



# Mobility Reliability of Transportation Systems: Traffic on I-71

Final Research Presentation

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Intermediate



# Why is this important?

S 75 CLOSED  
DOWNTOWN  
AT WESTERN-EX 2A



# Goals and Objectives

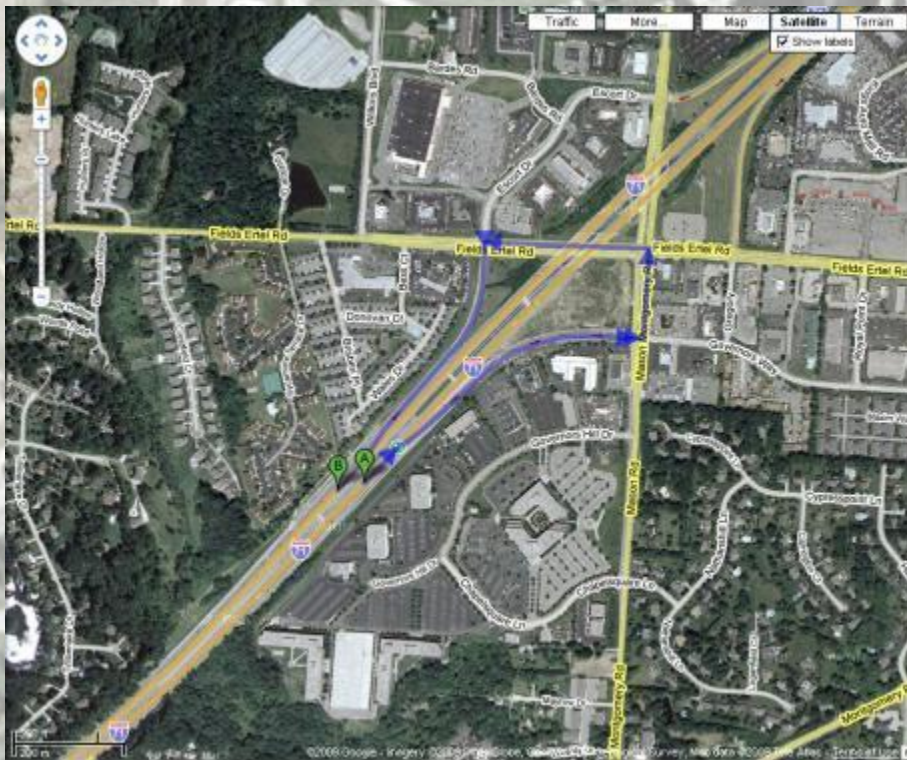
- Find travel time reliability measures along the I-71 corridor from exit 19 to exit 1.
  - Use GPS Data Loggers to acquire travel time data.
  - Use Excel spreadsheet to calculate travel time reliabilities.





# Data Collection

- Drive a car from Exit 19 to Exit 192 (Kentucky) and back. The car should follow the flow of traffic and try to avoid overtaking other vehicles or being overtaken by other vehicles.



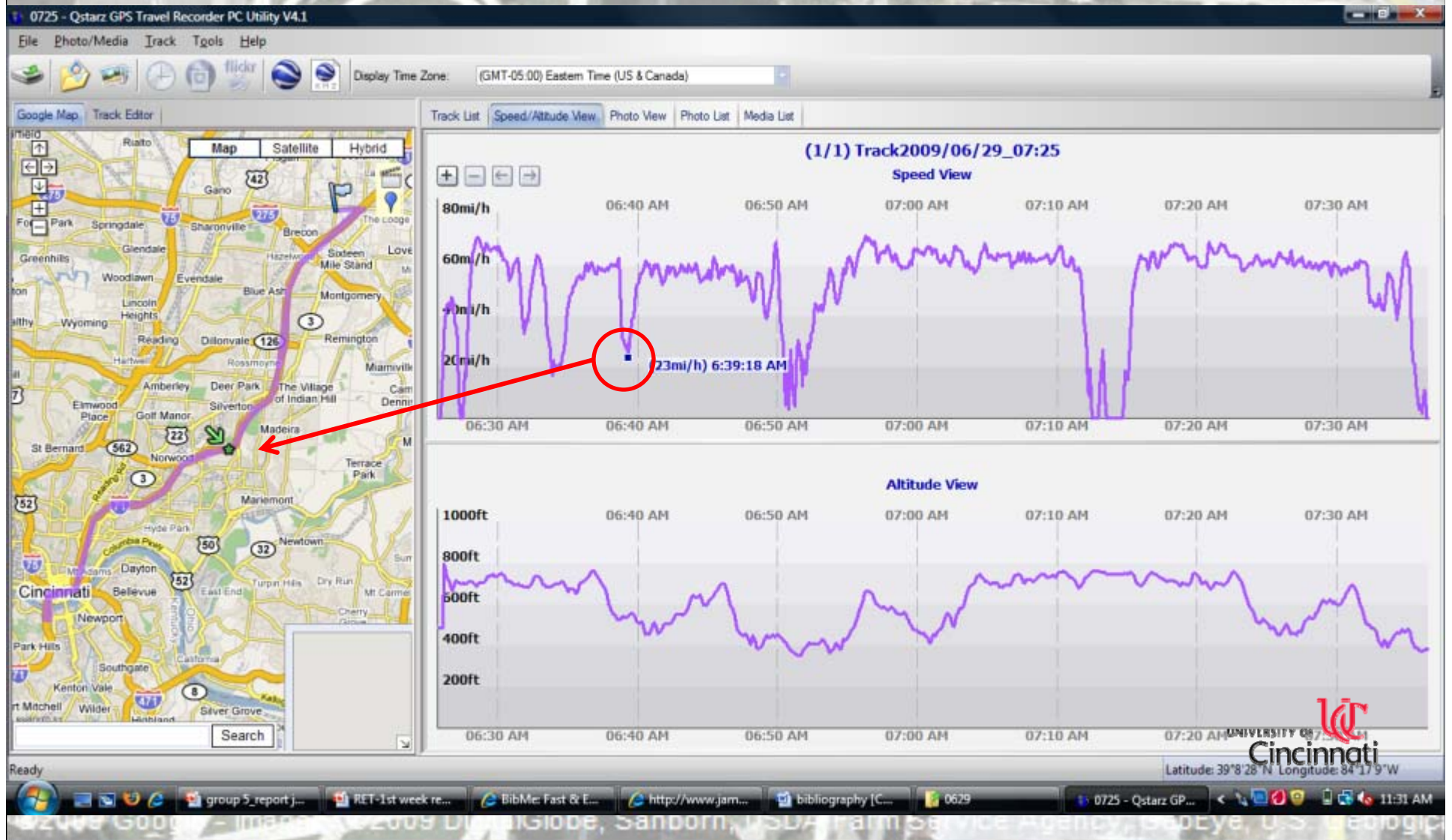
- U-Turn Plan@ exit 19



- U-Turn Plan@ exit 192



- Upload GPS data to Travel Recorder software
- Export to Excel spreadsheet





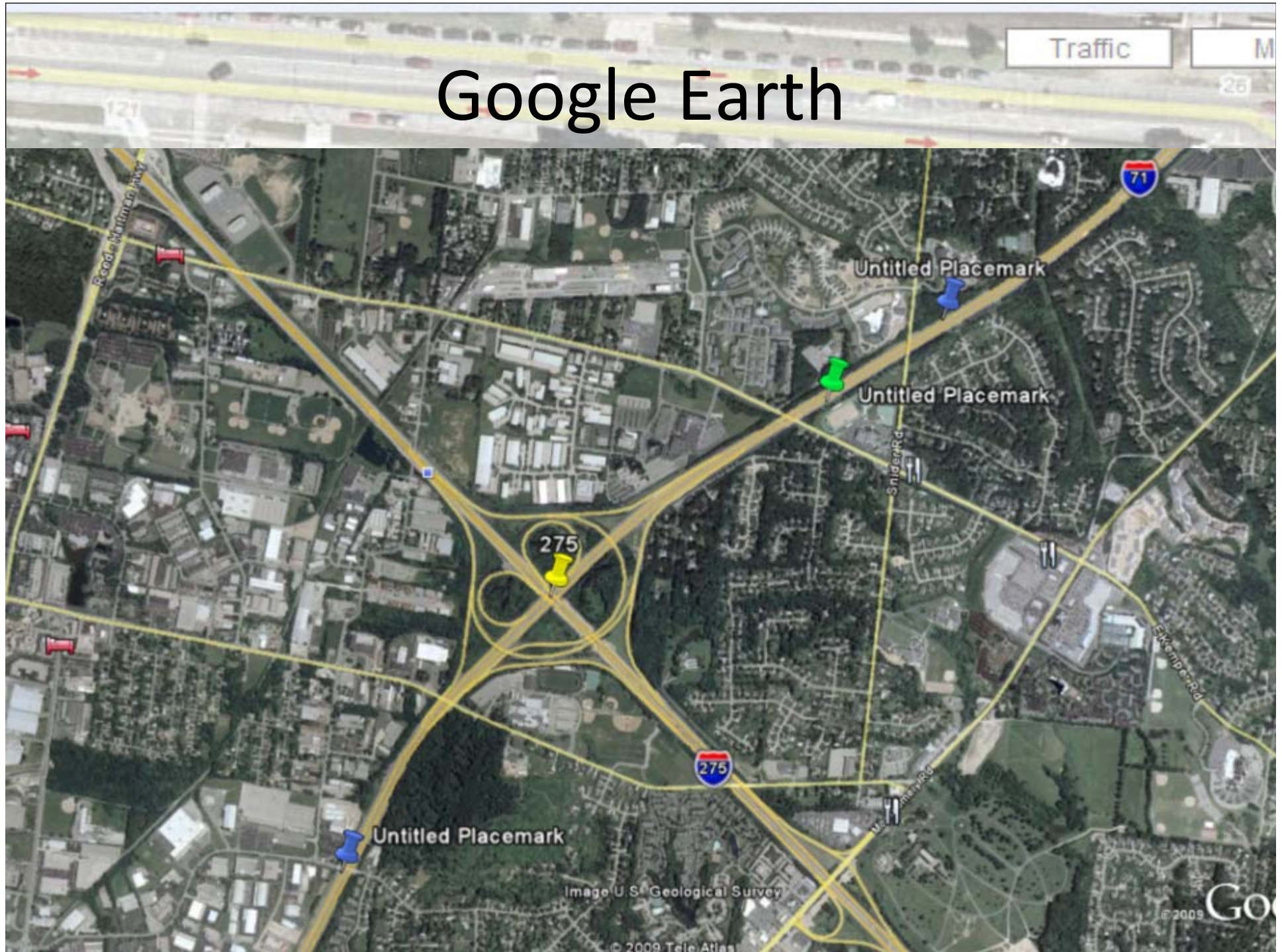
# Convert to Excel file

	A	B	C	D	E	F	G	H	I	J	K
1	INDEX	DATE	TIME	LATITUDE	N/S	LONGITUDE	E/W	ALTITUDE	SPEED		
5883	5882	7/8/2009	12:42:50	39.09813	N	84.51476	W	120.1827	82.52313		
5884	5883	7/8/2009	12:42:51	39.09809	N	84.51502	W	120.0806	81.72395		
5885	5884	7/8/2009	12:42:52	39.09805	N	84.51528	W	120.0867	80.42249		
5886	5885	7/8/2009	12:42:53	39.09802	N	84.51554	W	120.1002	80.80011		
5887	5886	7/8/2009	12:42:54	39.09799	N	84.51579	W	120.1145	78.99171		
5888	5887	7/8/2009	12:42:55	39.09795	N	84.51604	W	120.1919	78.35973		
5889	5888	7/8/2009	12:42:56	39.09792	N	84.51628	W	120.496	78.22572		
5890	5889	7/8/2009	12:42:57	39.09789	N	84.51652	W	120.8898	76.90102		
5891	5890	7/8/2009	12:42:58	39.09785	N	84.51676	W	121.5789	76.06204		
5892	5891	7/8/2009	12:42:59	39.09782	N	84.51701	W	122.3239	75.57971		
5893	5892	7/8/2009	12:43:00	39.0978	N	84.51726	W	123.344	72.97939		
5894	5893	7/8/2009	12:43:01	39.09779	N	84.5175	W	124.2237	70.6991		
5895	5894	7/8/2009	12:43:02	39.09778	N	84.51772	W	125.5407	65.65796		
5896	5895	7/8/2009	12:43:03	39.09779	N	84.51792	W	126.4349	62.67678	pin	
5897	5896	7/8/2009	12:43:04	39.0978	N	84.51811	W	127.5407	60.38778	end of southbound	
5898	5897	7/8/2009	12:43:05	39.09783	N	84.51831	W	128.8638	60.46827		
5899	5898	7/8/2009	12:43:06	39.09788	N	84.5185	W	129.8369	60.93292		
5900	5899	7/8/2009	12:43:07	39.09794	N	84.51867	W	131.2339	59.65063		
5901	5900	7/8/2009	12:43:08	39.09802	N	84.51882	W	131.3694	57.52724		
5902	5901	7/8/2009	12:43:09	39.09811	N	84.51897	W	133.0014	57.90644		
5903	5902	7/8/2009	12:43:10	39.09821	N	84.5191	W	133.7085	55.29136		
5904	5903	7/8/2009	12:43:11	39.0983	N	84.51923	W	134.821	53.10072		
5905	5904	7/8/2009	12:43:12	39.09838	N	84.51936	W	135.7682	52.55142		
5906	5905	7/8/2009	12:43:13	39.09846	N	84.51948	W	137.0567	53.69079		
5907	5906	7/8/2009	12:43:14	39.09853	N	84.51962	W	138.7899	53.7018		

0733yao north south north2 south2



# Google Earth





# MAP 3

## Segmentation Plan of Freeway Corridor Studied

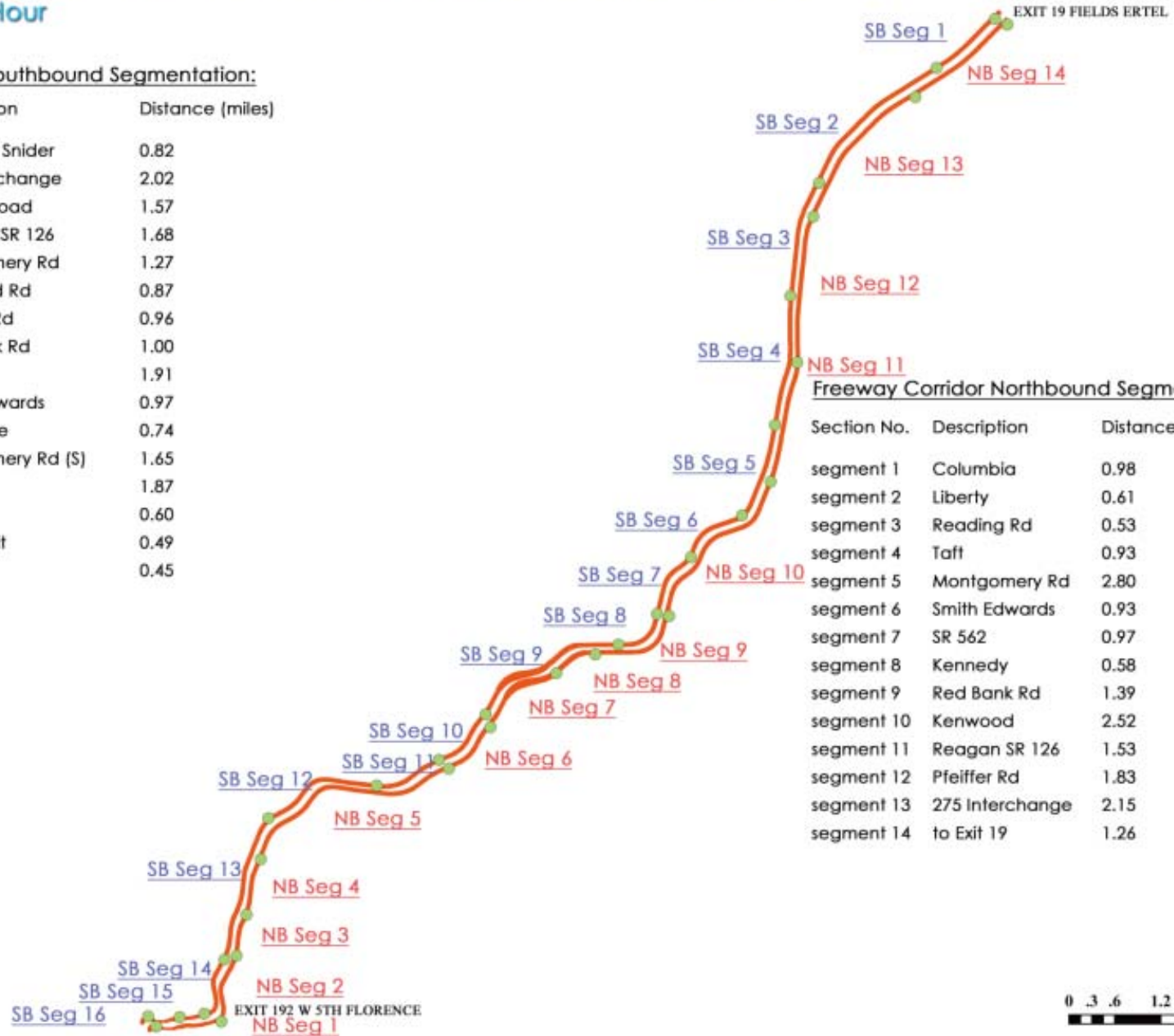
Morning Peak Hour

### Freeway Corridor Southbound Segmentation:

Section No.	Description	Distance (miles)
segment 1	Exit 19 to Snider	0.82
segment 2	275 Interchange	2.02
segment 3	Pfeiffer Road	1.57
segment 4	Reagan, SR 126	1.68
segment 5	Montgomery Rd	1.27
segment 6	Kenwood Rd	0.87
segment 7	Stewart Rd	0.96
segment 8	Red Bank Rd	1.00
segment 9	SR 562	1.91
segment 10	Smith Edwards	0.97
segment 11	Dana Ave	0.74
segment 12	Montgomery Rd (S)	1.65
segment 13	Taft	1.87
segment 14	Liberty	0.60
segment 15	71/50 split	0.49
segment 16	to finish	0.45

### Freeway Corridor Northbound Segmentation:

Section No.	Description	Distance (miles)
segment 1	Columbia	0.98
segment 2	Liberty	0.61
segment 3	Reading Rd	0.53
segment 4	Taft	0.93
segment 5	Montgomery Rd	2.80
segment 6	Smith Edwards	0.93
segment 7	SR 562	0.97
segment 8	Kennedy	0.58
segment 9	Red Bank Rd	1.39
segment 10	Kenwood	2.52
segment 11	Reagan SR 126	1.53
segment 12	Pfeiffer Rd	1.83
segment 13	275 Interchange	2.15
segment 14	to Exit 19	1.26





# Segmenting Excel and Calculate Travel Times

P403 $=I403*0.621371192$																
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
5826	5825	7/8/2009	12:41:45	39.10423	N	84.50468	W	129.8914	77.93871							48.42887
5827	5826	7/8/2009	12:41:46	39.10403	N	84.50466	W	129.0856	80.34956							49.9269
5828	5827	7/8/2009	12:41:47	39.10383	N	84.50464	W	127.6444	80.24683							49.86307
5829	5828	7/8/2009	12:41:48	39.10363	N	84.50461	W	126.1132	79.17645							49.19797
5830	5829	7/8/2009	12:41:49	39.10343	N	84.50459	W	125.3747	76.77186	segment 15	0:00:39					47.70382
5831	5830	7/8/2009	12:41:50	39.10322	N	84.50457	W	124.7169	75.16614							46.70607
5832	5831	7/8/2009	12:41:51	39.10304	N	84.50451	W	123.7216	75.67885							47.02466
5833	5832	7/8/2009	12:41:52	39.10285	N	84.50445	W	122.6759	76.11206							47.29384
5834	5833	7/8/2009	12:41:53	39.10267	N	84.50439	W	121.5445	72.53384							45.07044
5835	5834	7/8/2009	12:41:54	39.1025	N	84.50433	W	120.9029	72.55778							45.08531
5836	5835	7/8/2009	12:41:55	39.10232	N	84.50427	W	120.0905	72.55779							45.08532
5837	5836	7/8/2009	12:41:56	39.10215	N	84.50421	W	119.2781	72.5578							45.08533
5838	5837	7/8/2009	12:41:57	39.10197	N	84.50415	W	118.4658	72.55781							45.08533
5839	5838	7/8/2009	12:41:58	39.1018	N	84.50409	W	117.6536	72.55782							45.08534
5840	5839	7/8/2009	12:42:07	39.10023	N	84.50464	W	153.6235	56.52805							35.1249
5841	5840	7/8/2009	12:42:08	39.10013	N	84.50467	W	145.014	61.82243							38.41468
5842	5841	7/8/2009	12:42:09	39.10006	N	84.50479	W	130.1365	62.91781							39.09531
5843	5842	7/8/2009	12:42:10	39.09996	N	84.50494	W	126.9059	62.64278							38.92442
5844	5843	7/8/2009	12:42:11	39.09985	N	84.50507	W	126.2823	62.58057							38.88576
5845	5844	7/8/2009	12:42:12	39.09976	N	84.50521	W	126.5949	63.05316							39.17942
5846	5845	7/8/2009	12:42:13	39.09968	N	84.5054	W	126.441	65.47113							40.68187
5847	5846	7/8/2009	12:42:14	39.0996	N	84.50559	W	126.1856	67.29652							41.81612
5848	5847	7/8/2009	12:42:15	39.09953	N	84.50578	W	127.2101	68.29139							42.4343
5849	5848	7/8/2009	12:42:16	39.09944	N	84.50598	W	129.4089	69.25288							43.03175
5850	5849	7/8/2009	12:42:17	39.09939	N	84.50618	W	129.6806	69.55252							43.21793
5851	5850	7/8/2009	12:42:18	39.09936	N	84.50638	W	128.8994	69.56181							43.22371
5852	5851	7/8/2009	12:42:19	39.09933	N	84.5066	W	130.8435	72.38553							44.97828
5853	5852	7/8/2009	12:42:20	39.09929	N	84.50682	W	131.2246	75.19374							46.72322
5854	5853	7/8/2009	12:42:21	39.09926	N	84.50706	W	130.1034	78.35072							48.68488
5855	5854	7/8/2009	12:42:22	39.09922	N	84.50732	W	129.2112	81.56914							50.68471
5856	5855	7/8/2009	12:42:23	39.09918	N	84.50759	W	128.5457	83.61953							51.95877
5857	5856	7/8/2009	12:42:24	39.09913	N	84.50784	W	127.3767	83.8322							52.09091
5858	5857	7/8/2009	12:42:25	39.09909	N	84.50811	W	125.9144	84.67654							52.61556
5859	5858	7/8/2009	12:42:26	39.09905	N	84.50838	W	124.5662	85.14495							52.90662
5860	5859	7/8/2009	12:42:27	39.09901	N	84.50865	W	124.192	85.61013	segment 16	0:00:37					53.19567
5861	5860	7/8/2009	12:42:28	39.09897	N	84.50892	W	123.3126	84.90759							52.75913
5862	5861	7/8/2009	12:42:29	39.09893	N	84.50919	W	122.741	85.82059							53.32644



# Consolidation

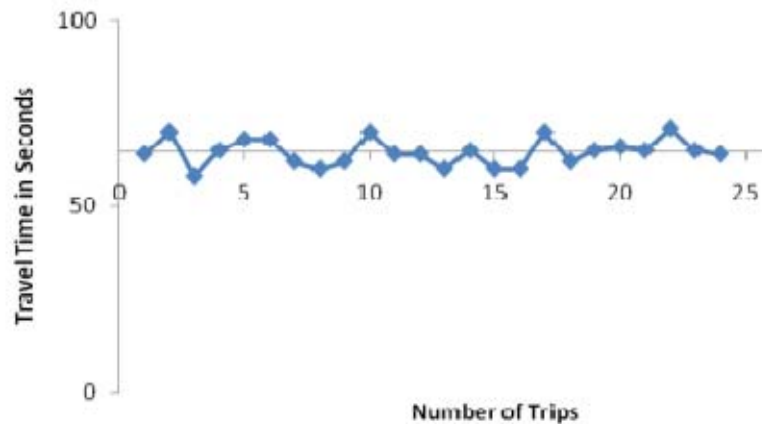


	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Southbound		629				630		701				706 (cf)			708 (cf)
2			kate	brad	yao		1		yao	brad	kate		brad	kate		brad
3	section 1		:46	:45	:44		1:00		1:37	1:37	2:24		:45	:50		:45
4	trip 2			:40			1:00				:48					:40
5																
6																
7																
8																
9	section 2		1:58	1:45	1:42		2:40		6:00	6:00	7:08		1:50	1:48		1:55
10				2:00			2:05				3:12					1:55
11																
12																
13																
14																
15	section 3		3:42	1:40	1:23		2:00		3:07	3:07	3:00		1:20	1:26		1:30
16				1:20			1:30				2:26					1:25
17																
18																
19																
20																
21	section 4		1:08	2:50	1:27		2:00		2:03	2:03	1:46		1:35	1:36		2:35
22				1:40			1:50				3:54					1:40
23																
24																
25																

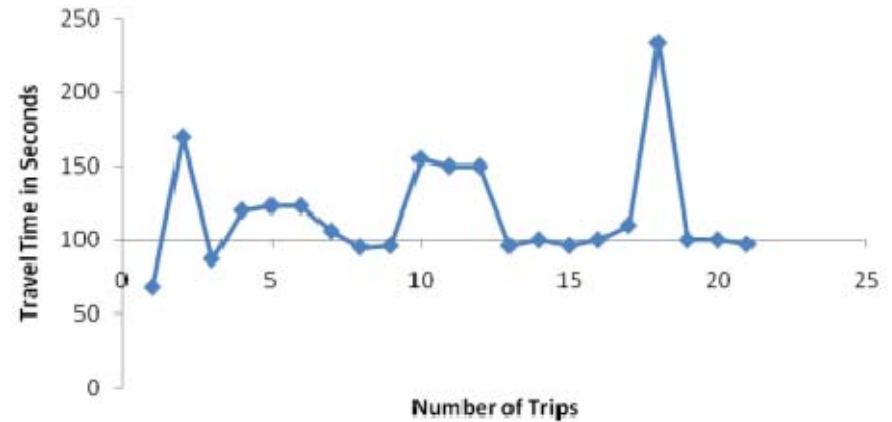


# Determine Critical Segments

SECTION 10

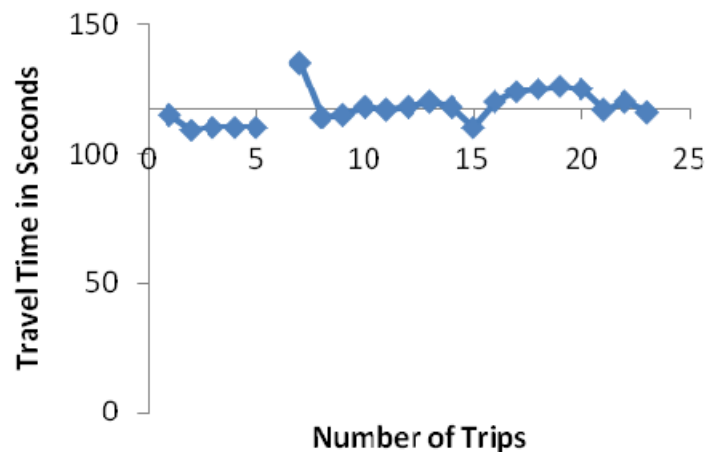


SECTION 4



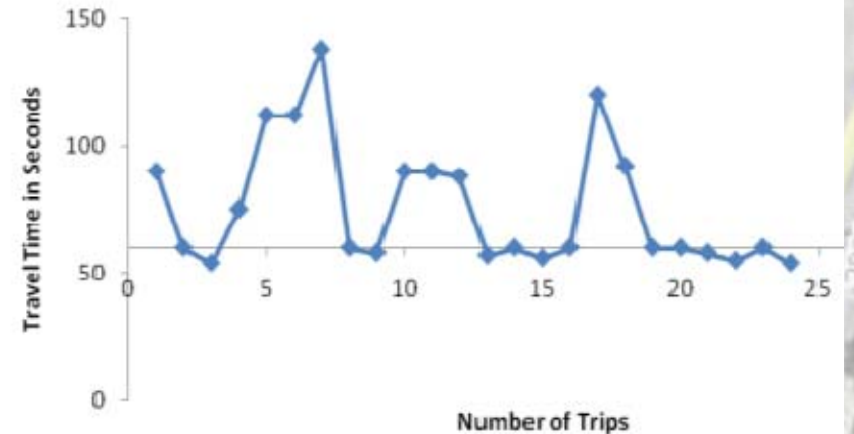
Reliable Segments

Section 13



Critical Segments

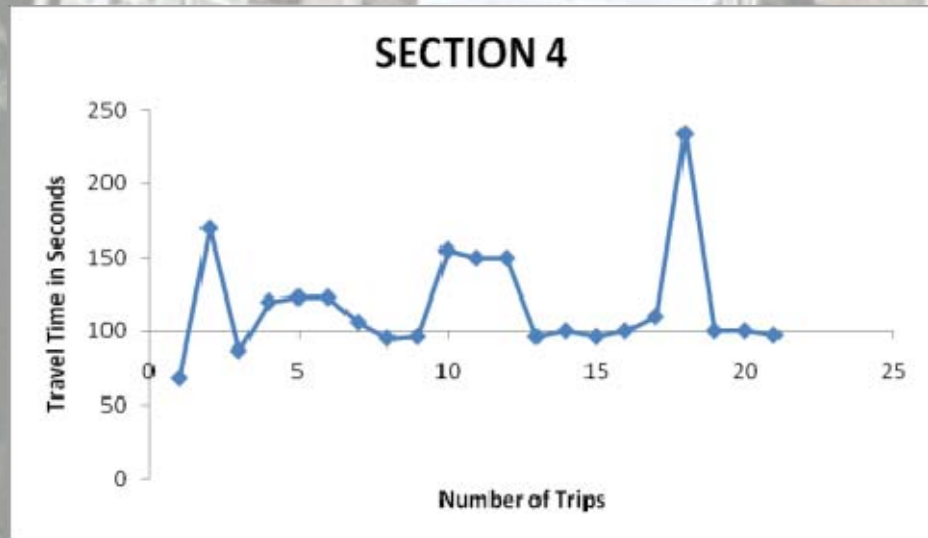
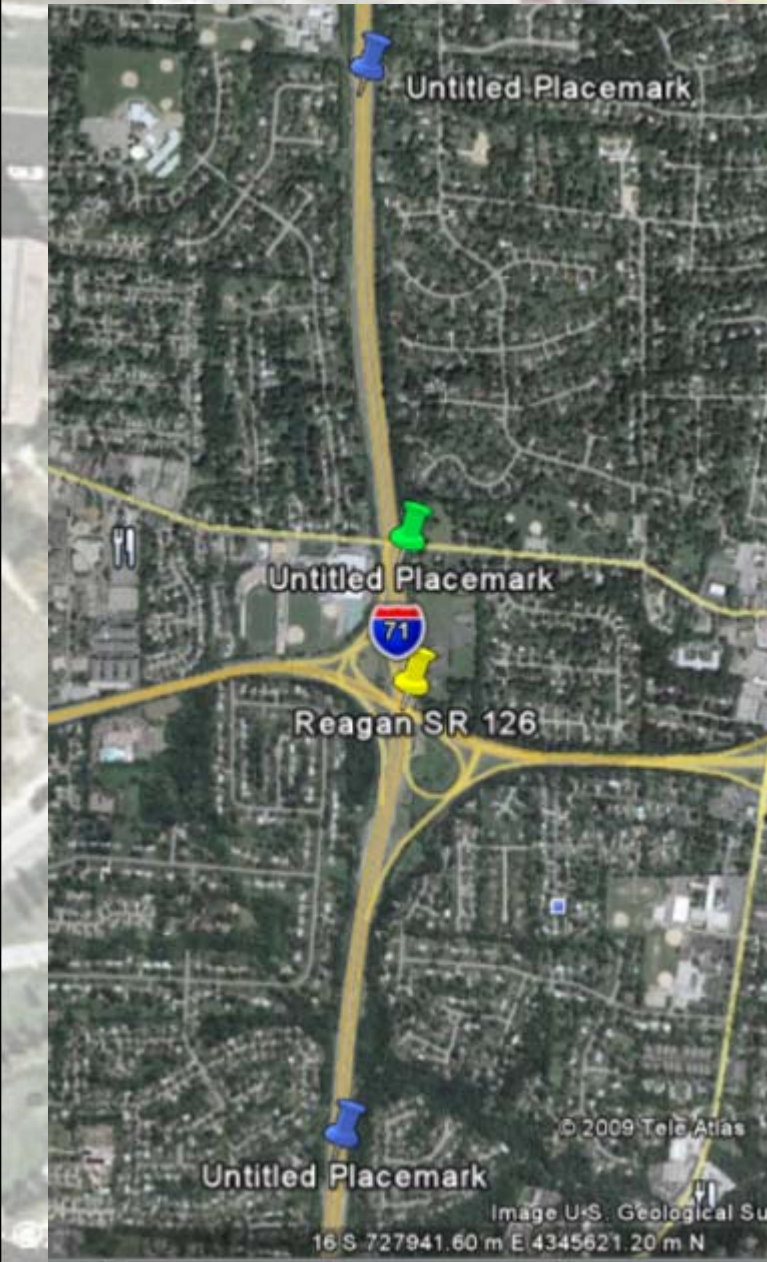
SECTION 7





# Analysis

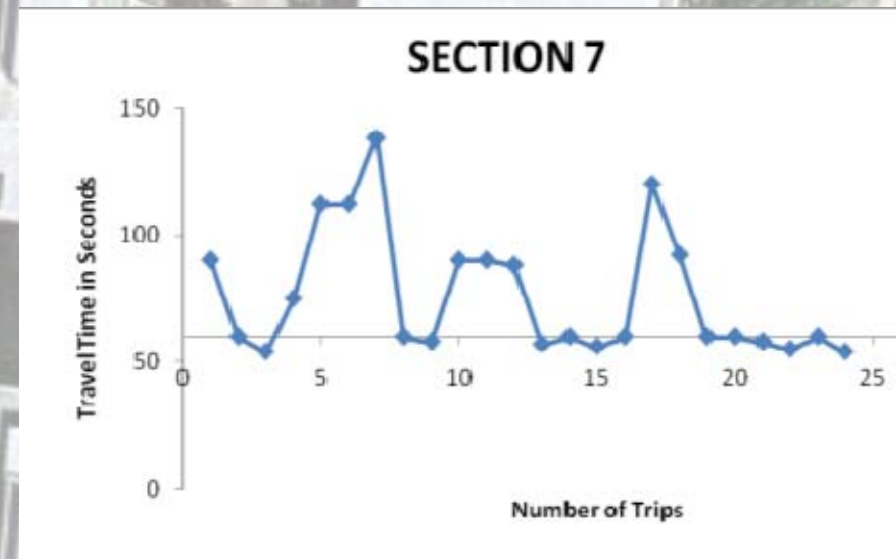
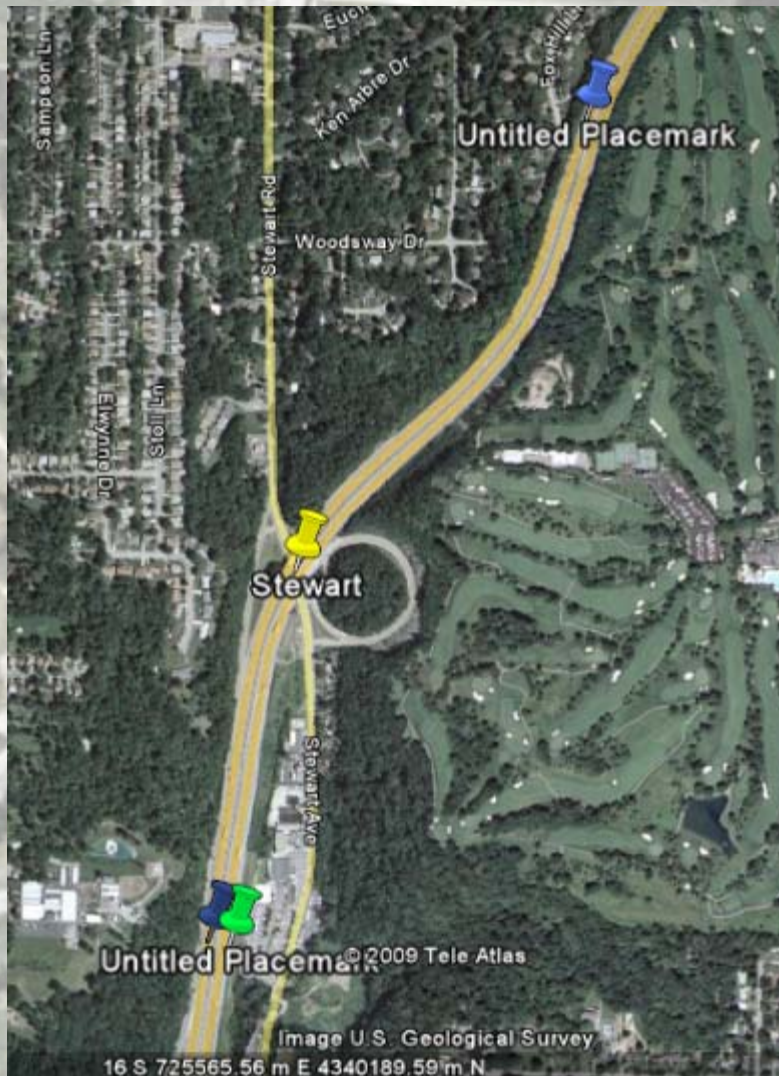
- Determine critical segments
  - Segment 4
  - 25 second delay time
  - 1.68 mile segment





# Analysis

- Determine critical segments
  - Segment 7
  - 13 second delay time
  - .96 mile segment













- Use ARTIMIS video to determine traffic volume on I-71 and the highways level of service.
  - Count cars and heavy vehicles along segments of I-71.
  - Use HCS software to determine specific levels of service.



# Level of Service

- LOS A 11pc/mi/ln
- LOS B 18pc/mi/ln
- LOS C 26 pc/mi/ln
- LOS D 35pc/mi/ln
- LOS E 45 pc/mi/ln
- LOS F >45pc/mi/ln
  
- LOS D or better is acceptable

LOS	Definition	Typ. Illustration
Acceptable	A Represents a free-flow operation. Vehicles are almost completely unimpeded in their ability to maneuver within the traffic stream.	
	B Represents reasonably free-flow operation. The ability to maneuver within the traffic stream is slightly restricted.	
	C Represents a traffic flow with speeds near or at free-flow speed of the freeway. Ability to maneuver within the traffic stream is noticeably restricted.	
	D Represents speeds that begin to decline with increased density. Ability to maneuver within the traffic stream is noticeably limited.	
Unacceptable	E Represents operation at its capacity. Vehicles are closely spaced within the traffic stream and there are virtually no useable gaps to maneuver.	
	F Represents a breakdown of vehicle flow. This condition exists within queues forming behind the breakdown points.	



# Northbound Level of Service

Northbound	Distance (miles)	Description	Level of Service
segment 1	0.98	Columbia	C
segment 2	0.61	Liberty	C
segment 3	0.53	Reading Rd	C
segment 4	0.93	Taft	C
segment 5	2.8	Montgomery Rd	C
segment 6	0.93	Smith Edwards	C
segment 7	0.97	SR 562	C
segment 8	0.58	Kennedy	D
segment 9	1.39	Red Bank Rd	D
segment 10	2.52	Stewart/Kenwood	A
segment 11	1.53	Reagan SR 126	A
segment 12	1.83	Pfeiffer Rd	A
segment 13	2.15	275 Interchange	A
segment 14	1.26	to Exit 19	A



# Southbound Level of Service

Southbound	Distance (miles)	Description	Level of Service
segment 1	0.82	Exit 19 to Snider	D
segment 2	2.02	275 Interchange	D
segment 3	1.57	Pfeiffer Road	D
segment 4	1.68	Reagan, SR 126	D
segment 5	1.27	Montgomery Rd	D
segment 6	0.87	Kenwood Rd	D
segment 7	0.96	Stewart Rd	D
segment 8	1	Red Bank Rd	D
segment 9	1.91	SR 562	C
segment 10	0.97	Smith Edwards	C
segment 11	0.74	Dana Ave	C
segment 12	1.65	Montgomery Rd	B
segment 13	1.87	Taft	C
segment 14	0.6	Liberty	C
segment 15	0.49	71/50 split	C
segment 16	0.45	to finish	C



# MAP 6

## Level of Service/Delay Plan of Freeway Segments

Morning Peak Hour

### LOS/Delay of Freeway Corridor Southbound Segments:

Section No.	Description	L.O.S.	Delay(sec)
segment 1	Exit 19 to Snider	D	9.21
segment 2	275 Interchange	D	39.66
segment 3	Pfeiffer Road	D	25.43
segment 4	Reagan, SR 126	D	24.86
segment 5	Montgomery Rd	D	22.20
segment 6	Kenwood Rd	D	6.05
segment 7	Stewart Rd	D	12.96
segment 8	Red Bank Rd	D	8.21
segment 9	SR 562	C	0.00
segment 10	Smith Edwards	C	1.01
segment 11	Dana Ave	C	5.48
segment 12	Montgomery Rd (S)	B	0.00
segment 13	Taft	C	0.00
segment 14	Liberty	C	0.01
segment 15	71/50 split	C	3.26
segment 16	to finish	C	7.64

### LOS/Delay of Freeway Corridor Northbound Segments:

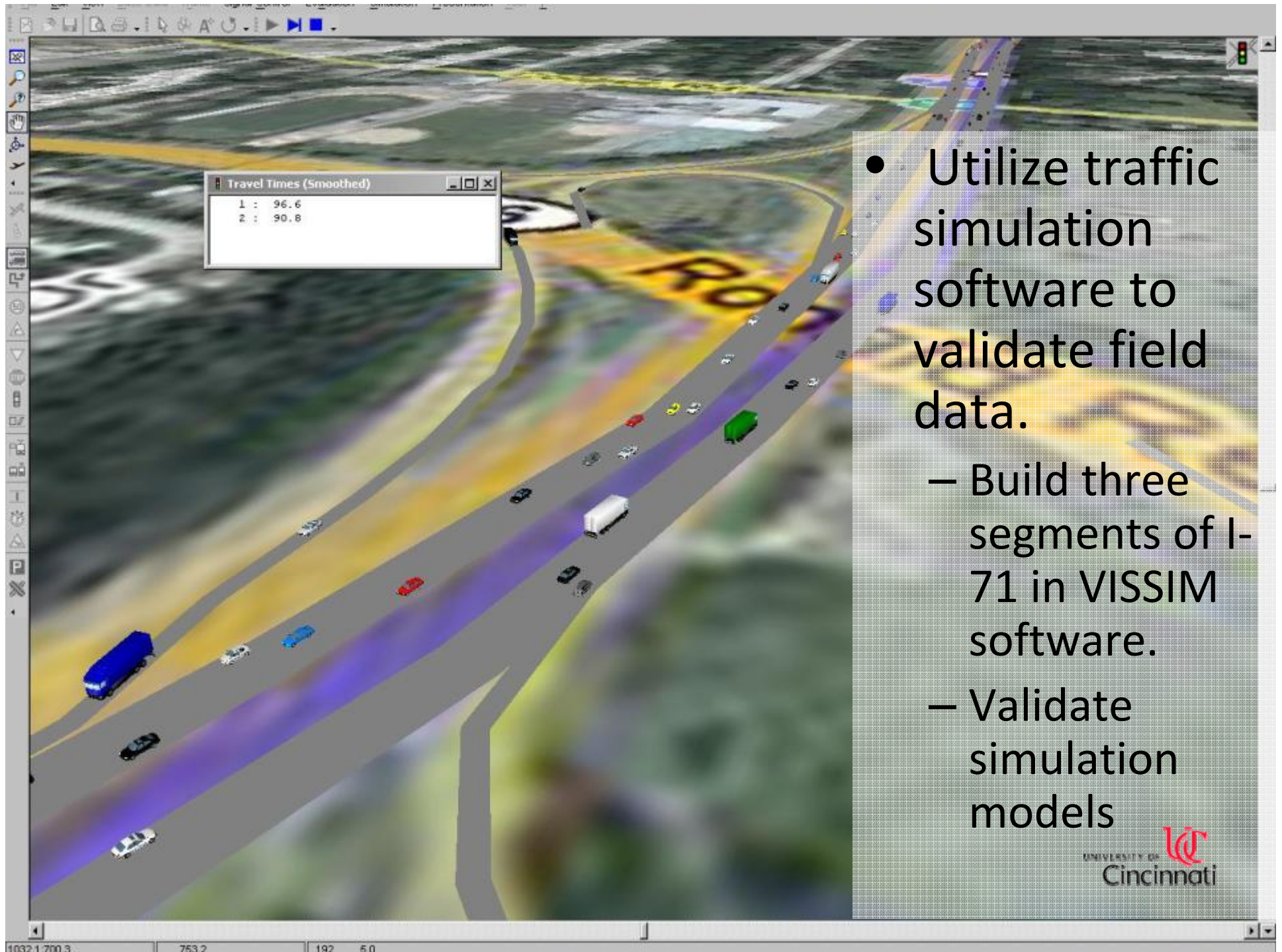
Section No.	Description	L.O.S.	Delay(sec)
segment 1	Columbia	C	4.60
segment 2	Liberty	C	0.00
segment 3	Reading Rd	C	0.00
segment 4	Taft	C	0.00
segment 5	Montgomery Rd	C	0.00
segment 6	Smith Edwards	C	0.00
segment 7	SR 562	C	0.00
segment 8	Kennedy	D	0.00
segment 9	Red Bank Rd	D	12.40
segment 10	Kenwood	A	8.51
segment 11	Reagan SR 126	A	3.49
segment 12	Pfeiffer Rd	A	4.11
segment 13	275 Interchange	A	5.38
segment 14	to Exit 19	A	2.60



NSF-RET Project 5: Measuring Travel Time Reliability of Transportation System

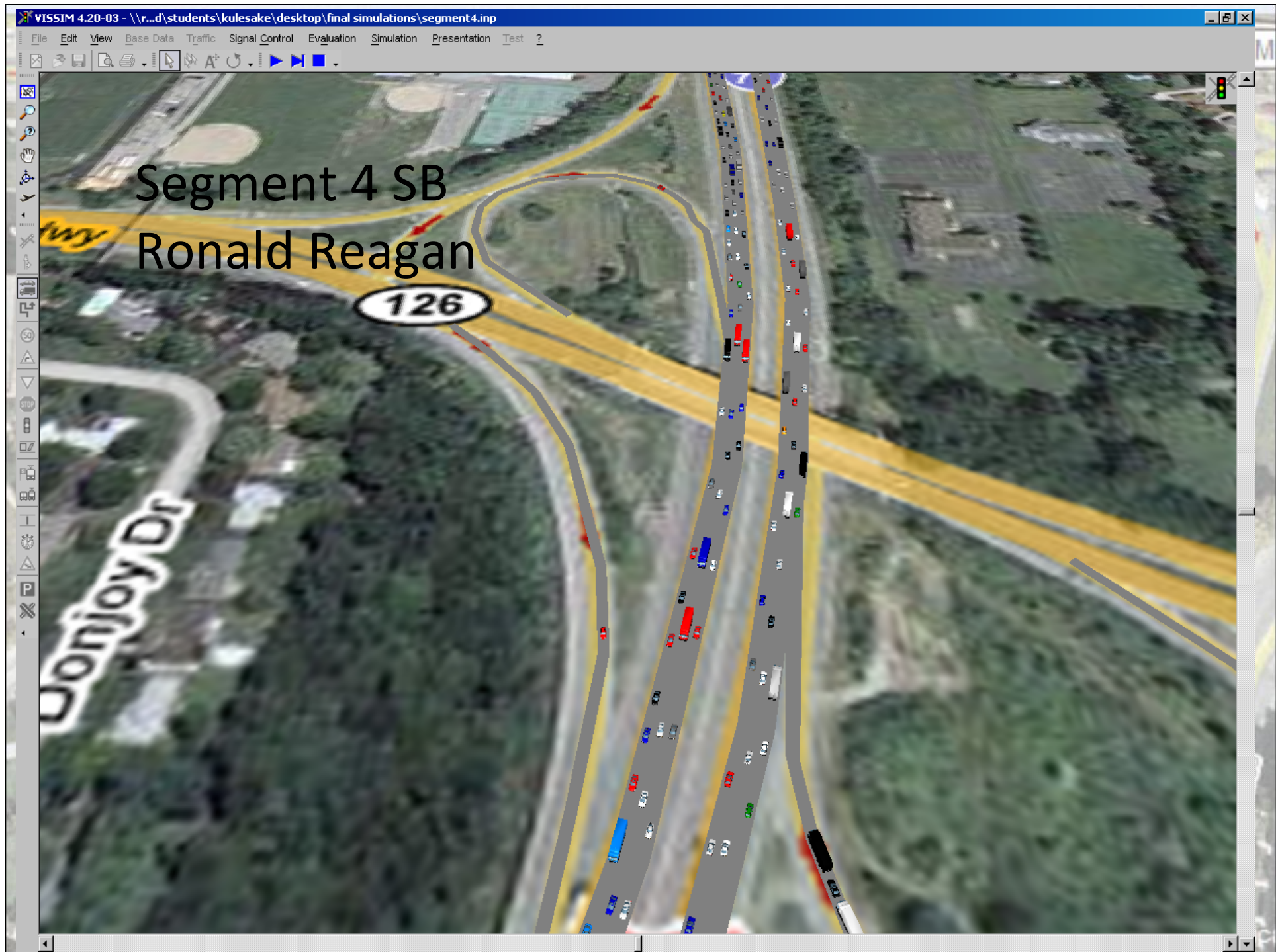
0 .3 .6 1.2 1.8 2.4 Miles





- Utilize traffic simulation software to validate field data.
  - Build three segments of I-71 in VISSIM software.
  - Validate simulation models







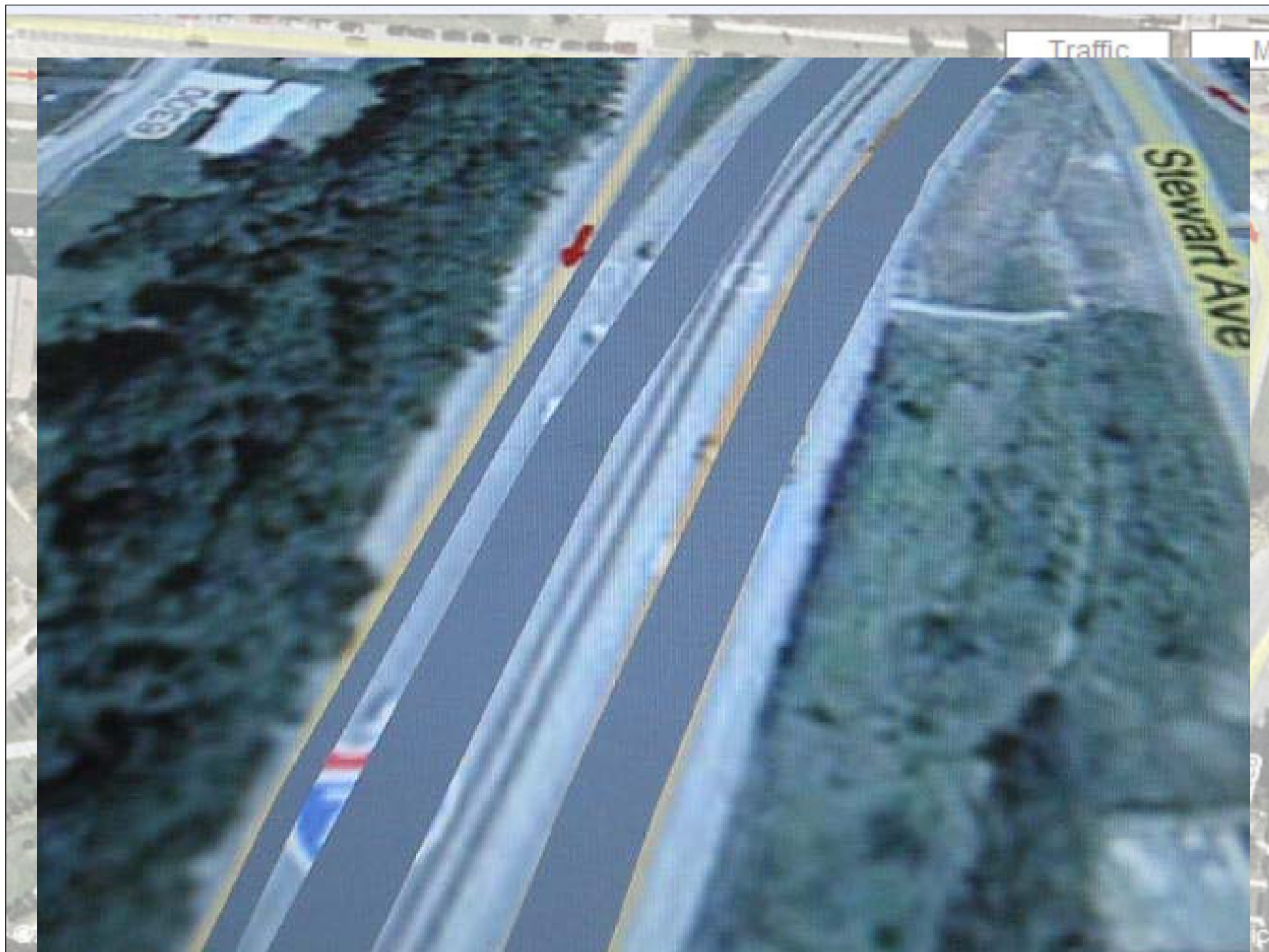






Segment 9 NB  
Red Bank Road









# Reliability

**Buffer Time** – The time that is added to the Average Travel Time to ensure 95% on Time arrival.

$95^{\text{th}}$  percentile time - Average travel time

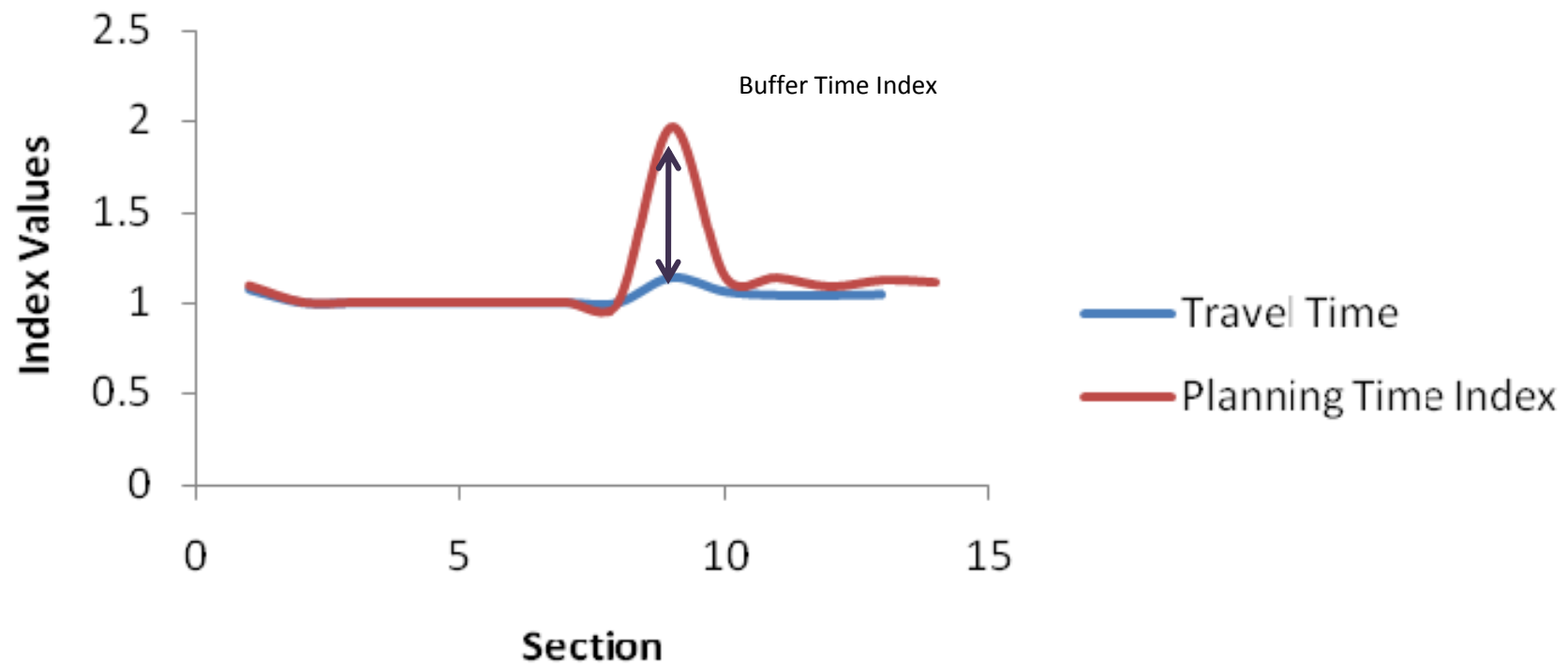
**Buffer Time Index** – Buffer Time / Average travel time

**Travel Time Index** – Average travel time / Free Flow time

**Planning Index** –  $95^{\text{th}}$  percentile time / Free Flow time

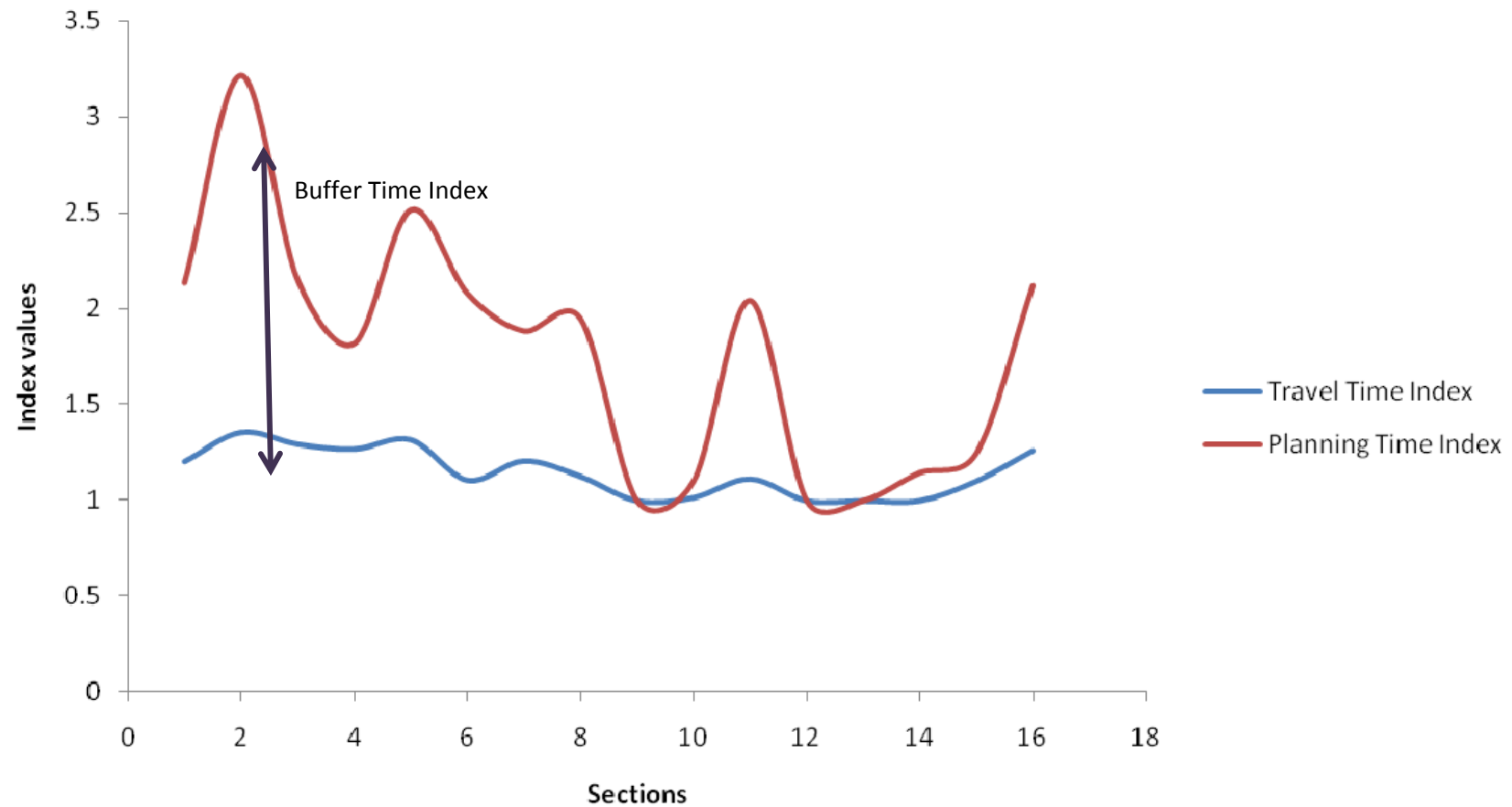


# Planning Time, Travel Time, Buffer Time: Northbound I-71





## Planning Time, Travel Time, Buffer Time: Southbound I-71



## Buffer Time is 95% on Time

SEGMENT	AVERAGE TIME	BUFFER TIME	ON TIME
<b>Fields Ertel Rd to Exit 1</b>	21 min 42 sec	12 min 18 sec	34 min
<b>Fields Ertel Rd to Montgomery</b>	8 min 49 sec	7 min 49 sec	16 min 30 sec
<b>Exit 1 to Fields Ertel Rd</b>	19 min 6 sec	2 min 21 sec	21 min 27 sec



MAP 6

# Level of Service/Delay Plan of Freeway Segments

Morning Peak Hour

## LOS/Delay of Freeway Corridor Southbound Segments:

Section No.	Description	L.O.S.	Delay(sec)
segment 1	Exit 19 to Snider	D	9.21
segment 2	275 Interchange	D	39.66
segment 3	Pfeiffer Road	D	25.43
segment 4	Reagan, SR 126	D	24.86
segment 5	Montgomery Rd	D	22.20
segment 6	Kenwood Rd	D	6.05
segment 7	Stewart Rd	D	12.96
segment 8	Red Bank Rd	D	8.21
segment 9	SR 562	C	0.00
segment 10	Smith Edwards	C	1.01
segment 11	Dana Ave	C	5.48
segment 12	Montgomery Rd (S)	B	0.00
segment 13	Taft	C	0.00
segment 14	Liberty	C	0.01
segment 15	71/50 split	C	3.26
segment 16	to finish	C	7.64

## LOS/Delay of Freeway Corridor Northbound Segments:

Section No.	Description	L.O.S.	Delay(sec)
segment 1	Columbia	C	4.60
segment 2	Liberty	C	0.00
segment 3	Reading Rd	C	0.00
segment 4	Taft	C	0.00
segment 5	Montgomery Rd	C	0.00
segment 6	Smith Edwards	C	0.00
segment 7	SR 562	C	0.00
segment 8	Kennedy	D	0.00
segment 9	Red Bank Rd	D	12.40
segment 10	Kenwood	A	8.51
segment 11	Reagan SR 126	A	3.49
segment 12	Pfeiffer Rd	A	4.11
segment 13	275 Interchange	A	5.38
segment 14	to Exit 19	A	2.60



# Items to Consider

- Data collected during summer months
  - Study of traffic during non-summer months
  - Extended period of study
    - Past data collection
- Data collected during morning peak hours
  - More study during non-peak hours
- Event Analysis
  - Accidents
  - Weather
- What happens if volume is increased?
  - Effects on LOS?