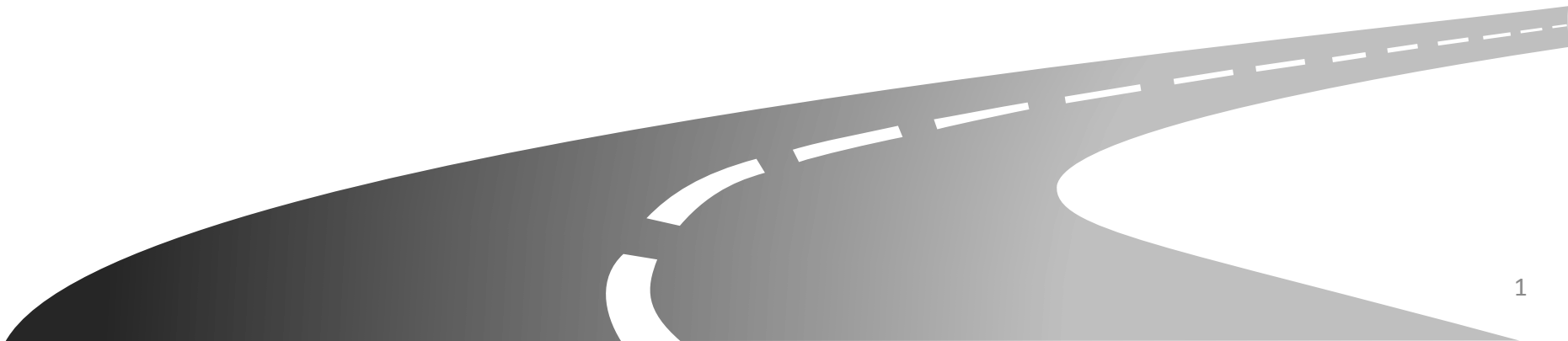
U.S. Department of Transportation
Federal Highway Administration

Office of Safety Research and Development

FHWA Motorcycle Crash Causation Study

Carol H. Tan, Ph.D
Office of Safety Research & Development
Federal Highway Administration

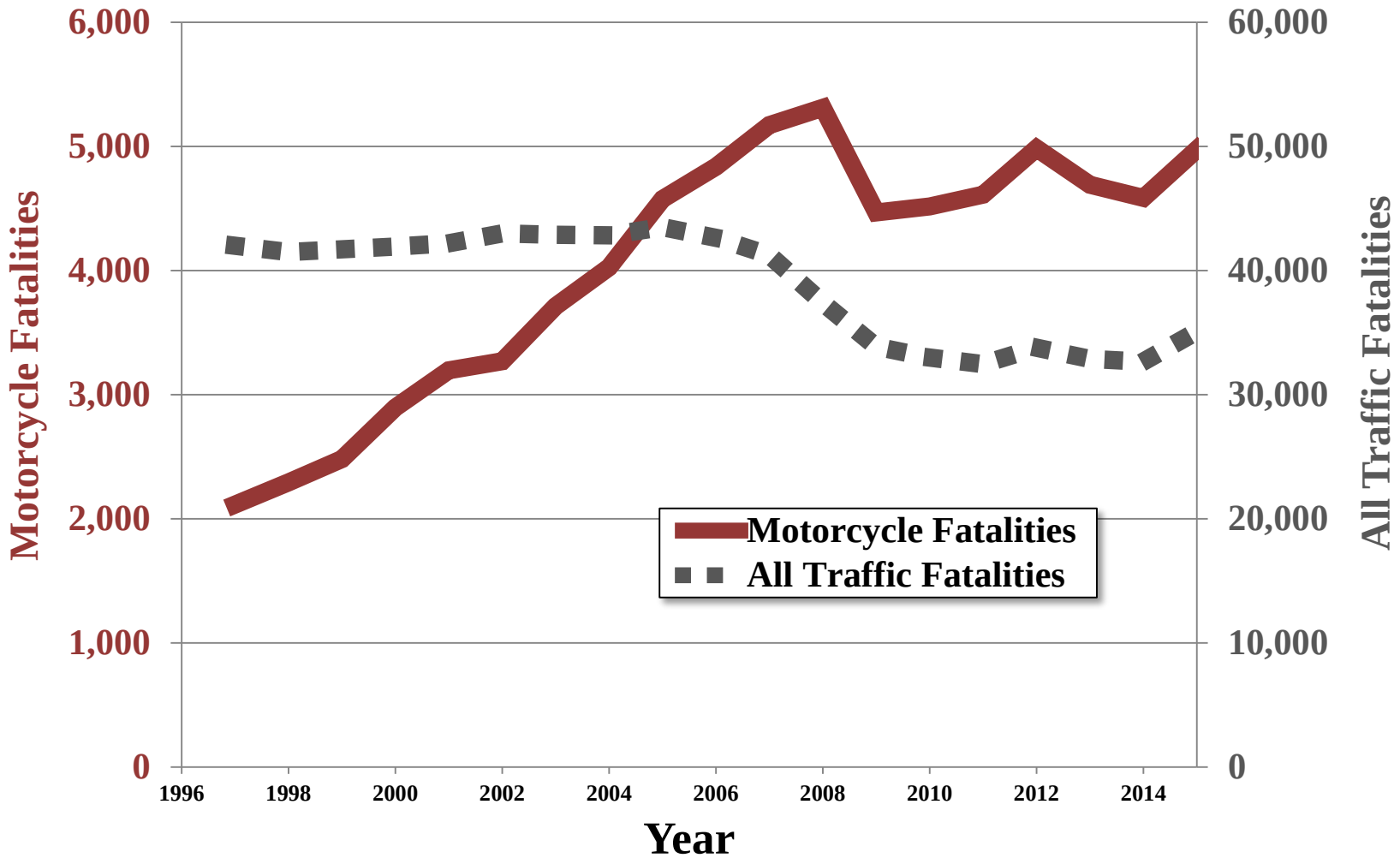
2017 SMSA
Sept 28, 2017



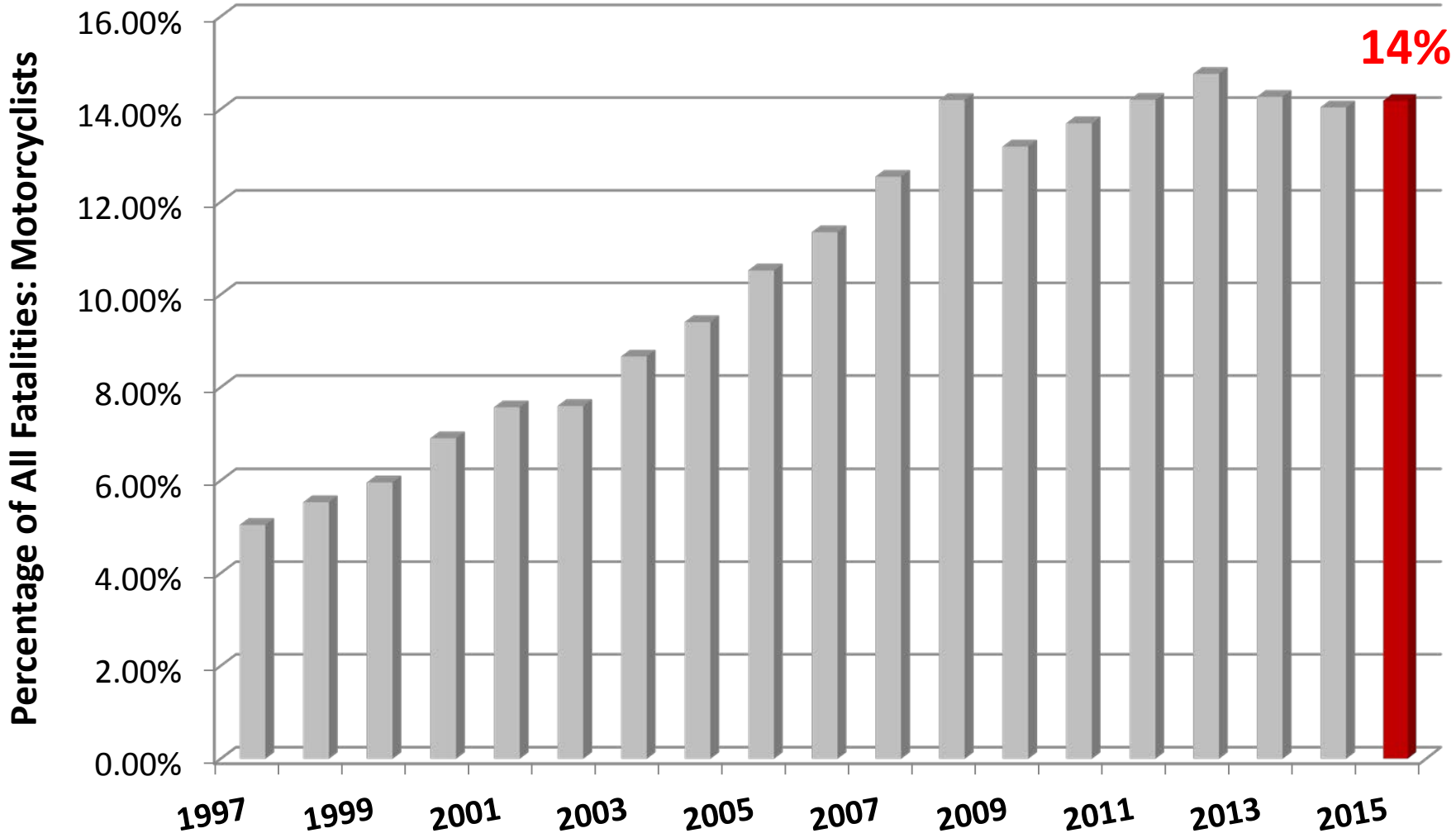
Presentation Overview

- Background
- Data Collection
- Results
- Current FHWA Activities

Background:
Why Study Motorcycles Crashes?



Background:
Why Study Motorcycles Crashes?

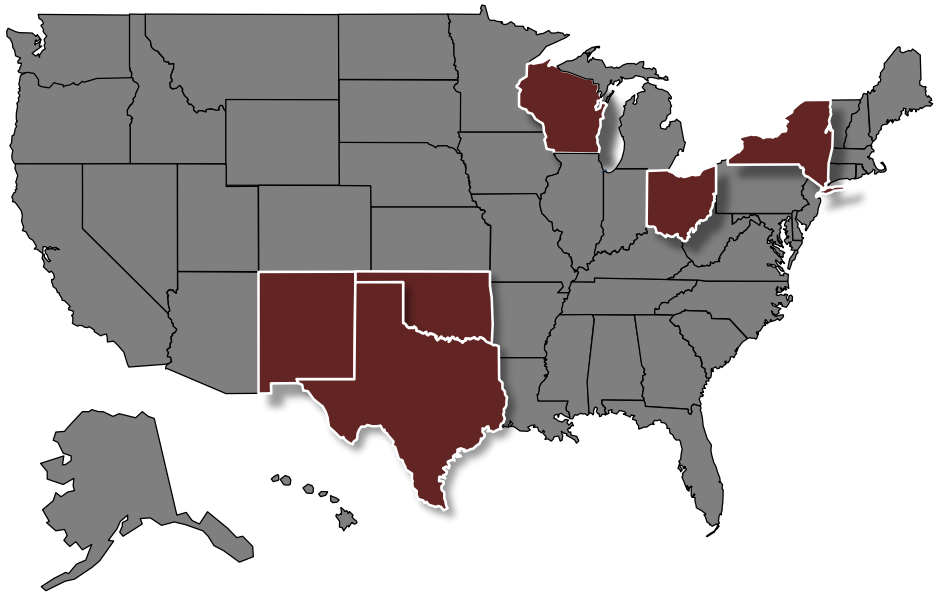


Background: Congressional Response

- **Congress mandated the Motorcycle Crash Causation Study (MCCS)**
  - OECD Data Collection Protocol
  - Oklahoma State University
- **NHTSA Pilot Study**
  - FHWA and NHTSA worked to develop data collection program
  - Final Report: June 2010

Background: MCCS Partners

- Partners
  - USDOT
    - FHWA
    - NHTSA
  - Six State DOTs
    - New Mexico
    - New York
    - Ohio
    - Oklahoma
    - Texas
    - Wisconsin
  - American Motorcyclist Association (AMA)
- Sample Size
  - 351 Crash Investigations
  - 702 Control Rider Interviews



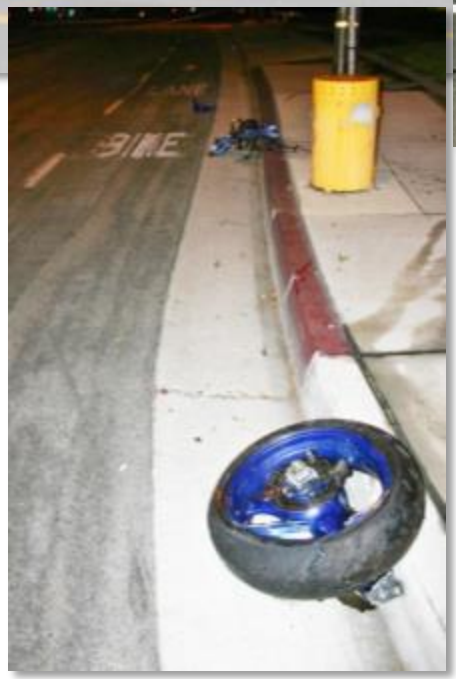
MCCS Data Collection

- Orange County, California
  - Urban
  - Rural
  - Commuters
  - Leisure Riders
- 3 Crash Investigators
  - 2 re-hired from the NHTSA Pilot
  - Experienced Crash Investigators
  - On call 24/7

OECD Methodology

- **Organisation for Economic Co-operative Development (OECD)**
  - On-Scene Investigation
  - Vehicle Inspection
  - Rider Interviews
  - Injury Data
  - Control Rider Interviews
    - 2 Controls/Crash
  - 1,600+ Data Elements

MCCS On-Scene Data Collection

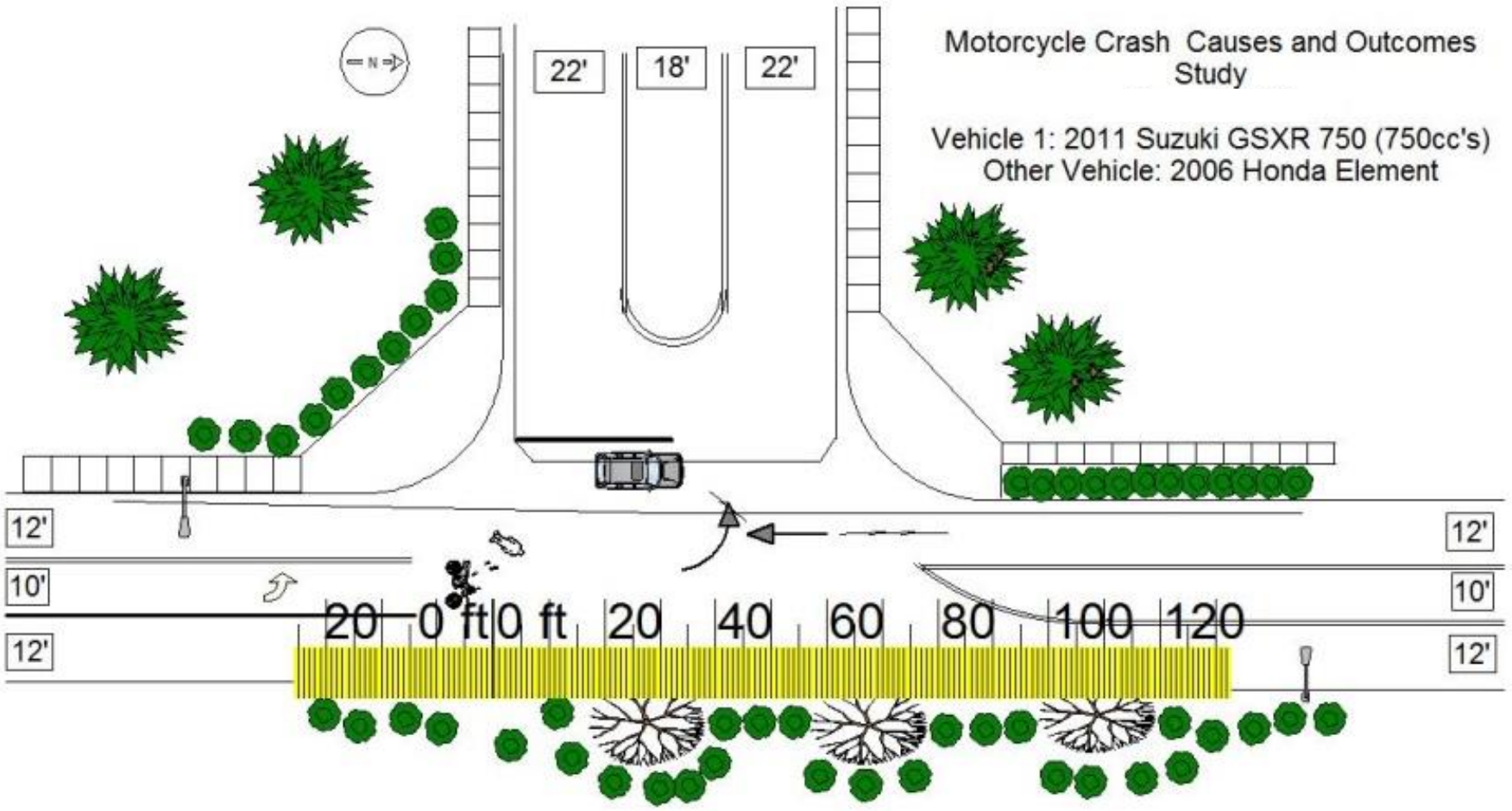


Crash Investigation Process

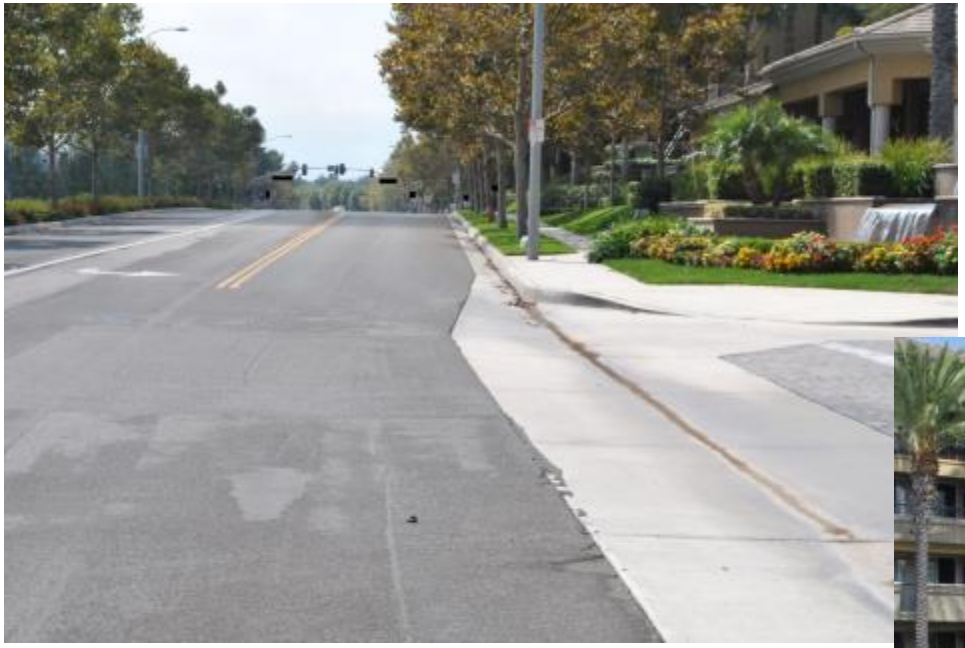
Respond On-Scene

- Scene / Evidence Documentation
- Interview participants / Witnesses
- Take initial measurements

Scene Diagram



Scene Diagram



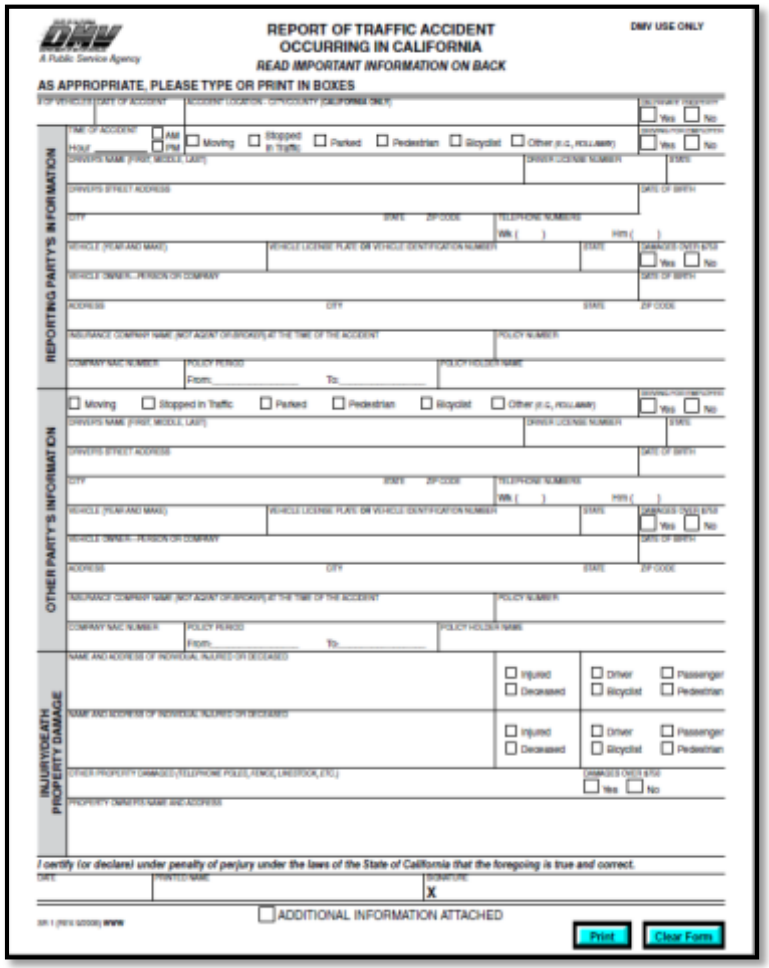
- **Detailed Measurements**
  - Lane width
  - Curb height
  - Point of Final Rest

- **Record any crash-related evidence**
  - Tire marks
  - Remaining debris
  - Damage to roadside objects

Motorcycle Investigation

Other Information Resources

- **Police Accident Report**
  - Description of crash event
  - BAC measurements
- **Rider Interviews**
  - Crash account
  - Riding history
  - Licensing status
  - Rider training
  - Emotional state


REPORT OF TRAFFIC ACCIDENT OCCURRING IN CALIFORNIA

READ IMPORTANT INFORMATION ON BACK

DMV USE ONLY

AS APPROPRIATE, PLEASE TYPE OR PRINT IN BOXES

REPORTING PARTY'S INFORMATION

OTHER PARTY'S INFORMATION

INJURY/DEATH PROPERTY DAMAGE

I certify (or declare) under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

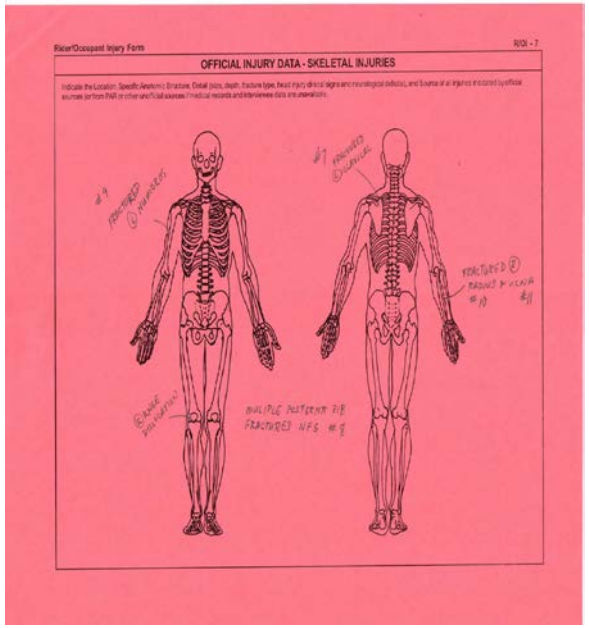
ADDITIONAL INFORMATION ATTACHED

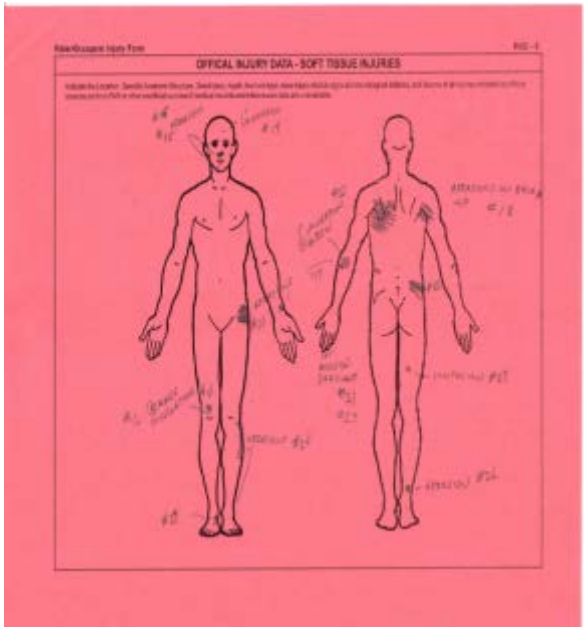
Print

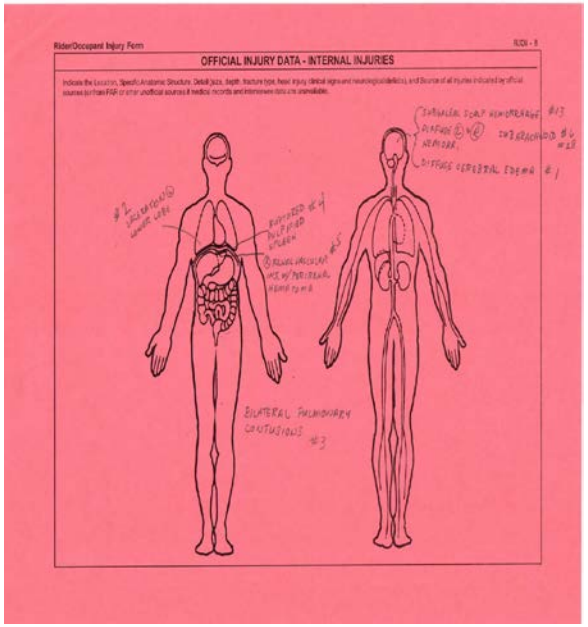
Clear Form

Medical Records

- **Obtain Medical Records from Hospital**
  - Code all injuries using Abbreviated Injury Scale (AIS)
  - Identify location and description of all injuries
- **Obtain coroner's report**
  - Injury details
  - Toxicology results







Helmet Reconstruction

- **Documentation**
  - Helmet certification
  - Manufacture date
  - Chin strap

- **Helmet recovery**
  - Offer $100 gift card for replacement helmet
  - Used for reconstruction (~10%)

Helmet Reconstruction

Recreate Crash Forces on Exemplar Helmet

Identify Impact Zones and Direction of Force

Control Interviews

- **Serve as Control Population**
- **Detailed data collection**
  - Rider history
  - Motorcycle detail
  - Protective equipment
  - Trip purpose
- **$40 Gas Card**

Results

Caution

- While It is Possible to Perform the Statistical Analysis and Calculate Statistically Significant Differences, Additional Analysis/Research is Required Before Cause and Effect Can be Demonstrated.

- The Contribution of This Study is to Help Identify Which Cause and Effect Studies May Be Needed.

Data Analysis

- While Data Collection was the Goal of the Study, (Limited) Data Analysis Was Performed
- Simple Comparisons of Proportions Were Conducted and Statistical Significance Identified* *(90 and 95 percentile, Over/Under Representation of Variable in Sample)*
  - Single vs. Multiple Vehicle Crashes
  - Fatal vs. Non-Fatal Crashes
  - Crash vs. Controls
  - (Limited) Study Data vs. Larger Data Sets/Previous Studies

* While it is possible to calculate the presence of absence of statistical significance with small samples, it is generally recommended that sample sizes of 25 or greater should be present before the statistical analysis should be used. Tables with small sample sizes are presented within this report as these may provide researchers with insight on how, or if, parameters that were not observed frequently may or may not be linked with motorcycle crash causation.

Variable	Question Identifier		Total Coded in Sample/Data Subset 1		Total Coded in Sample/Data Subset 2	Statistical Analysis	
			n_1		n_2		
Code	Meaning of Code	Category 1 Count	Proportion in Category 1	Category 2 Count	Proportion in Category 2	z	Significance
00	Meaning A	$n_{(Code\text{-}00,1)}$	$p_{(Code\text{-}00,\ 1)} = n_{(Code\text{-}00,1)}/n_1$	$n_{(Code\text{-}00,2)}$	$p_{(Code\text{-}00,\ 2)} = n_{(Code\text{-}00,2)}/n_2$	$z_{Code\text{-}01}$	Finding of Presence/Absence of Statistical Significance
01	Meaning B	$n_{(Code\text{-}01,1)}$	$p_{(Code\text{-}02,\ 1)} = n_{(Code\text{-}02,1)}/n_1$	$n_{(Code\text{-}01,2)}$	$p_{(Code\text{-}01,\ 2)} = n_{(Code\text{-}01,2)}/n_2$	$z_{Code\text{-}02}$	Finding of Presence/Absence of Statistical Significance
02	Meaning C	$n_{(Code\text{-}02,1)}$	$p_{(Code\text{-}03,\ 1)} = n_{(Code\text{-}03,1)}/n_1$	$n_{(Code\text{-}02,2)}$	$p_{(Code\text{-}03,\ 2)} = n_{(Code\text{-}03,2)}/n_2$	$z_{Code\text{-}03}$	Finding of Presence/Absence of Statistical Significance

$$z = (p_{(code,1)} - p_{(code,2)}) / ([p * (1-p) * (1/n_1+1/n_2)] \text{ ^.5 })$$

where

$p_{(code,1)}$ is the proportion in sample 1 with the code/characteristic of interest,

$p_{(code,2)}$ is the proportion in sample 2 with the code/characteristic of interest,

p is the proportion in the combined sample (all individuals with the code/characteristic of interest in both data subsets,

n_1 is the number in data subset 1, and

n_2 is the number in data subset 2. (see http://www.dummies.com/how-to/content/how-to-compare-two-population-proportions.html)

RESULTS

- *Motorcycle Crash Causation Study: Final Report*
- *Volume 1* – Data Collection Forms and Variable Naming (note: this volume was originally *Volume 1: Study Overview, Findings, Variables, and Data Forms*)
- *Volume 2 – Coding Manual* (note: this volume was originally *Volume 14 – Coding Manual*; subsequent volumes have been renumbered)
- *Volume 3 – Crash Form Data*
- *Volume 4– Environmental Form Data*
- *Volume 5 – Contributing Factors Data*
- *Volume 6 – Motorcycle Rider Data – Control Rider Data*
- *Volume 7– Motorcycle Passenger Data – Control Passenger Data*
- *Volume 8 – Motorcycle Mechanical Data – Control Motorcycle Data*
- *Volume 9 – Motorcycle Dynamics Data*
- *Volume 10 – Injury Form Data*
- *Volume 11 – Other Driver Data*
- *Volume 12 – Other Vehicle Data*
- *Volume 13 – Helmet Data*
- *Volume 14 – Comparisons to Other Studies*

Data Analysis (cont.)

- Example: Comparison/Analysis
  - Single vs. Multiple Vehicle Crashes

Crash Form

Case Number _____

1. Day of Week Crash Occurred ___
(1) Monday
(2) Tuesday
(3) Wednesday
(4) Thursday
(5) Friday
(6) Saturday
(7) Sunday .

2. Time of Day Crash Occurred ___ ___ : ___ ___
(24-hour clock).

3. First Harmful Event for Motorcycle ___ ___
(01) collision with other motor vehicle
(02) collision with fixed object
(03) collision with non-fixed object
(04) collision with pedestrian/cyclist/ non-motorist
(05) non-collision
(98) other event (specify) _____
(99) unknown event or object.

4. If This Case is a MC vs. MC, Provide Matching Case Number

_____

5. Presence at Crash Scene ___ ___
CODE UP TO 4
(00) not on-scene ___ ___
(01) nothing present ___ ___
(02) crash vehicles present ___ ___
(03) police present ___ ___
(04) EMS present ___ ___
(05) motorcycle rider present
(06) motor vehicle driver(s) present
(07) motorcycle passengers present
(08) motor vehicle passengers present
(09) non-motorists present
(98) other present (specify): _____
(99) unknown.

6. How Many Other Vehicles Were Involved in the Crash? ___ ___
(00) none
(01) one
(02) two
(03) three
(04) four or more
(96) non-contact with other vehicle
(97) not applicable
(98) other (specify) _____
(99) unknown.

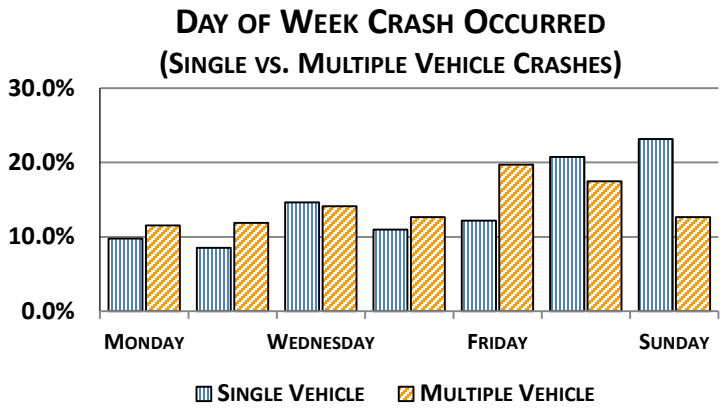
7. How Many Pedestrians Were Involved in the Crash? ___ ___
(00) none
(01) one
(02) two
(03) three
(04) four or more
(97) not applicable
(98) other (specify) _____
(99) unknown.

8. Number of Passengers on the Motorcycle ___ ___
(00) none
(01) one
(02) two
(03) three
(04) four
(05) five
(06) six
(99) unknown.

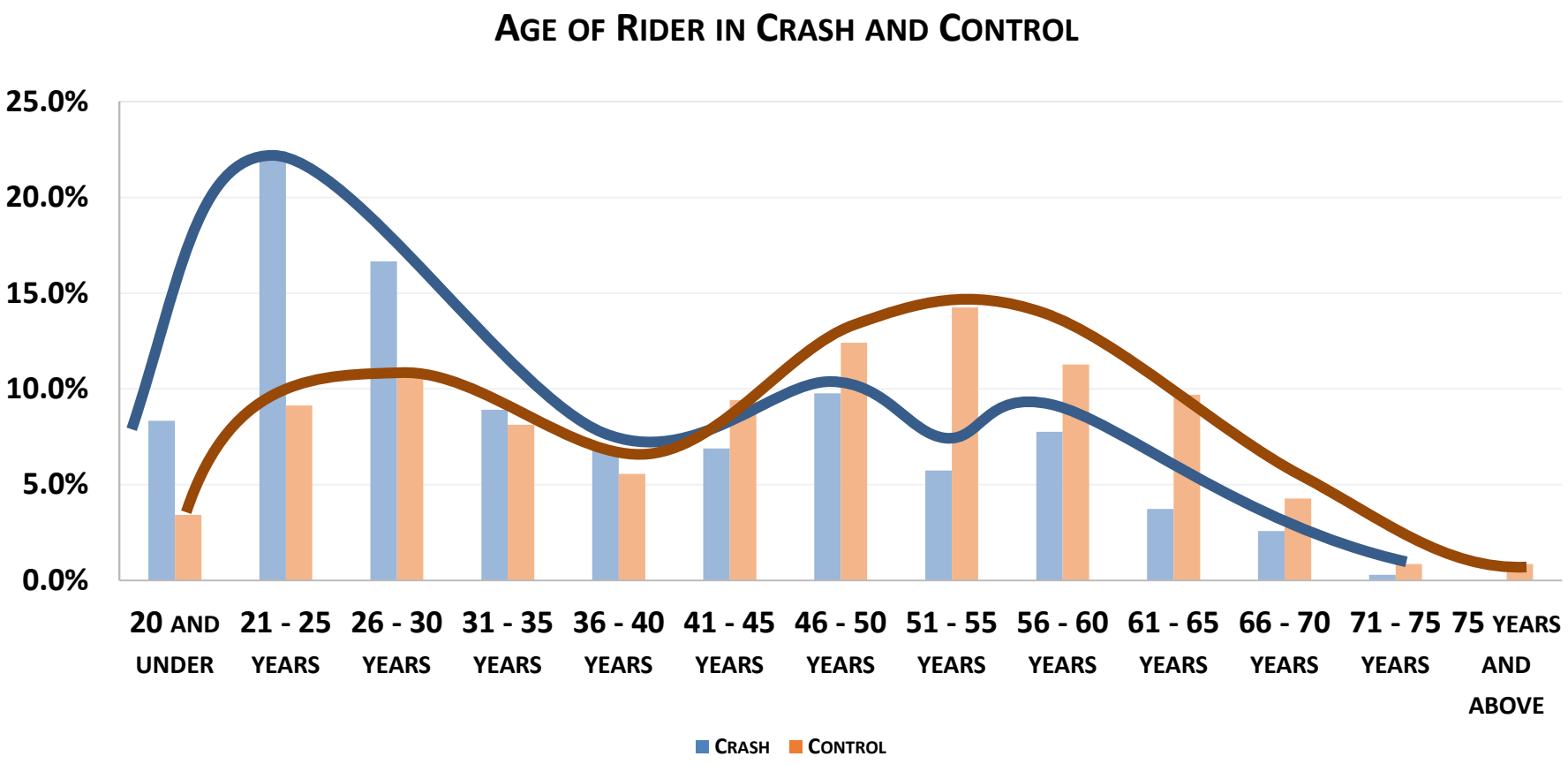
9. Are There Any Fatal Injuries Involved? ___ ___
(00) no
(01) yes
(99) unknown.

Single Vehicle Crashes were Overrepresented in the Sample Data (relative to Multiple Vehicle Crashes) on Sundays

Single vs. Multiple Vehicle Crashes (MC Data)							
CF001	Day of Week Crash Occurred		Total Coded 82		Total Coded 269	Statistical Analysis Single vs. Multiple Vehicle	
Code	Meaning of Code	Single Vehicle Count	Percent of Single	Multiple Vehicle Count	Percent of Multiple	z	Significance
01	Monday	8	9.8%	31	11.5%	0.446	Not Significant
02	Tuesday	7	8.5%	32	11.9%	0.847	Not Significant
03	Wednesday	12	14.6%	38	14.1%	-0.115	Not Significant
04	Thursday	9	11.0%	34	12.6%	0.402	Not Significant
05	Friday	10	12.2%	53	19.7%	1.551	Not Significant
06	Saturday	17	20.7%	47	17.5%	-0.669	Not Significant
07	Sunday	19	23.2%	34	12.6%	-2.332	Over Represented (95%)



Preliminary Results



Preliminary Results (Crash)

- **95%** of crashed riders were male
- **98.9%** of crashed riders were wearing helmets
  - **74%** were wearing full-face helmets
- **19%** of crashed riders did not have a MC license
  - 5% had no license at all

Preliminary Results

Type of Motorcycle Training	Crashes	Controls
None *	24%	15%
State Recognized, Entry-Level Motorcycle Course	50%	45%
Experienced Rider Course	8%	10%
High Performance/ Competitive Track Course	5%	5%
Self Taught*	6%	18%
Taught By Family and/or Friends	6%	7%

Preliminary Results

Age When Rider Began To Ride	Crashes	Controls
Never Rode Before, Or Rarely Ever Ride*	1%	0 %
Under The Age Of 17*	27%	40%
Age Between 17 - 25 Years*	51%	42%
Age Between 26-35 Years	13%	9%
Age Between 36-45 Years	5%	5%
Age Between 46-55 Years	2%	3%
Age More Than 55 Years	1%	1%

Preliminary Results (Crash)

- **11% of crashes resulted in a fatality to the rider**
  - **22%** of single vehicle crashes resulted in a fatality
  - **62%** of the fatalities involved a collision with a fixed object
- **77% coded as multiple vehicle**
  - **48%** of multi-vehicle crashes were the result of a turn by the MC or OV
  - **41%** of single vehicle crashes involved a rider leaving the roadway
- **10%** crashes occurred between 10pm-6am
  - 13% of fatalities
  - 12% of single vehicle crashes

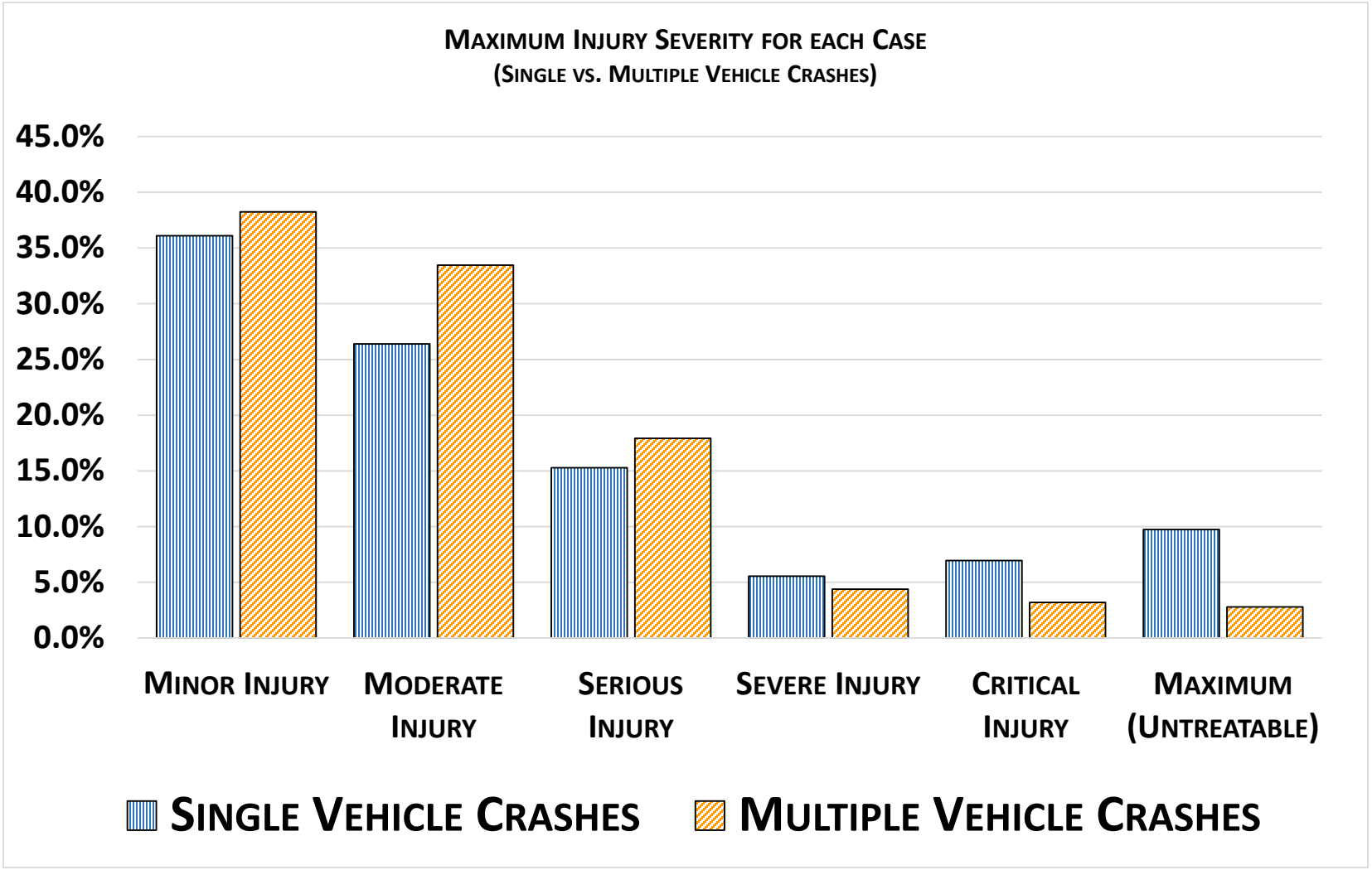
Preliminary Data (Environment)

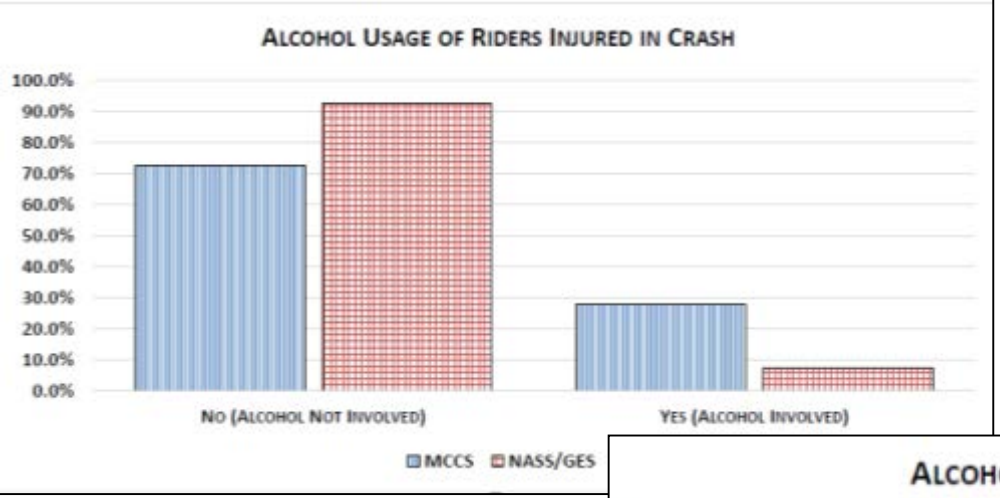
- **66.7% of crashes** occurred at an intersection
  - **50% of fatal crashes** occurred at intersections compared to **28% of non-fatal**
  - **17% of crashes** occurred at driveways
- **34% of crashes** occurred on curves
  - **48% of fatal crashes** occurred on curves as compared to **32% of non-fatal crashes**
- **74% of crashes** occurred on principal or minor arterials

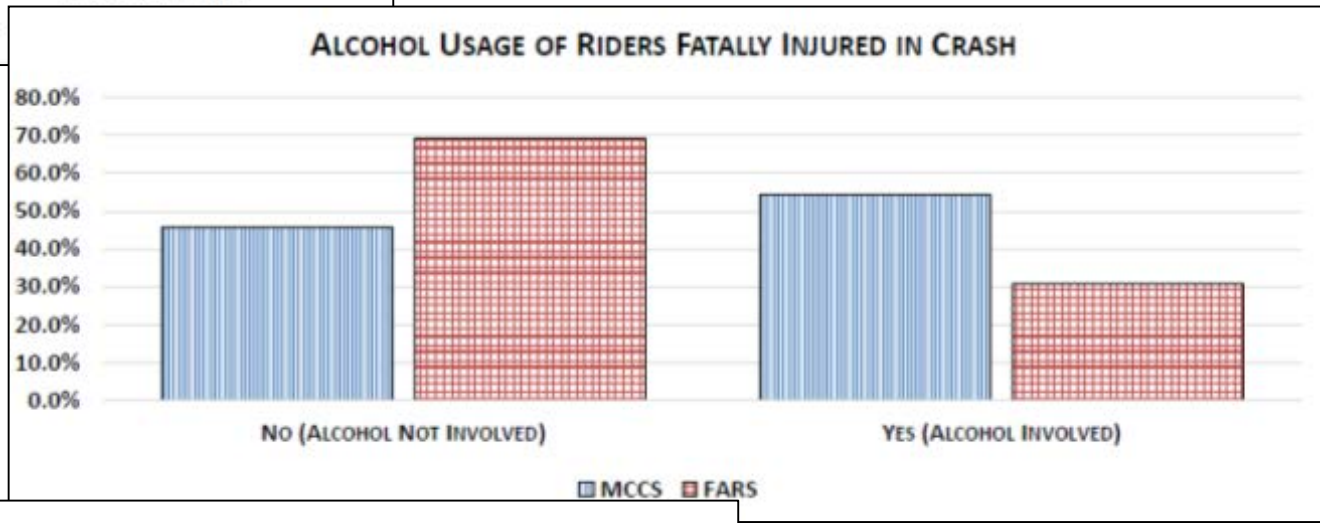
Preliminary Data (Causation)

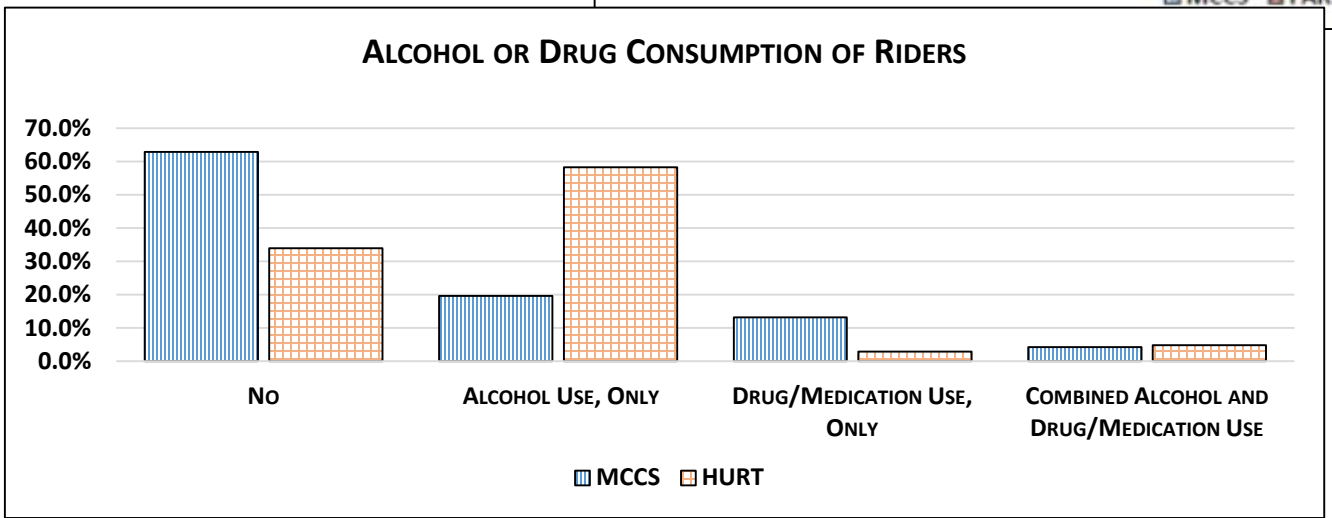
- A failure by the rider: the primary contributing factor in **44.3% of crashes** and a failure by the other vehicle driver was attributed to **51% of crashes**
  - **Unsafe acts by the rider** were deemed to be related to **50% of crashes**
  - **Traffic Scanning errors** by the other vehicle driver contributed to **70% of crashes**
  - **Inadequate control skills of the rider** contributed **to 26% of crashes**

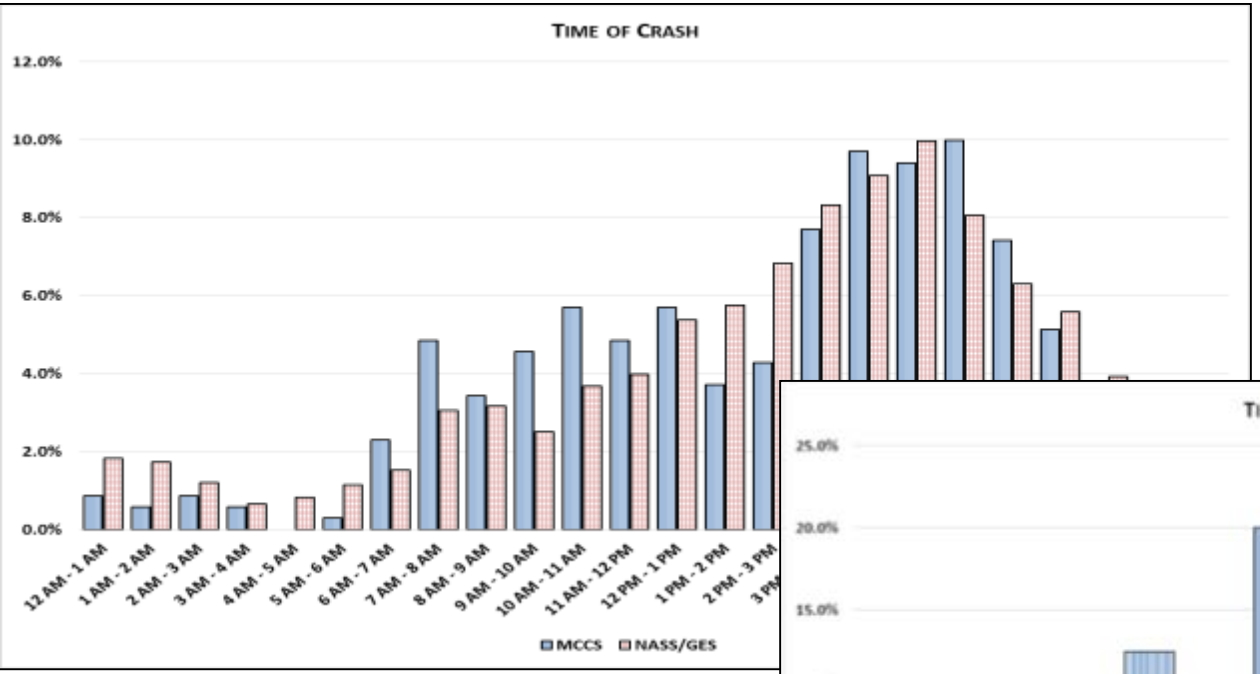
Preliminary Data (Injuries)

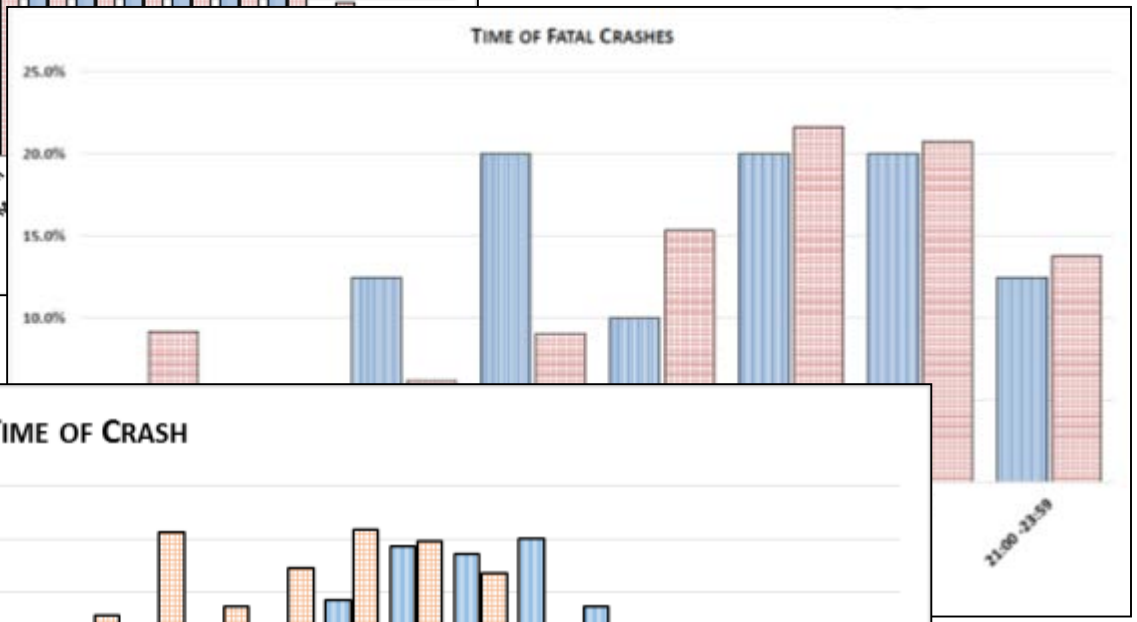


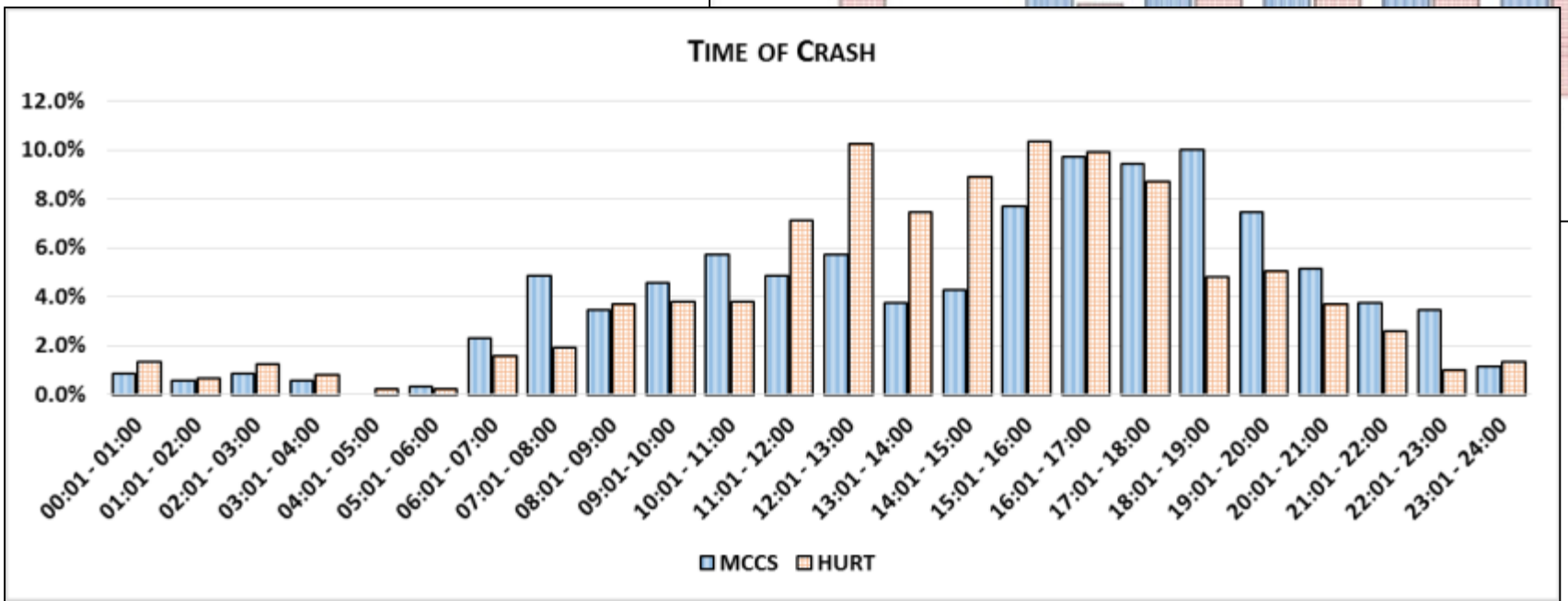

Alcohol Usage of Riders Injured in Crash
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
No (Alcohol Not Involved)
Yes (Alcohol Involved)
MCCS
NASS/GES

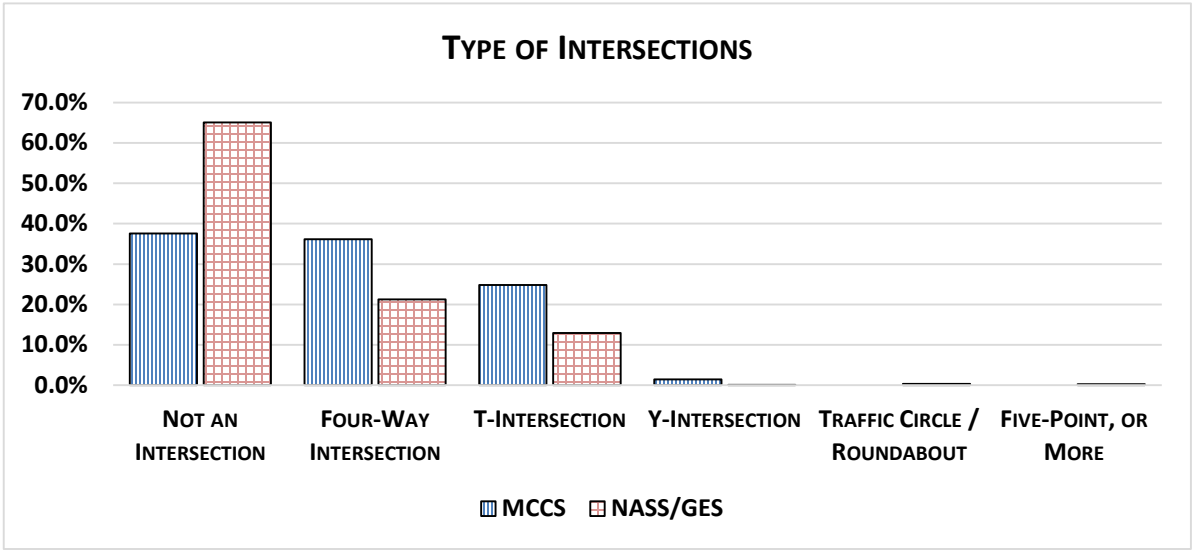

Alcohol Usage of Riders Fatally Injured in Crash
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
No (Alcohol Not Involved)
Yes (Alcohol Involved)
MCCS
FARS

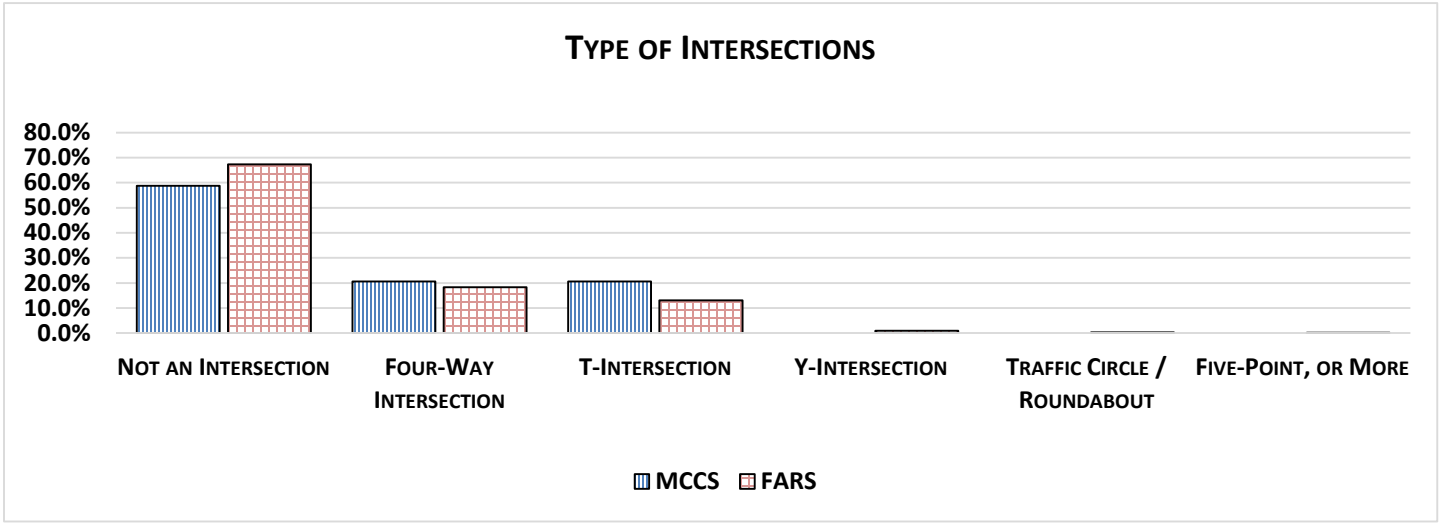

Alcohol or Drug Consumption of Riders
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
No
Alcohol Use, Only
Drug/Medication Use, Only
Combined Alcohol and Drug/Medication Use
MCCS
HURT


TIME OF CRASH
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
12 AM - 1 AM
1 AM - 2 AM
2 AM - 3 AM
3 AM - 4 AM
4 AM - 5 AM
5 AM - 6 AM
6 AM - 7 AM
7 AM - 8 AM
8 AM - 9 AM
9 AM - 10 AM
10 AM - 11 AM
11 AM - 12 PM
12 PM - 1 PM
1 PM - 2 PM
2 PM - 3 PM
MCCS
NASS/GES


TIME OF FATAL CRASHES
25.0%
20.0%
15.0%
10.0%
21:00 -23:59


TIME OF CRASH
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
00:01 - 01:00
01:01 - 02:00
02:01 - 03:00
03:01 - 04:00
04:01 - 05:00
05:01 - 06:00
06:01 - 07:00
07:01 - 08:00
08:01 - 09:00
09:01 - 10:00
10:01 - 11:00
11:01 - 12:00
12:01 - 13:00
13:01 - 14:00
14:01 - 15:00
15:01 - 16:00
16:01 - 17:00
17:01 - 18:00
18:01 - 19:00
19:01 - 20:00
20:01 - 21:00
21:01 - 22:00
22:01 - 23:00
23:01 - 24:00
MCCS
HURT


TYPE OF INTERSECTIONS
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
NOT AN INTERSECTION
FOUR-WAY INTERSECTION
T-INTERSECTION
Y-INTERSECTION
TRAFFIC CIRCLE / ROUNDABOUT
FIVE-POINT, OR MORE
MCCS
NASS/GES


TYPE OF INTERSECTIONS
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
NOT AN INTERSECTION
FOUR-WAY INTERSECTION
T-INTERSECTION
Y-INTERSECTION
TRAFFIC CIRCLE / ROUNDABOUT
FIVE-POINT, OR MORE
MCCS
FARS

Data Access

Data access administered by the FHWA Highway Safety Information System (HSIS) Program: www.hsisinfo.org

HSIS

HIGHWAY SAFETY INFORMATION SYSTEM

Current FHWA Activitiies

Current FHWA Safety Activities

- **Identifying Infrastructure-Based Motorcycle Crash Countermeasures – Yusuf Mohamedshah (Yusuf.Mohamedshah@dot.gov)**
- **Motorcycle Advisory Council (MAC) – Guan Xu (Guan.Xu@dot.gov)**
- **Addressing Motorcycle Crashes at Intersections – Jeff Shaw (Jeffrey.Shaw@dot.gov)**

Identifying Infrastructure-Based Motorcycle Crash Countermeasures

Phase I Project Objectives:

- Analysis of Motorcycle Crash Causation Study (MCCS) database.
- Identify three to five infrastructure-based countermeasures to reduce motorcycle crashes on our nation's highway.

Phase 1 Project Deliverables

- Summary report: literature review, data analysis methodology and results
- Potential infrastructure based countermeasures
- Research questions can be addressed using MCCS data
- Workshop findings and list of research questions paired with potential countermeasures
- Phase II plans
  - Plan to develop and field test three to five countermeasures
  - Evaluation plan to study effectiveness of these countermeasures on motorcycle crashes

More Information

- **Contact Information**

  Yusuf.Mohamedshah@dot.gov

  Carol.Tan@dot.gov

- **MCCS Website**

  http://www.fhwa.dot.gov/research/tfhrc/projects/safety/motorcycles/MCCS/index.cfm

Questions?

Thank You