

**TRANSPORTATION SCIENCES  
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**VERIDIAN ON-SITE AIR BAG DEPLOYMENT INVESTIGATION  
SCI TECHNICAL SUMMARY REPORT**

**VERIDIAN CASE NO. CA02-031**

**VEHICLE - 1997 HONDA CIVIC**

**LOCATION - STATE OF MASSACHUSETTS**

**CRASH DATE - JULY 2002**

Contract No. DTNH22-01-C-17002

Prepared for:

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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. <i>Abstract</i> This on-site investigation focused on a three-vehicle crash that involved a 1997 Honda Civic that was equipped with frontal air bags that deployed as a result of a head-on collision with a 1999 Toyota Tacoma pickup truck. A 60-year-old male driver of the Honda Civic was operating the vehicle on a two-lane undivided roadway while experiencing a medical episode. The driver of the Civic lost control of the vehicle and struck a guardrail on the right roadside, which caused a rapid air-out of the right front tire. The driver recovered and continued to travel in a southbound direction for approximately two miles. The driver of the Civic failed to negotiate a right curve and crossed the centerline. The Civic sideswiped a northbound 1993 Saturn that was traveling in the opposite lane. The Civic subsequently impacted a 1999 Toyota Tacoma pickup truck that was traveling behind the Saturn in a head-on configuration. The impact was sufficient to deploy the frontal air bag systems in the Civic and the Tacoma. The driver of the Civic was unrestrained and initiated a forward trajectory in response to the frontal impact. His torso loaded the deployed driver's air bag and his loading force compressed the air bag as he engaged the steering assembly. He also loaded the knee bolster and lower instrument panel with his lower extremities. The driver of the Civic sustained chest trauma which included a laceration of the thoracic aorta, bilateral flail chest laterally, maceration of the liver, and a transverse fracture of the fourth thoracic vertebrae. He also sustained a left elbow abrasion and contusion and bilateral knee abrasions and contusions. He was removed from the vehicle by rescue personnel and transported by ambulance to a local hospital where he expired shortly after arrival.			
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## TABLE OF CONTENTS

BACKGROUND .....	1
SUMMARY .....	2
Crash Site .....	2
Pre-Crash .....	2
Crash .....	2
Post-Crash .....	3
VEHICLE DATA - <i>1997 Honda Civic</i> .....	3
VEHICLE DAMAGE .....	4
Exterior Damage - <i>1997 Honda Civic</i> .....	4
Interior Damage - <i>1997 Honda Civic</i> .....	5
Exterior Damage - <i>1999 Toyota Tacoma</i> .....	7
MANUAL RESTRAINT SYSTEM - <i>1997 Honda Civic</i> .....	7
FRONTAL AIR BAG SYSTEM - <i>1997 Honda Civic</i> .....	8
OCCUPANT DEMOGRAPHICS - <i>1997 Honda Civic</i> .....	9
Driver .....	9
Driver Injuries .....	9
Driver Kinematics .....	10
Figure 16: Scene Schematic .....	12

**VERIDIAN ON-SITE AIR BAG DEPLOYMENT INVESTIGATION  
SCI TECHNICAL SUMMARY REPORT  
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SUBJECT VEHICLE - 1997 HONDA CIVIC  
LOCATION - STATE OF MASSACHUSETTS  
CRASH DATE - JULY 2002**

***BACKGROUND***

This on-site investigation focused on a three-vehicle crash that involved a 1997 Honda Civic (**Figure 1**) that was equipped with frontal air bags that deployed as a result of a head-on collision with a 1999 Toyota Tacoma pickup truck. A 60-year-old male driver of the Honda Civic was operating the vehicle on a two-lane undivided roadway while experiencing a medical episode. The driver of the Civic lost control of the vehicle and struck a guardrail on the right roadside, which caused a rapid air-out of the right front tire. The driver recovered and continued to travel in a southbound direction for approximately two miles. The driver of the Civic failed to negotiate a right curve and crossed the centerline. The Civic sideswiped a northbound 1993 Saturn that was traveling in the opposite lane. The Civic subsequently impacted a 1999 Toyota Tacoma pickup truck that was traveling behind the Saturn in a head-on configuration. The impact was sufficient to deploy the frontal air bag systems in the Civic and the Tacoma. The driver of the Civic was unrestrained and initiated a forward trajectory in response to the frontal impact. His torso loaded the deployed driver's air bag and his loading force compressed the air bag as he engaged the steering assembly. He also loaded the knee bolster and lower instrument panel with his lower extremities. The driver of the Civic sustained chest trauma which included a laceration of the thoracic aorta, bilateral flail chest laterally, maceration of the liver, and a transverse fracture of the fourth thoracic vertebrae. He also sustained a left elbow abrasion and contusion and bilateral knee abrasions and contusions. He was removed from the vehicle by rescue personnel and transported by ambulance to a local hospital where he expired shortly after arrival.



**Figure 1. On-scene photograph of the damaged 1997 Honda Civic**

This crash was identified by the local fire department and the crash information was forwarded to the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) due to a suspected air bag-related driver fatality. The Police Accident Report (PAR) was forwarded to the Veridian SCI team by NHTSA and on-site investigation was initiated.

## **SUMMARY**

### **Crash Site**

This three-vehicle crash occurred on a two-lane undivided roadway during daylight hours of July 2002. At the time of the crash, the weather was clear and the asphalt roadway surface was dry. The north/south roadway consisted of two travel lanes separated by a double-yellow centerline. The roadway was bordered by a concrete curb and concrete sidewalk on the east side and by asphalt shoulders on the west side. The crash occurred on a straight segment of the roadway with a two percent negative southbound grade. Opposing curves were present north and south of the crash site which created an “S” curve configuration. There was no traffic control present at the scene and the posted speed limit for the roadway was 56 km/h (35 mph). The scene schematic is included as **Figure 16** of this report.

### **Pre-Crash**

The 60-year-old male driver of the 1997 Honda Civic was operating the vehicle in a southbound direction on the two-lane roadway. He was reportedly experiencing a medical condition, and may have been operating the vehicle under the influence of alcohol. He lost control of the vehicle and drifted onto the right roadside and sideswiped a guardrail. The guardrail impact lacerated the sidewall of the right front tire and resulted in a rapid air-out. The vehicle was redirected onto the roadway and the driver regained control. Witnesses indicated that following the guardrail impact, the driver stopped the vehicle for a red traffic light at a subsequent intersection and continued southbound in an erratic manner when the light changed to the green phase. Approximately 0.4 km (0.3 miles) south of the intersection, the driver relinquished control of the Honda Civic. He failed to negotiate the right curve on approach to the crash site (**Figure 2**), and drifted across the centerline into the path of the northbound 1993 Saturn and 1999 Tacoma (**Figure 3**). The Saturn braked and steered right in an attempt to avoid the Civic.

### **Crash**

The left side of the Civic sideswiped the left side of the Saturn which resulted in minor damage to both vehicles. The Civic was redirected slightly to the right and into the path of the Toyota Tacoma pickup truck. The front aspect of the Honda Civic impacted the front aspect of the Toyota Tacoma. The front of the Civic underrode the front bumper of the Tacoma due to the higher ground clearance of the pickup truck. The impact resulted in moderate damage to both vehicles, and was sufficient to deploy the frontal air bag systems in the Civic and the Tacoma. The damage algorithm of the WinSMASH program computed a total delta-V of 39.0 km/h (24.2 mph) for the Honda and 27.0 km/h (16.8 mph) for the Toyota Tacoma, based on the respective crush profiles. The calculated Barrier Equivalent speed was 38.1 km/h (23.7 mph) for



**Figure 2. Southbound approach for the Honda Civic**



**Figure 3. Northbound approach for the Toyota Tacoma**

the Civic and 27.8 km/h (17.3 mph) for the Tacoma. Due to the size and weight of the Toyota Tacoma, the impact redirected the Honda rearward and slightly counterclockwise (CCW) from the point of impact approximately 1.5 m (5.0') to final rest.

**Post-Crash**

The Honda Civic came to rest facing south in the northbound lane and the Toyota Tacoma came to rest facing north in the northbound lane (**Figure 4**). A witness to the crash stated that passers-by attempted to stabilize the driver of the 1997 Honda Civic in the vehicle until rescue personnel arrived. Rescue personnel indicated that they found the driver of the Civic “under the dash” on the left side. The driver was removed from the vehicle by rescue personnel and transported by ambulance to a local hospital. Paramedics reported that the driver exhibited chest trauma, had a pulse and was breathing on his own at the time he was removed from the vehicle. The driver expired shortly after arrival at the hospital. The driver of the Toyota Tacoma was removed from the vehicle by rescue personnel and transported to a local hospital. His admission status was not known.



**Figure 4. Post-crash view showing final rest positions**

**VEHICLE DATA - 1997 Honda Civic**

The 1997 Honda Civic was identified by the Vehicle Identification Number (VIN) JHMEJ6578VS (production sequence omitted). The Civic was a four-door sedan equipped with a 1.6 liter, 4-cylinder engine, a 5-speed manual transmission, power front-disc and rear drum brakes, power steering, a tilt steering column, power windows, and power door locks. At the time of the vehicle inspection, the odometer reading was 133,187 km (82,761 miles).

The Honda Civic was equipped with Michelin All-Season Rainforce MX4 P185/65R14 tires. The specific tire data is as follows:

<b>Tire</b>	<b>Tread</b>	<b>Pressure</b>	<b>Recommended Pressure</b>
LF	5.6 mm (7/32")	244.8 kpa (35.5 psi)	210.0 kpa (30.0 psi)
LR	5.6 mm (7/32")	82.7 kpa (12.0 psi)	200.0 kpa (29.0 psi)
RF	5.6 mm (7/32")	0.0 kpa (0.0 psi)	210.0 kpa (30.0 psi)
RR	6.4 mm (8/32")	268.9 kpa (39.0 psi)	200.0 kpa (29.0 psi)

The front seating positions in the Honda Civic were configured with bucket seats with adjustable head restraints. The front left seat back was reclined 45 degrees from vertical at the time of the vehicle inspection, however, the seat back was fully reclined by rescue personnel to facilitate the removal of the

driver at the crash scene. The pre-crash orientation was not known. The rear seating positions were configured with a bench seat with a 60/40 split folding back and integral head restraints for the outboard positions.

## **VEHICLE DAMAGE**

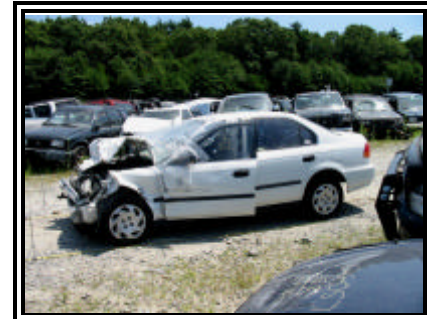
### **Exterior Damage - 1997 Honda Civic**

The 1997 Honda Civic sustained minor right side damage as a result of the pre-crash sideswipe impact with the guardrail. The impact resulted in longitudinal abrasions that began on the right front corner and extended rearward 166.4 cm (65.5") along the right side plane. Minor lateral crush was noted on the right front fender and measured 4.4 cm (1.8") at the rear aspect of the fender. The right front corner of the bumper fascia sustained heavy abrasions as a result of the contact with the guardrail. The guardrail contact also resulted in a laceration and hole in the sidewall of the right front tire that measured 8.9 cm (3.5") in width and 6.4 cm (2.5") in height (**Figure 5**). The right front wheel cover was abraded and deformed from the direct contact. An abrasion that measured 27.9 cm (11.0") in length was also present on the right rear quarter panel above the right rear wheel. The Collision Deformation Classification (CDC) for the guardrail impact was 12-FRES-1.



**Figure 5. View of abraded right front wheel cover and sidewall laceration**

The Honda Civic also sustained minor left side damage (**Figure 6**) which resulted from the sideswipe with the 1993 Saturn. The left front fender and left front door were abraded longitudinally from direct contact with the Saturn. The initial direct contact and lateral deformation could not be accurately determined due to masking damage from the frontal impact. The abrasions extended rearward along the left side plane 52.1 cm (20.5") aft of the leading edge of the left front door. The left front wheel cover was abraded. Three linear abrasions were located on the left side aspect of the bumper fascia, but it was not known if they were crash-related.



**Figure 6. Left side view of 1997 Honda Civic**



The frontal impact with the Toyota Tacoma pickup truck resulted in moderate frontal damage to the 1997 Honda Civic (**Figures 7 and 8**). The direct damage began 50.8 cm (20.0") right of center on the bumper fascia and extended laterally to the front left corner. The Civic underrode the Tacoma which allowed the grille area and hood to sustain direct contact damage evidenced by buckling, longitudinal abrasions and rearward crush. The bottom aspect of the bumper fascia was heavily abraded longitudinally from contact with the roadway surface and the fascia was fractured in four places from the impact. The entire bumper fascia was separated at the time of the vehicle inspection. The sheet metal and left corner of the upper radiator support were torn and crushed from direct contact. The protruding frame rails of the pickup truck penetrated the right aspect of the radiator core and components to the left of the left aspect of the radiator core. The upper and lower radiator supports and bumper beam were crushed rearward. The styrofoam filler was separated from the bumper beam at the time of the vehicle inspection. The left front wheel was displaced rearward and the left wheelbase was shortened 9.4 cm (3.7"). The right front wheel sustained minor rearward displacement and the right wheelbase was shortened 2.5 cm (1.0"). Both front fenders sustained induced buckling. The CDC for the frontal impact with the Toyota Tacoma was 12-FDEW-2. Six crush measurements were taken along the front bumper beam and were as follows: C1 = 22.2 cm (8.8"), C2 = 34.9 cm (13.8"), C3 = 37.4 cm (14.8"), C4 = 37.4 cm (14.8"), C5 = 34.2 cm (13.5"), C6 = 3.2 cm (1.3").

#### **Interior Damage - 1997 Honda Civic**

Interior damage to the 1997 Honda Civic was moderate and attributed to occupant contact and passenger compartment intrusion. The entire windshield was fractured from impact forces. A vertical laceration in the windshield laminate that measured 33.0 cm (13.0") in length was located 15.2 cm (6.0") left of center and 6.4 cm (2.5") below the windshield header. The windshield was also holed on the right aspect (**Figure 9**). The hole measured 38.1 cm (15.5") in height and 15.2 cm (6.0") in width and was located 33.7 cm (13.3") right of center and began 11.4 cm (4.5") below the windshield header. A light strand of hair was present in the fractured laminate, and a small clump of dark hair measuring 1.0 cm (0.4") was present on the inboard side of the hole on the outer aspect on the laminate 31.8 cm (12.5") below the header. The source of the hair was unknown, and the color of the small clump of hair was inconsistent with the driver's hair color. The left front window was



**Figure 7. View of frontal damage to the Honda Civic**



**Figure 8. Frontal view of damage to the Honda Civic**

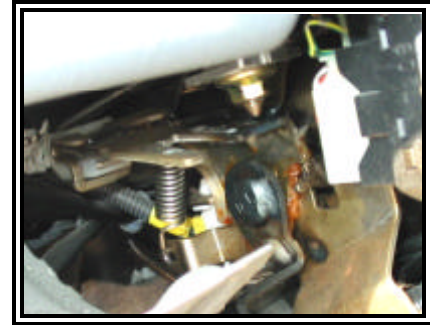


**Figure 9. View of holed windshield**

intact but was out of the window frame at the top aspect.

The entire steering wheel rim was deformed forward from occupant contact, and the all of the spokes were partially separated. The steering column was compressed forward with complete separation of the shear brackets (**Figure 10**).

The interior surface of the left front door was abraded in a triangular fashion 20.3 cm (8.0") aft of the leading door edge and 2.5 cm (1.0") below the belt line and measured 7.0 cm (2.5") in length. The knee bolster and left instrument panel were fractured and holed on both sides of the steering column from contact with the driver's knees and lower legs (**Figures 11 and 12**). The fracture on the left side of the column measured 12.7 cm (5.0") in width and the fracture on the right side of the column measured 10.2 cm (4.0") in width. The brake pedal was displaced slightly to the right. The rear view mirror was separated from the windshield. The glove box door was open at the time of the vehicle inspection, and would not close due to induced damage from the crash. A thin longitudinal abrasion that measured 7.0 cm (2.8") in length was present on the head liner 17.1 (6.8") left of center and 31.8 cm (12.5") rear of the windshield header. Small amounts of body fluid (blood) were present on both front seat cushions and on the front aspect of the front right seat back. The front left seat back was rotated in a slight counterclockwise (CCW) direction. Longitudinal intrusions into the driver's seating position included the left toe pan and the left instrument panel. The right toe pan intruded into the front right occupant space.



**Figure 10. View of separated left shear bracket**



**Figure 11. View of steering wheel and contact points**



**Figure 12. Close-up of damaged knee bolster and instrument panel**

### **Exterior Damage - 1999 Toyota Tacoma**

The 1999 Toyota Tacoma sustained moderate frontal damage as a result of the impact with the Honda Civic (**Figure 13**). The direct damage was concentrated on the front bumper and began 52.1 cm (20.5") right of center and extended 128.3 cm (50.5") along the bumper to the front left corner. The bumper sustained longitudinal abrasions and the bottom aspect was deflected rearward and upward due to the underride of the Civic. The bumper crush allowed both frame rails to protrude through the lower aspect of the bumper. The left frame rail was protruded 19.1 cm (7.5") and the right frame rail protruded 28.6 cm (11.3"). The right corner of the bumper was pulled inward slightly from induced damage. There was no direct contact damage above the bumper of the Toyota Tacoma. The direct and induced damage involved the entire frontal width of the pickup truck. The grille was separated from the Tacoma, the left head lamp was slightly displaced, and the right bumper corner was pulled inward slightly from induced damage. The left front wheel was displaced rearward and restricted against the left front fender which resulted in the shortening of the left wheelbase by 4.2 cm (1.7"). Both front fenders were buckled from induced damage. The CDC for the frontal impact with the Honda Civic was 12-FDEW-2. Six crush measurements were taken along the front bumper of the Toyota Tacoma and were as follows: C1 = 14.0 cm (5.5"), C2 = 16.5 cm (6.5"), C3 = 22.2 cm (8.8"), C4 = 24.8 cm (9.8"), C5 = 17.1 cm (6.8"), C6 = 3.8 cm (1.5").



**Figure 13. View of frontal damage to the Toyota Tacoma**

### **MANUAL RESTRAINT SYSTEMS - 1997 Honda Civic**

The 1997 Honda Civic was configured with manual 3-point lap and shoulder belts with sliding latch plates for both front positions and the rear outboard positions. The front seat restraints were configured with adjustable D-rings that were in the full-down position. A 2-point lap belt with a locking latch plate was present for the rear center position. The driver's manual restraint was configured with a emergency locking retractor (ELR). The front right passenger's seat belt and the rear outboard seat belts were equipped with switchable/automatic locking retractors (ALR's). The driver's seat belt was not in use at the time of the crash. There was no evidence of loading to the webbing, no abrasions to the D-ring or latch plate, and the retractor functioned properly at the time of the vehicle inspection.

### ***FRONTAL AIR BAG SYSTEM - 1997 Honda Civic***

The 1997 Honda Civic was equipped with frontal air bags for the driver and front right passenger positions that deployed as a result of the impact with the Toyota Tacoma pickup truck (**Figure 14**). The driver's air bag was housed in the steering wheel hub with asymmetrical H-configuration cover flaps. The top flap measured 10.2 cm (4.0") in width at the top aspect, 7.6 cm (3.0") in height, and 14.6 cm (5.8") in width at the tear seam. The bottom flap measured 8.3 cm (3.3") in width at the bottom aspect and 5.1 cm (2.0") in height. The driver's air bag was circular in shape and measured 61.0 cm (24.0") in diameter in its deflated state. The air bag was vented by two circular ports that measured 3.8 cm (1.5") in diameter and were located at the 11 and 1 o'clock positions on the rear aspect. The air bag was also tethered by two internal straps that measured 7.0 cm (2.8") in width and were located at the 12 and 6 o'clock positions. A faint abrasion was present on the top right quadrant of the air bag membrane located 19.1 cm (7.5") from the center of the air bag and measured 7.0 cm (2.8") in length and 3.8 cm (1.5") in width. A body fluid (blood) transfer was located on the bottom aspect of the air bag adjacent to the tear seam. The body fluid transfer measured 3.0 cm (1.2") in length and 0.8 cm (0.3") in height. Faint green/blue fabric transfers were located adjacent to the body fluid transfer along the bottom aspect of the air bag on the air bag seam (**Figure 15**). The transfers measured 8.9 cm (3.5") in length. Thin diagonal green fabric transfers/striations were located along the outboard air bag seam on the left lower quadrant. The transfers measured 14.0 cm (5.5") in length along the air bag seam.

The front right passenger's air bag deployed from a top-mount module with symmetrical H-configuration cover flaps. The cover flaps measured 4.8 cm (1.9") in height and 23.5 cm (9.3") in width. The front right passenger's air bag measured 45.7 cm (18.0") in width and 60.1 cm (24.0") in height. The air bag was not tethered and was vented by two circular ports that measured 3.8 cm (1.5") in diameter and were located at the 9 and 3 o'clock positions.



**Figure 14. Deployed frontal air bags in the Honda Civic**



**Figure 15. Body fluid transfer and fabric transfer on bottom aspect of the driver's air bag**

**OCCUPANT DEMOGRAPHICS - 1997 Honda Civic**

**Driver**

Age/Sex: 60-year-old male  
 Height: 173 cm (68")  
 Weight: 82 kg (180 lb)  
 Seat Track Position: Between mid track and full-rear track positions, based on the physical characteristics of the driver  
 Manual Restraint Use: Unrestrained  
 Usage Source: Vehicle inspection, rescue personnel, police report  
 Eyewear: Unknown  
 Type of Medical Treatment: Transported by ambulance to a local hospital and expired on arrival

**Driver Injuries**

<b>Injury</b>	<b>Injury Severity (AIS 90/Update 98)</b>	<b>Injury Mechanism</b>
Laceration of the thoracic aorta with greater than 20 percent blood loss	Critical (420210.5,4)	Steering wheel/column as a result of loading through the driver's air bag
Bilateral flail chest laterally	Critical (450266.5,3)	Steering wheel/column as a result of loading through the driver's air bag
Maceration of the liver	Critical (541828.5,1)	Steering wheel/column as a result of loading through the driver's air bag
Transverse fracture of the fourth thoracic vertebrae	Moderate (650416.2,7)	Indirect - Steering wheel/column as a result of loading through the driver's air bag
Posterior left elbow abrasion	Minor (790202.1,2)	Left interior door panel
Posterior left elbow contusion	Minor (790402.1,2)	Left interior door panel
Bilateral knee and lower leg abrasions	Minor (890202.1,3)	Left instrument panel/knee bolster
Bilateral knee and lower leg contusions	Minor (790402.1,3)	Left instrument panel/knee bolster

Injury source: Autopsy report

### **Driver Kinematics**

The 60-year-old male driver was operating the vehicle while experiencing a medical episode. Reports stated that the driver's blood sugar level was 30 mg at the time of the crash. A blood sugar level of that magnitude can cause a decreased level of alertness. He was unrestrained by the available manual 3-point lap and shoulder belt. At the time of the vehicle inspection, the driver's seat was adjusted to 6.4 cm (2.5") rear of full-forward and 12.7 cm (5.0") forward of full-rear. The seat track position was not consistent the driver's estimated height and weight. Based on SCI experience, the physical size of the driver would have necessitated a mid-to-rear seat track position. The seat track was moved to a forward track position between the extrication of the driver and the SCI vehicle inspection. The pre-crash seat back recline angle was not known.

The driver was most-likely conscious during the pre-crash guardrail impact. The guardrail impact did not result in significant occupant displacement, contacts, or injury, and the driver was able to regain his composure after the impact. Witnesses indicated that after the guardrail impact, the driver regained control of the vehicle and had stopped for a red traffic light at a subsequent intersection and continued southbound when the light changed to the green phase. Approximately 0.4 km (0.3 miles) south of the intersection, the driver relinquished control of the Honda Civic. Due to his condition, his level of alertness was most likely altered. The vehicle crossed the centerline and sideswiped the 1993 Saturn. The Civic was deflected slightly to the right and into the path of the northbound Toyota Tacoma. The unrestrained driver may have been redirected slightly left as a result of the sideswipe event.

At impact with the Toyota Tacoma, the frontal air bag system deployed and the driver initiated a forward trajectory. The air bag probably displaced his arms outward, and his left hand contacted the interior surface of the right door, evidenced by an abrasion to the surface of the interior door. He sustained a left posterior elbow abrasion and contusion from the door contact. The air bag may have expanded against the driver's clothing evidenced by green fabric transfers on the left outboard aspect and the bottom right aspect, although, the specific nature of his clothing could not be confirmed. The driver impacted the knee bolster and left instrument panel with his knees which resulted in fractures and displacement in the knee bolster and instrument panel. The instrument panel/knee bolster contacts resulted in bilateral knee and lower anterior leg abrasions and contusions. His torso continued in a forward direction and he loaded the deployed driver's air bag. Due to the 39.0 km/h (24.2 mph) delta-V, the driver compressed the deployed air bag against the steering wheel. His loading force was transmitted through the air bag and into the steering column, evidenced by the complete separation of the shear brackets and deformation to the steering wheel rim and spokes. The loading to the steering wheel assembly resulted in a bilateral flail chest laterally, a laceration of the thoracic aorta, and maceration of the liver. The total blood loss associated with the thoracic aorta injury and liver injury was over 1500 ml. He sustained a transverse fracture of the 4<sup>th</sup> thoracic vertebrae as an indirect result of loading the steering wheel assembly. He rebounded rearward and came to rest slumped partially to the right and partially under the steering assembly. Rescue personnel described the position of his lower extremities as "under the dash." He was removed from the vehicle by rescue personnel. Paramedics reported that the driver had a pulse and was breathing on his own when he was removed from the vehicle. He was transported by ambulance to a local hospital and rescue personnel

reported administering 1000 cc's of IV fluid during transport. The driver expired after arrival at the hospital.

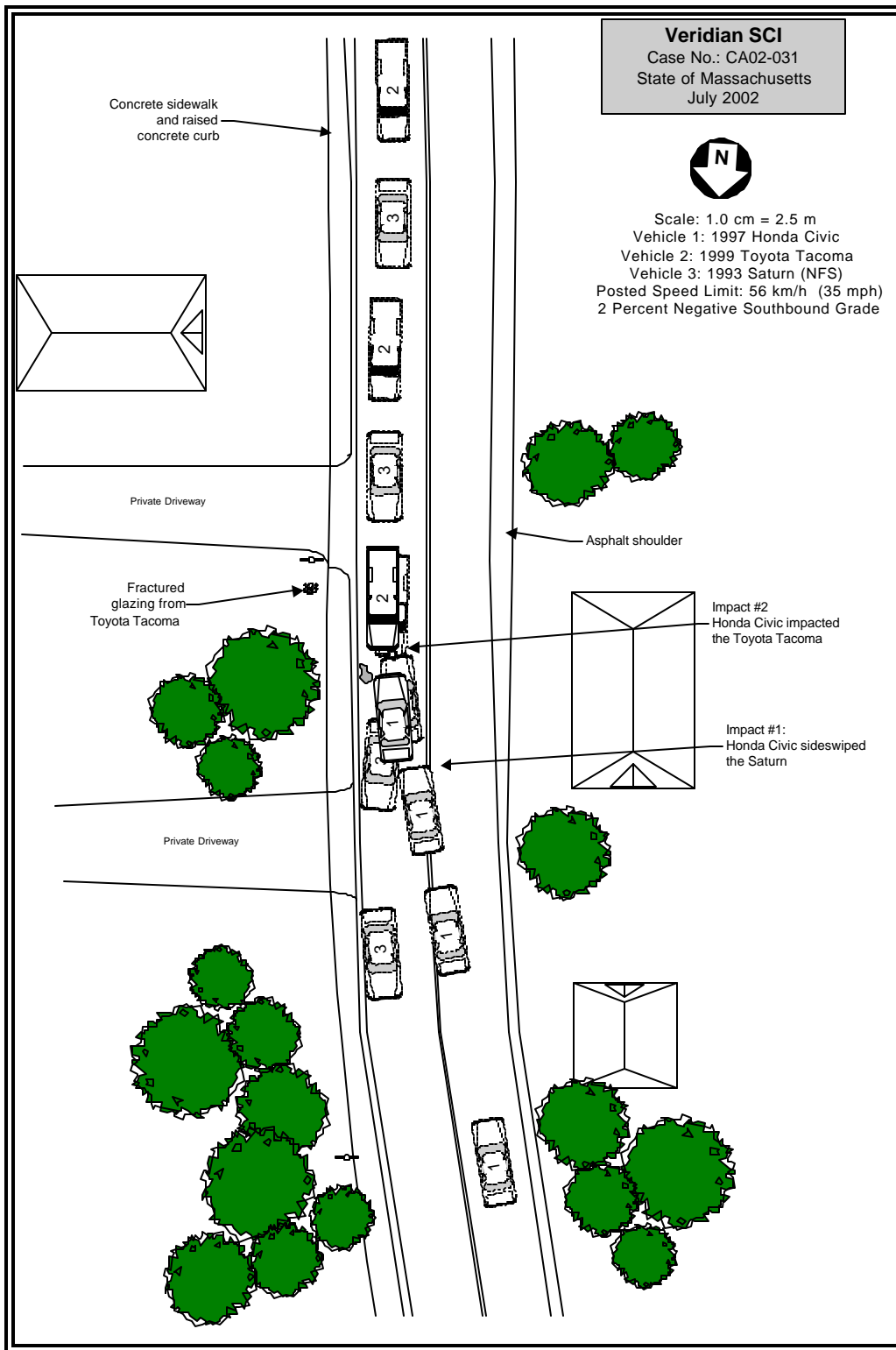


Figure 16. Scene schematic