Global Benchmarking Webinar Series: Improving Pedestrian Safety on Urban Arterials (Part 3)

Safe System Approach to Road Safety Audits

Rachel Carpenter  California Department of Transportation (Caltrans)
Tamara Redmon  Federal Highway Administration (FHWA)
Becky Crowe  Federal Highway Administration (FHWA)
Ana Fill  Massachusetts Department of Transportation
Brandon Darks  Tennessee Department of Transportation
Housekeeping

⇒ Submit your questions

⇒ Webinar archive: www.pedbikeinfo.org/webinars

⇒ Certificates and professional development hours

⇒ Follow-up email later today

⇒ Review previous episodes and sign up for upcoming sessions
Improving Pedestrian Safety on Urban Arterials

Part 1
Introduction and Overview of Study Findings
Sept 25, 2023

Part 2
The Movement and Place Framework
Oct 2, 2023

Part 3
Safe System Approach to Road Safety Audits
Oct 23, 2023

Part 4
Speed Management Policies and Practices
Nov 7, 2023
Recap: Study Team Overview

Shari Schaftlein (Study Team Lead)
Director, Office of Human Environment
Federal Highway Administration
Shari.Schaftlein@dot.gov

Darren Buck (Study Team Co-Lead)
Pedestrian and Bicycle Program Coordinator
Federal Highway Administration
Darren.Buck@dot.gov

Tamara Redmon
Pedestrian and Bicyclist Safety Team Leader
Federal Highway Administration
Tamara.Redmon@dot.gov

Rachel Carpenter
Chief Safety Officer
California Department of Transportation
rachel.carpenter@dot.ca.gov

Mark A. Cole, PE
State Highway Safety Engineer
Traffic Engineering Division
Virginia Department of Transportation
Mark.Cole@VDOT.Virginia.gov

Lee Austin
Central Area Engineer
City of Austin, TX
Lee.Austin@austintexas.gov

Laura Sandt
Director, Pedestrian and Bike Information Center
University of North Carolina Highway Safety Research Center
sandt@hsrc.unc.edu

Jonah Chiarenza
Community Planner (Report Lead)
U.S. DOT Volpe Center
Jonah.Chiarenza@dot.gov
Recap: Core Factors to Improve Safety

- **Reduce vehicle speed to mitigate kinetic energy** using geometric design and operational strategies, including emerging technologies like camera enforcement.

- **Separate vulnerable road users from motorized vehicles in time and space** when vehicle speeds exceed survivable levels.

- **Design roads and streets to suit their desired context** considering future land use, as well as economic, climate, public health, and equity goals.

Source: FHWA.
Recap: Design & Implementation Takeaway

Pedestrian Safety Challenges Require Proactive and Interdisciplinary Solutions

- Designing roads and streets that are safe for pedestrians and other vulnerable road users requires proactive and intentional solutions. The design and implementation of projects at all scales – network, corridor, and block – must contribute to a holistic vision that recalibrates modal priorities and is rooted in the Safe System approach. This means designing a transportation system that recognizes humans will make mistakes and mitigates negative outcomes by managing speed, changing roadway designs, and influencing user behavior.

- Communities cannot effectively address discrete transportation issues – safety, equity, public health, congestion, freight – in isolation. Sustainable solutions to these issues require analytical tools and multidisciplinary practitioners who can work outside of their silos to analyze the tradeoffs between different modal emphases through a rational, systemic approach.
Recap: Bake in Safety through Road Safety Audits

**Systemic Approach**

Span all stages of the project lifecycle:

1. Network / corridor-scale planning
2. Programming
3. Scoping / developing countermeasures
4. Project development / detailed design
5. Project delivery
6. Post project
7. Network operation / maintenance
“A Road Safety Audit is a **systematic** method of checking the safety aspects of new road improvement schemes. The term is generally considered to refer to a formal **independent and multi-disciplinary** detailed assessment of the safety performance of all new highway and traffic management schemes, including modifications to existing layouts, and are **undertaken at different stages** during the design, planning and construction process.”

Source: Pg. 83, *iRAP Star Rating and Investment Plan Manual* (iRAP)
NZ Approach: Institutionalizing RSAs

Figure 3: Safe System audit stages within project development
NZ Approach, cont’d

- Specific process
- Well-defined roles
- Multidisciplinary team
- Training/certification support

### Safe System Audit Process Steps

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Responsible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confirm audit stage</td>
<td>Identify project audit stage required or complete exception form</td>
<td>Client</td>
</tr>
<tr>
<td>Audit team selection</td>
<td>Select the Safe System audit Team Leader and team members including observers</td>
<td>Client/Safe System audit team leader</td>
</tr>
<tr>
<td>Safe System audit brief</td>
<td>Provide the Safe System audit team a brief including all relevant project information</td>
<td>Client/designer</td>
</tr>
<tr>
<td>Commencement meeting</td>
<td>Hold</td>
<td>Client/designer/Safe System audit team leader</td>
</tr>
<tr>
<td>Review of project background documents</td>
<td>Assess all necessary documents</td>
<td>Safe System audit team</td>
</tr>
<tr>
<td>Project site inspection</td>
<td>Identify project audit stages requires or complete exception form</td>
<td>Safe System audit team</td>
</tr>
<tr>
<td>Debrief meeting</td>
<td>Identify project audit stages requires or complete exception form</td>
<td>Client/designer/Safe System audit team</td>
</tr>
<tr>
<td>Report writing</td>
<td>Complete audit report and forward to client</td>
<td>Safe System audit team</td>
</tr>
<tr>
<td>Designer response to report</td>
<td>Designer provides responses to safety concerns related within report</td>
<td>Designer</td>
</tr>
<tr>
<td>Road safety engineer response to report</td>
<td>Road safety engineer provides responses to safety concerns</td>
<td>Road safety engineer</td>
</tr>
<tr>
<td>Client decision</td>
<td>Client reviews, comments, responses, and makes decisions</td>
<td>Client</td>
</tr>
<tr>
<td>Complete report with decisions</td>
<td>Complete audit tracking within report and feedback response to designer</td>
<td>Client</td>
</tr>
<tr>
<td>Implement client decision</td>
<td>Document final actions and finalise audit tracking</td>
<td>Client</td>
</tr>
</tbody>
</table>

Figure 4: The steps in a road safety audit

Page 11, Safe System Audit Guidelines (Waka Kotahi NZ Transport Agency)
Austroads Example

- Pre-construction assessment
- Articulates the potential for **exposure** to risk, **likelihood** of a crash or crash type, and **severity** of injury
- References standards/guidelines
Key RSA Safety Considerations

<table>
<thead>
<tr>
<th>SEVERITY</th>
<th>X</th>
<th>EXPOSURE</th>
<th>X</th>
<th>LIKELIHOOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMPACT SPEED (delta V)</td>
<td></td>
<td>NUMBERS OF PEOPLE = risk of event, number of vehicles = hazards</td>
<td></td>
<td>DESIGN LAYOUT</td>
</tr>
<tr>
<td>The speed and mass of each road user changes the force of impact</td>
<td></td>
<td>TIME AND DISTANCE not separated from harmful forces</td>
<td></td>
<td>Primary focus is on instinctive design that nudges drivers at key points for alertness or frequently for slower speeds (vertical and horizontal shifts of the driving path)</td>
</tr>
<tr>
<td>Survivable speeds = #1 goal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Auckland Transport Design Manual
### Table 3.1: Examples of pedestrian treatments based on treatment hierarchy

| Hierarchy                                                                 | Treatment | Influence  
|---------------------------------------------------------------------------|-----------|------------
| Safe System options (primary treatments)                                  |           | E, L, S    
| • Separation (footpath)                                                  |           |            
| • Separation (crossing point)                                            |           |            
| • Very low speed environment, especially at intersections or crossing points|           |            
| Supporting treatments (compatible with future implementation of Safe System options) |           | L, S, L, E, L 
| • Reduce speed environment/speed limit                                   |           |            
| • Pedestrian refuge                                                      |           |            
| • Reduce traffic volume                                                  |           |            
| Supporting treatments (does not affect future implementation of Safe System options) |           | L, L, L, L, S 
| • Pedestrian signals                                                     |           |            
| • Skid resistance improvement                                            |           |            
| • Improved sight distance to pedestrians                                 |           |            
| • Improved lighting                                                      |           |            
| • Rest-on-red signals                                                    |           |            
| Other considerations                                                     |           | L, S       
| • Speed enforcement                                                      |           |            

Source: Austroads, Guide to Road Safety Part 6: Managing Road Safety Audits

Note: The objective of the treatment hierarchy is to apply the primary treatments in a systematic, targeted way. Where it is not possible to apply these, or in the short term, other solutions should be used, working down through the options.
Road Safety Audits in CA

Road Safety Audit (RSA) – formal and independent safety performance review

- Pilot Program to be released in June 2024
- Develop Uniform Statewide Practice
- Explore Project Screening and Funding Mechanisms
- Train and Certify Auditors
- Partner with Headquarters Divisions and District Offices

Responsibilities:
- RSA Team
- Design Team/Project Owner

1. Identify Projects
2. Select RSA Team
3. Conduct Start-up Meeting
4. Perform Field Reviews
5. Analyze and Report on Findings
6. Present Findings to Owner
7. Prepare Formal Response
8. Incorporate Findings

Safety Benefits:
10-60% reduction in total crashes.

1.
CA Road Safety Audit Example

District 3, Colusa County, Route 20, Postmile 0.00 – 22.10

Completed a Road Safety Audit in April 2022

Developed short-term, mid-term, and long-term safety enhancements

Scoped Safety Project

Approved for HSIP Reactive Program, Cost $30,000,000

Construction Begins Fall 2026
Road Safety Audits in the U.S

Where are we?

Source: USDOT/Getty
RSAs were adopted in the U.S. because of a previous Global Benchmarking Scan.

- FHWA Proven Safety Countermeasure.
- NCHRP Project 17-125, “Incorporating the Safe System Approach into Road Safety Audits.”
Advance the integration of modern, multimodal Road Safety Audit (RSA) processes into new projects.

- Develop a “Roadmap" and other resources to advance RSAs
- Undertake a synthesis of current practices. (NCHRP Synthesis)

**GOAL: RSAs conducted through the lifecycle of a project**
RSA History in US

- **RSA Case Studies**
  - FHWA created the RSA Peer-to-Peer Program in 2006.
  - RSA accepted by the FHWA Resource Center as a Market Readiness Technology in 2008.

- **HSIP Final Rule**
  - Allows RSAs in 2008.

- **Proven Safety Countermeasure**

- **RSA software**

- **Tribal Road Safety Audit Case Studies**
  - RSA Newsletter distributed to over 1,200 tribal leaders in 2010.

- **RSA Design Visualization (3D models)**

- **Road Safety Audit Toolkit for Federal Land Mgt Agencies**

- **Cyclist Road Safety Audit Guidelines and Prompt Lists**

- **Pedestrian RSA Guidelines and Prompts**

- **RSA Guidelines**
  - FHWA introduced RSAs to State DOTs and FHWA Division Offices in 1996.

- **RSA Peer Exchange**
  - FHWA began providing training to State DOTs on the Pedestrian RSA Guidelines in 2009.

- **Federal and Tribal Lands Road Safety Audit Case Studies**

- **Award winning video**

- **Over 148 trainings, 3,700 participants**

- **Transit RSA Case Studies**

- **NCHRP Synthesis**

Source: FHWA
Resources:
https://highways.dot.gov/safety/data-analysis-tools/rsa/rsa-resources

- RSA Guidelines
- RSA Case Studies
- Pedestrian and Bicyclist RSA Guide and Prompt List
- RSA Toolkit for Federal and Tribal Lands
- An Evaluation of RSA Programs and Projects
- Using 3D Design Visualization in the RSA Process
- Road Safety Audits/Assessments Training (FHWA-NHI-380069) available through National Highway Institute
State Spotlight on Road Safety Audits

- Tennessee
- Massachusetts
PBIC Webinar Series #3: Road Safety Audits

Thank you!

Source: USDOT/Getty
Tennessee (TDOT) Roadway Safety Audit Program (RSA)

Brandon Darks, Manager
Project Safety Office
THE SAFE SYSTEM APPROACH

- Safe Road Users
- Safe Vehicles
- Safe Speeds
- Safe Roads
- Post-Crash Care

DEATH/SERIOUS INJURY IS UNACCEPTABLE

HUMANS MAKE MISTAKES

RESPONSIBILITY IS SHARED

SAFETY IS PROACTIVE

REDUNDANCY IS CRUCIAL

MANAGE CRASH ENERGY

REDUCE RISK OF ERROR
Innovative Design

J-Turn Intersection

Example: Roundabouts vs Signalized Intersections

<table>
<thead>
<tr>
<th>Feature</th>
<th>Roundabouts</th>
<th>Signalized Intersections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Speeds</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Lower Impact Angles</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Fewer Conflict Points</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

Is this why roundabouts are so effective at reducing severe crashes? YES !!!

- Manage speed
- Manage impact angles
- Manage impact energy distribution

Source: Fehr & Peers
Source: City of Carmel, IN
Source: Fehr & Peers
Focus on Vulnerable Road Users (VRU)

In addition to making East Boulevard in Charlotte, N.C., more attractive, a road diet reduced travel speeds, bicycle and pedestrian injury rates and the number of rear-end and left-turn collisions. Photo courtesy city of Charlotte.

- Separating users in space
- Separating users in time
- Increasing attentiveness and awareness
Safe System Applications

**ROADWAY DEPARTURE**
- Wider Edge Lines
- Longitudinal Rumble Strips and Stripes on Two-Lane Roads
- Enhanced Delineation for Horizontal Curves

**INTERSECTIONS**
- Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections
- Backplates with Retroreflective Borders

**PEDESTRIANS/BICYCLES**
- Rectangular Rapid Flashing Beacons (RRFB)
- Crosswalk Visibility Enhancements
<table>
<thead>
<tr>
<th>Emphasis Area</th>
<th>Safe System Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crash Data and Analysis</td>
<td>Post-Crash Care</td>
</tr>
<tr>
<td>Infrastructure Improvements</td>
<td>Safe Roads, Safe Speeds</td>
</tr>
<tr>
<td>Operations Improvements</td>
<td>Safe Roads, Safe Road Users, Safe Speeds</td>
</tr>
<tr>
<td>Vulnerable Road Users</td>
<td>Safe Road Users</td>
</tr>
<tr>
<td>Commercial Vehicles</td>
<td>Safe Road Users</td>
</tr>
<tr>
<td>Driver Behavior</td>
<td>Safe Road Users, Safe Speeds</td>
</tr>
</tbody>
</table>
Highway Safety Improvement Program (HSIP)

- Section 148 of Title 23, United States Code (23 USC 148)

Achieving a significant reduction in traffic fatalities and serious injuries on all public roads, including non-State-owned public roads.

- Strategic Highway Safety Plan (SHSP)
- All safety programs to use a data-driven process with set qualification criteria.
Safety Data

**HSIP Annual Report** - submitted to FHWA

**E-TRIMS**: Tennessee Roadway Information Management System  
TDOT Statewide database housing all roadway elements

AASHTO Safetyware- Numetric:

Early implementation: Crash analysis  
Network screening  
Training

Tennessee Integrated Traffic Analysis Network (TITAN)

Collecting/analyzing crash data/crash rates for HSIP eligibility
Strategic Highway Safety Plan (SHSP)

Highway Safety Improvement Program (HSIP)

RSA / Initiative

Collect and Process Crash Data

Identify Needs & Establish Emphasis Areas

Create Systemic Engineering Approaches Based on Needs

Inclusive Multidisciplinary Team with State and Local Stakeholders to Engineer, Educate, Enforce, and provide EMS services for roadways
RSA Process

- **Pre-Brief Meeting**
  - Site Identification
  - Crash Rates
  - Crash Diagrams

- **Site Visit**
  - Photo Inventory
  - Recommendations

- **RSA Packet**
  - Guidance Figures
  - Cost Estimate
  - Review Report
SHSP/HSIP Road Safety Audits / Initiatives

- Ramp Queue
- Spot Safety
- Wrong Way Initiative
- Local Road Safety Initiative
- Pedestrian Safety Initiative
HSIP Programs/Initiatives

Local Road Safety Initiative:
Identify and address safety concerns on local, non-state route segments located outside an urban boundary and NOT represented by a Metropolitan Planning Organization (MPO). (82 Counties - $ 22.5 MIL)

Typical countermeasures:
• Signs and pavement markings
• Edge line / shoulder rumbles
• Snowplow-able pavement markers
• Guardrail/barrier wall delineation
• Upgrade of guardrail/end terminals
HSIP Programs/Initiatives

Ramp Queue Program:
Identify and address Ramp safety concerns on Interstate and control access facilities: Ramp traffic queuing back to mainline traffic.

Typical countermeasures:
- Geometric Design
- Improve length of ramp storage
- Signalization of Ramp
- Improve shoulder for turn lane
- Signs and pavement markings
- Snowplow-able pavement markers
- Guardrail/barrier wall delineation
- Upgrade of guardrail/end terminals
Wrong Way Safety Initiative:
Address vehicles making wrong way movements onto ramps of access-controlled facilities.

Typical countermeasures:
- Signs and pavement markings (direction arrow)
- Snowplow able pavement markers
- Flexible Delineators
- Concrete curb/raised islands
- Bi-directional guardrail delineation
- Reflective signpost delineation
- Modular curbing
HSIP Programs/Initiatives

Pedestrian Safety Initiative:

Typical countermeasures:

• Pedestrian countdown signal heads
• Cross walks/Pedestrian crossing
• Concrete curb/raised islands
• Signs, pavement markings
• Reflective signpost delineation
• Modular curbing
• Pedestrian signal (PHD) HAWK
• Rapid flashing beacon (RRFB)
Project Delivery Method

“No-Plans Contract” - Projects calling only for improvements that have no in-depth design considerations and require no acquisition of right-of-way.

“Design” - More in-depth design of improvements (i.e. drainage, earthwork, signalization, survey, etc.) or the acquisition of right-of-way is required... the project will undergo a formal design.
Project schedules

- Project Safety Office (PSO)- request all phases of funding
  - Funding request to FHWA
  - Request NEPA /Environmental Doc.
  - Conduct/prepare RSA program
  - Let to construction – completion notice
TDOT HSIP Annual Funding

- **Highway Safety Improvement Program (HSIP)**
- Road Safety Audit (RSA) (~$25-35 mil/year)
  - STID-Project Safety Office
  - Local Road Safety Initiative (LRSI) (~$5.5 mil/year)
  - Operations Division
  - Multi-modal Division (~$6-7 mil/year)
- Statewide resurfacing program (~$8-10 mil/year)
- Spot Safety (NON-HSIP) (~$4.0 mil/year)
- Tennessee Highway Safety Office
TDOT HSIP Project/Funding History

- 2019 – 50 let- to-contract Cost: $ 49.5 Million
- 2020 – 85 let- to-contract Cost: $ 38.5 Million
- 2021 – 63 let- to-contract Cost: $ 35.6 Million
- 2022 – 44 let- to-contract Cost: $ 52.9 Million
- 2023 – 57 let- to-contract Cost: $ 62.4 Million
Thank you....

Questions & Comments !!
Contact Information:

Brandon Darks
Transportation Manager 2
Project Safety Office
Strategic Transportation Investments Division
TDOT
**Tel:** 615-253-3999

**Email:**
[Brandon.Darks@TN.Gov](mailto:Brandon.Darks@TN.Gov)
Road Safety Audits in Massachusetts

Ana Fill, PE., MassDOT
Why RSAs?

- FHWA proven safety countermeasure - 10% to 60% reduction in total crashes.
- Helps prioritize projects and clarify issues for politicians and decision makers.
- Strengthens connections between participants (different areas maintenance, enforcement, design also different agencies local, state, advocacy, etc.)
- Helps incorporation of safety enhancements into project (ideally before conceptual and preliminary design).

Safety Benefits:

10-60% reduction in total crashes\(^1\).

---

1. Road Safety Audits: An Evaluation of RSA Programs and Projects, FHWA-SA-12-037; and FHWA Road Safety Audit Guidelines, FHWA-SA-06-06.
When is RSA required in MA?

- When project area includes high crash locations (Top 5% Vehicle, Bicycle, or Pedestrian Intersections or Segments) of the most recent available years.

- When projects are looking to securing federal funding through the Highway Safety Improvement Program (HSIP) or are anticipated to utilize HSIP funding.
MassDOT Road Safety Audits Interactive Map

https://gis.massdot.state.ma.us/RoadSafetyAudits/
Two RSAs were done as part of training with FHWA

1st RSA was performed in 2007

By 2011, conducted more than 100 RSAs

2008, RSA became a necessary step in Highway Safety Improvement Program (HSIP) funding eligibility

2014, specializing in bike and pedestrian safety RSA

2013, Massachusetts SHSP included RSA as one of the main strategic program to improve roadway safety

Conducted more than 650+ RSAs to date across the state

2023, Massachusetts SHSP adopted the Safe System Approach and has RSAs as one of the initiatives.
5.10 Increase Road Safety Audits

A Road Safety Audit (RSA) is a formal safety review of an existing or planned roadway or intersection. The use of RSAs to inform projects has been shown to reduce crashes by between 10 - 60%. The Commonwealth’s RSA program is an important part of the HSIP and has expanded to include additional high-crash locations and individual crash types, such as pedestrian and bicycle hot spots. The RSA program should be emphasized, particularly in areas where equity concerns are present. These expansions can assist the Commonwealth in better identifying and improving problem areas on Massachusetts roadways.
Enhancing Massachusetts RSA Program

- Incorporate CMFs in the RSA Process
- Evaluate Countermeasures through a Safe System Approach Lens
- Adopt relevant findings from NCHRP projects:
  - NCHRP Synthesis 20-05/Topic 54-03: DOT Practices on Road Safety Audits
  - NCHRP 17-125: Incorporating the Safe System Approach into Road Safety Audits
- Create mechanism to implement RSA recommendations
Impacts of RSAs

Low-Cost, Short-Term Enhancement

After RSA: Installed flexible delineator post
Before RSA: Convert two-way stop control to signalized intersection
Impacts of RSAs

❖ Intersection offset
❖ Two way stop control
❖ Poor sight distance
❖ 40mph posted speed
❖ Grading issues
❖ Sag and crest curve combinations

❖ Modern Roundabout

Before

After RSA: Convert two-way stop control to modern roundabout

After

10/23/2023
Lessons Learned

Positive feedback from local communities and MPOs

Need to think about short and long term/low and high cost countermeasures.

Need to think broadly – consider VRU, human factors, vehicle design, etc.

Need to incorporate engineering and other (education, emergency response, etc.) countermeasures.

RSAs help designers consider safety as part of project improvements.

Goal is to truly integrate safety into all we do.
Thank you!

Ana.Fill@dot.state.ma.us
Discussion

⇒ **Send us your questions**

⇒ **Follow up with us:**
  - General Inquiries  pbic@pedbikeinfo.org

⇒ **Archive at**  www.pedbikeinfo.org/webinars