# Road Safety Assessment (RSA) Program

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Transportation Planning Committee

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Pima Association of Governments

# What is an RSA?

**Formal** safety performance examination of an existing or future road or intersection by an **independent, multidisciplinary** team

- Engineers
- Law Enforcement
- Emergency Services
- Maintenance
- Anyone else with an interest in improving safety

# What is the Goal of an RSA?

- Determine elements of the road that may present a safety concern: to what extent, to which users, and under what circumstances?
- Determine what opportunities exist to eliminate or mitigate identified safety concerns
- Identify combination of site-specific and best practice recommendations for safety improvements to be considered by owning agency

# Potential Benefits of an RSA

- Reduced crash frequency
- Reduced crash severity
- Multimodal safety concerns addressed
- Design RSAs: may reduce costs by identifying safety issues and correcting them before projects are built
- Promote awareness of safe design practices

# What is the difference between an RSA and a Traditional Safety Review?

| Road Safety Assessment | Traditional Safety Review |
|---|---|
| Performed by a team independent of the project | The safety review team is usually not completely independent of the design team |
| Performed by a multi-disciplinary team | Typically performed by a team with only design and/or safety expertise |
| Considers all potential road users | Often concentrates on motorized traffic |
| Accounting for road user capabilities and limitations is an essential element of an RSA | Safety Reviews do not normally consider human factor issues |
| Always generates a formal RSA report | Often does not generate a formal report |

# What RSAs Can and Can't Do

**CAN:**

- Make observations
- Make recommendations
- Attempt to account for human factors



**CAN'T:**

- Decide on what to implement
- Implement improvements
- Provide funding for improvements

# Where are RSAs Conducted?

- High crash frequency/rate sites
- Sites where traffic characteristics have changed significantly
- Sites that involve complex design

# Crash Analysis

- Acquire crash data from ADOT database of law enforcement crash reports
- Crash incidents are processed and assigned to the nearest intersection within defined distance thresholds (or to segments if not within defined thresholds)
- Distance Thresholds:
  - Single Point Urban Interchange (SPUI) - 350’
  - Signalized - 250’
  - Collector or Above & Collector or Above - 125’
  - Collector or Above & Local - 50’
  - Local & Local - 25’

# Crash Analysis – SPF Development

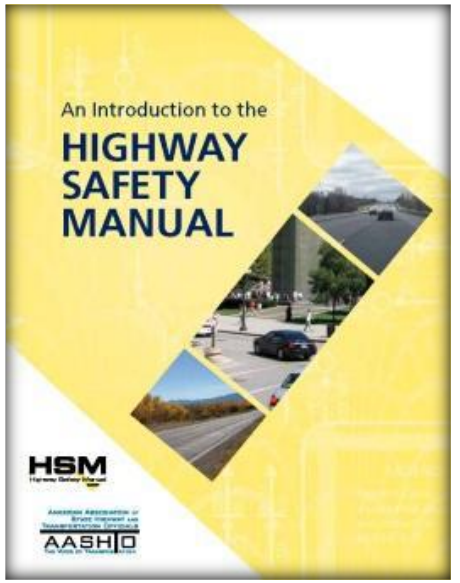
- For Segments and Intersections, Safety Performance Functions (SPFs) are Developed using the HSM:

  SPFs are equations used to predict the average number of crashes per year at a given location as a function of exposure (AADT) and roadway/intersection characteristics (e.g., number of lanes, traffic control, or median type)

$$\lambda_i = e^{\beta_0} \times AADT_{major}^{\beta_1} \times AADT_{minor}^{\beta_2} \times e^{(\beta_3 X_3 + \ldots + \beta_n X_n)} \quad (12)$$

where:

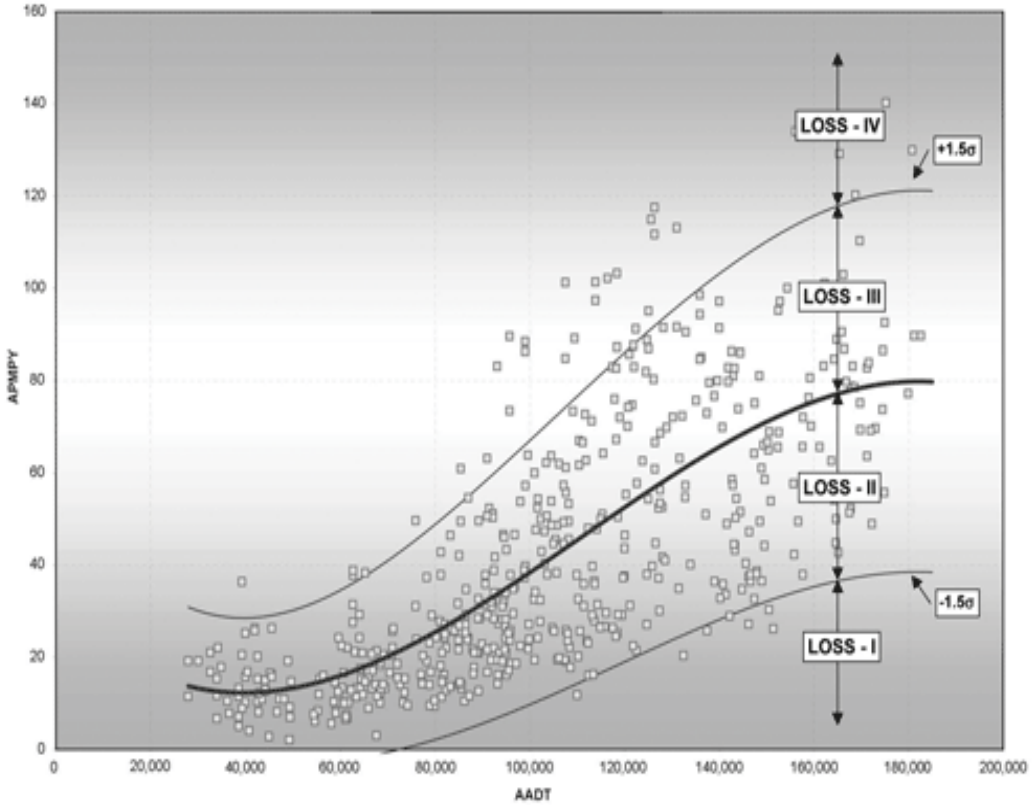
| | |
|---|---|
| $\lambda_i$ | = expected number of crashes at intersection $i$; |
| $e$ | = exponential function; |
| $\beta_0$ | = regression coefficient for constant; |
| $AADT_{major}$ | = average annual daily traffic (veh/day) for major roadway; |
| $AADT_{minor}$ | = average annual daily traffic (veh/day) for minor roadway; |
| $\beta_1, \beta_2$ | = regression coefficients for major and minor road AADT, respectively, |
| $\beta_3, \ldots, \beta_n$ | = regression coefficients for explanatory variables, $i = 3, \ldots, n$; and, |
| $X_3, \ldots, X_n$ | = vector of geometric design and other site-specific data. |



# Crash Analysis – Level of Safety

- Level of Safety Service (LOSS) is a safety categorization system for roadway segments or intersections in reference to their expected performance and is derived from SPFs.

- Simply put, LOSS helps categorize roads and intersections on a **1 to 4 scale**, with **1 indicating the lowest potential** for crash reduction (performing well), and **4 indicating the highest potential** for crash reduction (performing poorly).



# When are RSAs Conducted?

- Scoping/Planning
- Design
- Construction
- Existing Roadways

Improvements = Least Expensive

Improvements = Most Expensive

# Conducting an RSA

- Review crash data
- Meet with stakeholders

| EntireExtent | 2008 | 2009 | 2010 | 2011 | 2012 | Total |
|---|---|---|---|---|---|---|
| CURB | 2 | 2 | 2 | 3 | 1 | 10 |
| TREE_BUSH_STUMP_STANDING | 0 | 0 | 1 | 0 | 1 | 2 |
| TRAFFIC_SIGN_SUPPORT | 2 | 0 | 0 | 0 | 0 | 2 |
| TRAFFIC_SIGNAL_SUPPORT | 1 | 0 | 0 | 1 | 1 | 3 |
| OTHER_FIXED_OBJECT | 0 | 0 | 0 | 1 | 0 | 1 |
| Not Reported | 0 | 0 | 15 | 25 | 14 | 54 |
| | 142 | 120 | 96 | 57 | 47 | 462 |
| **InjurySeverity** | | | | | | |
| NO_INJURY | 92 | 76 | 55 | 23 | 21 | 267 |
| POSSIBLE_INJURY | 35 | 26 | 24 | 14 | 9 | 108 |
| NON_INCAPACITATING_INJURY | 11 | 16 | 12 | 13 | 11 | 63 |
| INCAPACITATING_INJURY | 4 | 2 | 5 | 6 | 5 | 22 |
| FATAL | 0 | 0 | 0 | 1 | 1 | 2 |
| | 142 | 120 | 96 | 57 | 47 | 462 |
| **Light Condition** | | | | | | |
| Daytime | 113 | 104 | 80 | 39 | 33 | 369 |
| Nighttime | 29 | 16 | 16 | 18 | 14 | 93 |
| | 142 | 120 | 96 | 57 | 47 | 462 |
| **Weather Condition** | | | | | | |
| CLEAR | 125 | 105 | 78 | 46 | 41 | 395 |

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| River and First | 2008 | 2009 | 2010 | 2011 | 2012 | Total |
|---|---|---|---|---|---|---|
| | 43 | 45 | 34 | 20 | 11 | 153 |
| **First Harmful Event** | | | | | | |
| OTHER_NON_COLLISION | 1 | 0 | 0 | 0 | 0 | 1 |
| MOTOR_VEHICLE_IN_TRANSPORT | 40 | 43 | 23 | 6 | 7 | 119 |
| PEDESTRIAN | 0 | 0 | 0 | 1 | 0 | 1 |
| PEDALCYCLE | 1 | 0 | 0 | 0 | 0 | 1 |
| CURB | 0 | 2 | 0 | 3 | 0 | 5 |
| TRAFFIC_SIGN_SUPPORT | 1 | 0 | 0 | 0 | 0 | 1 |
| Not Reported | 0 | 0 | 11 | 10 | 4 | 25 |
| | 43 | 45 | 34 | 20 | 11 | 153 |
| **InjurySeverity** | | | | | | |
| NO_INJURY | 26 | 30 | 18 | 8 | 3 | 85 |
| POSSIBLE_INJURY | 12 | 11 | 9 | 5 | 2 | 39 |
| NON_INCAPACITATING_INJURY | 2 | 4 | 5 | 6 | 5 | 22 |
| INCAPACITATING_INJURY | 3 | 0 | 2 | 1 | 1 | 7 |
| | 43 | 45 | 34 | 20 | 11 | 153 |
| **Light Condition** | | | | | | |
| Daytime | 37 | 39 | 30 | 11 | 6 | 123 |
| Nighttime | 6 | 6 | 4 | 9 | 5 | 30 |
| | 43 | 45 | 34 | 20 | 11 | 153 |
| **Weather Condition** | | | | | | |

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# Conducting an RSA

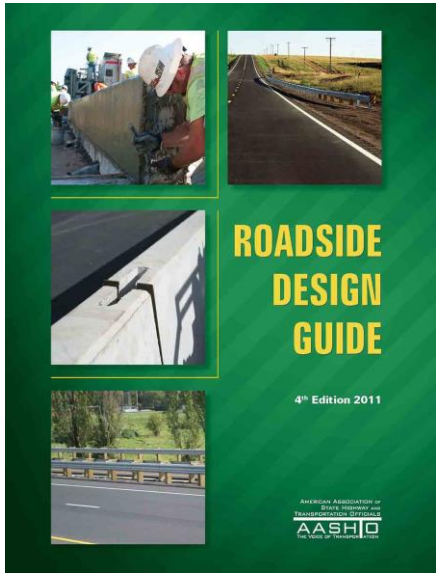
Conduct fieldwork

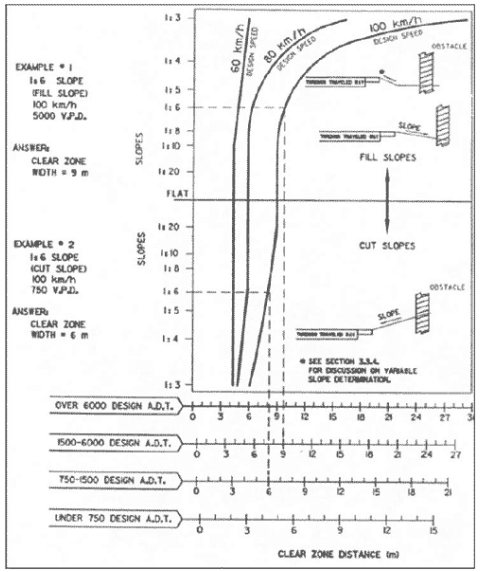
# Conduct fieldwork

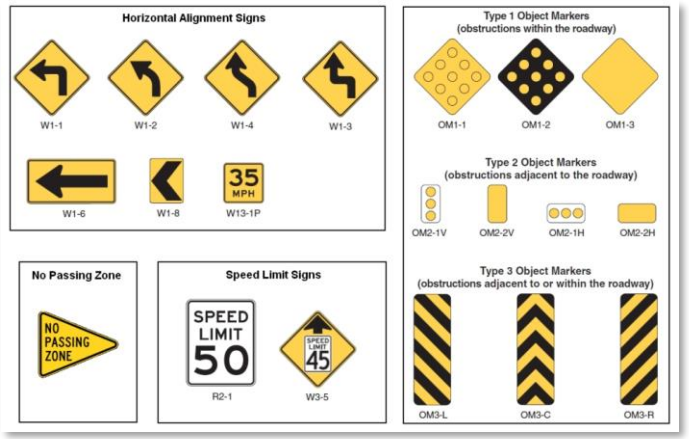
# Where’s the Stop sign?

# Conducting an RSA

- Perform analysis
  - Evaluate existing conditions for compliance with existing standards in the MUTCD, AASHTO Roadside Design Guide, NACTO,  etc.
  - However, an RSA is NOT a standards review.




| Design Speed | Design ADT | Fill Slopes | | | Cut Slopes | | |
|---|---|---|---|---|---|---|---|
| | | 1:6 or Flatter | 1:5 to 1:4 | 1:3 | 1:3 | 1:4 to 1:5 | 1:6 or Flatter |
| 60 km/h or less | Under 750 | 2.0-3.0 | 2.0-3.0 | [b] | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 |
| | 750-1500 | 3.0-3.5 | 3.5-4.5 | [b] | 3.0-3.5 | 3.0-3.5 | 3.0-3.5 |
| | 1500-6000 | 3.5-4.5 | 4.5-5.0 | [b] | 3.5-4.5 | 3.5-4.5 | 3.5-4.5 |
| | Over 6000 | 4.5-5.0 | 5.0-5.5 | [b] | 4.5-5.0 | 4.5-5.0 | 4.5-5.0 |
| 70-80 km/h | Under 750 | 3.0-3.5 | 3.5-4.5 | [b] | 2.5-3.0 | 2.5-3.0 | 3.0-3.5 |
| | 750-1500 | 4.5-5.0 | 5.0-6.0 | [b] | 3.0-3.5 | 3.5-4.5 | 4.5-5.0 |
| | 1500-6000 | 5.0-5.5 | 6.0-8.0 | [b] | 3.5-4.5 | 4.5-5.0 | 5.0-5.5 |
| | Over 6000 | 6.0-6.5 | 7.5-8.5 | [b] | 4.5-5.0 | 5.5-6.0 | 6.0-6.5 |
| 90km/h | Under 750 | 3.5-4.5 | 4.5-5.5 | [b] | 2.5-3.0 | 3.0-3.5 | 3.0-3.5 |
| | 750-1500 | 5.0-5.5 | 6.0-7.5 | [b] | 3.0-3.5 | 4.5-5.0 | 5.0-5.5 |
| | 1500-6000 | 6.0-6.5 | 7.5-9.0 | [b] | 4.5-5.0 | 5.0-5.5 | 6.0-6.5 |
| | Over 6000 | 6.5-7.5 | 8.0-10.0 [a] | [b] | 5.0-5.5 | 6.0-6.5 | 6.5-7.5 |
| 100 km/h | Under 750 | 5.0-5.5 | 6.0-7.5 | [b] | 3.0-3.5 | 3.5-4.5 | 4.5-5.0 |
| | 750-1500 | 6.0-7.5 | 8.0-10.0 [a] | [b] | 3.5-4.5 | 5.0-5.5 | 6.0-6.5 |
| | 1500-6000 | 8.0-9.0 | 10.0-12.0 [a] | [b] | 4.5-5.5 | 5.5-6.5 | 7.5-8.0 |
| | Over 6000 | 9.0-10.0 [a] | 11.0-13.5 [a] | [b] | 6.0-6.5 | 7.5-8.0 | 8.0-8.5 |
| 110 km/h | Under 750 | 5.5-6.0 | 6.0-8.0 | [b] | 3.0-3.5 | 4.5-5.0 | 4.5-4.9 |
| | 750-1500 | 7.5-8.0 | 8.5-11.0 [a] | [b] | 3.5-5.0 | 5.5-6.0 | 6.0-6.5 |
| | 1500-6000 | 8.5-10.0 [a] | 10.5-13.0 [a] | [b] | 5.0-6.0 | 6.5-7.5 | 8.0-8.5 |
| | Over 6000 | 9.0-10.5 [a] | 11.5-14.0 [a] | [b] | 6.5-7.5 | 8.0-9.0 | 8.5-9.0 |

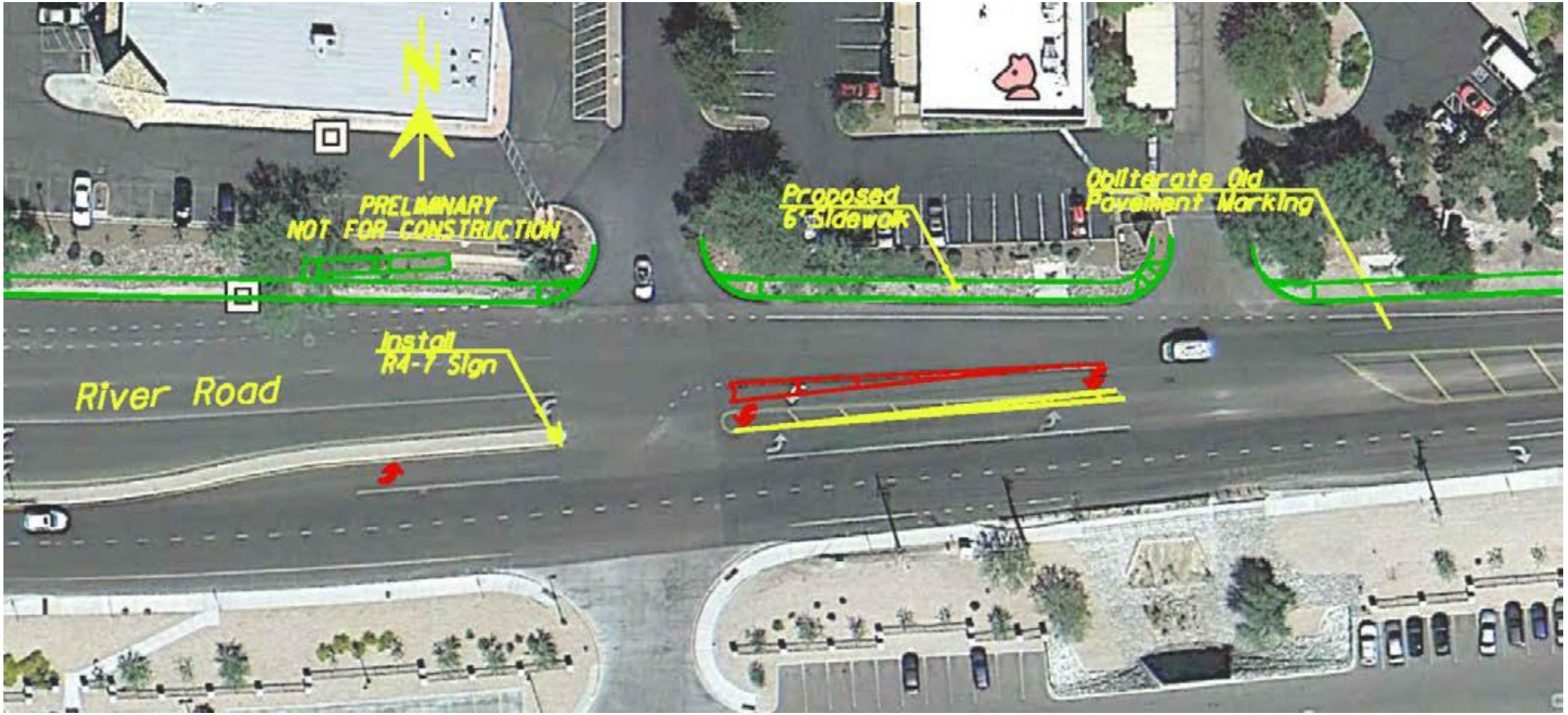
# Conducting an RSA

- Analysis continued
  - Explore existing, proven low-cost countermeasures to address safe
    - Before applying countermeasures, answer these questions
      1. What type of crash does it address?
      2. Where should it be used?
      3. Why will it work?
      4. What is the estimated time and cost to deploy?
      5. How effective will it be?

**Identified Safety Issue:**
**Severe Horizontal Alignment**

| Potential Treatments | Timeframe | CMF | Standard Error | Crash Type | Crash Severity |
|---|---|---|---|---|---|
| Install Chevrons | Near-Term | 0.96[1] | 0.09 | All | All |
| Install Advance Curve Warning Signs | Near-Term | 0.90[2] | Not Reported | All | Fatal/Injury |
| Flatten Curve | Long-Term | 0.33[3] | 0.32 | All | All |

[1] Srinivasan, R., Baek, J., Carter, D., Persaud, B., Lyon, C., Eccles, K., Gross, F., Lefler, N., "Safety Evaluation of Improved Curve Delineation." Report No. FHWA-HRT-09-045, Federal Highway Administration, Washington, D.C., (2009).
[2] Montella, A., "Safety Reviews of Existing Roads: A Quantitative Safety Assessment Methodology." Vol. TRB#05-1295, Washington, D.C., 2005 TRB 84th Annual Meeting: Compendium of Papers CD-ROM, (2005)
[3] Pitale, J.T., Shankwitz, C., Preston, H., and Barry, M."Benefit-Cost Analysis of In-Vehicle Technologies and Infrastructure Modifications as a Means to Prevent Crashes Along Curves and Shoulders." Minnesota Department of Transportation, (2009).


N
PRELIMINARY
NOT FOR CONSTRUCTION
Proposed
6' Sidewalk
Obliterate Old
Pavement Marking
Install
R4-7 Sign
River Road

# Conducting an RSA

- Submit findings, make recommendations

| Identified Safety Issue | Suggested Improvements |
|---|---|
| **Lack of exclusive turn lanes**.<br>There are no existing turn lanes along Main Street at First Street, which requires all turning movements to be made from the through lanes. There are heavy turning movements at this intersection during the AM and PM peak periods and the RSA team observed several potential conflicts between turning vehicles and through vehicles. | **Consider installation of exclusive left-turn lanes.**<br>•CMF: 0.53<br>•Standard error: 0.04<br>•Confidence interval: 0.45 – 0.61<br>•Applicable crash types: All<br>•Applicable crash severities: All<br>•Source: CMF Clearinghouse<br>•Reference: Harwood et al. *Safety Effectiveness of Intersection Left- and Right-Turn Lanes.* Report number FHWA-RD-02-089, Federal Highway Administration, Washington, DC, 2002 |

- Facility-owner formal response
- Implement findings/Make improvements (owner responsibility)

# RSA Process Summary

1. Startup Meeting

2. Site Visit

3. RSA Analysis

4. Preliminary Findings Meeting

# RSA Process Summary (continued)

## 5. RSA Report

FEDERAL HIGHWAY ADMINISTRATION

ILLINOIS DEPARTMENT OF TRANSPORTATION

HAMILTON ASSOCIATES

ROAD SAFETY AUDIT FOR

IMPROVEMENTS TO CLEAR LAKE AVENUE AND

DIRKSEN PARKWAY

SPRINGFIELD, ILLINOIS

Engineering and Planning Consultants

CONTRACT DTFH61-03-D00105

TASK ORDER BMISG05B022

## 6. Owner Response

**MEMORANDUM**

**DATE:** January 4, 2006

**TO:** Roadway Safety Audit Team

**FROM:** Richard B. Nassi
Transportation Administrator

**SUBJECT: Response to Road Safety Audit Recommendations**

Project: Road Safety Audit of six "HAWK" Pedestrian Crossing Sites, Tucson Arizona
Contract DTFH61-03-D00105 Task Order BMISG05B022
Description: Installation of six HAWK Pedestrian Crossings City-wide

**Issue 1: Use of the Alternating Flashing RED Signal Indication.** During on-site observations of the existing HAWK ( installations, most drivers were observed to remain stopped until the alternating flashing RED sequence has ended, even though they may legally pass through the crosswalk. Of those drivers who did proceed during the alternating flashing RED sequence, many following drivers continued slowly through the crosswalk without coming to a full STOP as required by law at a flashing RED beacon. Drivers who illegally enter the crosswalk during the flashing RED display may conflict with pedestrians legally in the crossing during the pedestrian clearance phase. This risk was rated B (low risk level).

The following suggestion(s) were discussed and action(s) were taken:

1. *Additional Signing:* Additional regulatory signaling was installed at selected HAWK crossing to determine their impact upon drivers as well as extensive educational program and enforcement. The black on white signs read "STOP—MAY PROCEED WITH CAUTION WHEN FLASHING". Observation of the signing over the last year, as well as the media campaign, has shown little change in the driver's behavior. However, enforcement has made a significant impact upon individual driver's behavior as it does with other traffic enforcement.
2. *Eliminate flashing interval:* The HAWK operation is very effective in gaining appropriate driver compliance at pedestrian crossings and significantly increases the percentage of drivers voluntarily stopping for pedestrians. The beacon signal displays a solid RED indication to traffic during the WALK interval and is then followed by an alternating flashing RED interval during the flashing DON'T WALK interval. The current alternating RED flashing sequence was adopted from the successful operations used in Europe, which uses a flashing AMBER at PELICAN crossings, and Los Angeles, which uses a flashing RED indication at midblock crossings. The advantages of the flashing RED indication a) allows the reasonable and prudent driver to proceed when it is safe to do so, and b) better matches the crossing time needs of the individual pedestrian to actual delay thus maintaining high driver compliance. It is impossible to have a pre-determined crossing time match the time necessary for all individuals that may cross. The beacon signal operation needs to match the user expectancy in order to keep the compliance high. The key to the issue is that the operation of the STOP command should be generally only as long as the pedestrian needs to cross and reach the other curb and not become

## 7. Implementation

# PAG RSA Program

- Performed 50 + RSAs throughout the region since 2011.
- Requested RSAs currently being scheduled.

# Questions?

Pima Association of Governments