



















































































# MISSOURI STATE HIGHWAY PATROL TECHNICAL ACCIDENT INVESTIGATION REPORT

Skidding  
Sideways,  
Vaulted

County: Lewis

Date: [REDACTED]

Time: 1230 hours

Location: [REDACTED]

Driver: [REDACTED]

Original Investigating Officer: Trooper Anthony A. O'Brien, #810

Reconstructionist: Sergeant Gregory K. Leftwich, #748

Date Reconstructionist Notified: July 28, 2005

Date of Report: July 28, 2005

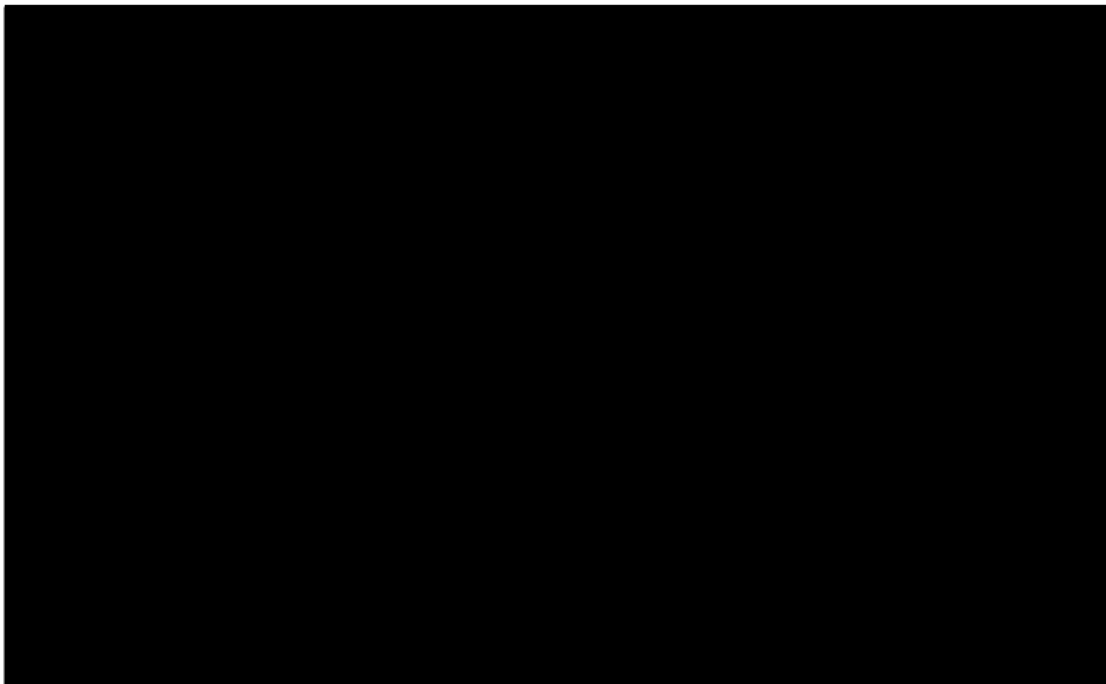
Reviewed By: Sergeant G. W. Bergfeld, #106

Reviewed Date: August 29, 2005

**Synopsis**

At approximately 1230 hours, [REDACTED] a one-vehicle crash occurred in Lewis County on US 61, approximately 73 feet north of [REDACTED]. [REDACTED] was killed when the southbound vehicle he was operating traveled off the west side of the road, struck a guardrail, vaulted into the air, struck an embankment, and came to rest on its top in a creek bed. [REDACTED] vehicle was also killed in this crash.

At approximately 1025 hours, [REDACTED] I was notified by Troop B Radio Personnel of this crash. I was also notified, Trooper Anthony A. O'Brien, the primary investigating officer, had requested a reconstruction of the crash in accordance with General Order 63-01. I arrived at the scene of the crash at 1056 hours and contacted Trooper O'Brien.



**Environmental Factors**

[REDACTED] US 61 at the crash location is a four-lane highway. The northbound and southbound lanes are divided by a grass median and they cross Durgens Creek on separate bridges. The southbound lanes are level, have a slight left-hand curve, and are 23 feet 8 inches wide. The right shoulder is 10 feet 11 inches wide and the left shoulder is 8 feet 1 inch wide. The roadway is composed of concrete and the shoulders are composed of a bituminous material. The roadway and shoulders at the crash location appear to be well maintained with no noticeable defects.

Missouri Department of Transportation blueprints of the crash location are attached to this report.

This crash was estimated to have occurred at approximately 1230 hours on [REDACTED]. The climate was mild, the sky clear, and the temperatures in the mid 80's. Weather and roadway conditions were not factors in this crash.

### Mechanical Factors

[REDACTED]

The odometer reading could not be obtained due to the damage incurred by vehicle #1 during the crash. The steering, suspension, and braking systems were intact and appeared to be in working order prior to the crash. Both front tires were Douglas Xtra Trac AW P185/75 R14's. The rear tires on Vehicle #1 were Cooper Trend Setter SE, P185/75 R14's. Upon my inspection, both front tires had 8/32 of an inch tread depth and were flat, this apparently occurring during the crash. The rear tires had 5/32 of an inch of tread depth. The left rear tire upon my inspection was flat however the right rear tire was still inflated. This vehicle is not equipped with driver or passenger side airbags. The driver and his passenger did utilize the seatbelts in this vehicle. The vehicle received severe damage to the entire vehicle especially the roof of the passenger compartment.

Vehicle #1 was towed from the scene by Robert's Garage of Ewing, Missouri and taken to their facility. I inspected the principal vehicle at the scene and at Robert's garage on [REDACTED].

The mechanical condition of the principal vehicle was not a factor in this crash.

### Human Factors



### Scene Investigation

I made a thorough investigation of the crash scene on [REDACTED] and August 1, 2005. Photographs of the scene and the principal vehicle were obtained and are attached to this report. Measurements of the crash scene were obtained by Trooper Anthony A. O'Brien and were recorded on his diagram contained in the Missouri Uniform Accident report, SHP-2N, [REDACTED] which he completed during his investigation of the crash. A copy of the diagram completed by Trooper O'Brien is attached to this report.

Evidence at the crash scene indicated Vehicle #1 was southbound on US 61 approaching Bridge #A3148 which crosses Durgens Creek. Vehicle #1 went out of control and went into a critical scuff. The vehicle rotated clockwise and skidded off the west side of the road. The vehicle struck a guardrail as it vaulted into the air when it left the roadway. Vehicle #1 flipped through the air a distance of 157 feet and falling 20.7 feet before striking the south bank of Durgens Creek. Vehicle #1 then came to final rest on its top in the Creek bed facing east.

There were pre-impact tire marks left by the principal vehicle and it vaulted through the air in this crash. The following is a scientific assessment of the speed of the Walker vehicle. First, the coefficient of friction was determined for the roadway at the crash scene. Then measurements of two chords and middle ordinates of the yaw mark made by Vehicle #1 were obtained. The measurements of the chord, middle ordinate, and the coefficient of friction were then placed into critical speed formulas to determine a range for the speed of the Walker Vehicle prior to leaving the roadway. Sergeant Mike Mahon, Major Crash Investigation Unit, and I made measurements, with the use of a total station device, of the distance the Walker vehicle vaulted from the guardrail to where it landed in the creek bed. Sergeant Mahon then placed those measurements into a vault formula (Appendix II) to determine the speed the Walker vehicle was traveling when it vaulted.

The coefficient of friction (drag factor) of the roadway's surface was determined with the use of a drag tire. The tire was weighed and then pulled on the same surface and in the same direction vehicle #1 skidded. The same scale used to weigh the drag tire was used when the drag tire was pulled on the roadway's surface. The weight of the drag tire was 30 pounds. The amount of force needed to pull the drag tire on the roadway's surface in the same direction vehicle #1 skidded was 23 pounds. The coefficient of friction of US 61 at the crash location was determined to be .76.

f = Drag Factor

F = Force needed to pull the drag tire on the surface to be measured.

W = Weight of the drag tire

Formula

$$F = 23$$

$$W = 30$$

$$f = \frac{F}{W} = \frac{23}{30} = .76$$

The critical speed of vehicle #1 was determined from measurements of the yaw marks it made during the crash. A chord and middle ordinate measurement was obtained in the first third of the yaw mark after rear wheel crossover to determine the radius of the curved tire mark made by vehicle #1. A second chord and middle ordinate measurement were made farther into the skid to give a range in speed for vehicle #1. The Radius' and the Drag factor were then placed into the critical speed formula to determine vehicle #1's speed. The first chord measurement used was 30 feet and the middle ordinate was 2 inches (.16 feet). The drag factor or coefficient of friction from the above formula was .76.

Radius Formula

$$R = \frac{C^2}{8(m)} + \frac{m}{2}$$

R = Radius

C = Chord = 30

m = Middle Ordinate = .16

8 = mathematical constant

2 = mathematical constant

$$R = \frac{30^2}{8(.16)} + \frac{.16}{2}$$

$$R = \frac{900}{1.28} + .08$$

$$R = 703.125 + .08$$

$$R = 703.205$$

The radius is adjusted by subtracting half of the vehicle's width from the existing radius to accommodate for the travel of the center of mass. The width of vehicle #1 is 5 feet.

$$R = 703.205 - 2.5 = 700.705$$

Critical Speed Formula

$$S = 3.86 \times \sqrt{R(f)}$$

S = Speed  
 R = Radius = 700.705  
 f = Drag Factor = .76  
 3.86 = mathematical constant

$$S = 3.86 \times \sqrt{700.705(.76)}$$

$$S = 3.86 \times \sqrt{532.5358}$$

$$S = 3.86 \times 23.0767372$$

$$S = 89.07620561$$

A second chord and middle ordinate measurement were obtained from the yaw mark made by vehicle #1 during this crash. The second chord measurement used was 30 feet and the second middle ordinate was 2.5 inches (.20 feet). The drag factor or coefficient of friction was .76.

Radius Formula

$$R = \frac{C^2}{8(m)} + 2$$

$$R = \frac{30^2}{8(.20)} + 2$$

$$R = \frac{900}{1.6} + .1$$

$$R = 562.5 + .1$$

$$R = 562.6$$

The radius is adjusted by subtracting half of the vehicle's width from the existing radius to accommodate for the travel of the center of mass. The width of vehicle #1 is 5 feet.

$$R = 562.6 - 2.5 = 560.1$$

### Critical Speed Formula #2

$$S = 3.86 \times [\sqrt{R(F)}]$$

$$S = 3.86 \times [\sqrt{560.1(.76)}]$$

$$S = 3.86 \times [\sqrt{425.676}]$$

$$S = 3.86 \times 20.63191702$$

$$S = 79.6391997$$

The speed of vehicle #1 was determined to be from 89 to 79 miles per hour. Sergeant Mike Mahon used measurements taken from the vault of vehicle #1 and determined the speed to be 89 miles per hour (see Appendix II). The posted speed limit for US 61 at the crash scene is 65 miles per hour. Speed was a factor in this crash.

### Findings

Vehicle #1 was southbound on US 61 approaching bridge [REDACTED]. Vehicle #1 went into a critical scuff and skidded off the west side of the road. The vehicle struck a guardrail as it vaulted into the air. The vehicle flipped through the air and struck the south bank of [REDACTED]. Vehicle #1 came to rest on its top in the creek bed facing east. The crash occurred on [REDACTED] at approximately 1230 hours and was not discovered until approximately 0945 hours, July 28, 2005. Driver #1 and his passenger were killed during the crash.

### Event Analysis

Investigation has shown that weather, roadway conditions, and mechanical conditions of the principal vehicle were not factors in this crash. There is no evidence to indicate [REDACTED] was impaired at the time of the crash.

US 61 is posted at 65 miles per hour. [REDACTED] was traveling between 80 and 89 miles per hour. For some unknown reason [REDACTED] was not able to maintain complete control of his vehicle. [REDACTED] attention and excessive speed are the primary contributing factors in this crash.

Sergeant G.K. Leftwich, #748  
Reconstructionist

Sergeant G.W. Bergfeld, #106  
Reviewing Reconstructionist

**Appendixes**

- Appendix I - Photo Log
- Appendix II - Mathematical equations (4 pages).
- Appendix III - Delorme Map locating crash area.
- Appendix IV - Delorme Map locating crash area (magnified view).
- Appendix V - Diagram of the crash scene.
- Appendix VI - MoDOT blueprint of the roadway at the crash location.
- Appendix VII - MoDOT blueprint of the roadway prior to the crash location.

## Appendix I

# Photograph Log

**Date of Crash:** [REDACTED]

**Location of Crash:** [REDACTED]

**Driver #1:** [REDACTED]

**Original Investigating Officer:** Trooper Anthony A. O'Brien, #810

**Reconstructionist:** Sergeant G.K. Leftwich, #748

**Photographer:** Sergeant G.K. Leftwich, #748

The following is a log of the photographs taken at the crash scene location and the principal vehicle. The negatives are stored at the Missouri State Highway Patrol General Headquarters, Accident Records Section, in Jefferson City, Missouri.

1. Photo #2 - View of Vehicle #1 at final rest.
2. Photo #3 - View of the crash location looking north.
3. Photos #4 through #12 - Views of Vehicle #1 at the final rest.
4. Photos #13 through #19 - Views of the roadway at the crash location looking south.
5. Photos #20 through #22 - Views of the skid marks and damage to the guardrail at the crash location.
6. Photos #23 through #25 - View of the crash location looking south from the guardrail.
7. Photos #26 and #27 - Views of the crash location, looking north.
8. Photos #28 through #36 - Views of Vehicle #1 taken at Robert's garage in Ewing, Missouri.
9. Photo #37 - View of Vehicle #1's V.I.N.

## Appendix II

C:\RECONSTRUCTIONS\2005\0727B\0727B

Job Description:

11:08:33

Page No.: 1

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|        |             |             |            |    |
|--------|-------------|-------------|------------|----|
| 1 N:   | 0.000 E:    | 0.000 El:   | 100.000 D: | TS |
| 100 N: | 20.546 E:   | -14.004 El: | 98.876 D:  | RP |
| 101 N: | 196.848 E:  | -32.718 El: | 99.331 D:  | TM |
| 102 N: | 149.307 E:  | -27.396 El: | 100.154 D: | TM |
| 103 N: | 97.490 E:   | -19.734 El: | 100.806 D: | TM |
| 104 N: | 55.978 E:   | -14.310 El: | 101.593 D: | TM |
| 105 N: | 48.768 E:   | -18.123 El: | 100.625 D: | TM |
| 106 N: | 30.981 E:   | -7.092 El:  | 101.059 D: | TM |
| 107 N: | 53.431 E:   | -20.894 El: | 103.646 D: | GR |
| 108 N: | 47.717 E:   | -18.111 El: | 103.600 D: | GR |
| 109 N: | 42.353 E:   | -15.401 El: | 103.649 D: | GR |
| 110 N: | 37.121 E:   | -12.038 El: | 103.423 D: | GR |
| 111 N: | 32.078 E:   | -8.292 El:  | 103.514 D: | GR |
| 112 N: | 26.781 E:   | -5.028 El:  | 103.606 D: | GR |
| 113 N: | 21.363 E:   | -1.864 El:  | 103.702 D: | GR |
| 114 N: | 31.036 E:   | -7.214 El:  | 101.034 D: | MP |
| 115 N: | 48.601 E:   | -18.284 El: | 100.642 D: | MP |
| 116 N: | -113.718 E: | 15.677 El:  | 82.900 D:  | MP |
| 117 N: | -110.412 E: | 15.993 El:  | 78.257 D:  | MP |
| 118 N: | 20.552 E:   | -14.013 El: | 98.877 D:  | RM |

104 N: 55.978 E: -14.310 El: 101.593 D: TM

101 N: 196.848 E: -32.718 El: -99.331 D: TM  
2.262

$2.262/142.069 = 0.015921953$  1.5 percent grade or 0.91 degrees

As Vehicle #1 scuffed across the left lane, right lane and the shoulder, it was traveling up a 1.5 percent grade or 0.9 degree.

The horizontal distance was measured from the center of the guard rail damage to the impact with the bank at the base of the small tree. That was a distance of 157.0'. The car fell 20.7' from 103.6' (height of the guardrail) to 82.9' (height of the base of the small tree). I ranged the takeoff angle from 0 to 29.9 degrees.

## Appendix II

**CASE NUMBER:** None

\* \* SPEED W/ AIRBORNE \* \*

$$S = \frac{2.73 \times D}{\cos \theta \times \sqrt{h^2 + (D \times \tan \theta)^2}}$$

$$S = \frac{2.73 \times 157.0000}{0.9998 \times \sqrt{20.7000^2 + (157.0000 \times 0.0158)^2}}$$

$$S = \frac{428.6100}{0.9998 \times \sqrt{23.1806}}$$

$$S = \frac{428.6100}{0.9998 \times 4.8146}$$

$$S = 89.0414$$

S = The Speed in MPH  
 2.73 = A Constant  
 D = The Distance in Feet  
 h = The Height in Feet  
 $\theta$  = The Departure Angle in Degrees.

| INPUTS:                  |          | RESULTS:                |          |
|--------------------------|----------|-------------------------|----------|
| The Distance in Feet is: | 157.0000 | The Speed in MPH is:    | 89.0414  |
| The Height in Feet is:   | 20.7000  | The Velocity in FPS is: | 130.5940 |
| The Depart. Angle is:    | 0.9100   |                         |          |

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## Appendix II

**CASE NUMBER: None**

### INCREMENTATION CALC'S

| <u>Dep Angle</u> | <u>Speed</u> | <u>Dep Angle</u> | <u>Speed</u> | <u>Dep Angle</u> | <u>Speed</u> |
|------------------|--------------|------------------|--------------|------------------|--------------|
| 0.0000           | 94.2062      | 5.0000           | 73.3406      | 10.0000          | 62.5735      |
| 0.1000           | 93.6156      | 5.1000           | 73.0493      | 10.1000          | 62.4113      |
| 0.2000           | 93.0244      | 5.2000           | 72.7691      | 10.2000          | 62.2554      |
| 0.3000           | 92.4126      | 5.3000           | 72.5007      | 10.3000          | 62.0957      |
| 0.4000           | 91.8443      | 5.4000           | 72.2258      | 10.4000          | 61.9369      |
| 0.5000           | 91.2538      | 5.5000           | 71.9711      | 10.5000          | 61.7798      |
| 0.6000           | 90.7072      | 5.6000           | 71.6954      | 10.6000          | 61.6243      |
| 0.7000           | 90.1388      | 5.7000           | 71.4302      | 10.7000          | 61.4697      |
| 0.8000           | 89.6111      | 5.8000           | 71.1834      | 10.8000          | 61.3228      |
| 0.9000           | 89.0729      | 5.9000           | 70.9184      | 10.9000          | 61.1705      |
| 1.0000           | 88.5631      | 6.0000           | 70.6624      | 11.0000          | 61.0207      |
| 1.1000           | 88.0337      | 6.1000           | 70.4244      | 11.1000          | 60.8777      |
| 1.2000           | 87.5518      | 6.2000           | 70.1742      | 11.2000          | 60.7208      |
| 1.3000           | 87.0680      | 6.3000           | 69.9280      | 11.3000          | 60.5740      |
| 1.4000           | 86.5651      | 6.4000           | 69.6972      | 11.4000          | 60.4348      |
| 1.5000           | 86.1060      | 6.5000           | 69.4555      | 11.5000          | 60.2911      |
| 1.6000           | 85.6209      | 6.6000           | 69.2166      | 11.6000          | 60.1549      |
| 1.7000           | 85.1768      | 6.7000           | 68.9937      | 11.7000          | 60.0134      |
| 1.8000           | 84.7072      | 6.8000           | 68.7602      | 11.8000          | 59.8700      |
| 1.9000           | 84.2774      | 6.9000           | 68.5282      | 11.9000          | 59.7307      |
| 2.0000           | 83.8291      | 7.0000           | 68.3130      | 12.0000          | 59.5986      |
| 2.1000           | 83.4050      | 7.1000           | 68.0862      | 12.1000          | 59.4672      |
| 2.2000           | 82.9722      | 7.2000           | 67.8620      | 12.2000          | 59.3231      |
| 2.3000           | 82.5679      | 7.3000           | 67.6467      | 12.3000          | 59.1945      |
| 2.4000           | 82.1406      | 7.4000           | 67.4413      | 12.4000          | 59.0672      |
| 2.5000           | 81.7489      | 7.5000           | 67.2245      | 12.5000          | 58.9405      |
| 2.6000           | 81.3409      | 7.6000           | 67.0080      | 12.6000          | 58.8014      |
| 2.7000           | 80.9614      | 7.7000           | 66.8033      | 12.7000          | 58.6767      |
| 2.8000           | 80.5567      | 7.8000           | 66.6050      | 12.8000          | 58.5540      |
| 2.9000           | 80.1889      | 7.9000           | 66.3966      | 12.9000          | 58.4231      |
| 3.0000           | 79.8052      | 8.0000           | 66.1966      | 13.0000          | 58.3023      |
| 3.1000           | 79.4472      | 8.1000           | 65.9927      | 13.1000          | 58.1734      |
| 3.2000           | 79.0720      | 8.2000           | 65.7962      | 13.2000          | 58.0544      |
| 3.3000           | 78.7249      | 8.3000           | 65.6079      | 13.3000          | 57.9367      |
| 3.4000           | 78.3622      | 8.4000           | 65.4166      | 13.4000          | 57.8108      |
| 3.5000           | 78.0241      | 8.5000           | 65.2195      | 13.5000          | 57.6949      |
| 3.6000           | 77.6706      | 8.6000           | 65.0315      | 13.6000          | 57.5717      |
| 3.7000           | 77.3412      | 8.7000           | 64.8456      | 13.7000          | 57.4567      |
| 3.8000           | 76.9967      | 8.8000           | 64.6548      | 13.8000          | 57.3360      |
| 3.9000           | 76.6840      | 8.9000           | 64.4836      | 13.9000          | 57.2227      |
| 4.0000           | 76.3493      | 9.0000           | 64.3017      | 14.0000          | 57.1099      |
| 4.1000           | 76.0364      | 9.1000           | 64.1171      | 14.1000          | 56.9990      |
| 4.2000           | 75.7100      | 9.2000           | 63.9401      | 14.2000          | 56.8817      |
| 4.3000           | 75.4143      | 9.3000           | 63.7641      | 14.3000          | 56.7725      |
| 4.4000           | 75.0959      | 9.4000           | 63.5901      | 14.4000          | 56.6629      |
| 4.5000           | 74.7814      | 9.5000           | 63.4179      | 14.5000          | 56.5478      |
| 4.6000           | 74.4968      | 9.6000           | 63.2475      | 14.6000          | 56.4413      |
| 4.7000           | 74.1899      | 9.7000           | 63.0716      | 14.7000          | 56.3345      |
| 4.8000           | 73.9122      | 9.8000           | 62.9041      | 14.8000          | 56.2222      |
| 4.9000           | 73.6127      | 9.9000           | 62.7384      | 14.9000          | 56.1242      |

## Appendix II

CASE NUMBER: None

### INCREMENTATION CALC's

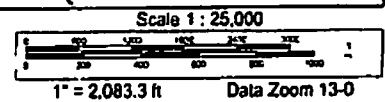
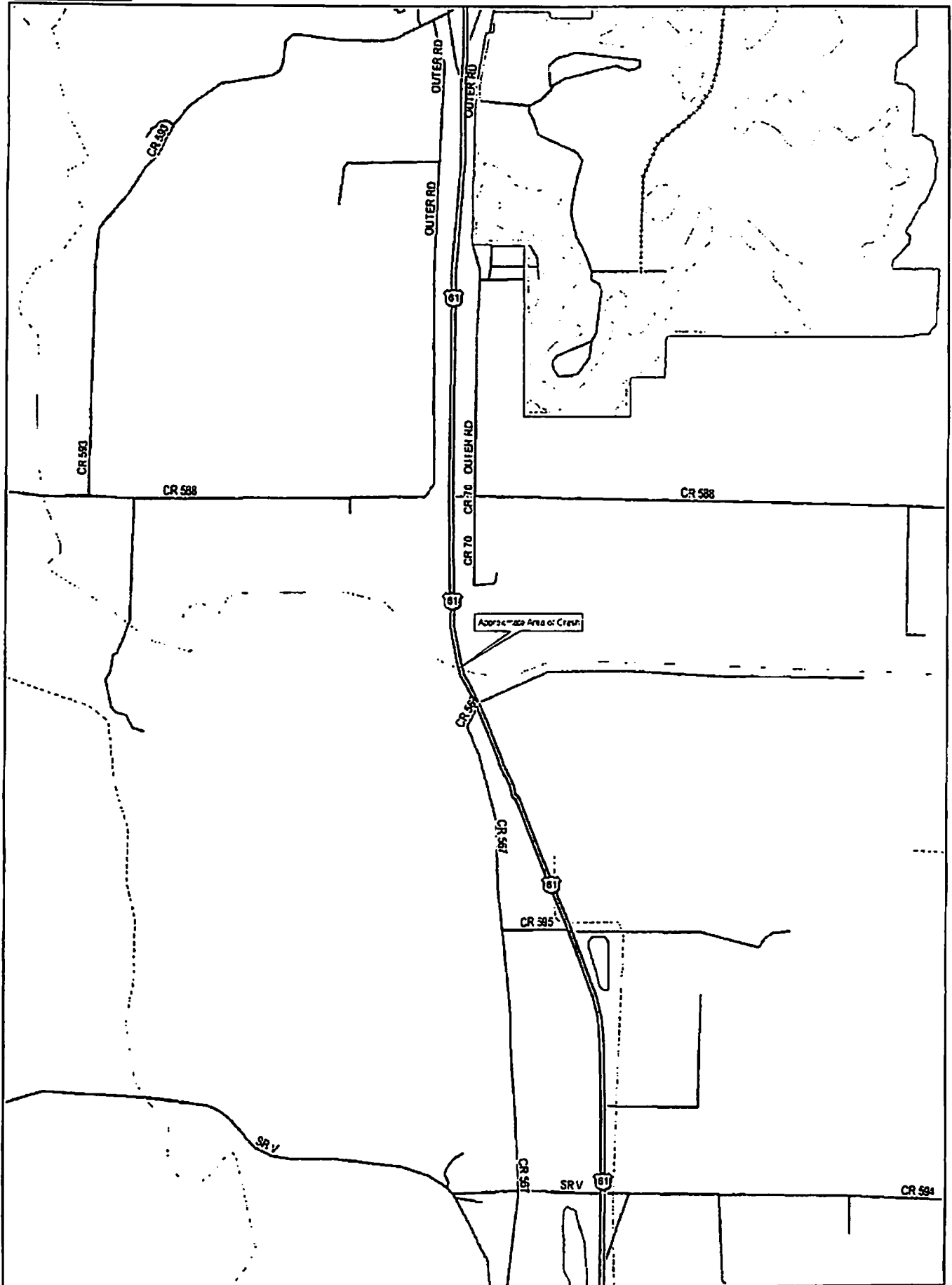
| <u>Dep Angle</u> | <u>Speed</u> | <u>Dep Angle</u> | <u>Speed</u> | <u>Dep Angle</u> | <u>Speed</u> |
|------------------|--------------|------------------|--------------|------------------|--------------|
| 15.0000          | 56.0135      | 20.0000          | 51.7064      | 25.0000          | 48.8027      |
| 15.1000          | 55.9097      | 20.1000          | 51.6354      | 25.1000          | 48.7599      |
| 15.2000          | 55.8078      | 20.2000          | 51.5652      | 25.2000          | 48.7123      |
| 15.3000          | 55.7055      | 20.3000          | 51.4952      | 25.3000          | 48.6708      |
| 15.4000          | 55.6044      | 20.4000          | 51.4309      | 25.4000          | 48.6205      |
| 15.5000          | 55.4985      | 20.5000          | 51.3612      | 25.5000          | 48.5792      |
| 15.6000          | 55.3988      | 20.6000          | 51.2930      | 25.6000          | 48.5292      |
| 15.7000          | 55.3066      | 20.7000          | 51.2256      | 25.7000          | 48.4891      |
| 15.8000          | 55.2026      | 20.8000          | 51.1577      | 25.8000          | 48.4398      |
| 15.9000          | 55.1054      | 20.9000          | 51.0906      | 25.9000          | 48.4009      |
| 16.0000          | 55.0092      | 21.0000          | 51.0304      | 26.0000          | 48.3578      |
| 16.1000          | 54.9126      | 21.1000          | 50.9643      | 26.1000          | 48.3131      |
| 16.2000          | 54.8171      | 21.2000          | 50.8983      | 26.2000          | 48.2712      |
| 16.3000          | 54.7178      | 21.3000          | 50.8391      | 26.3000          | 48.2294      |
| 16.4000          | 54.6243      | 21.4000          | 50.7747      | 26.4000          | 48.1822      |
| 16.5000          | 54.5312      | 21.5000          | 50.7062      | 26.5000          | 48.1454      |
| 16.6000          | 54.4391      | 21.6000          | 50.6481      | 26.6000          | 48.1043      |
| 16.7000          | 54.3473      | 21.7000          | 50.5847      | 26.7000          | 48.0639      |
| 16.8000          | 54.2564      | 21.8000          | 50.5281      | 26.8000          | 48.0235      |
| 16.9000          | 54.1659      | 21.9000          | 50.4656      | 26.9000          | 47.9842      |
| 17.0000          | 54.0764      | 22.0000          | 50.4045      | 27.0000          | 47.9391      |
| 17.1000          | 53.9933      | 22.1000          | 50.3435      | 27.1000          | 47.9000      |
| 17.2000          | 53.9057      | 22.2000          | 50.2880      | 27.2000          | 47.8621      |
| 17.3000          | 53.8177      | 22.3000          | 50.2232      | 27.3000          | 47.8231      |
| 17.4000          | 53.7307      | 22.4000          | 50.1691      | 27.4000          | 47.7852      |
| 17.5000          | 53.6446      | 22.5000          | 50.1098      | 27.5000          | 47.7474      |
| 17.6000          | 53.5588      | 22.6000          | 50.0507      | 27.6000          | 47.7108      |
| 17.7000          | 53.4746      | 22.7000          | 49.9930      | 27.7000          | 47.6752      |
| 17.8000          | 53.3893      | 22.8000          | 49.9405      | 27.8000          | 47.6386      |
| 17.9000          | 53.3123      | 22.9000          | 49.8836      | 27.9000          | 47.6021      |
| 18.0000          | 53.2229      | 23.0000          | 49.8267      | 28.0000          | 47.5630      |
| 18.1000          | 53.1404      | 23.1000          | 49.7700      | 28.1000          | 47.5272      |
| 18.2000          | 53.0648      | 23.2000          | 49.7146      | 28.2000          | 47.4924      |
| 18.3000          | 52.9769      | 23.3000          | 49.6639      | 28.3000          | 47.4588      |
| 18.4000          | 52.9024      | 23.4000          | 49.6099      | 28.4000          | 47.4241      |
| 18.5000          | 52.8222      | 23.5000          | 49.5554      | 28.5000          | 47.3869      |
| 18.6000          | 52.7429      | 23.6000          | 49.5062      | 28.6000          | 47.3544      |
| 18.7000          | 52.6638      | 23.7000          | 49.4525      | 28.7000          | 47.3210      |
| 18.8000          | 52.5856      | 23.8000          | 49.3995      | 28.8000          | 47.2839      |
| 18.9000          | 52.5135      | 23.9000          | 49.3471      | 28.9000          | 47.2531      |
| 19.0000          | 52.4306      | 24.0000          | 49.2949      | 29.0000          | 47.2172      |
| 19.1000          | 52.3595      | 24.1000          | 49.2428      | 29.1000          | 47.1902      |
| 19.2000          | 52.2835      | 24.2000          | 49.1920      | 29.2000          | 47.1544      |
| 19.3000          | 52.2077      | 24.3000          | 49.1412      | 29.3000          | 47.1248      |
| 19.4000          | 52.1334      | 24.4000          | 49.0956      | 29.4000          | 47.0901      |
| 19.5000          | 52.0587      | 24.5000          | 49.0456      | 29.5000          | 47.0606      |
| 19.6000          | 51.9905      | 24.6000          | 48.9963      | 29.6000          | 47.0322      |
| 19.7000          | 51.9168      | 24.7000          | 48.9470      | 29.7000          | 46.9987      |
| 19.8000          | 51.8452      | 24.8000          | 48.9035      | 29.8000          | 46.9668      |
| 19.9000          | 51.7782      | 24.9000          | 48.8544      | 29.9000          | 46.9390      |

2004

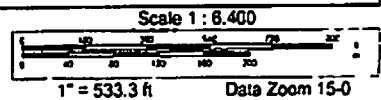
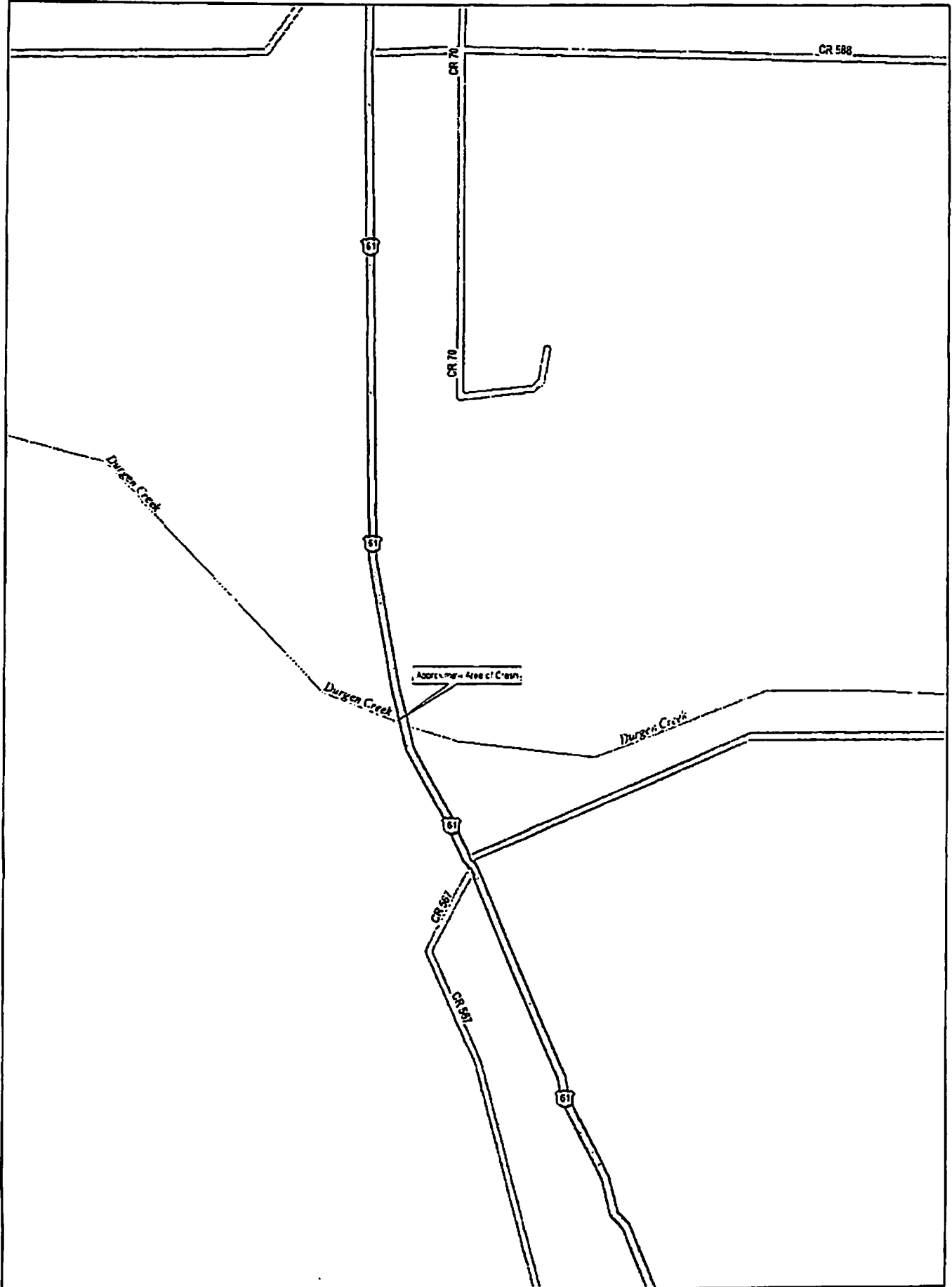
# Appendix III

DE LORME

Street Atlas USA® 2004



# Appendix IV









Turn down

Not caused  
(not a truck end impact)

Rollover, Vaulted





# MISSOURI STATE HIGHWAY PATROL TECHNICAL ACCIDENT INVESTIGATION REPORT

Skidding  
Sideways,  
Vaulted

County:

Date:

Time:

Location:

Driver:

Original Investigating Officer: Trooper Anthony A. O'Brien, #810

Reconstructionist: Sergeant Gregory K. Leftwich, #748

Date Reconstructionist Notified: July 28, 2005

Date of Report: July 28, 2005

Reviewed By: Sergeant G. W. Bergfeld, #106

Reviewed Date: August 29, 2005

Synopsis

At approximately 1230 hours, [REDACTED] a one-vehicle crash occurred in [REDACTED]

[REDACTED] operating traveled off the west side of the road, struck a guardrail, vaulted into the air, struck an embankment, and came to rest on its top in a creek bed. [REDACTED]

At approximately 1025 hours, [REDACTED], I was notified by Troop B Radio Personnel of this crash. I was also notified, Trooper Anthony A. O'Brien, the primary investigating officer, had requested a reconstruction of the crash in accordance with General Order 63-01. I arrived at the scene of the crash at 1056 hours and contacted Trooper O'Brien.

Environmental Factors

The crash began in the southbound lanes of US 61 approximately 2 [REDACTED] of Br [REDACTED]. US 61 at the crash location is a four-lane highway. The northbound and southbound lanes are divided by a grass median and they cross [REDACTED] in separate bridges. The southbound lanes are level, have a slight left-hand curve, and are 23 feet 8 inches wide. The right shoulder is 10 feet 11 inches wide and the left shoulder is 8 feet 1 inch wide. The roadway is composed of concrete and the shoulders are composed of a bituminous material. The roadway and shoulders at the crash location appear to be well maintained with no noticeable defects.

Missouri Department of Transportation blueprints of the crash location are attached to this report.

This crash was estimated to have occurred at approximately 1230 hours on [REDACTED]. The climate was mild, the sky clear, and the temperatures in the mid 80's. weather and roadway conditions were not factors in this crash.

### Mechanical Factors

[REDACTED]

The odometer reading could not be obtained due to the damage incurred by vehicle #1 during the crash. The steering, suspension, and braking systems were intact and appeared to be in working order prior to the crash. Both front tires were Douglas Xtra Trac AW P185/75 R14's. The rear tires on Vehicle #1 were Cooper Trend Setter SE, P185/75 R14's. Upon my inspection, both front tires had 8/32 of an inch tread depth and were flat, this apparently occurring during the crash. The rear tires had 5/32 of an inch of tread depth. The left rear tire upon my inspection was flat however the right rear tire was still inflated. This vehicle is not equipped with driver or passenger side airbags. The driver and his passenger did utilize the seatbelts in this vehicle. The vehicle received severe damage to the entire vehicle especially the roof of the passenger compartment.

Vehicle #1 was towed from the scene by Robert's Garage of Ewing, Missouri and taken to their facility. I inspected the principal vehicle at the scene and at Robert's garage on [REDACTED].

The mechanical condition of the principal vehicle was not a factor in this crash.

### Human Factor

[REDACTED]

### Scene Investigation

I made a thorough investigation of the crash scene on [REDACTED] and [REDACTED] 2005. Photographs of the scene and the principal vehicle were obtained and are attached to this report. Measurements of the crash scene were obtained by Trooper Anthony A. O'Brien and were recorded on his diagram contained in the [REDACTED] which he completed during his investigation of the scene. A copy of the diagram completed by Trooper O'Brien is attached to this report.

Evidence at the crash scene indicated Vehicle #1 [REDACTED] approaching [REDACTED]. Vehicle #1 went out of control and went into a critical skid. The vehicle rotated clockwise and skidded off the west side of the road. The vehicle struck a guardrail as it vaulted into the air when it left the roadway. Vehicle #1 flipped through the air a distance of 157 feet and falling 20.7 feet before striking the south bank of Durgens Creek. Vehicle #1 then came to final rest on its top in the Creek bed facing east.

There were pre-impact tire marks left by the principal vehicle and it vaulted through the air in this crash. The following is a scientific assessment of the speed of the Walker vehicle. First, the coefficient of friction was determined for the roadway at the crash scene. Then measurements of two chords and middle ordinates of the yaw mark made by Vehicle #1 were obtained. The measurements of the chord, middle ordinate, and the coefficient of friction were then placed into critical speed formulas to determine a range for the speed of the Walker Vehicle prior to leaving the roadway. Sergeant Mike Mahon, Major Crash Investigation Unit, and I made measurements, with the use of a total station device, of the distance the Walker vehicle vaulted from the guardrail to where it landed in the creek bed. Sergeant Mahon then placed those measurements into a vault formula (Appendix II) to determine the speed the Walker vehicle was traveling when it vaulted.

The coefficient of friction (drag factor) of the roadway's surface was determined with the use of a drag tire. The tire was weighed and then pulled on the same surface and in the same direction vehicle #1 skidded. The same scale used to weigh the drag tire was used when the drag tire was pulled on the roadway's surface. The weight of the drag tire was 30 pounds. The amount of force needed to pull the drag tire on the roadway's surface in the same direction vehicle #1 skidded was 23 pounds. The coefficient of friction of US 61 at the crash location was determined to be .76.

f = Drag Factor

F = Force needed to pull the drag tire on the surface to be measured.

W = Weight of the drag tire

Formula

$$F = 23$$

$$W = 30$$

$$f = \frac{F}{W} = \frac{23}{30} = .76$$

The critical speed of vehicle #1 was determined from measurements of the yaw marks it made during the crash. A chord and middle ordinate measurement was obtained in the first third of the yaw mark after rear wheel crossover to determine the radius of the curved tire mark made by vehicle #1. A second chord and middle ordinate measurement were made farther into the skid to give a range in speed for vehicle #1. The Radius' and the Drag factor were then placed into the critical speed formula to determine vehicle #1's speed. The first chord measurement used was 30 feet and the middle ordinate was 2 inches (.16 feet). The drag factor or coefficient of friction from the above formula was .76.

Radius Formula

$$R = \frac{C^2}{8(m)} + \frac{m}{2}$$

R = Radius

C = Chord = 30

m = Middle Ordinate = .16

8 = mathematical constant

2 = mathematical constant

$$R = \frac{30^2}{8(.16)} + \frac{.16}{2}$$

$$R = \frac{900}{1.28} + .08$$

$$R = 703.125 + .08$$

$$R = 703.205$$

The radius is adjusted by subtracting half of the vehicle's width from the existing radius to accommodate for the travel of the center of mass. The width of vehicle #1 is 5 feet.

$$R = 703.205 - 2.5 = 700.705$$

Critical Speed Formula

$$S = 3.86 \times [\sqrt{R(f)}]$$

S = Speed

R = Radius = 700.705

f = Drag Factor = .76

3.86 = mathematical constant

$$S = 3.86 \times [\sqrt{700.705(.76)}]$$

$$S = 3.86 \times [\sqrt{532.5358}]$$

$$S = 3.86 \times 23.0767372$$

$$S = 89.07620561$$

A second chord and middle ordinate measurement were obtained from the yaw mark made by vehicle #1 during this crash. The second chord measurement used was 30 feet and the second middle ordinate was 2.5 inches (.20 feet). The drag factor or coefficient of friction was .76.

Radius Formula

$$R = \frac{C^2}{8(m)} + 2$$

$$R = \frac{30^2}{8(.20)} + 2$$

$$R = \frac{900}{1.6} + .1$$

$$R = 562.5 + .1$$

$$R = 562.6$$

The radius is adjusted by subtracting half of the vehicle's width from the existing radius to accommodate for the travel of the center of mass. The width of vehicle #1 is 5 feet.

$$R = 562.6 - 2.5 = 560.1$$

### Critical Speed Formula #2

$$S = 3.86 \times [\sqrt{R(F)}]$$

$$S = 3.86 \times [\sqrt{560.1(.76)}]$$

$$S = 3.86 \times [\sqrt{425.676}]$$

$$S = 3.86 \times 20.63191702$$

$$S = 79.6391997$$

The speed of vehicle #1 was determined to be from 89 to 79 miles per hour. Sergeant Mike Mahon used measurements taken from the vault of vehicle #1 and determined the speed to be 89 miles per hour (see Appendix II). The posted speed limit for US 61 at the crash scene is 65 miles per hour. Speed was a factor in this crash.

### Findings

Vehicle #1 was southbound on US 61 [REDACTED] Vehicle #1 went into a critical scuff and skidded off the west side of the road. The vehicle struck a guardrail as it vaulted into the air. The vehicle flipped through the air and struck the south bank of [REDACTED] Creek. Vehicle #1 came to rest on its top in the creek bed facing east. The crash occurred on [REDACTED] at approximately 1230 hours and was not discovered until approximately 0945 hours, [REDACTED] Driver #1 and his passenger were killed during the crash.

### Event Analysis

Investigation has shown that weather, roadway conditions, and mechanical conditions of the principal vehicle were not factors in this crash. There is no evidence to indicate [REDACTED] was impaired at the time of the crash.

US 61 is posted at 65 miles per hour. [REDACTED] was traveling between 80 and 89 miles per hour. For some unknown reason [REDACTED] was not able to maintain complete control of his vehicle. [REDACTED] inattention and excessive speed are the primary contributing factors in this crash.



Sergeant G.K. Leftwich, #748  
Reconstructionist

Sergeant G.W. Bergfeld, #106  
Reviewing Reconstructionist

**Appendixes**

- Appendix I - Photo Log
- Appendix II - Mathematical equations (4 pages).
- Appendix III - Delorme Map locating crash area.
- Appendix IV - Delorme Map locating crash area (magnified view).
- Appendix V - Diagram of the crash scene.
- Appendix VI - MoDOT blueprint of the roadway at the crash location.
- Appendix VII - MoDOT blueprint of the roadway prior to the crash location.

## Appendix I

# Photograph Log

**Date of Crash:**

**Location of Crash:**

**Driver #1:**

**Original Investigating Officer:** Trooper Anthony A. O'Brien, #810

**Reconstructionist:** Sergeant G.K. Leftwich, #748

**Photographer:** Sergeant G.K. Leftwich, #748

The following is a log of the photographs taken at the crash scene location and the principal vehicle. The negatives are stored at the Missouri State Highway Patrol General Headquarters, Accident Records Section, in Jefferson City, Missouri.

1. Photo #2 - View of Vehicle #1 at final rest.
2. Photo #3 - View of the crash location looking north.
3. Photos #4 through #12 - Views of Vehicle #1 at the final rest.
4. Photos #13 through #19 - Views of the roadway at the crash location looking south.
5. Photos #20 through #22 - Views of the skid marks and damage to the guardrail at the crash location.
6. Photos #23 through #25 - View of the crash location looking south from the guardrail.
7. Photos #26 and #27 - Views of the crash location, looking north.
8. Photos #28 through #36 - Views of Vehicle #1 taken at Robert's garage in Ewing, Missouri.
9. Photo #37 - View of Vehicle #1's V.I.N.

# Appendix II

C:\RECONSTRUCTIONS\2005\0727B\0727B  
11:08:33

Job Description:

Page No.: 1

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|        |             |             |            |    |
|--------|-------------|-------------|------------|----|
| 1 N:   | 0.000 E:    | 0.000 El:   | 100.000 D: | TS |
| 100 N: | 20.546 E:   | -14.004 El: | 98.876 D:  | RP |
| 101 N: | 196.848 E:  | -32.718 El: | 99.331 D:  | TM |
| 102 N: | 149.307 E:  | -27.396 El: | 100.154 D: | TM |
| 103 N: | 97.490 E:   | -19.734 El: | 100.806 D: | TM |
| 104 N: | 55.978 E:   | -14.310 El: | 101.593 D: | TM |
| 105 N: | 48.768 E:   | -18.123 El: | 100.625 D: | TM |
| 106 N: | 30.981 E:   | -7.092 El:  | 101.059 D: | TM |
| 107 N: | 53.431 E:   | -20.894 El: | 103.646 D: | GR |
| 108 N: | 47.717 E:   | -18.111 El: | 103.600 D: | GR |
| 109 N: | 42.353 E:   | -15.401 El: | 103.649 D: | GR |
| 110 N: | 37.121 E:   | -12.038 El: | 103.423 D: | GR |
| 111 N: | 32.078 E:   | -8.292 El:  | 103.514 D: | GR |
| 112 N: | 26.781 E:   | -5.028 El:  | 103.606 D: | GR |
| 113 N: | 21.363 E:   | -1.864 El:  | 103.702 D: | GR |
| 114 N: | 31.036 E:   | -7.214 El:  | 101.034 D: | MP |
| 115 N: | 48.601 E:   | -18.284 El: | 100.642 D: | MP |
| 116 N: | -113.718 E: | 15.677 El:  | 82.900 D:  | MP |
| 117 N: | -110.412 E: | 15.993 El:  | 78.257 D:  | MP |
| 118 N: | 20.552 E:   | -14.013 El: | 98.877 D:  | RM |

104 N: 55.978 E: -14.310 El: 101.593 D: TM  
101 N: 196.848 E: -32.718 El: -99.331 D: TM  
2.262

$2.262/142.069 = 0.015921953$  1.5 percent grade or 0.91 degrees

As Vehicle #1 scuffed across the left lane, right lane and the shoulder, it was traveling up a 1.5 percent grade or 0.9 degree.

The horizontal distance was measured from the center of the guard rail damage to the impact with the bank at the base of the small tree. That was a distance of 157.0'. The car fell 20.7' from 103.6' (height of the guardrail) to 82.9' (height of the base of the small tree). I ranged the takeoff angle from 0 to 29.9 degrees.

## Appendix II

**CASE NUMBER:** None

### \*\* SPEED W/ AIRBORNE \*\*

$$S = \frac{2.73 \times D}{\cos \theta \times \sqrt{\pm h \pm (D \times \tan \theta)}}$$

S = The Speed in MPH  
 2.73 = A Constant  
 D = The Distance in Feet  
 h = The Height in Feet  
 $\theta$  = The Departure Angle in Degrees.

$$S = \frac{2.73 \times 157.0000}{0.9998 \times \sqrt{20.7000 + (157.0000 \times 0.0158)}}$$

$$S = \frac{428.6100}{0.9998 \times \sqrt{23.1806}}$$

$$S = \frac{428.6100}{0.9998 \times 4.8146}$$

$$S = 89.0414$$

| INPUTS:                  |          | RESULTS:                |          |
|--------------------------|----------|-------------------------|----------|
| The Distance in Feet is: | 157.0000 | The Speed in MPH is:    | 89.0414  |
| The Height in Feet is:   | 20.7000  | The Velocity in FPS is: | 130.5940 |
| The Depart. Angle is:    | 0.9100   |                         |          |

Sgt. Michael H. Mahon / 298, C-55  
 Missouri State Highway Patrol  
 599 South Mason Road  
 St. Louis, Missouri, 63141  
 Phone 636-639-9017  
 Fax 636-639-1878

E-Mail: [mh.mahon@rshp.dps.mo.gov](mailto:mh.mahon@rshp.dps.mo.gov)

## Appendix II

**CASE NUMBER: None**

### INCREMENTATION CALC'S

| <u>Dep Angle</u> | <u>Speed</u> | <u>Dep Angle</u> | <u>Speed</u> | <u>Dep Angle</u> | <u>Speed</u> |
|------------------|--------------|------------------|--------------|------------------|--------------|
| 0.0000           | 94.2062      | 5.0000           | 73.3406      | 10.0000          | 62.5735      |
| 0.1000           | 93.6156      | 5.1000           | 73.0493      | 10.1000          | 62.4113      |
| 0.2000           | 93.0244      | 5.2000           | 72.7691      | 10.2000          | 62.2554      |
| 0.3000           | 92.4126      | 5.3000           | 72.5007      | 10.3000          | 62.0957      |
| 0.4000           | 91.8443      | 5.4000           | 72.2258      | 10.4000          | 61.9369      |
| 0.5000           | 91.2538      | 5.5000           | 71.9711      | 10.5000          | 61.7798      |
| 0.6000           | 90.7072      | 5.6000           | 71.6954      | 10.6000          | 61.6243      |
| 0.7000           | 90.1388      | 5.7000           | 71.4302      | 10.7000          | 61.4697      |
| 0.8000           | 89.6111      | 5.8000           | 71.1834      | 10.8000          | 61.3228      |
| 0.9000           | 89.0729      | 5.9000           | 70.9184      | 10.9000          | 61.1705      |
| 1.0000           | 88.5631      | 6.0000           | 70.6624      | 11.0000          | 61.0207      |
| 1.1000           | 88.0337      | 6.1000           | 70.4244      | 11.1000          | 60.8777      |
| 1.2000           | 87.5518      | 6.2000           | 70.1742      | 11.2000          | 60.7208      |
| 1.3000           | 87.0680      | 6.3000           | 69.9280      | 11.3000          | 60.5740      |
| 1.4000           | 86.5651      | 6.4000           | 69.6972      | 11.4000          | 60.4348      |
| 1.5000           | 86.1060      | 6.5000           | 69.4555      | 11.5000          | 60.2911      |
| 1.6000           | 85.6209      | 6.6000           | 69.2166      | 11.6000          | 60.1549      |
| 1.7000           | 85.1768      | 6.7000           | 68.9937      | 11.7000          | 60.0134      |
| 1.8000           | 84.7072      | 6.8000           | 68.7602      | 11.8000          | 59.8700      |
| 1.9000           | 84.2774      | 6.9000           | 68.5282      | 11.9000          | 59.7307      |
| 2.0000           | 83.8291      | 7.0000           | 68.3130      | 12.0000          | 59.5986      |
| 2.1000           | 83.4050      | 7.1000           | 68.0862      | 12.1000          | 59.4672      |
| 2.2000           | 82.9722      | 7.2000           | 67.8620      | 12.2000          | 59.3231      |
| 2.3000           | 82.5679      | 7.3000           | 67.6467      | 12.3000          | 59.1945      |
| 2.4000           | 82.1406      | 7.4000           | 67.4413      | 12.4000          | 59.0672      |
| 2.5000           | 81.7489      | 7.5000           | 67.2245      | 12.5000          | 58.9405      |
| 2.6000           | 81.3409      | 7.6000           | 67.0080      | 12.6000          | 58.8014      |
| 2.7000           | 80.9614      | 7.7000           | 66.8033      | 12.7000          | 58.6767      |
| 2.8000           | 80.5567      | 7.8000           | 66.6050      | 12.8000          | 58.5540      |
| 2.9000           | 80.1889      | 7.9000           | 66.3966      | 12.9000          | 58.4231      |
| 3.0000           | 79.8052      | 8.0000           | 66.1966      | 13.0000          | 58.3023      |
| 3.1000           | 79.4472      | 8.1000           | 65.9927      | 13.1000          | 58.1734      |
| 3.2000           | 79.0720      | 8.2000           | 65.7962      | 13.2000          | 58.0544      |
| 3.3000           | 78.7249      | 8.3000           | 65.6079      | 13.3000          | 57.9367      |
| 3.4000           | 78.3622      | 8.4000           | 65.4166      | 13.4000          | 57.8108      |
| 3.5000           | 78.0241      | 8.5000           | 65.2195      | 13.5000          | 57.6949      |
| 3.6000           | 77.6706      | 8.6000           | 65.0315      | 13.6000          | 57.5717      |
| 3.7000           | 77.3412      | 8.7000           | 64.8456      | 13.7000          | 57.4567      |
| 3.8000           | 76.9967      | 8.8000           | 64.6548      | 13.8000          | 57.3360      |
| 3.9000           | 76.6840      | 8.9000           | 64.4836      | 13.9000          | 57.2227      |
| 4.0000           | 76.3493      | 9.0000           | 64.3017      | 14.0000          | 57.1099      |
| 4.1000           | 76.0364      | 9.1000           | 64.1171      | 14.1000          | 56.9990      |
| 4.2000           | 75.7100      | 9.2000           | 63.9401      | 14.2000          | 56.8817      |
| 4.3000           | 75.4143      | 9.3000           | 63.7641      | 14.3000          | 56.7725      |
| 4.4000           | 75.0959      | 9.4000           | 63.5901      | 14.4000          | 56.6629      |
| 4.5000           | 74.7814      | 9.5000           | 63.4179      | 14.5000          | 56.5478      |
| 4.6000           | 74.4968      | 9.6000           | 63.2475      | 14.6000          | 56.4413      |
| 4.7000           | 74.1899      | 9.7000           | 63.0716      | 14.7000          | 56.3345      |
| 4.8000           | 73.9122      | 9.8000           | 62.9041      | 14.8000          | 56.2222      |
| 4.9000           | 73.6127      | 9.9000           | 62.7384      | 14.9000          | 56.1242      |

## Appendix II

CASE NUMBER: None

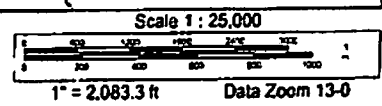
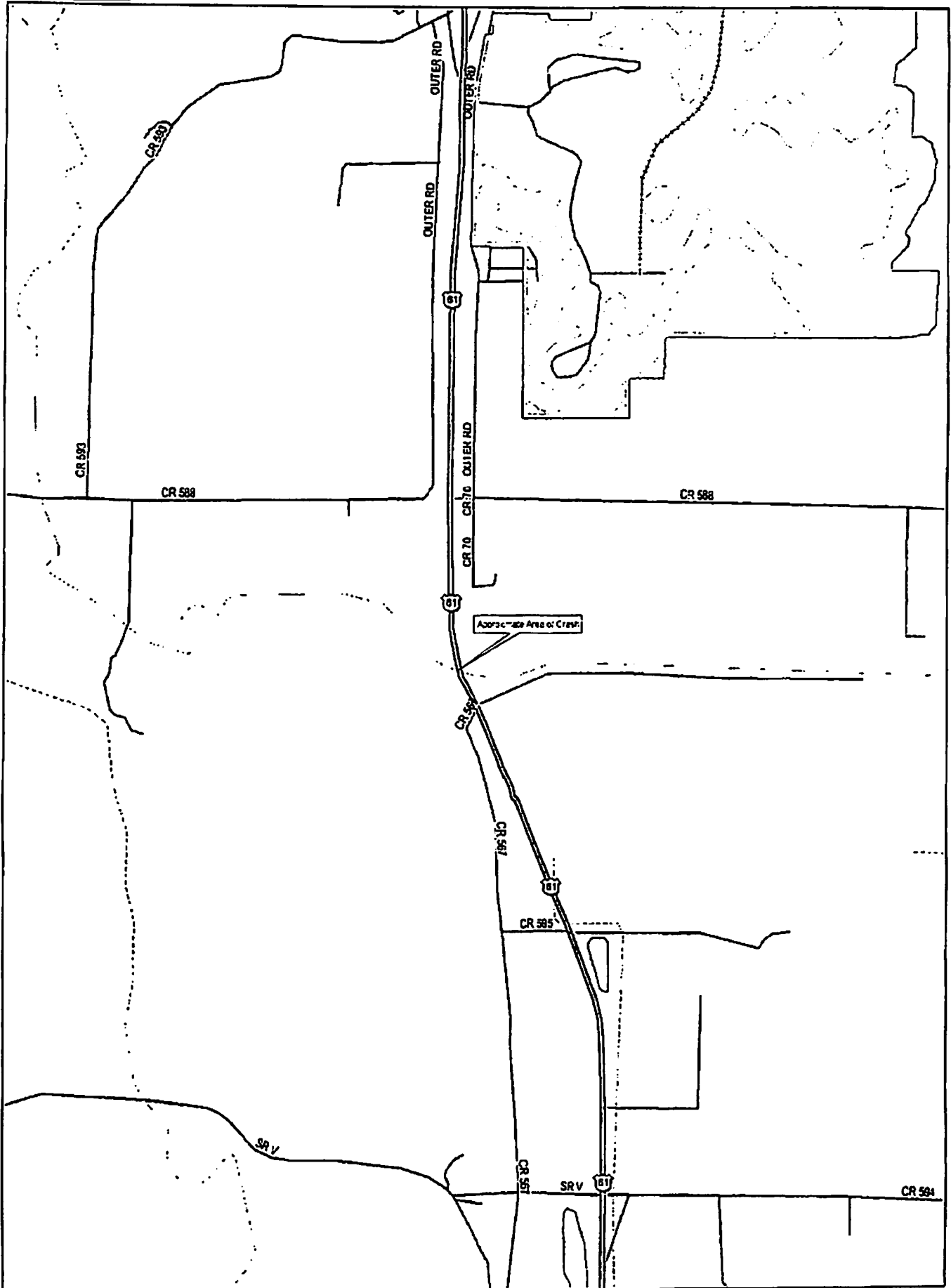
### INCREMENTATION CALC's

| <u>Dep Angle</u> | <u>Speed</u> | <u>Dep Angle</u> | <u>Speed</u> | <u>Dep Angle</u> | <u>Speed</u> |
|------------------|--------------|------------------|--------------|------------------|--------------|
| 15.0000          | 56.0135      | 20.0000          | 51.7064      | 25.0000          | 48.8027      |
| 15.1000          | 55.9097      | 20.1000          | 51.6354      | 25.1000          | 48.7599      |
| 15.2000          | 55.8078      | 20.2000          | 51.5652      | 25.2000          | 48.7123      |
| 15.3000          | 55.7055      | 20.3000          | 51.4952      | 25.3000          | 48.6708      |
| 15.4000          | 55.6044      | 20.4000          | 51.4309      | 25.4000          | 48.6205      |
| 15.5000          | 55.4985      | 20.5000          | 51.3612      | 25.5000          | 48.5792      |
| 15.6000          | 55.3988      | 20.6000          | 51.2930      | 25.6000          | 48.5292      |
| 15.7000          | 55.3066      | 20.7000          | 51.2256      | 25.7000          | 48.4891      |
| 15.8000          | 55.2026      | 20.8000          | 51.1577      | 25.8000          | 48.4398      |
| 15.9000          | 55.1054      | 20.9000          | 51.0906      | 25.9000          | 48.4009      |
| 16.0000          | 55.0092      | 21.0000          | 51.0304      | 26.0000          | 48.3578      |
| 16.1000          | 54.9126      | 21.1000          | 50.9643      | 26.1000          | 48.3131      |
| 16.2000          | 54.8171      | 21.2000          | 50.8983      | 26.2000          | 48.2712      |
| 16.3000          | 54.7178      | 21.3000          | 50.8391      | 26.3000          | 48.2294      |
| 16.4000          | 54.6243      | 21.4000          | 50.7747      | 26.4000          | 48.1822      |
| 16.5000          | 54.5312      | 21.5000          | 50.7062      | 26.5000          | 48.1454      |
| 16.6000          | 54.4391      | 21.6000          | 50.6481      | 26.6000          | 48.1043      |
| 16.7000          | 54.3473      | 21.7000          | 50.5847      | 26.7000          | 48.0639      |
| 16.8000          | 54.2564      | 21.8000          | 50.5281      | 26.8000          | 48.0235      |
| 16.9000          | 54.1659      | 21.9000          | 50.4656      | 26.9000          | 47.9842      |
| 17.0000          | 54.0764      | 22.0000          | 50.4045      | 27.0000          | 47.9391      |
| 17.1000          | 53.9933      | 22.1000          | 50.3435      | 27.1000          | 47.9000      |
| 17.2000          | 53.9057      | 22.2000          | 50.2880      | 27.2000          | 47.8621      |
| 17.3000          | 53.8177      | 22.3000          | 50.2232      | 27.3000          | 47.8231      |
| 17.4000          | 53.7307      | 22.4000          | 50.1691      | 27.4000          | 47.7852      |
| 17.5000          | 53.6446      | 22.5000          | 50.1098      | 27.5000          | 47.7474      |
| 17.6000          | 53.5588      | 22.6000          | 50.0507      | 27.6000          | 47.7108      |
| 17.7000          | 53.4746      | 22.7000          | 49.9930      | 27.7000          | 47.6752      |
| 17.8000          | 53.3893      | 22.8000          | 49.9405      | 27.8000          | 47.6396      |
| 17.9000          | 53.3123      | 22.9000          | 49.8836      | 27.9000          | 47.6021      |
| 18.0000          | 53.2229      | 23.0000          | 49.8267      | 28.0000          | 47.5630      |
| 18.1000          | 53.1404      | 23.1000          | 49.7700      | 28.1000          | 47.5272      |
| 18.2000          | 53.0648      | 23.2000          | 49.7146      | 28.2000          | 47.4924      |
| 18.3000          | 52.9769      | 23.3000          | 49.6639      | 28.3000          | 47.4588      |
| 18.4000          | 52.9024      | 23.4000          | 49.6099      | 28.4000          | 47.4241      |
| 18.5000          | 52.8222      | 23.5000          | 49.5554      | 28.5000          | 47.3869      |
| 18.6000          | 52.7429      | 23.6000          | 49.5062      | 28.6000          | 47.3544      |
| 18.7000          | 52.6638      | 23.7000          | 49.4525      | 28.7000          | 47.3210      |
| 18.8000          | 52.5856      | 23.8000          | 49.3995      | 28.8000          | 47.2839      |
| 18.9000          | 52.5135      | 23.9000          | 49.3471      | 28.9000          | 47.2531      |
| 19.0000          | 52.4306      | 24.0000          | 49.2949      | 29.0000          | 47.2172      |
| 19.1000          | 52.3595      | 24.1000          | 49.2428      | 29.1000          | 47.1902      |
| 19.2000          | 52.2835      | 24.2000          | 49.1920      | 29.2000          | 47.1544      |
| 19.3000          | 52.2077      | 24.3000          | 49.1412      | 29.3000          | 47.1248      |
| 19.4000          | 52.1334      | 24.4000          | 49.0956      | 29.4000          | 47.0901      |
| 19.5000          | 52.0587      | 24.5000          | 49.0456      | 29.5000          | 47.0606      |
| 19.6000          | 51.9905      | 24.6000          | 48.9963      | 29.6000          | 47.0322      |
| 19.7000          | 51.9168      | 24.7000          | 48.9470      | 29.7000          | 46.9987      |
| 19.8000          | 51.8452      | 24.8000          | 48.9035      | 29.8000          | 46.9668      |
| 19.9000          | 51.7782      | 24.9000          | 48.8544      | 29.9000          | 46.9390      |

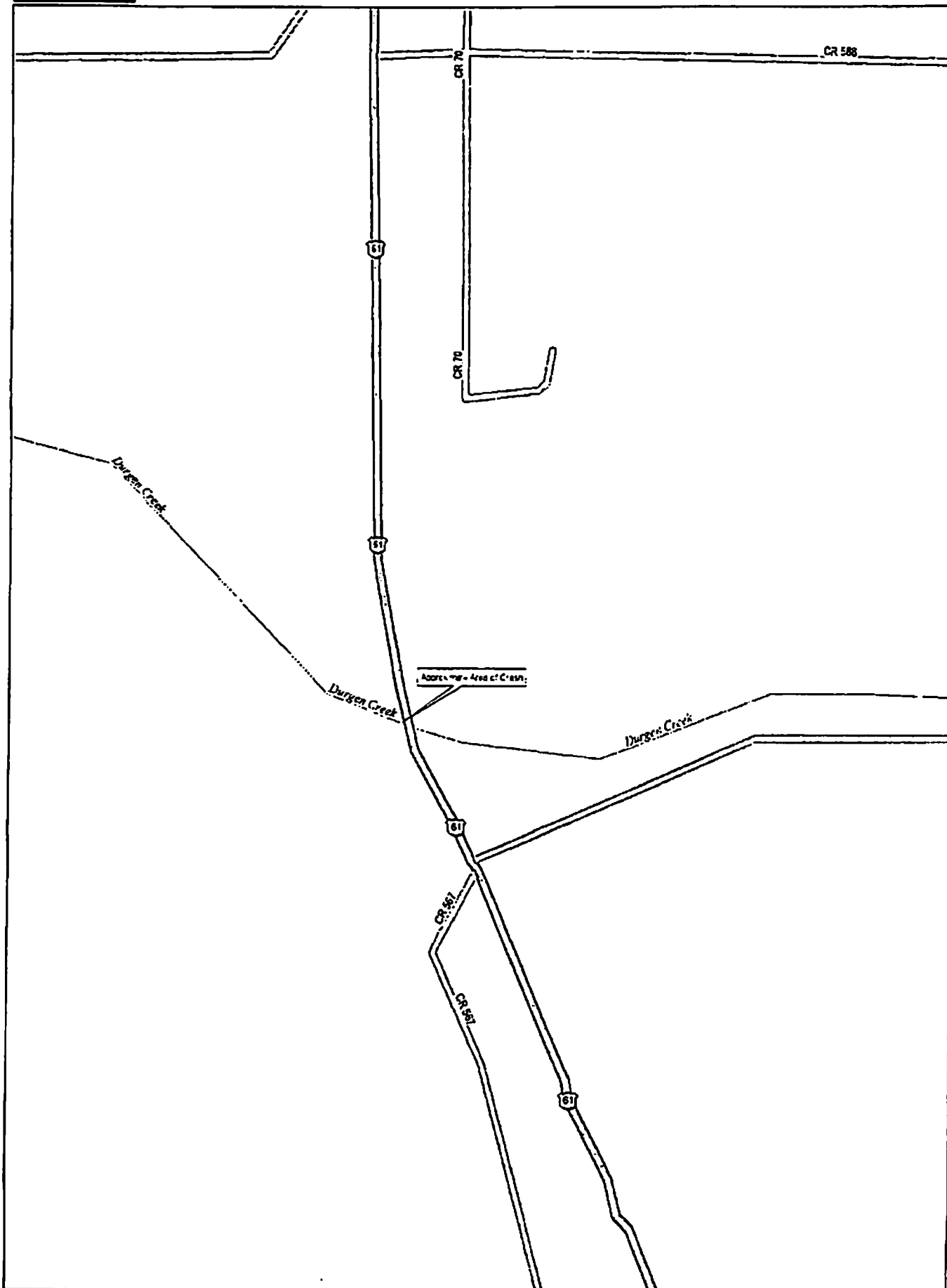
# Appendix III



Street Atlas USA® 2004

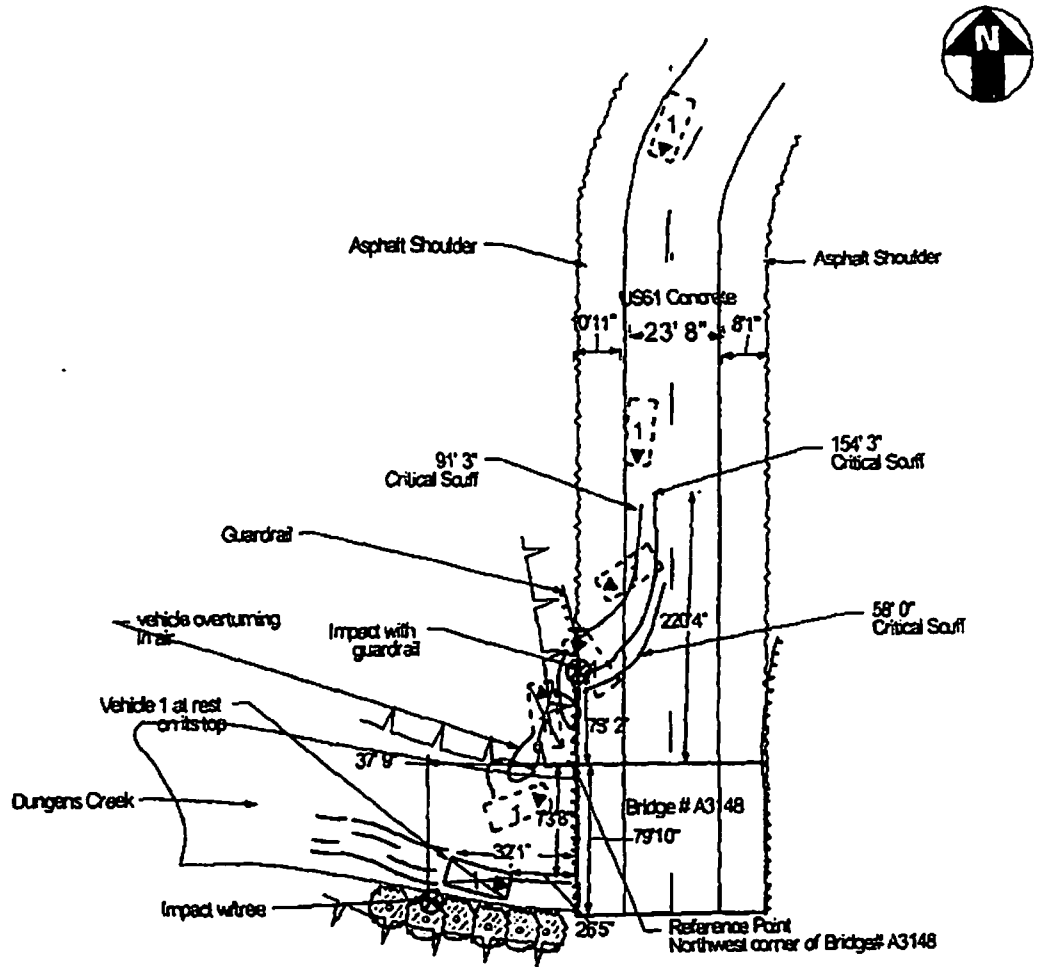


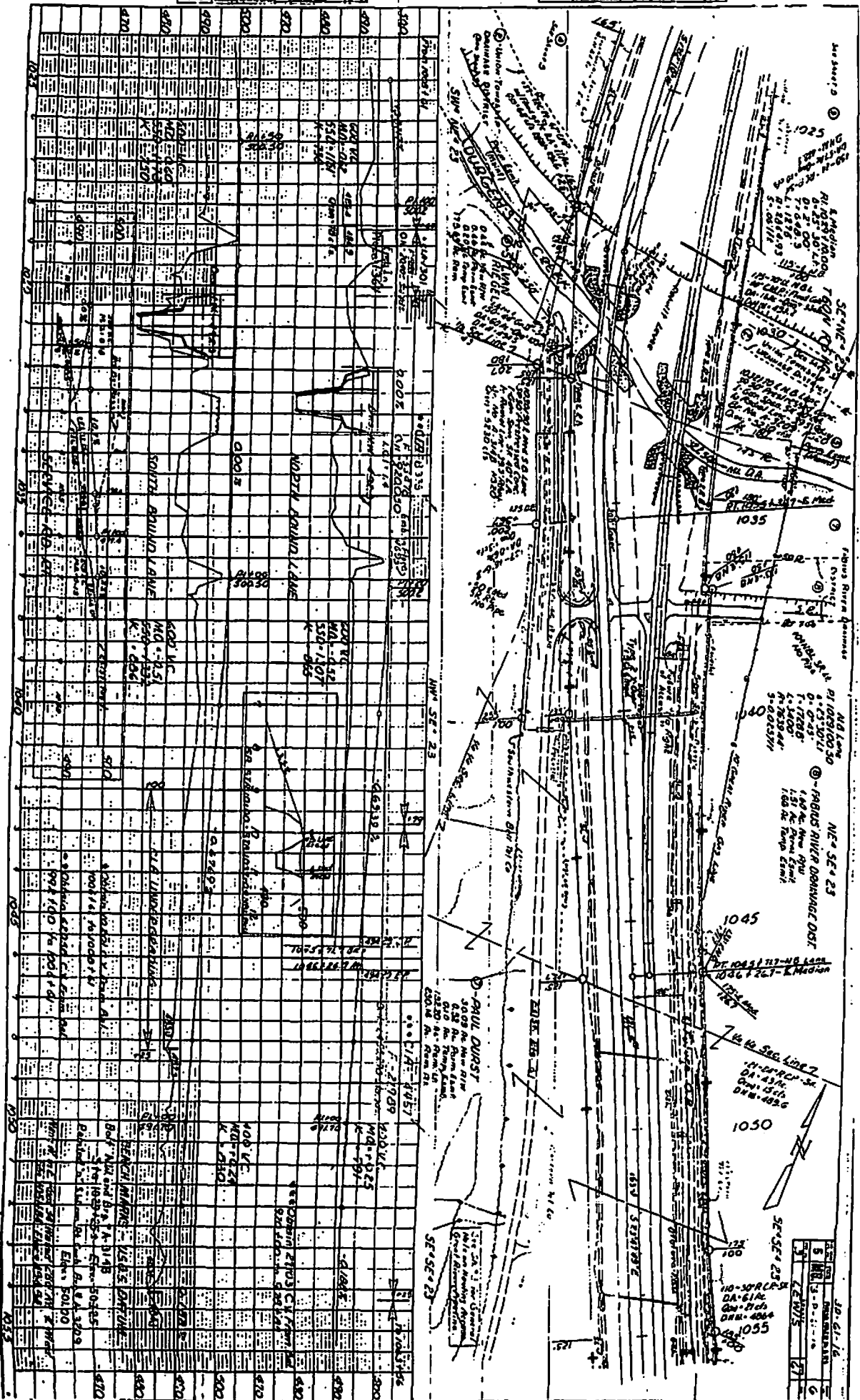
# Appendix IV





# Appendix V







Turn down

Not caused

(not a ER end impact)

Rollover, Vaulted