
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

TRANSPORTATION MANAGEMENT PLAN

Interstate 5 "Boat Section" Rehabilitation

03-SAC-5-KP 36.4/37.8 (PM 22.6/23.5)
EA 03-0A3601

February 25, 2008

Crash Reduction Strategies for Work Zones

Tracy Scriba, FHWA

Work Zone Conference

March 2009

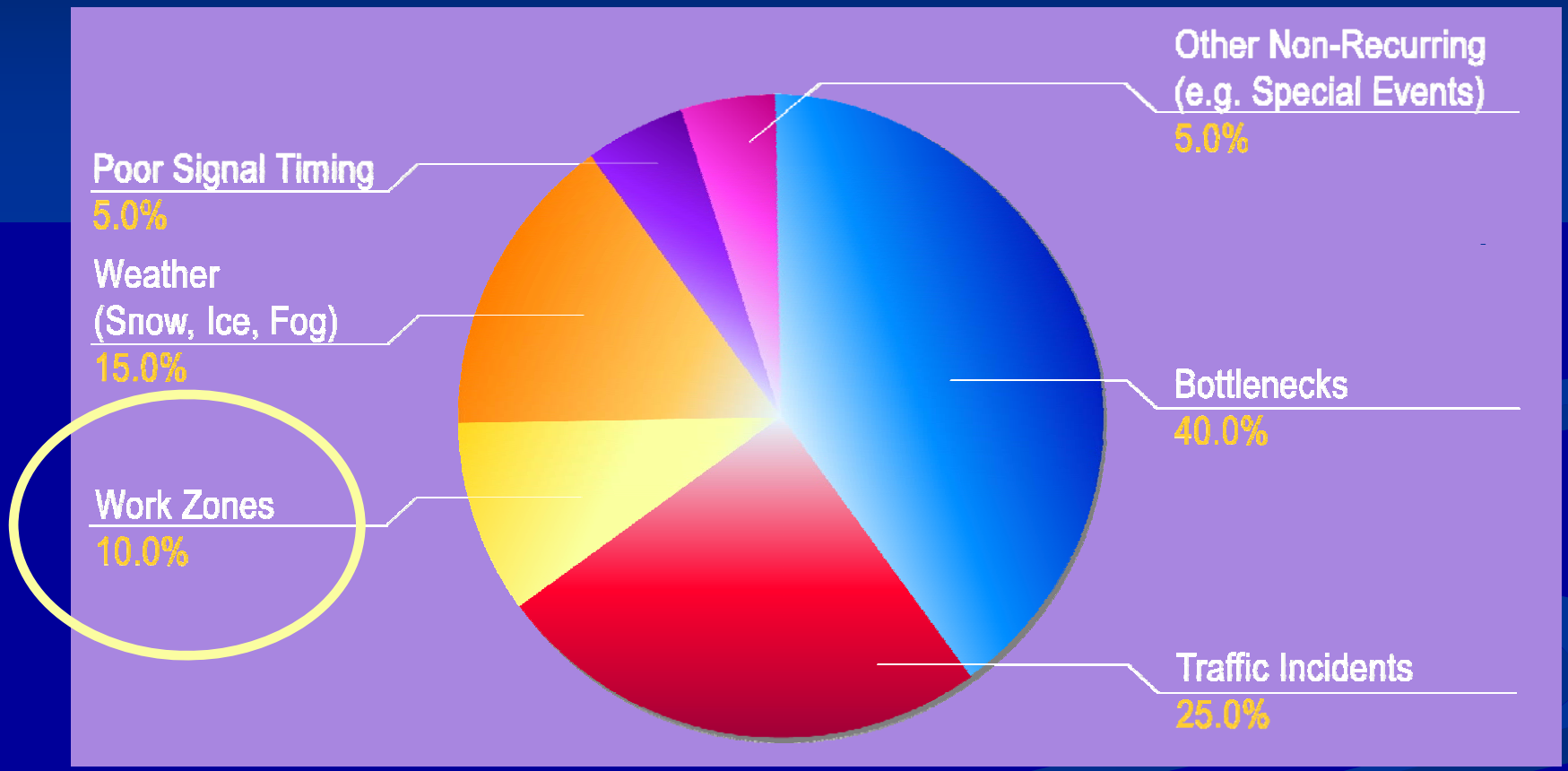
Presentation Outline

- Work Zone Safety and Mobility Challenges
- Work Zone Crash Reduction Strategies
  - ITS
  - Effective TMPs
  - Performance Monitoring

WZ Safety & Mobility Challenges

- Congestion
  - End-of-queue crashes
  - Delay
  - Dissatisfied motorists (private & commercial)
  - Difficulty in emergency vehicle access and response
  - Delayed contractor vehicle access (reduced efficiency)

Causes of Congestion



Source: " Traffic Congestion and Reliability;" FHWA (September, 2005)

WZ Safety & Mobility Challenges

- Speeding/Speed Management
  - Setting speed limits
  - Compliance with speed limits
  - Limited areas for law enforcement officer stationing
  - Limited areas to pullover speeders
- Crashes
  - Timely incident detection and response
  - Secondary crashes
  - Congestion
  - Intrusions
  - Work vehicle access/egress

WZ Crashes – A Few Facts
Rear-end Crashes

- **Rear-end crashes are over-represented**
  - Crashes with rear-end impacts increased 7.1 to 83 % in work zones vs non-work zones (depending on study cited and location)
- 2001 study of WZ crashes in Illinois:
  - More rear-end crashes during periods of work activity than during inactivity
  - Many rear-end crashes were severe - often the case when traffic traveling at high speeds crashes into back of a vehicle moving slowly in a queue
- Likely a result of creation of queues and congestion during work activities:
  - Closure of a traffic lane
  - Construction equipment moving into and out of the work area
- Can reduce rear-end crashes by avoiding the creation of traffic queues

WZ Crashes – A Few Facts
Day work – Night work

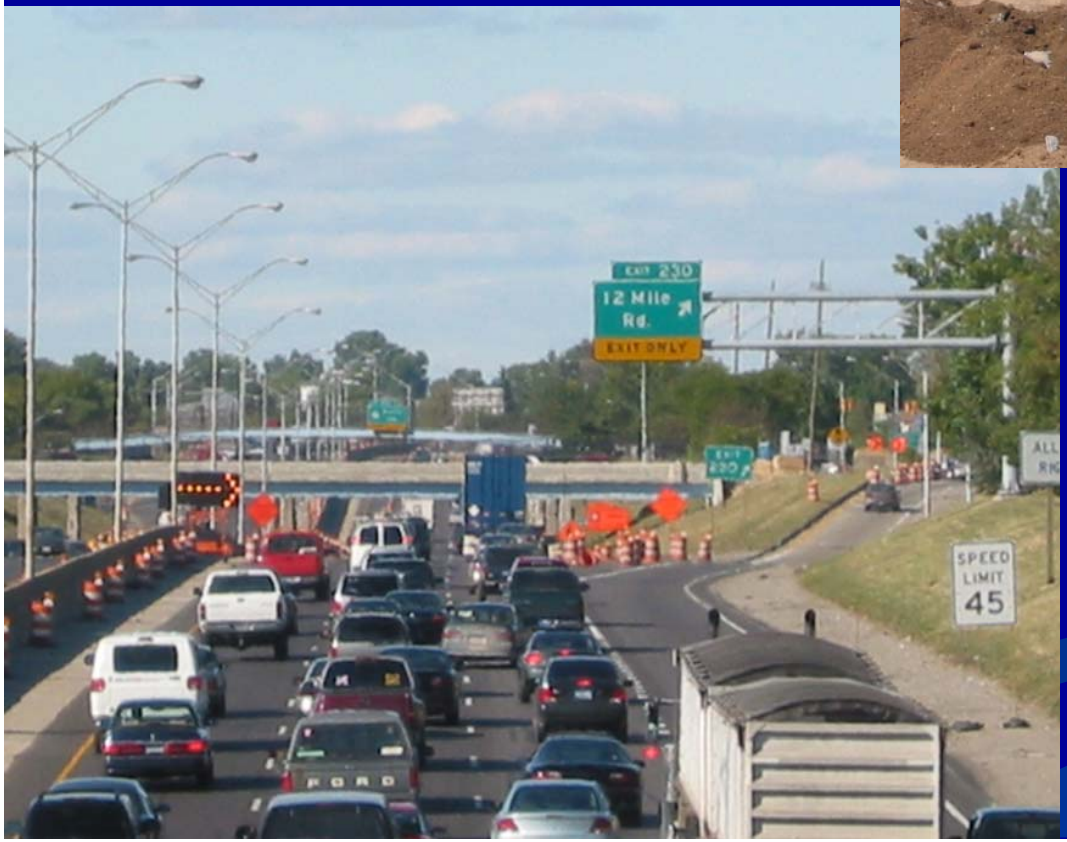
The risk of a crash for an individual driver encountering roadwork activity at night may go up more percentage-wise than during the day.

However, lower traffic demands at night can lead to <u>fewer additional crashes in total</u> over the duration of a project than would otherwise occur if the work were performed during the day.

WZ Safety & Mobility Challenges

- Performance Monitoring
  - Lack of data
  - Limited personnel to gather data
  - Difficulty in assessing impacts and estimating performance
  - Unknowns about appropriate work windows
  - Unknown effectiveness of WZ strategies

Which work zone will I get?



Context for WZ Crash Reduction

Part of overall WZ management

Effective work zone management requires:

- Understanding the likely impacts of a WZ
  - Safety and Mobility Impacts
- A combination of strategies
- Strategies should be chosen to solve specific problems

WZ Crash Reduction Strategies

- WZ crash reduction strategies include:
  - ITS
  - Effective Transportation Management Plans (TMPs)
  - Monitoring WZ Performance
- Not all-inclusive – there are many others

How ITS Can Help
Potential Benefits

- Improved mobility and traffic management
- More informed public
- Quicker incident response
- Greater safety of workers and travelers
- Better PR and relationships with stakeholders
- Enhanced speed management
- Better understanding of traffic conditions
- One study showed a benefit-cost ratio of 2:1, another showed a B-C ratio of 6:1

How ITS Can Help

Applications

- Traffic monitoring/management
- Traveler information
- Incident management
- Worker safety/protection
- Performance monitoring
- Setting allowable work hours
- Speed management/enforcement
- Tracking and evaluation of contract incentive/disincentives

How ITS Can Help

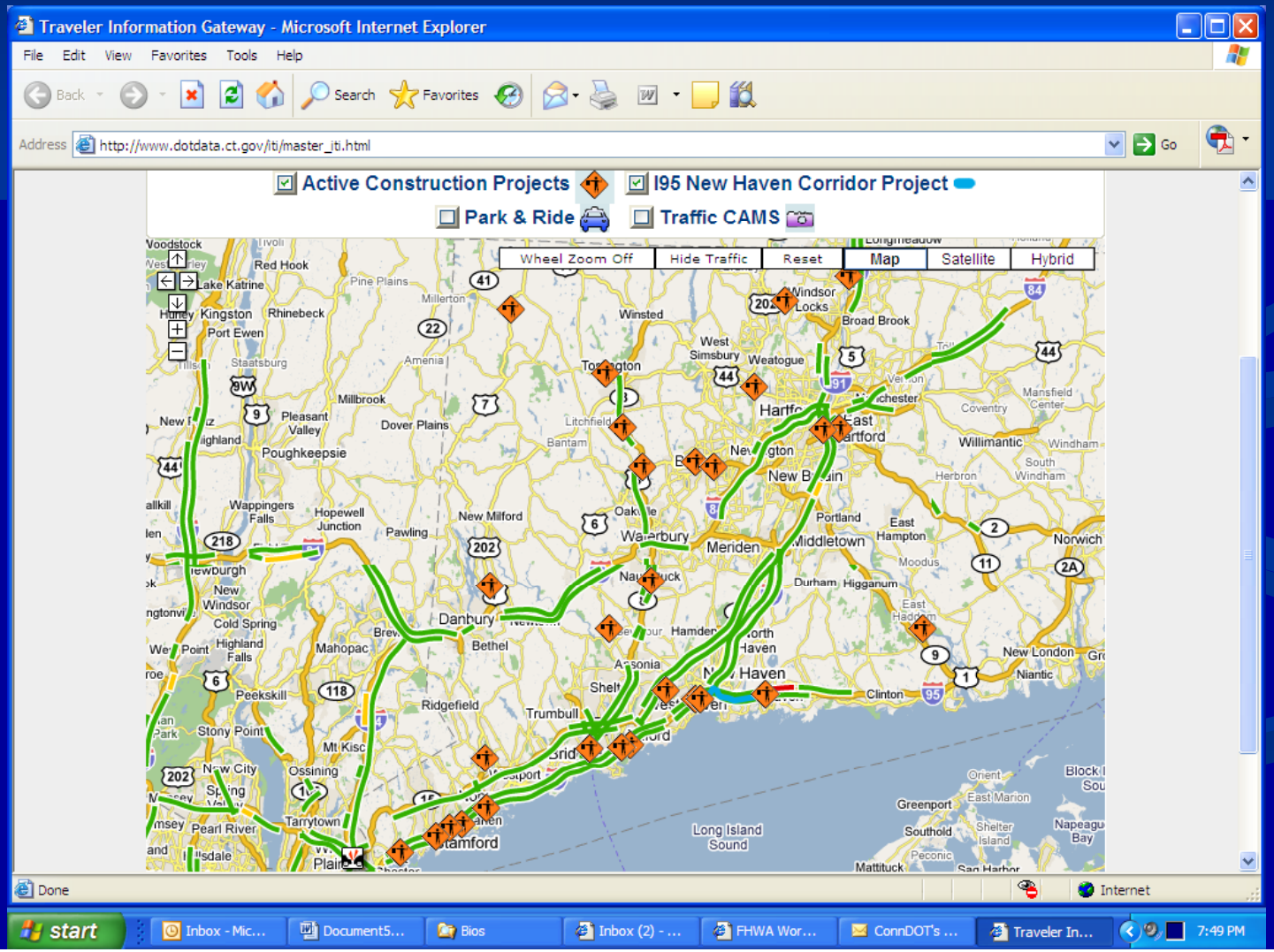
- Congestion
  - End-of-queue crashes
  - Delay
  - Dissatisfied motorists (private & commercial)
  - Difficulty in emergency vehicle access and response
  - Delayed contractor vehicle access (reduced efficiency)
- Speed detection and warning systems
- Traveler information systems, active diversion
- Data on best times to work and for deliveries

Example - Speed Detection and Warning Systems

- Alerts drivers to slowed or stopped traffic ahead
- Can reduce rear-end crashes and secondary crashes
- Use sensors to detect queues/slow speeds and signal the message board to activate

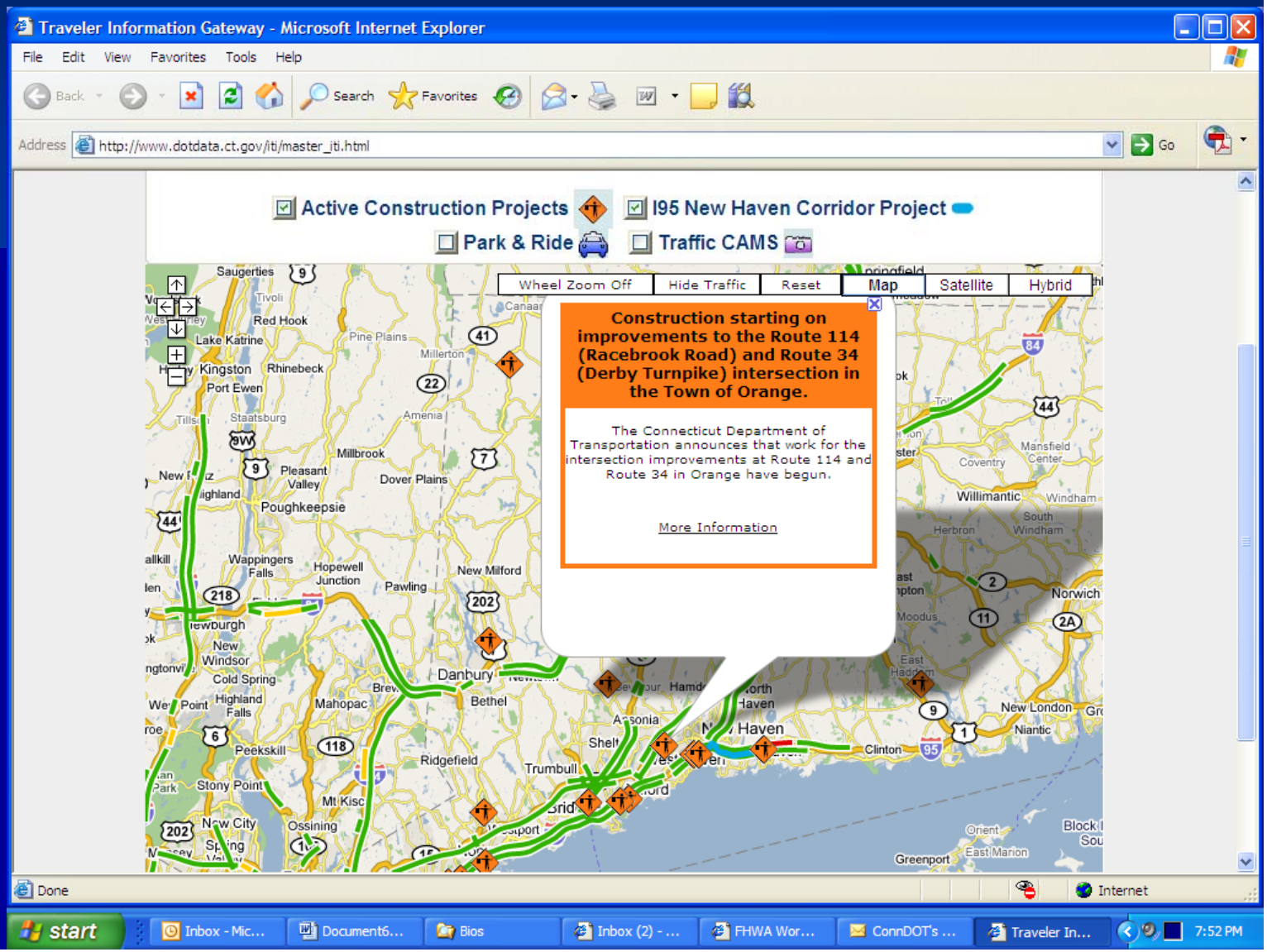
Example - ConnDOT Interactive Project Map

http://www.dotdata.ct.gov/iti/master_iti.html



ConnDOT Work Zone Information

- Road project info
- Incident info
- Near real-time streaming video



How ITS Can Help

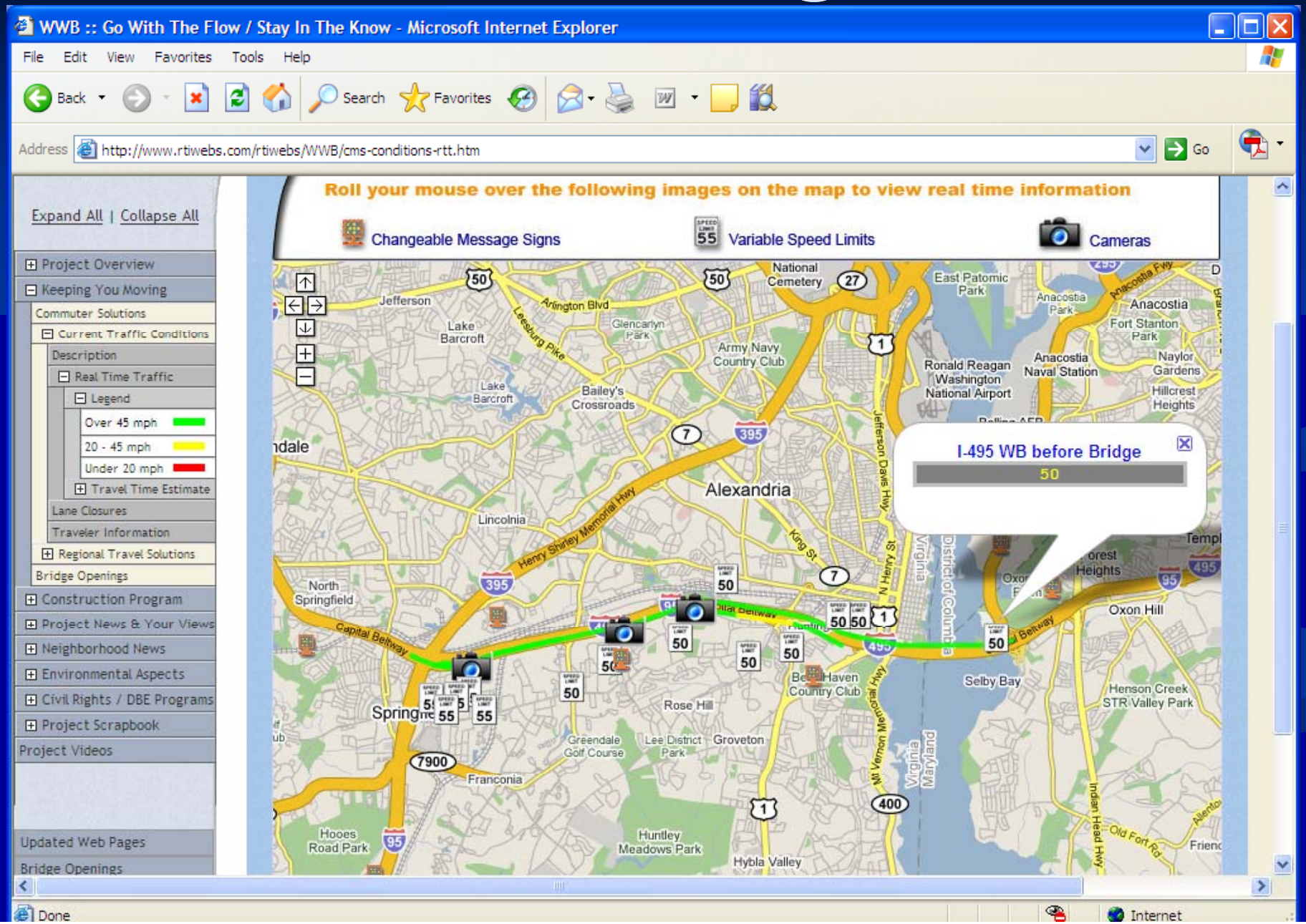
- Speeding/Speed Management
  - Setting speed limits
  - Compliance with speed limits
  - Limited areas for law enforcement officer stationing
  - Limited areas to pullover speeders

- Speed monitoring systems
- Variable speed limit systems
- Automated enforcement systems

Example - VDOT VSL System

- I-495/I-95 Telegraph Road Interchange Redesign of Woodrow Wilson Bridge Project
  - Work expected 2008 to 2013
  - Traffic reduced from 8 lanes to 6 long-term (further short-term lane closures at night)
- System
  - Speed limits can vary from 55mph to 35 mph
  - As congestion builds, speed limit decreases to try to maintain smooth flow and avoid stop-and-go traffic
  - Operators monitor system - can override speed limits, messages
  - Active enforcement used to increase compliance

www.wilsonbridge.com



How ITS Can Help

- Crashes
  - Timeliness of incident detection and response
  - Secondary crashes
  - Congestion
  - Intrusions
  - Work vehicle access/egress

- Cameras and queue detection systems
- Intrusion alarms
- Signs warning of trucks entering/leaving roadway

How ITS Can Help

A study of successful deployments showed that:

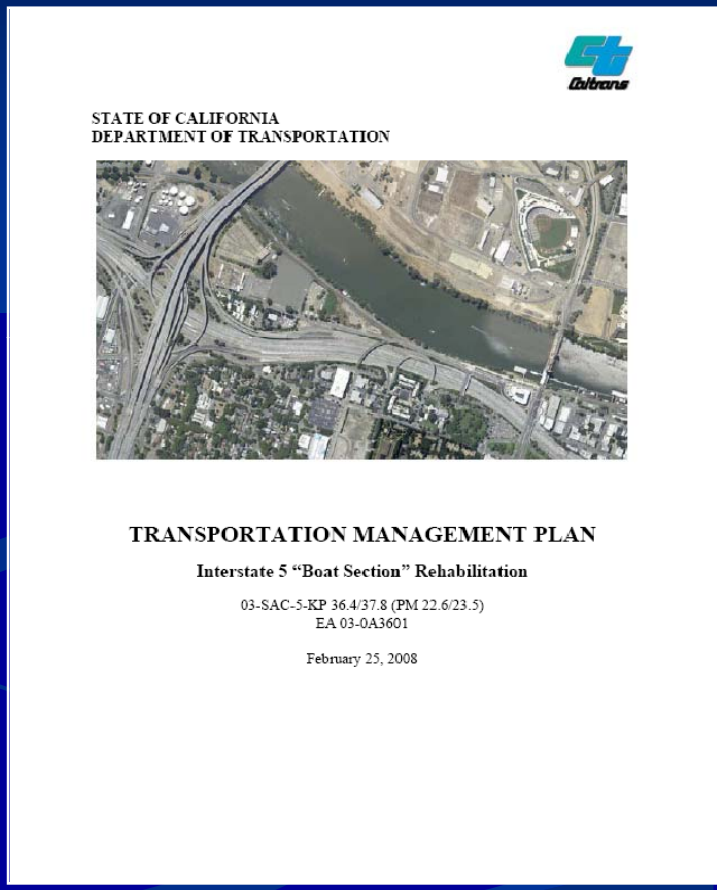
- 50-85% of drivers surveyed said they changed their route in response to WZ ITS info *(lower exposure)*
- Queue length reductions of 56-60% are possible
- Speed monitoring displays reduced speeds by 4-6 mph
- One study found a 20-40% reduction in vehicles traveling $\geq$ 10 mph over the speed limit when SMDs are used

FHWA ITS Effectiveness Study Results - 2008

- Reductions in aggressive maneuvers at WZ lane drops
  - MI: Forced merges were 7 times less frequent, and dangerous merges were 3 times less frequent when the ITS system was on (flashers on)
- Significant traffic diversion during congestion, and enhanced ability to manage WZ traffic and incidents
  - TX: Average of 10 % diversion (range of 1 to 28 %)
  - DC: Average of 52 % (range of 3 to 90 %) lower mainline volume
- Improved ability to react to stopped or slow traffic
  - AR: 82 % of surveyed drivers felt ITS system improved their ability to react to stopped or slow traffic
- Driver perception of improved WZ safety
  - AR: 49 % of surveyed drivers said ITS messages made them feel safer, 17 % were neutral, 32 % disagreed, 2 % did not answer

How TMPs Can Help

- Set of coordinated strategies implemented to manage the work zone impacts of a project
- Required for all Federal Aid highway projects by the Work Zone Safety and Mobility Rule



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How TMPs Can Help

- Work zone management is increasingly complex
  - Increasing traffic volumes using the same roads that agencies need to maintain and rehabilitate
  - Need traffic management efforts beyond temporary traffic control plans
- Has affects on:
  - Safety
  - Mobility
  - Constructability
- **TMPs = more comprehensive approach to managing WZ impacts**

TMP Components

- Must always include a Temporary Traffic Control Plan (TTC)
- For <u>significant projects</u>, TMPs must also contain:
  - Traffic operations (TO) component
  - Public information and outreach (PI) component
- A TMP may be a single document, or several documents/plans compiled together

Simply stated, a significant project is a project that the agency expects will cause a relatively high level of disruption.

TMP Strategies to Manage WZ Impacts

Temporary Traffic Control (TTC) Strategies	Public Information (PI) Strategies	Transportation Operations (TO) Strategies
-Traffic control/design approaches -Traffic control devices -Project coordination, contracting, and innovative construction	-Public awareness -Motorist information	-Demand management -Corridor/network management -WZ safety management -Traffic/incident management & enforcement

- Designers are encouraged to consider these strategies early on in the process for all projects, even if they aren't included in the TMP

TMPs Need to Be…

- Well-thought out
- Started early in project development
- Coordinated with other projects nearby
- Contain a combination of strategies
- Fit the expected level of WZ impacts
- Funded
- Updated as needed after project award
- Implemented!
- Monitored – and adjusted as needed

Identification of TMP Strategies

- Should be based on:
  - project constraints
  - type of work zone
  - anticipated WZ impacts
  - construction phasing/staging plan
- Some agencies use strict lane closure policies/strategies or permissible lane closure times that must be followed
- Agencies may use analysis tools to predict delays, queues, and impacts of detours and compare these for various strategies

Example - MI DOT TMP Template

Table of Contents:

- Executive Summary
- Temporary Traffic Control Plan (TTCP)
- Transportation Operations Plan (TOP)
- Public Information Plan (PIP)
- Delay Calculation Details
- Alternative Traffic Control
- Vicinity Map or Location Diagram

MI DOT TMP Executive Summary

- Basic description - Location, work type
- Specific Project Data:
  - Letting Date
  - Anticipated Project Duration *(Construction Start Date and Completion Date)*
  - Existing Lane Widths
  - Existing Paved Shoulder Widths
  - Existing Aggregate Shoulder Widths
  - Threshold Criteria
    - Which criteria were exceeded ?
    - How was delay calculated?
    - What is the source of traffic volumes?
  - Facility Details (e.g., ADT, lanes)
  - Crash Analysis and Safety Review

How Monitoring WZ Performance Can Help

- Gather data and <u>use it</u>!
  - Understand how work zones are performing
  - Identify issues and correct them
  - Make improvements to enhance performance
- Current work zones
  - Identify issues and address them now!
- Sample of work zones
  - Looks for trends
  - Assess effectiveness of strategies
  - Adjust design standards and WZ policies

Sources of Performance Data

- Lane closure, queue data from project personnel
- Crash reports
- Volume/occupancy data, speed data from existing sensors
- Installing temporary ITS during a project
- TMC data
- Sampling
  - Student interns doing travel time runs, observing queues
  - Rotating trailers with sensors to gather speed data

WZ Performance Measurement Examples

- Current Work Zones
  - New Mexico – incident response, maneuverability issues
  - Queue detection and management
- Sample of Work Zones
  - Ohio – merge areas, ramp back-ups, shoulder widths

Example - New Mexico

- Deployed a WZ ITS system at Big I reconstruct
- System included cameras to:
  - Help identify and quickly clear incidents
  - Monitor flow of traffic and driver behavior

➔ Incident response and clearance time reduced from 45 minutes to 25 minutes – secondary crashes avoided

➔ Saw areas where drivers had difficulty navigating the work zone. Made configuration changes to improve traffic flow (e.g., re-aligned a temporary ramp) - likely crashes avoided

Example - Queue Detection and Management

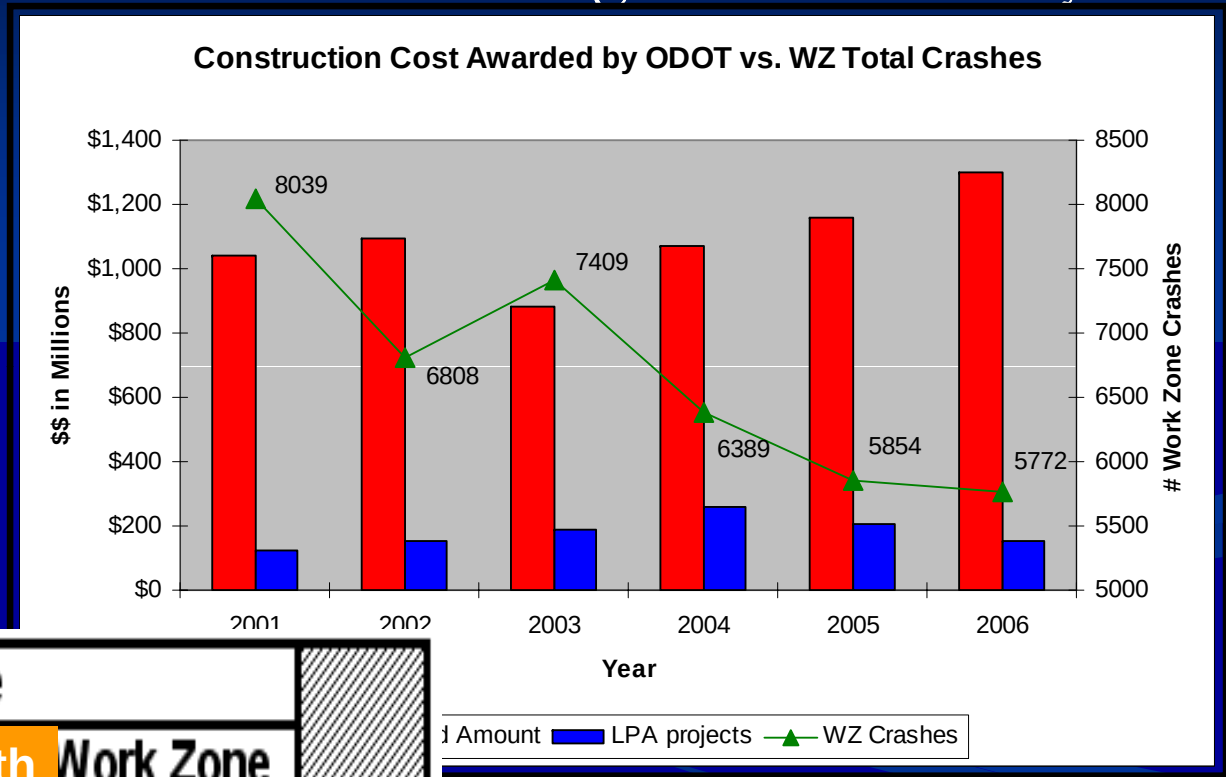
- Monitor performance
- Identify queues that weren't expected
- May lead to some changes in TMP:
  - Providing more info to the public (reduce volumes, alert motorists)
  - Moving advance warning signs further upstream
  - Adding a CMS to alert drivers
  - Adjusting lane closure schedule/work hours
  - Changing law enforcement deployment/positioning

Example - Ohio

- **3 Categories of WZ performance monitoring data in Ohio:**
  - Historic Data (primarily crash)
  - Near Real-time (also crash)
  - Real-time (mobility/speed)

WZ Crash Data in Ohio - Historic

Used by ODOT to assess how it is doing with WZ safety



Year	Crash Rate		
	Before Work Zone	With Work Zone	
2002	1.04	1.68	62%
2003	1.19	2.02	69%
2004	1.34	1.71	28%
2005	1.29	1.23	-5%
2006	1.51	1.51	0%

Crash Rate = Accidents/Million Vehicle Miles

ODOT's Historical WZ Crash Analysis

Work Zone Crash Summary - 2003

County	Route	Project	Begin SLM	End SLM	Length	Begin Month	End Month	Time Period (Days)	2003 Average ADT	Work Zone Crashes	Work Zone Rate	Work Zone Cost	Fatal	Injury	PDO
HAM	0275	32(02)	28.08	32.20	4.12	1	12	348	114,985	429	2.60	$5,500,494	0	83	346
CLE	275	2(02)	4.29	9.79	5.50	1	10	287	69,120	155	1.42	$3,034,793	1	32	122
		172(02)	9.79	13.58	3.79	1	12	358	59,890	255	3.14	$4,633,355	1	61	193
BUT	0075	420(02)	0.00	6.41	6.41	03	12	289	135,463	415	1.65	$6,721,326	0	107	389
HAM	0075	420(02)	15.27	17.40	2.13	03	12	289	140,495	162	1.87	$2,762,640	0	40	184
STA	0077	3008(00)	11.59	12.76	1.17	01	04	127	86,022	37	2.89	$338,094	0	3	34
		467(02)	12.76	14.81	2.05	05	10	180	87,148	79	2.46	$1,233,036	0	22	57
CUY	0480	485(02)	12.61	15.97	3.36	03	9	208	158,802	157	1.41	$2,394,036	0	42	115
MOT	0075	560(01)	18.20	19.79	1.59	01	12	365	98,970	50	0.87	$815,670	0	15	35
		100(03)	19.79	21.41	1.62	03	12	289	94,161	123	2.79	$1,878,714	0	33	90
MED	0071	239(00)	20.40	21.40	1	01	04	122	37,965	12	2.60	$208,872	0	4	8
		239(00)	23.52	24.52	1	03	07	152	48,663	9	1.22	$91,098	0	1	8
RIC	0071	116(01)	18.90	20.40	1.5	04	11	243	40,640	20	1.35	$1,242,209	1	4	15
								3,257		AVE.	2.02	$30,854,337	Ave. Cost / Day $9,473		

Free Flow Comparable

Comp. Crashes	Comp Year	Comp Year ADT	Comp. Rate	Percent Difference	Free Flow Cost	Fatal	Injury	PDO	Cost Difference	Hot Spot	Congested	HSP - I	[illegible]
259	'00	109,353	1.65	58%	########	0	48	211	########	Y	19	52	124
106	'00	78,100	0.86	65%	########	0	33	73	########	Y	242	336	348
115	'00	60,990	1.39	126%	########	1	24	90	########				
312	'02	129,109	1.30	27%	########	0	51	261	########	Y	90	168	11
135	'02	135,303	1.62	16%	########	0	27	108	########				
22	'99	82,379	1.80	61%	$339,228	0	6	16	-$1,134	Y	96	--	187
25	'99	81,604	0.83	196%	########	1	8	16	-$172,685				
101	'02	153,809	0.94	51%	########	0	27	74	$854,550	Y	212	328	143
48	'02	98,670	0.84	4%	$802,710	0	15	33	$12,960	Y	40	507	133
71	'02	92,077	1.65	69%	########	0	24	47	$631,962				
5	'99	40,965	1.00	159%	$97,956	0	2	3	$110,916	N	--	607	424
8	'99	53,250	0.99	23%	$117,396	0	2	6	-$26,298	--	--	--	--
10	'00	42,380	0.65	109%	$195,912	0	4	6	########	N	--	--	--
		AVE.	1.19	[illegible]			[illegible]	1	Ave. Difference $932,488				

WZ Crash Rate=2.02

NON WZ Crash Rate Rate =1.19

ODOT's Historical WZ Crash Analysis

- Drilled deeper into data
- Logged and analyzed hundreds of WZ crashes - looked for "abnormally" high concentrations of crashes
- Analysis showed need for new/revised specifications & processes

ODOT's Historical WZ Crash Analysis

Results –

Geometrics - The "abnormally" high concentrations of crashes showed there were major geometric contributing factors to Ohio's work zone crashes:

(a) Inadequate ramp merges

(b) Inadequate off-ramp capacity

(c) Insufficient paved shoulders

ODOT's Historical WZ Crash Analysis

- **Ramp Merges** – Created new standards for WZ on-ramp merges. Merges are now required to be detailed in plans. (now explicitly looked at in MOTAA)

- **Paved shoulders** – Created "desired/minimum" cross section that requires a 2' paved shoulder (now used in MOTAA and detailed design)

- **Off-Ramp-Capacity** – Now explicitly looked for in Maintenance of Traffic Alternative Analysis (MOTAA)

ODOT's Historical WZ Crash Analysis - Plans -

- Plan to perform historical WZ crash analysis every 2 years seeking additional "lessons learned"
- Policies/standards/specifications will be changed as necessary to keep problems from happening again

For more information on work zone management strategies

www.fhwa.dot.gov/workzones