SAFETY RISK: Queues in Work Zones
stopped vehicles beyond the advanced warning area

In 2015 there were an estimated 96,626 crashes in work zones, an increase of 7.8% over 2014
A work zone crash occurred once every 5.4 minutes
What is a Queue?

“A line of vehicles waiting their turn”
Queue Warning Systems Best Practices

Reason for Adopting:

• The purpose of implementing Queue Warning Systems is to reduce the number and severity of rear end crashes

Primary Benefits:

• Queue Warning Systems can help reduce primary and secondary incidents by alerting drivers to congested conditions
• Incident severity is reduced because drivers are prepared for impending congestion

States Where Used:

• California, Illinois, Michigan, Oregon, Pennsylvania, Texas, Virginia, Washington, Wisconsin
Where are Queues Likely to Occur?

- In the advance warning area
- Upstream of the advance warning area (more dangerous)
- In the traffic space near the work area itself

Back of Queue Issues

- Increased crash risk, particularly rear-end crashes
- Potentially large variability in speeds between approaching traffic and queued traffic
- Impacts on driver expectations
  - They may be accustomed to unencumbered travel and may have a slower perception-reaction time
Queue Management Pilot Program

Purpose:

• Reduce risk for severe injury and fatal crashes
• Evaluate different methods using 2018 interstate paving schedules

Background:

• 12 fatal crashes within traffic queues resulting in 13 deaths past 5 years on I-81 in Staunton District
  • Of those, 3 crashes and 4 fatalities were in work zone queues during contract allowable work hours

• Queue Management concept has been previously used: examples include the I-81 deep mill paving project, I-81 truck climbing lane project, supporting incident management and was part of some 2017 I-81 paving contracts
  • Severity of crashes in queue reduced and no high speed or fatal crashes into back of queue occurred
QM 2018 Pilot Program Goals

- Compare and evaluate queue management techniques implemented:
  - Costs of each
  - How each technique responded to changes to traffic patterns
  - Length of queue observed
  - Duration of queue observed
  - Crashes occurring within queue with and without technique in place
- Identify the most cost effective solution at reducing crashes
- Develop data driven conclusions working with VTRC
- Partner with the Virginia Asphalt Association
Queue Management Techniques Evaluated

• **Contract Specific Allowable Work Hours**
  • Restricting when contractor allowed to implement lane closures to avoid peak traffic volumes

• **Technology Based – Smart Work Zones**
  • Portable programmable message signs with traffic movement sensors

• **Queue Management Team (QMT) Approach**
  • QMT SPCN – Contractor provided
  • Safety Service Patrol provided
  • Interstate Maintenance Contractor provided
QM 2018 Pilot Program Contracts Utilized

QMT Contractor Provided - SPCN
  • I-81 Ramp Extensions – Augusta Co.
  • I-66 High Friction Surface Treatment - Warren Co.
  • PM8M – I-81 SB Paving - Augusta Co.

QMT Safety Service Patrol Contract
  • PM8N - I-64 WB Paving – Rockbridge & Alleghany Co.

QMT Interstate Maintenance Contract
  • PM8O – I-81 NB Paving – Shenandoah Co.

Restricted Allowable Work Hours
  • LM8B – I-81 NB/SB Paving – Frederick/Rockingham/Shenandoah Co.

Smart Work Zone Technology
  • PM8L – I-81 NB/SB Paving - Rockbridge Co.
Queue Management Team (QMT) Overview

Utilizes a Two Truck Team System

- First truck (Lead) stages approximately ½ mile in advance of the Road Work Ahead portable signs
- Truck Mounted Message Board – ROAD WORK AHEAD - SLOW TRAFFIC AHEAD
- If a queue develops the message changes to – WATCH FOR - STOPPED TRAFFIC AHEAD
- Second truck stages approximately 1 mile in advance of the first truck
- Truck Mounted Message Board – ROAD WORK AHEAD - SLOW TRAFFIC AHEAD

Can the distance vary?
- Yes - adjustments need to be made to insure trucks are located in a safe staging area clear of potential risk

What happens when the Queue begins?
- First truck advises Second truck of queue and monitors queue until it reaches their location
- First truck then advises Second truck they are beginning flipping maneuver
- Second truck maintains their location until the First truck is able to flip location and advises Second truck they are out of the work area
- Second truck moves forward to ½ mile in advance of queue location
- First truck stages 1 mile in advance of Second truck
- Message signs are updated as appropriate and TOC is advised of queue location
Queue Management Team Trucks

Contractor Vehicle

Safety Service Vehicle
First Message Traffic Advisory

ROAD WORK AHEAD

SLOW TRAFFIC AHEAD
Second Message Traffic Advisory
Queue Develops
What is a Smart Work Zone?

- A smart work zone or intelligent work zone refers to a site-specific configuration of traffic control technology deployed within a roadway work zone to increase the safety of construction workers, provide "real-time" travel information, and efficiently route motorists through a work zone.

QM Pilot Utilized Portable Automated Queue Warning (AQW)

- Based on real-time traffic data
- Automatically informs travelers of downstream queues
- Portable Sensors
- Communicates with PCMS
- Uses algorithm pre-programmed into software
Automated Queue Warning (AQW) Overview

• AQW Equipment Used in Pilot
  • 4 Portable Speed-Mac VP (vertical panel) Sensors
    • Each sensor located approximately every ½ mile to a mile
    • Doppler radar detection – 100-500 feet
    • 4G modem with GPS
    • Jamlogic Software
    • Solar Panel
  • 3 VDOT Provided PCMS
    • Located approximately 3 miles prior to work zone
    • Direct communication with sensors
    • Each board located approximately every mile
Automated Queue Warning (AQW) Overview

Speed Detection Sensor

PCMS sign
Automated Queue Warning (AQW) Overview
Automated Queue Warning (AQW) Overview

Jamlogic Software

- Web-based remote queue warning server
- Speed data uploaded every minute
- Each PCMS message pre-programmed based on distance from work zone
- Speed-Mac VP Sensor uploads traffic speeds to software that determines what PCMS message to display

Speed-Mac VP Sensors - PCMS

Average Speeds per minute < 45 mph - CAUTION SLOW TRAFFIC AHEAD
Average Speeds per minute < 20 mph - CAUTION STOPPED TRAFFIC AHEAD
Automated Queue Warning (AQW) Overview

• **Typical Costs**
  - **First Month Rental** - $5,800 (includes design, setup of up to 4 sensors, setup of up to 6 PCMS, jamlogic software)
  - **Consecutive Monthly Rental** - $4,000 per month (includes management and rental of all sensors)
  - **Sensors and PCMS Relocations** - $1,250 per each
  - **Each PCMS Board** - $45 per day

• **Example**
  - Typical 4 month paving contract requiring 5 relocations and 3 PCMS boards with sensors would total - $35,000 +/-
QM 2018 Pilot Program Costs

QMT Contractor Provided - SPCN

- **I-81 Ramp Extensions – Augusta Co.**
  - Start – 07/09/18 – Work Ongoing
  - Unit Price - $190 per hour – Final: 160 hours at Cost of $30,400
- **I-66 High Friction Surface Treatment - Warren Co.**
  - Start – 07/16/18 – Complete – 10/15/18
  - Unit Price - $250 per hour – Final: 279 hours at Cost of $69,750
- **PM8M – I-81 SB Paving - Augusta Co.**
  - Start – 06/04/18 – Work Ongoing - 44,000 tons
  - Unit Price - $170 per hour – Final: 770 hours at Cost of $130,900

QMT Safety Service Patrol Contract

- **PM8N - I-64 WB Paving – Rockbridge/Alleghany Co.**
  - No Data – No QMT Used
  - SSP Price - $100 per hour – Estimate: 120 hours at Cost of $12,000

QMT Interstate Maintenance Contract

- **PM8O – I-81 NB Paving – Shenandoah Co.**
  - Start – 08/06/18 - Complete – 08/29/18 – 9,000 tons
  - IM Price - $190 per hour – Final: 200 hours at Cost of $38,000

Restricted Allowable Work Hours

- **LM8B – I-81 NB/SB Paving – Frederick/Rockingham/Shenandoah Co.**
  - No Data – Contract Not Awarded

Smart Work Zone Technology - AQW

- **PM8L – I-81 NB/SB Paving - Rockbridge Co.**
  - Start – 07/29/18 – Complete – 10/17/18 - 25,000 tons
  - Cost: $13,800
Summary of Findings to Date

Work Zone Crashes

• **Contract PM8M – I-81 SB Paving - Augusta Co.** - 3 crashes with Queue Management Team
  • Report:
    • Incorrect MOT set up – signs, tapers, cone spacing
    • Working outside of allowable work hours
    • Weather related

• **Contract PM8L – I-81 NB/SB Paving - Rockbridge Co.** - 1 crash with Automated Queue Warning
  • Report:
    • MOT correctly installed
    • Advanced warning provided

Longest queue length observed – 5 miles

• **Contract PM8M – I-81 SB Paving - Augusta Co.**

Average duration of queues – 2 hours

• **All contracts**

Further data pending VTRC final report

• Are vehicles slowing down after first PCMS
• Speed profiles in work zone
• Queue profiles
• Benefit to Cost ratio across the techniques
Summary of Findings to Date

Queue Management Team (QMT)

Positives:
• Flexibility and maneuverability
• Messages can be adjusted rapidly to meet existing work zone traffic conditions
• Trucks can immediately adjust locations if queue extends beyond normal work area

Negatives:
• Adequate manpower
• Exposure to risks and hazards
• Detailed coordination and communication critical
• Truck during flipping maneuver could become a victim of the queue
• Adequate distances between interchanges for flipping maneuver

Automated Queue Warning (AQW)

Positives:
• Human exposure to risks and hazards removed
• Provides detailed data of traffic volumes and speed
• Messages are automated in real time to meet existing work zone traffic conditions
• Easy to setup and manage

Negatives:
• Coordination of layout with construction sequencing may cause delays and add cost to project
• PCMS located in a fixed location, risk of queue extending beyond board if layout design is incorrect
Future of Queue Warning Program – Staunton District

2019 Interstate Paving Schedules:
- QMT to be provided by Safety Service Patrol
- District Traffic Engineering will provide oversight
- Communication and Coordination **Critical** between Contractor and ACE

Queue Management Team:
- Interstate incident management
- Select 2020 interstate paving schedules
- Interstate ramp extension contracts
- Shorter duration work zones

Technology Based – Smart Work Zones:
- Select 2020 interstate paving schedules
- Future I-81 improvement contracts
- Bridge contracts
- Longer duration work zones

Contract Specific Allowable Work Hours:
Questions