of the WinSMASH program computed velocity changes of 18.8 km/h (11.7 mph) for the Dodge Grand Caravan based on the documented crush profile. The longitudinal and latitudinal components were -18.5 (-11.5 mph) and -3.3 km/h (-2.0 mph), respectively. The WinSMASH results appear conservative. The impact induced deceleration was sufficient to deploy the frontal air bag system in both vehicles. The front of the Ford F-150 pickup truck overrode the front bumper of the Dodge Grand Caravan. Both vehicles rotated clockwise (CW) approximately 10 degrees to final rest which was in close proximity to the point of impact. The Ford F-150 pickup truck came to rest facing north in the straddling the road edge. The Grand Caravan came to rest facing southwest straddling the edge of the roadside.

Post-Crash

The driver of the Ford F-150 was found lying face-up across the bench seat and was unconscious. His legs were still on the driver's side, however, his torso was lying laterally on the seat with his head on the right aspect of the seat. He was removed from the vehicle by rescue personnel and transported by ambulance to a local hospital where he expired after arrival. It was not known how the driver of the Dodge Caravan exited the vehicle. He had a police-reported complaint of neck pain and indicated to police that he would seek medical treatment on his own.

VEHICLE DATA - ***1994 Ford F-150 Pickup Truck***

The 1994 Ford F-150 pickup truck **(Figure 7)** was identified by the Vehicle Identification Number (VIN): 1FTEF15N3RN (production sequence omitted). The vehicle was a regular cab, full size, 4 x 2 pickup truck equipped with a 5.0 liter V-8 engine, and automatic transmission with overdrive. It was also equipped with dual fuel tanks, one forward of center of the rear axle on the left side and the other centered aft of the rear axle. The box measured 248.9 cm (98.0") in length. Attached

Figure 7. 1994 Ford F-150 pickup truck

to the box was a aluminum cap which weighed approximately 45.4 kg (100.0 lb). The pickup truck was also equipped with a rear step bumper, which was not included in the original manufacturer's specifications. The seating was configured with a three-person bench seat with a folding back. The bench seat was noted to be in the full-rear position at the time of the vehicle inspection. The seat had adjustable head restraints for both outboard seating positions. The driver's head restraint was fully lowered, and the right side was in the full-up position. The Ford F-150 pickup truck was equipped with 3-point manual lap and shoulder belts for both outboard positions and a lap belt for the center position. Both 3-point lap and shoulder belts were found in their stowed position and fully operational during the vehicle inspection. Both belts showed signs of historical usage, due to frequent operation and multiple drivers of this county highway-owned vehicle. The steering column was fixed with no tilt or telescoping adjustments.

VEHICLE DAMAGE

Exterior Damage - *1994 Ford F-150 Pickup Truck*

The 1994 Ford F-150 pickup truck sustained moderate frontal damage as a result of the impact with the Dodge Grand Caravan **(Figure 8)**. The direct contact damage was concentrated on the front bumper and began 2.5 cm (1.0") left of the centerline, and extended 90.2 cm (35.5") to the right bumper corner. The combined direct and induced damage measured 180.3 cm (71.0") from bumper corner to bumper corner. The maximum crush was located at C6 and measured 19.0 cm (7.5"). The right aspect of the bumper was crushed rearward around the right frame rail, which caused the frame rail to project through the bumper 8.3 cm (3.3"). Based on an exemplar vehicle, the leading edge of the right frame rail was displaced laterally 7.6 cm (3.0") to the left **(Figure 9)**. There was no movement of the left frame rail. The front right bumper corner was crushed against the right front wheel, which caused the wheel to be restricted. The right headlight assembly was displaced and the grille was fractured in multiple locations on the right side. The bottom right aspect of the grille was partially separated and longitudinal abrasions were noted on the bumper. The front aspect of the right fender was buckled rearward and outward, and the leading edge of the right door was deformed from being forced open against the displaced fender **(Figure 10)**. The right side of the hood was slightly displaced rearward and upward. The box was shifted to the left 7.6 cm (3.0"). The distance between the cab and the box was elongated on the right side and measured 8.9 cm (3.5"). The distance on the left side was shortened and measured 1.2 cm (0.5"). The right wheel base was shortened 4.0 cm (1.6"). The Collision Deformation Classification (CDC) for this impact was 12-FZEW-1. Six crush measurements spaced 36.1 cm (14.2") apart were taken

Figure 8. Frontal damage to Ford F-150 pickup truck

Figure 9. Displaced right frame rail protruding through bumper

Figure 10. Left side view of damage

at the level of the bumper and were as follows: C1 = 0.0 cm, C2 = 0.0 cm, C3 = 5.0 cm (2.0"), C4 = 18.0 cm (7.1"), C5 = 13.0 cm (5.1"), C6 = 19.0 cm (7.5").

Interior Damage - *1994 Ford F-150 Pickup Truck*

Interior damage to the 1994 Ford F-150 pickup truck was moderate and attributed to occupant contact. There was no glazing damage. The only intruded component was the right toe pan, which intruded 7.6 cm (3.0") longitudinally. The top half of the steering wheel rim was deflected forward 3.2 cm (1.3") from occupant loading **(Figure 11)**. The steering column was uniformly compressed as evidenced by the displacement of the shear capsules. Both shear capsules were displaced 2.5 cm (1.0") from the brackets **(Figure 12)**. The bend bracket located below the shear capsules was deflected forward 2.5 cm (1.0"). A scuff that measured 2.5 x 1.3 cm (1.0 x 0.5") was noted on the top aspect of the left instrument panel to the right of the steering wheel rim. Blood was noted on the bench seat cushion in the center and right positions.

Figure 11. Steering wheel deflection (note: rotated 180 degrees)

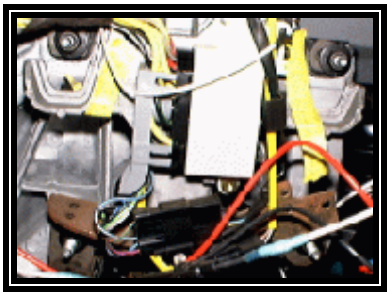

Figure 12. Shear capsules and bend bracket

Exterior Damage - *1997 Dodge Grand Caravan*

The 1997 Dodge Grand Caravan sustained moderate frontal damage as a result of the impact with the Ford F-150 pickup truck **(Figure 13)**. The direct damage began 53.3 cm (21.0") left of the centerline and extended 132.1 cm (52.0") to the right bumper corner. The combined direct and induced damage involved the entire frontal width of the Grand Caravan and measured 151.8 cm (59.8"). The frontal damage was concentrated above the level of the bumper. The maximum crush was located 2.5 cm (1.0") right of C4 and measured 20.3 cm (8.0") to the center of the radiator core. The bumper fascia was fractured to the right of center and had numerous longitudinal abrasions on the top aspect. The bumper fascia was partially separated from the right front fender. The right headlight assembly and grille were separated from the vehicle. The leading aspect of the hood was abraded and the hood was buckled slightly at the designated

Figure 13. Frontal damage to 1997 Dodge Grand Caravan

fold points. The right front fender was displaced rearward and outward. The Collision Deformation Classification (CDC) for this impact was 12-FDEW-1. Six crush measurements spaced 30.4 cm (11.9") apart were taken at the level of the front bumper and were as follows: C1 = 2.0 cm (0.8"), C2 = 1.0 cm (0.4"), C3 = 5.0 cm (2.0"), C4 = 6.0 cm (2.4"), C5 = 6.0 cm (2.4"), C6 = 2.0 cm (0.8").

Interior Damage - ***1997 Dodge Grand Caravan***

Interior damage to the 1997 Dodge Grand Caravan was minor. There was no glazing damage. There were no identifiable contacts or intrusions.

FRONTAL AIR BAG SYSTEM - ***1994 Ford F-150 Pickup Truck***

The 1994 Ford F-150 pickup truck was equipped with a frontal air bag for the driver's position only. The air bag deployed as a result of the frontal impact with the 1997 Dodge Grand Caravan. The driver's air bag was housed in the center of the steering wheel with asymmetrical H-configuration module cover flaps. The top flap measured 20.3 cm (8.0") in width and 12.7 cm (5.0") in height. The bottom flap measured 20.3 cm (8.0") in width and 3.8 cm (1.5") in height. There was no identifiable contacts or damage to the module cover flaps. The driver's air bag measured 56 cm (22") in diameter. Blood spattering was noted on the front air bag surface above the center aspect and continued at a downward angle toward the right side **(Figure 14)**. The air bag was vented by two vent ports that measured 3.8 cm (1.5") in diameter at located at the 11 and 1 o'clock positions. The air bag was tethered by two internal straps that measured 6.4 cm (2.5") in width.

Figure 14. Driver's air bag (note: steering wheel rotated 180 degrees)

FRONTAL AIR BAG SYSTEM - ***1997 Dodge Grand Caravan***

The 1997 Dodge Grand Caravan was equipped with frontal air bags for the driver and front right passenger positions. The air bags had deployed as a result of the frontal impact with the 1994 Ford F-150 pickup truck. The driver's air bag was housed in the center of the steering wheel with asymmetrical H-configuration module cover flaps. There was no identifiable contact evidence or damage to the air bag surface or module cover flaps.

The front right passenger's air bag deployed from the right mid-instrument panel area with a single cover flap design. The cover flap was rectangular in shape and hinged at the top aspect.

OCCUPANT DEMOGRAPHICS - ***1994 Ford F-150 Pickup Truck***

Driver

Age/Sex:	40-year-old male
Height:	175 cm (69")
Weight:	96 kg (212 lb)
Seat Track Position:	Full rear
Manual Restraint Use:	Unrestrained
Usage Source:	Vehicle inspection, injury data, police report
Eyewear:	Unknown
Type of Medical Treatment:	Transported by ambulance to a local hospital and expired

Driver Injuries - ***1994 Ford F-150 Pickup Truck***

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanisms
Bilateral uncal grooving and tonsillar coning	Critical (140202.5,8)	Air bag induced acceleration of the head
Brain swelling/cerebral edema, NFS	Serious (140660.3,9)	Air bag induced acceleration of the head
Blotchy hemorrhages of the conjunctiva of both eyes	Minor (240416.1,1) Minor (240416.1,2)	Driver's air bag
Forehead abrasions, nose abrasion, and irregular abrasions on the left and right face	Minor (290202.1,0)	Driver's air bag
Many petechial hemorrhages on the subgaleal in the forehead	Minor (290402.1,7)	Driver's air bag
Upper lip contusion	Minor (290402.1,8)	Driver's air bag
Multiple bilateral chest contusions, the largest measuring 3.8 cm (1.5")	Minor (490402.1,3)	Steering wheel rim
Contusion on the medial aspect of the right upper arm	Minor (790402.1,1)	Driver's air bag

Injury source: Autopsy report

Driver Kinematics - ***1994 Ford F-150 Pickup Truck***

The 40-year-old male driver of the Ford F-150 pickup truck was possibly out-of-position forward at the time of the crash. According to the brief interview with his wife, he was of large stature and weighed 96 kg (212 lb). He reportedly exercised every day and was in very good physical condition. It was suggested by the investigating officer that he may have fallen asleep prior to the crash. The nature and location of his injuries suggest that he was in close proximity to the driver's air bag. He was not restrained by the available 3-point manual lap and shoulder belt system.

At impact, the driver's air bag deployed and the expansion of the air bag against the driver's face resulted in a left and right conjunctiva injuries, a forehead abrasion, a nose abrasion, irregular left and right facial abrasions, and an upper lip contusion. According to the Medical Examiner, the driver's facial trauma caused bleeding from the mouth and nose. The smooth surface of the vinyl bench seat made it easy for the unrestrained driver to slide forward. The driver initiated a forward trajectory in response to the 12 o'clock crash force and loaded through the top aspect of air bag. He deflected the upper half of the steering wheel rim forward 3.2 cm (1.3") which resulted in bilateral chest contusions. The combined forward momentum of the driver and impeded deployment of the air bag compressed the steering column approximately 2.5 cm (1.0") as evidenced by shear capsule displacement. The air bag expansion accelerated the driver's head rearward. The air bag induced acceleration of the driver's head resulted in brain swelling/edema and bilateral uncal grooving and tonsillar coning. The air bag expansion projected the driver's right hand into the left instrument panel, as evidenced by a scuff that measured 2.5 x 1.3 cm (1.0 x 0.5"), although there was no soft tissue injury identified on the right hand to confirm this contact. The expansion of the air bag resulted in a contusion of the medial aspect of the right upper arm. He rebounded rearward and came to rest face-up lying laterally on the bench seat with his legs still in the driver's floor area.

According to the investigating officer, the driver was unconscious and lying face-up across the seat. The Medical Examiner stated that since the driver was lying face up and was unconscious, he aspirated on blood that collected in his mouth. The Medical Examiner identified the immediate cause of death to be asphyxia due to blood aspiration due to facial injuries.

The driver was removed from the pickup truck through the right door by rescue personnel. He was transported by ambulance to a local hospital where he expired from his injuries. The body was transferred to the morgue where an autopsy was performed.

OCCUPANT DEMOGRAPHICS - *1997 Dodge Grand Caravan*

Driver

Age/Sex:	35-year-old male
Height:	Not reported
Weight:	Not reported
Seat Track Position:	Mid-to-full rear
Manual Restraint Use:	3-point manual lap and shoulder belt
Usage Source:	Police report
Eyewear:	Unknown
Type of Medical Treatment:	Transported by ambulance to a local hospital but his admission status was not reported

Driver Kinematics - *1997 Dodge Grand Caravan*

The 35-year-old driver of the 1997 Dodge Grand Caravan was seated in a presumed upright posture at the time of the crash. He was restrained by the available 3-point manual lap and shoulder belt. At impact, the frontal air bag system deployed and he initiated a forward trajectory. He loaded the manual restraint and contacted the deployed driver's air bag which provided additional protection from the frontal crash forces. He had a police-reported complaint of neck pain and indicated to police that he would seek medical treatment on his own.

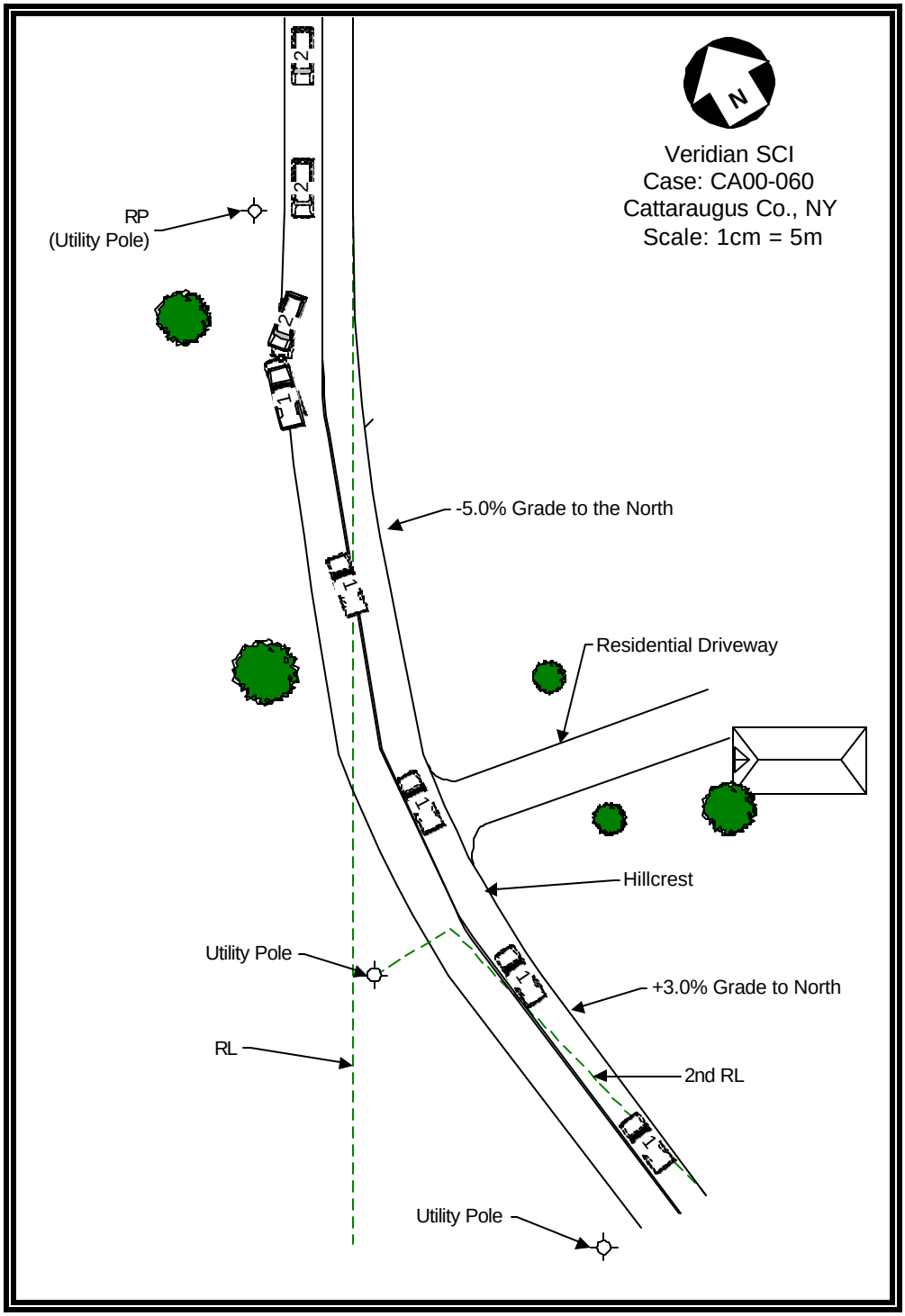

Figure 15. Scene schematic