

**TRANSPORTATION SCIENCES
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**ON-SITE ADVANCED OCCUPANT PROTECTION SYSTEMS/CHILD SAFETY SEAT
CRASH INVESTIGATION
SCI TECHNICAL SUMMARY REPORT**

VERIDIAN CASE NO. CA02-018

VEHICLE - 2002 DODGE CARAVAN

LOCATION - STATE OF PENNSYLVANIA

CRASH DATE - MARCH 2002

Contract No. DTNH22-01-C-17002

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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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| <p>16. <i>Abstract</i> This on-site investigation focused on a two-vehicle crash that involved a 2002 Dodge Caravan that was equipped with an Advanced Occupant Protection System (AOPS) and a 1989 Honda Accord. The Dodge Caravan was occupied by a restrained 36-year-old male driver, a restrained 35-year-old female front right passenger, a 3-year-old male restrained in a forward-facing child safety seat (CSS) on the second seat right position, and a 7-year-old male who was unrestrained and lying across the third seat. The 18-year-old female driver of the Accord failed to negotiate a right curve and crossed the centerline into the opposite travel lanes. The vehicles impacted in an off-set head-on configuration. The impact was sufficient to deploy the frontal air bag system and seat belt buckle pretensioners in the Caravan. The occupants of the Caravan initiated forward trajectories in response to the frontal impact force and loaded the manual restraint systems. The driver sustained seat belt-related contusions, a right knee contusion, and a left wrist sprain. The front right passenger sustained seat belt-related contusions and a left knee contusion. The 3-year-old child in the CSS was not injured. The 7-year-old child sustained a lower back contusion. The occupants of the Caravan were evaluated by rescue personnel at the scene, but were not transported to a medical facility. They sought evaluation from a family physician the following day.</p> | | | |
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**VERIDIAN ON-SITE ADVANCED OCCUPANT PROTECTION SYSTEMS/CHILD
SAFETY SEAT CRASH INVESTIGATION
SCI SUMMARY TECHNICAL REPORT
VERIDIAN CASE NO. CA02-018
SUBJECT VEHICLE - 2002 DODGE CARAVAN
LOCATION - STATE OF PENNSYLVANIA
CRASH DATE - MARCH 2002**

BACKGROUND

This on-site investigation focused on a two-vehicle crash that involved a 2002 Dodge Caravan (**Figure 1**) that was equipped with an Advanced Occupant Protection System (AOPS) and a 1989 Honda Accord. The Dodge Caravan was occupied by a restrained 36-year-old male driver, a restrained 35-year-old female front right passenger, a 3-year-old male restrained in a forward-facing child safety seat (CSS) on the second seat right position, and a 7-year-old male who was unrestrained and lying across the third seat. The 18-year-old female driver of the Accord failed to negotiate a right curve and crossed the centerline into the opposite travel lanes. The vehicles impacted in an off-set head-on configuration. The impact was sufficient to deploy the frontal air bag system and seat belt buckle pretensioners in the Caravan. The occupants of the Caravan initiated forward trajectories in response to the frontal impact force and loaded the manual restraint systems. The driver sustained seat belt-related contusions, a right knee contusion, and a left wrist sprain. The front right passenger sustained seat belt-related contusions and a left knee contusion. The 3-year-old child in the CSS was not injured. The 7-year-old child sustained a lower back contusion. The occupants of the Caravan were evaluated by rescue personnel at the scene, but were not transported to a medical facility. They sought evaluation from a family physician the following day.



Figure 1. Damaged 2002 Dodge Caravan

This crash was identified by NASS PSU 06 during the weekly sampling of Police Accident Reports (PARs). This crash was not selected as a CDS case, and the police crash report was forwarded to the Veridian SCI team. The notification was forwarded to NHTSA, and an on-site investigation was initiated on May 7, 2002 due to the presence of the AOPS and frontal air bag deployment in the 2002 Dodge Caravan. The 1989 Honda Accord could not be located for inspection.

SUMMARY

Crash Site

This two-vehicle crash occurred on a four-lane local roadway at the intersection of a two-lane local roadway during nighttime hours. At the time of the crash, light rain was falling, and the asphalt roadway was wet. The four-lane roadway was illuminated by overhead lights attached to utility poles on the west roadside. The north/south roadway consisted of two travel lanes in each direction separated by a double-yellow centerline. The roadway was bordered on the west side by a concrete curb and W-beam guardrail. The east side was bordered by concrete curbs, grassy areas and trees. From the northbound approach, the north/south roadway curved to the left. The two-lane local roadway intersected the four-lane roadway in a T-configuration at the south aspect of the curve. A stop sign was present for westbound traffic on the two-lane roadway approaching the T-intersection. The posted speed limit for both roadways was 40 km/h (25 mph). The scene schematic is included as **Figure 11** of this report.

Pre-Crash

The 36-year-old male driver of the Caravan was operating the vehicle in a north direction on the inboard lane of the four-lane roadway on approach to the left curve and T-intersection (**Figure 2**). The driver stated that the approximate speed of the vehicle was 48 km/h (30 mph) prior to the impact. The 18-year-old female driver of the Honda Accord was operating the vehicle in a south direction on approach to the right curve and T-intersection (**Figure 3**). For unknown reasons, the driver of the Accord lost control of the vehicle and failed to negotiate the right curve. Due to the wet roadway conditions, the Accord initiated a slight counterclockwise (CCW) yaw, crossed the centerline, and encroached into the opposite lane into the path of the Caravan. The driver of the Accord reportedly applied the brakes in full-lockup and steered right in an attempt to regain control of the vehicle. The driver of the Caravan detected the Accord encroaching into the lane and steered right and lightly applied the brakes (no lock-up) in an attempt to avoid the collision.

Crash

The 2002 Dodge Caravan and the 1989 Honda Accord impacted in an offset, head-on configuration. The front left aspect of the Accord contacted the front left aspect of the Caravan. The principal direction of force was in the 12 o'clock sector for the Caravan. Impact resulted in moderate damage to the Caravan and was sufficient to deploy the frontal air bag system and seat belt buckle pretensioners. The damage algorithm of the WinSMASH program computed a total delta-V of 18.0 km/h (11.2 mph) for the Caravan and a total delta-V of 29.0 km/h (18.0 mph) for the Accord based on the Caravan's damage profile and the Missing Vehicle routine for the Accord. The Caravan rotated clockwise (CCW) and came to rest adjacent to the



Figure 2. Northbound approach for the Dodge Caravan



Figure 3. Southbound approach for the Honda Accord

northeast corner of the intersection facing northwest. The Accord rotated counterclockwise (CCW) and came to rest in the southbound travel lanes facing east.

Post-Crash

The driver and front right passengers of the Caravan exited the vehicle under their own power through the respective front doors. The 3-year-old was removed from the CSS by the parents, and the 7-year-old male passenger exited the Caravan under his own power through the sliding right side door. The driver stated that a cellular telephone was present in the Caravan, which was used to call for emergency assistance after the crash. The cellular phone was not in use at the time of the crash. The occupants of the Caravan were evaluated by on-scene rescue personnel and did not receive medical treatment or transportation to a hospital. They sought treatment the following day from a private physician.

It was not known how the 18-year-old female driver of the Accord exited the vehicle. She sustained police-reported moderate injuries, described as “neck and back injuries” and was transported by a family member to a local hospital for treatment. Her admission status was unknown.

VEHICLE DATA - 2002 Dodge Caravan

The 2002 Dodge Caravan Sport was identified by the Vehicle Identification Number (VIN): 1B4GP45372B (production sequence omitted). The Caravan was a five-door minivan equipped with a 3.3 liter, V-6, FFV engine, a four-speed automatic transmission, power front disc and rear drum brakes, cruise control, tinted glazing, foldaway mirrors, power door locks and power windows. The Caravan had a tilt steering column which was found in the full-up position at the time of the vehicle inspection. The exact odometer reading was unknown, as the odometer was electronic and there was no power to the vehicle. The driver estimated the odometer reading to be approximately 5790 km (3600 miles). The Caravan was equipped with Goodyear Integrity 215/70R16 tires. The specific tire data is as follows:

| Tire | Tread | Pressure |
|-------------|-----------------|----------------------|
| LF | 7.0 mm (9/32") | 0.0 kpa |
| LR | 7.0 mm (9/32") | 248.0 kpa (36.0 psi) |
| RF | 7.0 mm (9/32") | 237.9 kpa (34.5 psi) |
| RR | 8.0 mm (10/32") | 241.3 kpa (35.0 psi) |

The front seating positions in the Caravan were configured with front bucket seats with integral head restraints. The driver’s seat track position was adjusted to the full-rear position with a total travel of 15.2 cm (6.0"). The front right seat was adjusted 6.4 cm (2.5") forward of full-rear and 15.2 cm (6.0") rear of full-forward with a total travel distance of 21.6 cm (8.5"). The second row consisted of two removable fixed-track bucket seats in the outboard positions which were configured with adjustable head restraints that were in the full-down position. The third row was configured with a split removable fixed-track bench

seat with a folding back. Adjustable head restraints were located on the outboard positions of the third seat back.

VEHICLE DAMAGE

Exterior Damage - 2002 Dodge Caravan

The 2002 Dodge Caravan sustained moderate frontal damage as a result of the impact with the Honda Accord (**Figure 4**). The direct damage began 34.9 cm (13.8") left of the centerline and extended 43.2 cm (17.0") left to the front left corner. The leading edge of the hood was abraded and crushed and the left front fender was crushed rearward and displaced slightly inward from direct contact. The left headlight assembly was separated from the vehicle. The entire bumper fascia and foam filler were separated from the Caravan and the plastic fascia was not available at the time of the vehicle inspection. The foam filler was fractured 49.5 cm (19.5") left of center from direct contact and was fractured 53.3 cm (21.0") to the right of center from induced damage. The combined direct and induced damage measured the entire frontal width of the Caravan. The entire hood was displaced slightly to the right. The top aspect of the grille was fractured 10.2 cm (4.0") to the right of center and entire grille was displaced from induced damage. The left headlight assembly was slightly displaced. The left front wheel was displaced rearward from direct and induced damage, which resulted in the reduction of the left wheelbase by 3.8 cm (1.5") (**Figure 5**). The left front tire was deflated and the left front wheel cover sustained multiple abrasions. The left corner of the bumper beam was crushed rearward and displaced downward, which resulted in the induced displacement of the entire bumper beam. The Collision Deformation Classification (CDC) for the impact with the Honda Accord was 12-FLEW-1. Six crush measurements were taken along the bumper beam. At the time of this PCS, free space had not been obtained and the crush measurements were approximated as follows: C1 = 15 cm (6"), C2 = 13 cm (5"), C3 = 8 cm (3"), C4 = 3 cm (1"), C5 = 3 cm (1"), C6 = 0 cm.



Figure 4. Frontal damage to the Dodge Caravan

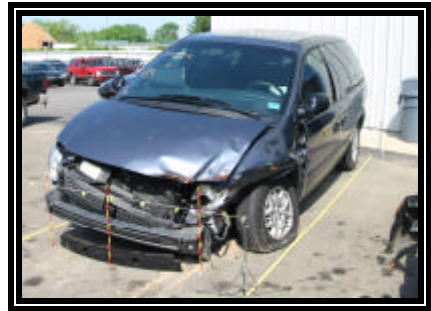


Figure 5. View of left front/left side damage to the Dodge Caravan

Interior Damage - 2002 Dodge Caravan

Interior damage to the 2002 Dodge Caravan was minor and attributed to occupant contact. The windshield laminate and vehicle glazing were intact and did not sustain damage. Both front doors were operational and slightly restricted due to the rearward displacement of the front fenders. A scuff which measured 5.7 cm (2.3") in width and 3.2 cm (1.3") in height was located on the knee bolster under the center aspect of the steering column which resulted from contact with the driver's knee. Occupant contact was also identified on the rear inboard aspect of the second row, right side bucket seat (**Figure 6**). The plastic seat back exhibited a scuff which measured 5.7 cm (2.3") in width and 7.6 cm (3.0") in height from contact with the unrestrained 7-year-old child. The rear view mirror appeared to have been displaced, although it was unknown if by occupant contact.



Figure 6. Scuff on the rear aspect of the second row right seat back

MANUAL RESTRAINT SYSTEMS - 2002 Dodge Caravan

All outboard seating positions in each row of the Caravan were configured with manual 3-point lap and shoulder belts with emergency locking retractors (ELR). The center position of the third row split bench seat was configured with a manual 2-point lap belt. There were no seat belt failures and all seat belts were in working order at the time of the vehicle inspection. The driver's belt was equipped with a sliding latch plate and the remaining lap and shoulder belts were equipped with cinching latch plates. Both front seat adjustable D-rings were adjusted to 7.6 cm (3.0") below the full-up positions. The driver's seat belt webbing exhibited a lateral crease 125.0 cm (49.0") above the lower anchor from probable latch plate loading. Minor stretch marks were located on the upper aspect of the shoulder belt and faint abrasions were present on the driver's D-ring and latch plate from occupant loading. The front right passenger's seat belt displayed minor stretch marks located 108.6 cm (42.8") above the lower anchor and a crease from latch plate loading 116.2 cm (45.8") above the lower anchor. Both front seat belts were configured with buckle pretensioners which deployed as a result of the crash. The driver's pretensioner stroke was 5.1 cm (2.0") and the front right pretensioner stroke was 3.6 cm (1.4") (**Figure 7**).



Figure 7. Front right buckle pretensioner

The manual 3-point lap and shoulder belt for the second row left seat showed signs of usage, however, it was not used in this crash. The manual 3-point lap and shoulder belt for the second row right seat showed signs of loading from the child safety seat. Minor stretch marks and crease marks were present on the webbing near the latch plate. The adjustable D-ring was in the full-down position at the time of inspection.

CHILD SAFETY SEAT - 2002 Dodge Caravan

The 3-year-old male child was restrained in a Century convertible CSS that was installed in the forward facing orientation. The CSS was not available for inspection, as it had been discarded by the family due to its involvement in the crash. The driver could not recall the specific model of the CSS. The driver stated that the CSS was approximately seven years old and was configured with a tray shield and three-point harness. The CSS was installed in the Caravan with the manual 3-point lap and shoulder belt on the second row right seat. The driver described the installation as “snug”, and stated that he pulled the shoulder belt tight to reduce the slack in the lap belt and secure the CSS to the vehicle. He stated that lateral movement was no more than 2.5 cm (1.0”) from side to side. He stated that the harness straps were routed through the top slots of the CSS, and the harness retainer clip was positioned near the mid-chest area of the child. The parents checked the tightness of the harness straps by making sure they could insert no more than one finger between the harness strap and shoulder of the child.

The driver stated that the owner’s manual and important tips were reviewed when the CSS was installed. He said the CSS was re-installed approximately once every year and was not involved in any previous crashes.

FRONTAL AIR BAG SYSTEM - 2002 Dodge Caravan

The 2002 Dodge Caravan was equipped with dual-stage air bags for the driver and front-right positions that deployed as a result of the impact with the Honda Accord. The driver’s air bag module was located in the steering wheel hub and configured with a single cover flap design hinged at the top aspect. The cover flap measured 20.6 cm (8.2”) in width and 11.4 cm (4.5”) in height and was contoured in a semi-circular fashion along the bottom aspect (**Figure 8**). The driver’s air bag was circular in shape and measured 61.0 cm (24.0”) in diameter (**Figure 9**). The air bag was tethered by two internal straps located at the 3 and 9 o’clock positions and the circular tether stitching in the center of the air bag face measured 22.9 cm (9.0”) in diameter. There were no external vent ports.



Figure 8. Driver’s air bag cover flap



Figure 9. Deployed driver’s air bag

The front right passenger's air bag deployed from a mid-mount module hinged at the top aspect. The rectangular module cover flap measured 30.5 cm (12.0") in width and 22.2 cm (8.8") in height. The cover flap was plastic construction with a vinyl outer surface that was blended with the vinyl on the instrument panel surface, with no obvious tear seams prior to deployment. The side and bottom aspects of the cover flap separated from the instrument panel as the air bag deployed.



Figure 10. Deployed front right passenger's air bag

The front right passenger's air bag measured 40.6 cm (16.0") in width and 71.1 cm (28.0") in height (**Figure 10**). There were no external vent ports or internal tether straps.

OCCUPANT DEMOGRAPHICS - 2002 Dodge Caravan

Driver

Age/Sex: 36-year-old male
 Height: 170.2 cm (67.0")
 Weight: 99.8 kg (220.0 lb)
 Seat Track Position: Full-rear
 Manual Restraint Use: Manual 3-point lap and shoulder belt
 Usage Source: Vehicle inspection, interview, police report
 Eyewear: Contact lens in right eye
 Type of Medical Treatment: Did not receive medical treatment

Driver Injuries

| Injury | Injury Severity (AIS 90/Update 98) | Injury Mechanism |
|--------------------------|---|--|
| Left shoulder contusion | Minor (790402.1,2) | Shoulder belt webbing |
| Left wrist sprain | Minor (751420.1,2) | Bracing/loading against steering wheel |
| Right knee contusion | Minor (890402.1,1) | Knee bolster |
| Left abdominal contusion | Minor (590402.1,2) | Lap belt webbing |

Injury source: Interview

Driver Kinematics

The 36-year-old male driver was seated in an upright posture with the seat track adjusted to the full-rear position. He was restrained by the manual 3-point lap and shoulder belt and had his hands at the 10 and 2 o'clock positions on the steering wheel rim. When the driver realized the impending crash, he steered right and braked in an attempt to avoid the collision, and braced his arms against the steering wheel rim. At impact with the Honda Accord, the frontal air bag system deployed and the seat belt buckle pretensioners fired. The bracing and subsequent loading of his arms against the steering wheel resulted in a left wrist sprain. The driver initiated a forward trajectory and loaded the manual restraint. He sustained a left shoulder contusion and a left abdominal contusion as a result of loading the lap and shoulder belt. His right knee struck the knee bolster, evidenced by a scuff that measured 5.7 cm (2.3") in width and 3.2 cm (1.3") in height on the bolster. He sustained a right knee contusion as a result of the knee bolster contact. His face contacted the deployed driver's air bag which offered additional protection from the frontal crash forces and from contact with the steering wheel. The driver exited the vehicle through the left front door under his own power. He did not seek medical treatment at the scene, but was evaluated by a private physician the following day.

Front Right Passenger

Age/Sex: 35-year-old female
Height: 170.2 cm (67.0")
Weight: 59.0 kg (130.0 lb)
Seat Track Position: Between mid-track and full-rear
Manual Restraint Use: Manual 3-point lap and shoulder belt
Usage Source: Vehicle inspection, interview, police report
Eyewear: Contact lenses
Type of Medical Treatment: Did not receive medical treatment

Front Right Passenger Injuries

| Injury | Injury Severity (AIS 90/Update 98) | Injury Mechanism |
|--------------------------|---------------------------------------|--|
| Right shoulder contusion | Minor (790402.1,1) | Shoulder belt webbing |
| Abdominal contusion | Minor (590402.1,0) | Lap belt webbing |
| Left knee contusion | Minor (890402.1,2) | Left aspect of center console/instrument panel |

Injury source: Interview

Front Right Passenger Kinematics

The 35-year-old female front right passenger was seated in an upright posture with the seat track adjusted between the mid-track and full-rear positions. She was restrained by the manual 3-point lap and shoulder belt. At impact, the frontal air bag system deployed. The front right passenger initiated a forward trajectory and loaded the manual restraint. She sustained a right shoulder contusion and an abdominal contusion as a result of loading the lap and shoulder belt. Her left knee struck the right aspect of the center console which resulted in a left knee contusion. She struck the deployed front right passenger's air bag which offered additional protection against the frontal crash forces and mitigated additional contact with the instrument panel. The front right passenger exited the vehicle through the right front door under her own power and assisted the children out of the vehicle. She did not receive medical treatment at the scene, but was evaluated by a private physician the following day.

Second Seat Right Child Passenger

| | |
|----------------------------|---|
| Age/Sex: | 3-year-old male |
| Height: | 83.8 cm (33.0") |
| Weight: | 16.8 kg (37.0 lb) |
| Seat Track Position: | Fixed |
| Manual Restraint Use: | Forward-facing convertible child safety seat anchored by the manual 3-point lap and shoulder belt |
| Usage Source: | Vehicle inspection, interview |
| Eyewear: | None |
| Type of Medical Treatment: | Did not receive medical treatment |

Second Seat Right Child Passenger Kinematics

The 3-year-old male child was restrained in a forward-facing Century convertible child safety seat. The CSS was installed in the second row right seat position, and was reportedly tightly installed. The child was secured in the CSS by the harness straps, and the harness retainer clip was positioned near the mid-chest area. The harness straps were reportedly snug, such that the driver could insert no more than one finger between the harness strap and the child's shoulder.

The child was asleep in the CSS prior to the crash. At impact, the child initiated a forward trajectory and loaded the harness system in the CSS. The CSS also moved in a forward direction and loaded the manual 3-point lap and shoulder belt. The child rebounded in a rearward direction and came to rest in the CSS. The child was not injured and was removed from the CSS by one of the parents. He did not receive medical treatment at the scene and was evaluated by a private physician the following day.

Third Seat Child Passenger

Age/Sex: 7-year-old male
Height: 124.5 cm (49.0")
Weight: 29.5 kg (65.0 lb)
Seat Track Position: Fixed
Manual Restraint Use: Unrestrained
Usage Source: Vehicle inspection, interview
Eyewear: None
Type of Medical Treatment: Did not receive medical treatment

Third Seat Child Passenger Injuries

| Injury | Injury Severity (AIS 90/Update 98) | Injury Mechanism |
|---------------------------|---|----------------------------|
| Lower back contusion, NFS | Minor (690402.1,8) | Second row, left seat back |

Injury source: Interview

Third Seat Child Passenger Kinematics

The 7-year-old male child was lying on his left side across the third bench seat, facing forward. He was unrestrained. At impact, the child initiated a forward trajectory and rolled forward off of the forward seat edge. The child struck the plastic cover on the rear aspect of the second row left seat back with his lower back area and sustained a contusion. A scuff mark was present on the plastic cover of the second row right seat back, most likely a result of contact with the child’s shoe. The child exited the vehicle under his own power and was evaluated by rescue personnel at the scene. He did not receive medical treatment and was evaluated by a private physician the following day.

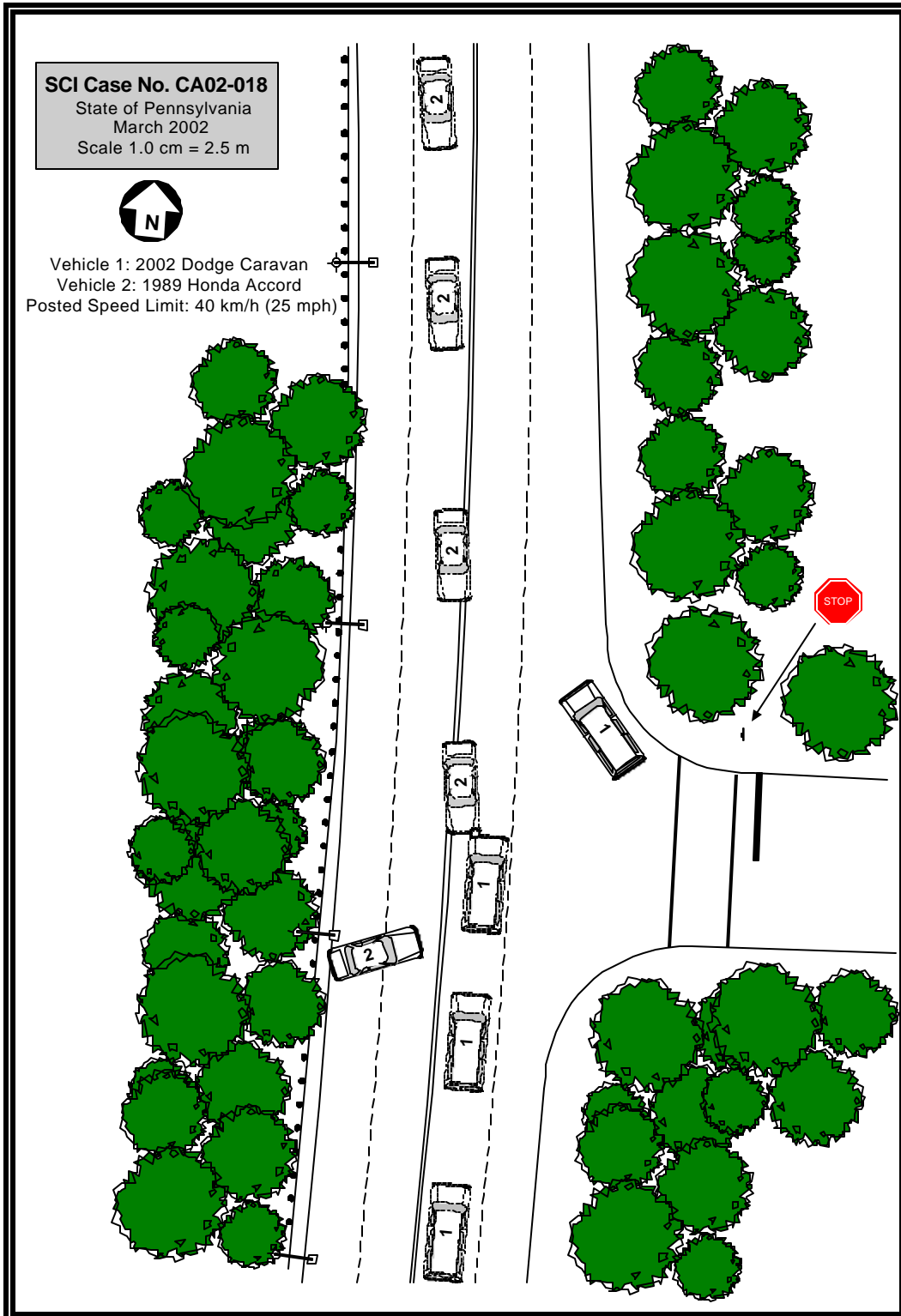


Figure 11. Scene schematic