I-12 RAMP METER SAFETY STUDY

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Louisiana Department of Transportation and Development

ABMB ENGINEERS, INC.

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1 Executive Summary

ABMB Engineers, Inc. (ABMB) conducted a study to evaluate the effectiveness of ramp meters for the performance on Interstate 12 in East Baton Rouge and Livingston Parishes. The ramp meters were deployed in 2010 on 14 entrance ramps which access Interstate 12. Impacts to travel times, travel speeds, safety, and traffic volumes are detailed and analyzed in this study.

This study was conducted by collecting data before and after the implementation of the ramp meters. The data includes volume collection from vehicle detection cameras, radar detection; travel times collected by ABMB and DOTD; as well as safety information from DOTD. This data was graphed and analyzed to observe changes caused by the implementation of ramp meters.

Ramp meters have been proven to increase safety of merging vehicles from the entrance ramps with the interstate traffic. To determine the effectiveness of the ramp meter regarding safety, crash data along the I-12 corridor was obtained from DOTD from 2005 to 2008 prior to ramp meter installation and from 2010 to 2011 after the installation of ramp meters. As shown in Table 1, the overall percentage of accidents has decreased along the Interstate 12 corridor with the use of ramp metering. Additionally, a significant reduction of crashes has been reported on the weaving section between Essen Lane and the I-10 eastbound exit. The number of crashes has reduced from 21 pre-ramp meter to 6 post-ramp meter.

There are two measures of congestion that can be recorded and evaluated: travel time and speed. Travel times were found to be shorter by four minutes on average during the morning commute and by three minutes on average during the afternoon commute. One of the primary concerns about ramp meters is the impact to side streets. Travel times along the on-ramps were collected for both before and after the deployment of ramp meters. The greatest impact was found to be 1:25 minutes. Since the travel times were reduced on average by 4:00 minutes on the mainline, the time waiting at the ramp meter is recaptured by improved travel times on the mainline. A summary of these findings can be seen in Table 1 below.

Table 1: Summary of Findings

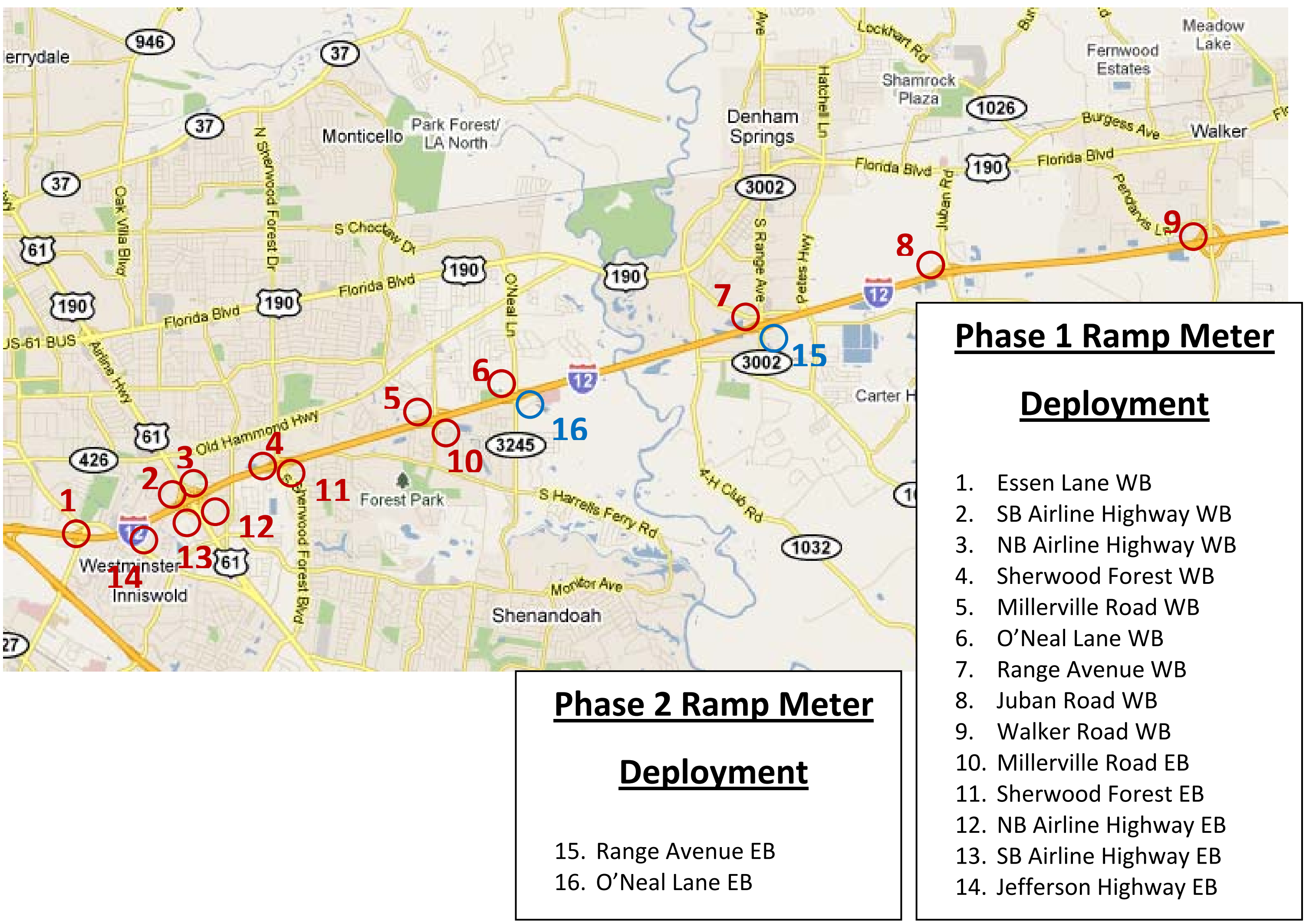
		No Ramp Meter	Ramp Meter	% Change
AM WB	Travel Time (minutes)	26:03	22:07	-15%
	Travel Speed (mph)	40	46	15%
	Number of Crashes (per year)	73	61	-17%
PM EB	Travel Time (minutes)	15:12	12:23	-19%
	Travel Speed (mph)	34	40	18%
	Number of Crashes (per year)	162	150	-7%

One additional finding of the study was that the onset of congestion during the afternoon peak period is delayed by 30 minutes or more as a result of ramp meter operation. This means that the Interstate operated in a free-flow state for an additional 30 minutes or more.

Due to the deployment of ramp meter, free-flow speeds were maintained for longer periods of time, travel times were reduced and crashes were reduced. Overall, the time spent waiting to be processed through the ramp meter is far outweighed by the gains experienced by having a safer, more reliable and less congested interstate. The price of congestion has been measured at $16.01 for passenger vehicles and $105.67 for freight. The ramp meters have been measured to save 131,625 hours of lost time per year. This equates to a savings to the motoring public of $3,287,466. At a total cost of $1,200,000 to install the entire system, the ramp meters provide a substantial improvement to the mobility of the general public.

Currently, the westbound ramp meters operate from 6:00 AM to 10:00 AM during the morning commute and the eastbound ramp meters operate from 2:00 PM to 7:00 PM during the evening commute. Based on this study, it was determined that the ramp meter operations may be shortened to operate between 6:30 to 9:00 in the morning and 3:00 to 7:00 in the afternoon.

Figure 1: Ramp Meter Deployment



2 Introduction

In 2009, widening of the Interstate 12 (I-12) corridor from East Baton Rouge Parish into Livingston Parish began, which was proposed to widen the existing four lane section to six lanes. The construction project was warranted due to the significant congestion that exists between East Baton Rouge and Livingston Parishes, which is a result of heavy commuter traffic along the corridor mixing with the commerce traffic along the I-10/12 corridor. While the additional lanes will greatly improve the congestion conditions, the widening project will have a short-term negative impact to capacity during construction. Additionally, Livingston Parish is also one of the fastest growing parishes in the state. Therefore, the number of commuters along the I-12 corridor is expected to increase and eventually congestion will reappear along the corridor.

3 Pre-Ramp Meter Deployment Feasibility Study

To address the reduced capacity during construction and future congestion, Dr. William Ankner (then Secretary of the Department of Transportation and Development (DOTD)), issued a feasibility study of ramp meters. This study consisted of reviewing existing ramp meter implementations, analyzing ramp meter implementation in Baton Rouge via VISSIM micro-simulation, and public involvement.

3.1 Best Management Practices Review

ABMB initially reviewed all regulatory documentation, as well as research literature on the design and operation of ramp meters. The most comprehensive document on the operation of ramp meters was the *FHWA Ramp Management Handbook*. The handbook provided guidance as to timing sequencing, ramp meter volume thresholds, signage, pavement markings and time of operation.

ABMB also sought the advice of active managers of ramp meter operations. Professionals in the Houston and Atlanta area were interviewed on the phone. ABMB staff also visited with staff and ramp meter operators from the Regional Transportation Commission of Southern Nevada. One of the most common themes gained from these professionals was to start the ramp meter program with a simple system, thereby greatly reducing the learning curve for the public and the agency responsible for maintaining the meters.

One of the most seminal studies completed on ramp metering was conducted in Minnesota, where ramp metering has been deployed since the 1960s. After decades of successful use, the public increasingly became skeptical of the effectiveness of the ramp meters. Despite the positive testimonies of the Minnesota DOT staff, the legislature mandated that the ramp meters be turned off for a comparative study at a cost of $650,000. A total of 430 ramp meters were deactivated for approximately a six week period.

Once the data was analyzed and compared between the operations with and without ramp meters, the following conclusions were made about operations ***without ramp meters***:

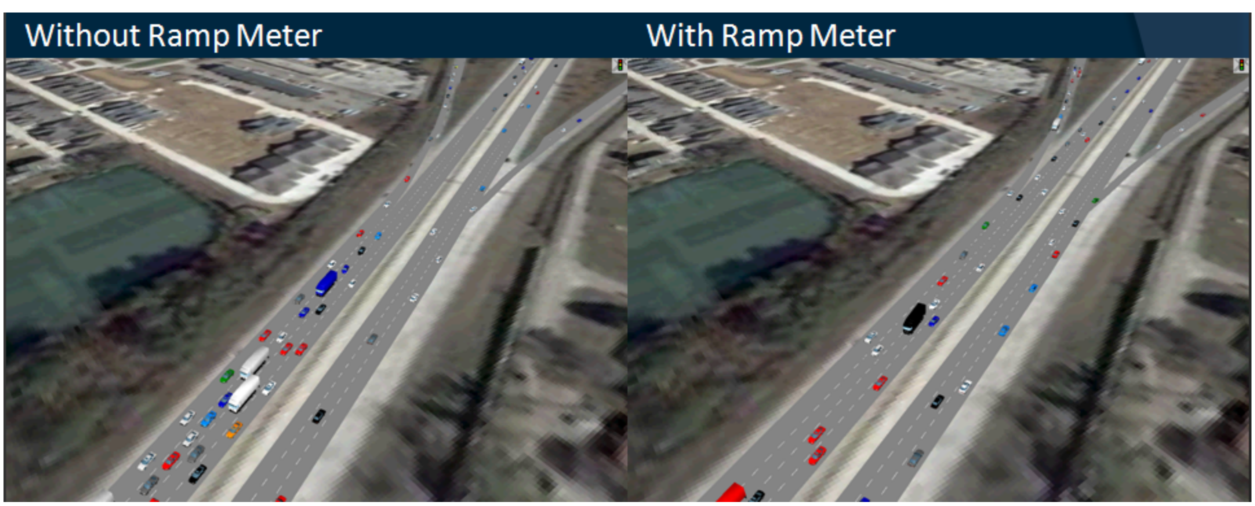
- Decline in through traffic of 14%
- 25,121 hours of additional wasted time
- Travel times became twice as unpredictable
- Crashes increased 26% (an increase of 1,041 crashes, or 4 crashes per day)

The results of the study were conclusive to reactivate their ramp meter system. In addition to the 430 meters online, the study showed a need for an expansion of the current system by 350 ramp meters in the region.

Based on the best management practices review as well as input from DOTD and the local FHWA personnel, a non-restrictive ramp meter deployment was considered to be the best option for further consideration. The intent of non-restrictive ramp meter operations is to disperse the platoons of vehicles entering the interstate. Large blocks of vehicles being released from a signal can cause significant amounts of turbulence on the main line. A non-restrictive ramp meter operation requires a vehicle to stop at the ramp meter for only about 4 seconds, thereby inducing a space between vehicles. The intent is not to store vehicles on the ramp to favor operations on the mainline.

Figure 2 shows a comparison of non-restrictive ramp metering with no ramp metering on I-12 at Sherwood Forest. As can be seen below, traffic is more evenly spaced and much less congested where ramp metering is utilized. With less congestion, the throughput on the interstate increases; therefore, more vehicles are traveling along the corridor at a higher speed.

Figure 2: Comparison of Non-Ramp Meter to Ramp Meter Operation



3.2 Analysis

The analysis tool used to develop measures of effectiveness for the I-12 study during the AM and PM peak hours was VISSIM, a micro-simulation modeling software. The VISSIM model included five interchanges on I-12 between Airline Highway and Range Avenue as well as all nearby traffic signals. The model was calibrated to effectively reflect the existing geometry and traffic counts within the study area through data collection. Data collection included travel times and queue measurements taken in the field as well as comments from DOTD and ABMB employees that drive the corridor daily. Four models were developed to represent the existing condition (or pre-widening) and future conditions (or post-widening), “No Ramp Meter” and “Ramp Meter” and AM and PM peak periods.

3.3 Results of Initial Study

The reported metrics of the VISSIM model revealed very positive results for the ramp meters. Average running speeds were found to increase by as much as 24.2% and by an average of 17.1% with the implementation of ramp meters on I-12 during the AM peak period. Additionally, travel times were found to decrease by as much as 19.5% and by an average of 14.6% with I-12 modeled as a four lane highway with ramp meters during the AM peak period.

Table 2: I-12 Ramp Meter Study Results

AM Average Running Speed (mph)				
		No Ramp Meter	Ramp Meter	% change
AM	4-lane I-12	24	28	17.1%
	6-lane I-12	29	33	14.2%
AM Travel Time (min.)				
		No Ramp Meter	Ramp Meter	% reduction
AM	4-lane I-12	24.9	21.3	14.6%
	6-lane I-12	20.8	18.2	12.4%

Based on output data from the model and practices from other states, an operating schedule of 6:00 AM to 10:00 AM for the morning operating period and 2:00 PM to 7:00 PM for the evening operating period was determined appropriate. Due to the significant benefits gained in the simulation models, the interchanges selected for ramp meters were expanded to include Essen Lane, Juban Road and Walker Road. The full ramp meter deployment locations can be seen in Figure 3. Because of the continuing construction on I-12 east of O’Neal Lane, the eastbound ramp meters at O’Neal Lane and Range Avenue were recommended to be deployed in a second phase after the widening construction is complete.

Figure 3: Ramp Meter Deployment

Phase 2 Ramp Meter Deployment

15. Range Avenue EB
16. O'Neal Lane EB

Phase 1 Ramp Meter Deployment

1. Essen Lane WB
2. SB Airline Highway WB
3. NB Airline Highway WB
4. Sherwood Forest WB
5. Millerville Road WB
6. O'Neal Lane WB
7. Range Avenue WB
8. Juban Road WB
9. Walker Road WB
10. Millerville Road EB
11. Sherwood Forest EB
12. NB Airline Highway EB
13. SB Airline Highway EB
14. Jefferson Highway EB

3.4 Public Involvement

Once the decision was made by Secretary Ankner to deploy ramp meters based on the positive results found in the modeling, a significant and robust public outreach plan was developed. DOTD had formed "Geaux Wider", a public awareness campaign in association with the I-12 widening project. The ramp meter public outreach efforts were folded into the Geaux Wider program. This provided an easy means to feed information regarding the ramp meter project to the Geaux Wider website and mailing lists. Three informational public meetings at differing locations along the corridor were also held to provide direct public access to the design team so that the benefits and proposed operations of ramp meters could be shown, as well as address driver concerns. There was significant media coverage at each public meeting, which resulted in further education of the public. DOTD employees were also interviewed along with guests on several news casts and radio stations.

One of the key design features that were explained to the public was that the ramp meters would be monitored by the Traffic Management Center (TMC) at DOTD headquarters. Each ramp meter is connected to the TMC and can be activated, de-activated or modified from the TMC. Each ramp meter location would also have a "flush" function such that if the stopped traffic from the ramp meter reached the side street, a "flush" function would be triggered where by the ramp meter would turn off for a period of time to clear the ramp.

3.5 Monitoring

After months of public meetings and education, the first ramp meter was activated on Tuesday, June 8, 2010. The remaining ramp meters were activated on an individual basis over the following months. The purpose for activating them individually was to provide sufficient monitoring as each meter was activated, which included multiple field visits. Included in the construction of the ramp meters were cameras to provide observation and monitoring of proper operation, driver behavior, and congestion from the Traffic Management Center at DOTD headquarters. This enabled the consultant and DOTD to adjust some of the timing and even the type of vehicle detection used at a number of on-ramps, where shadows and road curvature were creating problems for the video detection units. Each ramp meter remains to be monitored on a daily basis to ensure proper operation including making certain that the flush function is being activated to prevent ramp traffic from backing up onto the surface streets.

4 Objectives and Approach

The ramp meters along I-12 have been in operation for over a year. The goal of this report was to assess if ramp meters have had a positive or negative impact on the interstate and /or the surface streets. To achieve this goal, two objectives were established.

The first objective was to collect direct field measurements of flow conditions before and after deployment of the ramp meter system. ABMB and DOTD have collected travel times along the corridor using the floating car method to determine the benefits to the mainline. Travel times for each interchange were recorded from the nearest side-street signal to the merge point on the interstate to isolate the impact of the ramp meters to the surface streets and on-ramps.

The second objective was to compare flow conditions for the mainline as well as flow conditions for the individual ramps. One of the reported key benefits of ramp meters was improved safety conditions; therefore, a report of safety conditions comparing crash data before and after the ramp meter deployment will be included in the report. Because the corridor was still under construction at the time of the study, the safety data will only be compared in the segment not under construction.

5 Data Collection

To achieve the first objective of the study, various data sets pertaining to the corridor were obtained that include data of traffic flow conditions prior to and after ramp meter implementation. This data included volume collection from cameras, radar video detection, and tube counts; travel times collected by ABMB and DOTD; as well as crash data from DOTD. These data were graphed and analyzed to observe changes caused by the implementation of ramp meters.

5.1 Volumes

To obtain current volumes for analysis and design purposes, 24-hour counting stations utilizing pneumatic tubes were deployed on each ramp. Volume data for the mainline were through pneumatic tubes and radar vehicle detector (RVD) units. An example of the collected data can be seen in Table 3 below.

Table 3: Sample of Collected Volumes

AM Peak Hour	Movement	2010	PM Peak Hour	Movement	2010
Airline Hwy	NBL		Airline Hwy	NBL	
	NBT	2613		NBT	2375
	NBR	312		NBR	558
	SBL			SBL	
	SBT	2515		SBT	1860
	SBR	277		SBR	380
I-12 EB On Ramps	EBL		I-12 EB On Ramps	EBL	
	EBT			EBT	
	EBR	733		EBR	1088
	WBL			WBL	
	WBT			WBT	
	WBR	393		WBR	415

5.2 Safety

A record of crashes along the I-12 corridor was obtained from DOTD from 2005 to 2008 prior to ramp meter installation and from 2010 to 2011 after the installation of ramp meters. This data was compiled and compared to determine changes due to the activation of ramp meters in the corridor. While a typical safety study requires three years of data prior to and after the change in traffic flow conditions, one year of data should provide a measure of the safety benefits. A further study of the safety benefits should be completed once three years of data are available. As previously discussed, a segment of the Interstate is under construction where the ramp meters are operational. Therefore, only data collected on the segment where construction was not present was evaluated. Table 4 shows a sample of crash data received from DOTD.

Table 4: Sample of DOTD Crash Data

Control-Section 454-01 between logmiles 0.00 and 8.30
2010-01-01 to 2011-04-30
Non-Intersection Crashes Only

Csect	Log Mile	tot acc	pdo acc	fat acc	inj acc	num fat	num inj	crash date	most harm evt	type coll	type acc	surf cond	crash num	par ish	hour	int	iv agy	dir trav	move prior	ADT	Vehicle Type	Computed Latitude	Computed Longitude
454-01	6.71	1	1	0	0	0	0	1/2/2010	MV in Trans	S Swipe(sd)	Coll wt veh	dry	5355936	17	10	0	B	WW	HB	101400	SUV Passenger Car	30.44101	-91.0127
454-01	7.18	1	1	0	0	0	0	1/4/2010	MV in Trans	Rear End	Coll wt veh	dry	20100000121	17	17	0	A	EE	XQ	94200	Light Truck Light Truck	30.44286	-91.0052
454-01	8.25	1	1	0	0	0	0	1/4/2010	GuardRail Face	Non Coll	Run off rd	dry	20100005791	17	24	0	A	E	G	94200	Passenger Car	30.44704	-90.98813
454-01	0.1	1	1	0	0	0	0	1/5/2010	MV in Trans	Rear End	Coll wt veh	dry	5556501	17	9	0	B	WW	BA	143400	Passenger Car SUV	30.41814	-91.1172

5.3 Travel Times and Speed Data

Travel times and speed data were obtained through a variety of entities. The first set of travel time runs were made by ABMB during the preliminary study stage of the ramp meter implementation, utilizing a stop-watch and measured distance method to determine travel times. This included collecting travel times from the side streets to the merge point on the interstate. DOTD conducted floating car runs using GPS units to track positioning along I-12 during the peak hours prior to and after turning on the ramp meters in 2010.

During the implementation of the ramp meters, BlueTOAD travel time measuring devices were installed at eleven ramp meter locations. These devices capture MAC addresses from Bluetooth devices of motorists. When a driver passes two locations, the travel time and speed between the locations is calculated within the BlueTOAD system. This data is archived and available to DOTD staff. Approximately 8% of vehicles polled were captured using this method. All three of these data sets for travel times were utilized in this study to determine the effect of ramp meters on the corridor.

6 Results and Analysis

To achieve the overall goal of determining if the ramp meters have had a positive or negative impact on the interstate and /or the side streets, the second objective of the study, direct comparisons of safety, travel time, travel speed, and volume data, are reported in the following sections.

6.1 Volumes

To determine if the speed and travel time metrics were dependent of changes in volume before and after the ramp meter implementation, mainline volume data for a period of the year was collected before and after the ramp meters became operational. The results in Table 5 show that the peak period volumes are essentially the same during the AM and PM peak periods between 6:00 AM and 10:00 AM and between 2:00 PM and 7:00 PM, respectively. Therefore, the measurable outcomes of the study were not influenced mainline volumes.

Table 5: I-12 Peak Period Volumes

Mainline Volumes East of I-10/12 Split			
	No Ramp Meter	Ramp Meter	% Change
AM WB	20551	20588	0.18%
PM EB	17962	17972	0.06%

6.2 Safety

Improving safety is the primary goal of any roadway improvement project and is a reported benefit of ramp metering. The figures below display the number of crashes pre- and post-ramp meter. Table 6 shows that there has been a 17% decrease in the number of westbound crashes on the section of I-12 in East Baton Rouge Parish during the AM peak period with the use of ramp metering. Additionally, a 7% decrease in the number of eastbound crashes during the PM peak period.

Table 6: I-12 Corridor Safety Data (East Baton Rouge Parish)

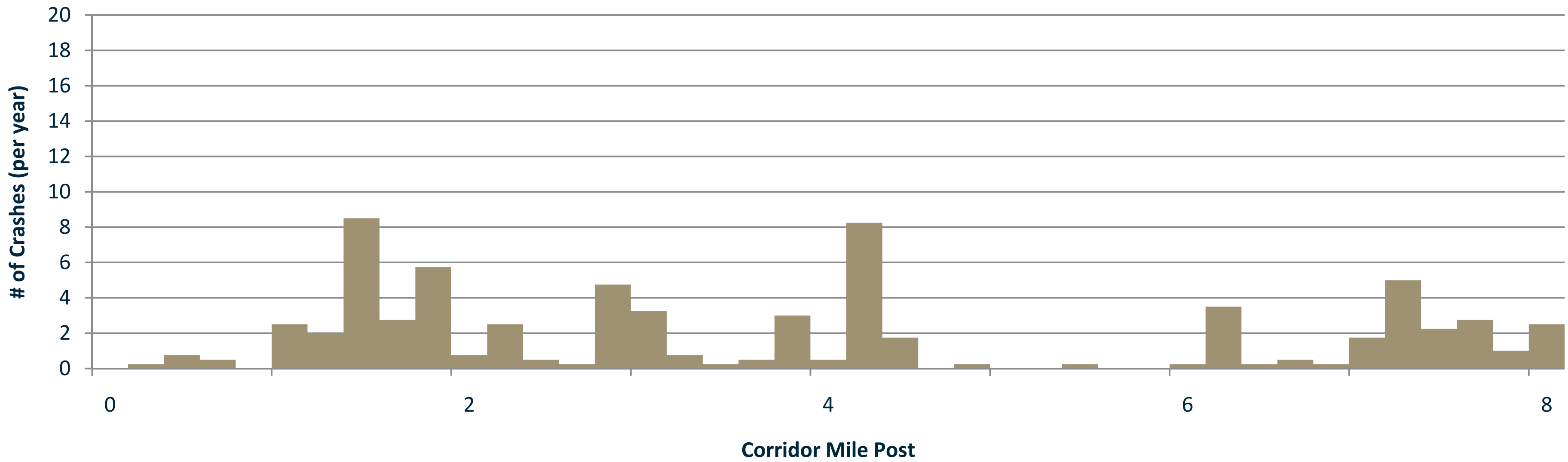
	2005-2008 Pre-Ramp Meter		2010-2011 Post-Ramp Meter		% Change
	Total	Total Per Year	Total	Total Per Year	
AM WB	292	73	81	61	-17%
PM EB	647	162	200	150	-7%

Figures 4 through 7 show the number of crashes at specific locations along the I-12 Corridor during the AM and PM peak periods, before and after ramp meter implementation. Prior to turning on the ramp meters, the majority of the wrecks occurred around exit and entrance ramps. Since the activation of the ramp meters, several of the crashes located near or around the ramps have been eliminated, which can be seen graphically in Figures 4 and 5.

Another finding of major significance is the reduction of crashes from 21 to 6 between the Essen Lane on-ramp and the I-10 eastbound off-ramp. This section of I-12 includes an auxiliary lane between the Essen Lane on-ramp and I-10 eastbound off-ramp, where a significant amount of weaving occurs during the morning commute. As seen in Figure 4, this created numerous crashes because of the dense platoons merging from Essen Lane. With the implementation of ramp meters, the platoons have been broken up creating more gaps for traffic to more easily weave in and out of the auxiliary lane.

As previously discussed, construction between O'Neal Lane and Juban Road was present at the time of the study; therefore, this section was not included in the evaluation.

Number of Crashes per Year
2005 - 2008
AM Peak Period, WB Traffic
Pre-Ramp Metering



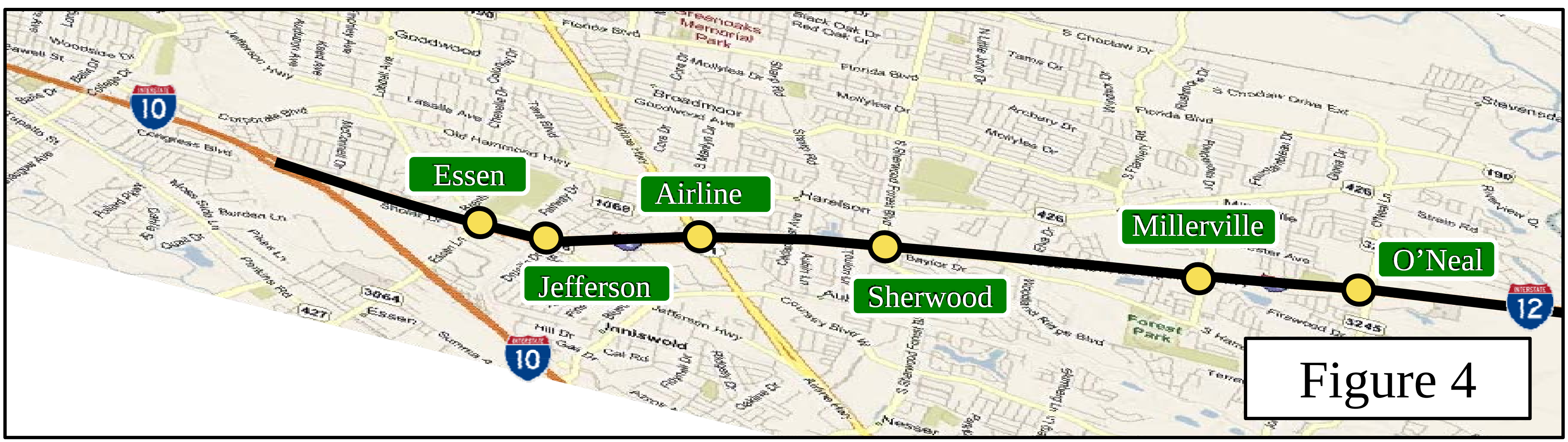
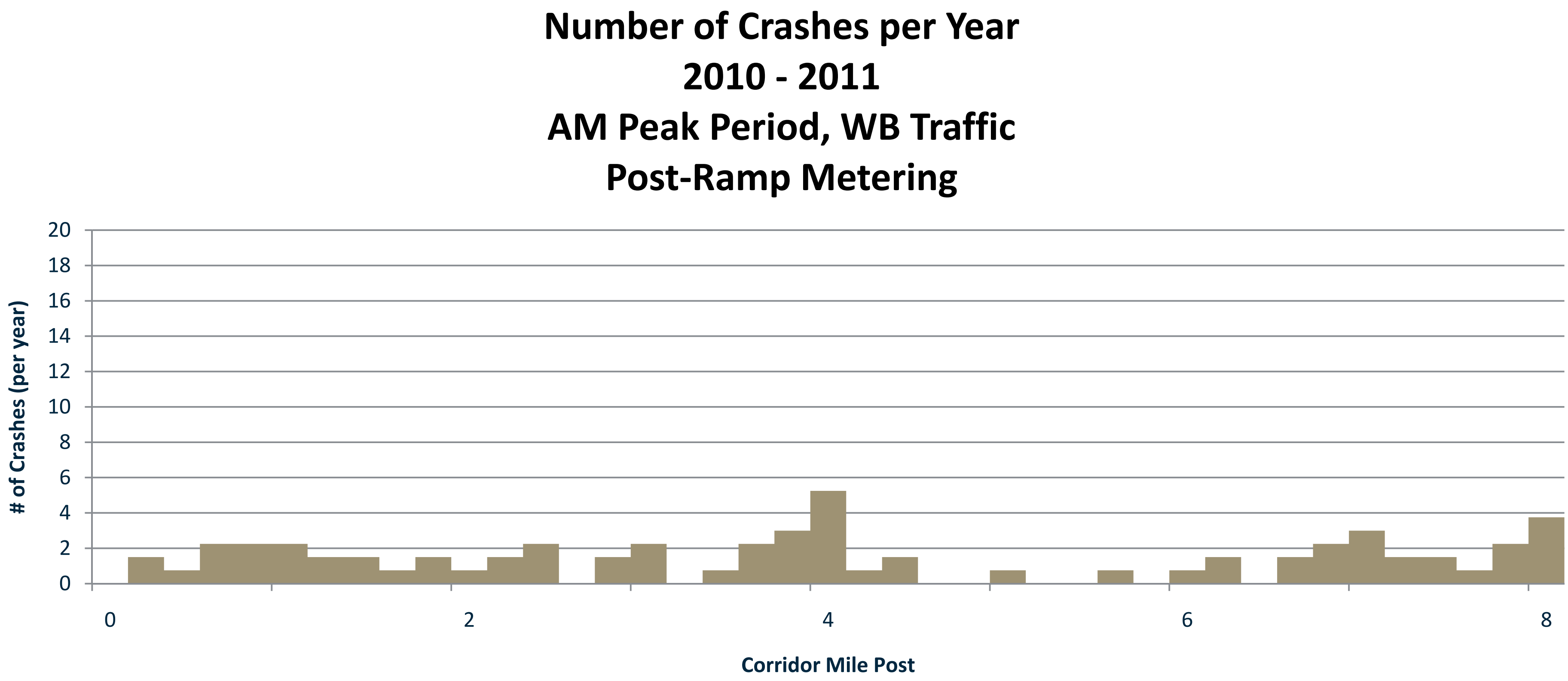


Figure 4

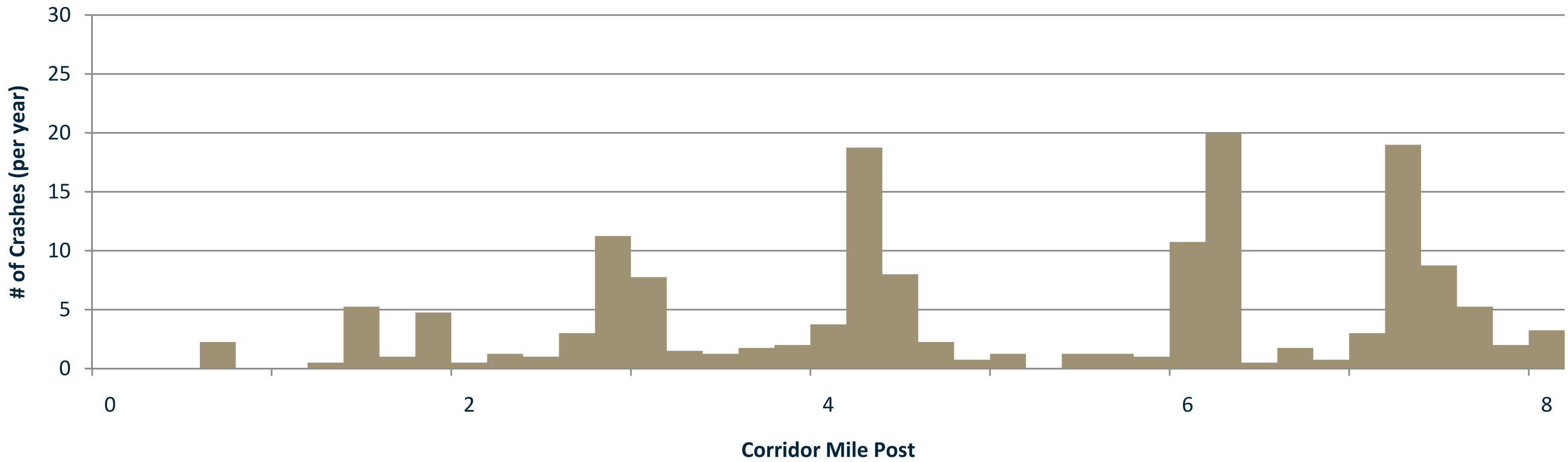


Number of Crashes per Year
2010 - 2011
AM Peak Period, WB Traffic
Post-Ramp Metering
# of Crashes (per year)
20
18
16
14
12
10
8
6
4
2
0
0
2
4
6
8
Corridor Mile Post

Essen
Jefferson
Airline
Sherwood
Millerville
O'Neal

Figure 5

Number of Crashes per Year
2005 - 2008
PM Peak Period, EB Traffic
Pre-Ramp Metering



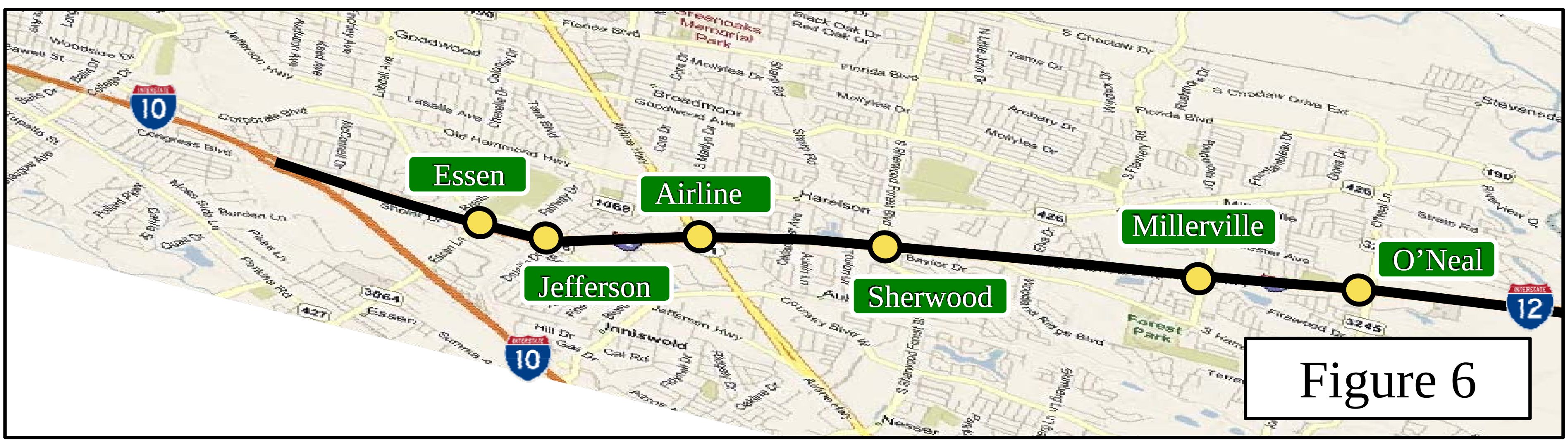
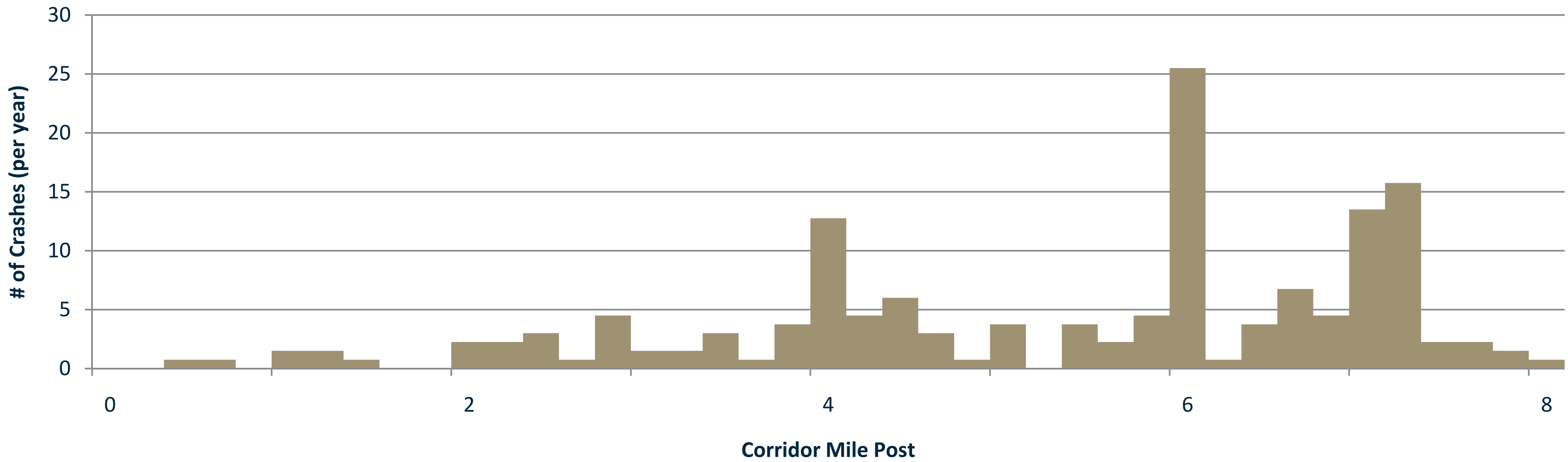


Figure 6

Number of Crashes per Year
2010 - 2011
PM Peak Period, EB Traffic
Post-Ramp Metering



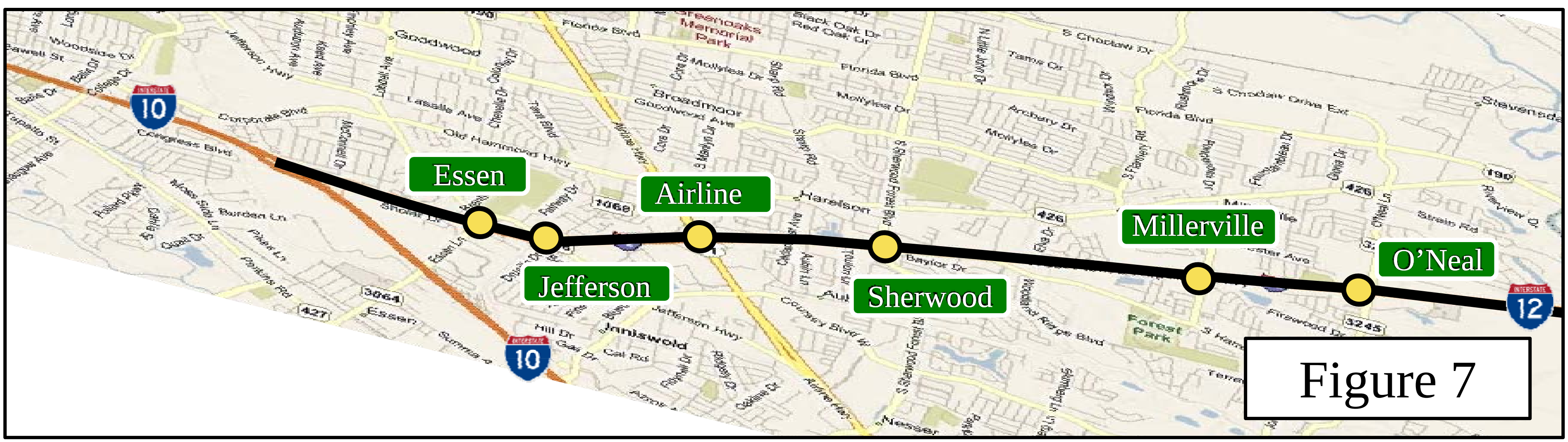


Figure 7

6.3 Travel Times

Travel times were obtained and analyzed for both the mainline and side street traffic entering the Interstate. It was important to not only look at the effects of ramp meters on Interstate traffic, but also whether or not delays are occurring on the side streets due to backups on the on-ramps.

6.3.1 Mainline Travel Times

Travel times for the AM peak period, which occur between 6:00 AM and 10:00 AM, can be seen in Figures 8 and 9. Figure 9 represents the travel times during the peak hour from 7:30 AM to 8:30 AM. On average, the measured travel times are improved in the AM peak period by four minutes (or 15%) with the ramp meters in operation. The travel time results for the PM peak period, which occur between 2:00 PM and 7:00 PM, can be seen in Figure 10. On average, the measured travel times are improved in the PM peak period by three minutes (19%) with the ramp meters in operation. Prior to ramp meters being active on I-12, travel times were more erratic for longer periods of time. For example, the average travel time is improved by four minutes in the morning; however, the largest decrease in travel times was 15:07 minutes. Now that the ramp meters are operating, shorter and more consistent travel times are experienced, as also seen in Figures 8-10. A summary of the change in average travel times can be seen in Table 7 below.

Table 7: Summary of Mainline Travel Times

Mainline Travel Times (min.)			
	No Ramp Meter	Ramp Meter	% Change
AM WB	26:03	22:07	-15%
PM EB	15:12	12:23	-19%

Figure 8: AM Field Measured Travel Times of Pre- and Post-Ramp Meter

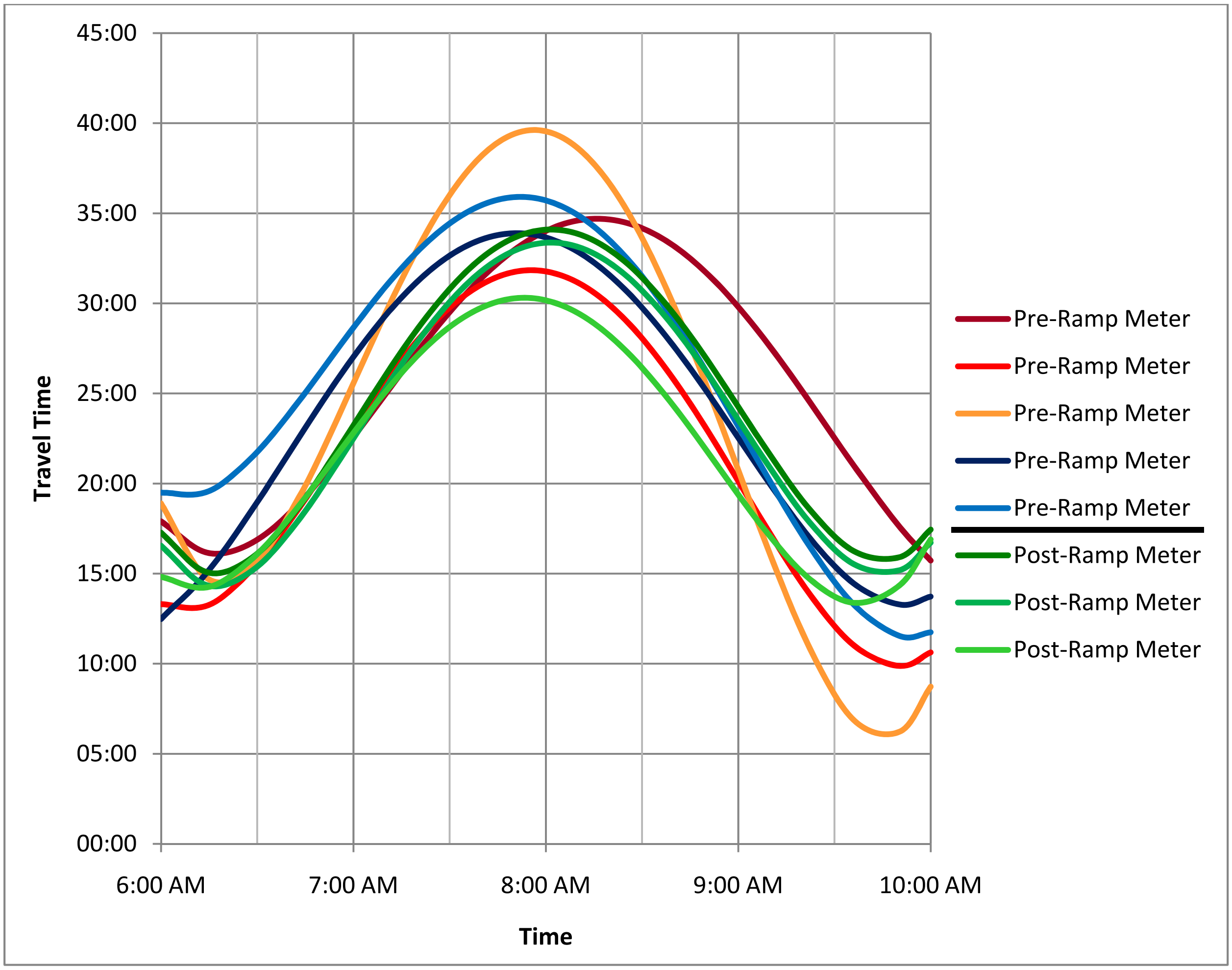


Figure 9: AM Peak Hour Field Measured Travel Times of Pre- and Post-Ramp Meter

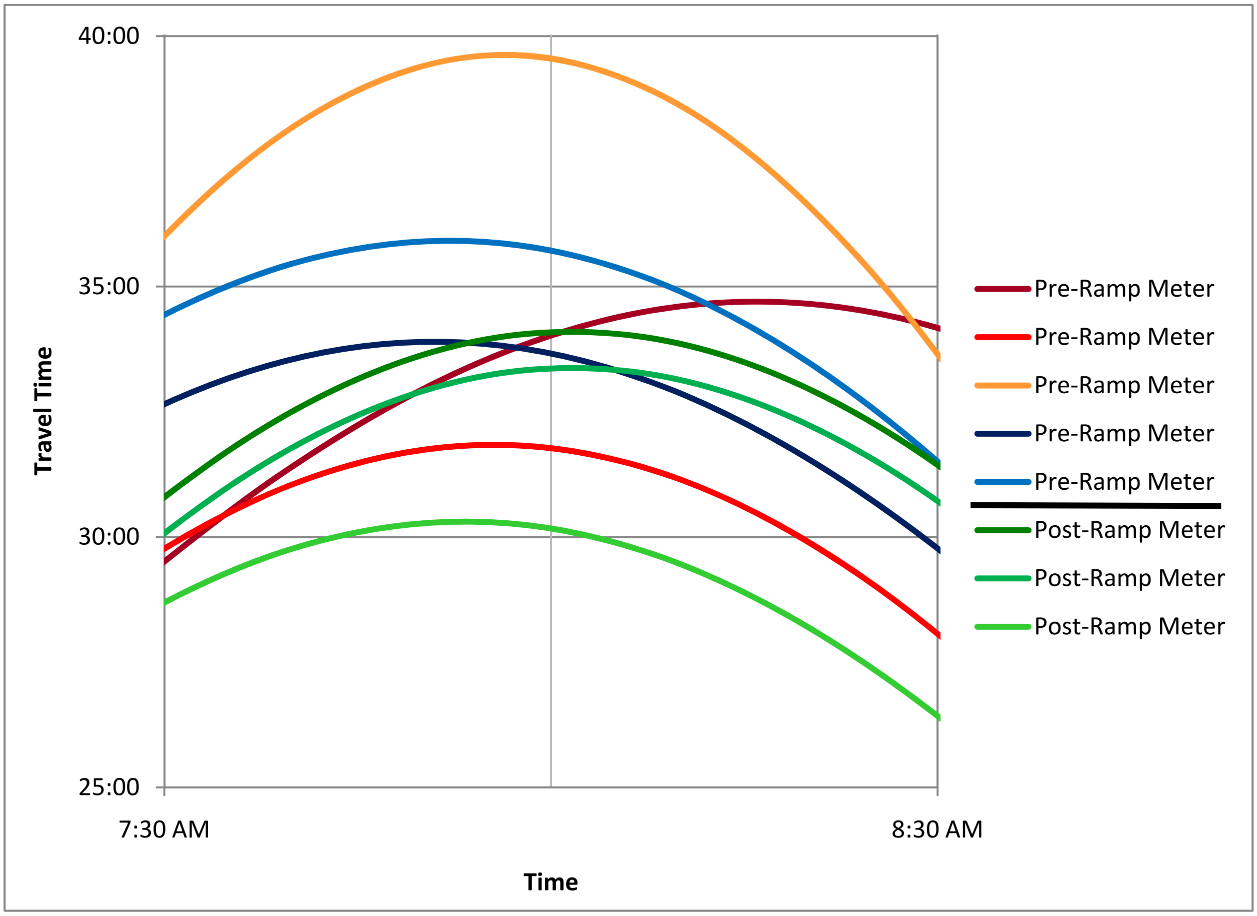
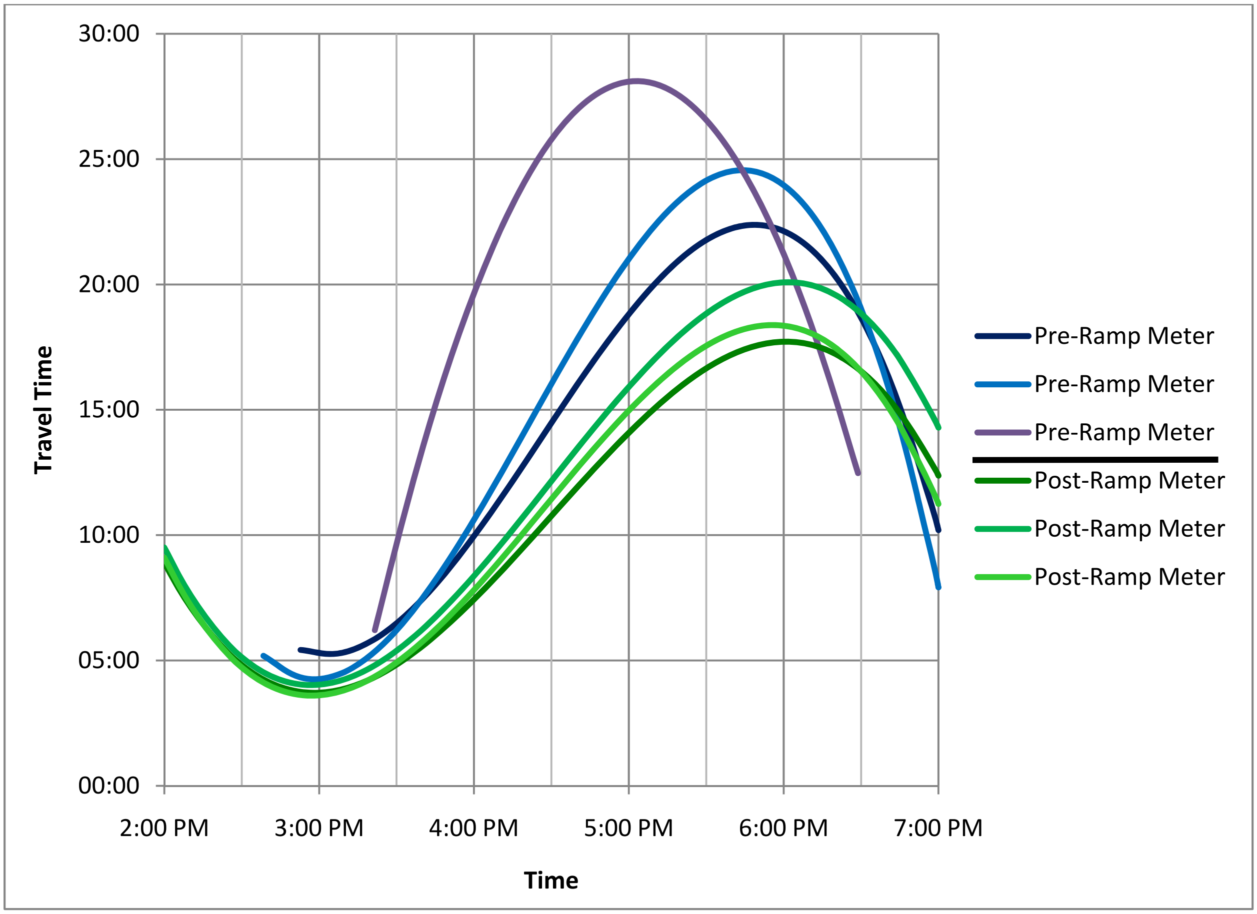


Figure 10: PM Field Measured Travel Times of Pre- and Post-Ramp Meter



6.3.2 Side Street Travel Times

A major concern for commuters has been the effect on side street traffic caused by queues at the ramp meters. In 2008, travel times were obtained from adjacent intersections north and south of the interstate at five interchanges. In 2011, after almost a full year of ramp meter operation, travel times were recorded once again along the same paths traversed in 2008. The difference in travel times can be seen in Table 8 below.

Table 8: Side Street Travel Times

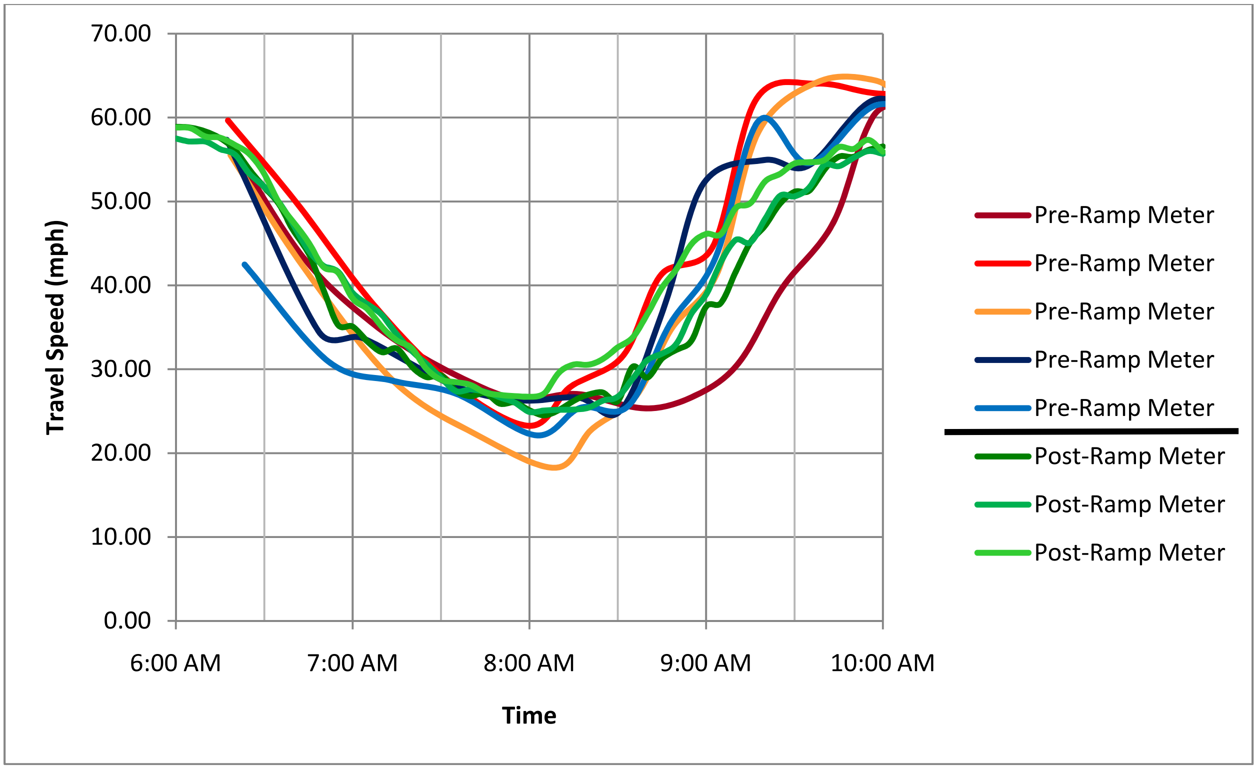
Ramp	Travel Time (seconds)		
	Pre-Ramp Meter	Post-Ramp Meter	Difference
Range Avenue NB	00:31	01:56	01:25
O'Neal NB	01:20	01:10	00:10
Millerville NB	00:25	00:32	00:07
Sherwood NB	00:52	01:03	00:11
Airline NB	00:27	00:57	00:30
Range Avenue SB	00:23	01:07	00:44
O'Neal SB	00:22	01:18	00:56
Millerville SB	00:36	01:01	00:25
Sherwood SB	00:22	01:18	00:56
Airline SB	01:01	01:35	00:34

As can be seen in the above table, travel times from adjacent intersections to the interstate have increased, but not by a large amount when compared to the savings in travel time on the mainline. Mainline travel times have increased by an average of three minutes, which is greater than the delay experienced at any on-ramp due to ramp meter operation. Additionally, the meters are operating efficiently and drivers have become comfortable with the ramp meter operation.

6.4 Travel Speeds

In addition to decreased travel times, speeds have also increased along the corridor due to less saturated flow conditions. As seen in Figure 11, it should be noted that the speed consistently increases during the AM peak, increasing by about four miles per hour on average throughout the AM peak period.

Figure 11: AM Travel Speeds from Walker Road to Essen Lane



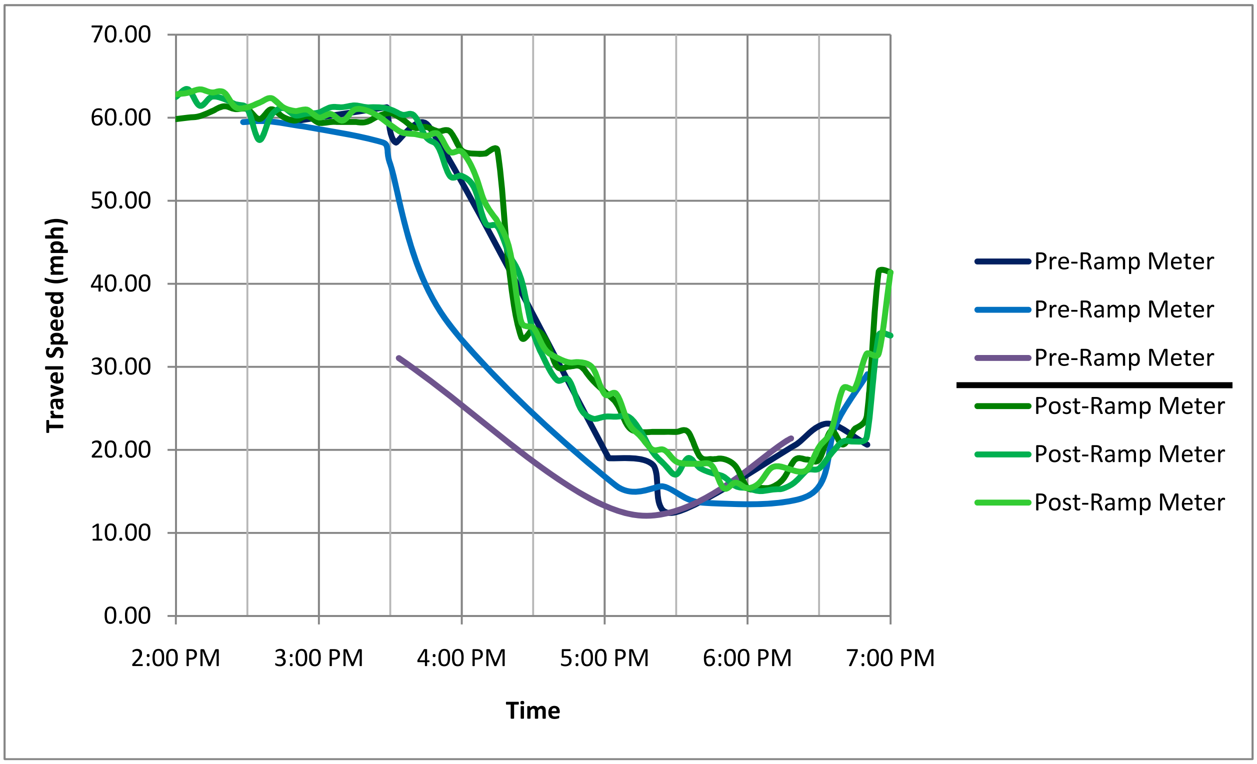
In the eastbound direction, there has been increase in average travel speed of about seven miles per hour throughout the PM peak period. As seen in Figure 12, the post-ramp meter speeds remain consistently above pre-ramp meter speeds. A summary of the change in the average running speed along the corridor can be seen in Table 9 below.

Table 9: Summary of Travel Speeds

Average Running Speed (mph)			
	No Ramp Meter	Ramp Meter	% Change
AM WB	40	46	15%
PM EB	34	40	18%

A very important item to note is that with the implementation of ramp meters, the onset of congestion has been prolonged by at least 30 minutes. Therefore, free-flow speeds are maintained for a longer period of time.

Figure 12: PM Travel Speeds from Essen Lane to O'Neal Lane



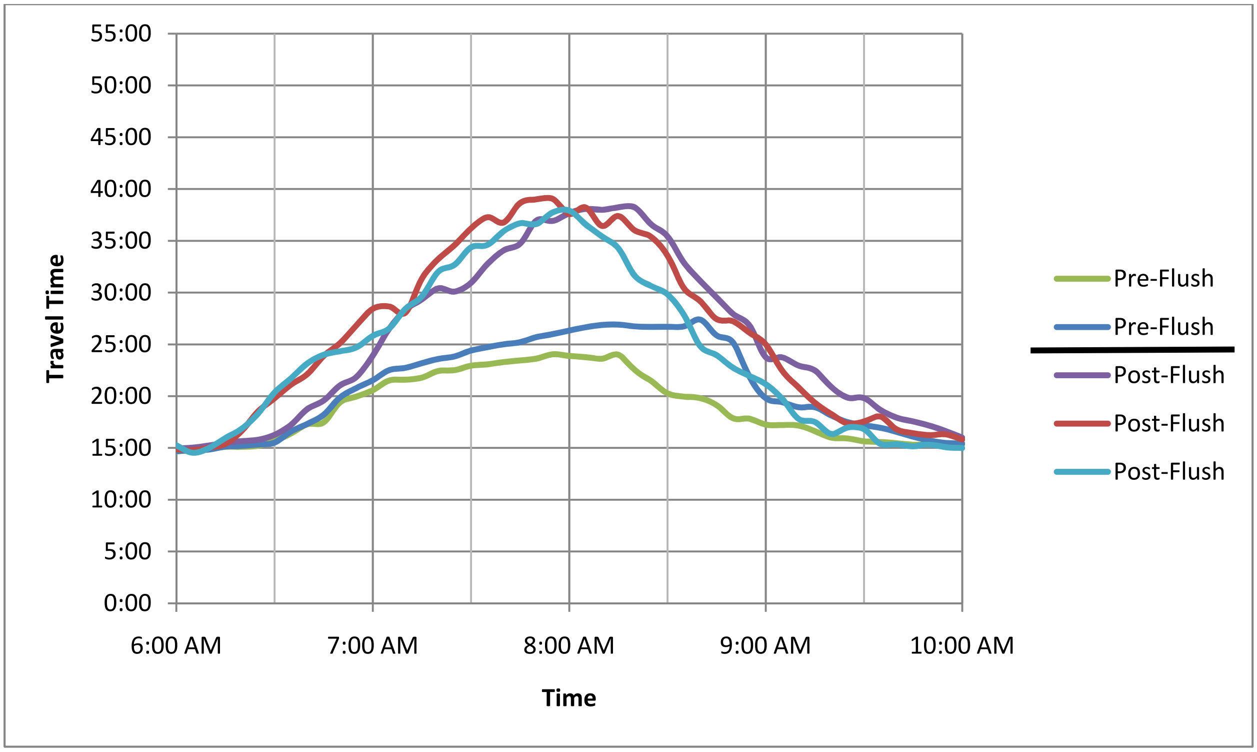
6.5 Ramp Meter Monitoring

As the ramp meters have been in operation for over a year, several issues continue to be monitored with great care. Three of the most significant issues being monitored are the flush functions at Range Avenue, O'Neal Lane and Millerville Road.

6.5.1 Ramp Meter Flush at Range Avenue

Due to the extraordinary high volumes at Range Avenue, it was determined that all three lanes should be utilized for the ramp meters. By doing so, the highest vehicle release rate of all the ramp meters along I-12 occurred at Range Avenue. To minimize the impact to the interstate, it was decided not to allow Range Avenue to "flush." The system operated under this condition for two months. However, a few complaints from the public were lodged with DOTD, stating that the ramp meters were the cause of congestion on Range Avenue. It was decided to allow the Range Avenue ramp meters to flush and do so to this day. Figure 13 shows the change in travel times before and after the flush function was added at Range Avenue. The average travel time to Essen Lane was found to be 19:57 minutes prior to enabling the flush function and 25:23 minutes after the flush function was activated at the westbound Range Avenue ramp meter. Therefore, on average, travel times increased by 5:26 minutes after the flush function was activated.

Figure 13: AM Travel Times Due to Range Flush Function



6.5.2 Ramp Meter Flush Function at O’Neal Lane

Due to the high volumes accessing the interstate during the morning commute at O’Neal Lane, the ramp meter flush function was consistently triggered throughout the morning. While the flush function allows the side street traffic to clear out and prevent congestion, it hampers the benefits the ramp meter provides to mainline. Large platoons enter the interstate at one time and create congestion at the merge point.

Additionally, there is currently on-going construction along South Harrell’s Ferry Road, which runs parallel to I-12. This construction project, along with widening efforts on I-12 and O’Neal Lane, has made the traffic situation even worse at this on-ramp.

6.5.3 Ramp Meter Flush Function at Millerville Road

At the Millerville Road westbound on-ramp, high volumes are accessing the interstate during the morning commute. Being a loop ramp, there is limited storage space, so the flush function was consistently triggered throughout the morning commute. Similar to the O’Neal on-ramp, large platoons of cars enter the interstate at one time creating congestion and decreasing safety. Additionally, the on-going construction on South Harrell’s Ferry Road is impacting traffic volumes and patterns, making the situation at this on-ramp even worse.

7 Findings

The overall goal of this study was to determine if the ramp meters deployed in 2010 had a positive or negative impact to the interstate and/or the side streets that access the interstate. To achieve this goal, two objectives were established: 1) collect direct field data on traffic characteristics and safety data and 2) compare and contrast the operations of the interstate and side streets before and after the ramp meters were deployed.

Safety has been greatly improved along the corridor due to a reduction of crashes: 17% in the AM and 7% in the PM. Another major safety finding was that the weaving maneuver in the auxiliary lane between Essen Lane and the I-10 interchange exit ramp was greatly improved since crashes were reduced from 21 to 6.

Travel times were found to be shortened by four minutes on average during the morning commute and by three minutes on average during the afternoon commute. One of the primary concerns about ramp meters is the impact to side streets. Travel times were collected for both before and after the deployment of ramp meters. The greatest impact was found to be 1:25 minutes. Since the travel times were reduced on average by 4:00 minutes on the mainline, the time waiting at the ramp meter is recaptured by improved travel times on the mainline. A summary of the findings can be seen in Table 10 below.

Table 10: Summary of Findings

		No Ramp Meter	Ramp Meter	% Change
AM WB	Travel Time (minutes)	26:03	22:07	-15%
	Travel Speed (mph)	40	46	15%
	Number of Crashes (per year)	73	61	-17%
PM EB	Travel Time (minutes)	15:12	12:23	-19%
	Travel Speed (mph)	34	40	18%
	Number of Crashes (per year)	162	150	-7%

One additional finding of the study was that the onset of congestion during the afternoon peak period is delayed by 30 minutes or more as a result of ramp meter operation. This means that the Interstate operated in a free-flow state for an additional 30 minutes or more.

The price of congestion has been measured at $16.01 for passenger vehicles and $105.67 for freight. The ramp meters have been measured to save 131,625 hours of lost time per year. This equates to a savings to the motoring public of $3,287,466. At a cost of $1,200,000 to install, the ramp meters maintain free-flow speeds for longer periods of time, reduce travel times and the risk of collisions. Overall, the time spent waiting to be processed through the ramp meter is far outweighed by the gains experienced by having a safer, more reliable and less congested interstate.

8 Recommendations

Currently, the westbound ramp meters operate from 6:00 AM to 10:00 AM during the morning commute and the eastbound ramp meters operate from 2:00 PM to 7:00 PM during the evening commute. Based on this study, it was revealed that the effectiveness of the ramp meters between 6:00 and 6:15, as well as 9:00 AM and 10:00 AM, are not significant. Therefore, ramp meter operation can be shortened to operate from 6:30 AM to 9:00 AM. The evening operating times can start one hour later at 3:00 PM rather than the current start time of 2:00 PM. It should be noted that the I-12 corridor was currently heavily impacted by the widening project. The operational times should be re-examined after the widening projects have been completed.

Activating the flush function has had a discernable, negative impact to the mainline operations. While DOTD did receive some complaints about queuing on Range Avenue, it has not been verified if the ramp meters were the actual cause of the queuing. Careful consideration should be given to deactivate the flush function at Range Avenue due to the tremendous operational and safety benefits gained from the ramp meters.

The O'Neal Lane westbound on-ramp flushes multiple times during the morning commute. The long-term solution is to add an additional lane to the on-ramp. The meter would operate similarly to the Sherwood Forest Boulevard westbound on-ramp. The Millerville Road westbound on-ramp flushes multiple times throughout the morning commute as well. The long-term solution is to build the currently proposed additional westbound on-ramp. The new on-ramp would service southbound Millerville traffic, while the existing ramp would service northbound Millerville traffic. By separating the volumes between the two on-ramps, the ramp meters would operate effectively with minimal flushing.