Evaluation of InSync System on Route 291 in Lee's Summit

MoDOT Research Forum

February 24, 2010

Jessica Hutton, MRI

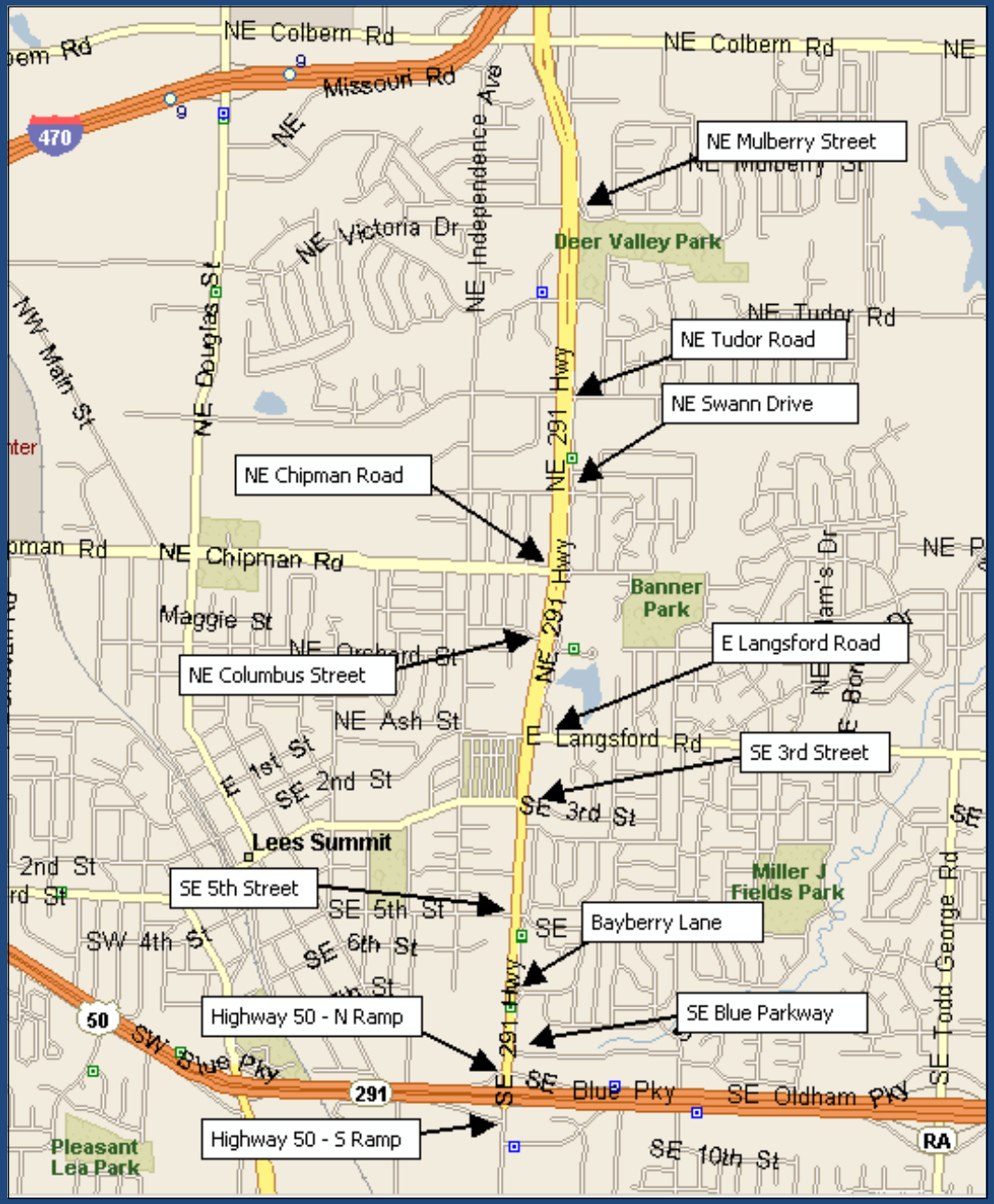
MRI

Map of Study Corridor

- 12 signals from Mulberry on north to US 50 EB ramps on south

- 3 study periods
  - Before (Nov 2008)
  - One month after (April/May 2009)
  - Five months after (Sept 2009)

- Purpose was to evaluate operational performance of InSync system on this corridor

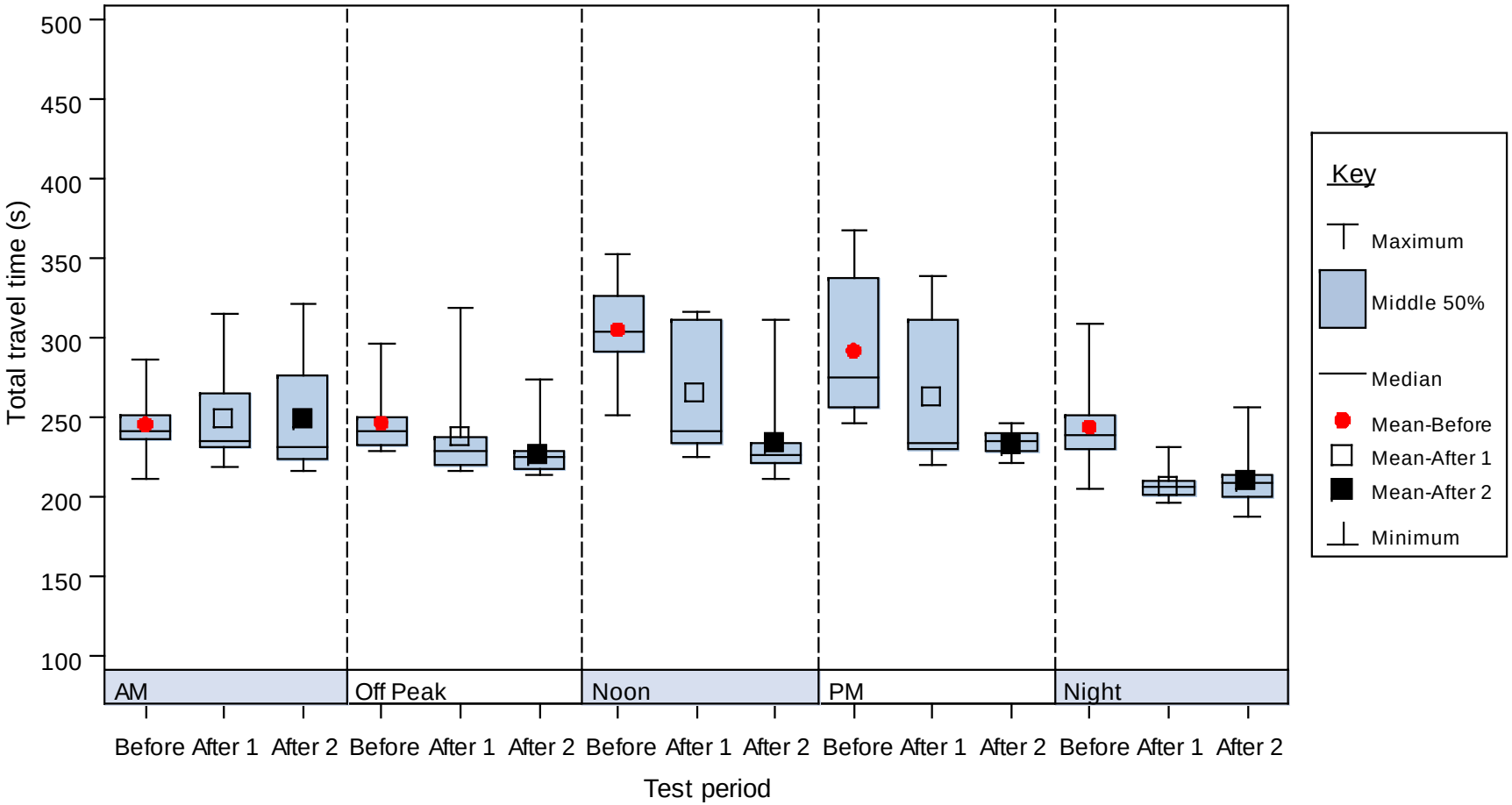


Study Elements

- Travel time study
  - Travel time over corridor
  - Individual intersection delay
  - Fuel consumption and emissions
  - Number of stops
  - Time spent at congested speeds
  - Minor street delay
  - Turning movement count
  - 5 times of day: AM peak, AM off peak, noon peak, PM peak, night off peak
- Minor street delay study
  - 4 intersections: Tudor, Chipman, Columbus, Langsford
  - 3 times of day: AM peak, AM off peak, PM peak
- Volume comparison
  - Volumes taken in 3 locations, both directions of travel
  - Evaluated for noticeable shifts in traffic volumes or patterns
- Turning movement comparison
  - Chipman Road
  - 6:30 am to 6:30 PM
  - Manual counts taken in field with handheld Jamar counter
  - Camera counts recorded by Rhythm and provided to MRI
  - Compared 15-minute counts

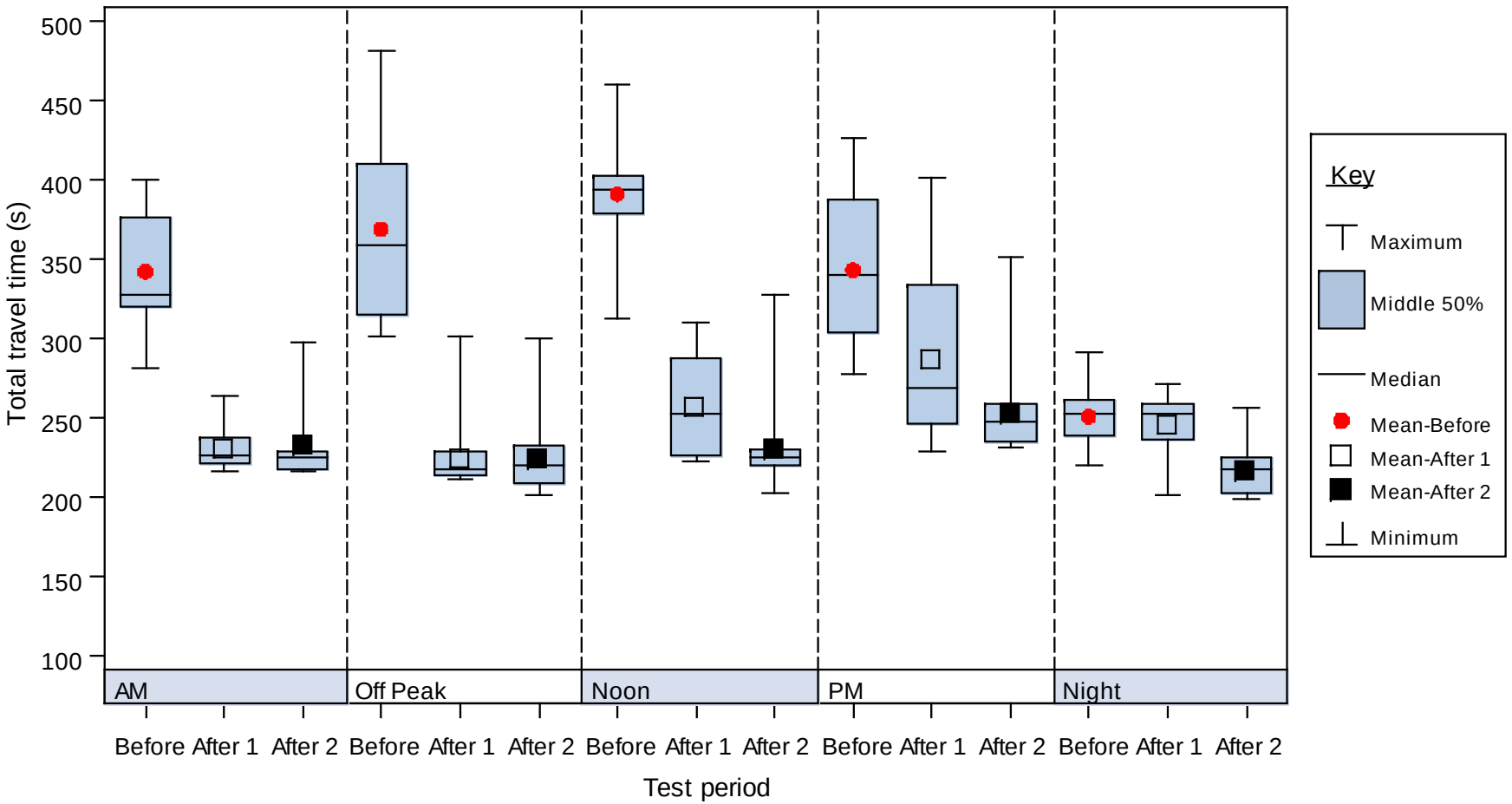
MRI

Northbound



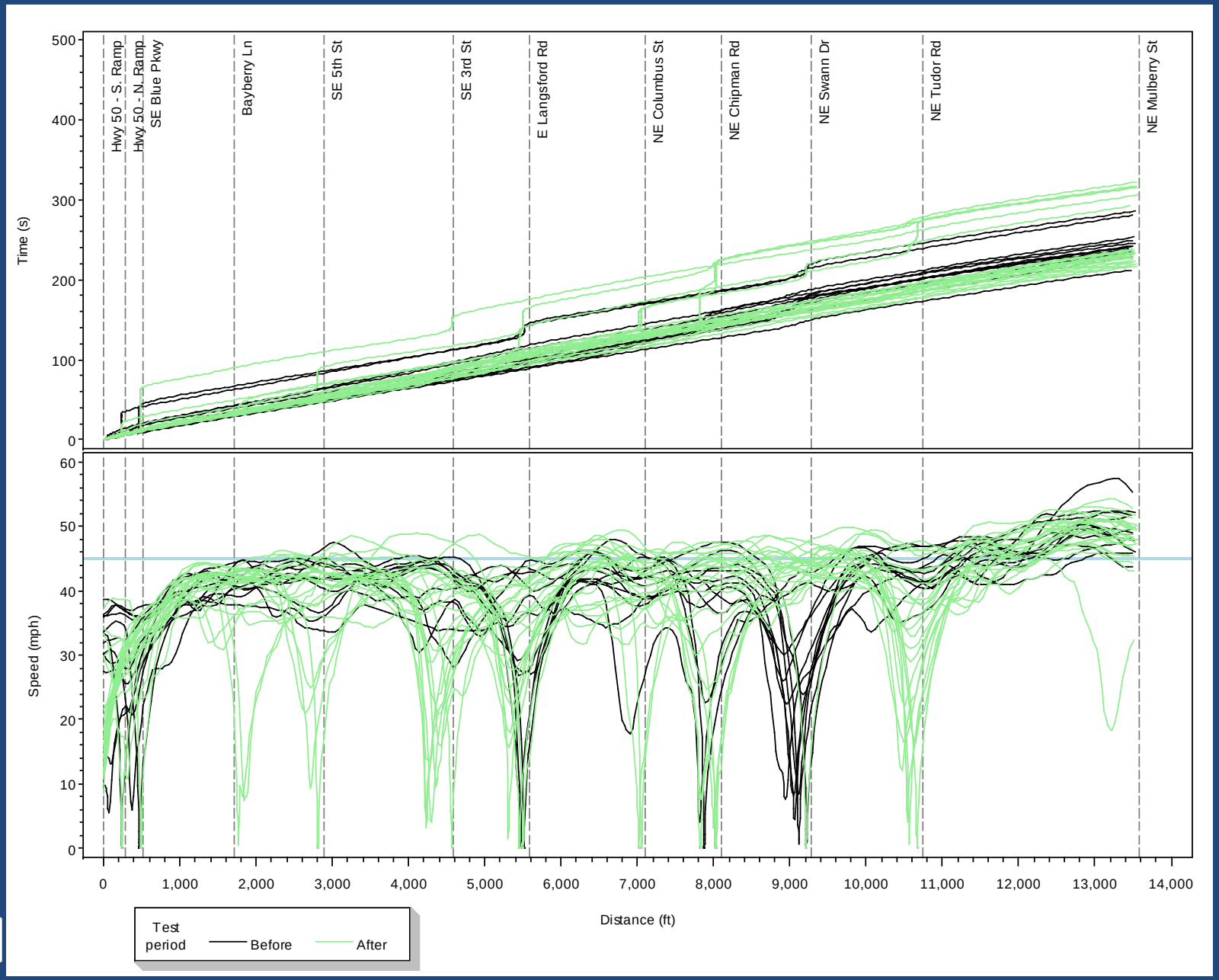
N	12	12	12	12	13	12	11	12	12	13	10	12	12	12	12
Min	212	219	217	229	216	214	252	225	211	247	220	221	205	197	188
Median	241.5	235.5	231	241.5	229	225	304	241	226.5	275	234	235	239	206	209.5
Max	286	315	322	297	319	274	353	317	311	368	339	247	309	232	256
Mean	246.1	250.3	250.0	247.1	239.8	227.8	305.5	266.7	235.0	292.4	264.4	234.8	244.5	208.0	211.2
Std Dev	20.4	33.3	41.4	21.5	30.9	15.9	26.0	40.4	28.3	45.6	47.5	7.3	26.3	10.2	16.7

Southbound

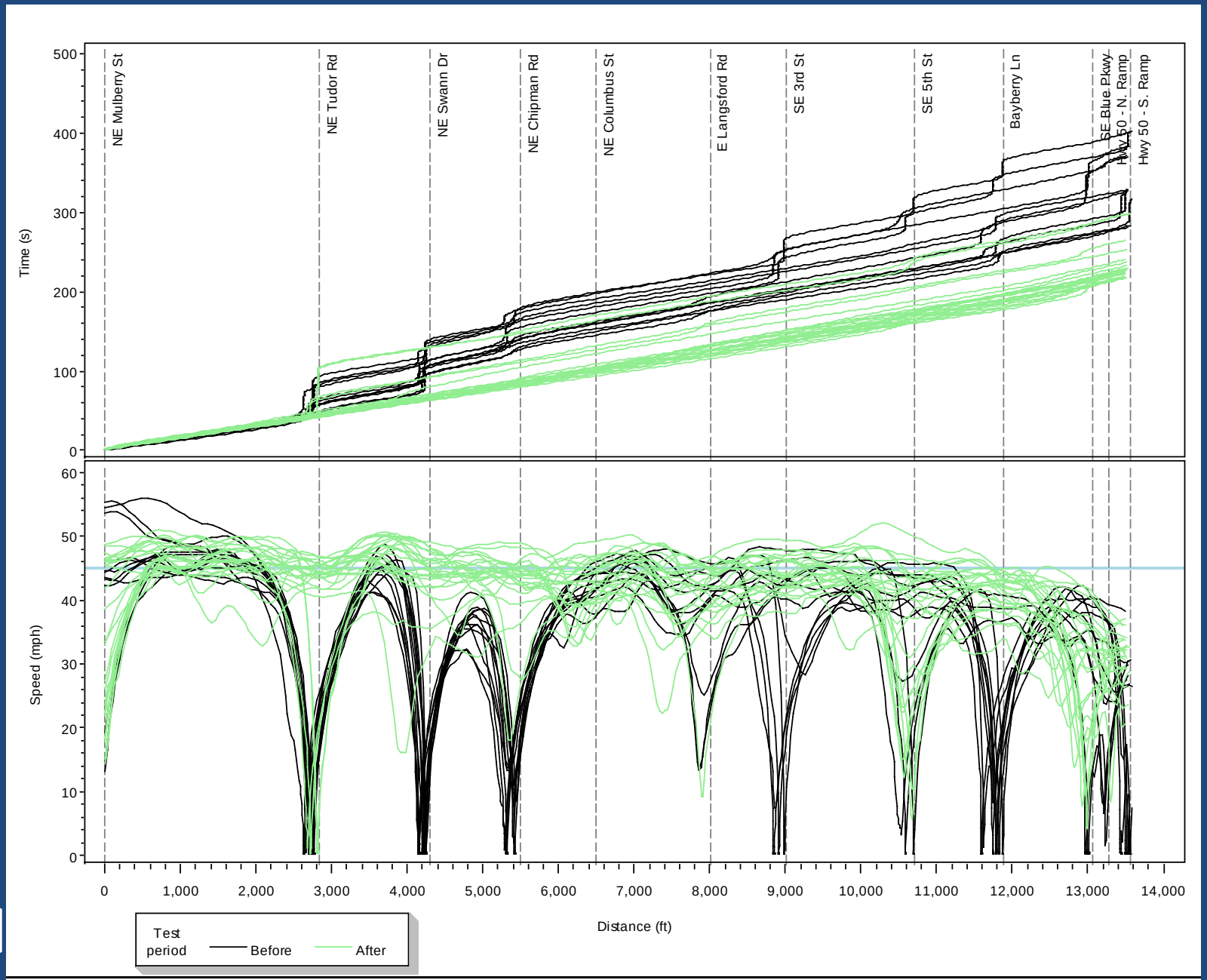


N	12	12	12	12	12	12	10	12	12	11	10	12	12	12	12
Min	281	216	216	301	211	202	313	223	203	278	229	231	220	201	199
Median	328	226	225	359.5	217.5	220	394	252.5	225.5	340	269	247.5	253	253	217.5
Max	401	264	298	482	302	300	461	310	328	427	402	352	291	272	257
Mean	342.7	231.3	234.8	369.6	225.9	225.9	391.5	258.2	231.5	343.6	288.1	254.8	251.2	246.7	217.9
Std Dev	41.6	14.3	29.8	55.7	24.9	26.3	38.7	34.7	31.6	46.4	58.1	32.5	18.7	18.7	17.2

AM Peak Northbound



AM Peak Southbound



Travel Time Run Results

Northbound

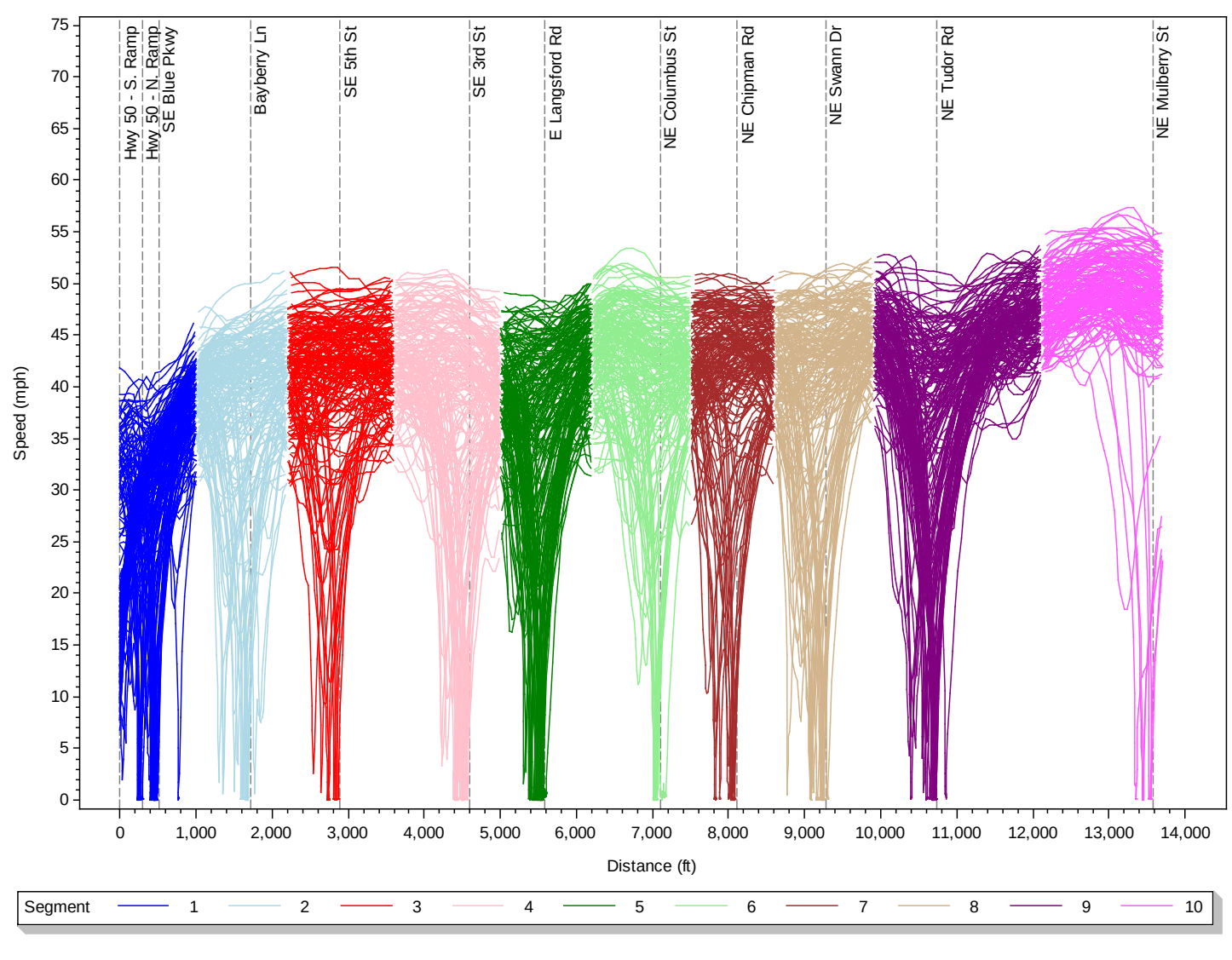
Time period	Travel time (sec)				P-value
	Before	After	Difference	Standard error	
AM Peak	246	250	4	11.5	0.724
AM Off Peak	247	234	–13	8.4	0.130
Noon Peak	306	251	**–55**	12.6	**<.001**
PM Peak	292	248	**–44**	13.7	**0.003**
Night Off Peak	244	210	**–34**	6.6	**<.001**

Southbound

Time period	Travel time (sec)				P–value
	Before	After	Difference	Standard error	
AM Peak	343	233	**–110**	10.7	**<.001**
AM Off Peak	370	226	**–144**	13.4	**<.001**
Noon Peak	392	245	**–147**	13.6	**<.001**
PM Peak	344	270	**–74**	17.5	**<.001**
Night Off Peak	251	232	**–19**	7.6	**0.019**

MRI

Segments for Individual Intersection Analysis



Intersection	Time period	Delay (sec)				P–value
		Before	After	Difference	Standard error	
US 50 Ramps and Blue Parkway	AM Peak	13.4	12.5	–0.9	4.8	0.849
	AM Off Peak	12.5	7.0	–5.5	2.3	0.024
	Noon Peak	19.6	15.1	–4.6	5.8	0.441
	PM Peak	14.5	17.1	2.7	6.7	0.694
	Night Off Peak	11.1	14.7	3.6	5.2	0.497
Bayberry Lane	AM Peak	2.6	3.7	1.2	1.3	0.369
	AM Off Peak	5.8	3.1	–2.7	2.1	0.199
	Noon Peak	4.4	6.7	2.3	2.2	0.319
	PM Peak	11.6	6.4	–5.2	3.1	0.101
	Night Off Peak	2.5	0.9	–1.6	1.1	0.148
5th Street	AM Peak	2.7	4.7	2.0	1.9	0.308
	AM Off Peak	4.0	3.1	–0.9	1.5	0.546
	Noon Peak	5.7	3.9	–1.9	1.7	0.277
	PM Peak	10.1	3.5	–6.7	3.4	0.058
	Night Off Peak	1.9	0.4	–1.5	1.3	0.277
3rd Street	AM Peak	3.6	7.1	3.6	1.9	0.07
	AM Off Peak	5.1	4.6	–0.6	1.4	0.679
	Noon Peak	22.7	4.9	–17.9	4.6	< .001
	PM Peak	20.2	4.6	–15.6	5.0	0.004
	Night Off Peak	0.3	0.7	0.3	0.8	0.678
Langsford Road	AM Peak	7.7	7.5	–0.2	3.1	0.958
	AM Off Peak	10.8	3.5	–7.3	1.7	< .001
	Noon Peak	18.3	5.8	–12.5	7.2	0.09
	PM Peak	23.9	4.9	–19.1	7.0	0.01
	Night Off Peak	11.5	4.1	–7.3	3.2	0.028
Columbus Street	AM Peak	3.1	4.9	1.8	2.6	0.496
	AM Off Peak	3.8	3.6	–0.2	2.0	0.928
	Noon Peak	6.3	4.6	–1.7	3.0	0.585
	PM Peak	5.2	3.4	–1.8	2.3	0.441
	Night Off Peak	3.7	0.0	–3.6	1.4	0.015
Chipman Road	AM Peak	5.9	8.5	2.5	5.6	0.654
	AM Off Peak	2.7	1.8	–0.8	0.6	0.188
	Noon Peak	3.0	6.1	3.1	3.3	0.364
	PM Peak	1.8	4.3	2.5	3.5	0.485
	Night Off Peak	2.8	0.4	–2.4	1.1	0.038
Swann Drive	AM Peak	11.3	2.4	–8.8	1.9	< .001
	AM Off Peak	6.3	3.0	–3.3	2.2	0.149
	Noon Peak	9.8	2.8	–7.0	3.0	0.028
	PM Peak	4.6	5.4	0.8	2.8	0.767
	Night Off Peak	4.5	0.3	–4.2	1.7	0.02
Tudor Road	AM Peak	1.7	6.1	4.4	2.2	0.049
	AM Off Peak	2.7	6.6	3.8	2.2	0.092
	Noon Peak	20.2	5.1	–15.1	4.7	0.003
	PM Peak	6.5	5.4	–1.1	3.4	0.754
	Night Off Peak	12.5	4.3	–8.3	3.3	0.016
Mulberry Street	AM Peak	–0.8	–0.4	0.4	0.7	0.563
	AM Off Peak	–0.7	3.2	3.9	3.2	0.23
	Noon Peak	–0.2	1.1	1.2	2.3	0.59
	PM Peak	–0.9	–0.6	0.3	0.3	0.36
	Night Off Peak	–0.3	–2.1	–1.8	1.2	0.129

Intersection	Time period	Delay (sec)				P–value
		Before	After	Difference	Standard error	
Mulberry Street	AM Peak	6.9	9.9	3.0	4.3	0.497
	AM Off Peak	5.1	18.1	13.0	5.2	0.017
	Noon Peak	23.8	17.9	–5.9	7.1	0.414
	PM Peak	10.1	27.4	17.3	7.6	0.03
	Night Off Peak	1.5	12.4	10.9	6.4	0.096
Tudor Road	AM Peak	27.2	8.5	–18.7	6.2	0.005
	AM Off Peak	31.1	6.2	–25.0	6.2	< .001
	Noon Peak	36.8	4.8	–32.1	3.6	< .001
	PM Peak	32.3	8.7	–23.6	7.4	0.003
	Night Off Peak	14.3	11.2	–3.0	5.0	0.545
Swann Drive	AM Peak	28.3	1.6	–26.7	0.8	< .001
	AM Off Peak	13.6	0.6	–13.0	3.1	< .001
	Noon Peak	22.3	1.2	–21.1	2.8	< .001
	PM Peak	4.4	1.3	–3.1	1.1	0.008
	Night Off Peak	3.1	0.6	–2.5	1.3	0.059
Chipman Road	AM Peak	19.2	2.1	–17.1	1.7	< .001
	AM Off Peak	16.0	1.1	–14.9	3.0	< .001
	Noon Peak	18.8	2.3	–16.4	3.6	< .001
	PM Peak	3.2	13.6	10.3	3.2	0.003
	Night Off Peak	3.5	2.2	–1.3	2.1	0.54
Columbus Street	AM Peak	2.1	2.0	–0.1	0.4	0.779
	AM Off Peak	13.3	2.0	–11.4	3.1	< .001
	Noon Peak	2.9	5.8	2.9	1.5	0.068
	PM Peak	3.1	5.9	2.8	1.6	0.084
	Night Off Peak	6.0	2.0	–4.0	3.0	0.184
Langsford Road	AM Peak	4.3	3.0	–1.3	1.2	0.298
	AM Off Peak	18.8	2.2	–16.6	2.9	< .001
	Noon Peak	22.6	6.0	–16.6	7.0	0.024
	PM Peak	50.9	6.3	–44.6	4.5	< .001
	Night Off Peak	6.3	1.6	–4.6	2.3	0.051
3rd Street	AM Peak	12.1	1.6	–10.6	3.1	0.002
	AM Off Peak	17.3	1.4	–15.9	4.5	0.001
	Noon Peak	27.4	5.2	–22.2	5.6	< .001
	PM Peak	3.6	8.7	5.1	2.8	0.075
	Night Off Peak	4.3	1.3	–3.0	1.9	0.122
5th Street	AM Peak	9.5	5.2	–4.2	2.7	0.123
	AM Off Peak	7.8	5.1	–2.7	2.4	0.261
	Noon Peak	3.7	7.1	3.4	3.5	0.334
	PM Peak	15.2	3.8	–11.4	3.2	0.001
	Night Off Peak	1.0	1.7	0.7	0.7	0.331
Bayberry Lane	AM Peak	18.4	2.9	–15.5	2.2	< .001
	AM Off Peak	21.0	2.3	–18.7	2.2	< .001
	Noon Peak	10.0	4.2	–5.8	2.7	0.041
	PM Peak	16.4	4.3	–12.2	3.8	0.003
	Night Off Peak	1.5	1.7	0.3	0.4	0.489
Blue Parkway and US 50 Ramps	AM Peak	25.3	10.4	–14.9	4.1	< .001
	AM Off Peak	33.6	8.3	–25.2	5.1	< .001
	Noon Peak	47.9	11.7	–36.2	5.3	< .001
	PM Peak	17.1	20.3	3.1	7.5	0.677
	Night Off Peak	16.7	15.3	–1.4	3.3	0.67

Number of Stops

Direction	Study period	Average number of stops				
		AM peak	AM off peak	Noon peak	PM peak	Night off peak
NB	Before	0.6	0.8	1.8	1.5	1.6
	After	0.7	0.4	0.6	0.7	0.3
	Percent change	*17*	*–50*	*–69*	*–57*	*–81*
SB	Before	3.9	4.6	4.7	2.6	1.8
	After	0.2	0.3	0.6	1.2	1.3
	Percent change	*–95*	*–95*	*–88*	*–56*	*–31*

MRI

Average speed and time spent in congestion

Direction	Time period	Test period	Average speed (mph)	Average time ≤ 3 mph (sec)	Average time ≤ 20 mph (sec)	Average time ≤ 30 mph (sec)
NB	AM peak	Before	37.6	7.6	21.9	40.8
		After	37.4	13.2	26.8	46.8
		Percent change	*–0.4*	*73.0*	*22.1*	*14.7*
	AM off peak	Before	37.5	7.0	20.8	42.8
		After	39.8	5.2	11.9	25.65
		Percent change	*6.0*	*–25.0*	*–42.8*	*–40.1*
	Noon peak	Before	30.4	53.4	76.1	100.5
		After	37.4	14.6	22.6	45.4
		Percent change	*23.2*	*–72.8*	*–70.2*	*–54.8*
	PM peak	Before	32.2	47.4	67.5	92.8
		After	37.5	13.0	25.4	47.5
		Percent change	*16.5*	*–72.5*	*–62.3*	*–48.8*
	Night off peak	Before	38.0	16.9	35.6	54.9
		After	44.1	1.6	7.8	16.6
		Percent change	*15.9*	*–90.2*	*–78.2*	*–69.9*
SB	AM peak	Before	27.3	59.3	113.9	158.3
		After	39.8	5.4	12.4	28.6
		Percent change	*45.8*	*–90.9*	*–89.1*	*–81.9*
	AM off peak	Before	25.5	82.2	138.6	188.1
		After	41.0	5.3	8.9	19.2
		Percent change	*61.0*	*–93.6*	*–93.6*	*–89.8*
	Noon peak	Before	23.8	104.7	161.9	204.7
		After	38.3	11.0	21.2	38.8
		Percent change	*60.9*	*–89.4*	*–86.9*	*–81.1*
	PM peak	Before	27.3	70.5	112.5	151.2
		After	34.8	15.8	40.2	73.0
		Percent change	*27.3*	*–77.5*	*–64.2*	*–51.7*
	Night off peak	Before	36.9	19.9	42.4	60.8
		After	40.0	10.8	24.8	38.8
		Percent change	*8.4*	*–45.7*	*–41.5*	*–36.1*

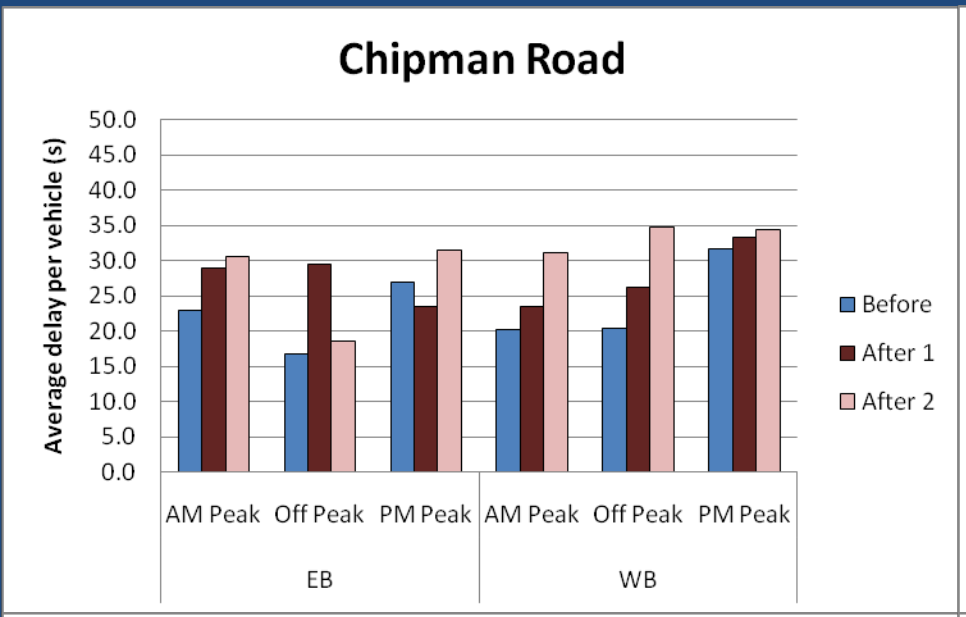
MRI

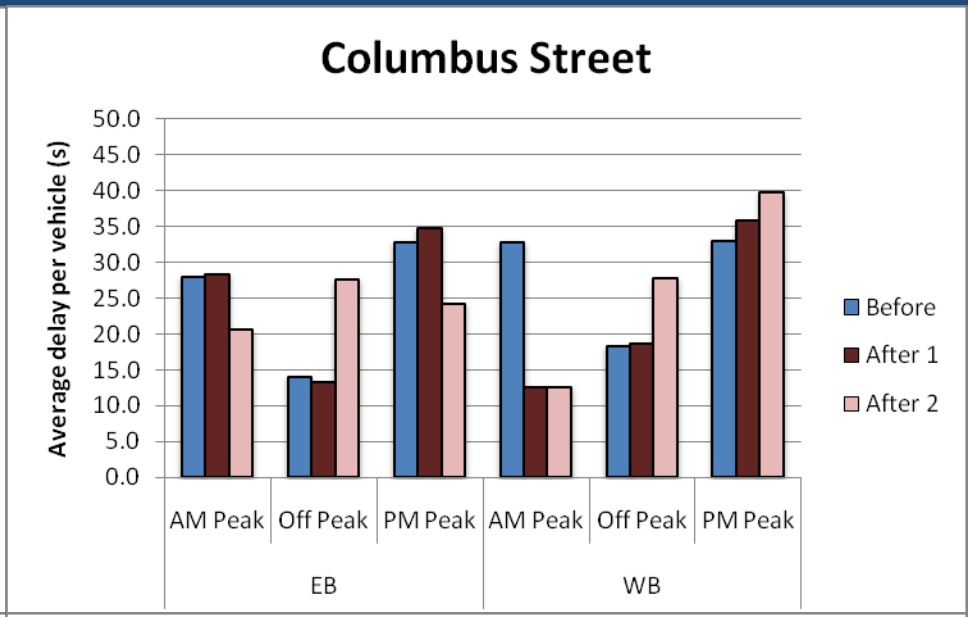
Average fuel consumption and emissions

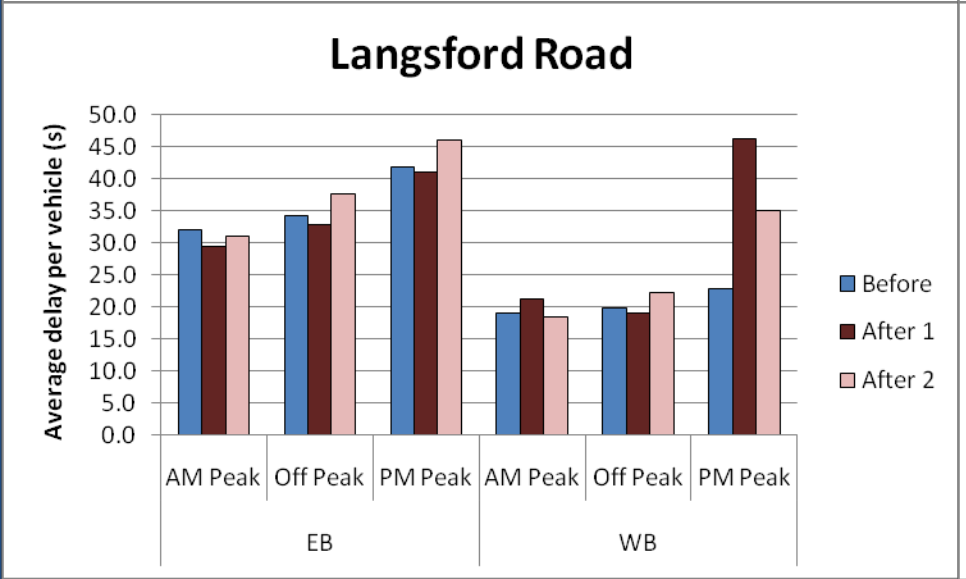
Direction	Time period	Test period	Average fuel consumption (gal)	Average HC (g)	Average CO (g)	Average NO_x (g)
NB	AM peak	Before	0.11	9.70	113.00	5.86
		After	0.12	10.30	117.85	6.38
		Percent change	*4.5*	*6.2*	*4.3*	*8.8*
	AM off peak	Before	0.11	10.50	122.60	6.61
		After	0.11	9.20	109.60	5.42
		Percent change	*0.0*	*–12.4*	*–10.6*	*–18.0*
	Noon peak	Before	0.12	12.00	132.10	7.30
		After	0.12	10.25	118.85	6.26
		Percent change	*–4.2*	*–14.6*	*–10.0*	*–14.2*
	PM peak	Before	0.12	11.60	130.70	7.00
		After	0.12	10.35	120.45	6.44
		Percent change	*–4.2*	*–10.8*	*–7.8*	*–8.1*
	Night off peak	Before	0.12	11.30	134.10	7.38
		After	0.11	8.90	112.45	5.41
		Percent change	*–8.3*	*–21.2*	*–16.1*	*–26.8*
SB	AM peak	Before	0.13	14.00	137.50	9.08
		After	0.11	8.30	97.80	4.55
		Percent change	*–19.2*	*–40.7*	*–28.9*	*–49.9*
	AM off peak	Before	0.13	14.10	137.50	8.80
		After	0.11	8.10	97.70	4.40
		Percent change	*–19.2*	*–42.6*	*–28.9*	*–50.0*
	Noon peak	Before	0.14	15.00	146.40	9.36
		After	0.11	9.25	108.35	5.40
		Percent change	*–21.4*	*–38.3*	*–26.0*	*–42.4*
	PM peak	Before	0.13	12.50	126.50	7.41
		After	0.11	10.85	118.70	6.70
		Percent change	*–15.4*	*–13.2*	*–6.2*	*–9.6*
	Night off peak	Before	0.12	9.50	104.10	5.63
		After	0.11	8.65	99.05	4.99
		Percent change	*–8.3*	*–8.9*	*–4.9*	*–11.5*

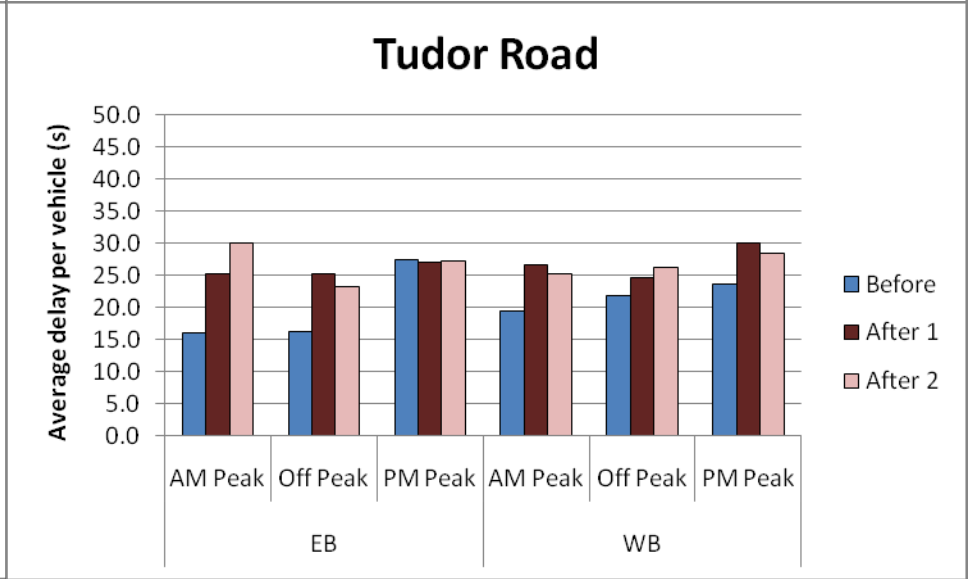
MRI

Minor Street Delay Study

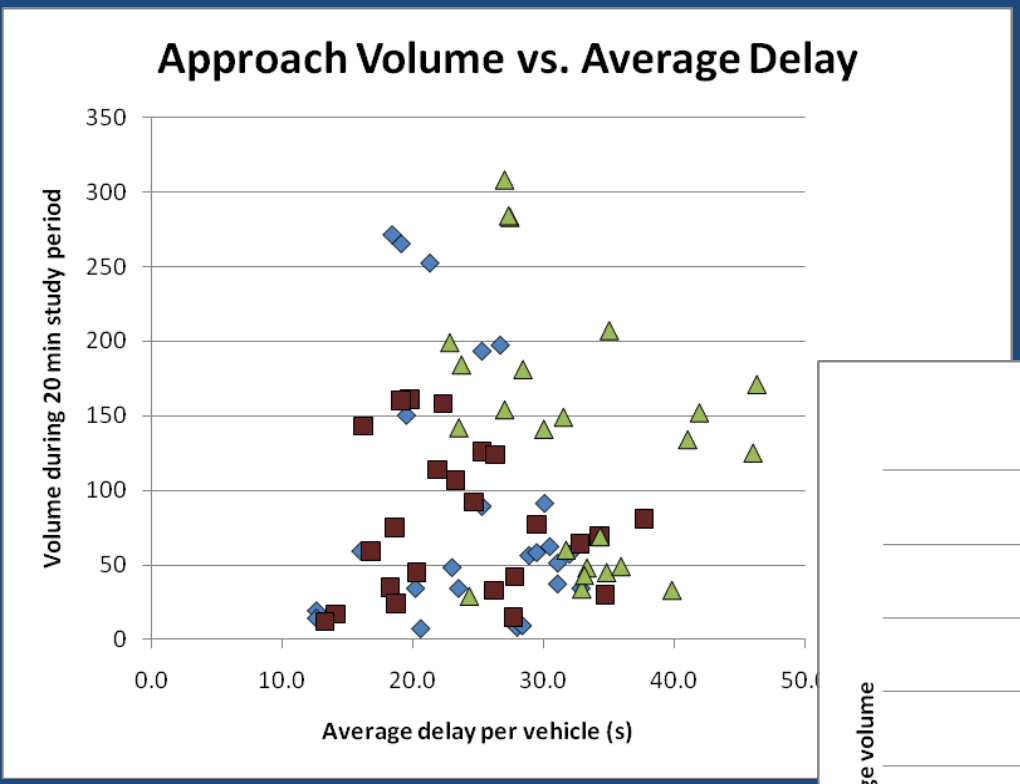




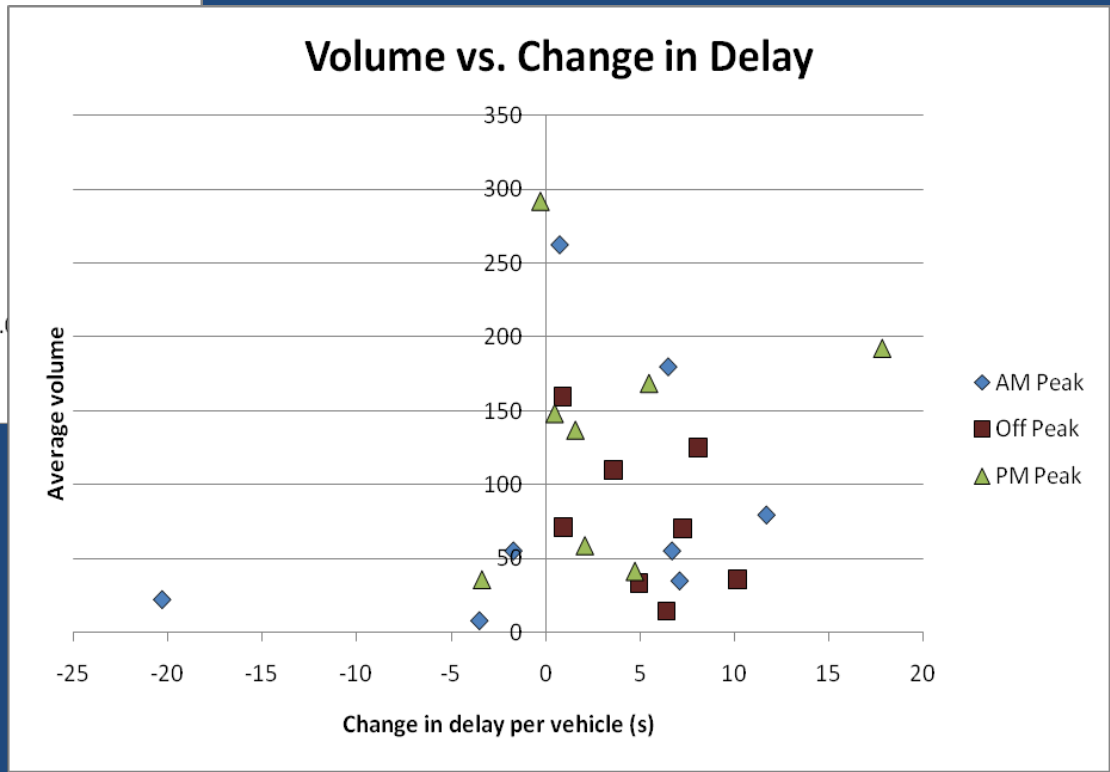




Minor Street Delay



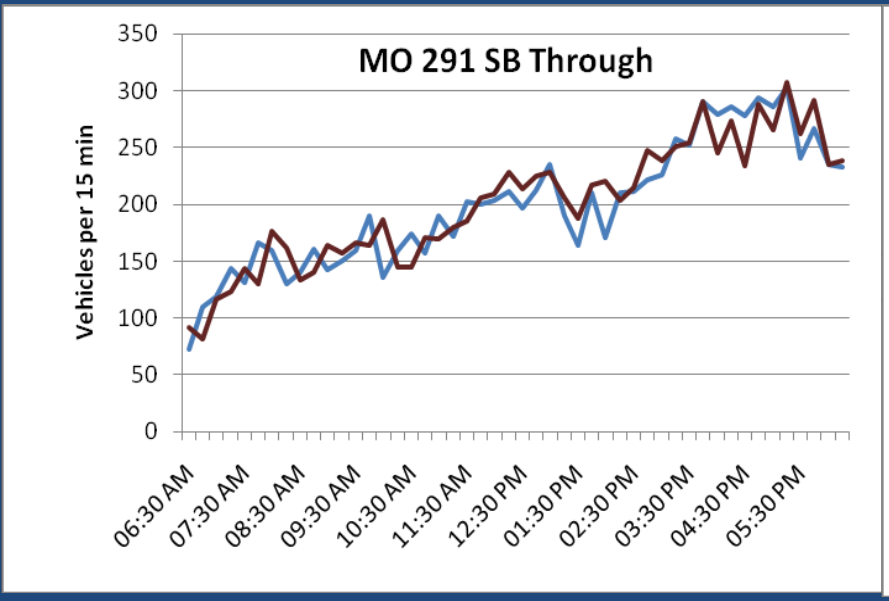
Graph below shows the difference between the before-period delay and the average of the delay measured in the two after periods. Shows that most approaches experienced an increase in average delay between 0 and 10 seconds.

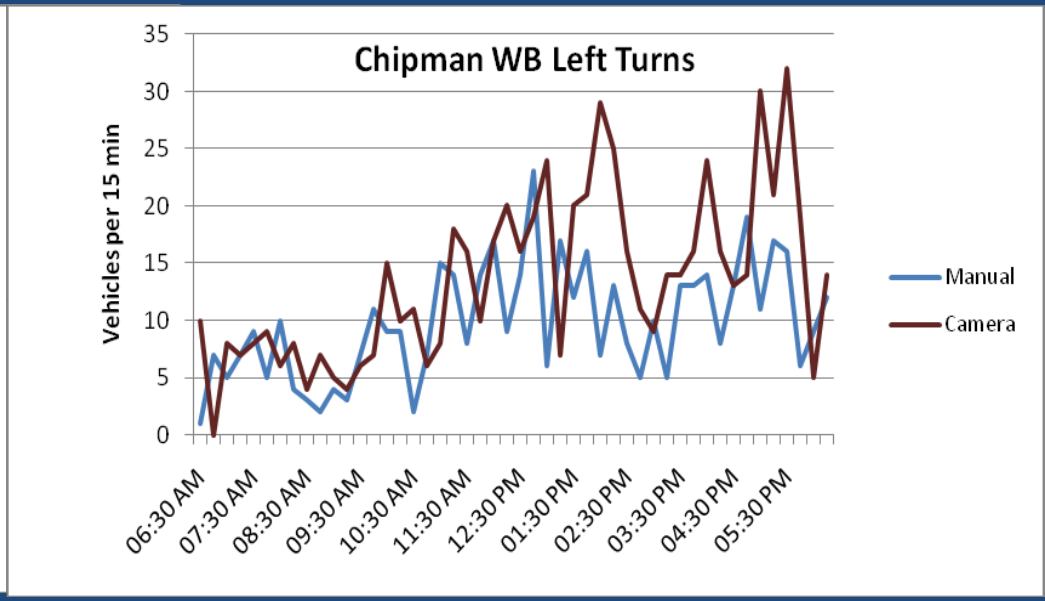


Graph above shows that there was no apparent relationship between volume and delay.

MRI

Turning movement count comparisons at Chipman





Graphs and tables indicate that camera counts typically counted more cars than the manual count, and that both count methods provided similar counts for mainline through movements and less similar counts for other movements.

Approach	Direction	Manual count	Camera count	Percent difference
NB	Right	526	1,020	93.9
	Through	9,679	9,483	–2.0
	Left	1,457	1,760	20.8
	Total	**11,662**	**12,263**	**5.2**
SB	Right	1,145	1,700	48.5
	Through	9,529	9,614	0.9
	Left	631	861	36.5
	Total	**11,305**	**12,175**	**7.7**
EB	Right	2,116	2,153	1.7
	Through	697	1,126	61.5
	Left	1,246	1,528	22.6
	Total	**4,059**	**4,807**	**18.4**
WB	Right	447	704	57.5
	Through	672	1,073	59.7
	Left	469	649	38.4
	Total	**1,588**	**2,426**	**52.8**

MRI

Conclusions

- InSync system resulted in:
  - shorter travel times for through traffic
  - reduced delay for through traffic
  - reduced time spent in congestion
  - fewer stops along the corridor
  - reduced fuel consumption
  - reduced emissions
  - Increase in average delay per vehicle on minor streets
- Most noteworthy improvements:
  - Average travel time reduction of 2.5 minutes (40%) during AM off Peak and Noon Peak in Southbound direction
  - No statistically significant increase in travel time during any time period
  - Average number of stops decreased by ~90% in many instances
  - Average speed increased 5 to 10 mph in many time periods

MRI

Conclusions

- System provided improvement during times of worst delay without harming other times of day
- Increased delay experienced by traffic on minor streets was outweighed by improvements for mainline traffic
- Traffic volume counts indicated that improvements were not due to changes in traffic patterns
- System appears to be a good investment for MoDOT in this location

MRI

Best Applications for InSync

- Locations where traffic growth is expected
- Locations where traffic demand shifts are not easily addressed by time-of-day plans
- Locations with a high number of incidents or special events
- Locations where unbalanced directional demand makes it hard to coordinate timing plans in both directions
- Locations where travel times are substantially higher than free flow

MRI

Future Research Opportunities

- Safety Analysis
  - Lee's Summit PD anecdotally says crashes have been reduced
  - Also believe red-light running has been reduced
- Study of left-turning vehicle delay
  - This study did not capture delay experienced by vehicles turning left from 291 onto side street
- Benefit-cost evaluation
  - Can extrapolate from data in this study, but…
  - Should consider possible negative consequences to minor street traffic
  - Need to make good assumptions about the times of day that were not evaluated, or extend study
- Long-term effectiveness
  - Will the corridor function well into the future without manual retiming?

MRI

Questions?

Jessica Hutton
Midwest Research Institute
jhutton@mriresearch.org

MRI