Safety Improvements Design-Build Project
St. Charles and Franklin Counties, MO

2018 TEAM Conference – Branson, MO -- March 8, 2018

David Simmons, MoDOT St. Louis District
Stephen Georges, MoDOT St. Louis District
Dawn Perkins, FHWA MO Division
James Ritter, Jacobs (CH2M)
Jarrett Jasper, Horner & Shifrin
David J. Simmons P.E.
Missouri Department of Transportation

PROJECT INCEPTION
No. 1 Tangible Result

Keep Customers and Ourselves Safe
Missouri Blueprint
October 2016

Fatal and Serious Injury Crashes 2012-2014

- Fatal and Serious Injury Crashes 2012-2014
  - Run off Road
  - Horizontal...
  - Unsignalized...
  - Head on Crashes
  - Pedestrians
  - Work Zones

It's Personal

Has A Face

Road to Saving Lives
Funding Safety

Safety Funds Programmed in FY 2017

- $73 Million
  - $58 Million District HSIP Funds
  - $15 Million District Open Container Funds

- $18 Million
  - MoDOT Striping Operations

- $10-15 Million
  - Guardrail Upgrades

Larger Construction Program = More Safety Improvements

Over $100 million total; increase of $60 million
Project Delivery Method Selection

How does MoDOT select projects for Design-Build?

1. Project Need Identified
2. Set Project Goals
3. Initial Project Risk Assessment
4. Project Delivery Method Selection

Which method allows project risk/opportunities to be most appropriately allocated?

- Design Build
- Design Bid Build

Central Office Approval (2% Limit)

Detailed Risk Assessment

Risk Allocation

Design Build Procurement

Evaluate Design Bid Build Innovative Contracting Options

Incentives Disincentives
- A + B Bidding
- Add Alternates
- Alternate Bidding
- ATCs
- Job Order Contracts

Design Process

Construction Contract
Project Delivery Method Selection

How does MoDOT select projects for Design-Build?

Typical Characteristics

1. Complexity of the Project
2. Opportunity for Innovation
3. Schedule/Schedule Component
4. Manageable Risks
   • Utilities
   • ROW
   • Environmental
   • Community Relations
5. Staff Availability and Market Conditions
Project History

• Goal: Maximize Safety Benefit, Save Lives  
  – Less political, more data driven
• Funding: $21M Budget
• Faster Implementation
• Goal Driven Design-Build Chosen
Project Team

**Project Directors**
- Vince Kaimann, P.E.
- Bill Schnell, P.E.
- Jim Gremaud, P.E. (retired)

**Project Engineers**
- Heather Copeland, P.E. Deputy Director
- Stephen Georges, P.E.
- Tao Liao, P.E.

**Support**
- Jon Nelson, P.E.
- Ray Shank, P.E.
- Jim Smith, P.E. (retired)
- CH2M Staff
- Bryce Gamblin, Attorney
- Dawn Perkins, FHWA
- Jessica Hochlan
- St. Louis and CO Staff

**Key Roles**
- Teresa Krenning, P.E.
- Eddie Watkins
- David Simmons, P.E.
- Stacey Smith, P.E.
Stephen Georges, P.E.
Missouri Department of Transportation

PROJECT GOALS & PROCUREMENT
Project Goals

1. Deliver the project within the budget of $24.11 million
2. Reduce fatal and serious injury crashes by maximizing safety improvements
3. Deliver all improvements with a reasonable service life and low maintenance cost
4. Minimize impacts to the public during and after construction
5. Complete construction on the project by October 1, 2019
Project Schedule

Request for Qualifications

Short Listing 5 Teams Approved
  December 16, 2016

Issue Request for Proposals
  January 20, 2017

Technical Discussions
  Jan. 23-March 29, 2017

Proposals Due
  April 10, 2017

Evaluation & Scoring of Proposals
  April 10 – May 2, 2017

Selection of Apparent Best Value
  May 3, 2017
Highest Crash Severity Locations Identified

- Data-Driven Selection
- 2013-2015 MSHP Records
- Fatal and Serious Injury Crash History
- High Severity & Target Crash Types
- Top 31 Locations
St. Charles County
15 High Severity Locations

Routes Include:
- I-70
- I-64
- U.S. 61
- Route H
- MO 94
- MO 364
- MO 370
- Outer Road 70
Franklin County
16 High Severity Locations

Routes Include:
- I-44
- U.S. 50
- MO 100
- MO 47
- MO 30
- Route FF
- Route HH
- Route NN
The RFP Conundrum

• 5 Prequalified Teams
• No other state has ever tried packaging multiple safety improvements into a Design-Build contract
• Use data-driven method as the main scoring criteria
• Didn’t know what the solution was going to be!
Opportunities for Innovation

Additional Applicable Standards (AAS)
- Additional Applicable Standards
- Products, Designs, Specifications not currently utilized by MoDOT
- Had to be submitted and approved by MoDOT and FHWA

Crash Modification Factors (CMF)
- Statistically determines how an improvement reduces crashes
- MoDOT included pre-approved CMFs in contract
- Teams encouraged to propose others for review and approval
Scoring Criteria

• **Safety Improvements** 45 Points
  – Based on Data-Driven Analysis

• **Maintenance and Durability of Improvements** 30 Points
  – 5 Year minimum design life

• **Maintenance of Traffic** 15 Points
  – Mobility during and after construction

• **Completion Schedule** 10 Points
  – Early Completion Encouraged

_________________________
100 Points Possible
One-on-One Meetings

- Improve Proposer understanding of Project Goals
- Feedback on whether the technical concepts achieve or exceed the Project goals
- Feedback on Highway Safety Manual Analysis, AAS, CMF, technical requirements, etc...
- Request for Clarification (RFC) of the Request for Proposal (RFP)
James Ritter, P.E.
CH2M (is now Jacobs)

EVALUATION & ADVISOR TEAM PERSPECTIVE
“Nerd Christmas”
For Traffic Safety Engineers

\[(1 + x)^n = 1 + \frac{nx}{1!} + \frac{n(n - 1)x^2}{2!} + \ldots\]
Analysis Tools

• **HSM Spreadsheets (NCHRP 17-38)**
  – Rural two-lane
  – Rural multi-lane
  – Urban arterial
  – Modified for Fatal Serious Injury, CMFs, Input & Output Summaries

• **ISATe Spreadsheets**
  – Freeways, Interstates
  – Unmodified
  – Supplemented w/ CMF post-processing worksheet
Modified HSM Spreadsheet
Project Specific Instructions

Safety Improvements (MoDOT J6P3194) - Instructions to Users for the Customized Highway Safety Manual Spreadsheet Tool

This spreadsheet tool is customized using the HSM spreadsheets developed as part of the NCHRP 17-38. Exhibit 1 at the bottom of this worksheet provides the original instructions that were provided as part of the source spreadsheets that are available for download at www.highwaysafetymanual.org. Instructions are provided below for use by the HSM users for MoDOT St. Louis District Safety Design Build Project (J6P3194). Please contact the project director, James Gremaud, with any questions or requests for clarifications.

James R Gremaud  
Project Manager  
Project Director - SL Safety  
1590 Woodlake Drive  
Chesterfield, MO 63017  
636-279-4524  
James.Gremaud@modot.mo.gov

Project Specific Instructions for HSM Spreadsheet Users

HSM Spreadsheet modifications for the proposed conditions

HSM analyses for the proposed condition shall be conducted using the "Proposer" copies of the No-Build condition spreadsheets. This section outlines the various steps in the process of quantifying the safety benefits of the proposed improvements.

In addition to the CMFs built into the standard HSM tool, there is a provision to apply up to three additional non-HSM incorporated CMFs into the spreadsheets. However, it should be noted that there are specific criteria and requirements for the application of non-HSM CMFs that can be used in these spreadsheets. The user should refer to the ITP and contact the MoDOT project director with any questions or requests for clarification.

Guidance in the selection of non-HSM CMFs is provided by the following FAQ from cmfcleaninghouse.org:

How can I apply multiple CMFs?  
If multiple countermeasures are implemented at one location, then common practice is to multiply the CMFs to estimate the combined effect of the countermeasures.
## Table 1 CMF for Rural Two-lane Roads (Segment)

<table>
<thead>
<tr>
<th>CMF Source</th>
<th>Number</th>
<th>Abbreviated Improvement Name (For Input Summary Tab)</th>
<th>Improvement Name (From CMF Clearinghouse, if applicable)</th>
<th>CMF Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MoDOT CMF Table</td>
<td>1</td>
<td>HFST</td>
<td>Improve pavement friction using High-friction surface treatment (HFST)</td>
<td>0.380</td>
</tr>
<tr>
<td>MoDOT CMF Table</td>
<td>2</td>
<td>Open graded friction course</td>
<td>Open graded friction course</td>
<td>0.959</td>
</tr>
<tr>
<td>MoDOT CMF Table</td>
<td>3</td>
<td>Ultra thin bonded wearing course</td>
<td>Ultra thin bonded wearing course</td>
<td>0.956</td>
</tr>
<tr>
<td>MoDOT CMF Table</td>
<td>4</td>
<td>Centerline and shoulder rumble strips</td>
<td>Install centerline and shoulder rumble strips</td>
<td>0.770</td>
</tr>
<tr>
<td>MoDOT CMF Table</td>
<td>5</td>
<td>Rumble, 2-ft shoulder, resurfacing</td>
<td>Install shoulder rumble stripe, widen shoulder from 0 to 2 feet, and pavement resurfacing</td>
<td>0.822</td>
</tr>
<tr>
<td>MoDOT CMF Table</td>
<td>6</td>
<td>Centerline rumble strips</td>
<td>Install centerline rumble strips</td>
<td>0.880</td>
</tr>
<tr>
<td>MoDOT CMF Table</td>
<td>7</td>
<td>Shoulder rumble strips</td>
<td>Install shoulder (or edgeline) rumble strips</td>
<td>0.940</td>
</tr>
<tr>
<td>MoDOT CMF Table</td>
<td>8</td>
<td>Safety edge treatment</td>
<td>Installation of safety edge treatment</td>
<td>0.983</td>
</tr>
<tr>
<td>MoDOT CMF Table</td>
<td>9</td>
<td>TWLTL</td>
<td>Install TWLTL (two-way left turn lane) on two lane road</td>
<td>0.739</td>
</tr>
<tr>
<td>&lt;&lt;Placeholder&gt;&gt;</td>
<td>10</td>
<td>&lt;&lt;User Input per CMF Request Form&gt;&gt;</td>
<td>&lt;&lt;User Input per CMF Request Form&gt;&gt;</td>
<td>1.000</td>
</tr>
<tr>
<td>&lt;&lt;Placeholder&gt;&gt;</td>
<td>11</td>
<td>&lt;&lt;User Input per CMF Request Form&gt;&gt;</td>
<td>&lt;&lt;User Input per CMF Request Form&gt;&gt;</td>
<td>1.000</td>
</tr>
<tr>
<td>&lt;&lt;Placeholder&gt;&gt;</td>
<td>12</td>
<td>&lt;&lt;User Input per CMF Request Form&gt;&gt;</td>
<td>&lt;&lt;User Input per CMF Request Form&gt;&gt;</td>
<td>1.000</td>
</tr>
<tr>
<td>&lt;&lt;Placeholder&gt;&gt;</td>
<td>13</td>
<td>&lt;&lt;User Input per CMF Request Form&gt;&gt;</td>
<td>&lt;&lt;User Input per CMF Request Form&gt;&gt;</td>
<td>1.000</td>
</tr>
<tr>
<td>&lt;&lt;Placeholder&gt;&gt;</td>
<td>14</td>
<td>&lt;&lt;User Input per CMF Request Form&gt;&gt;</td>
<td>&lt;&lt;User Input per CMF Request Form&gt;&gt;</td>
<td>1.000</td>
</tr>
<tr>
<td>&lt;&lt;Placeholder&gt;&gt;</td>
<td>15</td>
<td>&lt;&lt;User Input per CMF Request Form&gt;&gt;</td>
<td>&lt;&lt;User Input per CMF Request Form&gt;&gt;</td>
<td>1.000</td>
</tr>
<tr>
<td>&lt;&lt;Placeholder&gt;&gt;</td>
<td>16</td>
<td>&lt;&lt;User Input per CMF Request Form&gt;&gt;</td>
<td>&lt;&lt;User Input per CMF Request Form&gt;&gt;</td>
<td>1.000</td>
</tr>
<tr>
<td>&lt;&lt;Placeholder&gt;&gt;</td>
<td>17</td>
<td>&lt;&lt;User Input per CMF Request Form&gt;&gt;</td>
<td>&lt;&lt;User Input per CMF Request Form&gt;&gt;</td>
<td>1.000</td>
</tr>
<tr>
<td>&lt;&lt;Placeholder&gt;&gt;</td>
<td>18</td>
<td>&lt;&lt;User Input per CMF Request Form&gt;&gt;</td>
<td>&lt;&lt;User Input per CMF Request Form&gt;&gt;</td>
<td>1.000</td>
</tr>
<tr>
<td>&lt;&lt;Placeholder&gt;&gt;</td>
<td>19</td>
<td>&lt;&lt;User Input per CMF Request Form&gt;&gt;</td>
<td>&lt;&lt;User Input per CMF Request Form&gt;&gt;</td>
<td>1.000</td>
</tr>
</tbody>
</table>
### Modified HSM Spreadsheet

**Individual Segment Input Tab**

**Worksheet 1A – General Information and Input Data for Rural Two-Lane Two-Way Roadway Segments**

<table>
<thead>
<tr>
<th>Analyst Agency or Company</th>
<th>FE / FHA</th>
<th>Roadway Section</th>
<th>SH 82</th>
<th>SH 1016</th>
<th>Location Information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Analysis Year: 2010</td>
</tr>
</tbody>
</table>

#### Input Data

<table>
<thead>
<tr>
<th></th>
<th>Base Conditions</th>
<th>Site Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of segment, L (mi)</td>
<td>0</td>
<td>2.500</td>
</tr>
<tr>
<td>AADT (Veh/day)</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>Lane width (ft)</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>Shoulder width (ft)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Shoulder type</td>
<td>Paved</td>
<td></td>
</tr>
<tr>
<td>Density of horizontal curve (ft)</td>
<td>0</td>
<td>0.72</td>
</tr>
<tr>
<td>Number of curves (ft)</td>
<td>0</td>
<td>0.72</td>
</tr>
<tr>
<td>Speed transition curve (present/not present)</td>
<td>Not Present</td>
<td>Not Present</td>
</tr>
<tr>
<td>Super-elevation variance (%)</td>
<td>4.00</td>
<td>0</td>
</tr>
<tr>
<td>Grade (%)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Driveway density (driveways/mile)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Lane alignment (curved range present/not present)</td>
<td>Not Present</td>
<td>Not Present</td>
</tr>
<tr>
<td>Passing area (present 1 lane) present (2 lanes) present</td>
<td>Not Present</td>
<td>Not Present</td>
</tr>
<tr>
<td>Two-way left-turn lane (present/not present)</td>
<td>Not Present</td>
<td>Not Present</td>
</tr>
<tr>
<td>Residual hazard rating (1-7 scale)</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Segment lighting (present/not present)</td>
<td>Not Present</td>
<td>Not Present</td>
</tr>
<tr>
<td>Auto speed enforcement (present/not present)</td>
<td>Not Present</td>
<td>Not Present</td>
</tr>
<tr>
<td>National Factor (k)</td>
<td></td>
<td>1.00</td>
</tr>
</tbody>
</table>

**Worksheet 1B – Crash Modification Factors for Rural Two-Lane Two-Way Roadway Segments**

<table>
<thead>
<tr>
<th>CMF for Lane Width</th>
<th>CMF for Horizontal Curves</th>
<th>CMF for Gradients</th>
<th>CMF for Effect</th>
<th>CMF for Collision</th>
<th>CMF for Combined CF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CMF Tr (Equation 10-11)</th>
<th>CMF Tr (Equation 10-12)</th>
<th>CMF Tr (Equation 10-13)</th>
<th>CMF Tr (Equation 10-14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Crash Severity Level</th>
<th>N spf/hs</th>
<th>Overdispersion Parameter, k</th>
<th>Crash Severity Distribution</th>
<th>N spf/hs by Severity Distribution</th>
<th>Combined CMFs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Worksheet 1C – Roadway Segment Crashes for Rural Two-Lane Two-Way Roadway Segments**

<table>
<thead>
<tr>
<th>Crash Severity Level</th>
<th>N spf/hs</th>
<th>Overdispersion Parameter, k</th>
<th>Crash Severity Distribution</th>
<th>N spf/hs by Severity Distribution</th>
<th>Combined CMFs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Modified HSM Spreadsheet
### Consolidated Input Summary Tab

### Segment Input Summary Table

<table>
<thead>
<tr>
<th>Input Item/Segment Number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Location</strong></td>
<td>KM 0</td>
<td>KM 1</td>
<td>KM 2</td>
<td>KM 3</td>
<td>KM 4</td>
<td>KM 5</td>
<td>KM 6</td>
<td>KM 7</td>
</tr>
<tr>
<td>Route/Distance</td>
<td>CR 70</td>
<td>CR 70</td>
<td>CR 70</td>
<td>CR 70</td>
<td>CR 70</td>
<td>CR 70</td>
<td>CR 70</td>
<td>CR 70</td>
</tr>
<tr>
<td><strong>Right</strong></td>
<td>2115</td>
<td>2115</td>
<td>2115</td>
<td>2115</td>
<td>2115</td>
<td>2115</td>
<td>2115</td>
<td>2115</td>
</tr>
<tr>
<td><strong>Left</strong></td>
<td>2115</td>
<td>2115</td>
<td>2115</td>
<td>2115</td>
<td>2115</td>
<td>2115</td>
<td>2115</td>
<td>2115</td>
</tr>
<tr>
<td><strong>Sign</strong></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Street</strong></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td><strong>Length</strong>, [m]</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>AADT</strong>, [veh/day]</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td><strong>Lessee</strong>: [veh/day]</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
</tr>
<tr>
<td><strong>Street</strong></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td><strong>Right</strong></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Left</strong></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Sign</strong></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Street</strong></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td><strong>Length</strong>, [m]</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>AADT</strong>, [veh/day]</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td><strong>Lessee</strong>: [veh/day]</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
</tr>
<tr>
<td><strong>Street</strong></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td><strong>Right</strong></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Left</strong></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Sign</strong></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Street</strong></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td><strong>Length</strong>, [m]</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>AADT</strong>, [veh/day]</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td><strong>Lessee</strong>: [veh/day]</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
</tr>
<tr>
<td><strong>Street</strong></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td><strong>Right</strong></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Left</strong></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Sign</strong></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Street</strong></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td><strong>Length</strong>, [m]</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>AADT</strong>, [veh/day]</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td><strong>Lessee</strong>: [veh/day]</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
</tr>
<tr>
<td><strong>Street</strong></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td><strong>Right</strong></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Left</strong></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Sign</strong></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Street</strong></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td><strong>Length</strong>, [m]</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>AADT</strong>, [veh/day]</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td><strong>Lessee</strong>: [veh/day]</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
</tr>
</tbody>
</table>

### Intersection Input Summary Table

<table>
<thead>
<tr>
<th>Input Item/Intersection Number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Location</strong></td>
<td>KM 0</td>
<td>KM 1</td>
<td>KM 2</td>
<td>KM 3</td>
<td>KM 4</td>
</tr>
<tr>
<td><strong>Route/Distance</strong></td>
<td>CR 70</td>
<td>CR 70</td>
<td>CR 70</td>
<td>CR 70</td>
<td>CR 70</td>
</tr>
<tr>
<td><strong>AADT</strong>, [veh/day]</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td><strong>Lessee</strong>: [veh/day]</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
</tr>
<tr>
<td><strong>Street</strong></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td><strong>Right</strong></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Left</strong></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Sign</strong></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Street</strong></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>
### Modified HSM Spreadsheet
Output Summary Tab

#### Safety Performance - Output Summary

<table>
<thead>
<tr>
<th>General Information</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Description:</td>
<td>No Build</td>
<td></td>
</tr>
<tr>
<td>Project Location ID:</td>
<td>01-MO 100-F-2L-CL</td>
<td></td>
</tr>
<tr>
<td>Analyst</td>
<td>MM/STL</td>
<td>Date: 2/27/2017</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project Description</th>
<th>Log Mile</th>
<th>Expected Number of Crashes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ROADWAY SEGMENTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Segment 1</td>
<td>LM 52.588 to LM 53.09</td>
<td>0.012</td>
</tr>
<tr>
<td>Segment 2</td>
<td>LM 53.09 to LM 53.3</td>
<td>0.006</td>
</tr>
<tr>
<td>Segment 3</td>
<td>LM 53.3 to LM 53.41</td>
<td>0.002</td>
</tr>
<tr>
<td>Segment 4</td>
<td>LM 53.41 to LM 53.91</td>
<td>0.011</td>
</tr>
<tr>
<td>Segment 5</td>
<td>LM 53.91 to LM 54.68</td>
<td>0.017</td>
</tr>
<tr>
<td>Segment 6</td>
<td>LM 54.68 to LM 54.88</td>
<td>0.007</td>
</tr>
<tr>
<td>Segment 7</td>
<td>LM 54.88 to LM 55.4</td>
<td>0.012</td>
</tr>
<tr>
<td>Segment 8</td>
<td>LM 55.4 to LM 55.93</td>
<td>0.014</td>
</tr>
<tr>
<td>Segment 9</td>
<td>LM 55.93 to LM 56.14</td>
<td>0.005</td>
</tr>
<tr>
<td>Segment 10</td>
<td>LM 56.14 to LM 56.212</td>
<td>0.001</td>
</tr>
<tr>
<td>Segment 11</td>
<td></td>
<td>0.000</td>
</tr>
<tr>
<td>Segment 12</td>
<td></td>
<td>0.000</td>
</tr>
<tr>
<td>Segment 13</td>
<td></td>
<td>0.000</td>
</tr>
<tr>
<td>Segment 14</td>
<td></td>
<td>0.000</td>
</tr>
<tr>
<td>Segment 15</td>
<td></td>
<td>0.000</td>
</tr>
<tr>
<td>Segment 16</td>
<td></td>
<td>0.000</td>
</tr>
<tr>
<td>Segment 17</td>
<td></td>
<td>0.000</td>
</tr>
<tr>
<td>Segment 18</td>
<td></td>
<td>0.000</td>
</tr>
<tr>
<td>Segment 19</td>
<td></td>
<td>0.000</td>
</tr>
<tr>
<td>Segment 20</td>
<td></td>
<td>0.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INTERSECTIONS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Intersection 1</td>
<td>3ST</td>
<td>0.006</td>
</tr>
<tr>
<td>Intersection 2</td>
<td>4ST</td>
<td>0.010</td>
</tr>
<tr>
<td>Intersection 3</td>
<td>3ST</td>
<td>0.003</td>
</tr>
<tr>
<td>Intersection 4</td>
<td></td>
<td>0.000</td>
</tr>
<tr>
<td>Intersection 5</td>
<td></td>
<td>0.000</td>
</tr>
</tbody>
</table>

**Estimated Number of Crashes by Year**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.107</td>
<td>0.472</td>
<td></td>
</tr>
</tbody>
</table>
# ISATe Spreadsheet

## Unmodified

<table>
<thead>
<tr>
<th>Input Worksheet for Freeway Segments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clear</strong></td>
</tr>
<tr>
<td><strong>(View results in Column AV)</strong></td>
</tr>
<tr>
<td><strong>Basic roadway data</strong></td>
</tr>
<tr>
<td>Number of through lanes (n)</td>
</tr>
<tr>
<td>Freeway segment description</td>
</tr>
<tr>
<td>Segement length (L), m:</td>
</tr>
<tr>
<td><strong>Alignment Data</strong></td>
</tr>
<tr>
<td>Horizontal curve data</td>
</tr>
<tr>
<td>Curve radius (R), ft:</td>
</tr>
<tr>
<td>Length of curve (L1), m:</td>
</tr>
<tr>
<td>Length of curve in segment (L1seg), m:</td>
</tr>
<tr>
<td><strong>Cross section data</strong></td>
</tr>
<tr>
<td>Lane width (Wl), ft:</td>
</tr>
<tr>
<td>Outside shoulder width (Wsh), ft:</td>
</tr>
<tr>
<td>Inside shoulder width (Wsh), ft:</td>
</tr>
<tr>
<td>Median width (Wm), ft:</td>
</tr>
<tr>
<td>Rumble strips on outside shoulders?</td>
</tr>
<tr>
<td>Rumble strips on inside shoulders?</td>
</tr>
<tr>
<td>Length of barrier (Lb1), m:</td>
</tr>
<tr>
<td>Distance from edge of traveled way to barrier face (Wsh, m):</td>
</tr>
<tr>
<td>Length of barrier (Lb2), m:</td>
</tr>
<tr>
<td>Distance from edge of traveled way to barrier face (Wsh, m):</td>
</tr>
<tr>
<td>Length of barrier (Lb3), m:</td>
</tr>
</tbody>
</table>

## Calibration Factors
# ISATe Spreadsheet

## Separate Post-Processing to CMFs

### Highway Safety Manual (ISATe) Output Processing and Additional CMFs

#### for Freeway / Interstate Project Locations

<table>
<thead>
<tr>
<th>General Information (Proposer should input this data)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Description:</td>
</tr>
<tr>
<td>Project Location ID: (select from list)</td>
</tr>
<tr>
<td>Proposer Analyst / Point of Contact</td>
</tr>
<tr>
<td>Date:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Estimated Crash Statistics - Output from ISATe (Proposer should copy output for Fatal (K) and Serious Injury (A) crashes directly from ISATe file that has been modified based on proposed improvements)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crashes for Entire Facility by Year</td>
</tr>
<tr>
<td>Estimated number of crashes by year</td>
</tr>
<tr>
<td>K</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Modified Output for Project - Adjustment for Single Direction of the Freeway / Interstate (Calculated by formula based on above inputs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated Crash Statistics</td>
</tr>
<tr>
<td>Crashes for Analysis Direction by Year</td>
</tr>
<tr>
<td>Estimated number of crashes by year</td>
</tr>
<tr>
<td>0.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Application of Non-ISATe CMFs (Proposer is required to consult with MoDOT to determine permissibility and applicability of all CMFs not included in the ISATe spreadsheet tool)</th>
</tr>
</thead>
<tbody>
<tr>
<td>From Project CMF Table (or as determined in consultation with MoDOT)</td>
</tr>
<tr>
<td>Crash Type</td>
</tr>
<tr>
<td>CMF 1</td>
</tr>
<tr>
<td>CMF 2</td>
</tr>
<tr>
<td>CMF 3</td>
</tr>
<tr>
<td>Combined Non-ISATe CMFs by Severity</td>
</tr>
<tr>
<td>1.000</td>
</tr>
</tbody>
</table>

### Project Summary - Additional CMFs Applied (Calculated by formula based on above inputs)

<table>
<thead>
<tr>
<th>Estimated Crash Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crashes for Analysis Direction by Year (with Additional CMFs)</td>
</tr>
<tr>
<td>Estimated number of crashes by year</td>
</tr>
<tr>
<td>K</td>
</tr>
<tr>
<td>0.000</td>
</tr>
</tbody>
</table>
Analysis Constraints

**Predicted Crash Frequency Equation**

\[ N_{\text{predicted ru}} = N_{\text{spf ru}} \left( \text{CMF}_1 \times \text{CMF}_2 \times \ldots \right) C_r \]

- **Calibration Factor for Missouri**
- **Proposers Limited to 3 CMFs for Safety**
- **Improvements not included in HSM/ISATe Models**

**Expected Crash Frequency**

→ Observed crash data was input into spreadsheet tools

**Reduction in Expected Crash Frequency**

→ Scored on difference between Existing/No-Build and Proposed
Safety Improvements
Evaluating & Scoring Proposals

1. Proposer submits their Data Driven Analysis
   - List of Proposed Safety Improvements
   - Depiction of Safety Improvements
   - Highway Safety Manual Spreadsheets
   - Crash Modification Factors (CMF)
2. Analysis verified by MoDOT and their consultant

- Excel VBA/macro-based tool
- Identify changes to HSM, ISATe spreadsheets
- Validate each change is consistent with proposal
- Resolved apparent inconsistencies
- Validate Expected Crash Reduction
3. Proposal with greatest Reduction in Fatal and Serious Injury Crashes receives **all 45 points**

- All other Proposals Pro-Rated based on high score
Best Value Proposal – NB West
St. Charles County Improvements
Best Value Proposal – NB West
Franklin County Improvements
## Summary of Improvements

<table>
<thead>
<tr>
<th>Improvement Description</th>
<th>Quantity Proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guardrail Replacement (upgrading to MASH)</td>
<td>26,400+ LF</td>
</tr>
<tr>
<td>Crashworthy End Terminals (upgrading to MASH)</td>
<td>90+ each</td>
</tr>
<tr>
<td>High Friction Surface Treatment</td>
<td>72 curves, 2 intersections</td>
</tr>
<tr>
<td>Transverse Rumbles</td>
<td>11 locations</td>
</tr>
<tr>
<td>Centerline Rumbles</td>
<td>43.5 miles</td>
</tr>
<tr>
<td>Edgeline Rumbles</td>
<td>30.8 miles</td>
</tr>
<tr>
<td>Roundabout</td>
<td>MO 100 @ Bluff Rd</td>
</tr>
<tr>
<td>Improve channelized right turn lane</td>
<td>8 locations</td>
</tr>
<tr>
<td>Fluorescent Curve Signs</td>
<td>192 curves</td>
</tr>
<tr>
<td>Inlaid pavement markers</td>
<td>22.8 miles</td>
</tr>
<tr>
<td>Wet reflective pavement markings</td>
<td>11.2 miles</td>
</tr>
<tr>
<td>Intersection Conflict Warning System</td>
<td>6 locations</td>
</tr>
<tr>
<td>Flashing Beacons</td>
<td>10 locations</td>
</tr>
<tr>
<td>1” Asphalt Overlay (BP-1)</td>
<td>17.0 miles</td>
</tr>
</tbody>
</table>
PROPOSING TEAM’S PERSPECTIVE

Jarrett Jasper, P.E.
Horner & Shifrin
Team Development

- RFQ Release
  - Industry reaction
- NB West and H&S Partnership
- Design Partners:
  - Lochmueller Group
  - EDSI
  - Kivindyo Engineering Services
- Design-Build Experience
- RFP Release
Scoring Criteria

• **Safety Improvements** (45 Points)
  – Data-Driven Analysis & Scoring

• **Maintenance and Durability of Improvements** (30 Points)
  – 5 Year Service Life Minimum
  – Overlay of Existing Roadways, Upgrade Guardrail

• **Maintenance of Traffic** (15 Points)
  – Low Impacts to Traffic

• **Completion Schedule** (10 Points)
  – Coordination with Other Projects
  – Complete by November 30, 2018 (max points)
NB West Contracting
Proposed Safety Improvements

<table>
<thead>
<tr>
<th># of Safety Locations Improved</th>
<th># of Distinct Safety Improvements</th>
<th># of Approved Crash Modification Factors (CMF)</th>
<th># of Additional Applicable Standards (AAS)</th>
<th># Serious Injuries Reduced Annually</th>
<th># Fatal Crashes Reduced Annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>31 of 31</td>
<td>25</td>
<td>45</td>
<td>13</td>
<td>5.0</td>
<td>1.2</td>
</tr>
</tbody>
</table>

- Inlaid Pavement Marker
- Right Turn Lanes
- Transverse Rumbles
- Roundabout
- LED Stop Signs
- Stop Ahead Markings
- Guardrail
- Warning Flashers
- Stop Signs
- High Friction Surface

Road to Saving Lives
Design Coordination

- 31 Locations Throughout 2 Counties
- Design Team Responsibilities
- Weekly Meetings with MoDOT and Design Team
- Co-Location
- Separate Approvals for Each Location
- Coordination with Other Projects
- SharePoint & ProjectWise
Under Construction Now

Notice To Proceed #2

• Construction Started Mid-July 2017
  – Started locations in groups of 4 and expected to have up to 14 locations happening simultaneously.
  – 90 days allotted for each location
  – Critical Path – High Friction Surface Treatment
  – Completion November 30, 2018
# Rapid Implementation of Safety Improvements

<table>
<thead>
<tr>
<th>Improvement Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Friction Surface Treatment</td>
<td>101 curves, 26 tangents, 13 intersections</td>
</tr>
<tr>
<td>Improve channelized right turn lane</td>
<td>9 locations</td>
</tr>
<tr>
<td>Flashing Beacons</td>
<td>10 locations</td>
</tr>
<tr>
<td>Transverse Rumbles</td>
<td>11 locations</td>
</tr>
<tr>
<td>Centerline Rumbles</td>
<td>43.5 miles</td>
</tr>
<tr>
<td>Edgeline Rumbles</td>
<td>30.8 miles</td>
</tr>
<tr>
<td>Fluorescent Curve Signs</td>
<td>192 curves</td>
</tr>
<tr>
<td>Intersection Conflict Warning System</td>
<td>6 locations</td>
</tr>
<tr>
<td>Crashworthy End Terminals (upgrading to MASH)</td>
<td>90+ each</td>
</tr>
<tr>
<td>Guardrail Replacement (upgrading to MASH)</td>
<td>26,400+ LF</td>
</tr>
<tr>
<td>Wet reflective pavement markings</td>
<td>11.2 miles</td>
</tr>
<tr>
<td>Inlaid pavement markers</td>
<td>22.8 miles</td>
</tr>
<tr>
<td>1” Asphalt Overlay (BP-1)</td>
<td>17.0 miles</td>
</tr>
</tbody>
</table>
High Friction Surface Treatment (HFST)

Improve Friction
- Biggest safety improvement for project
- Aggregates
  - Chinese Bauxite – required for interstates
  - Phonolite – approved for all other routes

- Contract Quantity
  - 101 curves, 26 tangents, 13 intersections
  - 265,000 square yards (40 lane miles)

- Completed
  - 27 curves, 14 tangents, 4 intersections (10 lane miles)
Improved Channelized Right Turn Lane

Straightener angle to improve sight distance
Encourages drivers to stop
• 11 out of 24 complete
• CMF: 0.564
Flashing Beacons

Flashing beacons added to stop signs
Increases visibility of approaching intersection

• 8 out of 16 complete
• CMF: 0.900
Rumbles
Centerline & Edgeline

Provide feedback to driver (sound & feel) for lane departures

- **Centerline Rumbles**
  - 7 out of 42 miles complete
  - CMF: 0.88

- **Edgeline Rumbles**
  - 14 out of 38 miles complete
  - CMF: 0.94
Transverse Rumbles

Provide feedback to driver (sound & feel) to alert driver of approaching intersection

• 9 out of 23 complete
• CMF: 0.90
Intersection Conflict Warning System

Detection of vehicle on minor crossing route to notify drivers on major highway that vehicle is approaching intersection

• 3 locations out of 6 complete 2-lane highway
  • CMF: 0.450
• 4-lane highway
  • CMF: 0.734
Additional Safety Improvements to Come

- Dynamic Signal Warning Flashers
  - Rte. 94/ Hwy. 47
- Inlaid Pavement Markers
  - 61, 94, 364, I-70, I-44, 370
- Wet Reflective Pavement Markings
- Cable Barrier
  - Hwy. 61
Results & Findings

• Data supported smaller improvements spread system wide to deliver maximum safety results
  – *High Friction Surface Treatments* delivered most safety benefits per dollar
  – All teams had extensive rumbles, striping, guard cable, guard rail, and pavement treatments to increase friction
  – No team proposed shoulder widening

• THINK BIG!
National Roadway Safety Award

Jointly Sponsored by FHWA and the Roadway Safety Foundation

• 2017 Award for Program Planning, Development, & Evaluation
Project Website
For More Information

http://contribute.modot.mo.gov/stlouis-major_projects/SLSafetyDBProject/
Questions & Answers
Time Permitting

Safety Improvements
Design-Build Project

David Simmons, MoDOT St. Louis District
Stephen Georges, MoDOT St. Louis District
Dawn Perkins, FHWA MO Division
James Ritter, Jacobs (CH2M)
Jarrett Jasper, Horner & Shifrin