Smarter Work Zones Webinar Series

Webinar #12: Integrating Technology Applications – Massachusetts DOT

Todd Peterson and Neil Boudreau

April 26, 2016 1:00-2:30pm EST

Efficiency through technology and collaboration

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U.S. Department of Transportation
Federal Highway Administration

Smarter Work Zones

Introduction and Today's Speakers

Today's Speakers

Todd Peterson, P.E., PTOE
Transportation Specialist
FHWA Office of Operations

Neil Boudreau
Director of Traffic and Safety
Massachusetts DOT

Smarter Work Zones (SWZ) Webinar Series

- This is the twelfth in a series of monthly SWZ webinars
- Topics based on **what matters most to you!**
- Previous Webinar topics include:
  - Corridor-Based and Program-Based Project Coordination
  - Queue Warning Systems
  - Variable Speed Limits
  - Dynamic Lane Merge
  - Work Zone Project Coordination Guide and Examples
  - Integrating Project Coordination & Technology Applications: Iowa DOT
  - Lane Closure and Permitting Systems
- Recordings and materials for previous webinars are available on The National Work Zone Safety Information Clearinghouse website: https://www.workzonesafety.org/swz/webinars

- Coming Up:
  - Webinar #13: *Implementing Work Zone ITS Applications: Procurement*
    Wednesday, May 11th, 1:00-2:30pm EDT

Purpose of Today's Webinar

Discuss Massachusetts DOT (MassDOT's) implementation of Technology Applications using the Work Zone Intelligent Transportation Systems (ITS) Implementation Guide.

Topics include:

1. SWZ Technology Application Initiative
   - Show how the SWZ Technology Application initiative can be used by agencies to enhance their current work zone management practices
2. SWZ Real-World Example
   - Provide a real-world example of how MassDOT implemented Technology Applications using the Work Zone ITS Implementation Guide (FHWA-HOP-14-008).

Smarter Work Zones
SWZ Overview &
Technology Application Initiative

What are Smarter Work Zones (SWZ)?

Innovative strategies designed to optimize work zone safety and mobility

- Policies and practices used to incrementally and continuously improve WZ operations
- Tools to reduce WZ crashes and delays
- Tools to enhance WZ management strategies

Two Identified SWZ Initiatives:

Project Coordination

Coordination within a single project and/or among multiple projects within a corridor, network, or region, and possibly across agency jurisdictions

Technology Application

Deployment of Intelligent Transportation Systems (ITS) for dynamic management of work zone traffic impacts, such as queue and speed management

Today's Focus of Discussion

Technology Application – What is it?

Deployment of ITS for dynamic management of work zone traffic impacts, such as queue and speed management to **provide actionable information** to drivers and traffic managers.

Capabilities include:

- Improving driver awareness
- Providing dynamic and actionable guidance to drivers
- Enhancing tools for on-site traffic management

Source: FHWA

SWZ Technology Application Goals:

Goal 1A

By December 2016, 35 State DOTs have implemented business processes for work zone ITS technologies as identified in the Work Zone ITS Implementation Guide

- **What does this mean?**
  - Well-documented agency policies and processes to streamline consideration and use of work zone ITS technologies to minimize traffic impacts

SWZ Technology Application Goals:

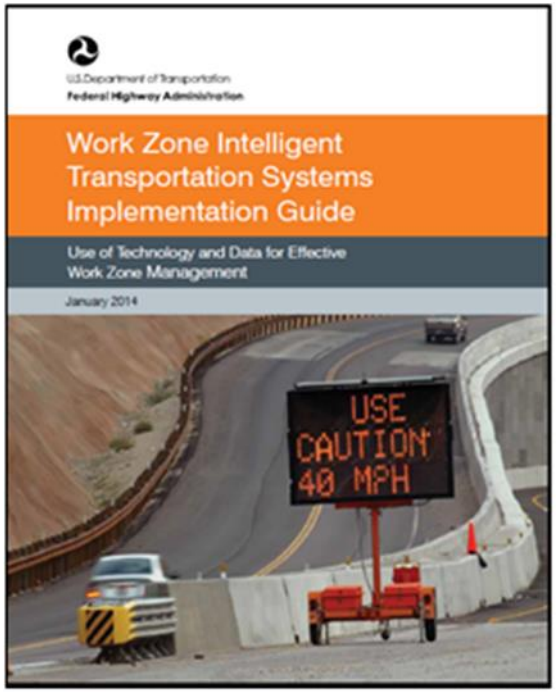
Goal 1B

By December 2016, 35 State DOTs have utilized at least one work zone ITS technology application for dynamic management of work zone impacts

- **What does this mean?**
  - Consideration of the six step process explained in the WZ ITS implementation guide to plan and implement ITS strategies
  - Identify and use ITS strategies such as speed and/or queue management on at least one project for dynamic management of work zone impacts

Work Zone ITS Implementation Guide

- Provide guidance on implementing ITS in work zones to assist public agencies, design and construction firms, and industry stakeholders
- Presented through a 6-step Systems Engineering Approach to WZ ITS implementation
- Available for download at: **http://ops.fhwa.dot.gov/publications/fhwahop14008/index.htm**



Source: FHWA

Smarter Work Zones

MassDOT's Integration of Technology Applications

Presentation Overview

- Highlight existing practices, define goals, and develop implementation plan
- Introduce new *Work Flow Process*
  - Design Standards (Steps 1-4)
  - Overview of SOP for contractors (Steps 5-7)
- Technology applications lessons learned

Technology Applications: Existing Practices

MassDOT has used Work Zone ITS applications on 12 projects to date

Monitoring traffic conditions and providing real-time feedback helps to lessen driver frustration about travel conditions

MassDOT's Real-Time Traffic Monitoring System specification is a "living document"

Sharing SWZ system access/data with partner agencies improves network mobility and credibility for project delivery

Technology Applications: MassDOT Goals

Pre-EDC3

- **Demonstration Phase**
  - Multiple project experience

Post-EDC3

- **Institutionalized**
  - Published standard procedures

Goal: Develop Standard Operating Procedures for planning, design and construction

Technology Applications: How to Achieve Goals

- Need SWZ design standards to help consultants understand *Concept of Operations*
- Update SWZ specifications for each application to define stand-alone requirements to aid consultants for future projects
- Create SOP for Contractors to understand expectations for use of work zone ITS
- Want a process to evaluate real-time data captured and generate work zone capacity values

Source: http://blog.commlabindia.com

Technology Applications: Implementation Plan (1 of 2)

Initial Focus

Source: Cliparts.com

- Use existing SWZ experience and the *Work Zone ITS Implementation Guide* to develop design standards
- Update SWZ applications matrix and scoring criteria to reflect Massachusetts experience
- Use current specifications and *Guide* to develop SOP for contractors who bid on SWZ systems
- Provide training workshop on SWZ systems

Technology Applications: Implementation Plan (2 of 2)

Long-Range Focus

- Develop stand-alone Concept of Operations
- Configure SWZ specifications into a “plug and play” format
- Build data warehouse module to capture real-time SWZ data
- Develop real-time data dashboard to evaluate performance

Source: nf5.com

Technology Applications: Where are we?

- Completed: “MassDOT Smart Work Zone Design Standards in December 2015*
- Completed: “MassDOT Smart Work Zone Standard Operating Procedures in December 2015*

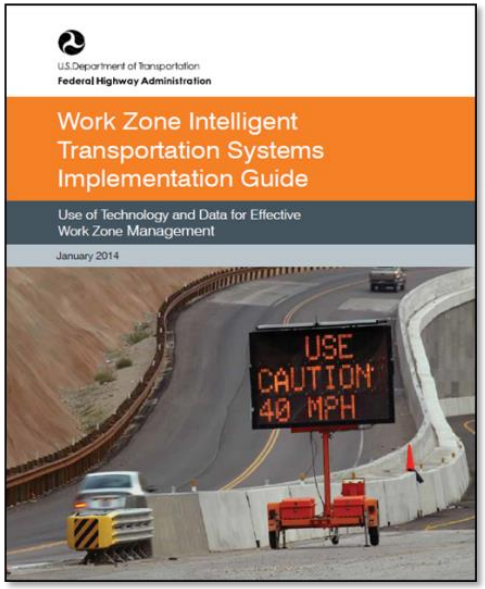
- Completed: “MassDOT Work Zone ITS Applications
- Evaluating: “MassDOT Scoring Criteria for Work Zone ITS”
- In-Progress: New *Concept of Operations* document

Source: freefuncheapnyc.com

*Updated in Feb. 2016

Technology Applications: Work Flow Process (1 of 2)

FHWA *Work Zone Intelligent Transportation Systems Implementation Guide*: Six-Step Process



Source: FHWA

Source: Battelle

Figure 4. Overview of the implementation process.

Technology Applications: Work Flow Process (2 of 2)

MassDOT's
Smart Work Zone
7-Step Process

- Step 1 • Assessment of SWZ Needs
- Step 2 • Planning SWZ Applications
- Step 3 • Layout and Design SWZ
- Step 4 • Define SWZ Specifications
- Step 5 • Deploy, Calibrate and Test SWZ
- Step 6 • Operate and Maintain SWZ
- Step 7 • Evaluate SWZ Data

Step 1: Assessment of SWZ Need (1 of 2)

Key Questions

Source: Clker.com

- Who are we trying to help with use of ITS in the work zone?
- How to best assess the expected work zone impacts and then determine what the issues/needs are?
- What are the goals of the project and how can SWZ applications be leveraged to support those goals?
- Who are the stakeholders that warrant involvement in the development of a SWZ to support the TMP?

Step 1: Assessment of SWZ Need (2 of 2)

Mobility Applications

- Notification to motorist on work zone operations
- Minimize project congestion through traffic diversion
- Providing real-time travel or delay times
- Dynamic lane merge

Safety Applications

- Warn motorists of stopped or slowed traffic
- Excessive speed warnings
- Vehicle exit/entry or clearance restriction notifications
- Protect workers from vehicle intrusions

Planning and Monitoring Applications

- Video surveillance
- Develop real-time performance reports
- Data-driven enforcement patrols
- Refine allowable work hours
- Evaluate throughput capacity

Step 1: Defining Specific Project Needs

MassDOT's ***Work Zone Transportation Management Procedures*** require that projects categorized at Impact Levels 3 or 4 shall include an ITS Monitoring Plan (IMP)

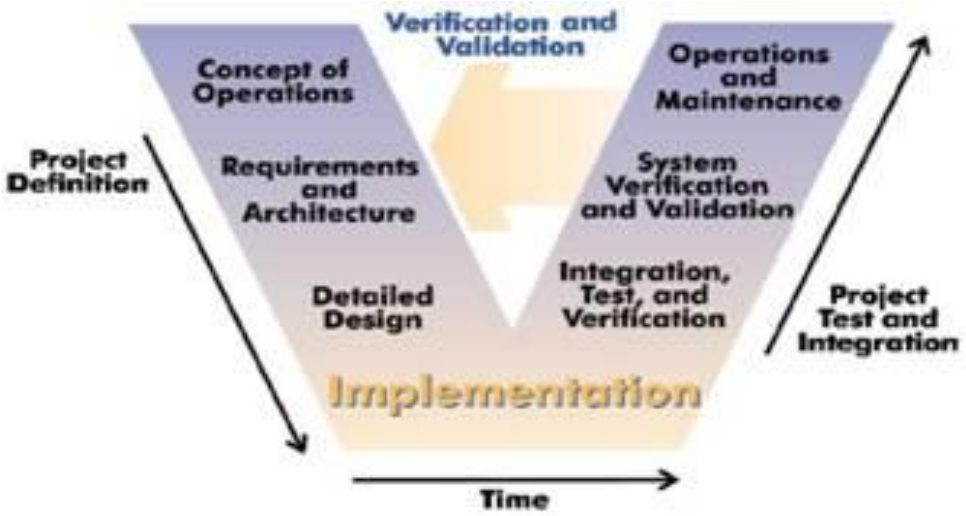
Impact Levels 1 & 2 may utilize work zone ITS devices

		Mobility Functions		Safety Functions	Planning & Monitoring Functions			
Project Impact	**Extent of ITS Coverage**	**Travel Time and Delay Notifications**	**Alternate Route Advisory**	**Congestion Warning**	**Video Surveillance**	**Site Traffic Data**	**Approach Traffic Data**	**Capacity Estimate**
Level 1 & 2	Work site	O	O	-	O	O	-	O
Level 3	Work site & vicinity	✓	✓	O	✓	✓	O	✓
Level 4 & Significant Projects	Work site, vicinity & approaches	✓	✓	✓	✓	✓	✓	✓

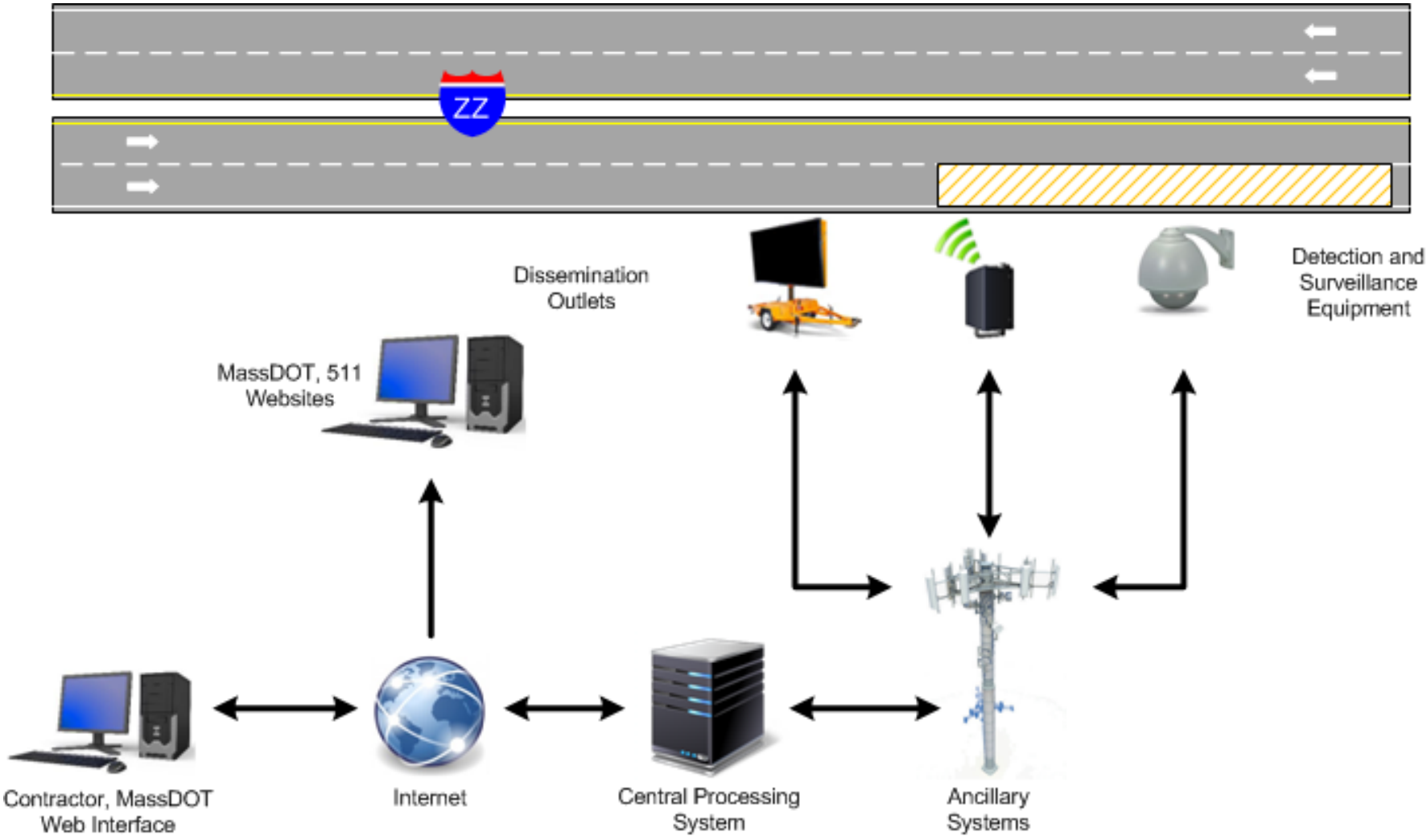
✓= Recommended for all O = Recommended for some cases

Step 2: Planning SWZ Applications

- What is the overall work zone ITS concept of operations?
  - Define expected system operation
  - Define data flow between system components
  - Define how the system will be managed



Step 2: Work Zone ITS Components



Step 2: Project Scoring Criteria (1 of 4)

massDOT Massachusetts Department of Transportation Highway Division

MassDOT Scoring Criteria for Work Zone ITS	
MassDOT Project Location:	**Project #**
Base Criteria – Existing Conditions	**N/A**
• AM Peak Hour Congestion [Yes - No] (*if yes estimated duration)	
• PM Peak Hour Congestion [Yes - No] (*if yes estimated duration)	
• Congestion in both AM & PM [Yes - No] (*if yes estimated duration)	
Factor 1 – Impacts on Roadway Geometry: Permanent Setup or Recurring Short Duration	**Score**
• Maintain existing cross-section (0 points)	0
• Loss of full shoulder (1 point)	
• Narrowed travel lanes (3 points)	
• Loss of travel lane (6 points)	
• Loss of multiple travel lanes (10 points)	
Factor 2 – Duration of work zone: Long-term stationary work will have a duration of:	**Score**
• > 2 years (8 points)	0
• > 1 year (6 points)	
• 6 - 12 months (4 points)	
• < 6 months (1 points)	
Factor 3 – Availability of Alternate Routes for detour or diversion of traffic:	**Score**
• No viable alternate routes (4 points)	0
• Alternate route with nominal capacity avaiable (2 points)	
• Alternate route with spare capacity available (1 points)	
• Several alternate routes available with spare capacity (0 points)	
Factor 4 – Queuing - Anticipated duration of Work Zone Queueing above recurring peak hour conditions are estimated to be:	**Score**
• > 4 hours per day (10 points)	0
• 2 to 4 hours per day (7 points)	
• 1-2 hours per day (5 points)	
• < 1 hour per day (3 points)	
Factor 5 – Delay Time (Average Delay of vehicles above and beyond existing conditions) *Note: use MassDOT WZ Delay Form*	**Score**
• Delays in excess of 30 minutes for a duration at least 2 hours (10 points)	

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MassDOT Scoring Criteria for Work Zone ITS	
MassDOT Project Location:	**Project #**
• Delays of between 20 to 30 minutes for a duration of 1 hour or more (5 points)	0
• Delays in between 12 to 20 minutes for a duration of 1 hour or more (2 points)	
• Delays less than 12 minutes (0 points)	
Factor 6 – Commercial Motor Vehicle Traffic Impacts:	**Score**
• Percent Heavy Vehicles >10% (6 points)	0
• Percent Heavy Vehicles 5 -10% (3 points)	
• Percent Heavy Vehicles <5% (1 point)	
Factor 7 – Impacts of Specific Issues (Based on Judgement: No Impact = 0 / Impact = 1)	**Score**
• Existing Crash History within the Work Zone limits	0
• Traffic Speed Variability	0
• Increased travel time or restricted access to regional traffic generators	0
• Unusual or Unpredictable Weather Patterns Such as Snow, Ice, and Fog	0
• Frequently Changing Operating Conditions for Traffic	0
• Merging Conflicts and Hazards At Work Zone Tapers	0
•Complex Traffic Control Layout with Multiple Access Points (i.e. Ramps or Side Streets)	0
• Construction Vehicle Entry/Exit Speed Differential Relative to Traffic	0
• Limited offset to median or roadside barrier/guardrail	0
• Lane Diversions - Use of Highway Crossover or Center Work Zone	0
Total Project Score	
If the total score is:	
• ≥30 – ITS is likely to provide significant benefits relative to costs for procurement	0
• ≥10 and <30 – ITS may provide some benefits and should be considered as a treatment to mitigate impacts	
• <10 – ITS may not provide enough benefit as a treatment to justify the associated costs	

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Step 2: Project Scoring Criteria (2 of 4)

Base Criteria – Existing Conditions
• AM Peak Hour Congestion [Yes - No] (*if yes estimated duration)
• PM Peak Hour Congestion [Yes - No] (*if yes estimated duration)
• Congestion in both AM & PM [Yes - No] (*if yes estimated duration)
Factor 1 – Impacts on Roadway Geometry: Permanent Setup or Recurring Short Duration
• Maintain existing cross-section (0 points)
• Loss of full shoulder (1 point)
• Narrowed travel lanes (3 points)
• Loss of travel lane (6 points)
• Loss of multiple travel lanes (10 points)
Factor 2 – Duration of work zone: Long-term stationary work will have a duration of:
• < 6 months (1 points)
• 6 - 12 months (4 points)
• > 1 year (6 points)
• > 2 years (8 points)

Step 2: Project Scoring Criteria (3 of 4)

Factor 3 – Availability of Alternate Routes for detour or diversion of traffic:
• Several alternate routes available with spare capacity (0 points)
• Alternate route with spare capacity available (1 points)
• Alternate route with nominal capacity available (2 points)
• No viable alternate routes (4 points)
Factor 4 – Queuing - Anticipated duration of Work Zone Queueing <u>above recurring peak hour conditions</u> are estimated to be:
• < 1 hour per day (3 points)
• 1-2 hours per day (5 points)
• 2 to 4 hours per day (7 points)
• > 4 hours per day (10 points)
Factor 5 – Delay Time (Average Delay of vehicles above and beyond existing conditions) *Note: use MassDOT WZ Delay Form*
• Delays less than 12 minutes (0 points)
• Delays in between 12 to 20 minutes for a duration of 1 hour or more (2 points)
• Delays of between 20 to 30 minutes for a duration of 1 hour or more (5 points)
• Delays in excess of 30 minutes for a duration at least 2 hours (10 points)

Step 2: Project Scoring Criteria (4 of 4)

Factor 6 – Commercial Motor Vehicle Traffic Impacts:
• Percent Heavy Vehicles <5% (1 point)
• Percent Heavy Vehicles 5 -10% (3 points)
• Percent Heavy Vehicles >10% (6 points)
Factor 7 – Impacts of Specific Issues (Based on Judgement: No Impact = 0 / Impact = 1)
• Existing Crash History within the Work Zone limits
• Traffic Speed Variability
• Increased travel time or restricted access to regional traffic generators
• Unusual or Unpredictable Weather Patterns Such as Snow, Ice, and Fog
• Frequently Changing Operating Conditions for Traffic
• Merging Conflicts and Hazards At Work Zone Tapers
• Complex Traffic Control Layout with Multiple Access Points (i.e. Ramps or Side Streets)
• Construction Vehicle Entry/Exit Speed Differential Relative to Traffic
• Limited offset to median or roadside barrier/guardrail
• Lane Diversions - Use of Highway Crossover or Center Work Zone
Total Project Score
If the total score is:
• ≥30 – ITS is likely to provide significant benefits relative to costs for procurement
• ≥10 and <30 – ITS may provide some benefits and should be considered as a treatment to mitigate impacts
• <10 – ITS may not provide enough benefit as a treatment to justify the associated costs

Step 2: Work Zone ITS Applications (1 of 3)

Matrix of the different types of WZ ITS Applications based on the Critical Project Characteristics

massDOT Massachusetts Department of Transportation Highway Division Critical Project Characteristics	Work Zone ITS Applications								
	Queue/speed reduction warning	Real-time traveler information	Incident management	Dynamic lane merge	Variable speed limit*	Automated enforcement**	Construction vehicle entrance/exit warning	Temporary ramp metering	Performance measurement
Frequent planned lane closures are expected, which will create queues that cause high speed differentials between queued and approaching traffic	●	●		○	●				
Emergency shoulders will be closed through the work zone and frequent stalls and fender-benders are expected to occur that will cause queues because they cannot be quickly moved to the shoulder	●	●	●						
Travel times and delays through the work zone will be highly variable and real-time information can improve pre-trip and real-time route choice, departure time, and possibly mode choice decisions		●	○						
Roadway access for emergency response vehicles will be significantly constrained by the project, increasing response and clearance times			●						
Frequent incidents are expected to occur within the project	○	●	●						
Having an operator able to view an incident within the project and assist responders in bringing appropriate equipment to the site will significantly reduce incident duration			●						
A long-term lane closure will create a v/c condition that is very close to 1.0, and improved flow rates through the lane closure could reduce the likelihood that a queue would form, or reduce its duration significantly when a queue did form				●				●	
The potential exists for queue spillback from the work zone into upstream interchanges or intersections (and resulting increase in cross-street congestion and rear-end crashes) due to an unequal utilization of all lanes, such that the encouragement of the use of all lanes for queue storage would reduce that probability of spillback conditions.		○	○	●					
Work activities will frequently occur for which lower speed limits would be beneficial to have on a temporary basis (i.e., during temporary lane closures on freeway mainlanes, for temporary full road closures, during periods construction vehicle/equipment access into and out of the work space from the travel lanes, etc.)			○		●		○		
Traffic speeds through the project vary widely due to oversaturated conditions during the peak period, and the timing and extent of congested travel will vary significantly day to day		○			●				
A reduced speed (and thus speed limit) is believed to be necessary because of work zone hazards that are not readily apparent to motorists and so will not likely result in lower speeds driven						●			
The project plans limit ability of enforcement to operate (no shoulders, barrier on both sides, long stretches between interchanges)						●			
Access to and from the work space occurs directly from the travel lanes							●		
A high number of construction vehicle deliveries into the work space will be required during the project							●		
The location and design of the access points could create confusion for motorists (i.e., access to the work space looks like an exit ramp and is near an existing actual exit ramp)		○					●		
Little or no acceleration lane is available for construction vehicles entering the travel lanes from the work space		○					●		
Capacity reductions in the work zone now create an oversaturated condition due to merging ramp vehicles								●	
Temporary ramp geometrics have constrained acceleration lane lengths								●	
Work activities have temporarily disabled one or more permanent ramp meters within the limits of an operational ramp metering system								●	
Project documents include traffic mobility performance requirements (i.e., maximum allowable delays) that must be monitored to ensure and quantify compliance. Incentive or Disincentive payments are used (performance specifications) based on mobility impacts (delays or queues)									●

February 2016

Source: Battelle / FHWA Work Zone ITS Guide

* Use of variable speed limits (regulatory) are not currently statutorily allowed. However, Work Zone Limits with the "when flashing" indication can be used.

** Massachusetts currently can not use Automated Speed Enforcement for work zones, only for toll facilities.

● Characteristic could be addressed with this portable Work Zone ITS application.

○ Characteristic could be addressed with a portable Work Zone ITS application if some modification(s) were made *or* real-time actions taken by the operator.

Step 2: Work Zone ITS Applications (2 of 3)

Source: pixabay.com

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Critical Project Characteristics

Critical Project Characteristics	Work Zone ITS Applications								
	Queue/speed reduction warning	Real-time traveler information	Incident management	Dynamic lane merge	Variable speed limit*	Automated enforcement**	Construction vehicle entrance/exit warning	Temporary ramp metering	Performance measurement
Frequent planned lane closures are expected, which will create queues that cause high speed differentials between queued and approaching traffic	●	●		○	●				
Emergency shoulders will be closed through the work zone and frequent stalls and fender-benders are expected to occur that will cause queues because they cannot be quickly moved to the shoulder	●	●	●						
Travel times and delays through the work zone will be highly variable and real-time information can improve pre-trip and real-time route choice, departure time, and possibly mode choice decisions		●	○						
Roadway access for emergency response vehicles will be significantly constrained by the project, increasing response and clearance times			●						
Having an operator able to view an incident within the project and assist responders in bringing appropriate equipment to the site will significantly reduce incident duration			●						
A long-term lane closure will create a v/c condition that is very close to 1.0, and improved flow rates through the lane closure could reduce the likelihood that a queue would form, or reduce its duration significantly when a queue did form				●				●	
The potential exists for queue spillback from the work zone into upstream interchanges or intersections (and resulting increase in cross-street congestion and rear-end crashes) due to an unequal utilization of all lanes, such that the encouragement of the use of all lanes for queue storage would reduce that probability of spillback conditions.		○	○	●					
Work activities will frequently occur for which lower speed limits would be beneficial to have on a temporary basis (i.e., during temporary lane closures on freeway mainlanes, for temporary full road closures, during periods construction vehicle/equipment access into and out of the work space from the travel lanes, etc.)			○		●		○		
Traffic speeds through the project vary widely due to oversaturated conditions during the peak period, and the timing and extent of congested travel will vary significantly day to day		○			●				
A reduced speed (and thus speed limit) is believed to be necessary because of work zone hazards that are not readily apparent to motorists and so will not likely result in lower speeds driven						●			
The project plans limit ability of enforcement to operate (no shoulders, barrier on both sides, long stretches between interchanges)						●			
Access to and from the work space occurs directly from the travel lanes							●		
A high number of construction vehicle deliveries into the work space will be required during the project							●		
The location and design of the access points could create confusion for motorists (i.e., access to the work space looks like an exit ramp and is near an existing actual exit ramp)		○					●		
Little or no acceleration lane is available for construction vehicles entering the travel lanes from the work space		○					●		
Capacity reductions in the work zone now create an oversaturated condition due to merging ramp vehicles								●	
Temporary ramp geometrics have constrained acceleration lane lengths								●	
Work activities have temporarily disabled one or more permanent ramp meters within the limits of an operational ramp metering system								●	
Project documents include traffic mobility performance requirements (i.e., maximum allowable delays) that must be monitored to ensure and quantify compliance. Incentive or Disincentive payments are used (performance specifications) based on mobility impacts (delays or queues)									●

February 2016

Source: Battelle / FHWA Work Zone ITS Guide

* Use of variable speed limits (regulatory) are not currently statutorily allowed. However, Work Zone Limits with the "when flashing" indication can be used.

** Massachusetts currently can not use Automated Speed Enforcement for work zones, only for toll facilities.

● Characteristic could be addressed with this portable Work Zone ITS application.

○ Characteristic could be addressed with a portable Work Zone ITS application if some modification(s) were made *or* real-time actions taken by the operator.

Step 2: Work Zone ITS Applications (3 of 3)

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Critical Project Characteristics

Critical Project Characteristics	Work Zone ITS Applications								
	Queue/speed drop warning	Real-time traveler information	Incident management	Dynamic lane merge	Variable speed limit*	Automated enforcement**	Construction vehicle entrance/exit warning	Temporary ramp metering	Performance measurement
Frequent planned lane closures are expected, which will create queues that cause high speed differentials between queued and approaching traffic	●	●		○	●				
Emergency shoulders will be closed through the work zone and frequent stalls and fender-benders are expected to occur that will cause queues because they cannot be quickly moved to the shoulder	●	●	●						
Travel times and delays through the work zone will be highly variable and real-time information can improve pre-trip and real-time route choice, departure time, and possibly mode choice decisions		●	○						
Roadway access for emergency response vehicles will be significantly constrained by the project, increasing response and clearance times			●						

Step 2: Example from I-93 Fast 14 Project

- Existing Geometry → 4-lanes each direction cut in half using crossover over 4.5 mile distance
- Weekend Traffic Volumes → approaching 6,000 vhp during peaks
- Traffic Management → lack of viable alternate routes with capacity
- Local Network → Road closures result in several detours

93 FAST 14
I-93 Rapid Bridge Replacement Project

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Step 2: Fast-14 Project Scoring Results

MassDOT Scoring Criteria for Work Zone ITS	
MassDOT Project Location: Medford (Design-Build)	**Project #**
Interstate 93 – 14 Bridge Superstructure Replacement	606255
Base Criteria – Existing Conditions * **Weekend Conditions**	**N/A**
• AM Peak Hour Congestion [Yes] No] (*if yes estimated duration)	+/- 1 hour
• PM Peak Hour Congestion [Yes] No] (*if yes estimated duration)	+/- 1 hour
• Congestion in both AM & PM [Yes] No] (*if yes estimated duration)	Approx 2-2.5 hrs.
Factor 1 – Impacts on Roadway Geometry: Permanent Setup or Recurring Short Duration	**Score**
• Maintain existing cross-section (0 points)	10
• Loss of full shoulder (1 point)	
• Narrowed travel lanes (3 points)	
• Loss of travel lane (6 points)	
• Loss of multiple travel lanes (10 points)	
Factor 2 – Duration of work zone: Long-term stationary work will have a duration of:	**Score**
• > 2 years (8 points)	1
• > 1 year (6 points)	
• 6 - 12 months (4 points)	
• < 6 months (1 points)	
Factor 3 – Availability of Alternate Routes for detour or diversion of traffic:	**Score**
• No viable alternate routes (4 points)	4
• Alternate route with nominal capacity available (2 points)	
• Alternate route with spare capacity available (1 points)	
• Several alternate routes available with spare capacity (0 points)	
Factor 4 – Queuing - Anticipated duration of Work Zone Queueing above recurring peak hour conditions are estimated to be:	**Score**
• > 4 hours per day (10 points)	10
• 2 to 4 hours per day (7 points)	
• 1-2 hours per day (5 points)	
• < 1 hour per day (3 points)	
Factor 5 – Delay Time (Average Delay of vehicles above and beyond existing conditions) *Note: use MassDOT WZ Delay Form*	**Score**
• Delays in excess of 30 minutes for a duration at least 2 hours (10 points)	

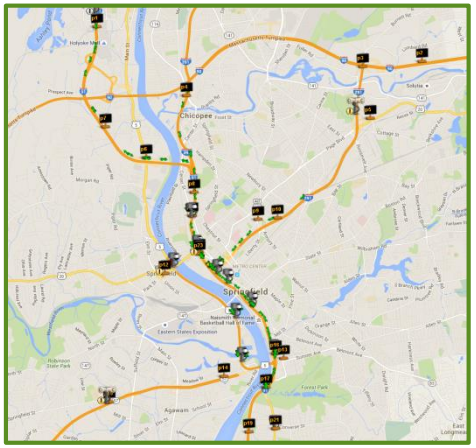
MassDOT Scoring Criteria for Work Zone ITS	
MassDOT Project Location: Medford (Design-Build)	**Project #**
Interstate 93 – 14 Bridge Superstructure Replacement	606255
• Delays of between 20 to 30 minutes for a duration of 1 hour or more (5 points)	5
• Delays in between 12 to 20 minutes for a duration of 1 hour or more (2 points)	
• Delays less than 12 minutes (0 points)	
Factor 6 – Commercial Motor Vehicle Traffic Impacts:	**Score**
• Percent Heavy Vehicles >10% (6 points)	1
• Percent Heavy Vehicles 5 -10% (3 points)	
• Percent Heavy Vehicles <5% (1 point)	
Factor 7 – Impacts of Specific Issues (Based on Judgement: No Impact = 0 / Impact = 1)	**Score**
• Existing Crash History within the Work Zone limits	0
• Traffic Speed Variability	1
• Increased travel time or restricted access to regional traffic generators	1
• Unusual or Unpredictable Weather Patterns Such as Snow, Ice, and Fog	0
• Frequently Changing Operating Conditions for Traffic	1
• Merging Conflicts and Hazards At Work Zone Tapers	1
•Complex Traffic Control Layout with Multiple Access Points (i.e. Ramps or Side Streets)	1
• Construction Vehicle Entry/Exit Speed Differential Relative to Traffic	0
• Limited offset to median or roadside barrier/guardrail	1
• Lane Diversions - Use of Highway Crossover or Center Work Zone	1
Total Project Score	
If the total score is:	***Good Candidate***
• ≥30 – ITS is likely to provide significant benefits relative to costs for procurement	38
• ≥10 and <30 – ITS may provide some benefits and should be considered as a treatment to mitigate impacts	
• <10 – ITS may not provide enough benefit as a treatment to justify the associated cost	

Score = 38
Good Candidate

Polling Questions/Questions

Step 3: Layout & Design SWZ

- Layout Guidelines – Identify the following key locations:
  - Start and end points
  - Merge points for lane drop(s)
  - Approaches to project site
  - Upstream decision points
  - Stable points upstream and downstream of bottleneck



Source: Google

- Locate required detection and surveillance equipment
- Add PCMS to disseminate messages at key locations
- Place all equipment locations on a Map with GIS points

Step 3: SWZ Equipment

- Portable Changeable Message Signs (PCMS)
- Portable Camera Trailers

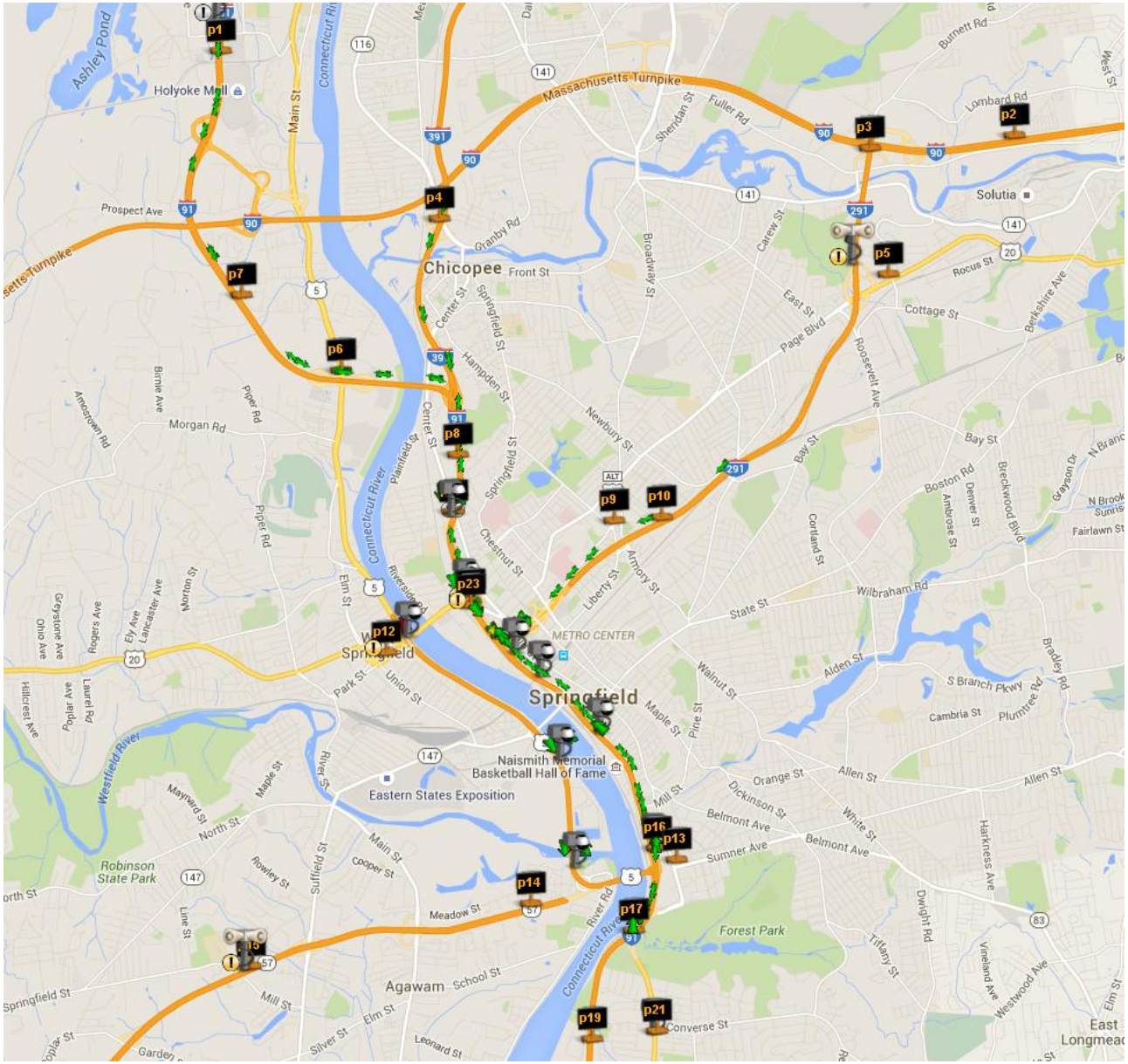
Source: MassDOT

Source: MassDOT

- SWZ Operating System
- Speed Feedback Boards
- Radar/Doppler Sensors
- Bluetooth Sensors
- Probe Data

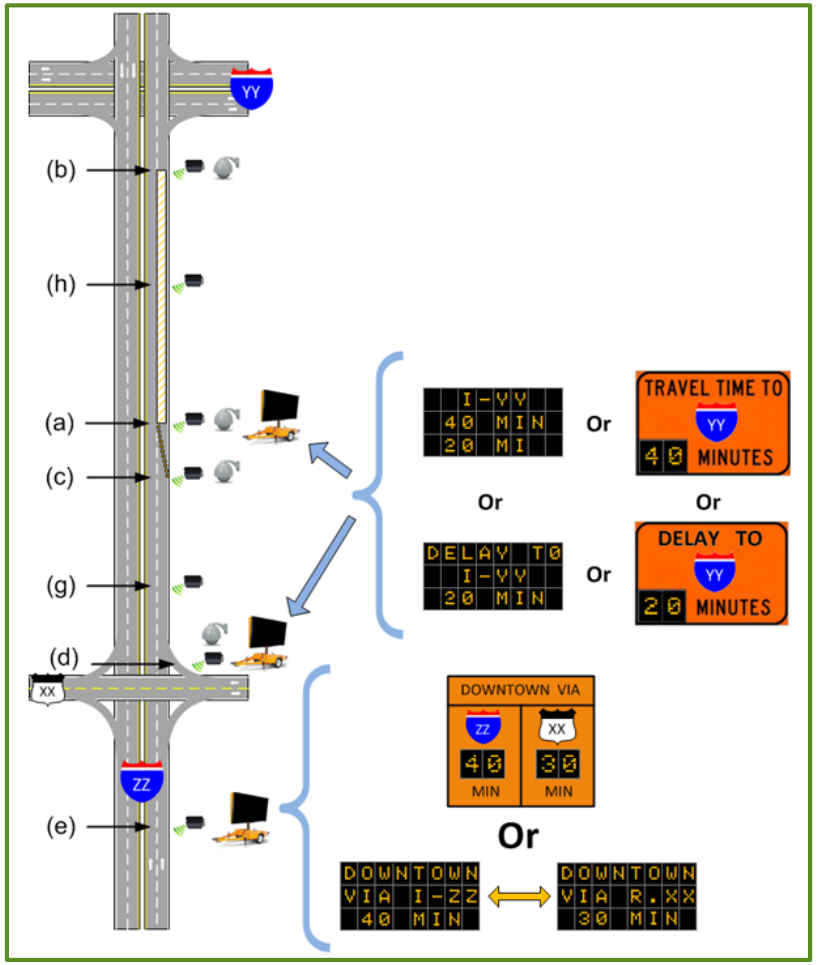
Source: MassDOT

Step 3: Current I-91 Springfield Project

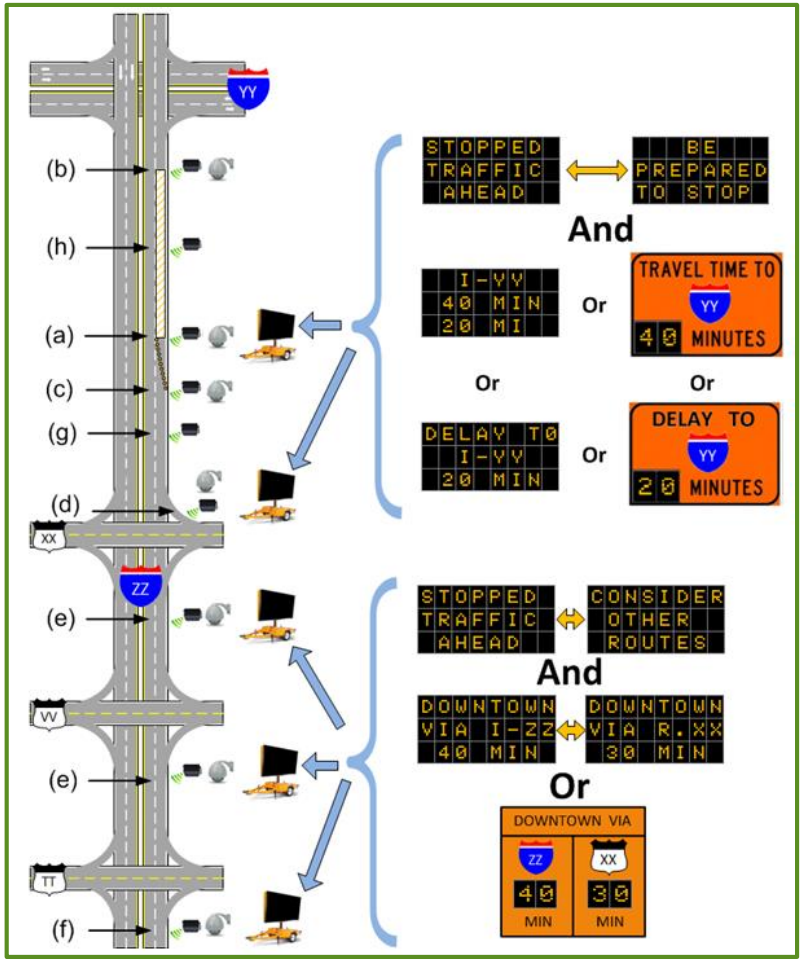


Source: Google

Step 3: Example Layouts



Impact Level 3

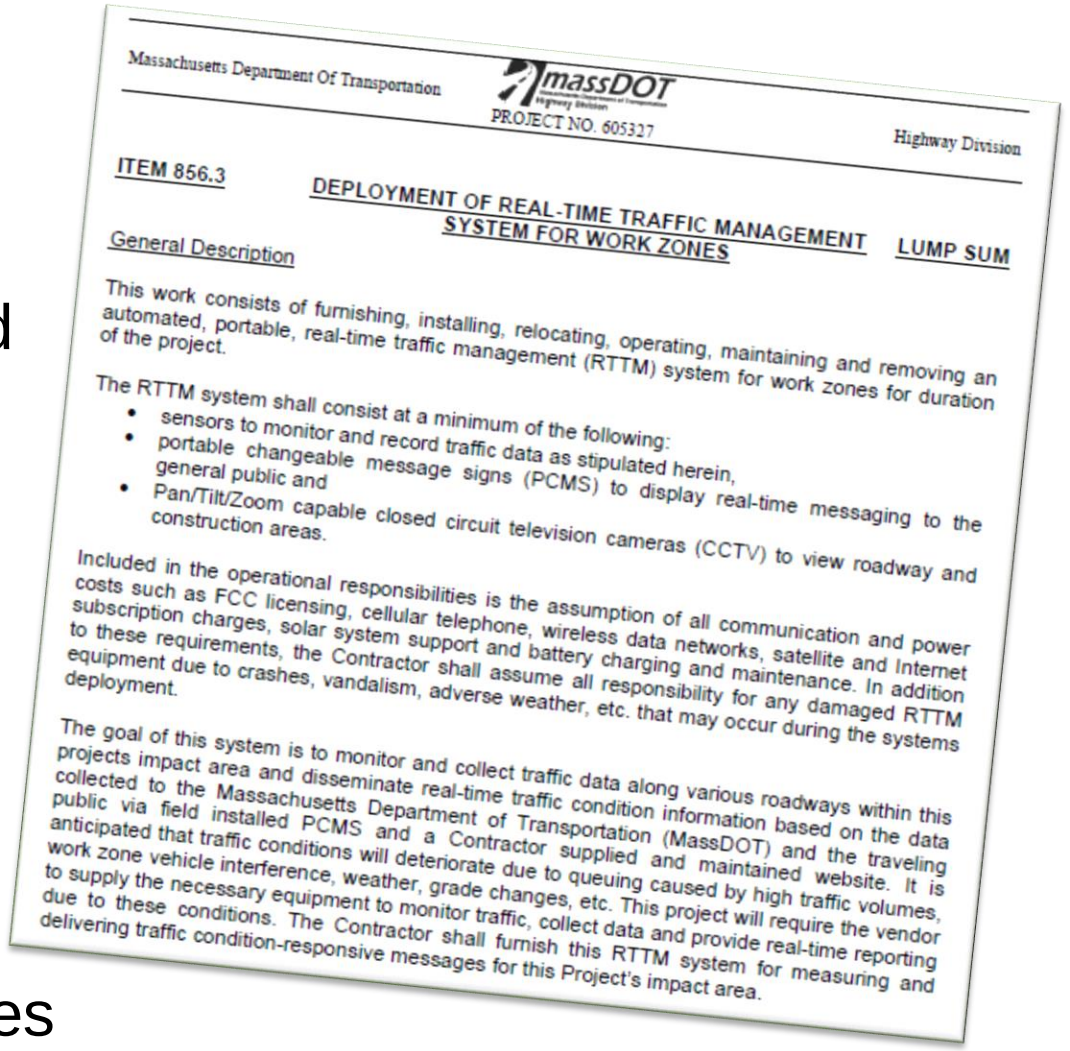


Impact Level 4

Step 4: Define SWZ Specifications

Lessons Learned

- Include detailed descriptions of the required equipment and expected functions
- Define expectations for system operations
- Document placement, calibration and testing expectations
- Define expected performance/deliverables



Massachusetts Department Of Transportation — MassDOT — Highway Division

PROJECT NO. 605327

ITEM 856.3 — **DEPLOYMENT OF REAL-TIME TRAFFIC MANAGEMENT SYSTEM FOR WORK ZONES** — **LUMP SUM**

General Description

This work consists of furnishing, installing, relocating, operating, maintaining and removing an automated, portable, real-time traffic management (RTTM) system for work zones for duration of the project.

The RTTM system shall consist at a minimum of the following:

- sensors to monitor and record traffic data as stipulated herein,
- portable changeable message signs (PCMS) to display real-time messaging to the general public and
- Pan/Tilt/Zoom capable closed circuit television cameras (CCTV) to view roadway and construction areas.

Included in the operational responsibilities is the assumption of all communication and power costs such as FCC licensing, cellular telephone, wireless data networks, satellite and Internet subscription charges, solar system support and battery charging and maintenance. In addition to these requirements, the Contractor shall assume all responsibility for any damaged RTTM equipment due to crashes, vandalism, adverse weather, etc. that may occur during the systems deployment.

The goal of this system is to monitor and collect traffic data along various roadways within this projects impact area and disseminate real-time traffic condition information based on the data collected to the Massachusetts Department of Transportation (MassDOT) and the traveling public via field installed PCMS and a Contractor supplied and maintained website. It is anticipated that traffic conditions will deteriorate due to queuing caused by high traffic volumes, work zone vehicle interference, weather, grade changes, etc. This project will require the vendor to supply the necessary equipment to monitor traffic, collect data and provide real-time reporting due to these conditions. The Contractor shall furnish this RTTM system for measuring and delivering traffic condition-responsive messages for this Project's impact area.

Step 4: Specifications for System Management

Purpose: Contractor/vendor shall supply the necessary equipment to monitor traffic, collect data, provide real-time reporting and remote messaging via the vendor supplied and maintained website

Required Personnel:

Project Manager – Overall project lead to manage RTTM project

Local Systems Manager – Experienced in managing day-to-day operation & maintenance of SWZ systems and equipment

Local Field Maintenance/Repair Technicians – maintain devices

Software Specialist – Configuration of system logic and calibration of algorithms to deliver real-time information

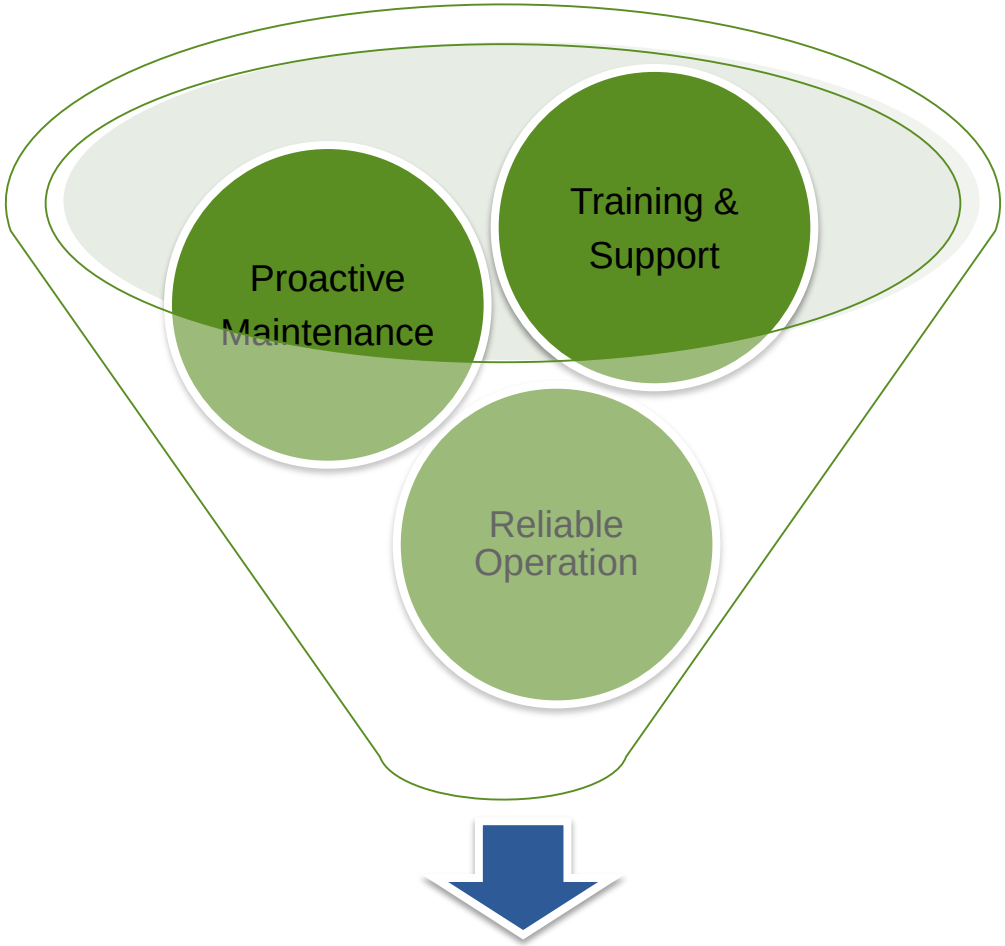
Step 5: Deploy, Calibrate, & Test SWZ

Key Takeaways

- Safe deployment that follows Roadside Design Guide (*clear zone*)
- Need GPS coordinates for equipment locations
- All devices must be calibrated to field conditions
- Develop testing plan to execute the functionality of the system

Vendor Activities	• Ensure system design and logic is valid • Develop plan for deployment
Contractor Activities	• Conduct Site Visit • Revise & Detail Design • Meet with MassDOT • Submit Plan
MassDOT Activities	• Provide permission for site visits • Attend Design Review • Approve Final Plan
Vendor, Contractor and MassDOT	• Operations Plan is submitted and accepted in writing by MassDOT

Step 6: Operate & Maintain SWZ



Successful Implementation

Step 7: Evaluate SWZ Data

So why do we insist on data collection?

- On-going evaluation of operations to support construction work hours
- Ability to calculate work zone throughput capacity
- Work zone mobility performance measures
- Develop public-facing work zone dashboard
- Planning for future traffic management plans

Source: clarabridge.com

Step 4: Use of SWZ Data

Whittier Bridge Construction Working Hours - Memorial Day to Labor Day - Min # Lanes Open Shown

NORTHBOUND	12 AM	1 AM	2 AM	3 AM	4 AM	5 AM	6 AM	7 AM	8 AM	9 AM	10 AM	11 AM	12 PM	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM	9 PM	10 PM	11 PM
Sunday	1	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	2	2	2	2	2	2	1	1
Monday	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	2	2	2	1	1
Tuesday	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	2	2	2	1	1
Wednesday	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	2	2	2	1	1
Thursday	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	2	2	2	1	1
Friday	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3	3	3	3	3	3	2	2	1
Saturday	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3	3	2	2	2	2	2	1	1

SOUTHBOUND	12 AM	1 AM	2 AM	3 AM	4 AM	5 AM	6 AM	7 AM	8 AM	9 AM	10 AM	11 AM	12 PM	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM	9 PM	10 PM	11 PM
Sunday	1	1	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3	3	3	3	3	2	1
Monday	1	1	1	1	1	2	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1
Tuesday	1	1	1	1	1	1	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1
Wednesday	1	1	1	1	1	1	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1
Thursday	1	1	1	1	1	1	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1
Friday	1	1	1	1	1	1	3	3	3	2	2	2	2	2	2	3	3	3	2	2	2	2	1	1
Saturday	1	1	1	1	1	1	1	1	2	2	3	3	3	3	3	3	3	3	3	2	2	2	2	1

Whittier Bridge Construction Working Hours - Labor Day To Memorial Day- Min # Lanes Open Shown

NORTHBOUND	12 AM	1 AM	2 AM	3 AM	4 AM	5 AM	6 AM	7 AM	8 AM	9 AM	10 AM	11 AM	12 PM	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM	9 PM	10 PM	11 PM
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Friday	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	2	2	2	1	1
Saturday	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1

SOUTHBOUND	12 AM	1 AM	2 AM	3 AM	4 AM	5 AM	6 AM	7 AM	8 AM	9 AM	10 AM	11 AM	12 PM	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM	9 PM	10 PM	11 PM
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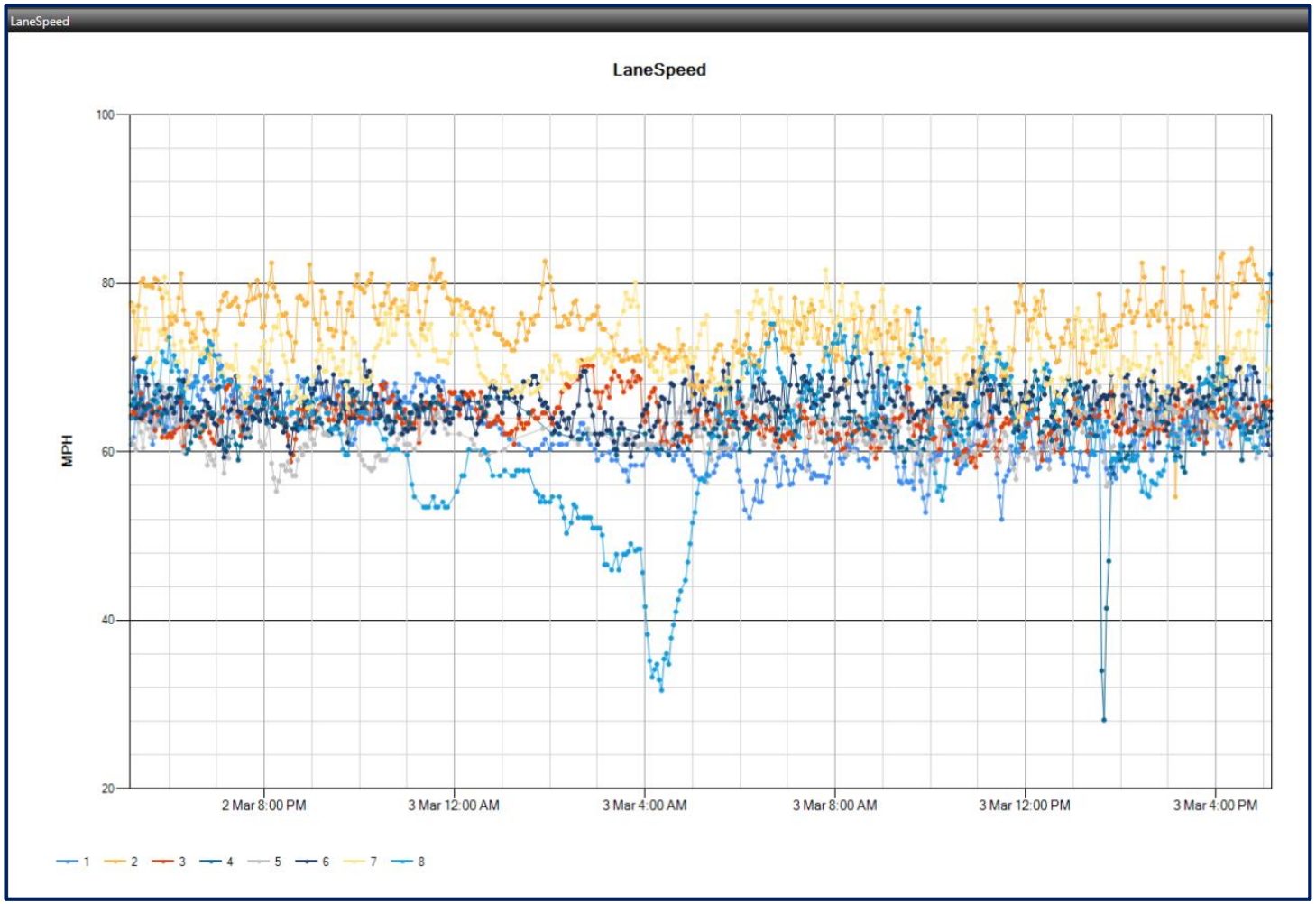
Friday	1	1	1	1	1	1	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1
Saturday	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1

Work Hour Matrix for Lane Closures

Step 4: Use of SWZ Data

Whittier Bridge – Lane Speed Graph



Implementation Plan: How are we doing?

- ✓ Use existing SWZ experience and FHWA *Work Zone ITS Implementation Guide* to develop design standards ***Done***
- ✓ Update SWZ applications matrix and scoring criteria to reflect Massachusetts experience ***Done***
- ✓ Use current specifications and *Guide* to develop SOP for contractors who bid on SWZ systems ***Done***
- ✓ Provide training workshop on SWZ systems ***Done***
- Prepare ConOps document ***Underway***
- Develop “Plug & Play” specifications ***Starting Soon***
- Build data warehouse module to capture real- time SWZ data to evaluate performance ***Starting Soon***
- Develop real-time data dashboard ***Starting Soon***

Source: jobinspirations.com

SWZ Technology Applications: Lessons Learned

- Make use of ITS in work zones part of your traffic management mitigation strategies
- Start planning your Concept of Operations early in project development
- Engage your stakeholders to obtain early buy-in
- Invest the time and effort to generate detailed project specifications

Source: mentorcloud.com

- Require detailed data capture and use the data to demonstrate successes
- Give stakeholders access to monitor the system operation

For More Information:

Neil Boudreau, State Traffic Engineer

MassDOT

neil.boudreau@state.ma.us

Smarter Work Zones

FHWA Resources

SWZ Interactive Toolkit Available!

https://www.workzonesafety.org/SWZ/

Source: FHWA

Other Resources – Technology Application

FHWA	• FHWA Work Zone Mobility and Safety Program – ITS and Technology http://www.ops.fhwa.dot.gov/wz/its/index.htm • FHWA Work Zone Mobility and Safety Program – Peer-to-Peer Program http://www.ops.fhwa.dot.gov/wz/p2p/index.htm • Work Zone ITS Implementation Guide http://www.ops.fhwa.dot.gov/publications/fhwahop14008/fhwahop14008.pdf • Work Zone ITS Case Studies http://www.ops.fhwa.dot.gov/publications/fhwahop14007/ • Work Zone ITS Overview Webinar http://www.ops.fhwa.dot.gov/wz/webinars/itsoverview013014/ullman/index.htm

Thanks for joining us!

- **Upcoming Events**
  - Webinar #13: *Implementing Work Zone ITS Applications: Procurement*
    - Wednesday, May 11, 2016, 1:00-2:30pm EST
- Registration: https://connectdot.connectsolutions.com/e6rwz52leqm/event/registration.html
  - Check The National Work Zone Safety Information Clearinghouse website for updates https://www.workzonesafety.org/SWZ/

- **Questions or Comments?**
  - Jawad Paracha (FHWA Operations, WZ Team) jawad.paracha@dot.gov