### **WORK ZONE DELAY ESTIMATION**

Work Zone Management, Accelerated Construction, and Smart Work Zones

TEAM Monthly Meeting November 16, 2004 Luis Porrello, Ph.D., P.E. – HNTB Corporation Tom Ryan, P.E. - MoDOT

## TOPICS

- FHWA directive
- QuickZone background, functions, requirements, and methodology
- TxDOT accelerated construction and A+B bidding
- IH-410 project, QuickZone model development and preliminary results
- Other QuickZone case studies and further enhancements
- Smart Work Zones

## **FHWA DIRECTIVE**

- The "soft cost" of traveler delay is typically not considered when key decisions about project staging and duration are made.
- FHWA recommendation to develop an analytical tool to estimate and quantify work zone delays.



Meeting the Customer's Needs for Mobility and Safety During Construction and Maintenance Operations



Office of Program Quality Coordination HPQ = 58 + 1

September 1798



- Work Zone Delay Impact Analysis Tool
  - FHWA-sponsored
  - Developed by Mitretek Systems
  - Available for purchase at McTrans or PCTrans (\$195)
- Microsoft Excel-based Application
- Open Source Code
- Targeted at State and Local Traffic Construction Staff, Operations and Planning, and Construction Contractors

# **QuickZone FUNCTIONS**



- **Quantifies** corridor delay resulting from capacity decreases in work zones
- **Identifies** delay impacts of alternative construction phasing plans
- Supports Trade-Off Analyses between construction costs and delay costs
- Considers Alternate Phasing Schedules:
  - Time-of-day (peak vs. off-peak)
  - Season (summer vs. winter)
- Assesses Impacts of Delay Mitigation Strategies:
  - E.g., Variable message sign deployments
  - Signal retiming on detour routes

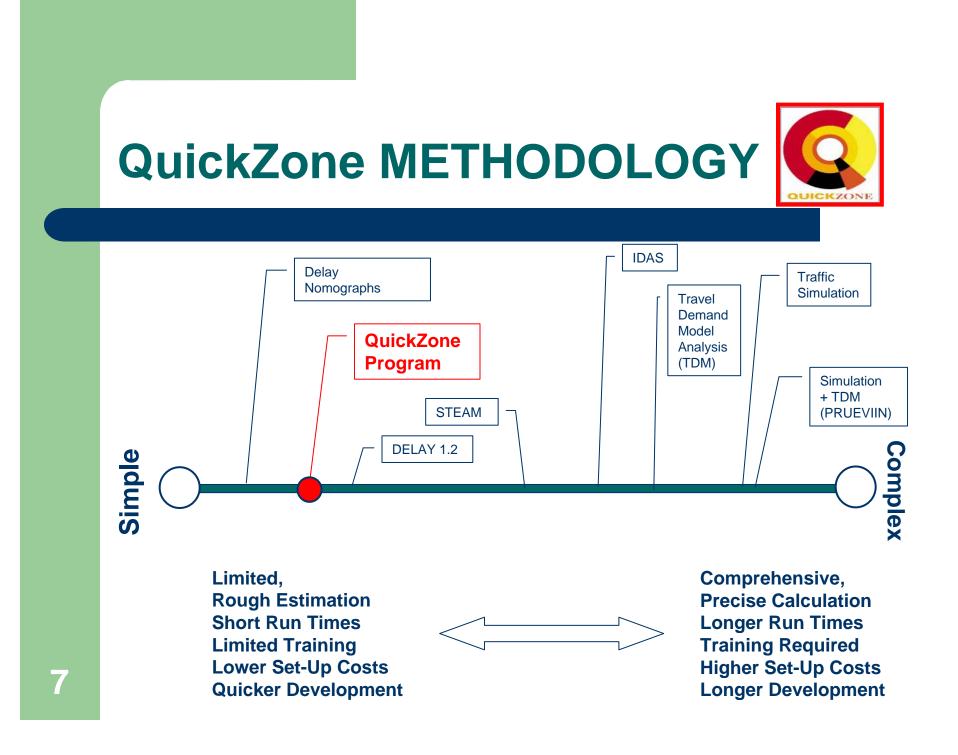
# QuickZone REQUIREMENTS

#### • Network

- Links & Nodes
- Link Characteristics
- Demand Characteristics
  - At minimum: AADT and some distribution of hourly demand

QUICKZON

- Hourly Counts
- Seasonality
- Capacity
  - Normal Conditions
  - Work Zone Conditions



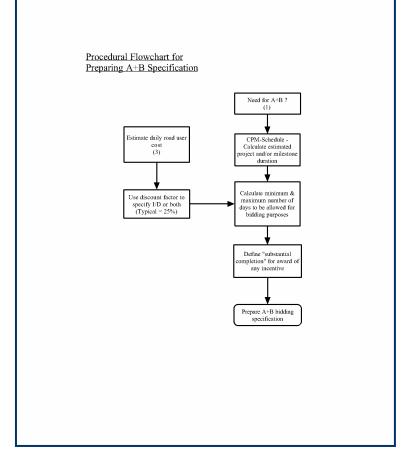
### TXDOT ACCELERATED CONSTRUCTION

- A+B Provisions. Consider for large and or highly critical projects where early completion should be a consideration for award.
- Milestones with Incentives/Disincentives. Identify specific project phases that have a significant impact on traffic or business.



## **A+B BIDDING**

- Incentive for early completion up to cap (number of days).
- Contractor's duration becomes CPM.
- Disincentive for late delivery, no cap.
- Contractor's rule of thumb: 5% of total cost to be "worth it"

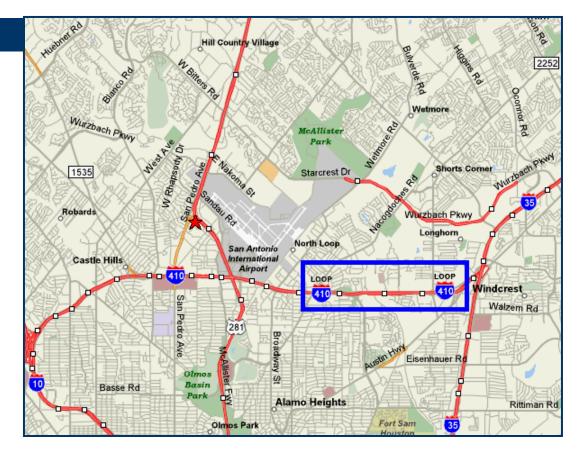


### **A+B BIDDING**

Bidder	"A+B" Cost	"A" Cost	"B" Days	RUC Rate \$/Day	Total "B"
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CONTRACTOR A	\$198,568,662.01	\$154,717,662.01	933	\$47,000	\$43,851,000.00
CONTRACTOR B	\$213,023,330.91	\$147,975,330.91	1,384	\$47,000	\$65,048,000.00
CONTRACTOR C	\$227,386,257.93	\$183,488,257.93	934	\$47,000	\$43,898,000.00
CONTRACTOR D	\$231,579,868.49	\$180,349,868.49	1,090	\$47,000	\$51,230,000.00
CONTRACTOR E	\$249,632,889.62	\$177,534,889.62	1,534	\$47,000	\$72,098,000.00

## **IH-410 WIDENING**

- Widening of IH-410 in San Antonio from Nacagoches Road to Perrin-Beitel Road.
- 6 Lanes to 8 Lanes
- 2003 ADT = 150,000
- Approximately \$70 Million



 Frequently noted shortcoming with QuickZone:
 Coding Large Networks (More on this later)

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- Links
- AADT Patterns
- Demand
- Seasonality
- Project Information
- Phasing Information
- Delay Cost
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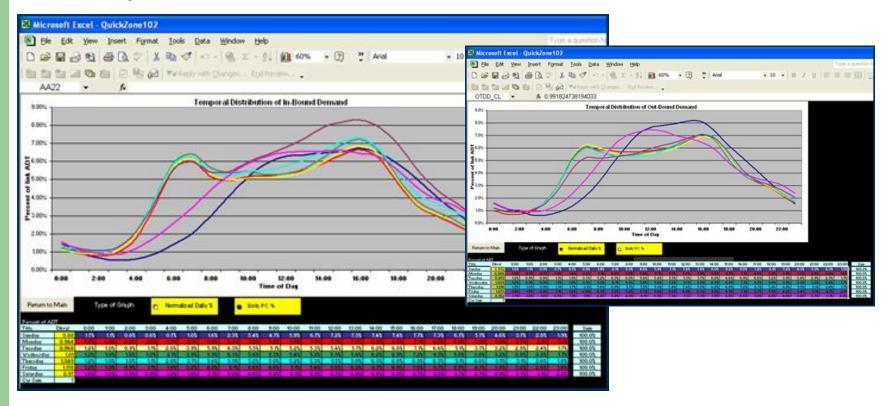
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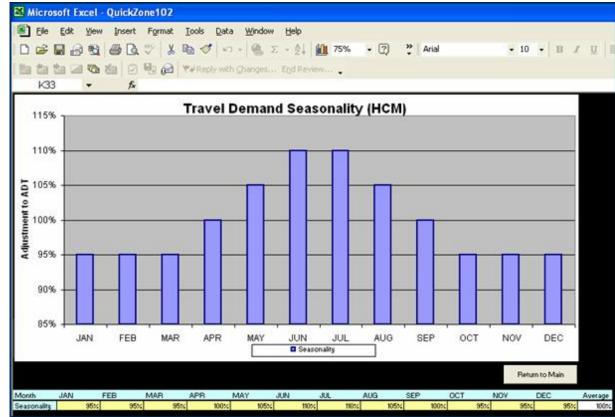
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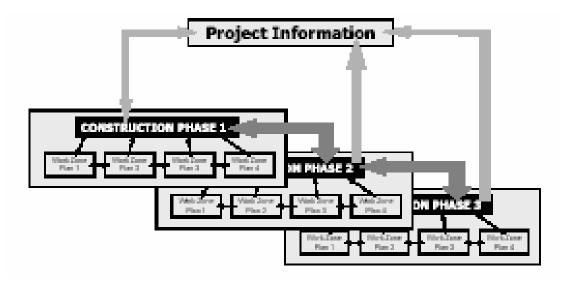
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1 2 3 4 5 6 7 8 8 9 10 11 12		76239 65856 55856 73376 62763 62163 62163 67212 59567 59597 63029 47784	1114 962 962 1072 908 908 908 908 908 908 908 908 908 908	724 626 628 697 697 591 591 639 597 599 507 599 454	500 435 435 434 464 450 450 450 450 450 387 387 387 387 387 385	416 359 359 400 400 309 309 367 320 320 320 320 320 324 4 261	456 394 439 439 372 372 402 351 351 351 377 286	671 573 573 546 646 547 547 547 547 547 547 545 545 555 555	1007 933 933 1046 1046 806 806 806 806 808 958 835 835 835 835 835 835 835	1550 1339 1339 1491 1491 1263 1263 1263 1368 1391 1991 1201 971	2274 1964 2189 2189 1054 1054 1054 1055 1747 1747 1080 1425	3133 2706 2708 3015 2554 2554 2554 2762 2407 2407 2590 1963	2924 3390 3390 2777 3777 3200 3200 3460 3096 3096 3244 2460	4508 3894 3894 4338 4338 4338 3676 3676 3676 3976 3977 3464 3464 3464 3727 2825	4803 4149 4149 4623 4623 3916 4623 3916 4234 3639 3639 3639 3639 3639 3639 3639 36	4863 4201 4201 4681 3965 3965 4287 3737 3737 3737 4021 3048	4937 4265 4265 4752 4752 4026 4026 4026 4026 3754 3754 2754 4012 3054	41 42 43 48 48 40 40 40 40 40 40 40 40 40 40 40 40 40
1 2 3 4 5 6 7 8 3 10 11		76239 65856 55856 73376 62363 6236 62363 62363 62363 62363 62363 62363 62363 62363 62363 62363 62363 62363 62363 62363 62363 62363 62363 6236 626 62	1114 962 962 1072 908 908 908 908 908 908 908 908 982 876 956 956 956 956 956 956 956 956 956 95	724 626 626 637 637 531 531 531 533 535 557 557 538 454 454	500 435 435 434 484 40 410 440 440 440 440 440 440 440 446 387 387 446 375 375	416 359 359 400 309 339 367 320 320 320 320 344 261 261	456 394 439 439 372 372 402 351 355 355 377 2266 286	671 579 573 646 646 547 547 591 591 595 555	1007 933 933 1046 1046 806 806 806 806 806 806 805 835 835 835 835 835 835 835 835 835 83	1550 1339 1339 1491 1491 1263 1263 1265 1366 131 1365 131 131	2274 1964 1964 2189 2189 1054 1054 1054 1054 2005 1747 1747 1747 1747 1949 1425 1425	3133 2706 2706 3085 3085 2554 2554 2554 2762 2407 2407 2590 1963 1963	3924           3390           3330           3777           3777           3200           3200           3260           3096           3096           3244           2460           2460	4508 3894 4338 4338 4338 3676 3676 3676 3976 3464 3464 3464 3727 2825 2825	4803 4149 4149 4623 3996 3996 4234 3699 3699 3699 3699 3699 3699 3699 36	4863 4201 4201 4681 3965 3965 4287 3737 3737 4021 3048 3048	4937 4265 4265 4752 4752 4026 4026 4026 4026 4052 3734 2734 2734 2734 3034 3034	15: 49 43 43 49 40 40 40 40 40 40 40 40 40 40 40 40 40
1 2 3 4 5 6 7 8 3 10 11 12 13		76239 65856 55856 73376 62763 62163 62163 67212 59567 58587 58587 63029 47784	1114 962 962 1072 908 908 908 908 908 908 908 908 908 908	724 626 626 637 531 531 531 531 531 531 531 531 531 531	500 435 435 484 484 484 480 440 440 440 444 387 387 387 387 387 387 387 385 385 383	416 359 359 400 400 309 309 367 320 320 320 320 320 324 4 261	456 394 439 439 372 372 402 351 351 351 377 286	671 573 573 546 646 547 547 547 547 531 515 515 515 515 555 420 420	1007 933 933 1046 1046 806 806 806 806 808 958 835 835 835 835 835 835 835	1550 1339 1339 1491 1491 1263 1263 1263 1368 1991 1201 971 971	22774 1964 1964 2189 2189 1054 1054 1054 1054 1054 1054 10747 1747 1747 1747 1090 1425 1425 1642	3133 2706 2708 3015 2554 2554 2554 2762 2407 2407 2590 1963	2924 3390 3390 2777 3777 3200 3200 3460 3096 3096 3244 2460	4508 3894 3894 4338 4338 4338 3676 3676 3676 3976 3977 3464 3464 3464 3727 2825	4803 4149 4149 4623 4623 3916 4623 3916 4234 3639 3639 3639 3639 3639 3639 3639 36	4863 4201 4201 4681 3965 3965 4287 3737 3737 3737 4021 3048	4937 4265 4265 4752 4752 4026 4026 4026 4026 3754 3754 2754 4012 3054	41 42 43 48 48 40 40 40 40 40 40 40 40 40 40 40 40 40
1 2 3 4 5 6 7 8 9 10 11 12 13 14		76229 65856 65856 73376 62963 62963 67212 58567 58567 58567 58567 63029 47794 47794	1114 962 962 962 1072 908 908 908 908 908 908 908 908 908 908	724 626 626 637 637 531 531 531 539 557 557 539 454 454	500 435 435 434 484 40 410 440 440 440 440 440 440 440 446 387 387 446 375 375	416 359 359 400 309 339 367 320 320 320 320 320 320 320 320 320 320	456 394 394 439 372 372 402 351 351 351 351 351 351 351 351 256 286 329	671 579 579 546 646 547 547 591 595 595 595 595 595 420 420 484	1087 903 939 939 1046 886 886 958 835 835 835 835 835 835 835 835 835 8	1550 1339 1339 1491 1263 1263 1263 1366 1391 1366 1391 1391 1297 1397 1397 1971 1779	2274 1964 1964 2189 2189 1054 1054 1054 1054 2005 1747 1747 1747 1747 1949 1425 1425	3133 2706 2706 3015 2554 2554 2554 2554 2554 2762 2407 2407 2407 250 2407 2553 1963 1963 2261	2924 3390 3390 3777 3777 3200 3200 3460 3096 3096 3096 3096 3244 2460 2460 2460	4500 3894 3894 4338 4338 3676 3676 3676 3676 3676 3676 3676 3	4803 4149 4149 4623 3996 3996 4234 3699 3699 3699 3699 3699 3699 3000 3000	4863 4201 4201 4681 3965 3965 4287 3737 3737 4021 3048 3048 3511	4937 4265 4265 4752 4752 4026 4026 4026 4026 4052 3734 2734 2734 3034 3034 3034	41 43 48 48 40 40 40 44 38 38 38 38 38 38 38 38 38 38 38 38 38
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15		76229 65856 65856 73376 73376 62163 62163 62163 67212 58587 58587 63069 47784 47784 47784 55036 76239	1114 962 962 1072 908 908 908 908 908 908 908 908 908 908	724 626 628 637 637 531 531 531 531 533 557 556 557 556 454 454 523 724	500 435 435 444 484 490 440 440 440 444 387 387 387 387 387 387 387 387 387 387	416 359 359 400 400 339 339 367 320 320 320 320 320 320 320 320 320 320	456 394 394 439 372 372 402 351 351 351 351 351 351 351 351 353 353	671 579 573 646 645 547 547 531 547 531 515 555 420 420 420 420 484 671	1007 503 503 503 5046 1046 806 806 806 805 805 805 805 805 805 805 805	1550 1339 1339 1481 1481 1260 1260 1260 1260 1260 1266 1391 1591 1201 1397 1591 1201 1771 1779 1771 1779 1750	2274 1964 1964 2189 2189 1054 1054 1054 1054 1054 1054 10747 1047 1047 1047 1047 1047 1047 1047 1047 1047 1054 1055 10566 1056 1056 1056 1056 1056 1056 1056 1056 1056 1056	3033 2706 2708 3005 2554 2554 2762 2407 2407 2407 2590 1963 3963 3963 2281 3133	2524 3390 3390 3777 3200 3200 3200 3460 3096 3244 2460 2440 2460 2463 3392 4	4500 3894 3894 4338 4338 4338 3876 3876 3876 3876 3876 3876 3876 3	4803 4145 4145 4149 4623 3916 4623 3916 4234 3639 3916 3916 3939 3939 3939 3939 3939	4063 4201 4201 4661 2965 3965 3965 4287 3737 3737 3737 3737 3048 3048 3048 3048 3511 4663	4937 4265 4265 4752 4026 4026 4026 4026 4026 23794 2794 4082 3094 3094 3094 3094 3094 3094	44 44 43 44 44 44 44 44 44 33 33 33 33 3

#### • Travel demand seasonality



#### • Project Information Module



#### • Project information

Project Desrciption	DH 410 Widening - Nacogdoches to Pervin Beitel
Project Start Date	Year Month Sunday of the week 2006 • Aug • 6 •
Project Duration	162 Weeks •
Aug	Project Timeline 6 2006 Sep 13 2009
Yearly Capacity Decrease	1 % Yearly Demand Increase 3 %

#### • Sequencing plan

CAPACITY REDUCTION FOR RESTRICTED LANE WIDTH AND LATERAL CLEARANCE							
		CAPACITY					
ADJUSTMENT CODE	TYPICAL SECTION	<b>REDUCTION</b> <sup>1</sup>					
AC-1	10-12-12-12-10	0					
AC-2	1-12-12-12-10	129					
AC-3	1-12-12-12-1	259					
AC-4	10-10-11-10-10	588					
AC-5	1-10-11-10-10	682					
AC-6	1-10-11-10-1	987					

AC-5				
SLD	LN#1	LN#2	LN#3	SLD
<u>AC-5</u> SLD 1'	10'	11'	10'	10'

LN#1 - No Reduction = 0.860
LN#2 - No Reduction = $0.950$
<u>LN#3 - No Reduction = 0.900</u>
Capacity Reduction = 682

#### IH 410 IMPROVEMENTS – NACOGDOCHES RD TO AUSTIN HWY CSJ 0521-04-187

#### OUTLINE SEQUENCE OF CONSTRUCTION November 2004

#### I. Phase 1

Shift EB and WB mainlane traffic to the outsides using 10<sup>°</sup>-11<sup>°</sup>-10<sup>°</sup> lane widths to allow construction of temporary shoulder pavement and construction of the median throughout the length of the project. Do not shift traffic until Phase 1 Stage 1 is complete.

#### A. Phase 1 Stage 1

- 1. Main Lanes
- a) Close and reconstruct WBML outside shoulder with temporary pavement near sta. 1011+00 to east project limit.

#### 2. Frontage Roads

- a) Construct the various EB and WB frontage road widenings as shown in the plans.
- b) Construct the WBFR low water crossing under traffic.
- c) Construct the EBFR bridge over Salado Creek and approaches. Build proposed structure in two stages to avoid breaking back the existing structure.

#### 3. Ramps

a) Keep existing WB ramps open during shoulder reconstruction. Widen ramp if needed to maintain taper in Phase 1 Stage 2.

#### B. Phase 1 Stage 2

- 1. Main Lanes
  - a) Shift traffic to Phase 1 configuration.
  - b) Construct temporary median pavement near sta. 905+00 to 917+00.
  - c) Construct permanent median pavement near sta. 917+00 to 930+00.
    d) Construct permanent median pavement with SSCB near sta. 930+00 to 968+00.
- e) Construct permanent median pavement with SSCB near sta. 930+00 to 9
   e) Construct temporary median pavement near sta. 968+00 to 987+00.
- construct temporary median pavement near sta. 968+00 to 987+00.
   f) Construct permanent median pavement near sta. 987+00 to 999+00.
- g) Construct permanent median pavement near sta. 987+00 to 999+00.
   g) Construct temporary median pavement near sta. 999+00 to 1011+00
- h) Construct permanent median pavement near sta. 1011+00 to 1034+00.
- i) Construct temporary median pavement near sta. 1034+00 to east limit.

#### 2. Frontage Roads

 a) Close the existing EBFR bridge over Salado Creek and divert traffic to the newly constructed bridge, one-lane phased structure.

1 of 8

3. Ramps

#### 4. Starcrest Underpass Bridge

410SequenceOfWork102004

11/16/04

#### • Sequencing plan

Phase 1 Stage 2

Begin Date: 4

		ADJUSTMENT	CAPACITY
	QUICKZONE LINK	CODE	DECREASE
	1	AC-2	129
	2	AC-5	682
	3	AC-5	682
	4	AC-5	682
	5	AC-5	682
	6	AC-5	682
NBOUND WORKZONE	7	AC-5	682
LINKS	8	AC-5	682
	9	AC-5	682
	10	AC-5	682
	11	AC-5	682
	12	AC-5	682
	13	AC-5	682
	14	AC-4	588
	24	AC-5	682
	25	AC-5	682
	26	AC-5	682
	27	AC-5	682
	28	AC-5	682
	29	AC-5	682
OUTBOUND	30	AC-5	682
WORKZONE LINKS	31	AC-5	682
	32	AC-5	682
	33	AC-5	682
	34	AC-5	682
	35	AC-5	682
	36	AC-5	682
	37	AC-4	588

#### • Sequencing plan

Const	ruction phases					X
		Constructi	on Phase 1	10		
F	Phase Description	Phase 5 - Stage	∋ 1			
	Duration	18	Weeks	•		
		Mar 22 2009	- Jul 26 20	09		
1	nfrastructure Cost	6	 Millions(\$)	L		
		Workzone F	Plan Editor			
_ <i>□</i> <sup>V</sup>	Vorkzone Plan Layo					
	Name of Plan	Starting Day	/+lime	Ending Da	y + Time	
1	Phase 5 - Stage 1	Sunday	0:00	Saturday	23:00	
2	N/A					
3	N/A					
4	N/A					
5	N/A					
6	N/A					
7	N/A					
	<<<	Close Cons	truction Phase Dal	ta	>>>	

#### • Phase descriptions, capacity reductions

Phase 10:Workzone Plan 1 of 7	Phase 10-Workzons Plan 1 of 7
Workzone Information       Workzone Plan Information         Workzone Plan       Phase 5 - Stage 1         Description       Workzone Start Time         Workzone Start Time       Workzone End Time         Sunday       0:00       Saturday       23:00	Workzone Information Workzone Links Mitigation Strategies Travel Behavior
Return To Phases >>>	Return To Phases

#### • Delay cost parameters

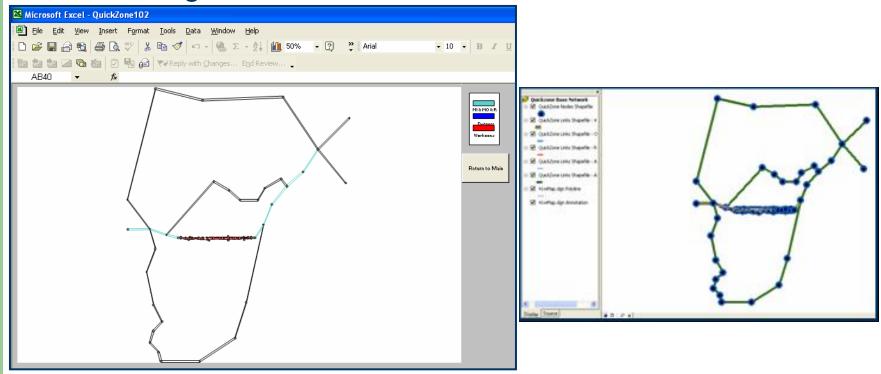
- CPI-adjusted delay costs
- OMB inflation rate projections

)e	lay Cost Paraments			×
	— Hourly Delay Costs Parameters —			
	Delay Cost per Car Hour	18.19	Dollars	
	Delay Cost per Truck Hour	24.50	Dollars	
	Amortization parameters			
	Amortized Period (Improvement Lifespan)	10	Years	
	Inflation Rate	2.30	%	
			Return to Mair	<u>_</u>

#### • Program controls

QuickZone 1.1
V1.1 OUICKZONE DELAY ESTIMATION TOOL
Input Data Program Controls Output Data Open/Save
Generate Network
Calculate Phase Data
Exit Quickzone

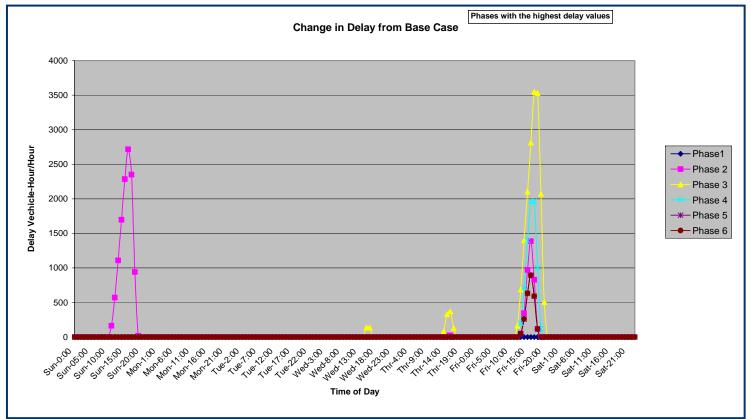
#### • Network generation



#### • Output data

QuickZone 1.1	×
	V1.1 ELAY ESTIMATION TOOL
Input Data Program Controls	Soutput Data Open/Save
Delay Graph Costing Graph	
Travel Summary Behavior Table	
	Exit Quickzone

#### • Delay graph



#### • Summary of results

- Unidirectional or both
- Baseline (recurring)
- After (work zone)
- Sum

Summary Form	
Direction	Case
	Baseline
C Outbound	C After
<ul> <li>Both</li> </ul>	C Sum
	ОК

#### • Summary of results - baseline

IH 410 Widening - Nacogdoches to Perrin Beitel Baseline Data																
Option Form	Option Form Queue-Both Delay-Both						Phase Travel Behavior (Weekly Inbound + Outbound)					Cost (millions \$)-Both				
Title	– Weekly Max (mi)	Weekly Total (mi)	Weekly User Max (min)	Weekly Total (VH)	Phase Total 1000 (VH)	Take Detour (V)	1 HR Shifting	Cancel Trip (V)	Mode Shift (V)	Infrastructure	Car	Delay Trucks	Total			
Phase 1 - Stage 1	2.41	10.5	21.3	7889	71	0	0	0	0	3	1.29	0.13	1.42			
Phase 1 - Stage 1	2.41	10.5	21.3	7889		Ŭ	Ũ	Ŭ	Ū	Ŭ		0.1.0				
Phase 1 - Stage 2	0.42	0.8	2.7	570.6	10.3	0	0	0	0	5	0.19	0.02	0.21			
Phase 1 - Stage 2	0.42	0.8	2.7	570.6												
Phase 2 - Stage 1	3.23	17.6	30.6	13213.8	476	0	0	0	0	12	8.65	0.88	9.53			
Phase 2 - Stage 1	3.23	17.6	30.6	13213.8												
Phase 2 - Stage 2	0.42	0.8	2.7	570.6	2.3	0	0	0	0	4	0.04	0	0.05			
Phase 2 - Stage 2	0.42	0.8	2.7	570.6												
Phase 2 - Stage 3	0.42	0.8	2.7	570.6	2.3	0	0	0	0	4	0.04	0	0.05			
Phase 2 - Stage 3	0.42	0.8	2.7	570.6												
Phase 2 - Stage 4	0.42	0.8	2.7	570.6	2.3	0	0	0	0	3	0.04	0	0.05			
Phase 2 - Stage 4	0.42	0.8	2.7	570.6												
Phase 3 - Stage 1	2.41	10.5	21.3	7889	174	0	0	0	0	8	3.16	0.32	3.48			
Phase 3 - Stage 1	2.41	10.5	21.3	7889												
Phase 4 - Stage 1	2.41	10.5	21.3	7889	284	0	0	0	0	15	5.17	0.52	5.69			
Phase 4 - Stage 1	2.41	10.5	21.3	7889												
Phase 4 - Stage 2	0.42	0.8	2.7	570.6	2.3	0	0	0	0	6	0.04	0	0.05			
Phase 4 - Stage 2	0.42	0.8	2.7	570.6												
Phase 5 - Stage 1	4.38	29	43.7	21752.5	392	0	0	0	0	6	7.12	0.72	7.84			
Phase 5 - Stage 1	4.38	29	43.7	21752.5												
Phase 5 - Stage 2	6.54	52.5	66.1	39355.3	157	0	0	0	0	4	2.86	0.29	3.15			
Phase 5 - Stage 2	6.54	52.5	66.1	39355.3												
										70	28.6	2.88	31.52			

#### • Summary of results – work zone

IH 410 Widening - Nacogdoches to Perrin Beitel After Data															
Option Form	m Queue-Both Delay-Both						Phase Travel Behavior (Weekly Inbound + Outbound)					Cost (millions \$)-Both			
	Weekly	Weekly	Weekly	Weekly	Phase	Take	1 HR	Cancel	Mode			Delay			
Title	Max (mi)	Total (mi)	User Max (min)	Total (VH)	Total 1000 (VH)	Detour (V)	Shifting	Trip (V)	Shift (V)	Infrastructure	Car	Trucks	Total		
Phase 1 - Stage 1	0	0	0	0	0	0	0	0	0	3	0	0	0		
Phase 1 - Stage 1	0	0	0	0											
Phase 1 - Stage 2	3.81	20.8	32.4	15598.5	281	0	0	0	0	5	5.11	0.52	5.63		
Phase 1 - Stage 2	3.81	20.8	32.4	15598.5							1	1			
Phase 2 - Stage 1	5.23	24	33.4	18025.6	649	0	0	0	0	12	11.8	1.2	13		
Phase 2 - Stage 1	5.23	24	33.4	18025.6											
Phase 2 - Stage 2	2.89	9.8	18.4	7361.4	29.4	0	0	0	0	4	0.54	0.05	0.59		
Phase 2 - Stage 2	2.89	9.8	18.4	7361.4											
Phase 2 - Stage 3	1.26	3.4	8.1	2545.7	10.2	0	0	0	0	4	0.19	0.02	0.2		
Phase 2 - Stage 3	1.26	3.4	8.1	2545.7											
Phase 2 - Stage 4	1.26	3.4	8.1	2545.7	10.2	0	0	0	0	3	0.19	0.02	0.2		
Phase 2 - Stage 4	1.26	3.4	8.1	2545.7											
Phase 3 - Stage 1	4.89	20.1	31.2	15057	331	0	0	0	0	8	6.03	0.61	6.64		
Phase 3 - Stage 1	4.89	20.1	31.2	15057											
Phase 4 - Stage 1	4.89	27.5	42.3	20648	743	0	0	0	0	15	13.52	1.37	14.89		
Phase 4 - Stage 1	4.89	27.5	42.3	20648											
Phase 4 - Stage 2	2.89	12.5	23.9	9379.1	37.5	0	0	0	0	6	0.68	0.07	0.75		
Phase 4 - Stage 2	2.89	12.5	23.9	9379.1											
Phase 5 - Stage 1	2.95	12.5	18.8	9399.8	169	0	0	0	0	6	3.08	0.31	3.39		
Phase 5 - Stage 1	2.95	12.5	18.8	9399.8											
Phase 5 - Stage 2	6.98	45.6	44.6	34221.5	137	0	0	0	0	4	2.49	0.25	2.74		
Phase 5 - Stage 2	6.98	45.6	44.6	34221.5											
	•		•							70	43.63	4.42	48.03		

### **ROAD USER COST REPORT**

<sup>(1)</sup>Incentive

/Disincentive

Equivalence

\$4,286

\$3,036

\$26,072

\$9,698

Average

Road User

Cost per Day

\$17,143

\$12,143

\$104,286

\$38,790

#### I-410 WIDENING

#### ROAD USER COST REPORT

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	Queue	Delay	Cost	Cost
Phase-Stage	Weekly	Weekly	Total	per day
	Max (mi)	Max (min)	(\$Million)	(\$)
Phase 1 - Stage 1	0	0	0	\$0
Phase 1 - Stage 2	3.81	32.4	4.58	\$40,893
Phase 2 - Stage 1	5.23	33.4	10.58	\$47,232
Phase 2 - Stage 2	2.89	18.4	0.48	\$17,143
Phase 2 - Stage 3	1.26	8.1	0.17	\$6,071
Phase 2 - Stage 4	1.26	8.1	0.17	\$6,071
Phase 3 - Stage 1	4.89	31.2	5.4	\$38,571
Phase 4 - Stage 1	4.89	42.3	12.12	\$54,107
Phase 4 - Stage 2	2.89	23.9	0.61	\$21,786
Phase 5 - Stage 1	2.95	18.8	2.76	\$24,643
Phase 5 - Stage 2	6.98	44.6	2.23	\$79,643
		TOTAL =	39.1	1

Milestone Description

Phase 2 - Stage 3 and Phase 2 - Stage 4

Phase 5 - Stage 1 and Phase 5 - Stage 2

Phase 2 - Stage 2

All Phases

Milestone

No.

1

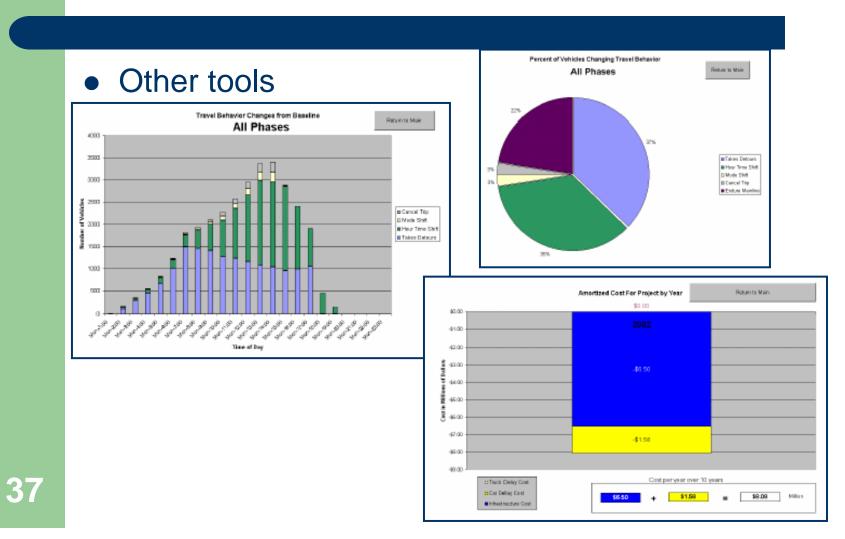
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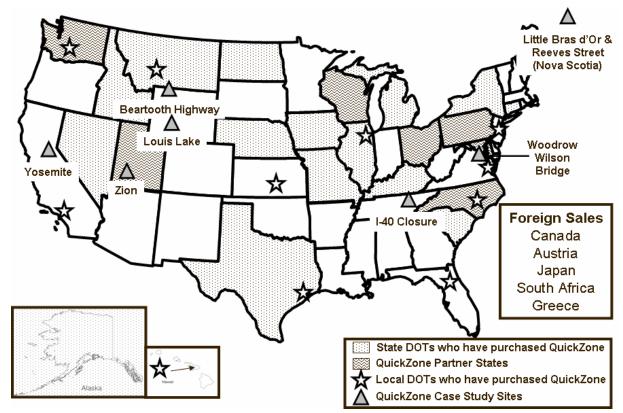
### QuickZone

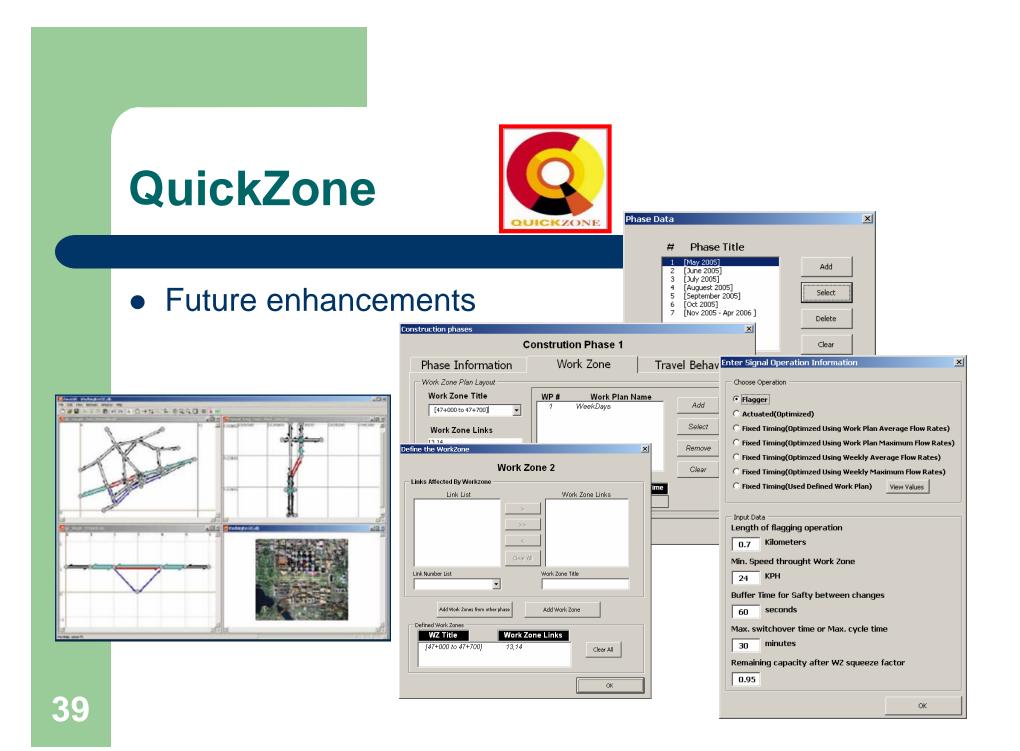






#### • Case studies





### QuickZone

#### • Future enhancements

Delay Costs	Vehicle Operating Costs	Inventory Cos	ts   Econom	ic Costs   Other	Costs
Truc	< Operating Costs				
Per	ent of trucks:	5	0.434	\$ per mile	
Pass	enger Car Operating Cost	s			
Per	ent of passenger cars:	95	0.173	\$ per mile	
Vehi	cle operating costs (calcul	ated)	0.186	\$ per mile	
	omment box				-
Ľ					Help
					Update Default
					Values

Percent of trucks: 5 Average vehicle occupancy: 1.14	
Parsent of asserger care: 96 Percent bases tips: 0 Percent bases t	
Average vehicle occupancy: 1.96	Update Default Values
Cost per vether of delay Trucks Personger cars All traffic (calculated) \$ 23.50 \$ (24.5) \$ (24.4)	Delay Costs   vehicle Operating Costs   Inventory Costs   Average Whicle Occupancy
CPUHD Comment box	Source: Business Trips 1.14 Highlights of the 2001 National Household Travel Survey, U.S.
Hob	Personal Trips 2.05 https://www.bts.gov/products/hational_household_household_results.
ad Economic Costs Input	X Benefits Total
Delay Costs Vehicle Operating Costs Inventory Costs Economic	Costs Other Costs
Value of Freight Average payload (lbs.): 50,000	resourcestion Cost Trend Substitute: Redover 1.5: Postaria Statistica Statistica Statistica 1.5: Postaria Microsoft September 2000.
Average payload (lbs.): 0.40	Source
Average payload value (\$)ib.):	Office of the Secretary of Transportation. The Value of Serving Transf Time. Department of Guadance for Conducting Economic (Fuluations. U.S. Department of
Average payload value (\$) 20,000 (calculated)	Transportation, April 1997.
Discount rate (%) 5	
Inventory cost per hour (calculated): 10 \$/hr	per truck
CFLHD Comment box	
	Help

QUICKZONE

U

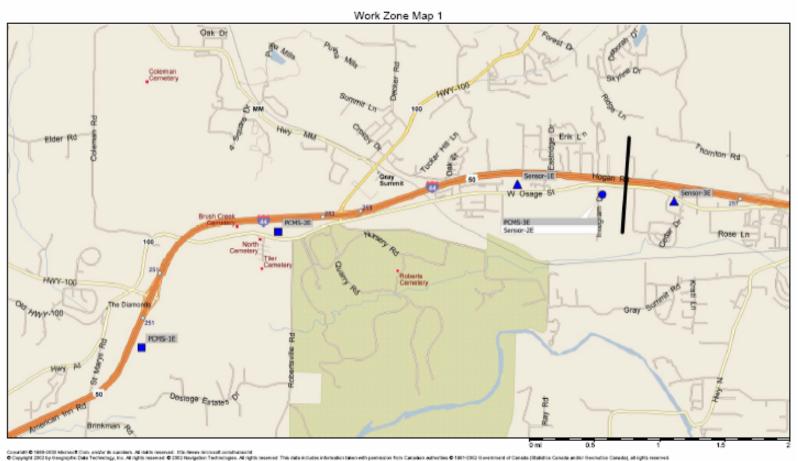
Provides Real Time Information
 Travel time through work zone

- Distance to the end of work zone

- Decision making by local travelers

- Provides Work Zone Management Tool

   Delay monitoring
  - Flexibility in Operations
  - Enhances Operations

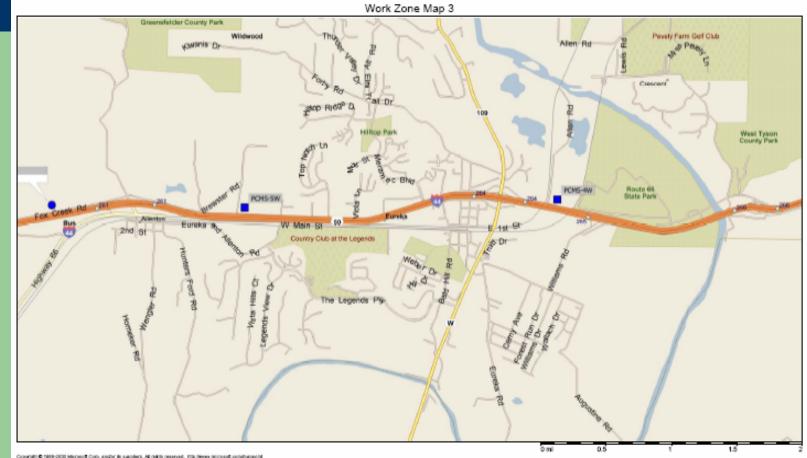


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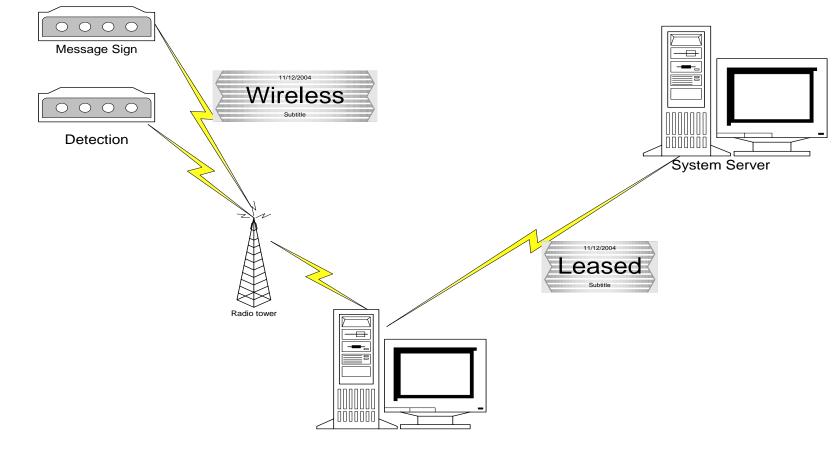


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Work Site Server