USE OF VSL IN CONSTRUCTION ZONES

Utah’s Smart Work Zone System Implementation

Kimley-Horn
Expect More. Experience Better.
## SWZ Concepts – Lots of Options!

### Table 3 – SWZ Core Components and Applications Summary

<table>
<thead>
<tr>
<th>LENGTH OF WORK ZONE</th>
<th>&lt; 1 MILE</th>
<th>1-2 MILES</th>
<th>&gt; 2 MILES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WITHOUT INTERSECTION IN WORK ZONE</td>
<td>WITH INTERSECTION IN WORK ZONE</td>
<td></td>
</tr>
<tr>
<td>&gt; 2 MILES</td>
<td>2 MILES</td>
<td>1-2 MILES</td>
<td>&lt; 1 MILE</td>
</tr>
<tr>
<td>INFORM - message sign, detector</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADVISE - message sign, detector</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WARN - CCTV, speed assignment, detector</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHECK (may not be needed) - speed feedback, detector</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADDITIONAL INFORM (may not be needed) - message sign, detector</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADDITIONAL ADVISE (may not be needed) - message sign, detector</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADDITIONAL WARN (may not be needed) - message sign, detector</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADDITIONAL CHECK (may not be needed) - message sign, detector</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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### Diagram

- "Standalone Detection"
- "Inform" "Advise" "Warn" "Check"
- "Standalone Detection" "Standalone Detection"
Overview of UDOT

- **Centerline Miles by Type**
  - 935 miles of Interstate
  - 2,945 miles of Level 1 (AADT>1,000)
  - 1,985 miles of Level 2 (AADT<1,000)
  - 5,865 miles total

- **Speed Limits**
  - 13% @ 80 mph
  - 35% @ 70 mph or higher
  - 60% @ 60 mph or higher
  - 82% @ 50 mph or higher
Portable Variable Speed Limit (PVSL) System

Project Goal

Goal: Improve safety within construction work zones through significant reduction in traveler speed within the boundary of Active Work Space.
PVSL System - Overview

Operational Deployment Scenario #2

Queue Warning Subsystem

VSL Subsystem
PVSL System - Overview

Operational Deployment Scenario #3

Queue Warning Subsystem

VSL Subsystem

LTDOT - Keeping Utah Moving

USE OF VSL IN CONSTRUCTION ZONES
PVSL System - Overview

• Communications
  o Wireless Cellular Gateway

• Power
  o Solar Powered Trailers
  o 7-day Battery Capacity with NO Sun Light

• Traffic Detectors
  o Forward Fire K-Band Doppler Radar
  o Easy/Fast Deployment
PVSL System - Overview

• Control System
  o Remote / Web-based Platform
  o Jam-Logic by Ver-Mac
  o No Integration with TMC
  o Contractor Controlled

• Portable Operator Interfaces
  o Laptop PC Application
  o Cell Phone / Notebook Application
Challenges - Max Speed Limit Drop per PVSL Trailer

- 10-mph was UDOT’s Standard Practice
  - 40-mph Drop = 4 Speed Limit Signs
- UDOT decided on 20-mph for PVSL Trailers
Challenges – Significant Reduction of Speed Limits

• UDOT Typical WZ Speed Limits (Max & Min)
  o Established by a Traffic Engineering Order (TEO)
  o Typically No more than 10 mph permitted

• Justification for Significant Reduction
  o Concept of Schools Zones
    • In Utah... only at crossings = excellent compliance
    • Why – Balance of Significant Speed Reduction w/ Shorter Length of Impact
    • Result – Greater Compliance
  o Limited AWS Length (1.5 – 2 miles)
    • More Significant Speed Reduction Permitted
Challenges – How to Automate Regulatory Speed Limits

• Algorithm to Raise/Lower Speed Limits
  o Never Done Before
    • For this Type of SWZ Application
  o Speed Harmonization Principles
    • >15mph Deviation = More Accidents
  o Algorithm Lessons Learned
    • Current Speed => 5 Minute Rolling Average
    • Frequency of Speed Limit Change => 15 Minute Minimum
    • Bad or No Data Received => VSL Speed Limit = Last Known Limit

West and Dunn 1971
VSL Algorithm

- Algorithm Lesson Learned
  - VSL SL = Average Speed
  - Rounded Down to 5mph Increment
  - Minus 5mph

Legend:
- Average Speed = Calculated Average Speed based on rolling 5 minutes of speed measurements in active work space.
- VSL SL = Speed limit posted on VSL sign
- TEO High = Maximum speed allowed by TEO, typically “Original Posted Speed” or “Original Posted Speed – 10 mph”.
- TEO Low = The lowest speed limit allowed by TEO.
- Frequency of Speed Limit Change = Minimum of 15 minutes between speed limit changes
- Bad or No Data Received => VSL SL = Last known VSL SL
Work Zone Deployments / Evaluation

• Project Year Deployment Scheduling

<table>
<thead>
<tr>
<th>Project/Name/Posted Speed/TEO LOW Speed</th>
<th>Location</th>
<th>Type of Construction</th>
<th>AADT and Number of Lanes</th>
<th>Operations Scenario Tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y1P1 Tremonton Posted Speed Limit = 80 mph TEO LOW Speed = 45 mph</td>
<td>I-15; Honeyville to Tremonton</td>
<td>Mill, paving, and bridge repair</td>
<td>22,000 AADT 4-lane divided highway</td>
<td>Scenario #2</td>
</tr>
<tr>
<td>Y2P1 Meadow Posted Speed Limit = 80 mph TEO LOW Speed = 50 mph</td>
<td>I-15; Baker Canyon to Meadow</td>
<td>Mill and paving</td>
<td>12,000 AADT 4-lane divided highway</td>
<td>Scenario #2</td>
</tr>
<tr>
<td>Y2P2 Honeyville Posted Speed Limit = 80 mph TEO LOW Speed = 50 mph</td>
<td>I-15; Corinne to Honeyville</td>
<td>Mill and paving</td>
<td>22,000 AADT 4-lane divided highway</td>
<td>Scenario #2</td>
</tr>
<tr>
<td>Y2P3 I-80 Posted Speed Limit = 80 mph TEO LOW Speed = 50 mph</td>
<td>I-80; milepost 20 to 30</td>
<td>Mill and paving</td>
<td>7,500 AADT 4-lane divided highway</td>
<td>Scenario #3</td>
</tr>
</tbody>
</table>
Work Zone Deployments / Evaluation

I-80 Speed Data Summary: July 13, 2017

- 5 Minute Rolling Average Speed (mph)
- Posted Speed Limit
- Preconstruction Posted Speed

Time of Day:
- 7:00 AM - 12:00 PM
- 12:00 PM - 5:00 PM
- 5:00 PM - 7:00 PM
### Speed Compliance

<table>
<thead>
<tr>
<th>Project</th>
<th>Speeds &lt; 10mph Over Posted Speed</th>
<th>10mph &lt; Speeds &lt; 15mph</th>
<th>Speeds &gt;=15mph Over Posted Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>PVSL</td>
<td>Baseline</td>
</tr>
<tr>
<td>Y1P1, Tremonton</td>
<td>23%</td>
<td>37%</td>
<td>10%</td>
</tr>
<tr>
<td>Y2P1, Meadows</td>
<td>88%</td>
<td>58%</td>
<td>9%</td>
</tr>
<tr>
<td>Y2P2, Honeyville</td>
<td>N/A</td>
<td>60%</td>
<td>N/A</td>
</tr>
<tr>
<td>Y2P3, I-80</td>
<td>43%</td>
<td>81%</td>
<td>42%</td>
</tr>
</tbody>
</table>

**Speed Compliance After Finetuning Algorithm Parameters**
Use of Portable and Dynamic Variable Speed Limits in Construction Zones

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