

Work Zone Performance Measure Pilot Test



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Talking Operations: Work
Zone Performance
Measurement Webinar

May 28, 2009

Objectives

- Identify useful work zone performance measures (WZPMs)
- Demonstrate computation of measures using actual work zone projects
- Document lessons learned, develop guidance

WZPM Requirements

- Based on agency goals and objectives
- Reflect “realities”
- Tied to alternatives available
 - When work should occur
 - How much roadway to use
 - Countermeasure strategies employed
- Requires a “suite” of measures

Exposure Measures

- Volumes, VMTs by time period
 - Active, inactive work hours
 - During hours of lane closures
- Work characteristics
 - Hours of work activity
 - % of available time used for work activities

Capacity Loss Measures

- Duration and magnitude of losses
 - Hours by number of lanes closed
 - % of time (total, work activity periods)
- Lane-mile-hours lost



Delay Measures

- Veh-hours of total delay
 - By time period (peak, off-peak, night, during lane closures)
- Delay per vehicle
 - by time period
 - % of vehicles exceeding threshold



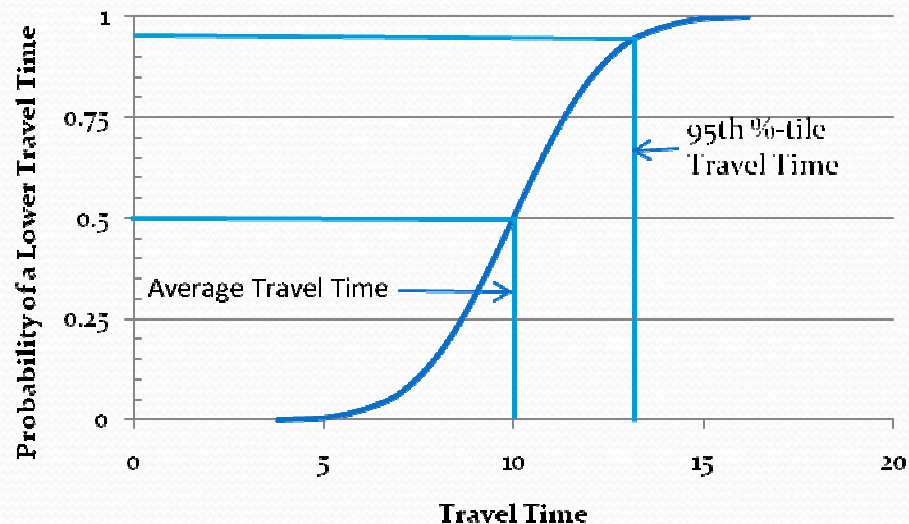
Queue Measures

- Frequency
- Duration
- Averages and maximums
- % of time queues exceed defined thresholds



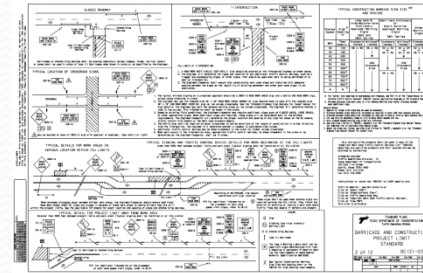
Travel Time Reliability Measures

- Buffer Index for affected time periods
- Change in Buffer Index relative to pre-work zone conditions



Possible Sources of Data

- Project information
- Traffic sensor data
- Field personnel documentation

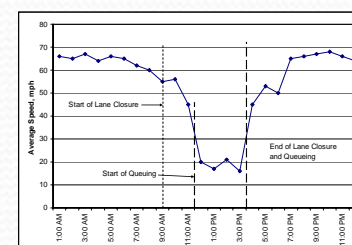
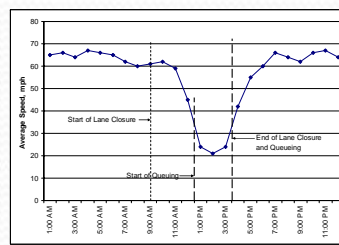
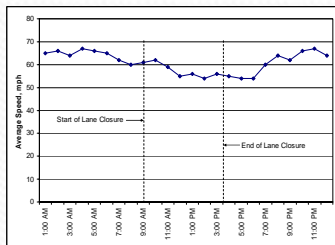


Project Information

- Traffic control plan (long-term capacity losses)
- Project limits
- Dates of phase changes
- Daily project diary information
 - Hours, direction of work activity
 - Lanes temporarily closed
 - Length of lane closures

Traffic Sensor Data

- Measure speeds, volumes, occupancies
- Estimate travel times
- Estimate queues



Traffic Probe Data

- Measure travel times
- Estimate queue presence, length
- Combine with historical or estimated volume data



Data Collected via Field Crew

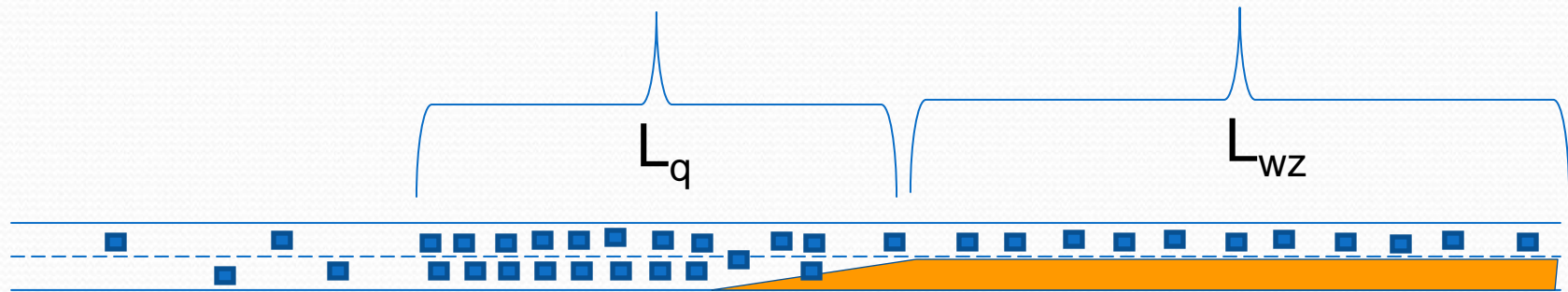
- Document onset, dissipation of queues
- Periodically document queue length
- Estimate delay
- Combine with historical or estimated volume data

Delay Estimation

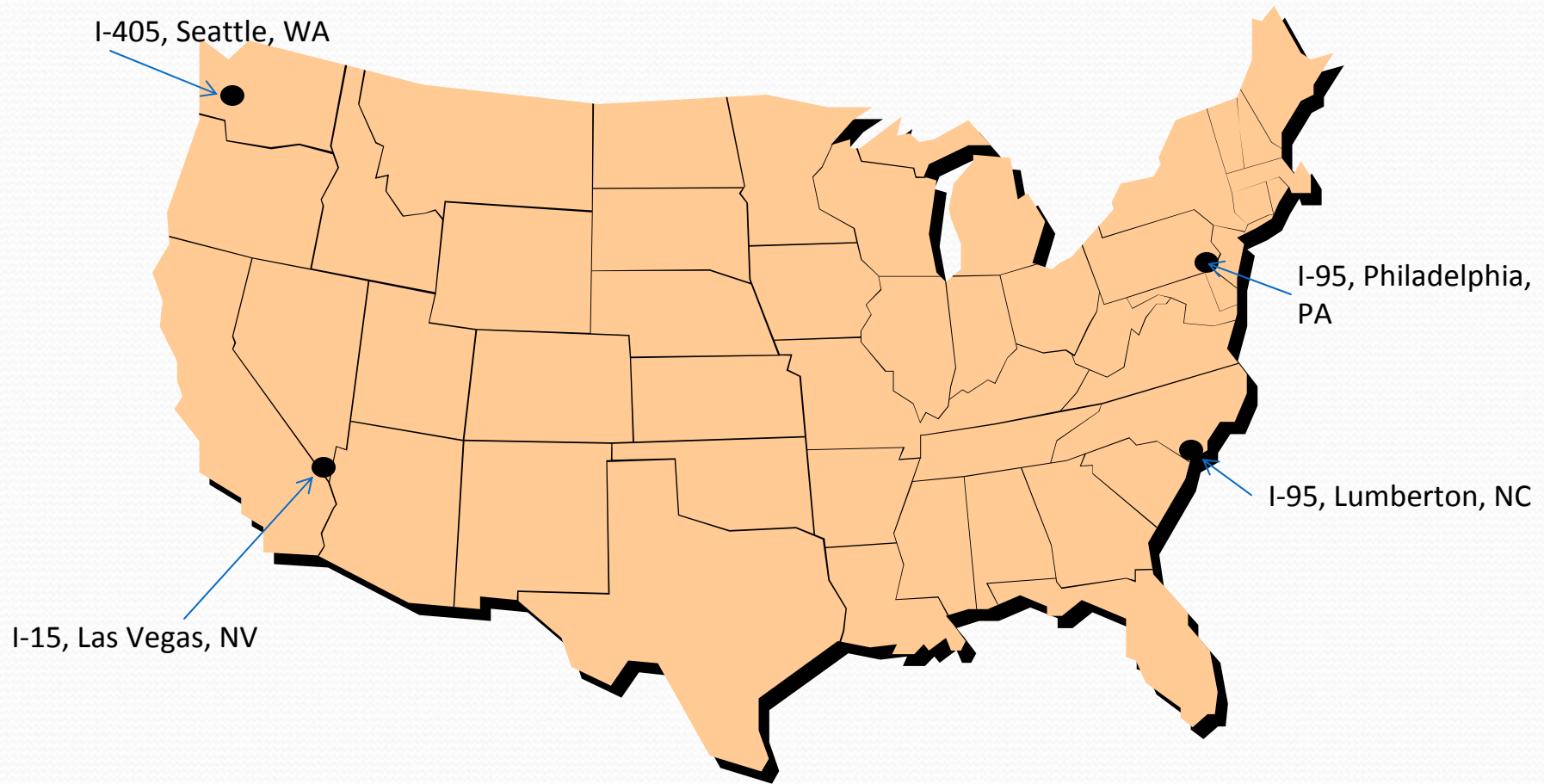
Average Speed in Queue

$$\left(\frac{U_f}{2} \right) \left(1 - \left(1 - \frac{WZ \text{ Capacity}}{\text{Normal Capacity}} \right)^{\frac{1}{2}} \right)$$

Speed at Capacity Flow
($U_f/2$)



Pilot Test Locations



Exposure Measure Results

Measure	I-95, Philadelphia	I-95, Lumberton	I-405, Seattle	I-15, Las Vegas
Days (nights) of work	30	31	47	139
% of available days (nights) used	56%	47%	51%	100%
% of available hours used	53%	44%	49%	n/a
% of work hours with:				
1 lane closed per dir	3%	100%	10%	100%
2 lanes closed per dir	94%		20%	
3 lanes closed per dir	3%		42%	
Lane-mile-hours closed	1,980	290	6,164	6,672
Vehicles through In closures	493,011	347,941	1,445,861	TBD
% ADT through closures	6-10%	25%	11%	100%
VMT through closures	1,429,863	680,006	5,527,529	TBD

Mobility Impacts – I-95 NB, Philadelphia

Measure	Field Crew	Traffic Sensor
Nights of work activity with queuing (%)	77	78
Ave duration of queue per night (hr)	2.7	1.6
Ave length of queue when present (mi)	0.6	2.7
Max length of queue during project (mi)	2.6	5.9
% nights when queue > 1 mi	14.7	20.0
% nights when queue > 2 mi	3.2	20.0
% veh through work zone that are queued	53	52
Ave delay per veh entering queue (min)	0.4	0.7
Max delay per veh entering queue (min)	2.7	6.8
Total delay during work (veh-hrs)	529	1,594

Mobility Impacts – I-405 SB, Seattle

Measure	Field Crew	Traffic Sensor
Nights of work activity with queuing (%)	81	51
Ave duration of queue per night (hr)	2.1	1.1
Ave length of queue when present (mi)	1.0	0.7
Max length of queue during project (mi)	4.0	1.4
% nights when queue > 1 mi	17.1	1.2
% nights when queue > 2 mi	11.8	0.0
% veh through work zone that are queued	23	12
Ave delay per veh entering queue (min)	1.5	1.0
Max delay per veh entering queue (min)	5.9	2.1
Total delay during work (veh-hrs)	3,569	1,290

Mobility Impacts – I-95 SB, Lumberton (8/4/2009)

Measure	Field Crew	Truck Probe
Duration of queue (hr)	5.5	4.0
Ave length of queue when present (mi)	1.2	2.8
Max length of queue (mi)	2.0	4.0
% veh through work zone that are queued	47	34
Ave delay per veh entering queue (min)	11.1	9.7
Max delay per veh entering queue (min)	18.2	13.6
Total delay during work (veh-hrs)	1,506	944

Average Speeds in Queue

Location	Via Traffic Flow Theory Estimate ^a	Via Traffic Sensor Measurement	Via Travel Time Study
I-95, Lumberton	6-30 mph	14-23 mph	9-29 mph
I-95, Philadelphia	6-35 mph	17-36 mph	6-13 mph
I-405, Seattle	6-35 mph	20-30 mph	12-33 mph

^a Lower value assumes queue extends upstream of lane closure across all regular lanes; upper value assumes queue occurs entirely within queue (speed at capacity flow)

Travel Time Reliability Impacts - I-15 SB, Las Vegas

Time Period	Before (Oct 1-19)	During Ph 1 (Oct 20-Jan 23)	During Ph 2 (Feb 2009)
AM Peak:			
Average TT(min)	6.2	8.4	6.7
95%-tile TT(min)	13.7	14.3	9.4
Buffer Index (%)	119.4	70.1	39.9
Mid-day:			
Average TT(min)	5.1	9.0	6.9
95%-tile TT(min)	6.2	16.2	11.7
Buffer Index (%)	20.3	79.5	70.0
PM Peak:			
Average TT(min)	5.4	13.2	8.6
95%-tile TT(min)	7.3	15.0	12.3
Buffer Index(%)	34.6	13.7	43.7

Key Findings, Lessons Learned

- Methods do exist to monitor wz performance
 - Project files
 - Field crews
 - Traffic surveillance technologies
- Several measures are needed
 - Exposure
 - Delay
 - Queues

Findings, Lessons (cont'd)

- Measures should be defined relative to agency goals, objectives, policies
- Congestion can occur even when estimated demand < estimated work zone capacity
 - Demand fluctuates daily, hourly
 - Demand estimate accuracy can vary
 - Work zone capacity estimate accuracy can vary

Findings, Lessons (cont'd)

- Field crew data
 - Consistency in queue documentation is critical
 - Queue location documentation (upstream, within) is important
- Traffic sensor data
 - Longer spacing or non-functioning sensors create greater queue estimation errors
 - Erroneous results can occur if sensors do not extend beyond limits of congestion