

WORK ZONE DELAY ESTIMATION

Work Zone Management,
Accelerated Construction,
and Smart Work Zones

TEAM Monthly Meeting

November 16, 2004

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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

September 1998

HPQ-58-1

QuickZone BACKGROUND



- 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



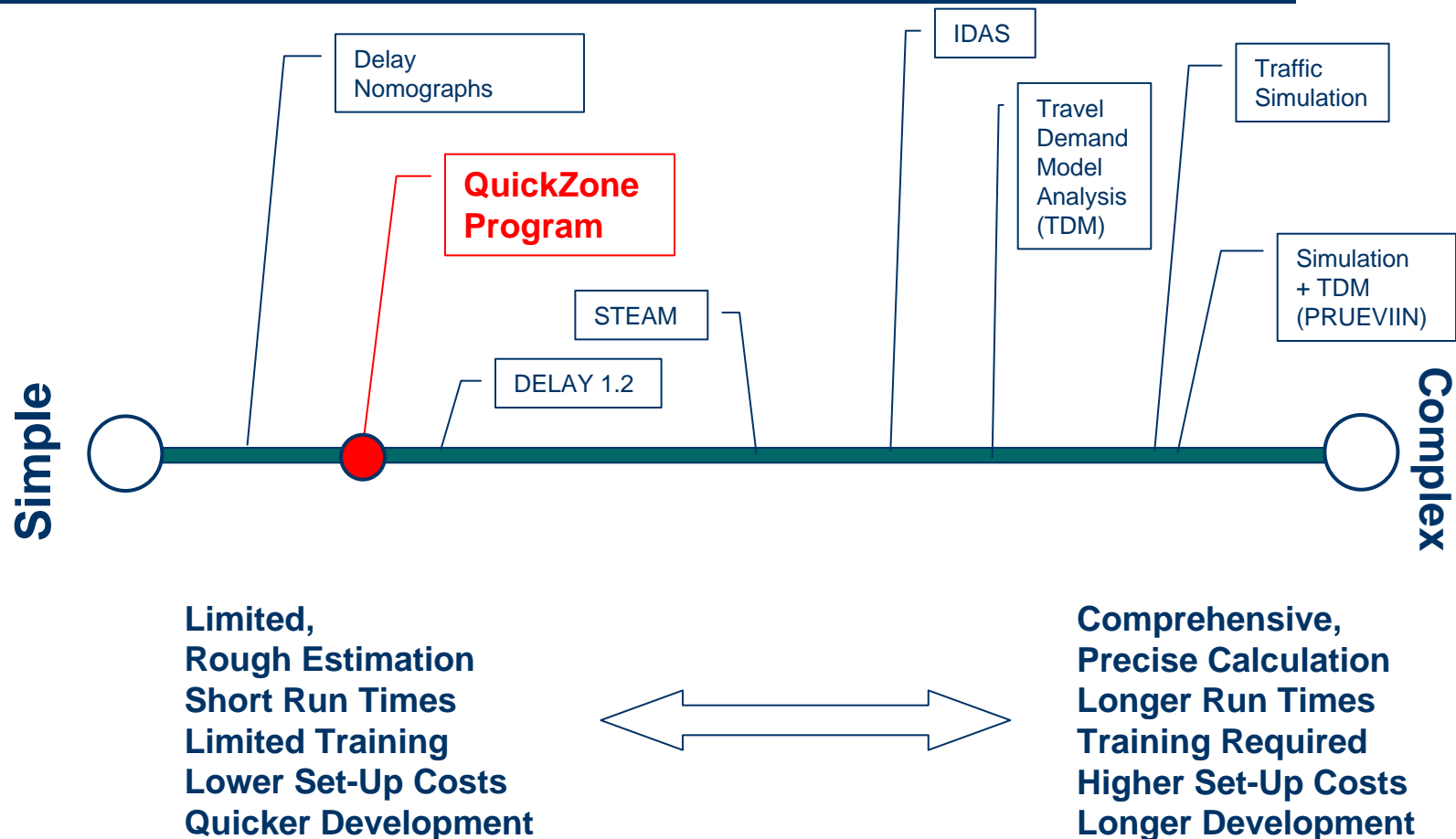
- **Quantifies** corridor delay resulting from capacity decreases in work zones
- **Identifies** delay impacts of alternative construction phasing plans
- **Supports Trade-Off Analyses** between construction costs and delay costs
- **Considers Alternate Phasing Schedules:**
 - Time-of-day (peak vs. off-peak)
 - 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
 - Hourly Counts
 - Seasonality
- Capacity
 - Normal Conditions
 - Work Zone Conditions

QuickZone METHODOLOGY



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.



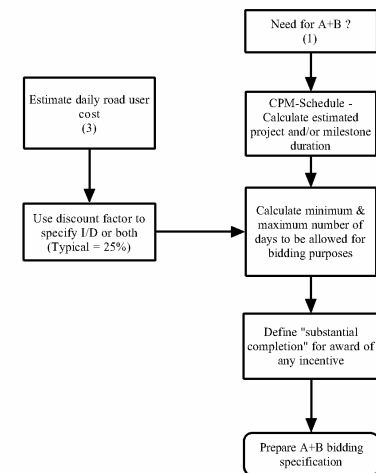
**Accelerated Construction
Strategies Guideline**

September 2003

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"

Procedural Flowchart for
Preparing A+B Specification

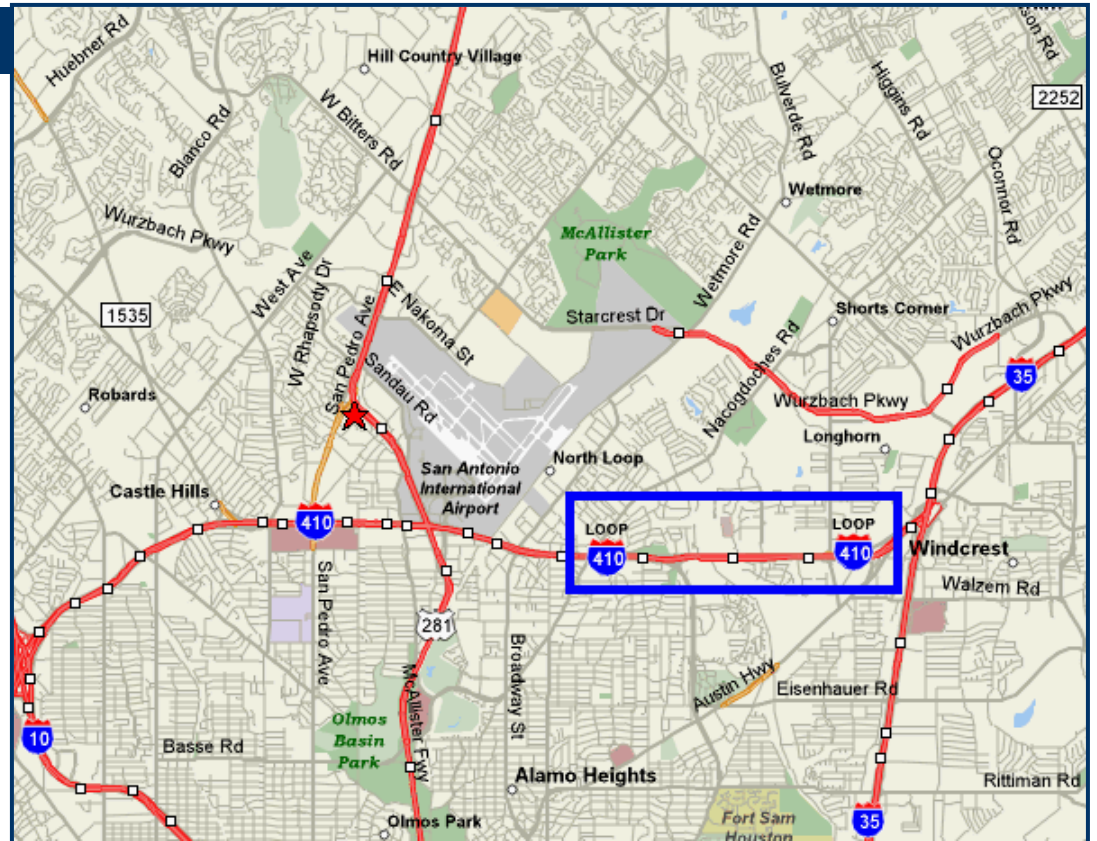


A+B BIDDING

	"A+B"	"A"	"B"	RUC Rate	
Bidder	Cost	Cost	Days	\$/Day	Total "B"
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

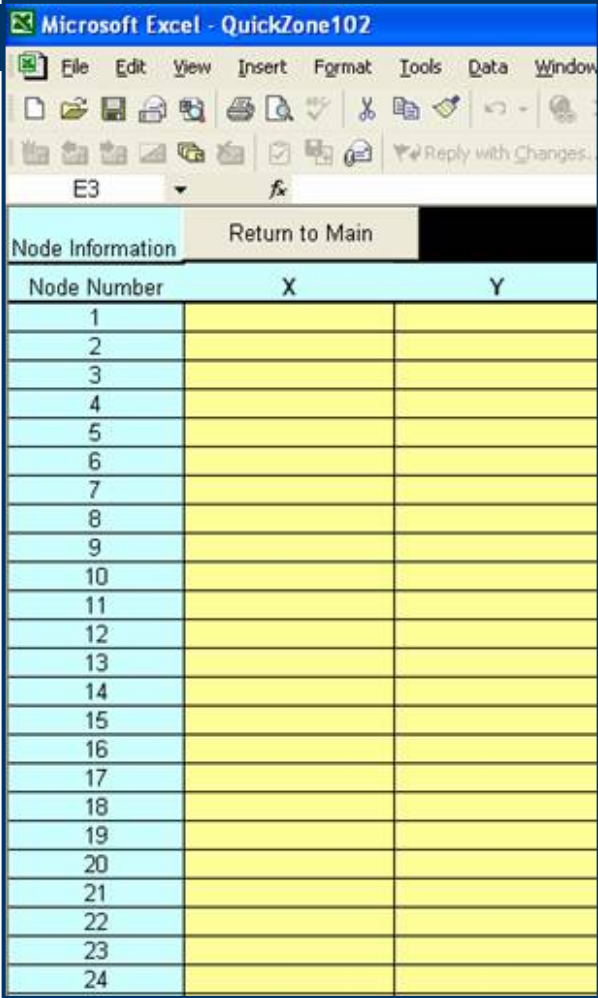
IH-410 WIDENING

- 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



NETWORK CONSTRUCTION

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

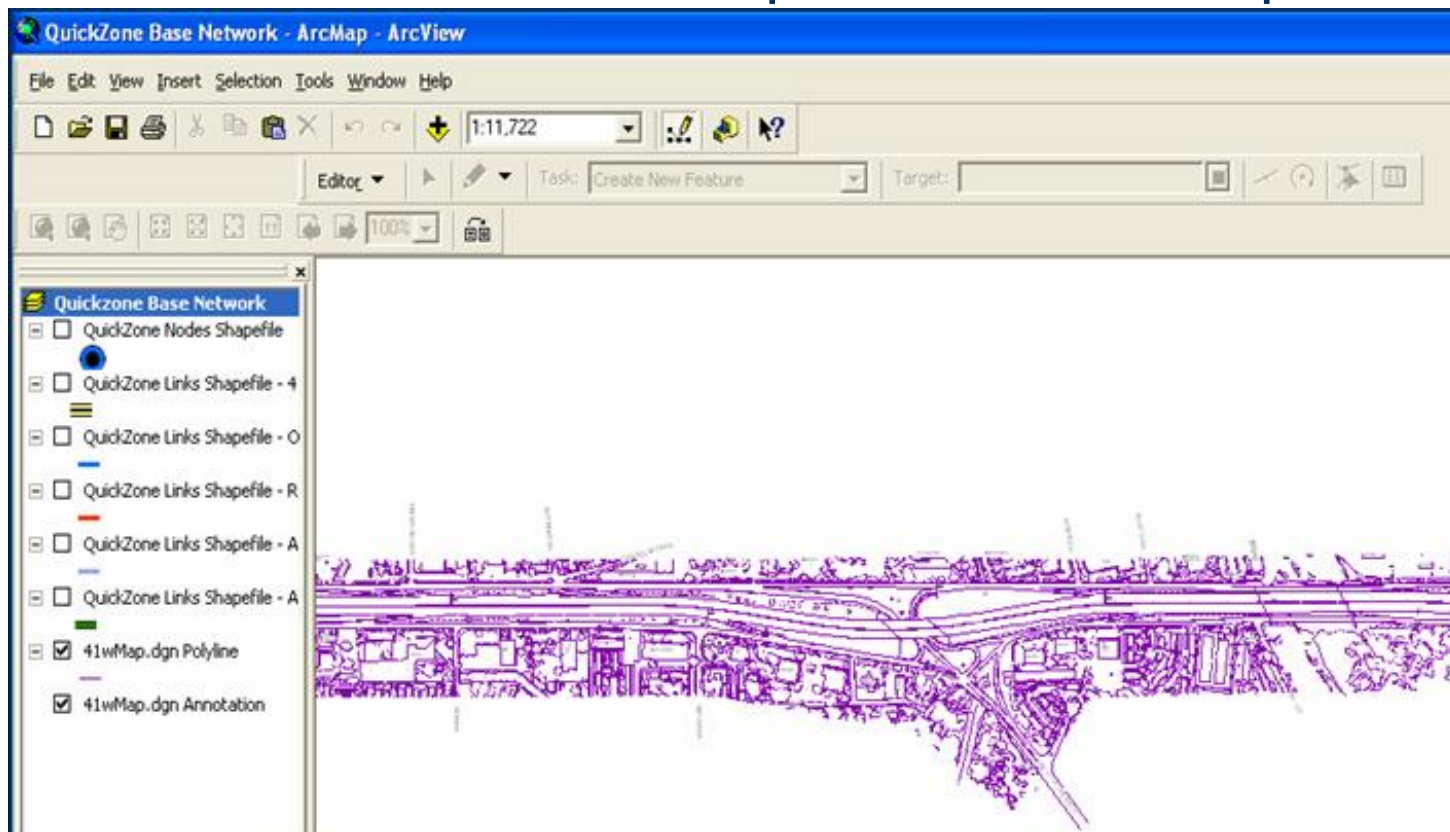


The screenshot shows a Microsoft Excel window titled "QuickZone102". The spreadsheet has a menu bar (File, Edit, View, Insert, Format, Tools, Data, Window) and a toolbar. The active cell is E3. Below the menu bar, there are two tabs: "Node Information" (selected) and "Return to Main". The spreadsheet contains a table with the following structure:

Node Number	X	Y
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		

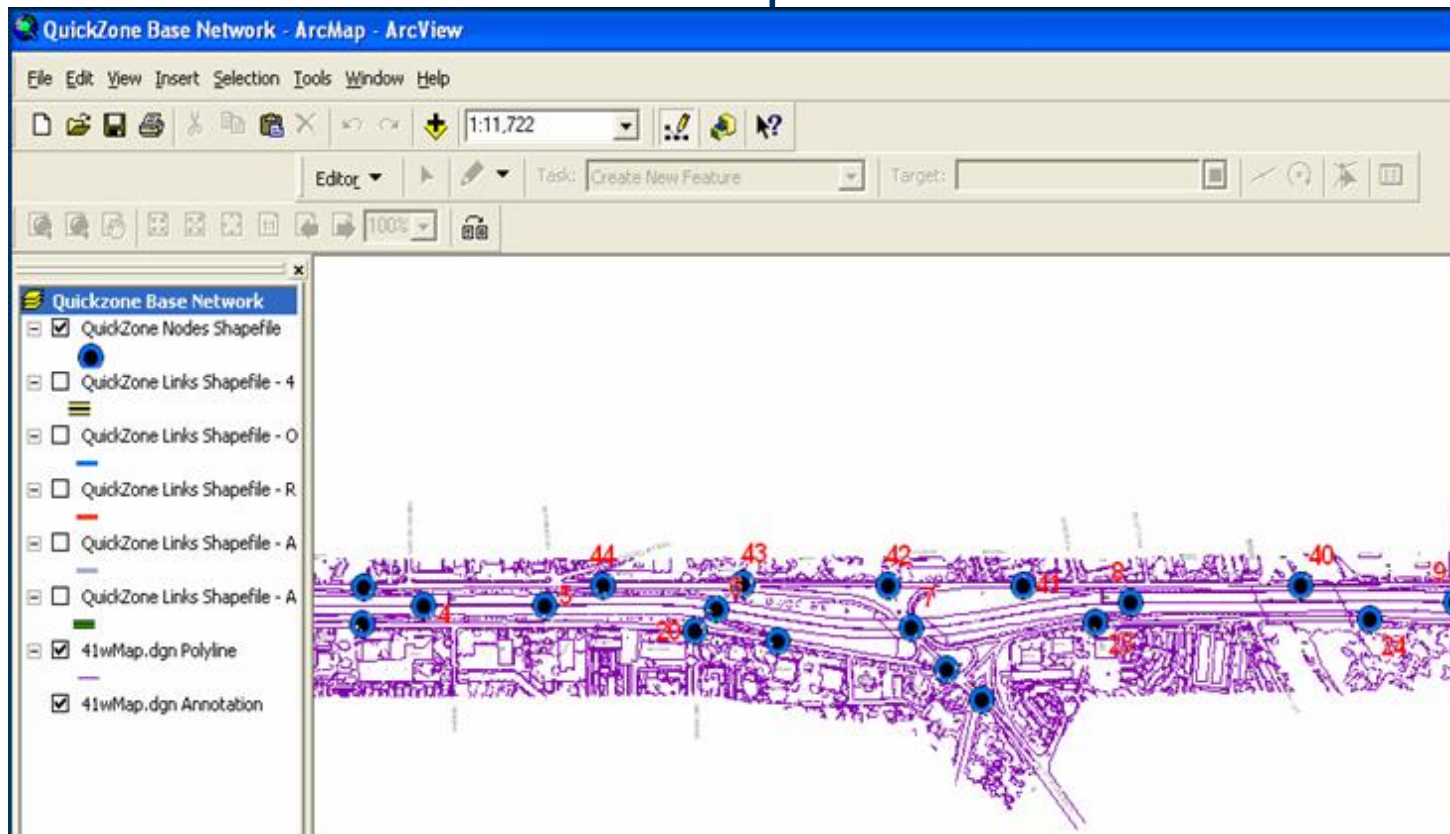
NETWORK CONSTRUCTION

- GIS-driven network development – base map



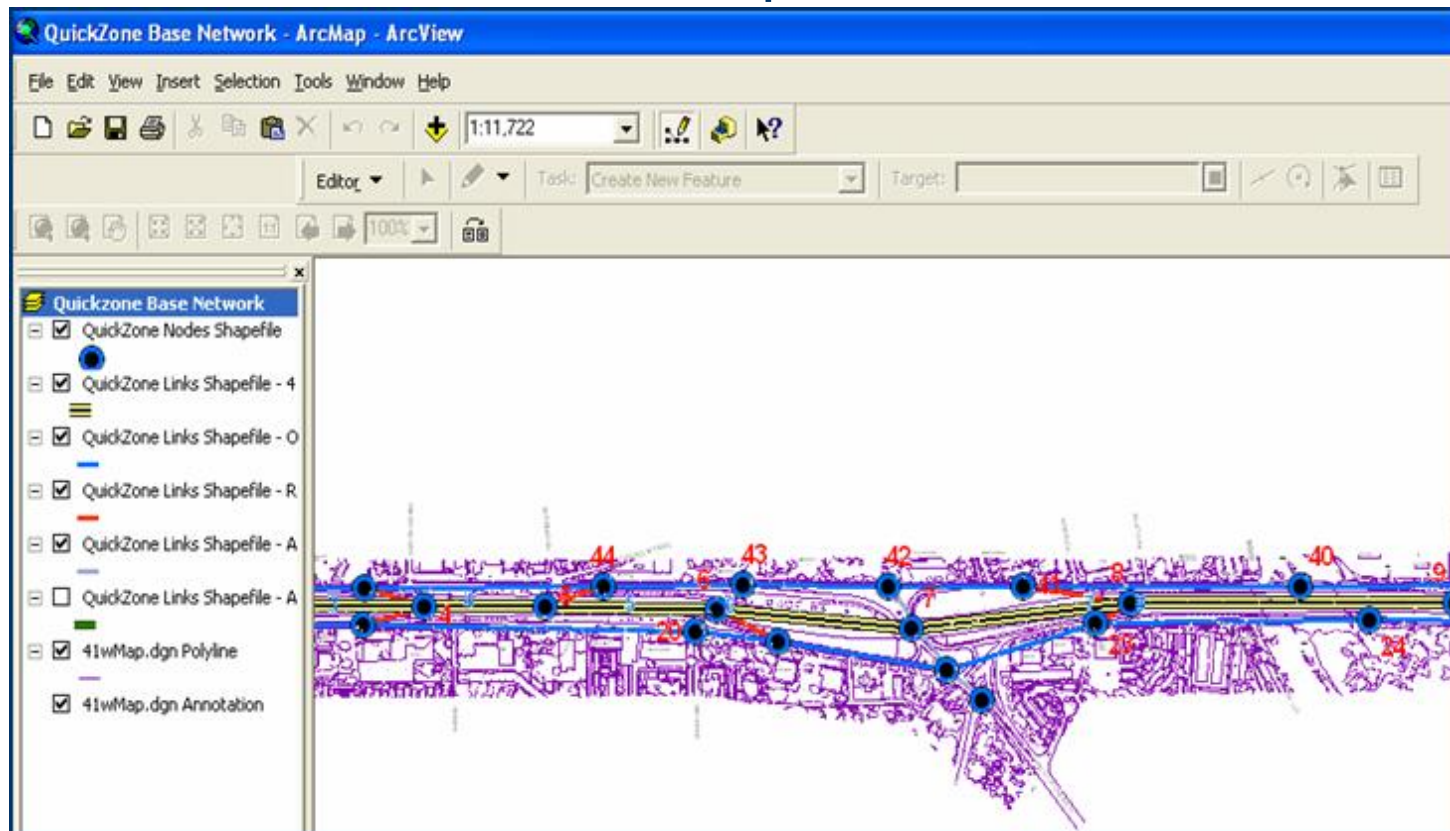
NETWORK CONSTRUCTION

- GIS-driven network development - nodes



NETWORK CONSTRUCTION

- GIS-driven network development - links



NETWORK CONSTRUCTION

- GIS-driven network development - attributes

The screenshot displays the ArcMap interface for a project titled "QuickZone Base Network". The main map area shows a network of links and nodes overlaid on a purple-toned map. Two attribute tables are open, providing detailed data for the network elements.

Attributes of QuickZone Links Shapefile - 410

FID	Shape*	Id	Length	ADT_EB
0	Polyline	1	814.321936	85470
1	Polyline	2	1184.248995	73830
2	Polyline	3	1088.089785	73830
3	Polyline	6	1300.849038	69690

Record: 1 | Show: All Selected | Records: (0 out of 21 Selected.)

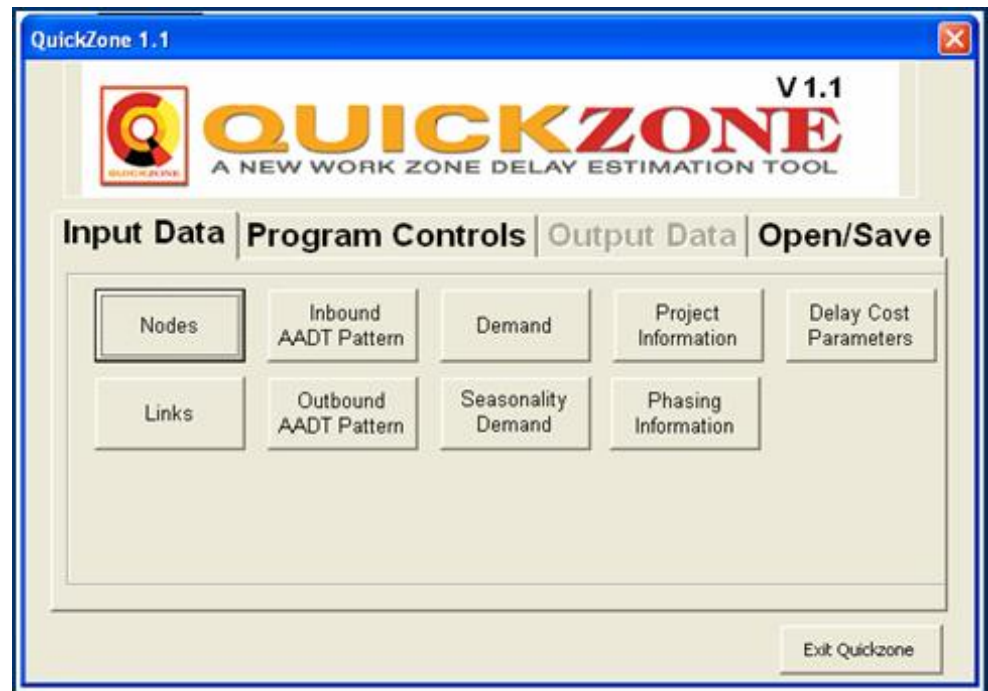
Attributes of QuickZone Nodes Shapefile

FID	Shape	Id	X_Coord	Y_Coord
0	Point	17	2142344	13737821
1	Point	16	2141129	13737883
2	Point	19	2143808	13737815
3	Point	20	2146015	13737778

Record: 1 | Show: All Selected | Records: (0 out of 89 Selected.)

QuickZone MODEL

- Nodes
- Links
- AADT Patterns
- Demand
- Seasonality
- Project Information
- Phasing Information
- Delay Cost Parameters



QuickZone MODEL

- Nodes and links

Microsoft Excel - QuickZone102

File Edit View Insert Format Tools Data Window Help

A4 1

Node Information Return to Main

Node Number	X	Y
67	2162805.00	13745543.00
68	2160854.00	13740977.00
69	2158843.00	13737970.00
70	2165031.00	13751285.00
71	2161121.00	13749191.00
72	2159515.00	13746537.00
73	2155255.00	13746537.00
74	2152672.00	13748632.00
75	2148971.00	13750727.00
76	2156722.00	13723424.00
77	2154068.00	13715463.00
78	2145619.00	13710226.00
79	2136402.00	13710226.00
80	2135843.00	13712321.00
81	2133748.00	13714416.00
82	2134586.00	13717070.00
83	2136681.00	13719164.00
84	2134586.00	13722865.00
85	2132980.00	13730267.00
86	2135075.00	13735574.00
87	2128485.00	13739888.00
88	2181334.25	13764921.00
89	2180431.75	13750352.00
90		

Microsoft Excel - QuickZone102

File Edit View Insert Format Tools Data Window Help

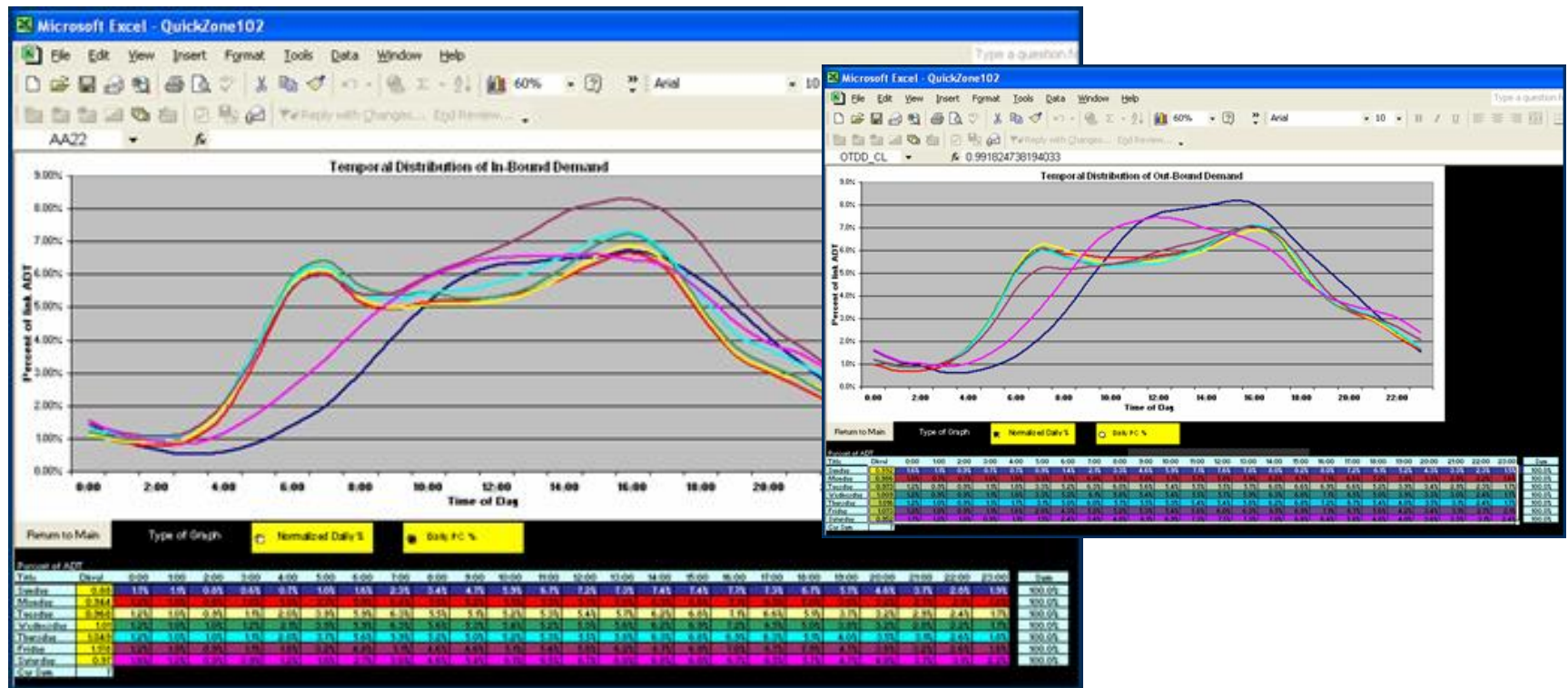
A4 1 75% Arial 10

Return to Main Formula Bar

Link #	A Node	B Node	Lanes	Capacity (VPL)	Length (Miles)	Freeflow Speed (mph)	Jam Density (V/MiL)	For O	Type	Position	Description
109	86	59	3	2250	0.074	65	250	O		2	SOUTH DETOUR SEWB
140	64	88	3	2250	1.903	65	250	I		1	LONG NORTH DETOUR NEEB
141	64	89	3	2250	1.903	65	250	I		1	LONG NORTH DETOUR NEEB
142	66	59	3	2250	1.608	65	250	O		1	LONG NORTH DETOUR SEWB
143	61	60	3	2250	4.883	65	250	O		2	LONG NORTH DETOUR SEWB
144	62	61	2	2250	2.382	70	250	O		2	LONG NORTH DETOUR SEWB
145	62	62	2	2250	3.648	70	250	O		2	LONG NORTH DETOUR SEWB
146	64	63	2	2250	2.737	70	250	O		2	LONG NORTH DETOUR SEWB
147	65	64	2	2250	1.946	65	250	I	M	1	LONG NORTH DETOUR SEWB
148	66	65	2	2250	0.952	65	250	I	M	1	LONG NORTH DETOUR SEWB
149	67	66	2	2250	1.023	65	250	I	M	1	LONG NORTH DETOUR SEWB
150	68	67	2	2250	0.394	65	250	I	M	1	LONG NORTH DETOUR SEWB
151	70	66	2	8000	0.408	50	250	I		1	SHORT NORTH DETOUR EEB
152	71	70	2	8000	0.84	50	250	I		1	SHORT NORTH DETOUR EEB
153	72	71	2	8000	0.887	50	250	I		1	SHORT NORTH DETOUR EEB
154	73	72	2	8000	0.887	50	250	I		1	SHORT NORTH DETOUR EEB
155	74	73	2	8000	0.63	50	250	I		1	SHORT NORTH DETOUR EEB
156	75	74	2	8000	0.805	50	250	I		1	SHORT NORTH DETOUR EEB
157	58	75	2	8000	3.026	50	250	I		1	SHORT NORTH DETOUR EEB
158	76	68	2	2250	2.476	65	250	I		1	SOUTH DETOUR NEEB
159	77	76	2	2250	1.939	65	250	I		1	SOUTH DETOUR NEEB
160	78	77	2	2250	1.803	65	250	I		1	SOUTH DETOUR NEEB
161	79	78	2	2250	1.746	65	250	I		1	SOUTH DETOUR NEEB
162	80	79	2	2250	0.441	65	250	I		1	SOUTH DETOUR NEEB
163	81	80	2	2250	0.563	65	250	I		1	SOUTH DETOUR NEEB
164	82	81	2	2250	0.527	65	250	I		2	SOUTH DETOUR NEEB
165	83	82	2	2250	0.563	65	250	I		2	SOUTH DETOUR NEEB
166	84	83	2	2250	0.805	65	250	I		1	SOUTH DETOUR NEEB
167	85	84	2	2250	1.624	65	250	I		1	SOUTH DETOUR NEEB
168	86	85	2	2250	1.081	65	250	I		2	SOUTH DETOUR NEEB
169	59	86	3	2250	0.074	65	250	I		1	SOUTH DETOUR NEEB
170	89	44	2	2250	1.903	65	250	O		2	LONG NORTH DETOUR SEWB
171	88	44	2	2250	1.903	65	250	O		2	LONG NORTH DETOUR SEWB

QuickZone MODEL

- Temporal distribution of demand



QuickZone MODEL

- Demand

Microsoft Excel - QuickZone102

Return To Main PCE Value For Trucks 3.5 Copy AADT for all Demands

Click to Toggle Between Vehicles and PCE >> Vehicles

Inbound - Truck Percentages

	0-00	1-00	2-00	3-00	4-00	5-00	6-00	7-00	8-00	9-00	10-00	11-00	12-00	13-00	14-00	15-00
Weekday	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%
Weekend	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%

Outbound - Truck Percentages

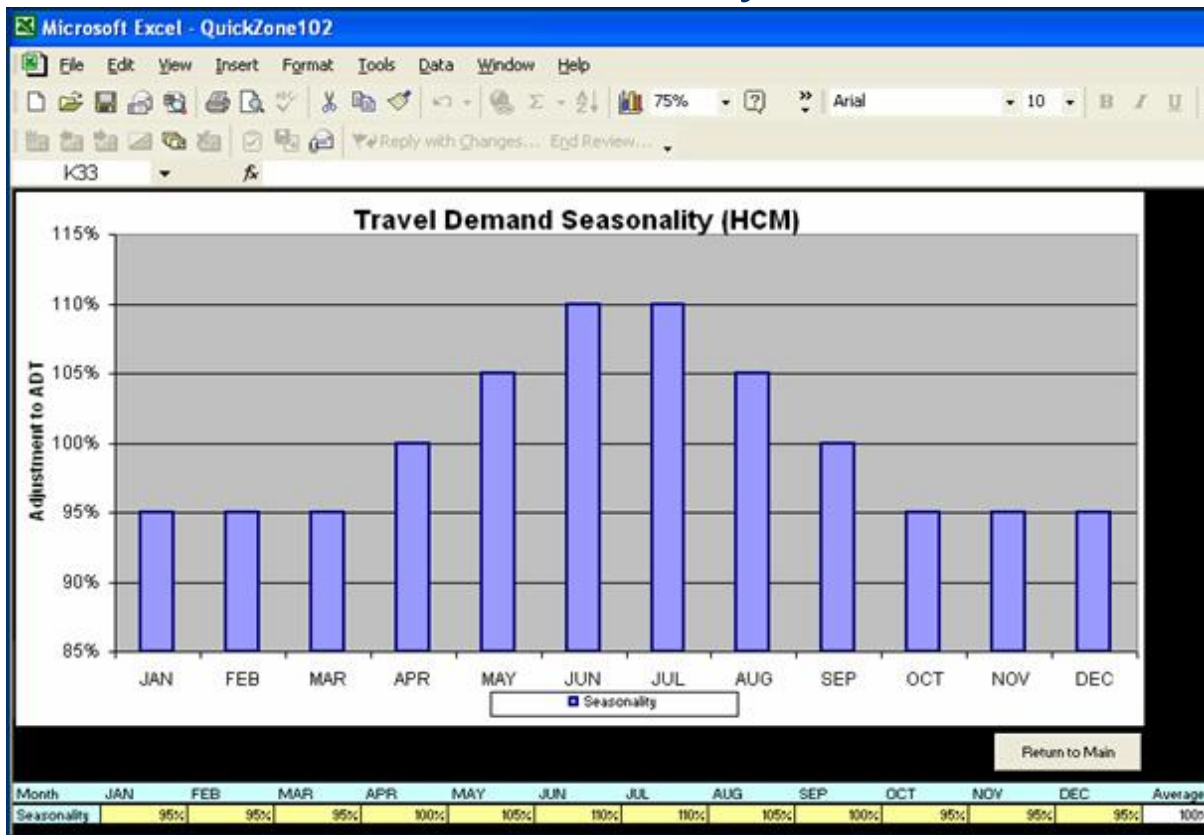
	0-00	1-00	2-00	3-00	4-00	5-00	6-00	7-00	8-00	9-00	10-00	11-00	12-00	13-00	14-00	15-00
Weekday	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%
Weekend	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%

Sunday

Link	I or O	AADT	0-00	1-00	2-00	3-00	4-00	5-00	6-00	7-00	8-00	9-00	10-00	11-00	12-00	13-00	14-00	15-00
1	I	76239	1114	724	503	416	456	671	1087	1550	2274	3133	3524	4508	4803	4863	4937	4991
2	I	85856	962	626	435	359	394	579	939	1339	1964	2706	3390	3994	4149	4201	4265	4311
3	I	85856	962	626	435	359	394	579	939	1339	1964	2706	3390	3994	4149	4201	4265	4311
4	I	73376	1072	697	484	400	439	646	1046	1491	2189	3015	3777	4338	4523	4681	4752	4803
5	I	73376	1072	697	484	400	439	646	1046	1491	2189	3015	3777	4338	4523	4681	4752	4803
6	I	62163	908	591	410	339	372	547	896	1263	1854	2554	3200	3676	3996	3965	4026	4069
7	I	62163	908	591	410	339	372	547	896	1263	1854	2554	3200	3676	3996	3965	4026	4069
8	I	67212	882	639	444	387	402	591	958	1368	2005	2762	3460	3974	4234	4287	4352	4400
9	I	58587	856	557	387	320	351	515	835	1191	1747	2407	3096	3464	3691	3737	3794	3835
10	I	58587	856	557	387	320	351	515	835	1191	1747	2407	3096	3464	3691	3737	3794	3835
11	I	63029	921	599	416	344	377	555	898	1281	1880	2590	3244	3727	3971	4021	4082	4126
12	I	47784	698	454	315	261	286	420	681	971	1425	1963	2460	2825	3080	3048	3094	3128
13	I	47784	698	454	315	261	286	420	681	971	1425	1963	2460	2825	3080	3048	3094	3128
14	I	55036	804	523	363	300	329	484	784	1119	1642	2261	2833	3254	3467	3511	3564	3603
15	I	76239	1114	724	503	416	456	671	1087	1550	2274	3133	3524	4508	4803	4863	4937	4991
16	I	55036	804	523	363	300	329	484	784	1119	1642	2261	2833	3254	3467	3511	3564	3603
17	I	67556	987	642	446	369	404	594	963	1373	2015	2776	3477	3994	4256	4309	4375	4422
18	I	76239	1114	724	503	416	456	671	1087	1550	2274	3133	3524	4508	4803	4863	4937	4991

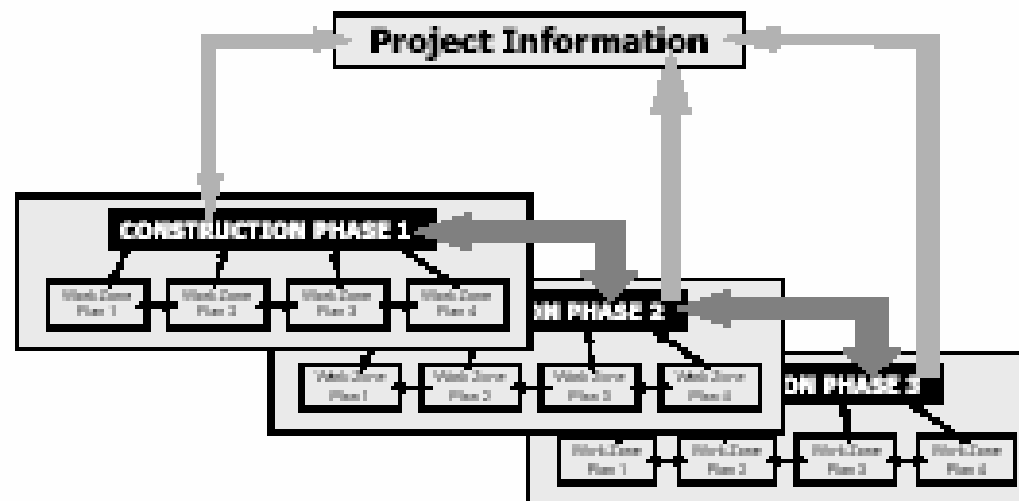
QuickZone MODEL

- Travel demand seasonality



QuickZone MODEL

- Project Information Module



QuickZone MODEL

- Project information

The screenshot shows a software window titled "Project Information" with a close button in the top right corner. The window contains the following fields and controls:

- Project Description:** A text box containing "DH 410 Widening - Nacogdoches to Perrin Beltel".
- Project Start Date:** Three dropdown menus for "Year" (2006), "Month" (Aug), and "Sunday of the week" (6).
- Project Duration:** A text box containing "162" and a dropdown menu for "Weeks".
- Project Timeline:** A horizontal timeline showing "Aug 6 2006" followed by an ellipsis and "Sep 13 2009".
- Yearly Capacity Decrease:** A text box containing "1" followed by a percent sign (%).
- Yearly Demand Increase:** A text box containing "3" followed by a percent sign (%).
- Return to Main:** A button at the bottom left of the window.

QuickZone MODEL

- Sequencing plan

CAPACITY REDUCTION FOR RESTRICTED LANE WIDTH AND LATERAL CLEARANCE		
ADJUSTMENT CODE	TYPICAL SECTION	CAPACITY REDUCTION ¹
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	
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 mainline traffic to the outsides using 10'-11'-10' 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 temporary median pavement near sta. 968+00 to 987+00.
- f) 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.

3. Ramps

4. Starcrest Underpass Bridge

QuickZone MODEL

- Sequencing plan

Phase 1 Stage 2			
<i>Begin Date: 4</i>			
<i>Cost (\$M): 5</i>			
	QUICKZONE LINK	ADJUSTMENT CODE	CAPACITY DECREASE
INBOUND WORKZONE LINKS	1	AC-2	129
	2	AC-5	682
	3	AC-5	682
	4	AC-5	682
	5	AC-5	682
	6	AC-5	682
	7	AC-5	682
	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
OUTBOUND WORKZONE LINKS	24	AC-5	682
	25	AC-5	682
	26	AC-5	682
	27	AC-5	682
	28	AC-5	682
	29	AC-5	682
	30	AC-5	682
	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	

QuickZone MODEL

- Sequencing plan

Construction phases

Construction Phase 10

Phase Description: Phase 5 - Stage 1

Duration: 18 Weeks

Mar 22 2009 - Jul 26 2009

Infrastructure Cost: 6 Millions(\$)

Workzone Plan Editor

Workzone Plan Layout

	Name of Plan	Starting Day + Time		Ending Day + 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 Construction Phase Data >>>

QuickZone MODEL

- Phase descriptions, capacity reductions

Phase 10: Workzone Plan 1 of 7

Workzone Information | Workzone Links | Mitigation Strategies | Travel Behavior

Workzone Plan Information

Workzone Plan Description: Phase 5 - Stage 1

Workzone Start Time: Sunday 0:00

Workzone End Time: Saturday 23:00

<<< Return To Phases >>>

Phase 10: Workzone Plan 1 of 7

Workzone Information | Workzone Links | Mitigation Strategies | Travel Behavior

Links Affected By Workzone

Link Number Affected	Capacity Decrease
2	600
3	600
4	600
5	600

Link Number List: [] Add New

Link Number: [] Total Capacity Decrease: []

Return To Phases

QuickZone MODEL

- Delay cost parameters
 - CPI-adjusted delay costs
 - OMB inflation rate projections

Delay Cost Parameters

Hourly Delay Costs Parameters

Delay Cost per Car Hour	18.19	Dollars
Delay Cost per Truck Hour	24.50	Dollars

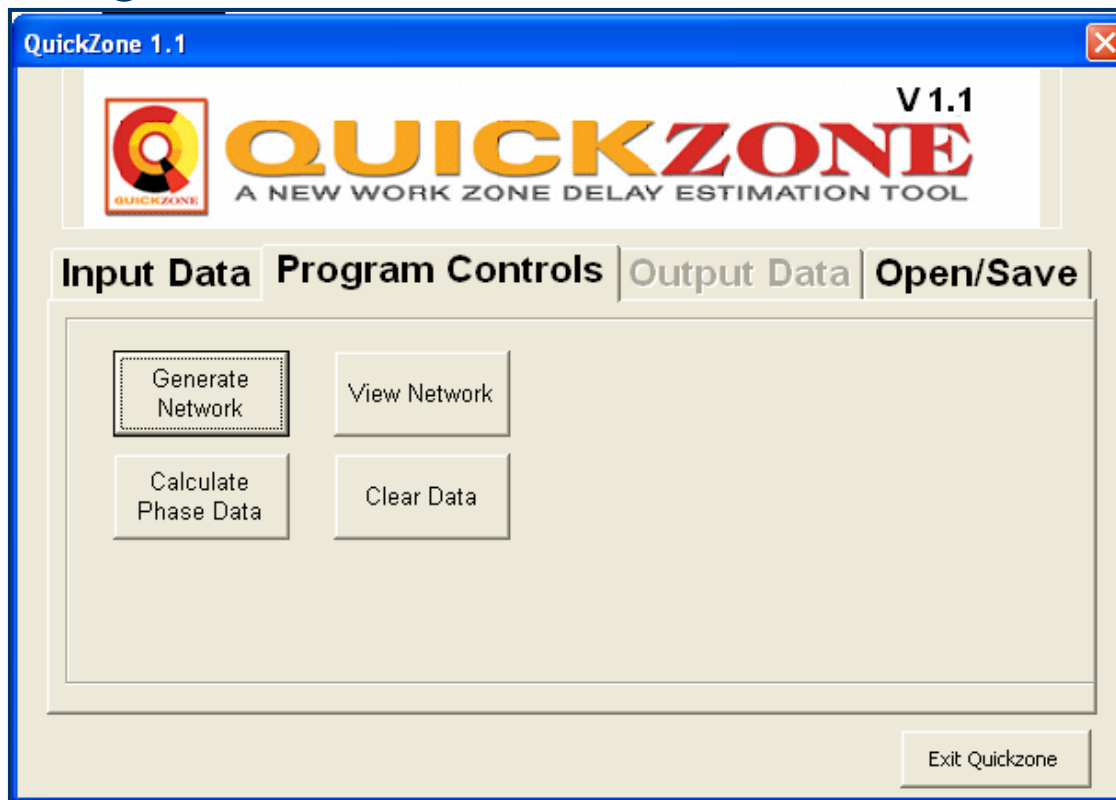
Amortization parameters

Amortized Period (Improvement Lifespan)	10	Years
Inflation Rate	2.30	%

Return to Main

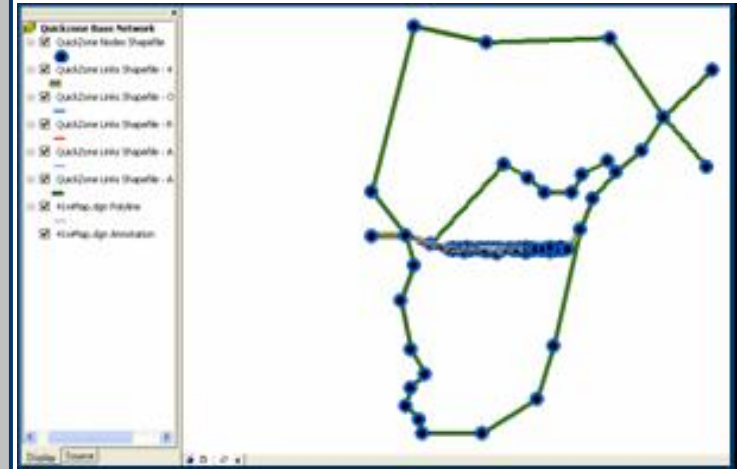
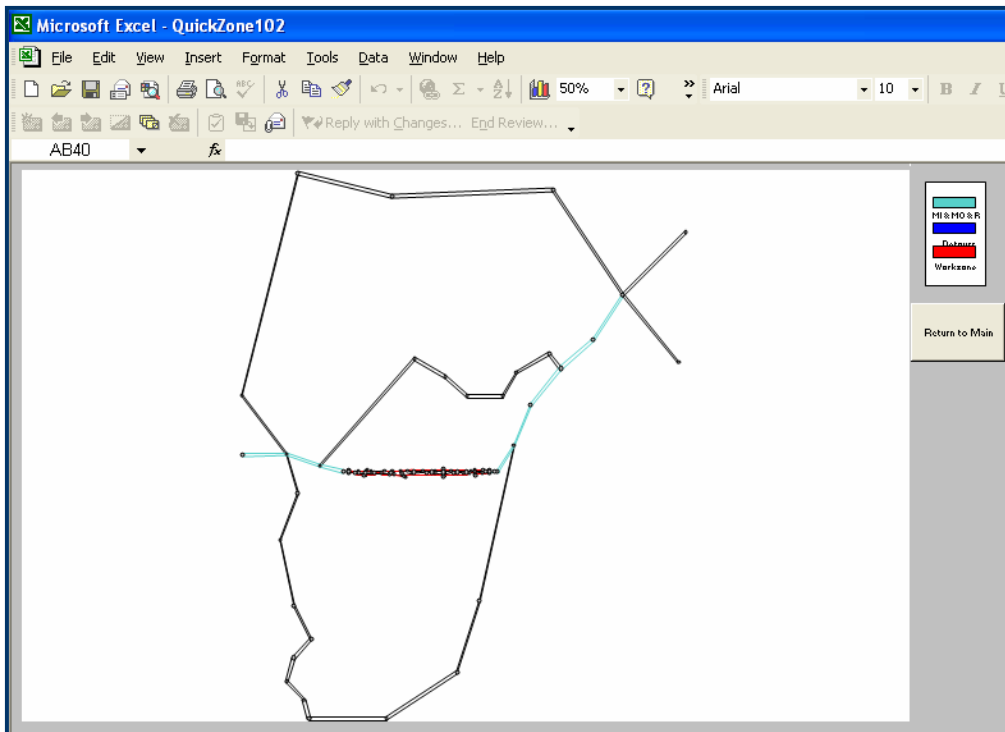
QuickZone MODEL

- Program controls



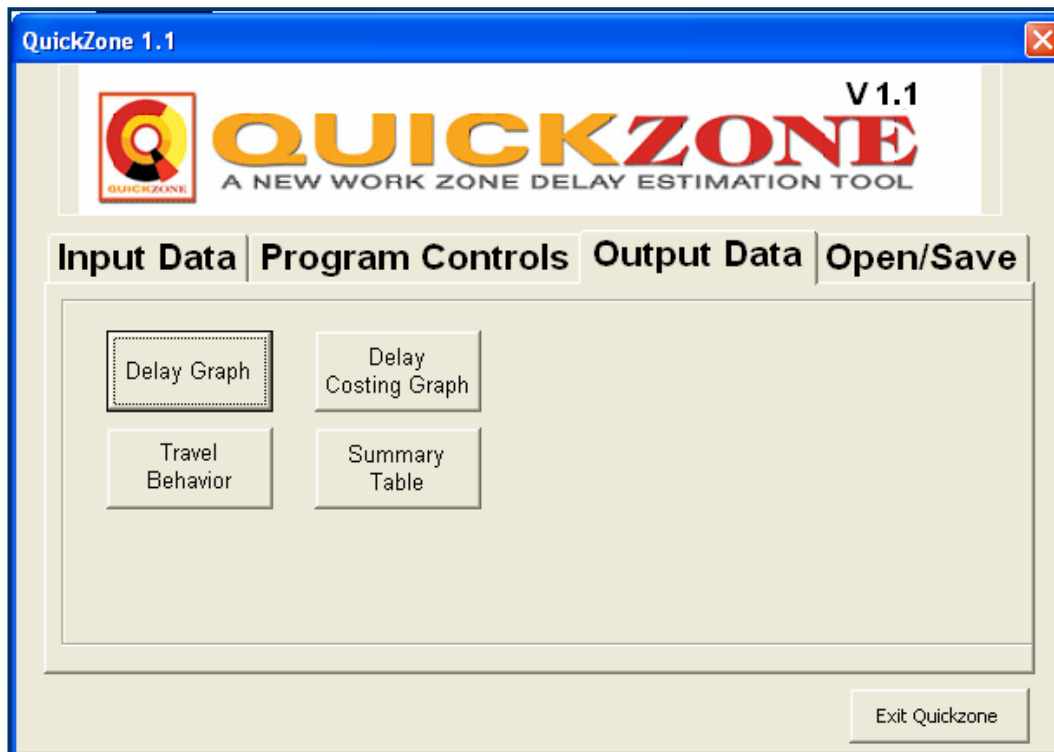
QuickZone MODEL

- Network generation



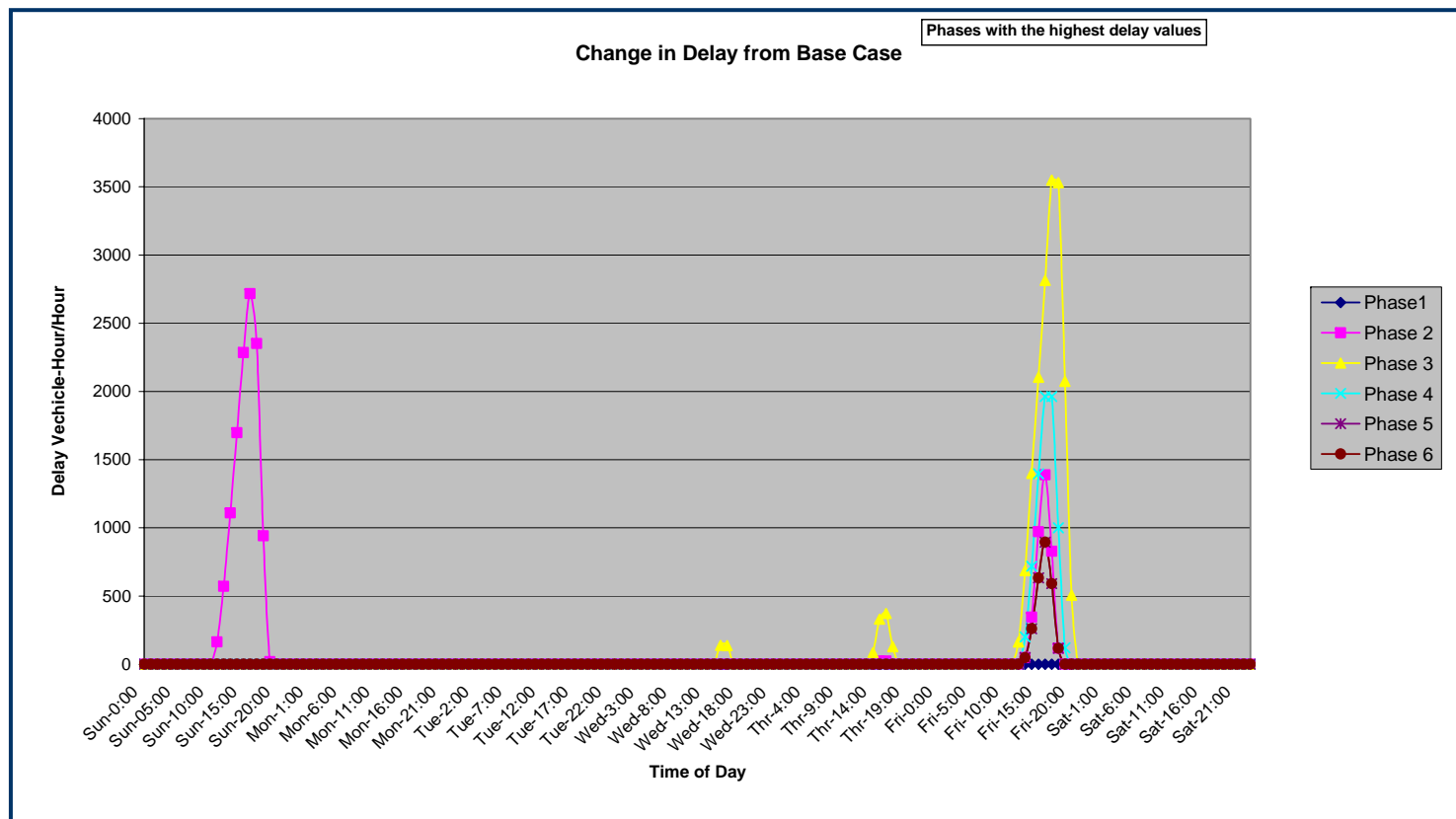
QuickZone MODEL

- Output data



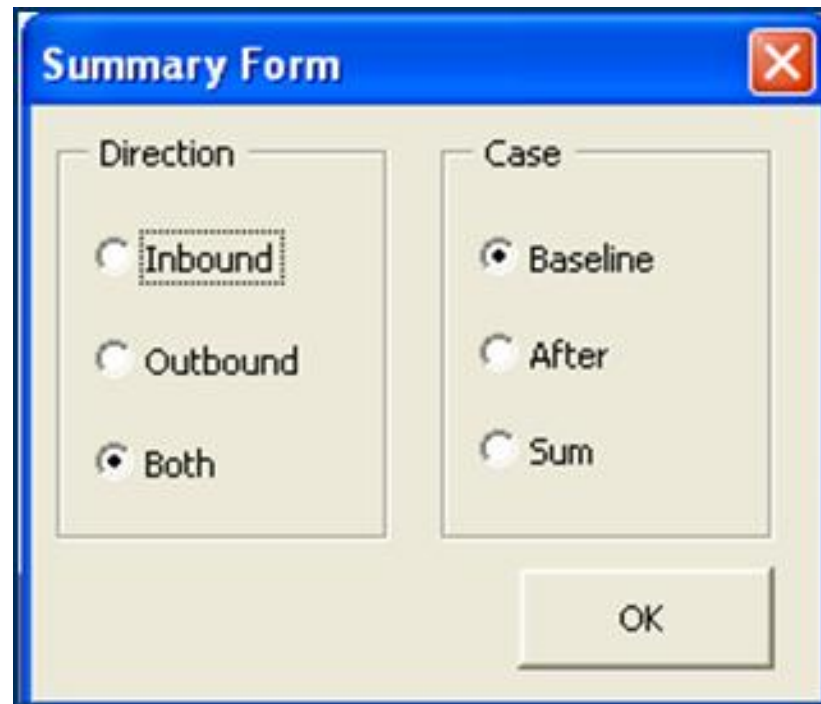
QuickZone MODEL

- Delay graph



QuickZone MODEL

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



The image shows a dialog box titled "Summary Form" with a blue title bar and a close button (X) in the top right corner. The dialog box is divided into two main sections: "Direction" and "Case".

Direction:

- Inbound
- Outbound
- Both

Case:

- Baseline
- After
- Sum

At the bottom right of the dialog box is an "OK" button.

QuickZone MODEL

- Summary of results - baseline

IH 410 Widening - Nacogdoches to Perrin Beitel
Baseline Data

Option Form	Queue-Both		Delay-Both			Phase Travel Behavior (Weekly Inbound + Outbound)				Cost (millions \$)-Both			
	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									
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

QuickZone MODEL

- Summary of results – work zone

IH 410 Widening - Nacogdoches to Perrin Beitel													
After Data													
Option Form	Queue-Both		Delay-Both			Phase Travel Behavior (Weekly Inbound + Outbound)				Cost (millions \$)-Both			
	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	0	0	0	0	0	0	0	0	0	3	0	0	0
Phase 1 - Stage 1	0	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									
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

Milestone No.	Milestone Description	Average Road User Cost per Day	(1) Incentive /Disincentive Equivalence
1	Phase 2 – Stage 2	\$17,143	\$4,286
2	Phase 2 – Stage 3 and Phase 2 – Stage 4	\$12,143	\$3,036
3	Phase 5 – Stage 1 and Phase 5 – Stage 2	\$104,286	\$26,072
A+B	All Phases	\$38,790	\$9,698

Phase-Stage	Queue Weekly Max (mi)	Delay Weekly Max (min)	Cost Total (\$Million)	Cost per day (\$)
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	

I-410 WIDENING

ROAD USER COST REPORT

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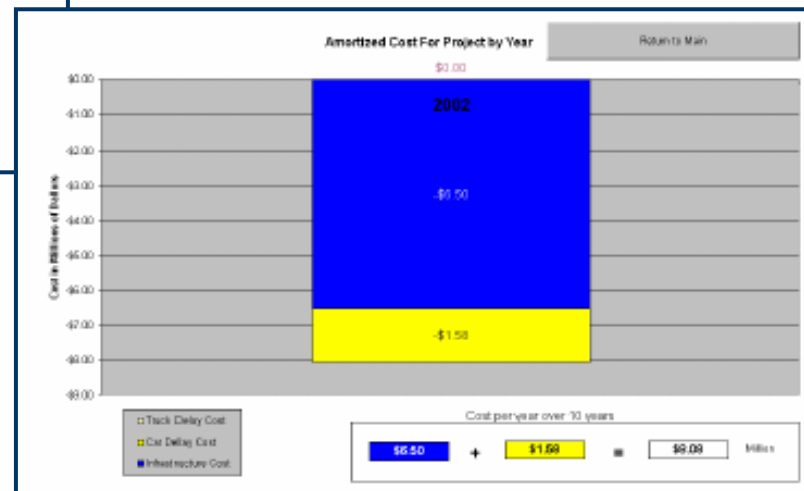
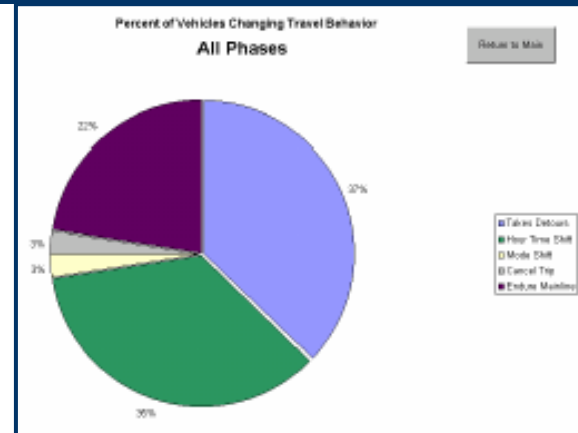
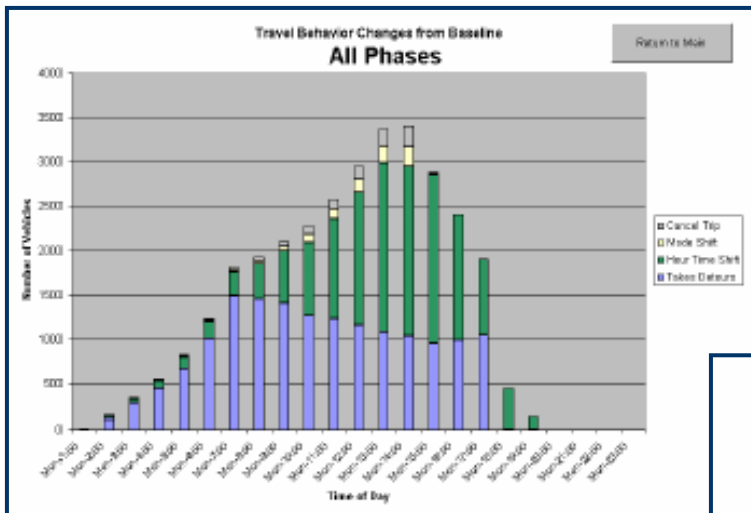
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QuickZone

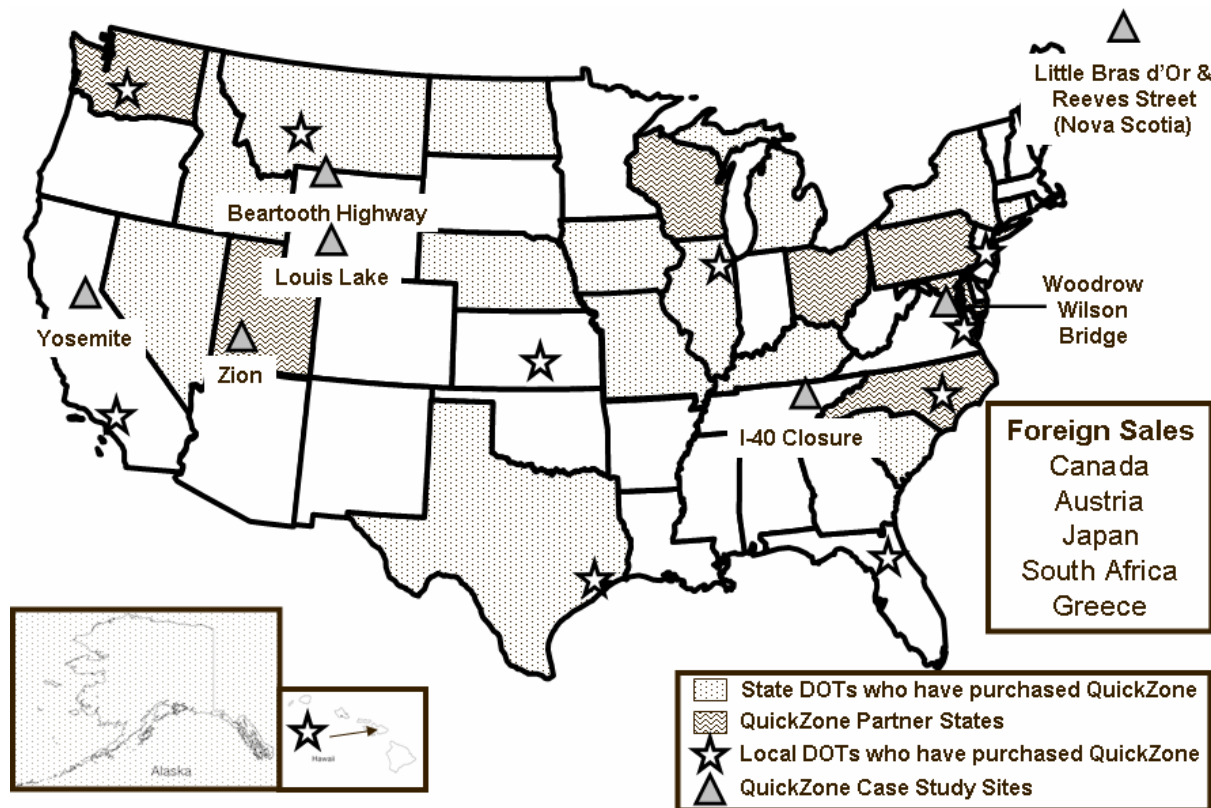
- Other tools



QuickZone



- Case studies



QuickZone



- Future enhancements

Phase Data

#	Phase Title
1	[May 2005]
2	[June 2005]
3	[July 2005]
4	[August 2005]
5	[September 2005]
6	[Oct 2005]
7	[Nov 2005 - Apr 2006]

Add
Select
Delete
Clear

Construction phases

Construction Phase 1

Phase Information | Work Zone | Travel Behavior

Work Zone Plan Layout

Work Zone Title: [47+000 to 47+700]

WP # | Work Plan Name

1	WeekDays
---	----------

Add
Select
Remove
Clear

Enter Signal Operation Information

Choose Operation

Flagger

Actuated(Optimized)

Fixed Timing(Optimized Using Work Plan Average Flow Rates)

Fixed Timing(Optimized Using Work Plan Maximum Flow Rates)

Fixed Timing(Optimized Using Weekly Average Flow Rates)

Fixed Timing(Optimized Using Weekly Maximum Flow Rates)

Fixed Timing(Used Defined Work Plan) View Values

Input Data

Length of flagging operation: Kilometers

Min. Speed through Work Zone: KPH

Buffer Time for Safety between changes: seconds

Max. switchover time or Max. cycle time: minutes

Remaining capacity after WZ squeeze factor:

OK

Define the WorkZone

Work Zone 2

Links Affected By Workzone

Link List | Work Zone Links

Link Number List: [47+000 to 47+700] | Work Zone Title: 13,14

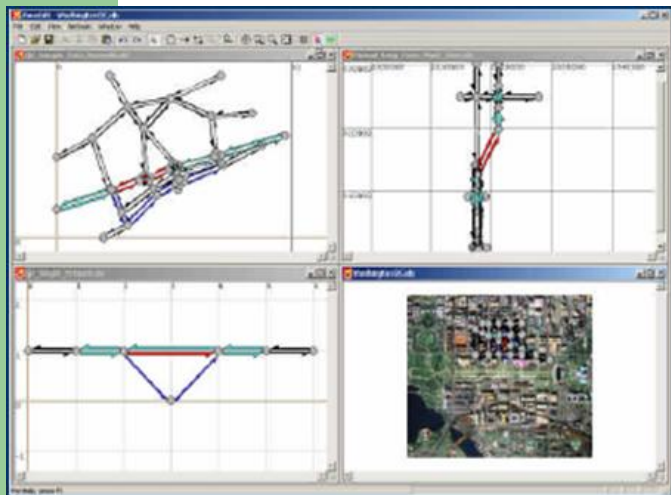
Add Work Zones from other phase | Add Work Zone

Defined Work Zones

WZ Title	Work Zone Links
[47+000 to 47+700]	13,14

Clear All

OK



QuickZone



- Future enhancements

User and Economic Costs Input

Delay Costs | Vehicle Operating Costs | Inventory Costs | Economic Costs | Other Costs

Truck Operating Costs

Percent of trucks: \$ per mile

Passenger Car Operating Costs

Percent of passenger cars: \$ per mile

Vehicle operating costs (calculated) \$ per mile

CFLHD Comment box

Help

Update Default Values

User and Economic Costs Input

Delay Costs | Vehicle Operating Costs | Inventory Costs | Economic Costs | Other Costs

Trucks

Percent of trucks: Average vehicle occupancy:

Passenger cars

Percent of passenger cars:

Trip purpose

Percent business trips: Trip length (% of personal trips)

Percent personal trips: Local trips:

Average vehicle occupancy: Inter-city trips:

Cost per vehicle of delay (calculated)

Trucks	Passenger cars	All traffic
\$ 23.58	\$ 24.52	\$ 24.41

CFLHD Comment box

Help

Update Default Values

Delay Costs | Vehicle Operating Costs | Inventory Costs

Average Vehicle Occupancy

Business Trips	1.14	Source: Highlights of the 2001 National Household Travel Survey, U.S. Department of Transportation, Bureau of Transportation Statistics, http://www.bts.gov/products/national_household_travel_survey/fig_highlights_of_the_2001 , Accessed September 2003.
Personal Trips	2.05	

Source:

Benefits	Total
6.94	24.19
6.42	20.69

Source:

Office of the Secretary of Transportation, The Value of Saving Travel Time: Departmental Guidance for Conducting Economic Evaluations, U.S. Department of Transportation, April 1997.

User and Economic Costs Input

Delay Costs | Vehicle Operating Costs | Inventory Costs | Economic Costs | Other Costs

Value of Freight

Average payload (lbs.):

Average payload value (\$/lb.):

Average payload value (\$) (calculated)

Discount rate (%)

Inventory cost per hour (calculated): \$/hr per truck

CFLHD Comment box

Help

Update Default Values

SMART WORK ZONE SYSTEM

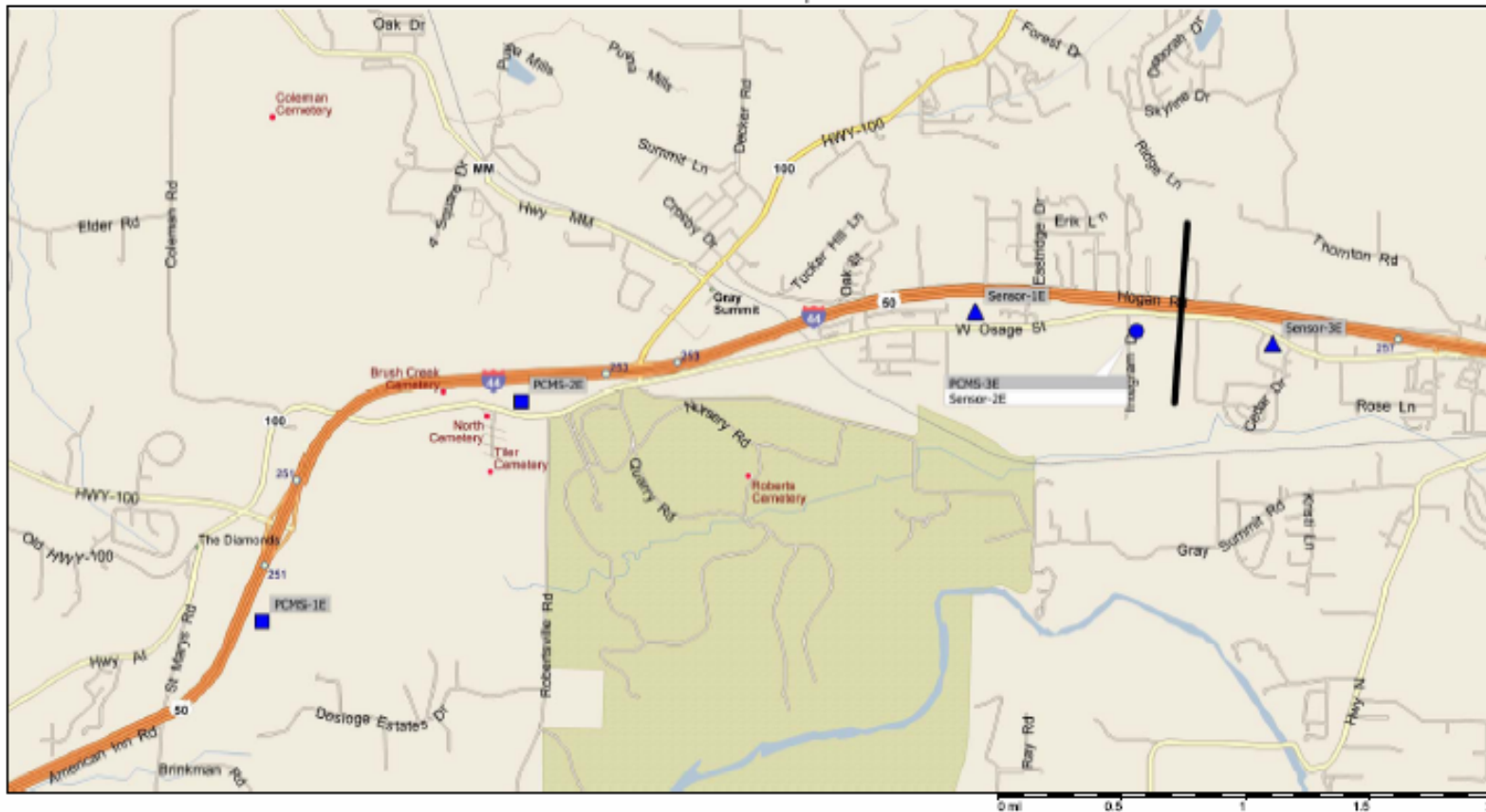
- Provides Real Time Information
 - Travel time through work zone
 - Distance to the end of work zone
 - Decision making by local travelers

SMART WORK ZONE SYSTEM

- Provides Work Zone Management Tool
 - Delay monitoring
 - Flexibility in Operations
 - Enhances Operations

SMART WORK ZONE SYSTEM

Work Zone Map 1



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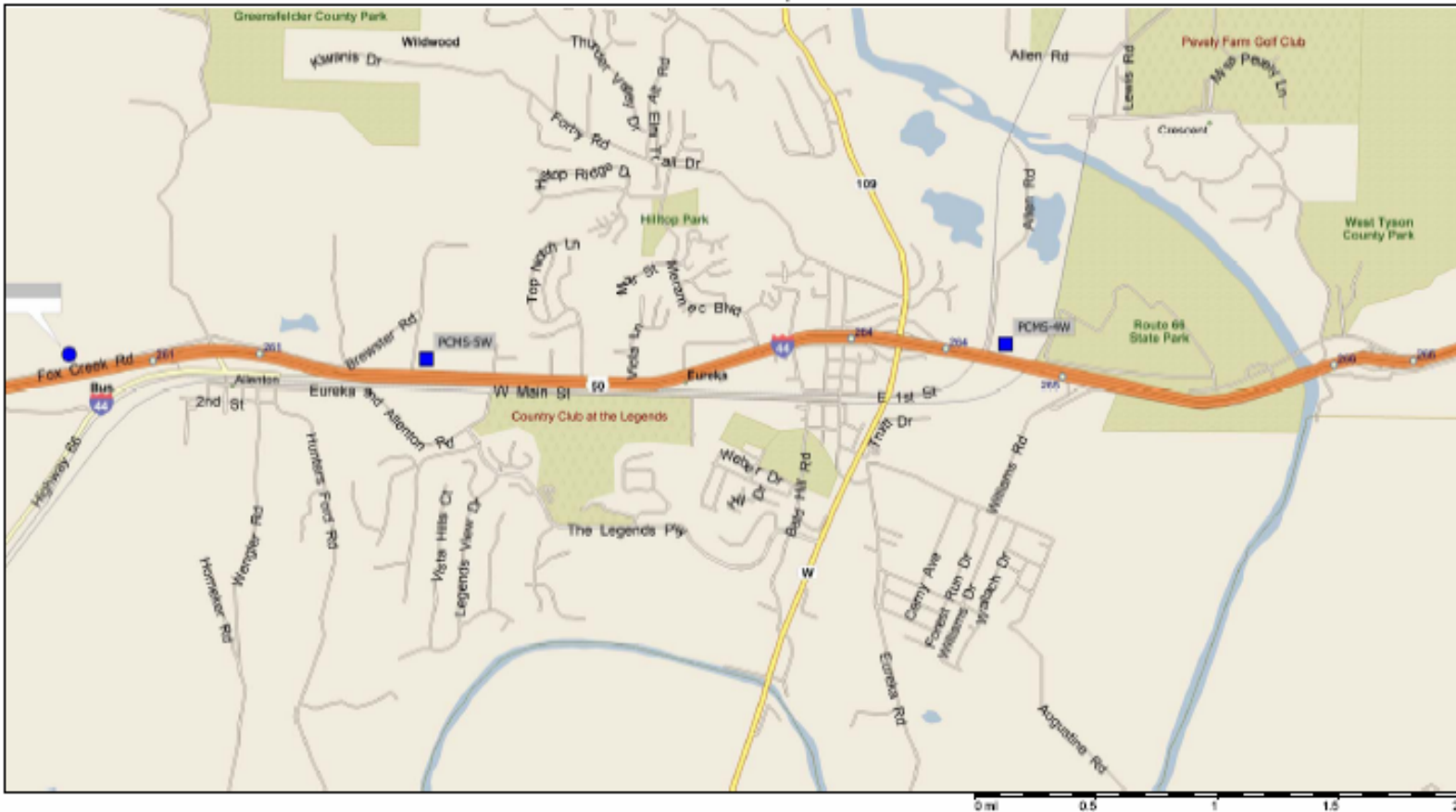
SMART WORK ZONE SYSTEM

Work Zone Map 2



SMART WORK ZONE SYSTEM

Work Zone Map 3



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SMART WORK ZONE SYSTEM

