FINAL

SONOMA US 101 RAMP METERING BEFORE/AFTER TECHNICAL REPORT

December 2015

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December 23, 2015 Project #: 13496

Ms. Linda Lee and Ms. Winnie Chung
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Caltrans District 4
Office of Traffic Systems, Mail Station 5F
111 Grand Ave
Oakland, CA 94612

RE: Sonoma County US 101 Ramp Metering Implementation
Deliverable 7.5B – Final Before and After Metering Study

Dear Ms. Lee, Ms. Chung, Mr. Chow, and Mr. Levy:

Kittelson & Associates, Inc. (KAI) is pleased to submit this report for US 101 ramp metering study in Sonoma County. This report is Deliverable 7.5B of the project.

Please call me at 510.839.1742 if you have any questions.

Sincerely,

KITTELSON & ASSOCIATES, INC.

Richard Dowling, Ph.D., PE
Senior Principal Engineer

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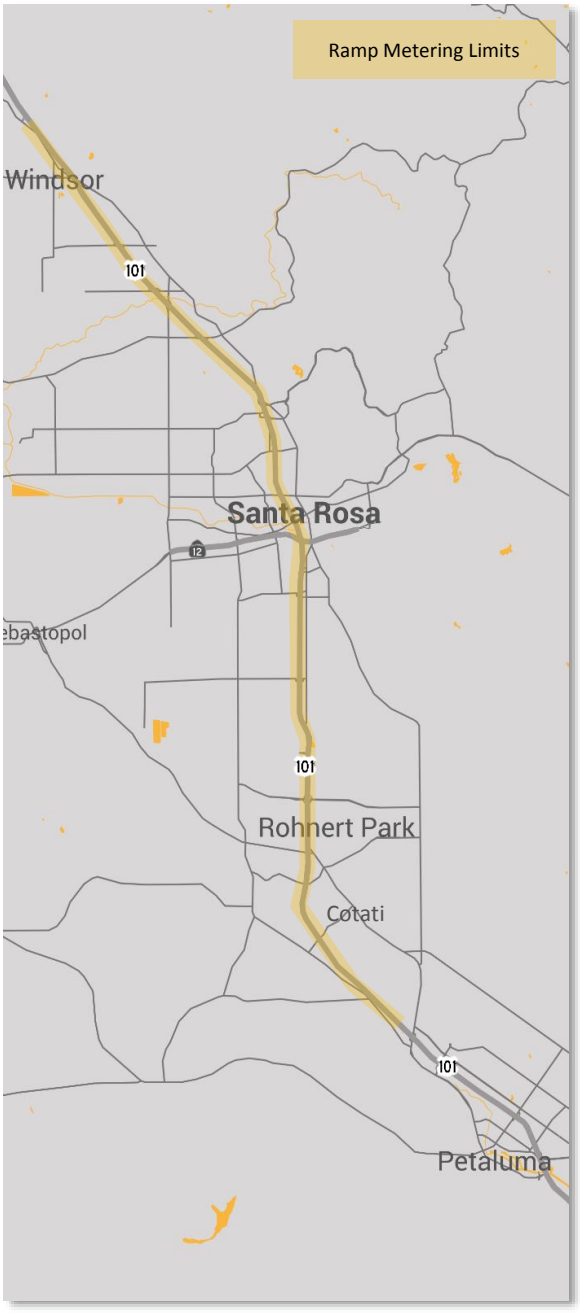
EXECUTIVE SUMMARY

This report provides a comprehensive comparison of conditions before and after the implementation of ramp metering on US 101 in Sonoma County, California from Old Redwood Highway in Petaluma to Arata Lane in Windsor. Ramp meters were activated in September and October of 2014 and continue to operate during weekday AM and PM peak periods from 6 AM to 10 AM and from 3 PM to 7 PM, respectively. Ramp metering is a traffic management strategy, which uses traffic signals and accompanying equipment and techniques to manage on-ramp flow onto the freeway system.

Ramp metering plans were developed and fine-tuned to manage the entry of vehicles onto the freeway and maintain efficient traffic operations on the freeway and local streets. The purpose of ramp metering is to better serve drivers by reducing travel times, smoothing merging operations, and improving safety. Extensive data collection efforts were conducted before and after the implementation of ramp metering ("Before" and "After") in order to determine its effectiveness. The data included travel time surveys, traffic counts on the freeway, visual observation of freeway and ramp queues, and traffic counts on the arterial street system.



The Before and After analysis also took into consideration background changes that occurred on the corridor throughout the duration of the multiyear study. These changes include, but are not limited to, (a) the completion of the Airport Boulevard/Fulton Road interchange consolidation, (b) the opening of the Graton Resort and Casino, and (c) growth in background traffic volumes on the corridor. The primary finding from the evaluation of these changes is that traffic demand has increased substantially on the US 101 corridor, particularly south of SR 12 in the PM peak period.

Despite increased demand across all time periods, corridor travel times were found to decrease for all time periods surveyed. The following bullets summarize the maximum travel time changes by direction and peak period.

- In the northbound direction, freeway mainline volumes in the AM peak period increased by up to eight percent, but travel times decreased by up to 2.0 minutes (or 10 percent).
- In the southbound direction, freeway mainline volumes in the AM peak period increased by up to eight percent, but travel times decreased by up to 2.1 minutes (or 8 percent).
- In the northbound direction, freeway mainline volumes in the PM peak period increased by up to six percent, but travel times decreased by up to 3.1 minutes (or 12 percent).
- In the southbound direction, freeway mainline volumes in the PM peak period increased by up to eight percent, but travel times decreased by up to 4.8 minutes (or 16 percent).

(Between Old Redwood Highway in Petaluma and Arata Lane in Windsor)

With respect to on-ramp queuing, the SR 12 connectors to US 101 were found to be susceptible to long queues due to a combination of ramp metering and merge delays resulting from congestion on US 101. The queues were not substantially longer than in the Before observations, but the shift of the head of the queue from the US 101 merge point back to the ramp metering line resulted in queues that reached further upstream on SR 12. Although the SR 12 connector queues were not found to affect local street operations, they did at times limit the use of auxiliary lanes on SR 12 to access adjacent interchanges. A few local street ramps were observed to queue to their storage capacities and, on rare occasions, slightly beyond. It is possible that during temporary surges in traffic volumes, these queues would exceed storage capacity.

Traffic operations on arterial segments and at intersections were monitored before and after ramp metering to gauge its effect on segment traffic volumes and intersection operations. Minor variations in peak hour traffic counts, daily traffic counts, or intersection levels of service were found. While ramp metering may have caused some of these changes, other factors—including the recent completion of the widening of Santa Rosa Avenue—may have had an equal or greater effect on the observed changes.

The analysis of Before and After conditions found that travel times on US 101 decreased for all time periods surveyed. It is important to note that the decreases in freeway travel times were realized despite background traffic volume growth over the last two years and the opening of the Graton Resort and Casino.

On-ramp metering rates were developed and fine-tuned in the field to eliminate or minimize queue spillback to local streets. Despite using high metering rates, the SR 12 on-ramps to US 101 continue to be susceptible to queuing.

A review of traffic data on local arterial segments and intersections found no definitive evidence of systemic traffic diversion due to ramp metering. The small changes noted were likely a result of normal variation in traffic volumes and increased capacity on Santa Rosa Avenue, rather than diversion due to ramp metering on US 101.

INTRODUCTION

The Metropolitan Transportation Commission (MTC) worked with Caltrans, Sonoma County Transportation Authority (SCTA), and other local agencies to implement ramp metering for US 101 in Sonoma County. US 101 is a regional freeway facility that serves local and regional travel needs from/to and through Sonoma County. The US 101 corridor supports several travel markets including daily commuter trips, local freight and goods movements, recreational trips, regional trips, and intercity/local travel. It is the only north-south freeway in the County, serving the cities of Petaluma, Cotati, Rohnert Park, Santa Rosa, and the Town of Windsor within the study corridor for this project. US 101 is the only major interregional connector linking the San Francisco Bay Area to the northern California coast.

Ramp metering is a traffic management strategy, which uses traffic signals and accompanying equipment and techniques to manage on-ramp flow onto the freeway system. It is considered a cost-effective operational strategy to manage freeway operations in light of increased traffic congestion on US 101 and limited funding to add new capacity. The ramp metering implementation plan was developed in cooperation with stakeholders along the corridor, including:

- City of Cotati
- City of Petaluma
- City of Rohnert Park
- City of Santa Rosa
- Town of Windsor
- Sonoma County
- Sonoma County Transportation Authority (SCTA)
- Sonoma-Marin Area Rail Transit (SMART)

This study evaluated traffic conditions before and after the implementation of ramp metering (herein after referred to as Before and After). The limits of the study corridor were from Old Redwood Highway in Petaluma to Arata Lane in Windsor. Ramp metering was implemented within a subset of the study corridor, as described below and shown in Exhibit 1:

- US 101 northbound: from the Gravenstein Highway (SR 116 West) interchange to the Shiloh Road interchange, PM 12.868 to PM 27.649 (approximately 15 miles). A total of 17 ramps were metered.
- US 101 southbound: from the Arata Lane interchange to the Pepper Road interchange, PM 30.5 to PM 8.871 (approximately 22 miles). A total of 25 ramps were metered.

The interchange ramps that are included within the study area are shown in Exhibit 1 below and in more detail in an online map[1] (see Appendix Exhibit A-1 in Appendix A for a detailed print version). Metering was implemented only at the on-ramp locations, as shown in Appendix Exhibit A-2.

[1] https://www.google.com/maps/d/viewer?usp=sharing&mid=z959r31kfpU0.kvin5tozWI2s

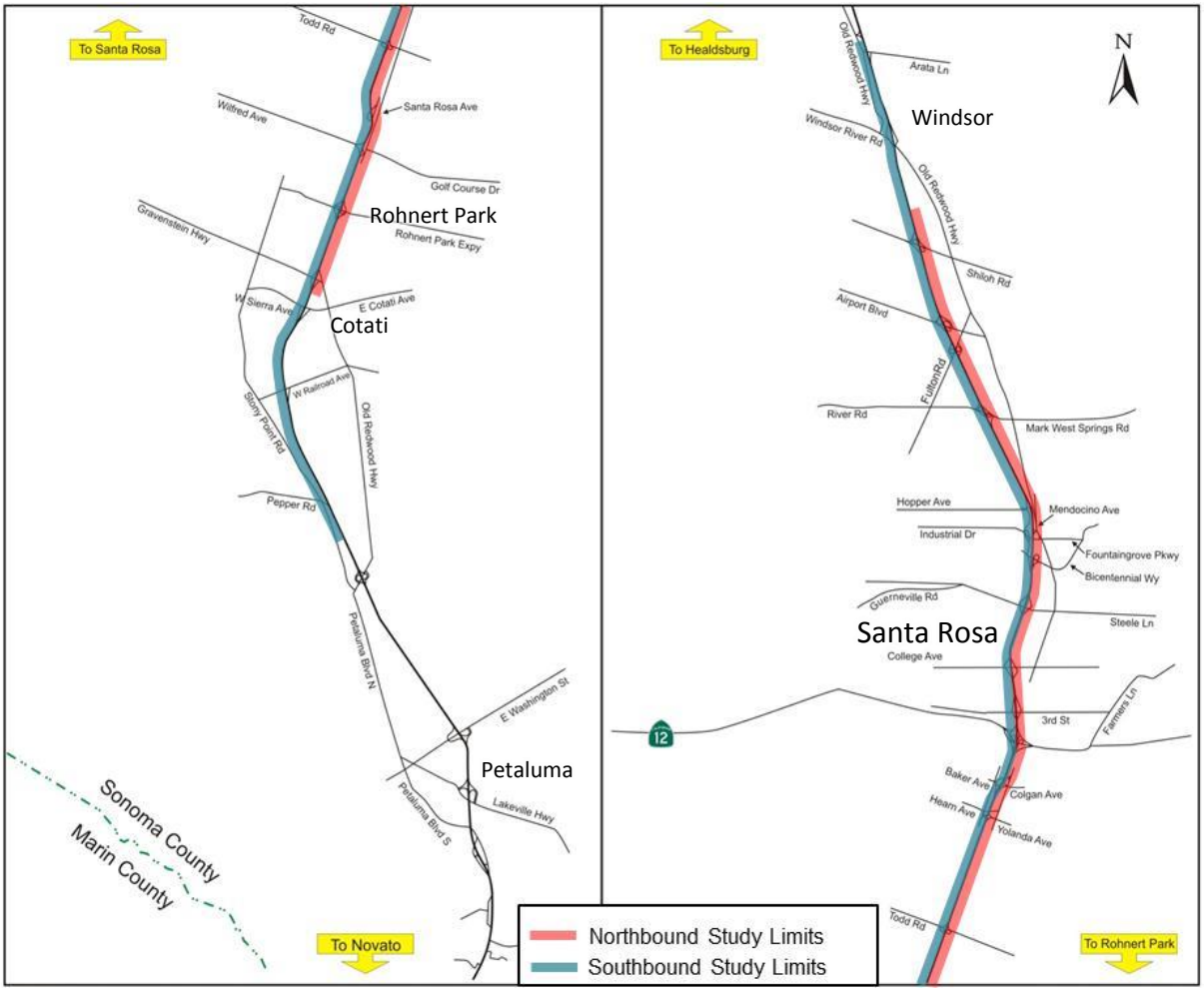
Before traffic operations were observed during midweek days, Fridays, and Sundays from Tuesday, April 30 through Sunday, May 19, 2013 to develop the Before baseline. The following time periods were studied:

- Midweek AM northbound and southbound: 6 AM to 10 AM
- Midweek PM northbound and southbound: 3 PM to 7 PM
- Friday PM northbound: 3 PM to 7 PM
- Sunday PM southbound: 3 PM to 7 PM

The days and hours of ramp metering were determined based on the findings from the Before conditions analysis. Due to the relatively free-flow Before traffic operations within the study corridor on Sundays, only weekdays were considered for ramp metering. Furthermore, Friday operations were found to be similar to those of other weekdays, such that a Friday-specific plan was not justified.

Ramp meters were activated in September and October 2014 during the morning and afternoon peak periods of weekdays in both directions of US 101, from 6 AM to 10 AM and 3 PM to 7 PM.

Exhibit 1: Ramp Metering Limits



DATA COLLECTION SUMMARY

Extensive data collection efforts were conducted before the ramp meters were turned on, as well as after the ramp meters were implemented and operational. The following data were collected:

- Travel time data collected from floating car surveys (tach runs) and INRIX®
- Freeway mainline and ramp counts
- Visual observations of traffic operations and on-ramp queues
- Local arterial roadway segment and intersection counts

Before ramp metering freeway data were collected on six (6) days between April 30, 2013 and May 5, 2013 with three consecutive midweek days, two typical Fridays, and one typical Sunday. The details of those data were documented in the *Deliverable 2.5B - Existing Conditions Technical Memorandum*, submitted on November 21, 2013. The exact dates and time periods of observations were:

- Tuesday, April 30, 2013, from 6 to 10 AM and 3 to 7 PM
- Wednesday, May 1, 2013, from 6 to 10 AM and 3 to 7 PM
- Thursday, May 2, 2013, from 6 to 10 AM and 3 to 7 PM
- Friday, May 3, 2013, from 3 to 7 PM
- Friday, May 10, 2013, from 3 to 7 PM
- Sunday, May 5, 2013, from 3 to 7 PM

After ramp metering freeway data were also collected on three (3) midweek days between May 5, 2015 and May 7, 2015. The exact dates and time periods of observations were:

- Tuesday, May 5, 2015, from 6 to 10 AM and 3 to 7 PM
- Wednesday, May 6, 2015, from 6 to 10 AM and 3 to 7 PM
- Thursday, May 7, 2015, from 6 to 10 AM and 3 to 7 PM

TRAVEL TIME DATA

Freeway travel time data were collected from two different sources for US 101 between Old Redwood Highway in Petaluma and Arata Lane in Windsor (approximately 23 miles).

- **Floating car surveys** were conducted by Metro Traffic Data. GPS-equipped vehicles were deployed in the field to collect travel speed and travel time data. Field-recorded speeds along the corridor also enable the evaluation of bottleneck locations, queue lengths, and duration of congestion. Floating car surveys were conducted along the study corridor at approximately 15-minute headways in May 2013 and May 2015. These surveys focused exclusively on traffic in the mixed-flow lanes. Detailed floating car data are included in Appendix D.

- **INRIX® travel time data:** This data source is primarily based on cellular vehicle probes, as well as consumer GPS-based devices. INRIX's travel times are reported between origin and destination pairs and are for mixed-flow traffic lanes and the HOV lane combined. In other words, INRIX does not have the ability to separate vehicle probes on the general purpose lanes from probes on the HOV lanes. On the other hand, INRIX can provide travel times for several days at a time, which is useful in assessing the variability of travel times in a corridor. For this study, INRIX data were used to check how well the floating car runs represented typical conditions.

TRAFFIC COUNTS

Various traffic counts were collected along the study corridor and its vicinity to capture potential changes in traffic volumes and travel patterns between Before and After conditions.

Freeway Mainline and Ramp Counts

Caltrans provided freeway mainline and ramp traffic counts for both the Before and After conditions. These data were collected from in-pavement vehicle detectors. All counts were collected during ramp metering hours on the data collection dates listed above.

PeMS Counts

Supplemental freeway counts were downloaded from Caltrans' PeMS (Freeway Performance Measurement System) website. The PeMS counts consist of midweek days between February 2013 and June 2015, which covers the duration of the Before and After study.

PeMS data varies in quality over sensor stations and over time. Even when quality is acceptable, the analyst must keep in mind that PeMS provides throughput counts—which may or may not be equal to demand at a given location.

To overcome these issues, only data points where the "Percent Observed" data quality measure exceeded 75 percent were used. Furthermore, total peak period counts at various sensor locations were used in the analysis to avoid working with potentially constrained peak hour counts. Finally, an outlier filtering technique[2] was used in combination with graphical tools to develop more accurate trends from PeMS data.

[2] *Modified Z-Scores,* Boris Iglewicz and David Hoaglin, University of California (1993).

Arterial Counts

Pneumatic tubes were used to collect bidirectional traffic volumes at the two arterial locations listed below.

1. Cleveland Avenue south of College Avenue (Santa Rosa)
2. Santa Rosa Avenue north of Baker Avenue (Santa Rosa)

Turning movement traffic volumes were collected during a morning peak period (7 AM to 9 AM) and an afternoon peak period (4 PM to 6 PM) on Thursday, May 2, 2013 and Tuesday, May 5, 2015 for nine (9) intersections:

1. Industrial Drive and Cleveland Avenue (Santa Rosa)
2. Mendocino Avenue and Fountaingrove Parkway (Santa Rosa)
3. College Avenue and US 101 SB Ramps (Santa Rosa)
4. Santa Rosa Avenue and US 101 NB Baker Ave Ramps/Colgan Avenue (Santa Rosa)
5. Corby Avenue and US 101 SB Hearn Avenue Ramps (Santa Rosa)
6. Commerce Boulevard and US 101 NB Golf Course Drive Ramps (Rohnert Park)
7. Commerce Boulevard and Rohnert Park Expressway (Rohnert Park)
8. Commerce Boulevard and US 101 NB Old Redwood Highway On-Ramp (Cotati)
9. Gravenstein Highway (SR 116) and US 101 SB Ramps (Cotati)

This map[3] shows the arterial count locations. Appendix Exhibit A-3 also presents these locations.

[3] https://www.google.com/maps/d/viewer?usp=sharing&mid=z959r31kfpU0.kxF3zonn4CmA

RAMP METERING PLAN

The ramp metering plan was developed and fine-tuned to manage the entry of vehicles onto the freeway and to maintain efficient traffic operations on the freeway without negatively affecting local streets. Ramp metering plans were developed for 18 northbound and 25 southbound on-ramps along the US 101 study corridor. The March 2014 *Deliverable 4.2B: Final Sonoma US 101 Ramp Metering Implementation Plan* produced by Kittelson & Associates, Inc. describes the plan in more detail.

In summary:

- Between 6:00 AM and 6:30 AM, the ramp meters would rest on green unless unexpected congestion is detected, at which point they switch to four-second cycles. Four-second cycles allow a maximum of 900 vehicles per hour per lane to enter the freeway from the on-ramp. From 6:30 AM to 7:00 AM and from 9:00 AM to 10:00 AM (i.e., "shoulder hours"), the ramp meters would operate at four-second cycles.
- From 7:00 AM to 9:00 AM, the ramp meters would operate at or near optimal metering rates.
- From 3:00 PM to 6:30 PM, the ramp meters would operate at or near optimal metering rates.
- From 6:30 PM to 7:00 PM, the ramp meters would operate at four-second cycles.

Visual observations were conducted during the initial activation of ramp metering in September and October 2014. During activation, consultant staff provided support to Caltrans in monitoring ramp meter operations, adjusting and fine-turning metering rates and other controller settings, as well as collecting floating car data (tach runs).

Caltrans staff also set up and activated end-of-queue detectors at the foot of all metered on-ramps to minimize spillback to local streets. These detectors recognize when ramp metering queues are about to exceed the available on-ramp storage and signal the controller to gradually shorten metering cycles. Appendix B provides an introduction to this and other aspects of ramp metering design and operations.

Appendix C documents the adjustments and fine-tuning of ramp metering rates performed by Caltrans staff to reduce or eliminate excess queuing while still managing the entry of vehicles onto the freeway. The reasons for adjusting ramp metering rates based on field observations include, but are not limited to:

- **Platooning of vehicles.** Ramp metering rates are typically developed based on 15-minute volume counts, but some locations exhibit much shorter surges in traffic volume. For example, a nearby upstream signal can result in one- to two-minute surges.
- **Lane utilization.** The ramp metering plan assumes equal lane utilization at multilane on-ramps. In reality, small differences in width, striping, or turning movements at an intersection result in uneven lane utilization.
- **Changes in demand.** Traffic volumes may have changed between the time of the Before data collection and that of the implementation phase. This could be the result of a new development or a change in existing land use.

BACKGROUND CHANGES

This chapter provides additional context to inform the Before and After comparisons presented in subsequent chapters. Because the two data collection periods took place over a period of two years, a proper comparison must take into account background changes. These changes include, but are not limited to, (a) the completion of the Airport Boulevard/Fulton Road interchange consolidation, (b) the opening of the Graton Resort and Casino, and (c) growth in background traffic volumes on the corridor. The primary finding from the evaluation of these changes is that traffic demand has increased substantially on the US 101 corridor, particularly south of SR 12 in the PM peak period.

FREEWAY CONSTRUCTION

The only major freeway construction effort taking place within the study area during the time of the Before and After study was the reconstruction of the Airport Boulevard and Fulton Road interchange north of Santa Rosa. This project converted two existing partial interchanges on US 101 at Fulton Road and at Airport Boulevard into a single complete interchange at Airport Boulevard, eliminating the on- and off- ramps at Fulton Road.

The completion of the interchange took place between the time of ramp metering activation in September and October 2014 and the time of the after data collection effort (May 2015). The completion of the interchange reconstruction simplified traffic operations on this portion of the corridor and likely resulted in faster mainline speeds and redistribution of on- and off-ramp volumes between the River Road and Airport Boulevard interchanges.

The Marin-Sonoma Narrows[4] project to widen US 101 and the new interchange at Petaluma Boulevard South[5] are currently underway south of the study area. The effect of these construction efforts on the study results were considered negligible.

[4] http://www.dot.ca.gov/dist4/msn/

[5] http://www.dot.ca.gov/dist4/101petalumablvd/

NEARBY DEVELOPMENTS

The Graton Resort and Casino located in Rohnert Park, CA opened for business in November 2013, after the Before data collection effort but before the activation of ramp meters on the corridor. The 340,000 square foot casino and resort complex was forecast to add 17,177 daily trips to the area. Out of these new trips, 1,281 were forecast to occur in the AM peak hour and 2,127 in the PM peak hour.[6] The temporal distribution of casino/hotel traffic is markedly different from that of traditional land uses, as explained in the Graton Casino Traffic Impact Study ("Casino TIS"):

> *In addition, casino facilities are open 24/7 and typically do not generate extreme peaks like other uses. Instead, casino/hotel traffic follows a smoother curve that builds steadily from early morning until about 7:00 PM, after which traffic levels slowly decline. Based on existing traffic volume information and expected trip generation from the casino and hotel, it was determined that the weekday PM peak period represents the worst case period to evaluate.*

In the Casino TIS, inbound and outbound traffic to the casino was assumed to primarily use Golf Course Drive/Wilfred Avenue and the Rohnert Park Expressway. With respect to freeway level of service, the Casino TIS estimated that the casino/hotel traffic would degrade level of service on several segments of both southbound and northbound US 101 in the PM peak hour. The largest increases in freeway density (a measure of congestion) were predicted by the Casino TIS to occur between the Rohnert Park Expressway (RPX) and Gravenstein Highway interchanges.

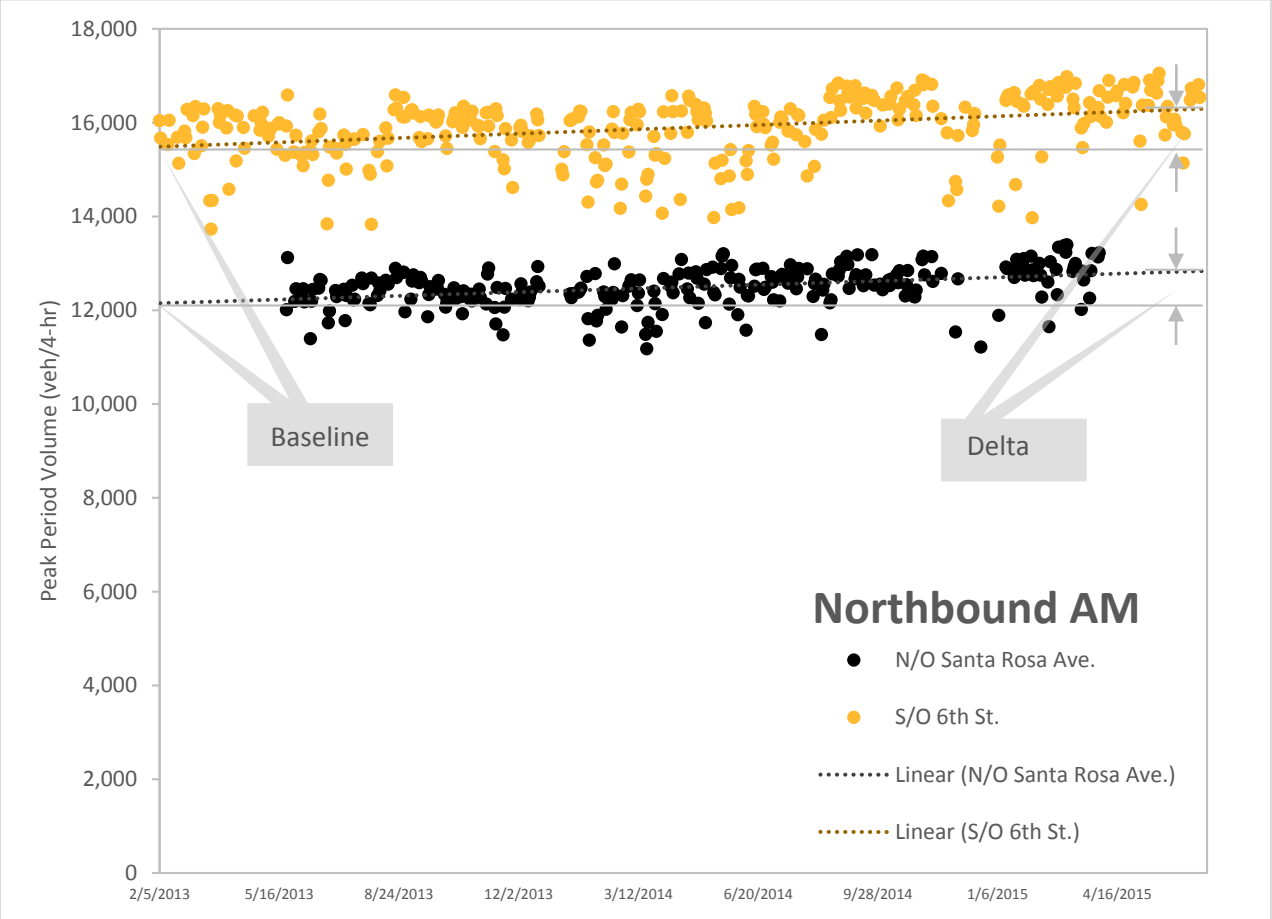
FREEWAY TRAFFIC VOLUMES

The supplemental freeway counts obtained from PeMS cover midweek days between February 2013 and June 2015 at fifteen locations on US 101. The long and continuous coverage of PeMS counts allows for long-term estimates of background traffic growth.

To improve the accuracy of the estimates, outliers were removed and the remaining data were reviewed graphically using scatter plots. Four of the fifteen locations were found to have reliable and consistent data throughout the study period. A best-fit linear regression was used on data from these locations to estimate the prevailing trend over the February 2013 through June 2015 time interval. Exhibit 2 is an annotated sample of this analysis methodology.

[6] *Final Traffic Impact Study Update Alternate Variant H-Sub 1 [for the] Graton Rancheria Casino and Hotel – Sonoma County, CA*. Kimley-Horn and Associates, Inc. (January 2013). Page 55: Project Trip Generation.

Exhibit 2: Sample PeMS Background Volume Analysis, Northbound, AM Peak Period

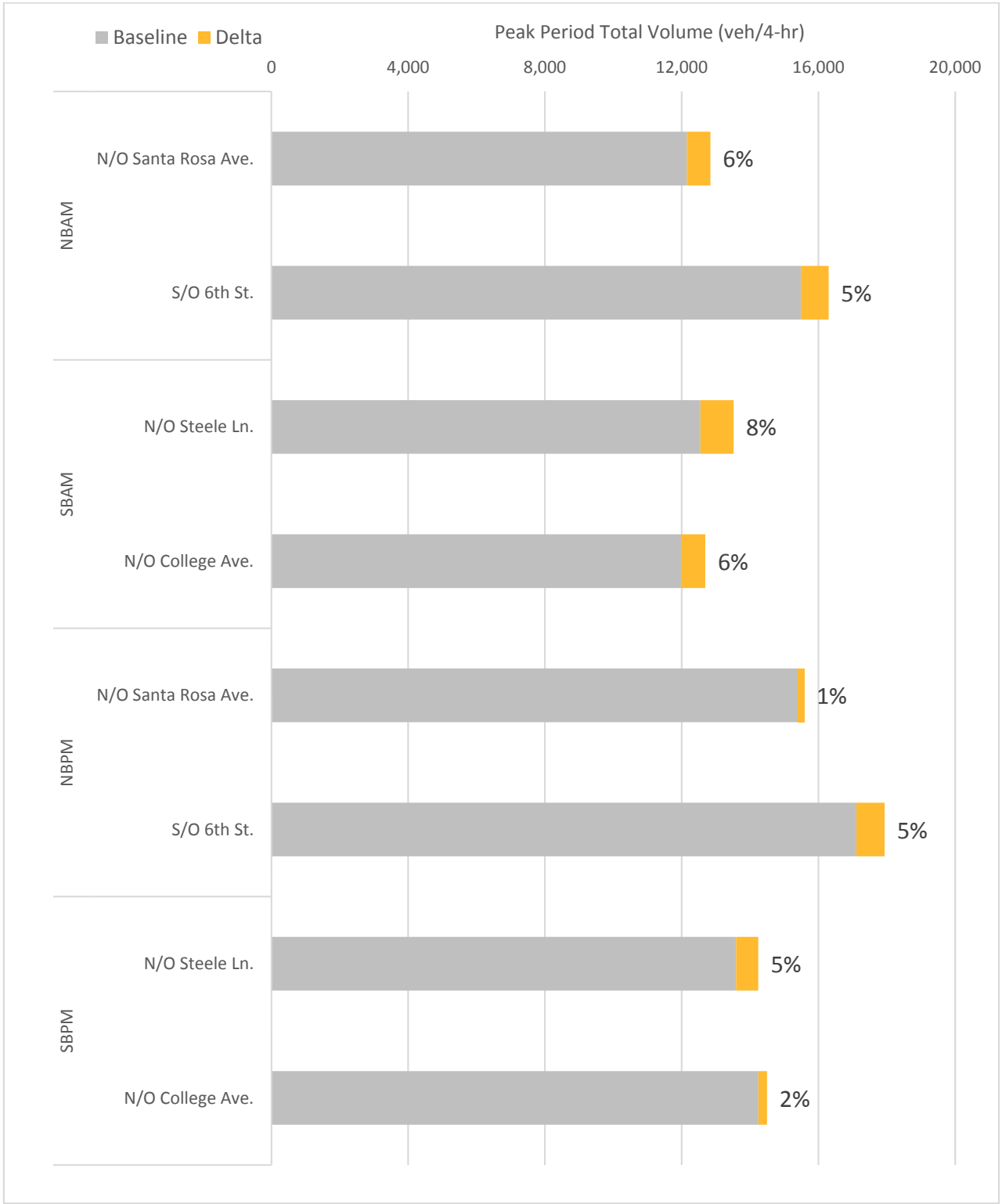


Data Source: PeMS (2013 to 2015)

Exhibit 3 presents a summary of PeMS data on the corridor, showing baseline volumes representing early 2013 and the percent increase or decrease from the baseline by mid-2015. These volumes and changes are based on the linear regression described above and do not necessarily represent actual traffic volumes during the Before and After surveys. The Mainline and Ramp Traffic Volumes section of this report presents traffic counts collected by Caltrans specifically for the Before and After data collection dates.

A comparison of the 2013 and 2015 PeMS peak period traffic volumes in Exhibit 3 shows noticeable increases in all directions and peak periods.

Exhibit 3: PeMS Background Traffic Volumes



Data Source: PeMS. The baseline and delta values result from a best-fit linear regression of valid data points. Baseline represents the intercept on the first day of data (February 5, 2013), and delta represents the linear change between the last day and first day of data (June 30, 2015 and February 5, 2013, respectively).

TRAFFIC DATA COMPARISON

This chapter provides comparisons of the data collected as part of the Before and After surveys, described in detail in the Data Collection Summary section.

FREEWAY TRAVEL TIMES

Travel time comparisons were based on the floating car surveys conducted as part of this study. INRIX data were used to verify the representativeness of floating car data. This check led to the adjustment of the Before southbound PM peak period floating car data. These data had been based on a single day of runs due to major incidents on two out of the three data collection dates. The adjustment process is documented in Appendix Exhibit D-1.

Exhibit 4 through Exhibit 7 present travel time comparisons before and after the implementation of ramp metering.

Corridor travel times were found to decrease for all time periods surveyed. The maximum travel time changes by direction and peak period were as follows:

- In the northbound direction, travel times in the AM peak period decreased by up to 2.0 minutes (or 10 percent).
- In the southbound direction, travel times in the AM peak period decreased by up to 2.1 minutes (or 8 percent).
- In the northbound direction, travel times in the PM peak period decreased by up to 3.1 minutes (or 12 percent).
- In the southbound direction, travel times in the PM peak period decreased by up to 4.8 minutes (or 16 percent).

Bottleneck extents—in space and time—were also reviewed through the use of speed contours diagrams. Speed contour diagrams plot speeds with time in the y-axis and space (i.e., distance) in the x-axis. Color coding helps discern time-location pairs with slow speeds from those with near free-flow speeds.

Length	2.75	1.30	0.61	0.52	0.68	0.28	0.35	0.43	0.22	0.49	1.06	0.22	1.58	0.30	0.27	0.17	0.39	0.36	0.39	0.35	0.08	0.38	0.59	0.45
3:00 PM	62	65	59	63	65	62	60	58	56	56	62	61	60	57	60	59	58	61	63	59	61	60	59	61
3:15 PM	66	68	68	67	67	63	65	65	60	54	50	55	57	61	49	47	53	61	64	60	57	60	64	65
3:30 PM	61	62	62	63	65	64	63	62	63	60	61	60	54	59	51	45	52	57	58	59	60	63	62	63
3:45 PM	60	65	64	66	68	67	67	65	65	63	41	50	43	35	29	37	48	55	59	60	61	64	65	65
4:00 PM	59	65	70	66	66	69	68	64	53	59	50	23	34	50	38	37	46	55	47	36	42	53	59	61
4:15 PM	58	65	63	63	61	62	59	60	60	47	30	35	37	24	28	37	49	57	48	48	51	53	59	58
4:30 PM	65	66	64	62	61	60	63	62	62	54	25	17	30	24	25	33	50	56	55	52	57	58	62	62
4:45 PM	63	66	65	66	67	65	63	62	58	41	33	21	27	31	30	35	50	56	45	41	54	58	63	63
5:00 PM	62	65	65	68	68	60	63	63	65	63	30	32	30	23	28	36	47	58	53	31	37	46	61	64
5:15 PM	61	65	65	69	65	63	62	65	64	42	24	21	27	27	31	41	51	59	64	55	53	63	66	64
5:30 PM	58	59	59	66	66	63	63	62	63	64	31	27	23	24	23	33	43	55	65	62	61	65	65	66
5:45 PM	63	65	64	64	66	64	63	62	61	54	27	33	30	24	30	44	52	60	62	61	60	61	64	65
6:00 PM	59	63	64	67	70	68	67	68	66	63	59	46	49	37	27	35	47	56	58	58	58	60	63	60
6:15 PM	63	63	64	66	64	64	64	65	65	64	63	64	60	59	60	59	62	64	66	64	59	61	60	62
6:30 PM	64	69	68	66	68	67	64	64	65	65	64	65	62	67	67	64	62	64	66	65	61	66	66	64
6:45 PM	64	69	68	71	70	71	69	67	68	62	65	64	65	63	63	63	62	64	65	63	62	68	66	66

The following bullets describe the changes in bottleneck extents relative to those observed during the Before data collection. Existing bottleneck extents are documented in detail in the *Deliverable 2.5B – Existing Conditions* memorandum dated November 21, 2013.

- In the northbound direction during the AM peak period, freeway mainline queues due to the Yolanda Avenue-Baker Avenue bottleneck were about two miles shorter in the After surveys. On the other hand, peak hour speeds through the queue approaching the SR 12-College Avenue bottleneck were found to be slower than in the Before survey. In terms of duration, congestion started later (7:30 AM vs. 7:15 AM) than in the Before conditions. In both the Before and After surveys, the entire study corridor was at or near free-flow speeds by 9:00 AM.

- In the southbound direction during the AM peak period, Before and After freeway mainline queues were found to be similar in length and duration. However, speeds through the queue approaching the SR 12-Baker Avenue bottleneck were considerably faster in the After survey.

- In the northbound direction during the PM peak period, the Yolanda Avenue-Baker Avenue bottleneck queue was found to stretch about three quarters of a mile longer in the After surveys. The bottleneck was also observed to start 15 minutes earlier and end 30 minutes earlier, for a net reduction in duration of 15 minutes. The sporadic slowdowns near Airport Boulevard observed during the Before surveys were not observed during the After surveys, likely due to the completion of the Fulton Road/Airport Boulevard interchange reconstruction.

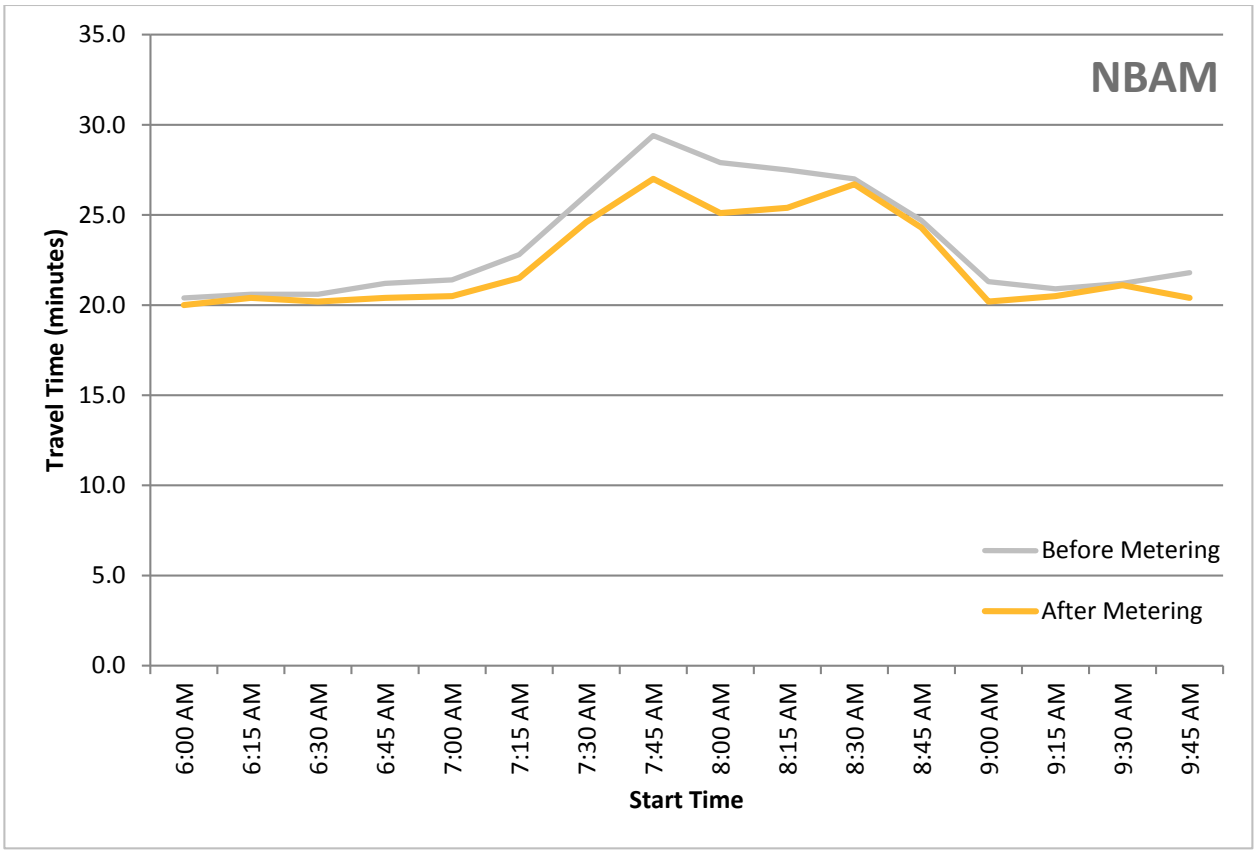
- In the southbound direction during the PM peak period, the After mainline queue approaching the SR 12-Baker Avenue bottleneck was slightly shorter in space and time—about half a mile and 30 minutes, respectively. Speeds through the queue approaching the College Avenue bottleneck were faster in the After surveys, although the extent of the queue was similar. A minor bottleneck at River Road, which was not present in the Before dataset, was observed in the After dataset between 5:00 PM and 6:00 PM.

Although ramp metering is likely a major contributor to the positive changes described above and in Exhibit 4 through Exhibit 7, the background changes described in the previous section are also likely to have influenced traffic operations on the corridor.

Appendix D contains detailed day-by-day travel time plots and speed contours diagrams, as well as more detailed comparisons of Before and After conditions.

Exhibit 4: Before and After Travel Times, Northbound, AM Peak Period

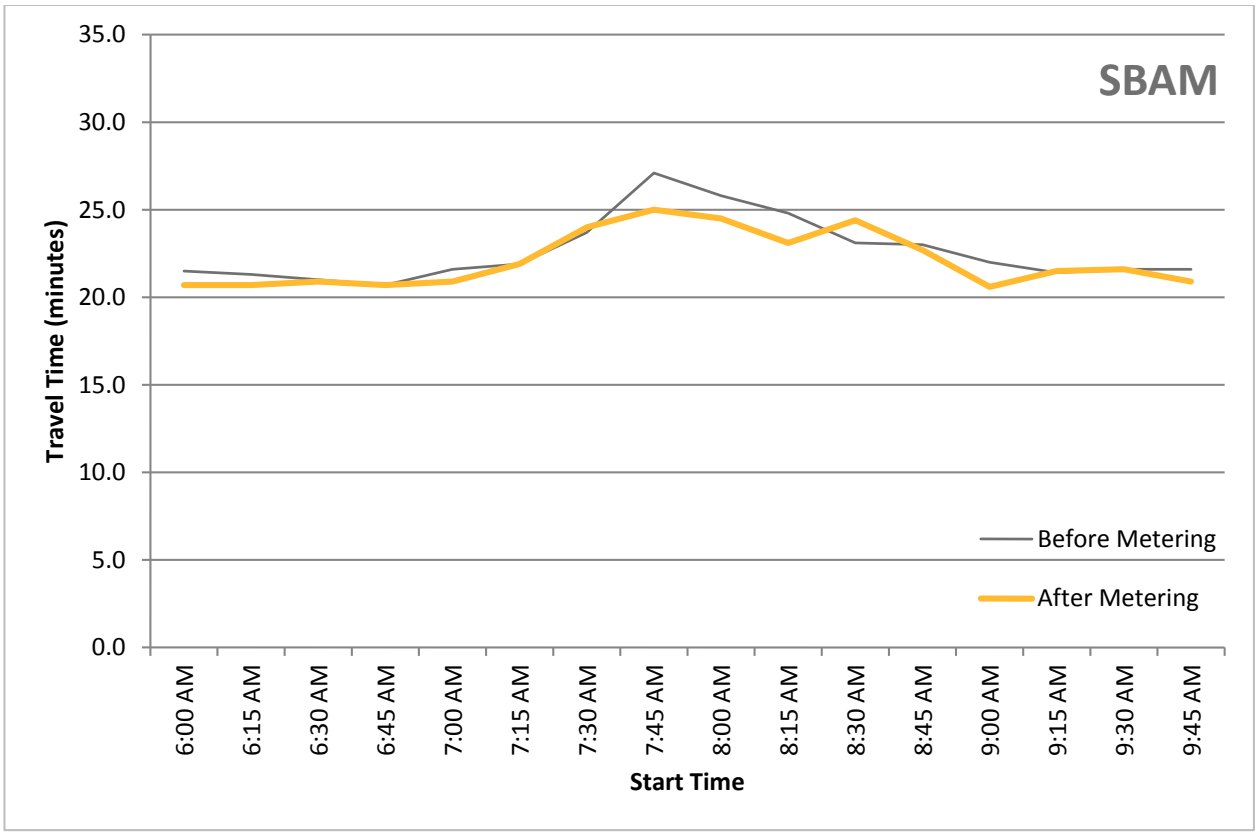
Start Time	Before Metering	After Metering	Difference	
6:00 AM	20.4	20.0	-0.4	-2.0%
6:15 AM	20.6	20.4	-0.2	-1.0%
6:30 AM	20.6	20.2	-0.4	-1.9%
6:45 AM	21.2	20.4	-0.8	-3.8%
7:00 AM	21.4	20.5	-0.9	-4.2%
7:15 AM	22.8	21.5	-1.3	-5.7%
7:30 AM	26.1	24.6	-1.5	-5.7%
7:45 AM	29.4	27.0	-2.4	-8.2%
8:00 AM	27.9	25.1	-2.8	-10.0%
8:15 AM	27.5	25.4	-2.1	-7.6%
8:30 AM	27.0	26.7	-0.3	-1.1%
8:45 AM	24.7	24.3	-0.4	-1.6%
9:00 AM	21.3	20.2	-1.1	-5.2%
9:15 AM	20.9	20.5	-0.4	-1.9%
9:30 AM	21.2	21.1	-0.1	-0.5%
9:45 AM	21.8	20.4	-1.4	-6.4%



Notes:
Travel times reported in minutes between Old Redwood Highway and Arata Lane, a distance of approximately 23 miles.
Grey shading indicates the time with the highest travel time (dis)savings.
Before data obtained on 4/30/2013 and 5/1/2013.
After data obtained on 5/5/2015, 5/6/2015 (partial) and 5/7/2015.

Exhibit 5: Before and After Travel Times, Southbound, AM Peak Period

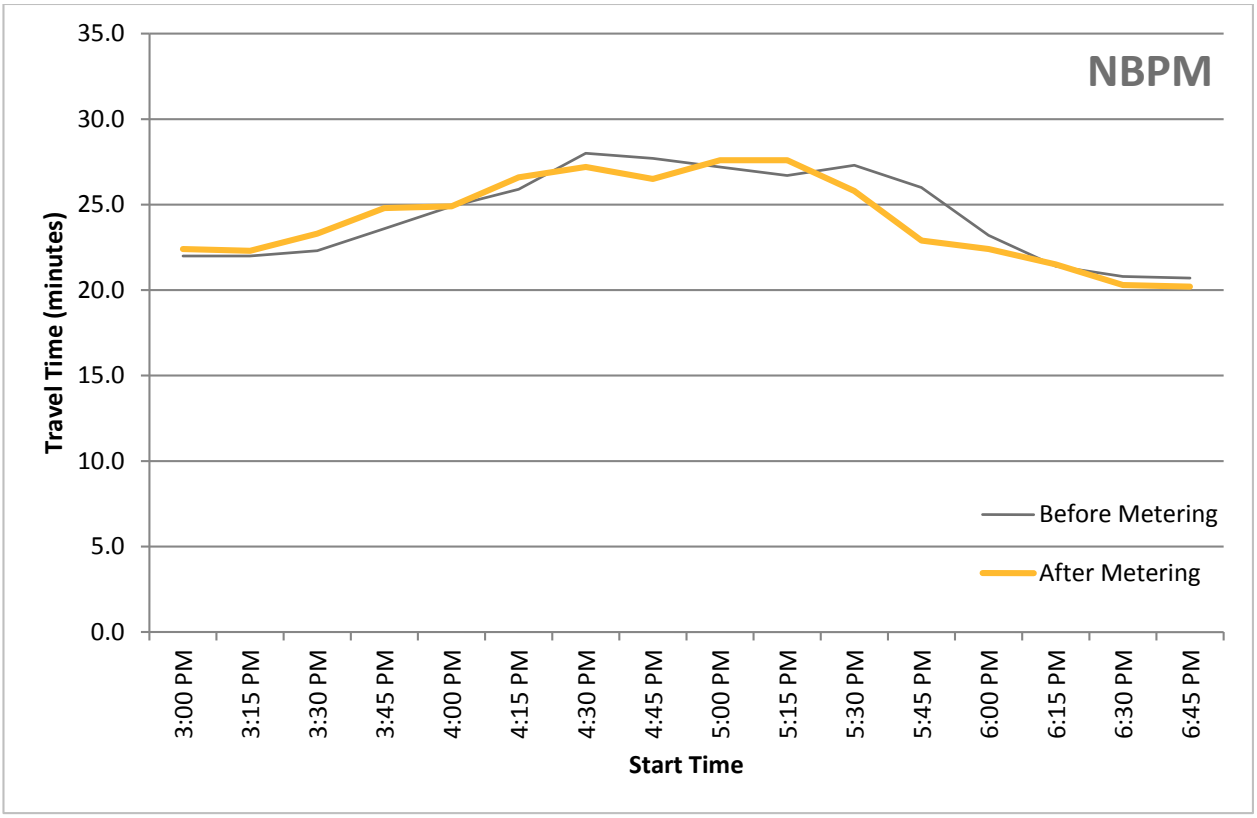
Start Time	Before Metering	After Metering	Difference	
6:00 AM	21.5	20.7	-0.8	-3.7%
6:15 AM	21.3	20.7	-0.6	-2.8%
6:30 AM	21.0	20.9	-0.1	-0.5%
6:45 AM	20.7	20.7	0.0	0.0%
7:00 AM	21.6	20.9	-0.7	-3.2%
7:15 AM	21.9	21.9	0.0	0.0%
7:30 AM	23.7	24.0	0.3	1.3%
7:45 AM	27.1	25.0	-2.1	-7.7%
8:00 AM	25.8	24.5	-1.3	-5.0%
8:15 AM	24.8	23.1	-1.7	-6.9%
8:30 AM	23.1	24.4	1.3	5.6%
8:45 AM	23.0	22.7	-0.3	-1.3%
9:00 AM	22.0	20.6	-1.4	-6.4%
9:15 AM	21.4	21.5	0.1	0.5%
9:30 AM	21.6	21.6	0.0	0.0%
9:45 AM	21.6	20.9	-0.7	-3.2%



Notes:
Travel times reported in minutes between Arata Lane and Old Redwood Highway, a distance of approximately 23 miles.
Grey shading indicates the time with the highest travel time (dis)savings.
Before data obtained on 4/30/2013, 5/1/2013 and 5/2/2013 (partial).
After data obtained on 5/5/2015, 5/6/2015 (partial) and 5/7/2015 (partial).

Exhibit 6: Before and After Travel Times, Northbound, PM Peak Period

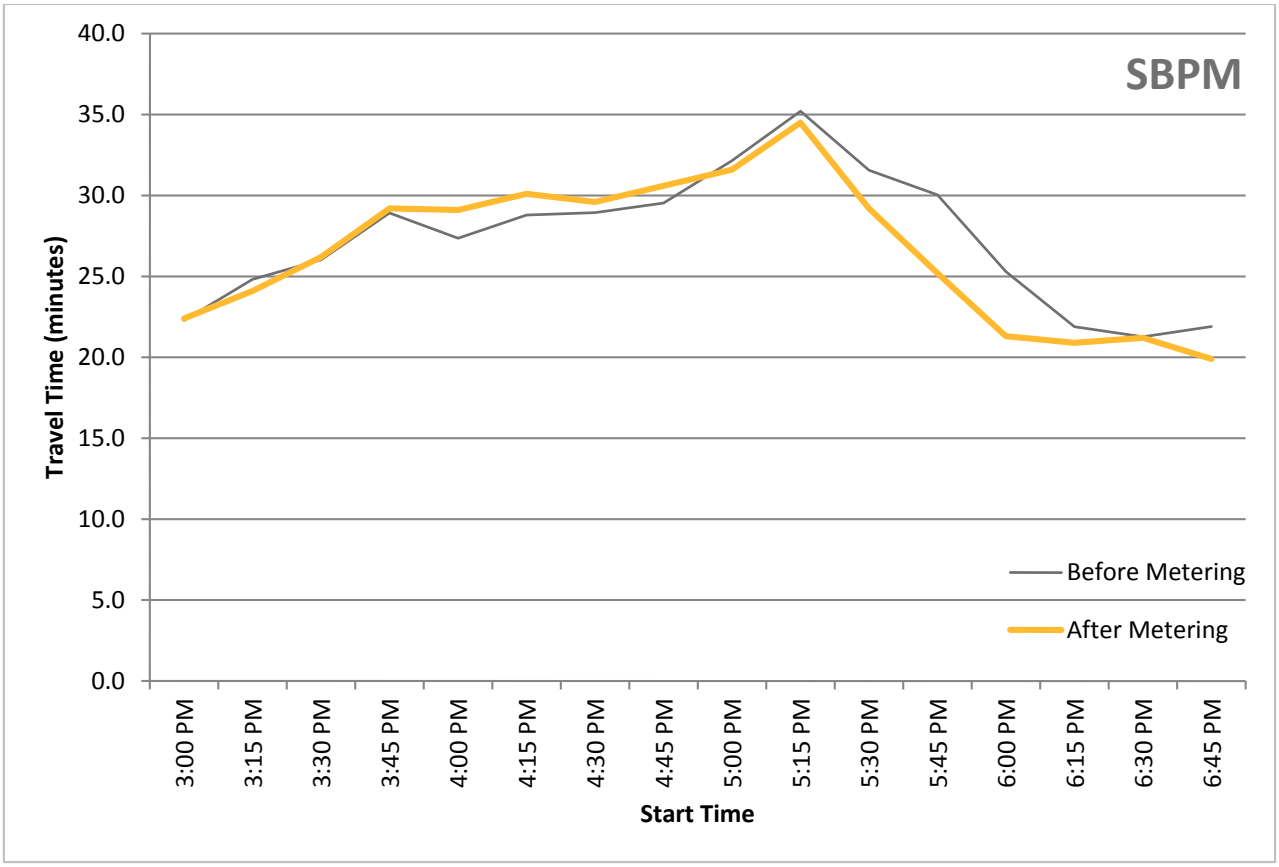
Start Time	Before Metering	After Metering	Difference	
3:00 PM	22.0	22.4	0.4	1.8%
3:15 PM	22.0	22.3	0.3	1.4%
3:30 PM	22.3	23.3	1.0	4.5%
3:45 PM	23.6	24.8	1.2	5.1%
4:00 PM	24.9	24.9	0.0	0.0%
4:15 PM	25.9	26.6	0.7	2.7%
4:30 PM	28.0	27.2	-0.8	-2.9%
4:45 PM	27.7	26.5	-1.2	-4.3%
5:00 PM	27.2	27.6	0.4	1.5%
5:15 PM	26.7	27.6	0.9	3.4%
5:30 PM	27.3	25.8	-1.5	-5.5%
5:45 PM	26.0	22.9	-3.1	-11.9%
6:00 PM	23.2	22.4	-0.8	-3.4%
6:15 PM	21.4	21.5	0.1	0.5%
6:30 PM	20.8	20.3	-0.5	-2.4%
6:45 PM	20.7	20.2	-0.5	-2.4%



Notes:
Travel times reported in minutes between Old Redwood Highway and Arata Lane, a distance of approximately 23 miles.
Grey shading indicates the time with the highest travel time (dis)savings.
Before data obtained on 4/30/2013 and 5/1/2013.
After data obtained on 5/5/2015, 5/6/2015 and 5/7/2015.

Exhibit 7: Before and After Travel Times, Southbound, PM Peak Period

Start Time	Before Metering	After Metering	Difference	
3:00 PM	22.3	22.4	0.1	1%
3:15 PM	24.8	24.1	-0.7	-3%
3:30 PM	26.0	26.2	0.2	1%
3:45 PM	28.9	29.2	0.3	1%
4:00 PM	27.4	29.1	1.7	6%
4:15 PM	28.8	30.1	1.3	5%
4:30 PM	28.9	29.6	0.7	2%
4:45 PM	29.5	30.6	1.1	4%
5:00 PM	32.2	31.6	-0.6	-2%
5:15 PM	35.2	34.5	-0.7	-2%
5:30 PM	31.6	29.2	-2.4	-7%
5:45 PM	30.0	25.2	-4.8	-16%
6:00 PM	25.3	21.3	-4.0	-16%
6:15 PM	21.9	20.9	-1.0	-5%
6:30 PM	21.3	21.2	-0.1	0%
6:45 PM	21.9	19.9	-2.0	-9%



Notes:
Travel times reported in minutes between Arata Lane and Old Redwood Highway, a distance of approximately 23 miles.
Grey shading indicates the time with the highest travel time (dis)savings.
The Before data obtained on 5/1/2013 were not considered representative of typical conditions and was adjusted based on INRIX April 2013 data. See Appendix Exhibit D-1 for details.
After data obtained on 5/5/2015 (partial), 5/6/2015 and 5/7/2015.

MAINLINE AND RAMP TRAFFIC VOLUMES

The Freeway Traffic Volumes section above uses PeMS data to assess the long-term trends in traffic volumes on US 101 through the duration of the ramp metering implementation study. In addition to the PeMS data, freeway mainline and on-ramp volumes were obtained from Caltrans equipment at most study ramps during the Before and After data collection weeks (in May 2013 and May 2015, respectively). While this dataset does not provide the same level of temporal continuity as PeMS, it does offer more comprehensive coverage during the days and times when the floating car travel time data were collected.

Peak period volumes are presented instead of peak hour volumes to ameliorate the potential effect of constrained conditions (i.e., bottlenecks) on counts. Nevertheless, it should not be assumed that these mainline or on-ramp counts represent demand volumes.

Freeway Mainline Traffic Volume Comparison

Freeway mainline traffic volumes along various sections throughout the study corridor were compared between May 2013 and May 2015. The findings are consistent with the PeMS-based analysis presented in the Background Changes section: mainline volumes were generally higher during the After data collection week than during the Before data collection week. The single highest increase took place in the PM peak period in the southern section of the study corridor.

Exhibit 8 shows the locations that were found to experience the largest changes in peak period volumes—either negative or positive—between May 2013 and May 2015. The full set of Before and After freeway mainline volumes is included in Appendix Exhibit A-4 through Appendix Exhibit A-7.

Exhibit 8: Top Five Freeway Mainline Volume Changes

Location[1]	Before[2]	After	Change[3]
Northbound, AM Peak Period			
College Avenue	14,822	15,144	322 (+2.2%)
Steele Lane/Guerneville Road	13,553	14,097	544 (+4.0%)
Mendocino Avenue	9,933	10,656	723 (+7.3%)
River Road/Mark West Springs Road	9,985	10,819	834 (+8.3%)
Shiloh Road	6,562	6,893	331 (+5.0%)
Southbound, AM Peak Period			
Shiloh Road	9,305	9,867	562 (+6.0%)
Hopper Avenue	10,683	11,483	800 (+7.5%)
Todd Rod	*13,581*	14,139	558 (+4.1%)
Rohnert Park Expressway	*11,102*	11,835	733 (+6.6%)
Pepper Road	*14,231*	14,786	555 (+3.9%)
Northbound, PM Peak Period			
Gravenstein Highway (SR 116)	12,058	12,751	693 (+5.7%)
Rohnert Park Expressway	*12,400*	13,164	764 (+6.2%)
Golf Course Drive/Wilfred Avenue	14,783	15,154	371 (+2.5%)
Yolanda Avenue/Hearn Avenue	14,806	15,492	686 (+4.6%)
Baker Avenue	17,651	18,217	566 (+3.2%)
Southbound, PM Peak Period			
Hearn Avenue	14,995	15,580	585 (+3.9%)
Todd Rod	14,735	15,383	648 (+4.4%)
Rohnert Park Expressway	12,180	13,118	938 (+7.7%)
Gravenstein Highway (SR 116)	10,102	10,757	655 (+6.5%)
Pepper Road	12,406	13,098	692 (+5.6%)

All volumes in vehicles/four hours
[1] Counts generally conducted upstream of on-ramps.
[2] Italics indicate locations where volumes were updated following the completion of *Deliverable 2.5B – Existing Conditions* Volumes at these locations are sourced from *Deliverable 3.1B FREQ Calibration*.
[3] Red shading indicates increases in volumes, gray shading indicates decreases.
Data Source: Caltrans (May 2013 and May 2015)

Freeway Ramps Traffic Volume Comparison

Similar to the freeway mainline count comparison described above, a review of May 2013 and May 2015 ramp counts was conducted to assess changes in demand. Comparisons were only performed for locations where valid Caltrans counts were available. In general, the highest increases in ramp traffic volumes were in the vicinity of the Airport Boulevard/Fulton Road interchange reconstruction project and the Graton Resort and Casino area. The Airport Boulevard and River Road ramps were observed to carry more traffic in the After dataset, likely due to motorists that previously used Fulton Road ramps. The Rohnert Park Expressway and Wilfred Avenue/Golf Course Drive off-ramps from northbound US 101 saw large increases in the PM peak period, presumably due to Graton Casino patrons.

Two on-ramps to US 101 northbound show notable declines in traffic volume in both peak periods: the SR 12 connectors and Baker Avenue. At SR 12, it is likely a result of SR 12 eastbound motorists staying on SR 12 and taking the next exit at E Street to avoid the connector queue. At Baker Avenue, the decline may be due to "positive" diversion, as motorists may choose to access the freeway at an upstream on-ramp to avoid longer ramp metering queues. As will be shown in the Arterial Segments section, there is no evidence of motorists diverting from US 101 to Santa Rosa Avenue, even with higher volumes on the freeway.

Exhibit 9 shows the locations that were found to experience the most change—either negative or positive—between May 2013 and May 2015. Appendix Exhibit A-8 through Appendix Exhibit A-11 include the full dataset of ramp counts.

Exhibit 9: Top Five Ramp Volume Changes

Location	Before[1]	After	Change[2]
Northbound, AM Peak Period			
Golf Course Drive/Wilfred Avenue on-ramp	1,313	1,686	373 (+28.4%)
Baker Avenue on-ramp	1,950	1,539	-411 (-21.1%)
River Road off-ramp	*2,089*	2,561	472 (+22.6%)
Airport Boulevard off-ramp	2,584	3,386	802 (+31.0%)
Airport Boulevard on-ramp	812	1,396	584 (+71.9%)
Southbound, AM Peak Period			
Arata Lane on-ramp	*1,027*	1,283	256 (+24.9%)
Airport Boulevard on-ramps	1,445	2,072	627 (+43.4%)
River Road off-ramp	984	1,540	556 (+56.5%)
College Avenue on-ramp	*2,370*	2,796	426 (+18.0%)
SR 12 off-ramp	4,726	5,475	749 (+15.9%)
Northbound, PM Peak Period			
Rohnert Park Expressway off-ramp	2,251	3,986	1,735 (+77.1%)
Baker Avenue on-ramp	3,391	2,956	-435 (-12.8%)
SR 12 on-ramp	7,072	6,321	-751 (-10.6%)
Airport Boulevard off-ramp	1,015	1,889	874 (+86.1%)
Airport Boulevard on-ramp	1,270	2,001	731 (+57.6%)
Southbound, PM Peak Period			
River Road off-ramp	1,217	2,111	894 (+73.5%)
Bicentennial Way on-ramp	3,746	3,484	-262 (-7.0%)
Steele Lane/Guerneville Road off-ramp	10,644	10,337	-307 (-2.9%)
College Avenue on-ramp	3,324	4,057	733 (+22.1%)
SR 12 off-ramp	7,209	8,347	1,138 (+15.8%)

All volumes in vehicles/four hours
[1] Counts generally conducted upstream of on-ramps.
[2] Italics indicate locations where volumes were updated following the completion of *Deliverable 2.5B – Existing Conditions* Volumes at these locations are sourced from *Deliverable 3.1B FREQ Calibration*.
[3] Red shading indicates increases in volumes, gray shading indicates decreases.
Data Source: Caltrans (May 2013 and May 2015)

ON-RAMP QUEUES

Existing on-ramp queues were observed at all on-ramps as part of the Before data collection effort. These Before queues were due to delays at the merge point, usually as a result of mainline congestion. The Before observations were spaced at approximately 30 minutes during the peak periods of the survey days.

Similarly, on-ramp queue observations were conducted as part of the initial activation surveys and the After surveys. The queues observed during these follow-up surveys were primarily a result of ramp meters, but in rare cases they were also influenced by mainline congestion. These observations were spaced at approximately 15 minutes. The observations can be divided into those at the SR 12 connectors to US 101 and those at local street on-ramps.

During the After surveys, the SR 12 eastbound and westbound connectors to **northbound US 101** were found to routinely exceed their storage capacity during the peak hours. The queues were not substantially longer than in the Before observations, but the shift of the head of the queue from the US 101 merge point back to the ramp metering line resulted in queues that reached further upstream on SR 12.

- The long queues result from a combination of merge delays and ramp metering delays. Any incidents on the US 101 mainline can exacerbate the merging delays and result in even longer queues.
- During the peak hours, the connector queues were observed to impede SR 12 through traffic. Motorists getting on SR 12 westbound at the E Street on-ramp and wishing to continue through could not make full use of the SR 12 auxiliary lane as it was often occupied by the ramp queue. A similar situation also applied to motorists getting on SR 12 eastbound from the Dutton Avenue on-ramp.
- Ramp metering on the SR 12 connectors to northbound US 101 appeared to simplify the merging movements between the SR 12 eastbound and SR 12 westbound connectors.

The SR 12 westbound connector to **southbound US 101** (loop) was observed to queue beyond capacity in the peak hour of the AM peak period. The queue reaches upstream of the northbound US 101 to westbound SR 12 connector (loop), preventing those motorists from making full use of the short auxiliary lane.

A few local street ramps were observed to queue to their storage capacities and, on rare occasions, slightly beyond. It is possible that during temporary surges in traffic volumes, these queues would exceed storage capacity. These local on-ramps include, but are not limited to:

- Gravenstein Highway on-ramp to northbound US 101 in the PM peak period.
- Baker Avenue on-ramp to northbound US 101 in the AM and PM peak periods.
- Sixth Street on-ramp to northbound US 101 in the AM and PM peak periods.
- Shiloh Road eastbound on-ramp to southbound US 101 in the PM peak period.
- Airport Boulevard on-ramp to southbound US 101 in the PM peak period.
- Mendocino Avenue on-ramp to southbound US 101 in the PM peak period.
- Bicentennial Way on-ramp to southbound US 101 in the PM peak period.
- Steele Lane on-ramp to southbound US 101 in the PM peak period.
- College Avenue on-ramp to southbound US 101 in the PM peak period (excess queueing had already been resolved by the time of the After survey).
- Third Street on-ramp to southbound US 101 in the PM peak period.
- Todd Road on-ramp to southbound US 101 in the PM peak period.

Exhibit 10 and Exhibit 11 present maximum queues during incident-free conditions for the SR 12 connectors and local street on-ramps with notable queues, respectively. To better illustrate the observed queues on SR 12, Exhibit 12 and Exhibit 13 present the schematics of the Before and After conditions, respectively.

The Next Steps section at the end of this report explores potential short-term and long-term strategies to reduce excess queuing.

Exhibit 10: Before and After Maximum Observed Queues, SR 12 Connectors

Direction	On-ramp	Total Available Storage[1]	Before May 2013[2]	After May 2015[3]	% of Obs. Exceeding Storage
AM Peak Period					
NB	SR 12 EB Connector	690' (23)	**4,000' (133)**	**1,710' (57)**	**24%**
NB	SR 12 WB Connector	1,500' (50)		**2,250' (75)**	**14%**
SB	SR 12 WB Connector	870' (29)	2,000' (67)	**1,440' (48)**	**31%**
SB	SR 12 EB Connector	1,230' (41)		840' (28)	0%
PM Peak Period					
NB	SR 12 EB Connector	690' (23)	**4,000' (133)**	**1,350' (45)**	**38%**
NB	SR 12 WB Connector	1,500' (50)		960' (32)	0%
SB	SR 12 WB Connector	870' (29)	2,280' (76)	540' (18)	0%
SB	SR 12 EB Connector	1,230' (41)		1,110' (37)	0%

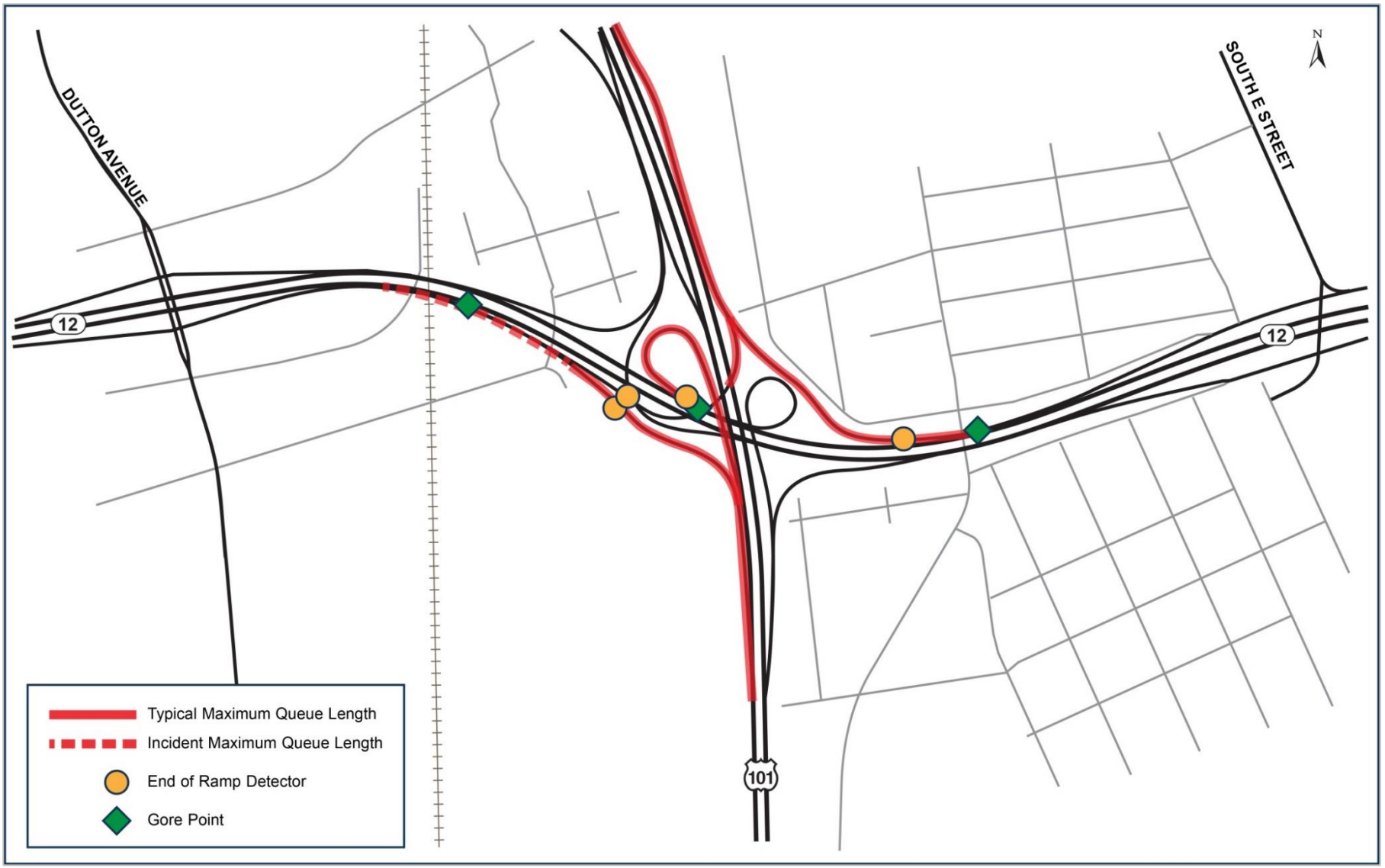
Exhibit 11: Before and After Maximum Observed Queues, Local Street On-Ramps

Direction	On-ramp	Total Available Storage[1]	Before May 2013[2]	After May 2015[3]	% of Obs. Exceeding Storage
AM Peak Period					
NB	Gravenstein Highway	540' (18)	0' (0)	300' (10)	0%
NB	Baker Avenue	720' (24)	0' (0)	720' (24)	0%
NB	Downtown/Sixth Street	540' (18)	0' (0)	**600' (20)**	**4%**
SB	Shiloh Road EB (Diagonal)	870' (29)	0' (0)	450' (15)	0%
PM Peak Period					
NB	Gravenstein Highway	540' (18)	0' (0)	420' (14)	0%
NB	Baker Avenue	720' (24)	390' (13)	510' (17)	0%
NB	Sixth Street	540' (18)	0' (0)	**900' (30)**	**13%**
SB	Shiloh Road EB (Diagonal)	870' (29)	0' (0)	**960' (32)**	**9%**
SB	Airport Blvd. EB (Diagonal)	1,680' (56)	0' (0)	900' (30)	0%
SB	Mendocino Avenue	150' (5)	0' (0)	150' (5)	0%
SB	Bicentennial Way	780' (26)	0' (0)	630' (21)	0%
SB	Steele Lane	930' (31)	0' (0)	**1,140' (38)**	**7%**
SB	Downtown/Third Street	450' (15)	0' (0)	**600' (20)**	**22%**
SB	Todd Road	570' (19)	0' (0)	480' (16)	0%

[1] Values are shown in feet (number of vehicles). Approximately 30 feet per vehicle length was assumed. Grey shading and bold indicates queues exceeding storage capacity. | [2] Queues are measured in feet from the merge point.
[3] Queues are measured in feet from on-ramp meter limit line. Detailed queue lengths are available here[7].
[4] Percent of incident-free observations in the peak period (6-10 AM or 3-7 PM) where queues exceeded storage.

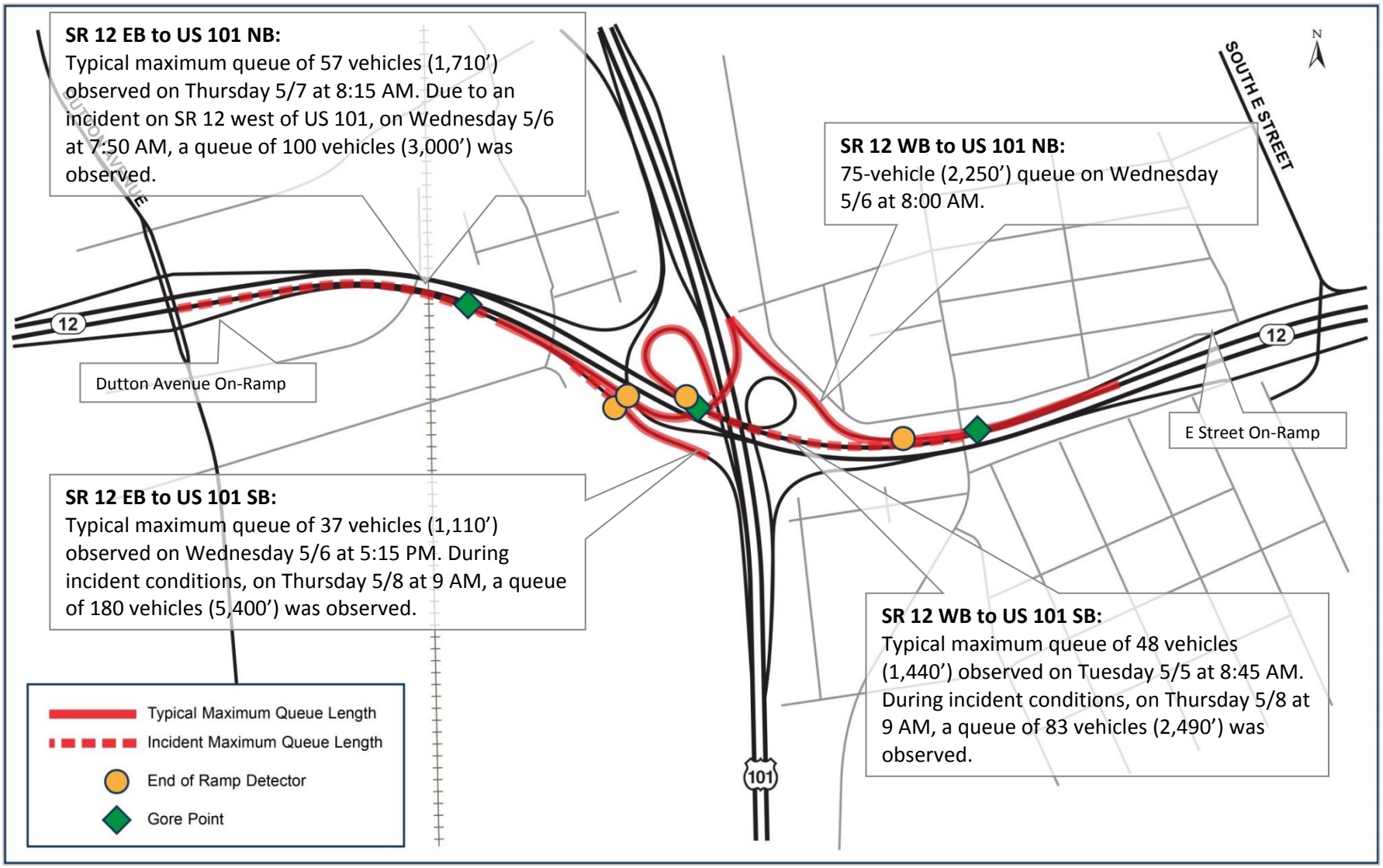
[7] https://docs.google.com/spreadsheets/d/16cySj75jx215cI_XvA-zXPxUVJFSScc2KxLbS_u8g8I/edit?usp=sharing

Exhibit 12: SR 12 Interchange Maximum Observed Queues, Before Ramp Metering



Source: *Sonoma US 101 Ramp Metering Implementation Plan - Deliverable 2.5B – Existing Conditions Memo – Final*. Kittelson & Associates, Inc. (November 21, 2013)

Exhibit 13: SR 12 Interchange Maximum Observed Queues, After Ramp Metering



Data Source: Kittelson & Associates, Inc. field observations (May 2015)

LOCAL STREET TRAFFIC OPERATIONS

In order to compare potential changes to arterial traffic volumes and traffic operations due to ramp metering, this study also evaluated nine intersections and two arterial segments along local streets in the vicinity of the US 101 corridor (see map[8]). As described in the Arterial Counts section, data collection for local streets was conducted concurrently with the freeway data collection.

Arterial Segments

Exhibit 14 provides a comparison of traffic volumes on the two surveyed arterial segments: Cleveland Avenue and Santa Rosa Avenue. As seen in the comparison, the average daily traffic (ADT) counts on arterial segments show minimal variation (below three percent) between May 2013 and May 2015. Slightly higher percentage variations were observed in the peak hour counts, with northbound counts showing increases and southbound counts showing decreases. None of the variations were found to be suggestive of systemic traffic diversion due to ramp metering.

The interpretation of the variations was performed taking into account the data's sample size, background changes on the arterials and on US 101, and the effects of ramp metering on the freeway mainline and on-ramps:

- The midweek daily and peak hour averages used for this analysis were based on two to three days of data.
- Santa Rosa Avenue was recently widened from Yolanda Avenue to Kawana Springs Road, about 1,800 feet south of the count location used in this report. The widening improved the capacity of Santa Rosa Avenue through added travel, turn, and bicycle lanes[9]. Additional work in this section of Santa Rosa Avenue is expected in the future to further relieve congestion from busy retail activity.
- Traffic volumes on US 101 were found to increase substantially between the Before and After surveys. Despite this, the implementation of ramp metering was found to reduce travel times on US 101 for all time periods surveyed.

As shown in Exhibit 14, percentage differences for peak hour counts range from three to eight percent *increases* in the northbound direction and one to fourteen percent *decreases* in the southbound direction. In absolute terms, this translates to changes between 9 and 49 vehicles per hour. The largest peak hour increases, 35 and 48 vehicles per hour, occurred at northbound Santa Rosa Avenue in the AM and PM peak hour, respectively. These modest increases were likely a result of normal variation in traffic volumes and increased capacity on Santa Rosa Avenue, rather than diversion due to ramp metering on US 101.

[8] https://www.google.com/maps/d/edit?mid=z959r31kfpU0.kxF3zonn4CmA&usp=sharing

[9] http://www.pressdemocrat.com/csp/mediapool/sites/PressDemocrat/News/story.csp?page=1

The day-by-day machine count data for the arterial segments are included in Appendix E.

Exhibit 14: Before and After Arterial Traffic Volumes

#	Roadway Segment	Lanes in Each Direction	Before Ramp Metering		After Ramp Metering		Comparison	
			NB	SB	NB	SB	NB	SB
AM Peak Hour								
1	Cleveland Avenue South of College Avenue	1	168	184	181	158	13 (+8%)	-26 (-14%)
2	Santa Rosa Avenue North of Baker Avenue	2[1]	708	638	743	589	35 (+5%)	-49 (-8%)
PM Peak Hour								
1	Cleveland Avenue South of College Avenue	1	263	385	272	354	9 (+3%)	-31 (-8%)
2	Santa Rosa Avenue North of Baker Avenue	2[1]	1,114	1,129	1,162	1,118	48 (+4%)	-11 (-1%)
Daily								
1	Cleveland Avenue South of College Avenue	1	2,864	3,149	2,911	3,144	47 (+2%)	-5 (-0%)
2	Santa Rosa Avenue North of Baker Avenue	2[1]	12,695	11,810	12,631	11,419	-64 (-1%)	-391 (-3%)

[1] Between the Before and After observations, Santa Rosa Avenue was widened from Yolanda Avenue to Kawana Springs Avenue, and re-striped in the vicinity of the Baker Avenue intersection.

Intersections

Two-hour peak period turning movement traffic counts were conducted at all eight study intersections on Thursday, May 2, 2013 for the Before data collection and Tuesday, May 5, 2015 for the After data collection. The field data sheets are included as Appendix F.

To evaluate the performance of the monitored intersections, intersection level of service (LOS) based on *Highway Capacity Manual 2000* (HCM 2000) methodologies were computed using the Synchro software program. Peak hour traffic volumes, intersection geometries, and signal timing data were input to compute LOS and delay results. Exhibit 15 provides a summary of the HCM 2000 LOS criteria and a description of general traffic conditions associated with each level of service.

Intersection LOS and average delay results are summarized in Exhibit 16. As shown, all intersections currently operate at LOS D or better, which is consistent with the Before analysis. In the Before ramp metering analysis, all intersections but the Mendocino Avenue & Fountaingrove Parkway intersection were found to operate at LOS D or better.

Total entering volumes do not show differences beyond what could be considered normal variation between two days of data. The delay and level of service results are similar between Before and After conditions, indicating that ramp metering and the background changes on US 101 did not have a significant impact on intersection operations. At a few intersections, After average delays were found to be lower than Before delays despite small increases in total entering volume. A close look at those intersections revealed that the lower delays were explained by favorable patterns in traffic growth (e.g., increases in main-street through volumes coupled with decreases in side-street turning movements).

Detailed LOS calculation sheets are included in Appendix G.

Exhibit 15: Definition of Level of Service for Signalized Intersections

Level of Service	Description of Traffic Conditions	Average Control Delay (seconds)
A	Free flowing. Most vehicles do not have to stop.	≤10.0
B	Minimal delays. Some vehicles have to stop, although waits are not bothersome.	>10.0 and < 20.0
C	Acceptable delays. Significant numbers of vehicles have to stop because of steady, high traffic volumes. Still, many pass without stopping.	>20.0 and < 35.0
D	Tolerable delays. Many vehicles have to stop. Drivers are aware of heavier traffic. Cars may have to wait through more than one red light. Queues begin to form, often on more than one approach.	>35.0 and < 55.0
E	Significant delays. Cars may have to wait through more than one red light. Long queues form, sometimes on several approaches.	>55.0 and < 80.0
F	Excessive delays. Intersection is jammed. Many cars have to wait through more than one red light, or more than 60 seconds. Traffic may back up into "up-stream" intersections.	> 80.0

Source: Highway Capacity Manual 2000

Exhibit 16: Before and After Intersection Level of Service, AM and PM Peak Hours

#	Intersection Location	Juris.	Peak Hour	Total Entering Volume			Delay (sec.)		LOS	
				Before	After	% Diff.	Before	After	Before	After
1	Industrial Drive & Cleveland Avenue	Santa Rosa	AM	2,069	2,142	+4%	39	47	D	D
			PM	2,814	2,969	+6%	42	47	D	D
2	Mendocino Avenue & Fountaingrove Parkway	Santa Rosa	AM	3,997	3,689	-8%	61	52	**E**	D
			PM	4,358	4,347	0%	45	44	D	D
3	College Avenue & US 101 SB	Santa Rosa	AM	2,357	2,429	+3%	24	26	C	C
			PM	2,609	2483	-5%	17	16	B	B
4	Santa Rosa Avenue & US 101 NB Baker Avenue Ramps	Santa Rosa	AM	1,809	1,719	-5%	25	25	C	C
			PM	3,358	3,001	-11%	31	26	C	C
5	Corby Avenue & US 101 SB Hearn Avenue Ramps	Santa Rosa	AM	1,733	1,764	+2%	21	19	C	B
			PM	1,810	2,112	+17%	17	20	B	C
6	Commerce Boulevard & US 101 NB Golf Course Drive Ramps	Rohnert Park	AM	1,222	1,249	+2%	17	17	B	B
			PM	1,879	2,077	+11%	21	19	C	B
7	Commerce Blvd. & Rohnert Park Expressway	Rohnert Park	AM	2,904	2,715	-7%	30	28	C	C
			PM	4,049	4,253	+5%	43	48	D	D
8	Commerce Blvd. & US 101 NB Old Redwood Hwy On-Ramp	Cotati	AM	1,708	1,779	+4%	17	22	B	C
			PM	1,866	2,117	+13%	9	9	A	A
9	Gravenstein Highway (SR 116) & US 101 SB Ramps	Cotati	AM	2,078	2,195	+6%	15	16	B	B
			PM	2,415	2,542	+5%	14	15	B	B

Notes: LOS: Level of Service, calculated using Synchro 8, based on HCM 2000 methodologies. Gray shading and bold type indicate LOS below LOS D.

CONCLUSION

Ramp metering was implemented on US 101 in Sonoma County between September and October 2014. Ramp metering plans were developed and fine-tuned in the field to manage vehicle entry onto the freeway without negatively affecting traffic operations on local streets.

Extensive data collection was conducted to evaluate the effectiveness of ramp metering for the US 101 corridor. Comprehensive Before and After data were collected in May 2013 and May 2015, respectively. These surveys were supplemented with visual observations during activation in September and October 2014. Finally, additional information was collected to assess background changes during the two years between the Before and After surveys.

Three background changes were identified as potential factors in traffic operations on US 101. These three factors were evaluated and summarized to provide context to the comparison of the Before and After data presented in this report:

- The completion of the Airport Boulevard/Fulton Road interchange reconstruction between the time of activation and the time of the After data collection.
- The opening of the Graton Resort and Casino in Rohnert Park, near the southern end of the study corridor. The casino was expected to add 17,177 daily trips to the area, with trip generation peaking in the PM peak period.
- Increases in freeway mainline volumes throughout the corridor, as measured from reliable PeMS detectors. The highest increases were observed in the southern part of the study corridor in the PM peak period.

Following the investigation of these context factors, the comprehensive data sets collected as part of this project were compared. These data sets can be categorized as freeway travel times, freeway and on-ramp vehicle counts, and traffic data on local streets.

Corridor travel times were found to decrease for all time periods surveyed. The maximum travel time changes by direction and peak period were as follows:

- In the northbound direction, travel times in the AM peak period decreased by up to 2.0 minutes (or 10 percent).
- In the southbound direction, travel times in the AM peak period decreased by up to 2.1 minutes (or 8 percent).
- In the northbound direction, travel times in the PM peak period decreased by up to 3.1 minutes (or 12 percent).
- In the southbound direction, travel times in the PM peak period decreased by up to 4.8 minutes (or 16 percent).

Traffic counts collected at mainline and ramp locations during the weeks of Before and After data collection (May 2013 and May 2015, respectively) confirm the findings of the analysis of background traffic volume changes. Traffic volumes during the After week were substantially higher than during the Before week, with increases of up to eight percent.

With respect to on-ramp queuing, the SR 12 connectors to US 101 were found to be susceptible to long queues due to a combination of ramp metering and merge delays resulting from congestion on US 101. The queues were not substantially longer than in the Before observations, but the shift of the head of the queue from the US 101 merge point back to the ramp metering line resulted in queues that reached further upstream on SR 12. Although the SR 12 connector queues were not found to affect local street operations, they did at times limit the use of auxiliary lanes on SR 12 to access adjacent interchanges. A few local street ramps were observed to queue to their storage capacities and, on rare occasions, slightly beyond. It is possible that during temporary surges in traffic volumes, these queues would exceed storage capacity.

Traffic operations on arterial segments and at intersections were monitored before and after ramp metering to gauge its effect on segment traffic volumes and intersection operations. As seen in the comparison, the average daily traffic (ADT) counts on arterial segments show minimal variation (below three percent) between May 2013 and May 2015. Slightly higher percentage variations were observed in the peak hour counts, with northbound counts showing increases and southbound counts showing decreases. None of the variations were found to be suggestive of systemic traffic diversion due to ramp metering.

Total entering volumes and LOS at the study intersections were computed to compare Before and After conditions. Total entering volumes do not show differences beyond what could be considered normal variation between two days of data. The delay and level of service results are similar between Before and After conditions, indicating that ramp metering and the background changes on US 101 did not have a significant impact on intersection operations.

The analysis of Before and After conditions found that travel times on US 101 decreased for all time periods surveyed. It is important to note that the decreases in freeway travel times were realized despite background traffic volume growth over the last two years and the opening of the Graton Resort and Casino.

On-ramp metering rates were developed and fine-tuned in the field to eliminate or minimize queue spillback to local streets. Despite using high metering rates, the SR 12 on-ramps to US 101 continue to be susceptible to queuing.

A review of traffic data on local arterial segments and intersections found no definitive evidence of systemic traffic diversion due to ramp metering. The small changes noted were likely a result of normal variation in traffic volumes and increased capacity on Santa Rosa Avenue, rather than diversion due to ramp metering on US 101.

NEXT STEPS

Although the involvement of Kittelson & Associates, Inc. concludes with this report, Caltrans will continue to monitor and refine ramp metering operations in US 101 in Sonoma County. This section describes next steps and how local stakeholders can contribute to the continued success of ramp metering in Sonoma County.

QUEUING ON SR 12 CONNECTORS

As described in earlier sections, excess queuing on the SR 12 connectors to US 101 was observed during the After surveys. Caltrans is considering at least three short-term options to reduce queuing at these ramp meters:

- **Reducing cycle lengths.** The ramp meters at the two SR 12 connectors to northbound US 101 and the ramp meter at the westbound SR 12 to southbound US 101 connector operate slightly below the maximum rate (i.e., 900 vehicles per hour) in the AM peak hours. Increasing the metering rates to the maximum would reduce queuing by about ten percent. In the PM peak hours, the eastbound SR 12 connector to northbound US 101 is already operating at the maximum rate, but the rate at the other connectors could be slightly increased.
- **Two cars per green.** Operating a ramp meter at two-cars-per-green would theoretically increase capacity to 1,200 vehicles per hour[10]. In practice, distracted motorists and large vehicles result in metering rates of about 1,000 vehicles per hour. Nevertheless, this would result in an additional ten percent reduction in queuing. Driver education and prominent signage could be used to further increase the effective metering rate of two-cars-per-green.
- **Occasional flushing.** If queueing is still excessive, the ramp meters could be programmed to operate on solid green for two or three periods of time to "flush" long queues. This is a last resort solution as it negates the benefits of ramp metering: to manage the entry of vehicles onto the freeway, with the purpose of reducing friction and smoothing merging movements.

If travel demand continues to increase at its current pace, longer term solutions at this interchange will need to be evaluated. This should include capital improvements at the interchange, improving public transit in Sonoma County, and/or ramp metering on SR 12.

RAMP METERING PLAN

Due to the ever-changing nature of travel patterns, the current ramp metering plan may become outdated at some locations and will need to be revised. In fact, there are locations in Sonoma County

[10] It is not 1,800 vehicles per hour (i.e., twice the one-car-per-green maximum rate) as the minimum cycle length must be increased from 4.0 seconds to 6.0 seconds to accommodate the additional car's passing time.

that have already required revisions to their ramp metering rates to accommodate substantial growth in traffic volumes that had occurred during the course of the implementation.

Other locations, including, but not limited to, Shiloh Road's on-ramps to southbound US 101 in Windsor and the Third Street on-ramp to southbound US 101 in downtown Santa Rosa are currently being re-evaluated. Lowering ramp metering cycle lengths is usually effective in minimizing or eliminating excess queuing in local streets.

GEOMETRIC IMPROVEMENTS AT ON-RAMPS

In addition to revising the ramp metering plan, Caltrans monitors traffic operations at the on-ramps to identify and correct issues that may reduce the capacity of the ramp meters. In most cases, striping and/or signage changes can be sufficient to ensure that the ramp metering plan's capacities are being met.

Although Caltrans performs regular monitoring, local stakeholders can help direct Caltrans' attention to specific on-ramps. For example, Caltrans evaluated the appropriateness of the wide lane striping at the Baker Avenue on-ramp to northbound US 101 and the Third Street on-ramp to southbound US 101 at the request of staff at the City of Santa Rosa, which noted driver confusion at these on-ramps. Exhibit 17 presents aerial imagery of these two on-ramps.

Exhibit 17: Baker Avenue and Third Street On-Ramp Aerials

Source: Google Maps (2015)

At the Baker Avenue on-ramp, the current lane width of about 24 feet could be re-striped to 18 feet to reduce driver confusion while still accommodating turning truck traffic. At the Third Street on-ramp, geometric constraints and design standards regarding taper length do not allow for the narrowing of the current lane width. However, by moving the meter limit line upstream, a two-lane ramp meter could be installed. Although storage capacity at the on-ramp would be slightly reduced, the two-lane ramp meter would have twice the capacity and thus be able to serve the same demand with similar or lower queue lengths. Note that this would require the relocation of loops, conduits, the signal head, and the limit line.

ONGOING MONITORING

The benefits of ramp metering can only be fully realized if the system is operating properly. To this end, Caltrans conducts and will continue to conduct regular assessments of system performance in Sonoma County. However, Caltrans depends on the public and their representatives to identify specific concerns that need more immediate attention.

The public can submit a Maintenance Service Request through Caltrans' website[11]. These requests are continuously monitored and forwarded to the appropriate staff person for timely action. City or County transportation officials in Sonoma County can forward any concerns related to ramp metering to the Sonoma County Transportation Authority (SCTA) liaison[12]. Caltrans staff is in direct contact with the SCTA liaison and can act promptly to resolve ramp metering concerns in Sonoma County. ■

[11] http://www.dot.ca.gov/hq/maint/msrsubmit/

[12] As of the time of this writing, the SCTA liaison is James Cameron.

APPENDIX A - SUPPLEMENTARY EXHIBITS

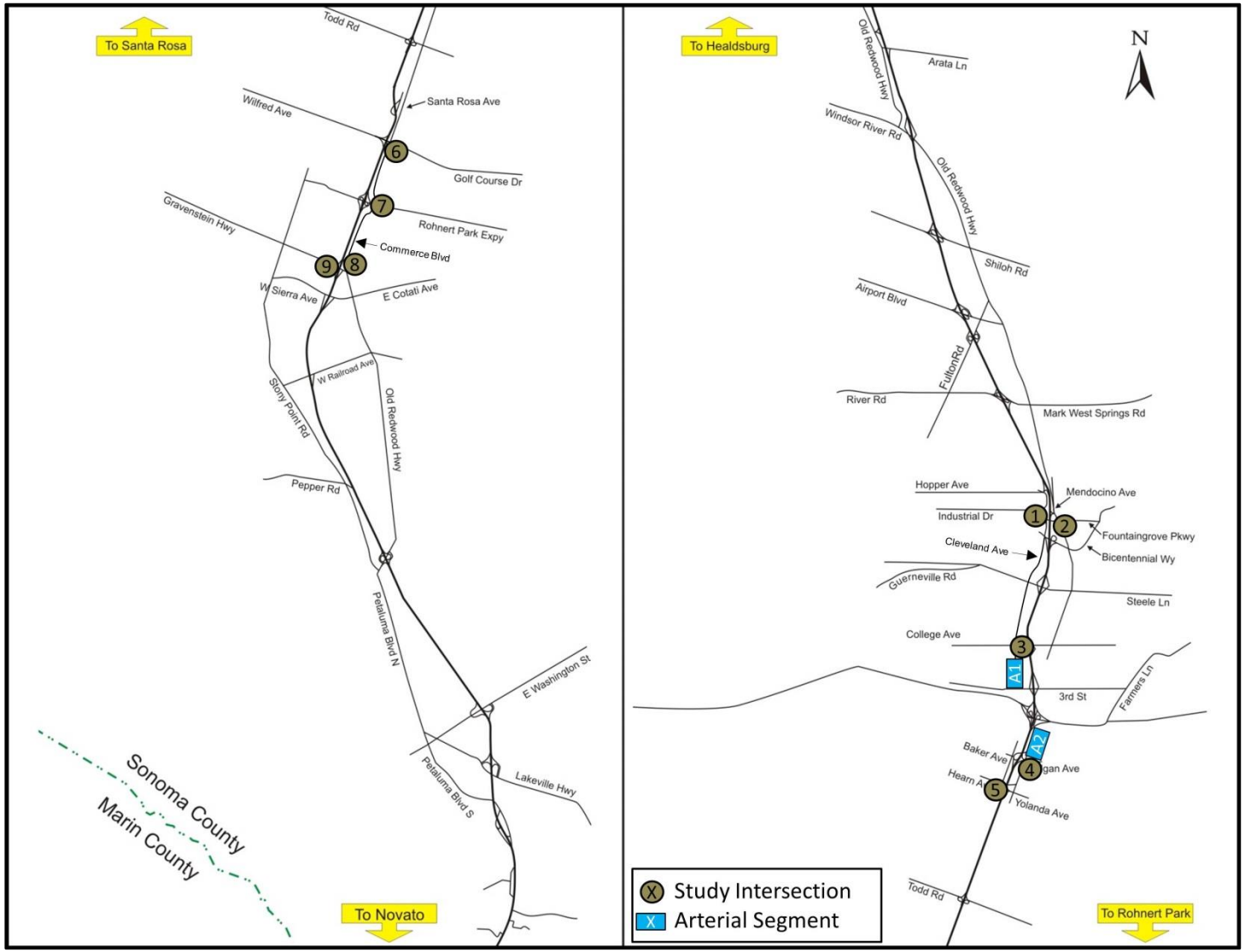
Appendix Exhibit A-1: Study Ramps

US 101 Southbound	US 101 Northbound
Old Redwood Hwy/Arata Lane on-ramp	Gravenstein Highway (SR 116) off-ramp
Windsor River Road/Old Redwood Highway off-ramp	Gravenstein Highway (SR 116) on-ramp
Windsor River Road/Old Redwood Highway on-ramp	Rohnert Park Expressway off-ramp
Shiloh Road off-ramp	Rohnert Park Expressway eastbound on-ramp
Shiloh Road westbound on-ramp	Rohnert Park Expressway westbound on-ramp
Shiloh Road eastbound on-ramp	Golf Course Drive/Wilfred Avenue off-ramp
Airport Boulevard off-ramp	Golf Course Drive/Wilfred Avenue on-ramp
Airport Boulevard on-ramp	Santa Rosa Avenue off-ramp
Fulton Road off-ramp	Todd Road off-ramp
Fulton Road on-ramp	Todd Road on-ramp
River Road off-ramp	Yolanda Avenue/Hearn Avenue off-ramp
Mark West Springs Road westbound on-ramp	Yolanda Avenue/Hearn Avenue on-ramp
River Road eastbound on-ramp	Baker Avenue off-ramp
Hopper Avenue off-ramp	Baker Avenue on-ramp
Hopper Avenue on-ramp	SR 12 off-ramp
Mendocino Avenue on-ramp	Downtown/3rd Street off-ramp
Bicentennial Way on-ramp	SR 12 on-ramp
Steele Lane/Guerneville Road off-ramp	Downtown/6th Street on-ramp
Steele Lane/Guerneville Road on-ramp	College Avenue off-ramp
College Avenue off-ramp	College Avenue on-ramp
College Avenue on-ramp	Steele Lane/Guerneville Road off-ramp
Downtown/6th Street off-ramp	Steele Lane/Guerneville Road on-ramp
SR 12 off-ramp	Bicentennial Way off-ramp
Downtown/3rd Street on-ramp	Mendocino Avenue off-ramp
SR 12 on-ramp	Mendocino Avenue on-ramp

US 101 Southbound	US 101 Northbound
Baker Avenue/Corby Avenue off-ramp	River Road off-ramp
Baker Avenue/Corby Avenue on-ramp	River Road eastbound on-ramp
Hearn Avenue/Corby Avenue off-ramp	Mark West Springs Road westbound on-ramp
Hearn Avenue/Corby Avenue on-ramp	Fulton Road off-ramp
Todd Road off-ramp	Fulton Road on-ramp
Todd Road on-ramp	Airport Boulevard off-ramp
Wilfred Avenue/Golf Course Drive off-ramp	Airport Boulevard on-ramp
Wilfred Avenue/Golf Course Drive on-ramp	Shiloh Road off-ramp
Rohnert Park Expressway off-ramp	Shiloh Road eastbound on-ramp
Rohnert Park Expressway westbound on-ramp	Shiloh Road westbound on-ramp
Rohnert Park Expressway eastbound on-ramp	
Gravenstein Highway (SR 116) off-ramp	
Gravenstein Highway (SR 116) on-ramp	
W Sierra Avenue on-ramp	
Pepper Road on-ramp	

Appendix Exhibit A-2: Metered Ramps

Appendix Exhibit A-3: Arterial Study Locations



Appendix Exhibit A-4: Freeway Mainline Traffic Counts, Northbound, AM Peak Period

Location	Before	After	Change
Midweek AM Peak Period (6-10 AM)			
Gravenstein Highway (SR 116)	8,790	8,921	131 (+1.5%)
Golf Course Drive/Wilfred Avenue	12,365	12,613	248 (+2.0%)
Yolanda Avenue/Hearn Avenue	12,361	12,485	124 (+1.0%)
Baker Avenue	14,954	15,128	174 (+1.2%)
SR 12	11,105	11,368	263 (+2.3%)
Downtown	16,311	16,524	213 (+1.3%)
College Avenue	14,822	15,144	322 (+2.1%)
Steele Lane/Guerneville Road	13,553	14,097	544 (+3.9%)
Mendocino Avenue	9,933	10,656	723 (+6.8%)
River Road/Mark West Springs Road	9,985	10,819	834 (+7.7%)
Shiloh Road	6,562	6,893	331 (+4.8%)
Shiloh Road	6,741	7,038	297 (+4.2%)

All volumes in vehicles/four hours
[1] Counts generally conducted upstream of on-ramps.
[2] Italics indicate locations where volumes were updated following the completion of *Deliverable 2.5B – Existing Conditions* Volumes at these locations are sourced from *Deliverable 3.1B FREQ Calibration*.
[3] Red shading indicates increases in volumes, gray shading indicates decreases.
Data Source: Caltrans (May 2013 and May 2015)

Appendix Exhibit A-5: Freeway Mainline Traffic Counts, Southbound, AM Peak Period

Location	Before	After	Change
Midweek AM Peak Period (6-10 AM)			
Windsor River Road/Old Redwood Highway	*6,415*	6,392	-23 (-0.4%)
Shiloh Road westbound	9,042	9,373	331 (+3.7%)
Shiloh Road eastbound	9,305	9,867	562 (+6.0%)
Airport Boulevard	10,369	10,406	37 (+0.4%)
River Road/Mark West Springs Road	10,665	10,888	223 (+2.1%)
Hopper Avenue	10,683	11,483	800 (+7.5%)
Mendocino Avenue	*12,432*	12,779	347 (+2.8%)
Bicentennial Way	12,883	13,363	480 (+3.7%)
Steele Lane/Guerneville Road	13,868	13,763	-105 (-0.8%)
College Avenue	*14,397*	14,299	-98 (-0.7%)
Downtown	8,146	8,403	257 (+3.2%)
Baker Avenue	*15,982*	16,350	368 (+2.3%)
Hearn Avenue	*13,698*	14,220	522 (+3.8%)
Todd Rod	*13,581*	14,139	558 (+4.1%)
Wilfred Avenue/Golf Course Drive	*12,864*	12,983	119 (+0.9%)
Rohnert Park Expressway westbound	*11,102*	11,835	733 (+6.6%)
Rohnert Park Expressway eastbound	10,037	10,536	499 (+5.0%)
Pepper Road	*14,231*	14,786	555 (+3.9%)

All volumes in vehicles/four hours
[1] Counts generally conducted upstream of on-ramps.
[2] Italics indicate locations where volumes were updated following the completion of *Deliverable 2.5B – Existing Conditions* Volumes at these locations are sourced from *Deliverable 3.1B FREQ Calibration*.
[3] Red shading indicates increases in volumes, gray shading indicates decreases.
Data Source: Caltrans (May 2013 and May 2015)

Appendix Exhibit A-6: Freeway Mainline Traffic Counts, Northbound, PM Peak Period

Location	Before	After	Change
Midweek PM Peak Period (3-7 PM)			
Gravenstein Highway (SR 116)	12,058	12,751	693 (+5.7%)
Rohnert Park Expressway	*12,400*	13,164	764 (+6.2%)
Golf Course Drive/Wilfred Avenue	14,783	15,154	371 (+2.5%)
Yolanda Avenue/Hearn Avenue	14,806	15,492	686 (+4.6%)
Baker Avenue	17,651	18,217	566 (+3.2%)
SR 12	12,442	12,771	329 (+2.6%)
Downtown	18,184	18,112	-72 (-0.4%)
College Avenue	17,283	17,170	-113 (-0.7%)
Steele Lane/Guerneville Road	15,570	15,626	56 (+0.4%)
Mendocino Avenue	12,290	12,537	247 (+2.0%)
River Road eastbound	*11,975*	12,146	171 (+1.4%)
River Road/Mark West Springs Road	12,587	12,767	180 (+1.4%)
Shiloh Road eastbound	9,907	9,940	33 (+0.3%)
Shiloh Road westbound	10,373	10,382	9 (+0.1%)

All volumes in vehicles/four hours
[1] Counts generally conducted upstream of on-ramps.
[2] Italics indicate locations where volumes were updated following the completion of *Deliverable 2.5B – Existing Conditions* Volumes at these locations are sourced from *Deliverable 3.1B FREQ Calibration*.
[3] Red shading indicates increases in volumes, gray shading indicates decreases.
Data Source: Caltrans (May 2013 and May 2015)

Appendix Exhibit A-7: Freeway Mainline Traffic Counts, Southbound, PM Peak Period

Location	Before	After	Change
Midweek PM Peak Period (3-7 PM)			
Arata Lane	7,539	7,335	-204 (-2.7%)
Shiloh Road westbound	9,667	9,881	214 (+2.2%)
Shiloh Road eastbound	9,887	10,187	300 (+3.0%)
Airport Boulevard	11,422	11,060	-362 (-3.2%)
River Road/Mark West Springs Road	12,332	12,335	3 (+0.0%)
River Road eastbound	14,168	14,139	-29 (-0.2%)
Hopper Avenue	12,148	12,219	71 (+0.6%)
Mendocino Avenue	13,171	13,233	62 (+0.5%)
Bicentennial Way	15,854	15,825	-29 (-0.2%)
College Avenue	*16,891*	17,200	309 (+1.8%)
Downtown	9,364	9,260	-104 (-1.1%)
Baker Avenue	17,034	17,548	514 (+3.0%)
Hearn Avenue	14,995	15,580	585 (+3.9%)
Todd Rod	14,735	15,383	648 (+4.4%)
Wilfred Avenue/Golf Course Drive	13,734	13,752	18 (+0.1%)
Rohnert Park Expressway westbound	10,868	11,438	570 (+5.2%)
Rohnert Park Expressway eastbound	12,180	13,118	938 (+7.7%)
Gravenstein Highway (SR 116)	10,102	10,757	655 (+6.5%)
W Sierra Avenue	11,688	12,223	535 (+4.6%)
Pepper Road	12,406	13,098	692 (+5.6%)

All volumes in vehicles/four hours
[1] Counts generally conducted upstream of on-ramps.
[2] Italics indicate locations where volumes were updated following the completion of *Deliverable 2.5B – Existing Conditions* Volumes at these locations are sourced from *Deliverable 3.1B FREQ Calibration*.
[3] Red shading indicates increases in volumes, gray shading indicates decreases.
Data Source: Caltrans (May 2013 and May 2015)

Appendix Exhibit A-8: Ramp Traffic Counts, Northbound, AM Peak Period

Location	Before (May 2013)	After (May 2015)	Change
Midweek AM Peak Period (6-10 AM)			
Gravenstein Highway (SR 116) off-ramp	1,839	2,095	256 (+13.9%)
Gravenstein Highway (SR 116) on-ramp	2,869	3,019	150 (+5.2%)
Rohnert Park Expressway off-ramp	2,761	2,621	-140 (-5.1%)
Rohnert Park Expressway eastbound on-ramp	547	715	168 (+30.7%)
Rohnert Park Expressway westbound on-ramp	2,053	1,983	-70 (-3.4%)
Golf Course Drive/Wilfred Avenue off-ramp	626	808	182 (+29.0%)
Golf Course Drive/Wilfred Avenue on-ramp	1,313	1,686	373 (+28.4%)
Todd Road off-ramp	1,340	1,264	-76 (-5.6%)
Todd Road on-ramp	1,665	1,781	116 (+7.0%)
Yolanda Avenue/Hearn Avenue off-ramp	918	1,003	85 (+9.3%)
Yolanda Avenue/Hearn Avenue on-ramp	2,933	2,904	-29 (-1.0%)
Baker Avenue on-ramp	1,950	1,539	-411 (-21.1%)
SR 12 on-ramp	6,252	5,956	-296 (-4.7%)
Downtown on-ramp	1,125	1,153	28 (+2.5%)
College Avenue on-ramp	1,813	1,819	6 (+0.3%)
Steele Lane/Guerneville Road off-ramp	2,283	2,308	25 (+1.1%)
Steele Lane/Guerneville Road on-ramp	1,695	1,818	123 (+7.3%)
Mendocino Avenue on-ramp	2,050	2,136	86 (+4.2%)
River Road off-ramp	*2,089*	2,561	472 (+22.6%)
Mark West Springs Road westbound on-ramp	722	840	118 (+16.3%)
Airport Boulevard off-ramp	2,584	3,386	802 (+31.0%)
Airport Boulevard on-ramp	812	1,396	584 (+71.9%)
Shiloh Road off-ramp	2,624	2,722	98 (+3.7%)
Shiloh Road eastbound on-ramp	230	284	54 (+23.5%)
Shiloh Road westbound on-ramp	367	423	56 (+15.2%)

All volumes in vehicles/four hours
[1] Counts generally conducted upstream of on-ramps.
[2] Italics indicate locations where volumes were updated following the completion of *Deliverable 2.5B – Existing Conditions* Volumes at these locations are sourced from *Deliverable 3.1B FREQ Calibration*.
[3] Red shading indicates increases in volumes, gray shading indicates decreases.
Data Source: Caltrans (May 2013 and May 2015)

Appendix Exhibit A-9: Ramp Traffic Counts, Southbound, AM Peak Period

Location	Before (May 2013)	After (May 2015)	Change
Midweek AM Peak Period (6-10 AM)			
Arata Lane on-ramp	*1,027*	1,283	256 (+24.9%)
Windsor River Road/Old Redwood Hwy on-ramp	3,162	3,071	-91 (-2.9%)
Shiloh Road off-ramp	848	895	47 (+5.5%)
Shiloh Road westbound on-ramp	1,377	1,483	106 (+7.7%)
Shiloh Road eastbound on-ramp	1,627	1,682	55 (+3.4%)
Airport Boulevard off-ramp	1,457	1,356	-101 (-7.0%)
Airport Boulevard on-ramps	1,445	2,072	627 (+43.4%)
River Road off-ramp	984	1,540	556 (+56.5%)
Mark West Springs Road westbound on-ramp	1,871	1,965	94 (+5.0%)
River Road eastbound on-ramp	1,393	1,388	-5 (-0.4%)
Hopper Avenue off-ramp	*2,861*	2,827	-34 (-1.2%)
Hopper Avenue on-ramp	*1,235*	1,267	32 (+2.6%)
Mendocino Avenue on-ramp	*592*	718	126 (+21.3%)
Bicentennial Way on-ramp	*2,655*	2,566	-89 (-3.3%)
College Avenue on-ramp	*2,370*	2,796	426 (+18.0%)
SR 12 off-ramp	4,726	5,475	749 (+15.9%)
SR 12 on-ramp	6,460	6,275	-185 (-2.9%)
Baker Avenue on-ramp	*817*	880	63 (+7.7%)
Hearn Avenue off-ramp	*2,979*	3,034	55 (+1.8%)
Hearn Avenue on-ramp	*1,402*	1,559	157 (+11.2%)
Wilfred Avenue/Golf Course Drive on-ramp	*1,647*	1,657	10 (+0.6%)
Rohnert Park Expressway westbound on-ramp	*1,021*	991	-30 (-3.0%)
Rohnert Park Expressway eastbound on-ramp	*720*	839	119 (+16.5%)
Gravenstein Highway (SR 116) on-ramp	*1,855*	1,766	-89 (-4.8%)
W Sierra Avenue on-ramp	*1,026*	903	-123 (-12.0%)
Pepper Road on-ramp	*775*	794	19 (+2.4%)

All volumes in vehicles/four hours
[1] Counts generally conducted upstream of on-ramps.
[2] Italics indicate locations where volumes were updated following the completion of *Deliverable 2.5B – Existing Conditions* Volumes at these locations are sourced from *Deliverable 3.1B FREQ Calibration*.
[3] Red shading indicates increases in volumes, gray shading indicates decreases.
Data Source: Caltrans (May 2013 and May 2015)

Appendix Exhibit A-10: Ramp Traffic Counts, Northbound, PM Peak Period

Location	Before (May 2013)	After (May 2015)	Change
Midweek PM Peak Period (3-7 PM)			
Gravenstein Highway (SR 116) off-ramp	2,895	3,149	254 (+8.8%)
Gravenstein Highway (SR 116) on-ramp	2,524	2,783	259 (+10.3%)
Rohnert Park Expressway off-ramp	2,251	3,986	1,735 (+77.1%)
Rohnert Park Expressway eastbound on-ramp	1,131	1,310	179 (+15.8%)
Rohnert Park Expressway westbound on-ramp	2,407	2,273	-134 (-5.6%)
Golf Course Drive/Wilfred Avenue off-ramp	1,389	1,730	341 (+24.5%)
Golf Course Drive/Wilfred Avenue on-ramp	2,444	2,673	229 (+9.4%)
Todd Road off-ramp	1,569	1,398	-171 (-10.9%)
Todd Road on-ramp	2,041	1,997	-44 (-2.1%)
Yolanda Avenue/Hearn Avenue off-ramp	671	636	-35 (-5.2%)
Yolanda Avenue/Hearn Avenue on-ramp	3,449	3,211	-238 (-6.9%)
Baker Avenue on-ramp	3,391	2,956	-435 (-12.8%)
SR 12 on-ramp	7,072	6,321	-751 (-10.6%)
Downtown on-ramp	2,445	2,302	-143 (-5.8%)
College Avenue on-ramp	2,540	2,337	-203 (-8.0%)
Steele Lane/Guerneville Road off-ramp	3,138	3,149	11 (+0.3%)
Steele Lane/Guerneville Road on-ramp	2,575	2,570	-5 (-0.2%)
Mendocino Avenue on-ramp	3,209	2,987	-222 (-6.9%)
River Road off-ramp	3,391	3,410	19 (+0.6%)
Airport Boulevard off-ramp	1,015	1,889	874 (+86.1%)
Airport Boulevard on-ramp	1,270	2,001	731 (+57.6%)
Shiloh Road off-ramp	3,899	3,971	72 (+1.8%)
Shiloh Road eastbound on-ramp	481	528	47 (+9.8%)
Shiloh Road westbound on-ramp	707	710	3 (+0.4%)

All volumes in vehicles/four hours
[1] Counts generally conducted upstream of on-ramps.
[2] Italics indicate locations where volumes were updated following the completion of *Deliverable 2.5B – Existing Conditions* Volumes at these locations are sourced from *Deliverable 3.1B FREQ Calibration*.
[3] Red shading indicates increases in volumes, gray shading indicates decreases.
Data Source: Caltrans (May 2013 and May 2015)

Appendix Exhibit A-11: Ramp Traffic Counts, Southbound, PM Peak Period

Location	Before (May 2013)	After (May 2015)	Change
Midweek PM Peak Period (3-7 PM)			
Arata Lane on-ramp	944	1,001	57 (+6.0%)
Windsor River Road/Old Redwood Hwy on-ramp	2,653	2,594	-59 (-2.2%)
Shiloh Road off-ramp	800	868	68 (+8.5%)
Shiloh Road westbound on-ramp	1,533	1,486	-47 (-3.1%)
Shiloh Road eastbound on-ramp	1,851	1,959	108 (+5.9%)
Airport Boulevard on-ramps	3,335	3,430	95 (+2.9%)
River Road off-ramp	1,217	2,111	894 (+73.5%)
Mark West Springs Road westbound on-ramp	1,824	1,914	90 (+5.0%)
River Road eastbound on-ramp	1,296	1,155	-141 (-10.9%)
Hopper Avenue off-ramp	3,347	3,148	-199 (-5.9%)
Hopper Avenue on-ramp	988	950	-38 (-3.8%)
Mendocino Avenue on-ramp	1,050	1,230	180 (+17.2%)
Bicentennial Way on-ramp	3,746	3,484	-262 (-7.0%)
Steele Lane/Guerneville Road off-ramp	10,644	10,337	-307 (-2.9%)
Steele Lane/Guerneville Road on-ramp	3,607	3,806	199 (+5.5%)
College Avenue on-ramp	3,324	4,057	733 (+22.1%)
SR 12 off-ramp	7,209	8,347	1,138 (+15.8%)
SR 12 on-ramp	5,894	5,700	-194 (-3.3%)
Baker Avenue on-ramp	964	918	-46 (-4.8%)
Hearn Avenue off-ramp	2,824	2,728	-96 (-3.4%)
Wilfred Avenue/Golf Course Drive on-ramp	1,673	1,864	191 (+11.4%)
Rohnert Park Expressway westbound on-ramp	824	836	12 (+1.5%)
Rohnert Park Expressway eastbound on-ramp	1,443	1,279	-164 (-11.3%)
Gravenstein Highway (SR 116) on-ramp	1,579	1,361	-218 (-13.8%)
W Sierra Avenue on-ramp	558	478	-80 (-14.3%)
Pepper Road on-ramp	632	632	0 (+0.0%)

All volumes in vehicles/four hours
[1] Counts generally conducted upstream of on-ramps.
[2] Italics indicate locations where volumes were updated following the completion of *Deliverable 2.5B – Existing Conditions* Volumes at these locations are sourced from *Deliverable 3.1B FREQ Calibration*.
[3] Red shading indicates increases in volumes, gray shading indicates decreases.
Data Source: Caltrans (May 2013 and May 2015)

APPENDIX B - INTRO TO RAMP METERING DESIGN AND OPERATIONS

This section provides an introduction to the design and operational aspects of ramp metering. It is intended to serve as a quick reference for readers with questions about how ramp metering works. For a more complete description of design and operations guidance, refer to the Caltrans *Ramp Meter Design Manual*[13] (2013).

LOCAL TRAFFIC RESPONSIVENESS

The ramp meters on US 101 in Sonoma County are "local traffic responsive", similar to those in most California freeways. Under local traffic responsive operation, metering rates adjust by predetermined amounts based on freeway mainline traffic conditions just upstream of the on-ramp. In Sonoma County, the ramp meters are also programmed to display a solid green indication during the shoulder hours if the freeway mainline is free flowing. Note that ramp meters take a few minutes to turn on or off.

RAMP METERING LINE

The limit line location is determined based on the on-ramp's transition taper, but is typically placed a minimum of 23 meters upstream of the point at which the distance from the on-ramp edge to the freeway mainline edge is equal to 7 meters.

MULTILANE CONSIDERATIONS

There are some design considerations in the *Ramp Meter Design Manual* that apply to multilane on-ramps:

- On local street entrance ramps, the multi-lane segment should transition to a single lane width between the ramp meter limit line and the 2-meter separation point (from the mainline edge of traveled way).
- Depending on approach geometrics and speed, the lane drop transition should be accomplished with a taper of between 30:1 and 50:1. However, the lane drop taper past the limit line shall not be less than 15 to 1.

[13] http://www.dot.ca.gov/hq/traffops/trafmgmt/ramp_meter/

Similarly, the operations of ramp metering on multilane ramps are also slightly different:

- In some parts of California, including the Bay Area, Caltrans has implemented a stagger offset—typically 1.4 seconds—to reduce conflicts between vehicles on adjacent lanes. This is only a practice and is not a standard: some parts of California do not have this stagger. Note that this stagger only works when there are queues on both lanes. If one lane is queued but the other is free, there is a possibility that the waiting vehicle and a vehicle approaching the free meter will receive a green indication at the same time. This situation is commonplace at multilane on-ramps with an HOV bypass lane.

METER LINE DETECTORS

The size and sensitivity of ramp meter demand detectors (i.e., the inductive loops immediately upstream of the meter line) are chosen based on the physical characteristics of the approach. For example, on a wide on-ramp, the loop's size may be increased to detect vehicles that stop toward the inside or outside of the lane. Similarly, if it is noted that vehicles are not being consistently detected, the sensitivity of the loop may be increased.

The expectation is that vehicles larger than the lightest motorcycles (e.g., Vespas) will be consistently detected by the demand detector. Although Caltrans performs regular monitoring of ramp metering hardware, local stakeholders can help direct Caltrans' attention to specific on-ramps where vehicles are not being detected on a consistent basis.

Note that multilane on-ramps limit the maximum size and sensitivity that a single detector may have. In these situations, an overly sensitive detector may trigger cycling in multiple lanes, which is undesirable.

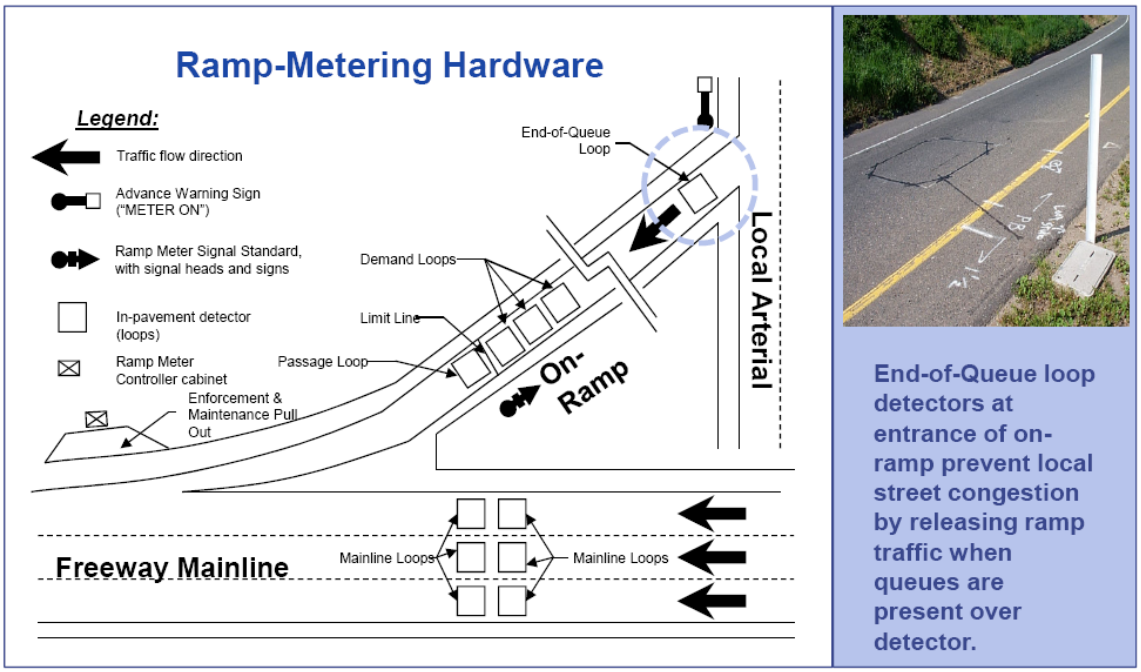
END-OF-QUEUE DETECTORS

Caltrans has activated all functioning end-of-queue detectors at all metered on-ramps on US 101 in Sonoma County. End-of-queue detectors are placed at the upstream end of the ramp to minimize or eliminate queue spillover onto local streets. When the detector is triggered, it sends a signal to the ramp meter controller. The controller then reduces the cycle length, as long as it is longer than the minimum cycle length. Below is a more detailed explanation of the process and a schematic of the on-ramp, labeled Appendix Exhibit B-1.

The end-of-queue detector is activated by measuring queue average occupancy, using a 1-minute exponential running average updated every 15 seconds. If a queue has been detected during metering, the metering rate will be increased by a pre-specified parameter every 15 seconds until either the queue has dissipated, or the maximum metering rate has been reached (typically 900 vehicles per hour per lane). Once the queue has been dissipated, the metering rate will be decreased by the same user

entry parameter every 15 seconds until the metering rate is restored to its normal metering rate specified for the time period.

Appendix Exhibit B-1: Typical Ramp Meter End-of-Queue Detector Placement



APPENDIX C - ADJUSTMENTS TO RECOMMENDED METERING RATES

During activation, consultant staff provided support to Caltrans in monitoring ramp meter operations, adjusting and fine-turning metering rates and other settings, and collecting floating car data in the field. This technical appendix summarizes the changes implemented as part of this fine-tuning process.

RATIONALE FOR CHANGES TO RAMP METERING PLAN

The reasons for considering adjusting ramp metering rates based on field observations include, but are not limited to:

- **Platooning of vehicles.** Ramp metering rates are typically developed based on 15-minute volume counts, but some locations exhibit much shorter surges in traffic volume. For example, a nearby upstream signal can result in one- to two-minute surges.
- **Lane utilization.** The ramp metering plan assumes equal lane utilization at multilane on-ramps. In reality, small differences in width, striping, or turning movements at an intersection result in uneven lane utilization.
- **Changes in demand.** Traffic volumes may have changed between the time of the Before data collection and that of the implementation phase. This could be the result of a new development or a change in existing land use.

CHANGES TO EARLY MORNING SOLID GREEN OPERATIONS

The ramp metering plan recommended that, between 6:00 AM and 6:30 AM, the ramp meters rest on green unless unexpected congestion is detected, at which point they switch to four-second cycles.

- The adjusted ramp metering plan extended the solid green operations until approximately 7:00 AM. The extension was coupled with a lowering of the minimum occupancy threshold to trigger 4-second cycles.

CHANGES TO LATE MORNING FOUR-SECOND CYCLE OPERATIONS

The ramp metering plan recommended that, between 9:00 AM to 10:00 AM, the ramp meters operate at four-second cycles.

- The adjusted ramp metering plan uses solid green operations from 9:00 AM to 10:00 AM. As with the early morning adjustments, the change was coupled with a lowering of the minimum occupancy threshold to trigger 4-second cycles.

CHANGES TO LATE AFTERNOON OPTIMAL CYCLES

The ramp metering plan recommended that, between 6:30 PM to 7:00 PM, the ramp meters operate at four-second cycles.

- The adjusted ramp metering plan uses solid green operations from 6:30 PM to 7:00 PM. The minimum occupancy threshold to trigger 4-second cycles was also lowered.

EXTENSION OF SOLID GREEN OPERATIONS

On ramps that are downstream of bottlenecks, the original ramp metering plan recommended 4-second cycles. For northbound US 101, this would have applied to all on-ramps north of Mendocino Avenue. For southbound US 101, ramps south of Hearn Avenue/Yolanda Avenue would have received similar treatment.

- Downstream of bottlenecks, the adjusted metering plan keeps meters resting on green unless unexpected congestion is detected on the mainline.

CHANGES TO THE BAKER AVENUE ON-RAMP TO US 101 NB

Special considerations were made for the Baker Avenue on-ramp to northbound US 101. This ramp was a focus of the field observations and activation fine-tuning due to storage capacity limitations.

- In the ramp metering plan, this ramp was one of two to be recommended to operate under two-cars-per-green to increase its capacity (SR 12 EB to US 101 NB was the other one). As such, it would operate at a longer minimum cycle length (6 seconds instead of 4 seconds). After initial tests with two-cars-per-green and one-car-per-green, the ramp was permanently kept with two-cars-per-green operation.
- This ramp continues to cycle through the 9:00 AM to 10:00 AM hour, unlike other ramps in the adjusted metering plan.

CHANGES TO THE SR 12 CONNECTORS TO US 101 NB

In the ramp metering plan, the SR 12 eastbound to US 101 northbound flyover connector was one of two to be recommended to operate under two-cars-per-green (NB Baker Avenue was the other one). The SR 12 westbound to US 101 northbound diagonal ramp was recommended to operate with one car per green and short cycles.

- Upon activation, it was noted that the two SR 12 connectors share the same ramp metering controller. Because two-cars-per-green operation requires a different minimum cycle length, the two plans had to be reconciled. The adjusted metering plan uses one-car-per-green operations on both connectors.

RELAXATION OF METERING RATES ON CONSTRAINED RAMPS

During activation, several on-ramps were found to queue beyond the expected queue length. As discussed in the body of the report, this could be due to various factors, including platooning of vehicles from an upstream signal, uneven lane utilization, or changes in demand. In those cases, the ramp metering rates are "relaxed" to have shorter cycles and thus let through more vehicles per hour. The following list identifies the ramp where metering rates were relaxed:

Northbound

- Rohnert Park Expressway EB (loop)
- Sixth Street
- Steele Lane

Southbound

- Airport Boulevard EB (diagonal)
- Bicentennial Way
- College Avenue (during peak hours)
- Yolanda Avenue/Hearn Avenue

TIGHTENING OF METERING RATES ON UNCONSTRAINED RAMPS

When on-ramps have sufficient storage capacity and are located upstream of a freeway mainline bottleneck, stricter ramp metering could result in additional travel time savings without negatively affecting local streets. "Tightening" of ramp metering rates—increases in cycle time—can also be used to compensate for relaxation of rates elsewhere. The adjusted plan uses tighter metering rates for higher levels of congestion. In other words, the metering rates may be unchanged from the recommended plan during "typical conditions", but be tighter (i.e., lower) during heavy congestion.

The fine-tuning process tightened metering rates at the following on-ramps:

Northbound

- Wilfred Avenue/Golf Course Drive
- Todd Road
- Hearn Avenue/Yolanda Avenue
- Mendocino Avenue

Southbound

- Airport Boulevard WB (loop)
- Steele Lane (during heavy congestion only)
- College Avenue (from 6:15 PM only)
- Third Street
- SR 12
- Baker Avenue

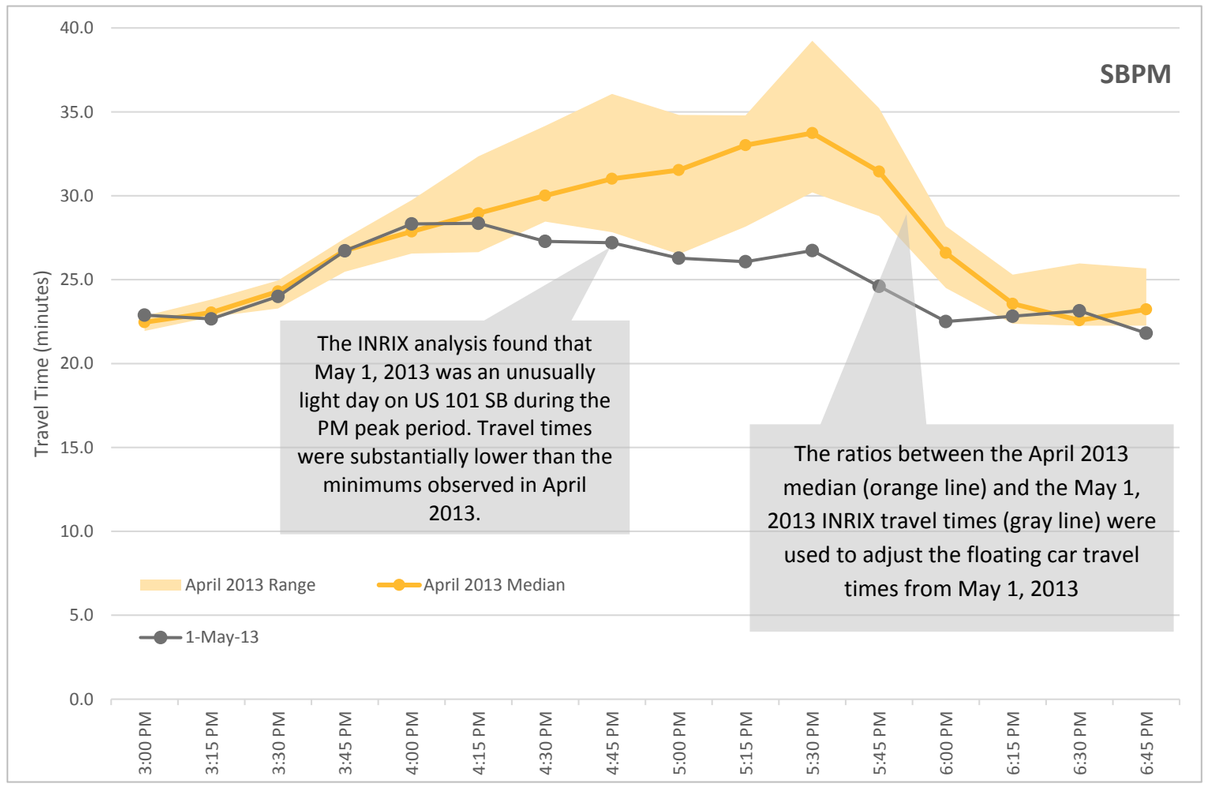
APPENDIX D - ADDITIONAL FLOATING CAR SURVEY DATA

Appendix Exhibit D-1: Data Check for Before Conditions, Southbound, PM Peak Period

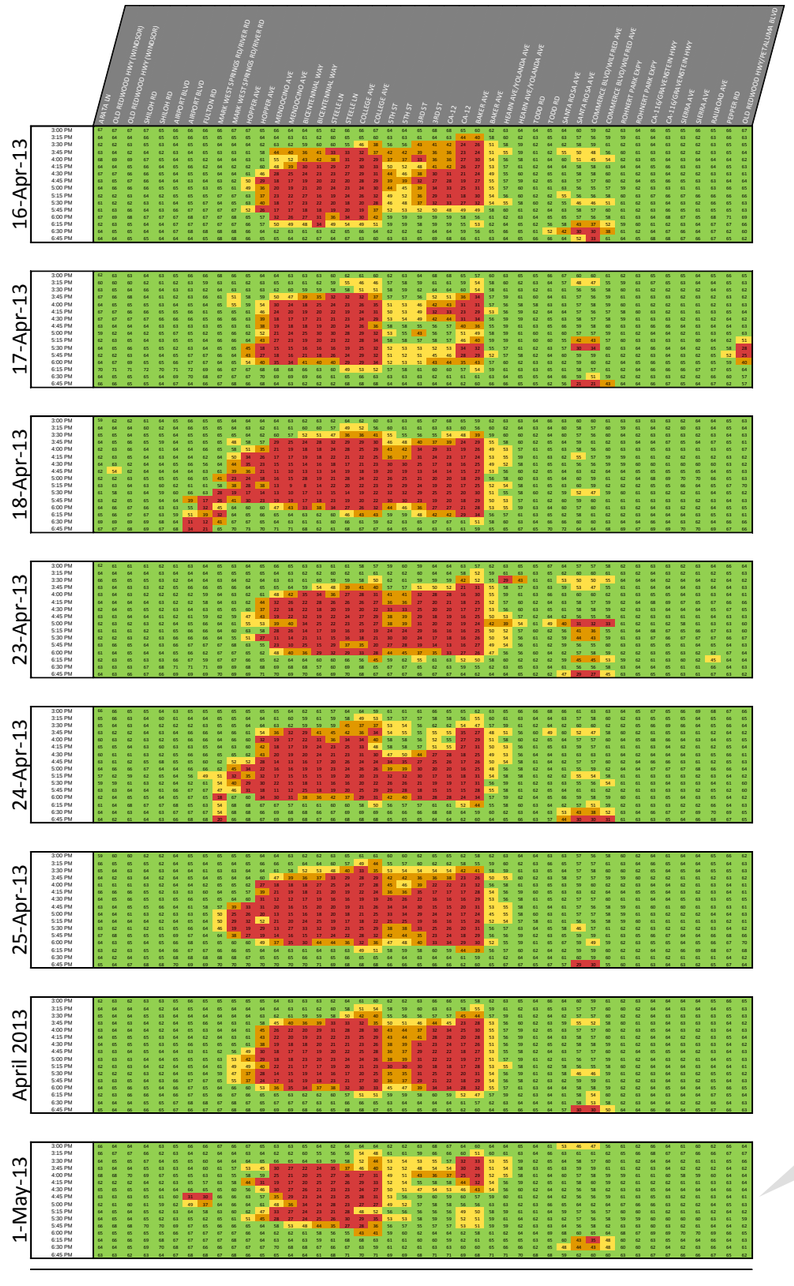
INRIX data were used to assess how well the floating car data represented typical conditions. This was particularly critical for the Before southbound travel times in the PM peak period, as two out of the three floating car data collection dates experienced severe incidents. Therefore, a single day of floating car data (May 1, 2013) was used to represent the Before conditions.

An analysis of INRIX travel time data for the two weeks prior to the floating car surveys suggested that the single day of Before travel times did not reflect typical conditions on the corridor. Travel times on US 101 southbound in the PM peak period in April 2013 were typically longer than what was observed on May 1, 2013. Travel times from later weeks in May 2013 were not considered to be representative because of the end-of-semester activities at the area's schools and colleges.

To provide a more accurate representation of typical Before travel times, the ratios between the April 2013 median travel times and the May 1, 2013 travel times from the INRIX data were used to scale the May 1, 2013 Before floating car travel times. As part of this process, the INRIX data were time-shifted 15 minutes earlier to better align with the floating car surveys. (The floating car surveys represent times of day for the beginning of the survey, while the INRIX times represent the actual time of day traversing each segment.)

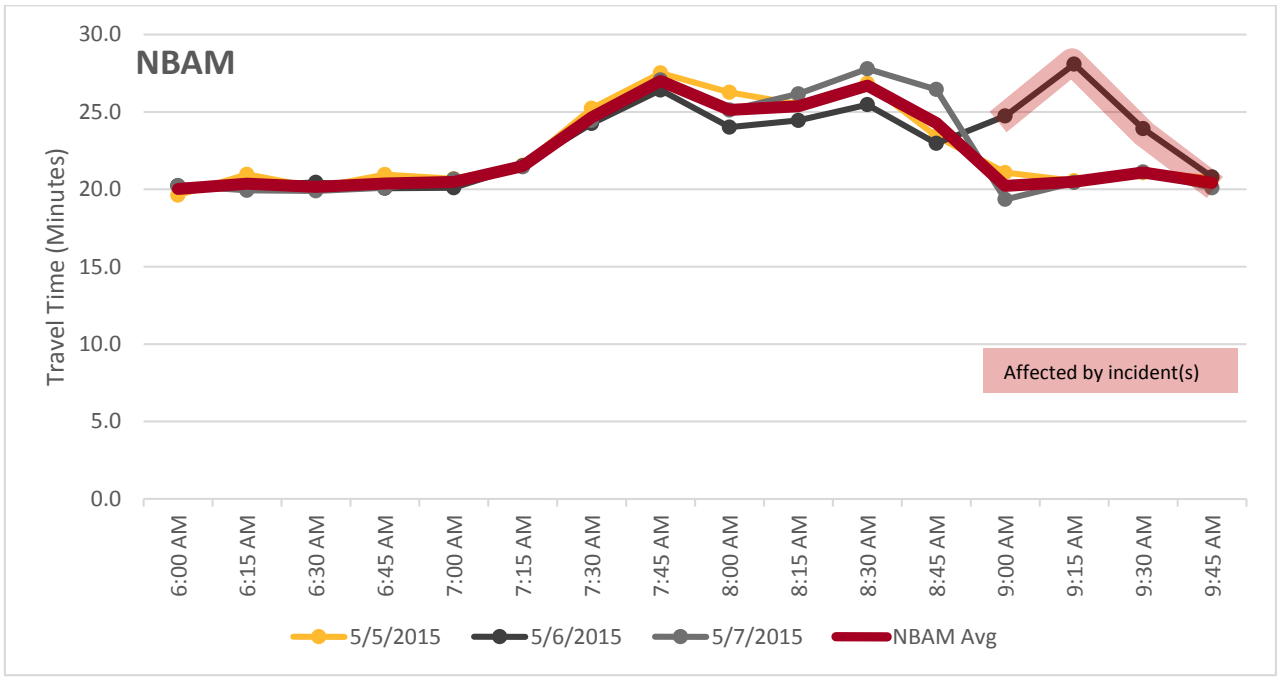


Data Source: INRIX data for midweek days between April 16 and April 25, plus May 1, 2013 (i.e., the day of the only incident-free Before floating car run)

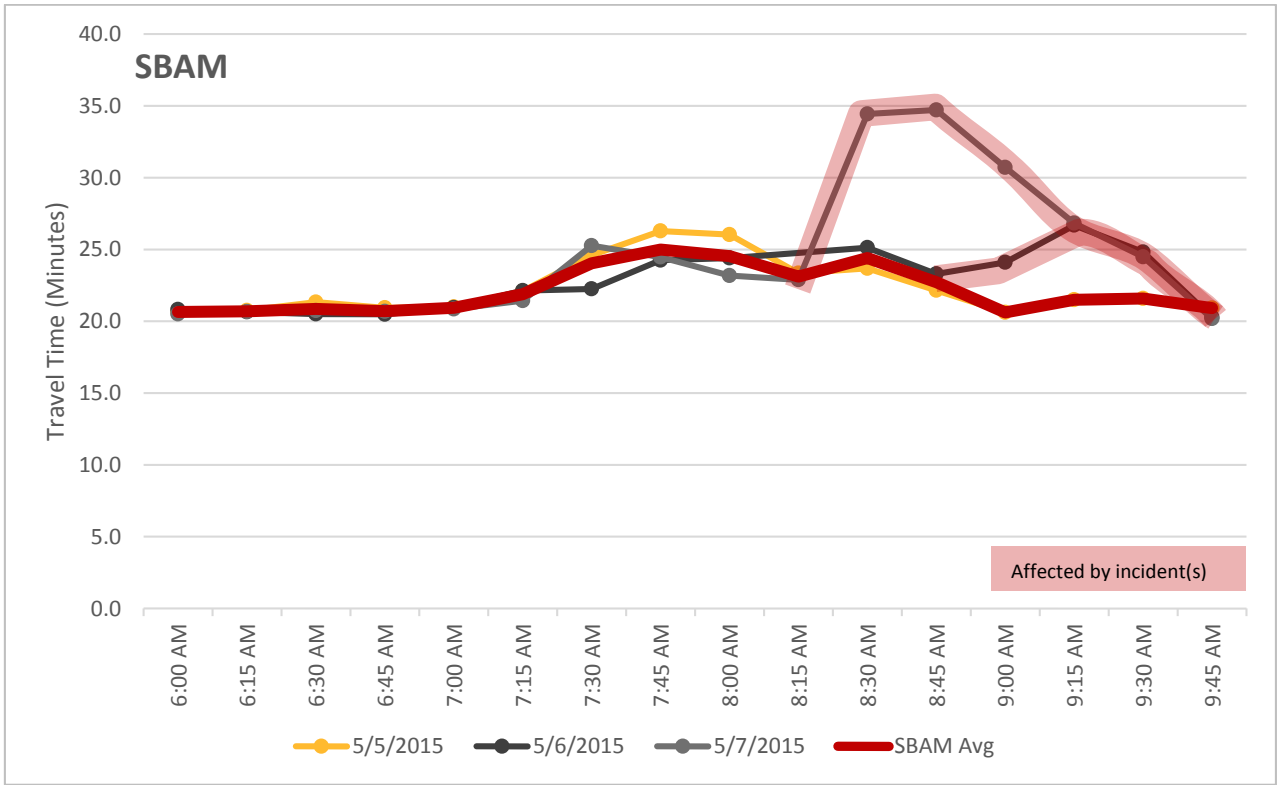


Similarly, speed contours from May 1, 2013 were adjusted by the ratio of the April 2013 median speeds to the May 1, 2013 speeds (both from INRIX).

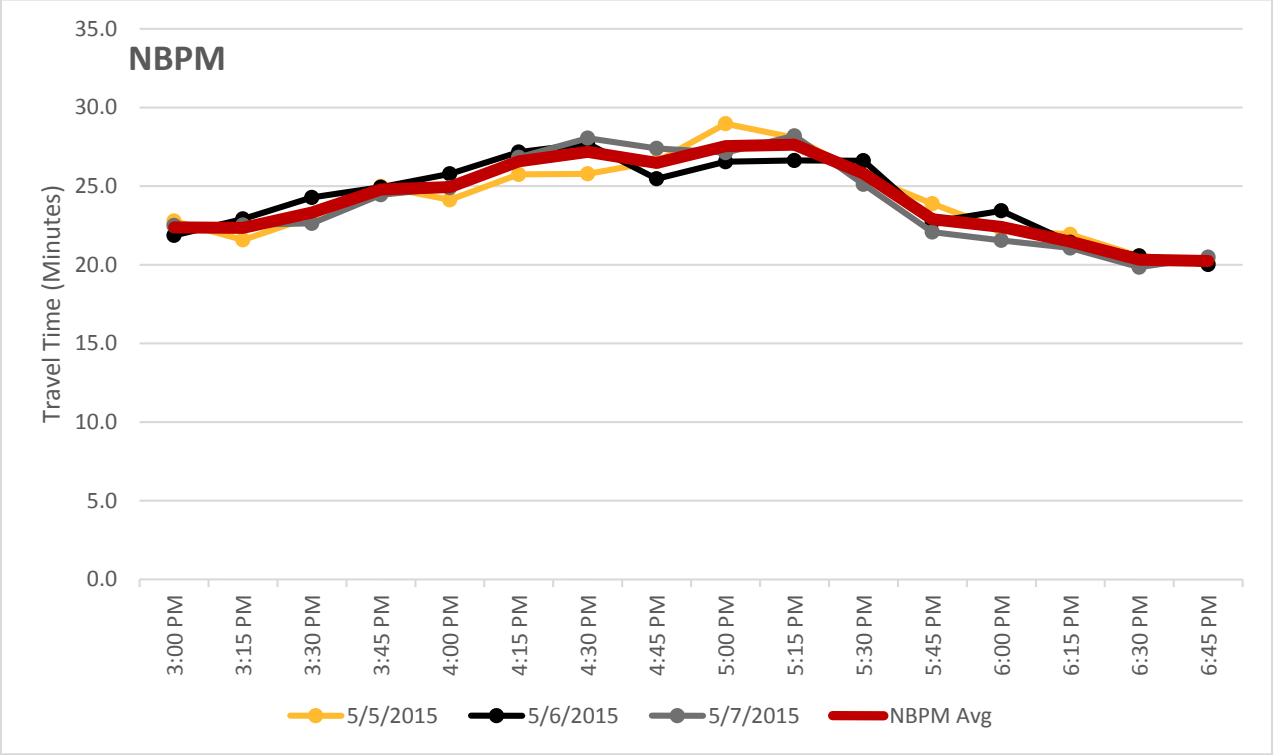
Appendix Exhibit D-2: Travel Times After Ramp Metering, Northbound, AM Peak Period



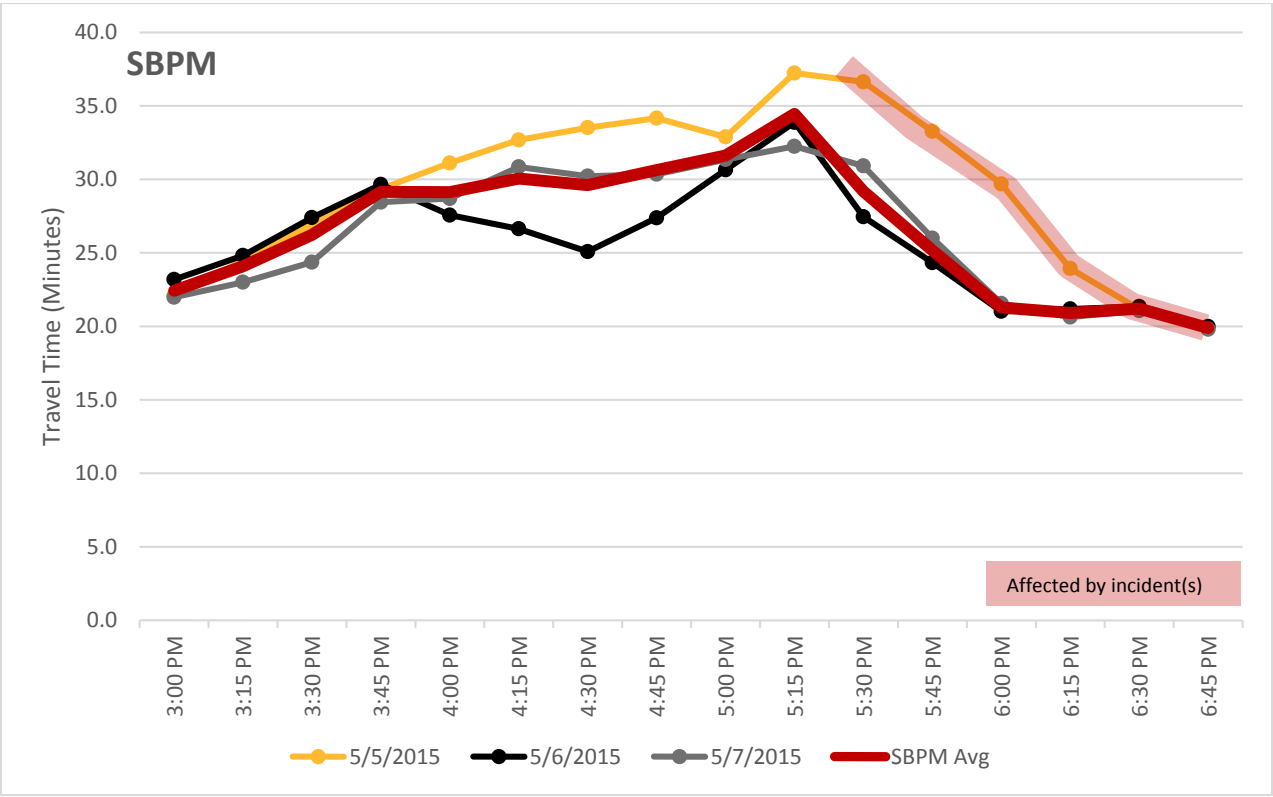
Appendix Exhibit D-3: Travel Times After Ramp Metering, Southbound, AM Peak Period



Appendix Exhibit D-4: Travel Times After Ramp Metering, Northbound, PM Peak Period



Appendix Exhibit D-5: Travel Times After Ramp Metering, Southbound, PM Peak Period



Appendix Exhibit D-6: Speed Contours After Ramp Metering, Northbound, AM Peak Period

Avg. Typ. Cond.

Time	Old Redwood Highway WB On-ramp to Railroad Ave Off-ramp	Railroad Ave Off-ramp to Sierra Ave Off-ramp	Sierra Ave Off-ramp to SR 116 Off-ramp	SR 116 Off-ramp to SR 116 On-ramp	SR 116 On-ramp to Rohnert Park Expressway Off-ramp	Rohnert Park Expressway Off-ramp to Rohnert Park Expressway EB On-ramp	Rohnert Park Expressway EB On-ramp to Rohnert Park Expressway WB On-ramp	Rohnert Park Expressway WB On-ramp to Golf Course Drive Off-ramp	Golf Course Drive Off-ramp to Golf Course Drive On-ramp	Golf Course Drive On-ramp to Santa Rosa Ave Off-ramp	Santa Rosa Ave Off-ramp to Todd Road Off-ramp	Todd Road Off-ramp to Todd Road On-ramp	Todd Road On-ramp to Yolanda Ave Off-ramp	Yolanda Ave Off-ramp to Yolanda Ave On-ramp	Yolanda Ave On-ramp to Baker Ave Off-ramp	Baker Ave Off-ramp to Baker Ave On-ramp	Baker Ave On-ramp to SR 12 Off-ramp	SR 12 Off-ramp to 3rd Street Off-ramp	3rd Street Off-ramp to SR 12 On-ramp	SR 12 On-ramp to Morgan / 6th Street On-ramp	Morgan / 6th Street On-ramp to College Ave Off-ramp	College Ave Off-ramp to College Ave On-ramp	College Ave On-ramp to Steele Lane Off-ramp	Steele Lane Off-ramp to Steele Lane On-ramp	Steele Lane On-ramp to Bicentennial Way Off-ramp	Bicentennial Way Off-ramp to Mendocino Ave Off-ramp	Mendocino Ave Off-ramp to Mendocino Ave On-ramp	Mendocino Ave On-ramp to River Road Off-ramp	River Road Off-ramp to River Road EB On-ramp	River Road EB On-ramp to River Road WB On-ramp	River Road WB On-ramp to Fulton Rd Off-ramp	Fulton Rd Off-ramp to Fulton Rd On-ramp	Fulton Rd On-ramp to Airport Blvd Off-ramp	Airport Blvd Off-ramp to Airport Blvd On-ramp	Airport Blvd On-ramp to Shiloh Rd Off-ramp	Shiloh Rd Off-ramp to Shiloh Rd On-ramp	Shiloh EB On-ramp to Shiloh WB On-ramp	Shiloh WB On-ramp to Old Redwood Highway Off-ramp	Old Redwood Highway Off-ramp to Old Redwood Highway On-ramp	Old Redwood Highway On-ramp to Arata Lane Off-ramp
Length	2.75	1.30	0.61	0.52	0.68	0.28	0.35	0.43	0.22	0.49	1.06	0.22	1.58	0.30	0.27	0.17	0.39	0.36	0.39	0.35	0.08	0.38	0.59	0.45	0.29	0.47	0.35	1.50	0.24	0.20	0.70	0.21	0.22	0.37	0.83	0.22	0.18	1.37	0.49	0.84
6:00 AM	67	67	66	66	69	70	68	68	66	67	68	68	69	68	69	68	67	68	71	71	69	70	68	69	68	70	70	69	68	70	69	68	69	71	68	67	68	68	65	62
6:15 AM	64	69	69	69	68	67	67	67	66	67	68	65	64	67	66	66	67	67	66	66	65	67	68	68	69	69	68	68	68	68	68	70	69	69	69	68	68	68	66	62
6:30 AM	66	71	71	68	68	68	67	68	67	66	69	67	67	66	67	67	68	69	70	69	66	67	66	66	69	69	68	65	66	67	67	66	67	70	71	71	71	69	66	64
6:45 AM	66	69	66	66	63	64	63	65	66	66	64	65	63	63	66	66	68	68	69	67	66	68	69	69	70	69	69	68	69	68	69	69	69	70	69	68	65	68	66	65
7:00 AM	67	71	68	66	68	69	67	69	66	66	66	63	62	62	62	61	61	61	66	67	65	67	66	67	67	67	67	66	69	69	70	69	69	71	70	67	69	69	67	60
7:15 AM	64	69	68	66	67	66	65	64	62	64	60	58	57	56	54	56	57	60	64	64	63	63	63	63	65	62	62	62	63	65	66	66	67	67	67	66	66	65	64	63
7:30 AM	63	66	65	65	65	66	65	48	59	64	37	52	43	28	31	40	49	44	29	35	44	56	60	61	66	63	65	61	66	63	61	57	66	69	66	67	68	68	68	62
7:45 AM	62	68	70	69	68	66	62	48	57	56	50	38	27	23	25	38	30	24	21	29	46	55	59	59	59	59	65	64	65	67	68	67	66	67	67	68	69	69	65	62
8:00 AM	62	69	67	67	65	64	64	68	68	65	61	64	37	21	25	34	34	32	27	34	42	53	59	61	62	62	64	64	62	64	66	66	70	65	63	65	63	61	59
8:15 AM	64	67	67	67	65	66	64	62	60	61	45	39	32	17	33	41	52	47	24	33	41	53	60	64	66	65	63	64	63	64	66	64	67	70	68	67	67	68	67	63
8:30 AM	62	68	66	67	63	66	63	64	63	43	45	19	25	30	29	33	47	46	27	35	42	50	62	61	62	63	64	64	64	65	66	66	67	67	68	69	62	58	56
8:45 AM	63	65	67	65	65	66	66	63	61	61	44	49	34	30	35	41	51	56	51	42	50	56	61	62	59	60	60	61	64	65	66	64	65	64	63	62	62	64	65	61
9:00 AM	68	71	68	70	69	70	69	68	68	67	65	62	65	65	64	61	63	65	67	64	63	67	66	66	65	69	69	70	72	72	70	70	71	72	69	68	68	67	65	62
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Tue 5/5/2015

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6:30 AM	65	73	70	71	68	66	64	65	65	67	72	71	68	65	68	69	69	69	72	71	72	73	64	64	68	70	71	65	64	67	64	65	68	74	76	74	72	67	65	62
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Wed 5/6/2015

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8:15 AM	65	69	71	71	70	70	65	64	65	63	62	52	57	12	25	41	52	38	21	27	35	52	64	64	65	62	63	61	59	60	62	62	69	71	70	69	69	69	68	63
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9:45 AM	67	67	68	67	69	71	69	65	62	63	61	56	57	66	66	66	66	65	67	66	66	66	65	65	66	70	68	68	68	67	71	71	70	72	66	66	65	67	63	59

Thu 5/7/2015

6:00 AM	66	70	67	66	66	68	65	66	64	66	67	65	66	66	67	67	66	67	68	70	71	71	69	67	70	70	67	68	66	66	66	65	67	69	67	65	68	67	65	63
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9:00 AM	66	72	69	71	71	71	72	72	72	68	73	71	71	72	67	64	65	66	69	69	66	69	69	73	70	73	73	76	77	78	72	72	75	73	72	72	71	70	69	66
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9:30 AM	62	68	66	64	66	66	67	68	64	62	64	66	65	66	68	68	65	65	69	67	65	69	65	64	66	69	66	62	65	65	65	62	64	70	71	70	69	63	57	57
9:45 AM	66	68	67	64	66	70	70	71	69	70	70	65	65	62	65	62	63	63	66	68	67	70	71	70	72	72	72	70	69	70	71	69	70	70	70	68	70	67	69	65

Legend
Speed greater than 55 mph
Speed 45 to 55 mph
Speed 35 to 45 mph
Speed less than 35 mph

Data Source: Metro Traffic Data floating car runs during May 2015. | Faded cells were not used to develop the average of typical conditions. See *Deliverable 7.4: Visual Observations Memo* for more details.

Appendix Exhibit D-7: Speed Contours After Ramp Metering, Southbound, AM Peak Period

Avg. Typ. Cond.

Time	Aviara Lane On-ramp to Old Redwood Highway Off-ramp	Old Redwood Highway Off-ramp to Old Redwood Highway On-ramp	Old Redwood Highway On-ramp to Shiloh Road Off-ramp	Shiloh Road Off-ramp to Shiloh WB On-ramp	Shiloh WB On-ramp to Shiloh EB On-ramp	Shiloh EB On-ramp to Airport Blvd Off-ramp	Airport Blvd Off-ramp to Airport Blvd On-ramp	Airport Blvd On-ramp to Patton Road Off-ramp	Fulton Road Off-ramp to Fulton Road On-ramp	Fulton Road On-ramp to River Road Off-ramp	River Road Off-ramp to River Road WB On-ramp	River Road WB On-ramp to River Road On-ramp	River Road On-ramp to Hopper Ave Off-ramp	Hopper Ave Off-ramp to Hopper Ave On-ramp	Hopper Ave On-ramp to Mendocino Ave On-ramp	Mendocino Ave On-ramp to Bicentennial Way On-ramp	Bicentennial Way On-ramp to Guerneville Road Off-ramp	Guerneville Road Off-ramp to Guerneville Road On-ramp	Guerneville Road On-ramp to College Ave Off-ramp	College Ave Off-ramp to College Ave On-ramp	College Ave On-ramp to Downtown Off-ramp	Downtown Off-ramp to SR 12 Off-ramp	SR 12 Off-ramp to 3rd Street On-ramp	3rd Street On-ramp to SR 12 On-ramp	SR 12 On-ramp to Baker Ave Off-ramp	Baker Ave Off-ramp to Baker Ave On-ramp	Baker Ave On-ramp to Corby Ave Off-ramp	Corby Ave Off-ramp to Corby Ave On-ramp	Corby Ave On-ramp to Todd Road Off-ramp	Todd Road Off-ramp to Todd Road On-ramp	Todd Road On-ramp to Golf Course Drive Off-ramp	Golf Course Drive Off-ramp to Golf Course Drive On-ramp	Golf Course Drive On-ramp to Rohnert Park Expressway Off-ramp	Rohnert Park Expressway Off-ramp to Rohnert Park Expressway WB On-ramp	Rohnert Park Expressway WB On-ramp to Rohnert Park Expressway EB On-ramp	Rohnert Park Expressway EB On-ramp to SR 116 Off-ramp	SR 116 Off-ramp to SR 116 On-ramp	SR 116 On-ramp to Sierra Ave On-ramp	Sierra Ave On-ramp to Pepper Road On-ramp	Pepper Road On-ramp to Old Redwood Highway Off-ramp
Length	1.38	0.45	1.30	0.21	0.16	0.93	0.33	0.17	0.20	0.72	0.22	0.20	1.30	0.28	0.36	0.45	0.24	0.64	0.47	0.41	0.12	0.33	0.34	0.42	0.40	0.15	0.26	0.23	1.59	0.17	1.05	0.83	0.64	0.20	0.18	0.75	0.51	0.64	2.97	1.04
6:00 AM	63	68	70	71	70	70	70	70	71	69	69	68	69	69	69	67	64	68	68	67	66	67	70	68	68	67	69	68	68	66	66	66	67	68	69	70	68	67	66	67	62
6:15 AM	64	69	69	67	68	70	69	68	68	67	67	67	68	68	66	67	66	67	68	68	68	67	70	68	68	68	67	69	69	67	65	68	69	69	69	69	66	67	67	63
6:30 AM	64	67	70	69	68	68	69	70	69	69	70	68	68	66	67	65	64	65	68	68	67	67	68	67	66	66	67	66	67	69	67	65	66	65	65	68	68	68	68	57
6:45 AM	70	68	70	70	68	69	69	70	69	70	72	70	68	70	71	70	68	69	68	67	66	68	71	71	67	65	66	65	65	65	66	68	68	67	66	68	69	69	66	57
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7:15 AM	68	70	70	69	69	63	62	65	64	66	63	62	63	64	65	64	62	60	59	60	63	65	66	65	49	54	58	61	62	64	63	64	69	66	64	65	64	60	65	59
7:30 AM	66	70	68	64	65	60	64	64	61	60	63	61	60	64	59	60	63	64	49	46	48	57	62	42	41	50	59	53	60	59	63	66	66	64	64	58	62	60	57	37
7:45 AM	65	64	66	60	61	60	62	63	56	47	50	40	54	51	33	39	44	49	40	37	46	57	61	38	44	53	54	48	55	53	57	63	68	64	62	65	67	64	66	60
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8:15 AM	64	68	68	65	65	65	62	64	65	60	58	60	63	66	62	59	63	66	69	67	60	67	56	33	42	22	46	51	63	58	56	63	65	66	64	63	67	64	64	55
8:30 AM	68	70	67	25	28	47	60	59	61	63	62	58	63	66	64	65	65	62	60	58	58	51	48	19	31	48	56	59	60	64	65	64	65	65	64	66	68	69	65	61
8:45 AM	66	72	69	70	68	63	65	64	66	65	56	50	56	53	29	50	52	57	62	62	60	62	64	52	36	54	61	64	65	67	63	62	68	67	65	67	69	69	67	61
9:00 AM	67	70	72	71	68	68	70	71	72	73	71	70	71	68	66	66	66	69	72	65	63	65	68	66	64	65	65	64	64	64	65	68	69	69	69	71	69	66	67	62
9:15 AM	60	59	67	62	63	67	63	64	62	69	72	70	72	72	73	73	71	73	66	64	67	69	72	67	62	63	65	68	65	66	62	63	65	63	65	68	64	63	59	62
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Tue 5/5/2015

6:00 AM	62	69	71	71	71	72	70	70	69	67	69	67	68	68	68	67	67	70	69	67	68	67	69	68	68	70	72	72	69	68	66	67	67	71	72	68	66	63	65	66
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6:30 AM	63	66	68	67	67	67	66	66	66	66	67	67	67	66	66	66	66	66	67	67	67	66	66	66	66	66	66	66	66	66	66	65	61	62	62	64	69	65	65	67	55
6:45 AM	74	73	72	72	69	70	69	67	65	69	69	67	65	66	67	67	64	68	67	65	65	69	72	71	65	63	63	63	64	68	66	68	68	66	66	66	68	69	64	53
7:00 AM	62	66	68	69	68	67	65	67	68	68	68	66	70	69	67	67	61	66	67	68	67	65	65	66	65	65	65	62	65	64	63	68	69	69	69	68	68	68	66	66
7:15 AM	68	71	70	67	66	66	65	65	67	66	66	65	67	64	64	64	57	53	51	58	60	65	69	69	40	56	62	64	64	61	61	67	72	68	61	61	60	56	61	65
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7:45 AM	67	56	63	54	58	58	61	65	64	61	54	35	50	60	24	26	34	40	33	39	46	55	55	22	34	52	63	61	64	51	58	64	69	62	63	67	70	63	67	56
8:00 AM	64	66	68	66	67	63	62	61	62	60	41	36	49	60	40	22	32	38	42	33	44	53	53	24	32	47	55	60	59	62	64	64	64	64	65	65	65	65	66	61
8:15 AM	61	68	63	65	67	69	58	60	63	67	66	63	64	66	63	63	68	67	73	69	63	68	49	23	35	49	60	63	65	55	54	65	65	64	59	58	64	62	61	58
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9:00 AM	67	70	72	71	68	68	70	71	72	73	71	70	71	68	66	66	66	69	72	65	63	65	68	66	64	64	65	68	69	69	69	71	69	66	67	62				
9:15 AM	60	59	67	62	63	67	63	64	62	69	72	70	72	72	73	73	71	73	66	64	67	69	72	67	62	63	65	68	65	66	62	63	65	63	65	68	64	63	59	62
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Wed 5/6/2015

6:00 AM	65	68	70	70	70	69	69	71	72	70	69	68	70	71	70	65	63	64	64	65	65	65	70	69	68	65	67	68	66	63	63	66	68	67	67	67	65	66	68	62
6:15 AM	64	70	65	66	68	68	66	67	69	64	63	65	66	66	60	65	65	67	69	69	70	72	71	66	70	73	73	74	73	70	65	69	73	75	75	70	66	66	66	66
6:30 AM	66	69	70	71	69	71	73	74	73	72	72	69	70	67	67	64	62	66	69	69	67	69	70	68	66	64	64	64	68	72	69	69	70	69	66	68	69	69	71	54
6:45 AM	68	65	68	70	71	69	69	71	70	70	70	68	69	72	74	73	73	73	71	72	68	67	70	72	67	64	67	68	66	68	69	70	68	64	64	66	67	68	67	59
7:00 AM	60	64	66	66	66	68	68	70	69	70	70	67	70	70	69	67	68	68	68	65	59	60	63	61	60	61	62	64	67	67	67	68	69	69	67	67	67	66	69	65
7:15 AM	66	69	72	71	69	59	57	62	58	65	66	66	61	60	62	61	61	59	61	60	60	61	60	59	56	58	59	61	63	66	63	58	68	66	64	66	66	64	65	57
7:30 AM	67	72	72	70	70	69	64	65	63	62	66	65	61	64	63	63	66	60	64	57	53	59	66	61	54	54	58	41	59	53	62	68	69	63	66	67	64	61	60	61
7:45 AM	62	68	70	68	67	65	65	60	45	31	38	34	54	58	56	58	58	59	42	37	43	58	65	60	49	56	46	37	56	52	58	64	68	66	64	65	71	68	67	69
8:00 AM	67	68	67	66	65	65	65	60	59	59	52	55	61	60	58	57	60	58	59	62	60	63	66	34	32	46	55	58	46	49	54	63	65	65	66	67	66	54	54	55
8:15 AM																																							
8:30 AM	71	73	65	16	17	37	57	58	61	61	58	52	62	66	60	61	62	64	62	67	69	72	69	27	26	50	57	63	62	66	65	62	62	64	64	66	70	70	63	59
8:45 AM	69	74	69	69	69	68	67	69	69	66	48	47	58	45	18	42	57	57	59	61	61	62	66	62	39	51	61	67	65	67	60	56	67	65	61	65	69	68	67	59
9:00 AM	64	69	71	69	68	70	69	70	71	72	72	71	70	64	63	61	60	61	68	68	68	68	69	63	61	60	58	61	46	8	26	66	67	66	66	67	70	70	69	64
9:15 AM	69	60	67	67	67	66	66	65	63	62	60	61	63	60	62	63	60	59	61	57	56	59	57	53	47	54	50	38	20	21	33	60	67	68	67	69	69	68	66	64
9:30 AM	64	66	68	64	64	62	63	63	63	64	65	65	66	66	66	66	64	62	62	62	60	62	63	64	64	64	64	62	23	40	42	58	63	62	62	66	67	67	68	61
9:45 AM	71	73	76	74	73	73	74	74	73	73	72	71	71	71	72	69	71	71	71	70	66	68	71	69	69	68	69	70	68	65	68	70	70	71	72	71	69	67	65	52

Thu 5/7/2015

6:00 AM	63	67	70	71	71	69	71	71	72	70	70	71	71	70	70	68	64	69	70	69	66	68	70	66	68	67	70	66	68	67	68	67	71	70	70	70	70	71	67	59
6:15 AM	68	67	67	65	64	68	69	69	69	68	70	68	68	67	69	70	65	67	68	66	67	67	67	67	66	65	66	67	66	68	64	67	68	66	66	69	68	68	69	65
6:30 AM	63	66	71	69	68	67	69	69	69	70	71	68	67	66	68	64	64	64	67	67	65	66	68	67	65	67	69	68	68	68	67	68	67	65	66	69	69	68	67	62
6:45 AM	68	67	69	69	65	67	70	71	73	73	76	76	69	71	71	70	67	66	67	65	65	68	70	72	69	67	68	64	65	61	64	65	68	70	69	70	70	70	67	59
7:00 AM	65	66	71	70	70	72	72	70	70	70	72	69	66	66	66	66	64	68	72	69	68	73	71	66	63	62	67	69	69	66	70	67	63	60	63	66	68	64	64	60
7:15 AM	69	70	69	71	71	65	65	66	68	68	58	55	63	69	70	66	69	69	67	62	69	70	69	66	53	49	54	58	60	66	65	67	68	65	67	68	66	60	69	56
7:30 AM	66	70	68	64	65	63	66	63	63	64	64	57	57	61	58	62	65	70	36	45	49	55	63	58	51	52	61	61	61	63	68	67	64	64	62	47	58	57	58	20
7:45 AM	66	68	65	59	60	58	61	64	64	66	64	60	59	40	32	44	45	51	48	35	50	57	64	58	55	51	54	52	48	57	55	62	67	63	61	64	61	60	65	57
8:00 AM	68	69	72	70	67	58	57	59	57	63	64	61	69	67	67	65	63	63	66	55	54	60	59	64	55	25	38	52	50	61	45	62	63	62	61	63	61	63	67	54
8:15 AM	68	68	74	65	63	62	67	68	67	55	52	57	62	66	62	56	59	65	65	64	58	67	66	60	51	14	38	43	61	62	58	60	65	68	71	69	70	66	66	53
8:30 AM	65	69	70	64	65	66	62	58	63	58	30	27	50	62	60	64	60	60	61	63	60	20	5	6	6	14	57	68	69	68	67	68	69	73	70	70	69	71	66	63
8:45 AM	68	72	68	64	67	69	69	53	55	59	59	45	63	59	59	35	16	12	16	17	22	16	8	10	14	20	52	62	67	70	63	64	68	66	66	69	71	66	69	67
9:00 AM	66	70	70	72	71	64	56	54	60	66	69	68	69	66	67	62	60	63	18	16	13	9	9	14	13	17	50	62	65	64	66	64	65	69	69	69	69	70	71	66
9:15 AM	66	70	67	66	64	66	66	65	65	68	68	66	65	65	66	66	64	62	57	60	52	19	9	12	19	27	43	54	67	70	66	61	65	66	66	70	68	66	69	58
9:30 AM	58	61	68	64	63	63	63	61	62	65	67	62	62	57	63	63	64	61	64	65	64	66	52	27	36	48	54	58	58	57	57	62	68	66	66	67	63	59	60	31
9:45 AM	70	74	73	71	74	71	69	68	69	67	71	69	72	66	69	67	71	71	69	69	67	69	70	70	61	61	64	66	71	69	70	67	73	72	73	73	69	71	68	56

Legend
Speed greater than 55 mph
Speed 45 to 55 mph
Speed 35 to 45 mph
Speed less than 35 mph

Data Source: Metro Traffic Data floating car runs during May 2015. | Faded cells were not used to develop the average of typical conditions. See *Deliverable 7.4: Visual Observations Memo* for more details. | White cells indicate that no data were available.

Appendix Exhibit D-8: Speed Contours After Ramp Metering, Northbound, PM Peak Period

Avg. Typ. Cond.

Time	Old Redwood Highway WB On-ramp to Railroad Ave Off-ramp	Railroad Ave Off-ramp to Sierra Ave Off-ramp	Sierra Ave Off-ramp to SR 116 Off-ramp	SR 116 Off-ramp to SR 116 On-ramp	SR 116 On-ramp to Rohnert Park Expressway Off-ramp	Rohnert Park Expressway Off-ramp to Rohnert Park Expressway EB On-ramp	Rohnert Park Expressway EB On-ramp to Rohnert Park Expressway WB On-ramp	Rohnert Park Expressway WB On-ramp to Golf Course Drive Off-ramp	Golf Course Drive Off-ramp to Golf Course Drive On-ramp	Golf Course Drive On-ramp to Santa Rosa Ave Off-ramp	Santa Rosa Ave Off-ramp to Todd Road Off-ramp	Todd Road Off-ramp to Todd Road On-ramp	Todd Road On-ramp to Yolanda Ave Off-ramp	Yolanda Ave Off-ramp to Yolanda Ave On-ramp	Yolanda Ave On-ramp to Baker Ave Off-ramp	Baker Ave Off-ramp to Baker Ave On-ramp	Baker Ave On-ramp to SR 12 Off-ramp	SR 12 Off-ramp to 3rd Street Off-ramp	3rd Street Off-ramp to SR 12 On-ramp	SR 12 On-ramp to Morgan / 6th Street On-ramp	Morgan / 6th Street On-ramp to College Ave Off-ramp	College Ave Off-ramp to College Ave On-ramp	College Ave On-ramp to Steele Lane Off-ramp	Steele Lane Off-ramp to Steele Lane On-ramp	Steele Lane On-ramp to Bicentennial Way Off-ramp	Bicentennial Way Off-ramp to Mendocino Ave Off-ramp	Mendocino Ave Off-ramp to Mendocino Ave On-ramp	Mendocino Ave On-ramp to River Road Off-ramp	River Road Off-ramp to River Road EB On-ramp	River Road EB On-ramp to River Road WB On-ramp	River Road WB On-ramp to Fulton Rd Off-ramp	Fulton Rd Off-ramp to Fulton Rd On-ramp	Fulton Rd On-ramp to Airport Blvd Off-ramp	Airport Blvd Off-ramp to Airport Blvd On-ramp	Airport Blvd On-ramp to Shiloh Rd Off-ramp	Shiloh Rd Off-ramp to Shiloh EB On-ramp	Shiloh EB On-ramp to Shiloh WB On-ramp	Shiloh WB On-ramp to Old Redwood Highway Off-ramp	Old Redwood Highway Off-ramp to Old Redwood Highway On-ramp	Old Redwood Highway On-ramp to Acata Lane Off-ramp
Length	2.75	1.30	0.61	0.52	0.68	0.28	0.35	0.43	0.22	0.49	1.06	0.22	1.58	0.30	0.27	0.17	0.39	0.36	0.39	0.35	0.08	0.38	0.59	0.45	0.29	0.47	0.35	1.50	0.24	0.20	0.70	0.21	0.22	0.37	0.83	0.22	0.18	1.37	0.49	0.84
3:00 PM	61	66	66	64	62	66	64	63	61	59	52	54	56	54	47	49	54	62	57	45	49	59	57	61	59	58	62	62	65	65	68	67	66	68	68	66	67	66	65	64
3:15 PM	66	65	65	66	67	66	67	65	59	54	40	53	57	62	48	41	52	60	55	40	47	56	61	64	66	63	62	66	67	69	69	69	68	70	69	68	68	68	66	63
3:30 PM	64	66	64	67	67	64	58	56	43	53	47	53	47	29	29	38	44	53	64	63	63	62	62	62	60	61	63	63	67	68	69	70	71	71	67	64	66	69	66	61
3:45 PM	66	67	66	64	61	62	60	63	51	35	34	41	32	28	31	39	52	59	62	53	56	62	67	66	65	64	66	61	63	66	68	66	65	67	68	68	68	69	67	64
4:00 PM	62	66	67	68	64	63	60	66	65	60	37	33	33	22	26	33	49	60	52	48	54	61	59	62	64	65	65	63	65	67	69	67	68	67	65	65	67	68	62	60
4:15 PM	61	66	65	66	63	63	62	62	63	37	26	37	28	23	27	35	48	59	53	51	49	56	62	62	62	61	62	64	65	66	67	67	68	68	65	65	64	64	63	65
4:30 PM	61	65	64	66	69	69	59	54	22	32	27	25	30	26	23	31	48	60	47	36	47	56	63	66	63	62	62	63	66	64	65	66	65	67	63	64	65	64	68	60
4:45 PM	64	66	68	65	60	56	45	39	49	29	30	49	32	28	28	37	46	55	50	48	53	58	61	60	61	60	61	60	64	62	63	64	63	65	64	63	64	66	62	62
5:00 PM	65	70	68	66	66	66	63	65	63	38	21	19	28	22	26	39	52	58	60	48	50	51	61	46	51	52	56	60	57	61	64	66	68	70	68	67	67	66	64	62
5:15 PM	60	69	70	67	70	71	67	67	58	34	22	23	25	21	28	40	50	57	51	43	53	62	63	63	64	63	64	64	64	63	61	59	67	66	65	67	69	65	61
5:30 PM	61	67	65	65	64	61	61	65	61	40	31	33	27	27	30	42	52	58	61	58	54	56	56	61	63	64	63	65	64	68	66	64	66	67	67	67	68	65	64	61
5:45 PM	62	67	65	66	68	67	67	65	67	64	41	42	41	32	36	46	57	62	66	63	60	64	66	64	66	66	68	67	67	68	67	66	66	68	69	67	68	68	68	64
6:00 PM	60	64	63	63	63	63	61	60	58	62	48	52	47	55	43	39	53	62	68	64	61	60	66	61	60	64	67	65	70	69	69	67	71	71	68	67	69	68	69	68
6:15 PM	63	67	68	66	66	65	66	66	67	67	63	61	54	40	46	49	57	64	68	63	59	63	64	62	64	65	66	67	68	69	71	69	69	70	68	68	67	66	64	63
6:30 PM	66	68	66	66	69	70	67	67	66	65	66	67	67	66	65	64	63	63	64	67	68	70	71	71	69	69	68	67	67	69	67	66	68	69	70	69	69	70	66	60
6:45 PM	67	67	65	67	69	69	66	65	65	67	66	60	65	64	67	68	64	66	68	69	70	70	70	70	69	68	68	67	67	68	69	69	70	70	69	68	69	69	69	66

Tue 5/5/2015

3:00 PM	63	67	68	66	63	68	65	65	60	58	48	50	62	50	36	43	56	64	46	34	43	59	60	57	61	62	61	62	64	61	62	63	62	66	69	67	66	63	62	63
3:15 PM	66	66	70	70	70	70	70	69	56	49	47	51	58	60	58	55	59	64	47	48	55	64	68	66	64	65	70	70	71	70	67	69	71	71	70	69	68	67	64
3:30 PM	59	68	69	70	68	66	68	64	36	52	56	57	54	23	23	35	43	52	61	63	64	60	62	63	62	63	61	61	65	66	74	75	74	74	71	63	68	67	67	64
3:45 PM	66	68	67	69	56	54	52	61	55	51	31	28	31	41	27	42	55	57	60	49	51	59	68	67	65	65	64	65	65	64	63	64	65	64	64	67	67	66		
4:00 PM	68	65	62	66	65	66	66	68	63	56	38	52	35	34	24	27	47	62	66	54	55	58	59	62	62	64	65	59	65	67	71	71	71	74	66	63	67	70	64	65
4:15 PM	62	66	68	68	67	66	62	60	65	30	24	60	37	26	23	38	49	58	63	50	43	53	64	64	62	63	61	63	66	65	65	65	65	65	65	65	65	65	65	65
4:30 PM	66	67	67	72	71	71	68	62	28	23	32	61	37	26	31	30	52	65	40	35	46	55	64	67	64	60	65	61	67	70	68	68	65	68	61	63	64	61	65	58
4:45 PM	65	66	70	64	55	50	32	24	37	33	31	52	37	18	31	37	41	51	67	65	61	58	61	60	62	63	62	58	64	63	64	66	66	67	69	67	68	66	64	65
5:00 PM	68	69	68	66	66	66	61	63	59	50	19	18	24	21	27	39	48	53	57	51	47	45	57	30	37	46	59	63	63	65	65	60	61	61	63	63	63	63	60	60
5:15 PM	56	68	70	64	66	70	62	62	65	41	24	14	23	20	32	41	51	56	62	59	54	62	56	58	62	61	63	61	65	65	63	61	60	68	69	70	71	70	61	61
5:30 PM	58	67	67	66	66	67	66	68	56	24	28	48	29	40	37	46	53	59	62	55	49	51	61	62	61	62	66	63	63	68	70	66	68	68	71	72	73	68	69	66
5:45 PM	61	63	64	64	65	63	63	64	66	64	31	35	44	22	28	42	56	63	68	64	59	63	68	66	69	71	67	65	66	67	67	67	69	71	69	67	68	68	68	62
6:00 PM	60	67	65	71	70	66	62	64	63	66	38	49	49	56	45	42	52	61	69	62	62	59	63	52	55	68	74	70	73	70	65	66	68	67	70	75	71	72	74	
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6:30 PM	65	69	66	68	68	67	65	66	66	63	63	65	64	63	62	62	62	70	70	70	72	75	72	71	71	68	68	67	67	68	68	67	67	68	68	65	68	63	60	
6:45 PM	70	68	64	65	65	64	63	60	58	60	66	65	67	66	68	68	66	70	72	72	71	72	68	71	72	68	68	67	65	66	65	67	68	69	67	63	63	71	71	69

Wed 5/6/2015

3:00 PM	57	67	66	64	58	61	62	67	68	65	61	53	58	62	57	54	55	63	68	58	52	60	52	63	63	57	64	64	66	67	71	68	67	70	68	66	69	69	66	63
3:15 PM	68	61	62	68	69	64	68	60	47	50	36	51	57	60	35	36	53	63	56	37	47	55	59	63	68	67	65	67	67	68	67	71	69	70	67	66	67	67	62	58
3:30 PM	65	66	65	70	73	70	50	54	44	48	36	48	38	24	29	41	45	53	65	63	62	61	61	60	60	63	63	62	67	71	70	69	70	70	66	64	63	70	66	61
3:45 PM	67	69	69	65	62	66	63	60	39	22	46	61	29	24	33	38	49	55	59	66	64	64	67	69	64	65	68	64	65	66	69	64	68	70	71	71	72	71	67	62
4:00 PM	57	68	71	70	64	58	53	60	64	62	50	26	30	17	22	40	50	58	38	37	49	62	56	60	62	65	62	65	67	68	69	66	66	67	67	67	66	67	62	61
4:15 PM	59	67	65	65	62	62	63	63	63	41	27	40	25	21	28	33	51	60	39	45	49	55	61	61	62	62	64	63	63	65	66	66	68	66	63	65	63	62	66	70
4:30 PM	59	73	69	67	67	67	55	58	57	58	22	20	25	24	21	32	45	61	44	34	48	55	60	64	62	66	59	61	65	65	65	67	67	72	66	65	65	65	71	66
4:45 PM	64	63	64	65	68	64	58	61	57	52	29	46	32	34	28	34	53	61	58	46	53	58	58	58	59	58	60	64	69	71	65	65	62	63	58	59	62	64	60	60
5:00 PM	65	70	71	66	65	67	65	66	65	24	23	31	30	21	26	34	52	64	70	55	57	60	66	65	67	59	61	58	52	62	69	69	72	75	75	70	69	69	66	67
5:15 PM	63	69	70	70	72	72	72	71	50	31	32	35	22	20	26	38	50	62	61	40	53	63	68	67	69	67	68	68	64	62	61	60	55	67	68	66	67	70	70	63
5:30 PM	60	65	63	63	57	51	56	63	60	54	30	19	28	25	23	39	51	54	54	57	53	53	59	65	67	69	64	64	65	67	62	61	68	68	67	67	67	63	61	59
5:45 PM	65	71	64	65	67	68	68	66	68	64	39	38	35	58	63	65	63	64	65	65	65	64	66	65	67	65	66	65	65	65	66	70	70	70	68	66	66	66	66	66
6:00 PM	58	63	64	59	57	59	58	57	57	58	53	49	38	53	45	42	48	58	67	67	59	60	71	66	63	59	59	59	69	67	70	71	73	71	67	63	61	63	64	64
6:15 PM	61	68	68	66	68	66	66	64	65	66	60	63	59	55	56	58	60	67	67	60	55	62	61	55	59	62	63	67	68	68	71	66	66	66	66	67	67	66	63	63
6:30 PM	67	65	67	63	68	73	68	66	65	67	66	66	67	67	66	61	60	60	61	62	64	67	70	70	65	67	64	65	67	71	67	66	69	68	70	69	70	71	65	58
6:45 PM	65	70	68	68	71	71	68	70	71	72	67	66	66	65	66	65	63	65	68	69	72	71	70	70	71	69	69	68	65	67	71	70	69	69	70	71	71	68	69	66

Thu 5/7/2015

3:00 PM	63	64	65	64	66	68	66	58	57	54	49	60	50	52	56	51	51	60	64	48	52	59	61	62	53	56	61	59	66	67	71	71	70	70	68	66	67	66	67	65
3:15 PM	65	68	63	62	64	65	65	65	65	56	37	62	66	69	58	35	49	58	47	37	47	57	61	60	63	60	57	62	64	67	70	68	67	69	68	67	69	68	69	68
3:30 PM	67	63	58	60	60	58	58	52	53	59	54	57	51	50	38	39	44	55	66	64	64	67	64	63	58	58	65	65	68	67	64	66	69	70	64	66	67	68	65	57
3:45 PM	64	63	62	59	67	70	69	70	69	50	30	49	37	24	35	36	52	64	66	48	53	64	67	63	65	63	67	55	61	67	70	69	66	68	67	70	70	71	68	65
4:00 PM	62	66	67	67	64	66	64	70	68	61	29	32	35	22	34	34	51	60	64	62	60	63	63	66	69	66	67	66	64	67	68	66	68	68	61	63	65	68	68	62
4:15 PM	61	65	63	65	61	63	61	61	63	44	27	25	25	21	30	35	44	58	64	58	56	60	62	61	62	59	62	66	66	68	68	70	70	73	68	65	64	65	59	60
4:30 PM	59	58	59	61	69	68	57	46	12	30	30	19	30	29	21	30	48	54	60	40	47	58	64	68	62	61	62	67	65	58	64	64	63	62	63	64	67	66	67	57
4:45 PM	63	69	71	67	58	55	54	56	61	18	30	51	27	43	25	39	45	54	37	40	47	57	63	62	63	60	61	59	59	54	59	62	61	65	65	64	63	68	63	61
5:00 PM	62	70	66	66	66	64	62	65	66	58	22	14	30	26	26	45	57	59	56	40	48	50	59	58	57	53	50	60	56	57	59	69	72	75	68	68	68	68	68	61
5:15 PM	62	69	70	68	71	71	68	68	61	32	16	31	31	23	26	40	50	55	37	35	52	63	66	63	61	60	63	58	61	65	65	64	64	66	62	59	62	67	66	60
5:30 PM	66	68	66	67	71	69	62	65	67	69	36	55	26	22	32	41	53	62	66	62	63	65	50	57	62	62	61	68	65	69	67	65	63	66	64	64	65	65	63	58
5:45 PM	60	68	66	71	72	72	70	63	67	65	66	64	45	33	32	38	53	59	65	60	58	65	63	61	64	64	71	70	69	70	67	62	60	65	71	67	69	71	69	65
6:00 PM	62	63	61	61	63	63	63	61	55	61	59	60	58	55	39	33	60	66	69	64	64	62	66	69	65	66	69	66	68	66	68	66	75	73	69	69	71	72	73	67
6:15 PM	64	67	64	66	63	63	66	66	66	67	63	55	59	56	58	59	64	69	64	65	67	68	67	67	65	67	66	69	69	71	71	71	71	70	68	66	65	63	61	
6:30 PM	65	71	65	68	71	70	68	68	67	67	69	69	70	68	67	68	69	68	69	70	71	71	70	69	70	70	70	69	68	68	67	65	69	71	72	71	73	72	69	62
6:45 PM	66	65	64	66	72	71	68	66	68	70	65	52	61	62	67	71	64	64	65	66	66	68	71	68	65	66	65	66	70	72	72	71	72	72	71	70	71	69	66	62

Legend
Speed greater than 55 mph
Speed 45 to 55 mph
Speed 35 to 45 mph
Speed less than 35 mph

Data Source: Metro Traffic Data floating car runs during May 2015

Appendix Exhibit D-9: Speed Contours After Ramp Metering, Southbound, PM Peak Period

Avg. Typ. Cond.

Time	Arata Lane On-ramp to Old Redwood Highway Off-ramp	Old Redwood Highway Off-ramp to Old Redwood Highway On-ramp	Old Redwood Highway On-ramp to Shiloh Road Off-ramp	Shiloh Road Off-ramp to Shiloh WB On-ramp	Shiloh WB On-ramp to Shiloh EB On-ramp	Shiloh EB On-ramp to Airport Blvd Off-ramp	Airport Blvd Off-ramp to Airport Blvd On-ramp	Airport Blvd On-ramp to Fulton Road Off-ramp	Fulton Road Off-ramp to Fulton Road On-ramp	Fulton Road On-ramp to River Road Off-ramp	River Road Off-ramp to River Road WB On-ramp	River Road WB On-ramp to Vine River Road On-ramp	River Road On-ramp to Hopper Ave Off-ramp	Hopper Ave Off-ramp to Hopper Ave On-ramp	Hopper Ave On-ramp to Mendocino Ave On-ramp	Mendocino Ave On-ramp to Bicentennial Way On-ramp	Bicentennial Way On-ramp to Guerneville Road Off-ramp	Guerneville Road Off-ramp to Guerneville Road On-ramp	Guerneville Road On-ramp to College Ave Off-ramp	College Ave Off-ramp to College Ave On-ramp	College Ave On-ramp to Downtown Off-ramp	Downtown Off-ramp to SR 12 Off-ramp	SR 12 Off-ramp to 3rd Street On-ramp	3rd Street On-ramp to SR 12 On-ramp	SR 12 On-ramp to Baker Ave Off-ramp	Baker Ave Off-ramp to Baker Ave On-ramp	Baker Ave On-ramp to Corby Ave Off-ramp	Corby Ave Off-ramp to Corby Ave On-ramp	Corby Ave On-ramp to Todd Road Off-ramp	Todd Road Off-ramp to Todd Road On-ramp	Todd Road On-ramp to Golf Course Drive Off-ramp	Golf Course Drive Off-ramp to Golf Course Drive On-ramp	Golf Course Drive On-ramp to Rohnert Park Expressway Off-ramp	Rohnert Park Expressway Off-ramp to Rohnert Park Expressway WB On-ramp	Rohnert Park Expressway WB On-ramp to Rohnert Park Expressway EB On-ramp to SR 116 Off-ramp	SR 116 Off-ramp to SR 116 On-ramp	SR 116 On-ramp to Sierra Ave On-ramp	Sierra Ave On-ramp to Pepper Road On-ramp	Pepper Road On-ramp to Old Redwood Highway Off-ramp
Length	1.38	0.45	1.30	0.21	0.16	0.93	0.33	0.17	0.20	0.72	0.22	0.20	1.30	0.28	0.36	0.45	0.24	0.64	0.47	0.41	0.12	0.33	0.34	0.42	0.40	0.15	0.26	0.23	1.59	0.17	1.05	0.83	0.64	0.20	0.18	0.75	0.51	0.64	2.97	1.04
3:00 PM	67	71	67	66	67	66	65	65	63	65	63	63	61	60	60	59	57	58	56	42	49	58	61	54	42	55	60	59	61	51	61	66	66	64	65	69	68	68	67	59
3:15 PM	65	68	66	64	60	61	60	62	65	66	64	54	63	65	63	60	56	32	30	25	47	57	62	48	53	55	60	63	62	57	61	61	64	67	67	67	67	65	65	54
3:30 PM	65	67	66	64	60	62	56	58	60	62	62	60	62	61	59	31	17	26	26	29	44	54	61	30	33	48	58	62	63	55	58	60	62	61	62	67	66	63	64	57
3:45 PM	65	66	68	65	60	63	63	63	64	60	60	51	30	24	17	22	29	23	27	35	47	52	45	23	27	45	55	60	62	60	62	62	63	66	68	70	70	69	66	56
4:00 PM	64	68	67	65	65	64	63	63	64	64	56	37	53	22	15	21	18	27	25	33	46	40	27	22	34	50	56	58	57	52	57	62	61	63	66	66	65	66	67	59
4:15 PM	60	65	64	61	60	62	63	64	64	63	61	49	36	20	21	19	29	24	28	29	38	28	22	21	30	46	57	58	58	59	59	63	66	64	65	64	63	63	66	61
4:30 PM	67	70	71	67	66	62	63	63	64	67	56	28	55	39	21	20	19	23	27	31	46	27	14	20	38	46	37	42	55	59	60	65	66	65	67	71	68	65	68	62
4:45 PM	60	63	67	65	62	60	63	64	65	63	60	46	33	23	20	17	18	22	28	29	41	32	24	19	37	48	56	60	61	58	61	62	65	62	65	67	65	62	65	62
5:00 PM	64	66	65	65	64	64	63	62	64	59	32	21	45	22	15	18	23	17	24	29	45	37	23	22	33	47	55	55	52	50	56	61	63	65	66	68	65	63	64	56
5:15 PM	64	66	65	62	59	63	53	51	40	33	22	16	26	13	16	19	19	15	23	27	46	45	36	27	38	42	33	43	57	51	55	60	59	60	62	61	61	62	63	57
5:30 PM	66	66	69	70	68	67	66	62	42	24	21	21	54	63	49	18	31	23	28	31	45	40	26	22	34	50	55	55	61	59	60	64	62	61	63	66	63	65	66	66
5:45 PM	69	70	71	71	72	69	68	12	22	51	30	29	53	58	59	55	58	37	29	30	51	58	64	44	51	55	61	60	60	61	62	64	67	66	67	69	65	63	69	63
6:00 PM	68	71	70	71	70	70	69	68	68	69	64	64	64	63	60	58	59	59	50	49	52	64	66	62	59	60	65	66	67	70	67	67	69	69	68	69	67	67	69	64
6:15 PM	66	67	68	69	68	69	70	71	71	71	70	69	70	69	66	64	65	67	65	59	55	62	65	63	59	61	66	65	67	65	64	67	70	69	68	67	69	68	68	63
6:30 PM	65	68	67	67	66	64	67	72	71	66	67	65	65	65	63	63	62	64	64	65	61	61	63	62	57	59	65	67	67	69	68	66	66	66	66	68	67	67	69	62
6:45 PM	68	71	74	75	74	73	73	74	73	73	72	71	71	73	72	71	70	70	69	68	66	68	68	67	67	68	69	70	69	69	70	70	72	71	70	75	71	70	69	62

Tue 5/5/2015

3:00 PM	66	72	68	67	67	68	67	68	69	67	65	62	61	65	61	57	61	54	50	39	52	61	66	60	60	62	61	60	63	50	58	62	65	66	68	73	72	70	68	61
3:15 PM	68	70	66	62	57	61	54	58	62	66	67	47	65	72	64	63	62	33	19	20	46	56	62	64	61	53	55	59	62	69	64	60	64	66	68	67	66	65	63	64
3:30 PM	60	67	68	66	61	66	65	65	65	66	68	66	65	63	61	20	17	24	22	29	42	50	59	22	29	50	60	64	67	62	63	64	66	59	59	65	65	61	65	57
3:45 PM	70	62	66	64	60	60	64	66	66	57	61	62	30	24	15	23	34	32	26	39	49	48	32	16	27	48	55	58	61	62	64	66	65	68	68	69	69	69	65	54
4:00 PM	63	68	69	67	67	67	63	65	66	62	66	68	50	24	14	21	13	25	22	35	54	26	13	15	31	46	54	57	57	59	55	64	60	62	66	63	63	66	69	62
4:15 PM	64	64	66	60	55	55	59	62	61	62	68	68	31	14	19	20	35	20	35	23	32	15	15	15	25	41	56	65	57	62	62	65	70	67	66	68	67	68	64	58
4:30 PM	68	72	71	62	61	57	60	60	61	67	42	13	46	26	14	15	13	19	27	34	48	15	10	13	38	50	57	54	59	63	60	63	68	68	71	72	69	68	68	65
4:45 PM	64	64	68	64	55	54	61	61	63	61	57	31	20	25	15	24	10	21	35	23	37	19	19	15	35	44	53	57	61	54	58	62	65	63	67	71	70	60	65	62
5:00 PM	66	65	67	65	64	63	64	62	61	49	18	33	45	18	17	15	19	16	26	24	46	54	27	15	33	40	53	57	45	59	60	62	64	62	64	66	65	67	63	57
5:15 PM	66	64	70	69	66	69	68	65	67	65	21	18	20	10	9	12	14	11	17	20	51	57	62	65	56	52	57	62	59	52	58	59	55	58	61	59	57	59	60	57
5:30 PM	65	66	68	66	65	65	68	64	65	66	29	21	19	14	9	10	8	15	16	17	56	62	63	61	61	60	67	66	62	59	53	60	67	68	69	70	68	66	67	64
5:45 PM	70	70	72	71	69	66	66	68	70	70	71	28	19	35	10	13	12	14	17	21	41	51	58	64	55	57	58	60	64	59	64	64	65	62	66	71	71	69	71	65
6:00 PM	65	70	72	71	69	69	71	71	72	70	70	69	42	12	14	17	14	12	26	37	41	55	59	60	58	54	56	60	61	60	67	71	71	69	67	71	65	62	65	63
6:15 PM	65	68	70	68	69	69	71	71	69	71	72	65	63	41	20	29	45	32	33	38	39	51	61	65	63	63	64	67	67	69	69	66	65	62	64	69	67	66	67	64
6:30 PM	67	66	67	66	66	66	66	65	65	64	67	67	67	67	67	66	63	63	61	54	58	60	62	62	63	64	63	66	67	67	66	66	66	66	66	65	67	67	71	64
6:45 PM	73	81	77	72	69	72	73	72	74	74	73	71	71	71	69	70	72	69	68	69	65	66	69	68	65	66	67	67	67	66	68	71	72	69	67	71	68	69	71	64

Wed 5/6/2015

3:00 PM	69	70	65	64	68	67	65	65	65	66	60	60	58	58	60	65	59	58	56	44	48	54	57	44	28	51	54	53	59	47	62	66	65	63	63	66	62	63	69	52
3:15 PM	63	70	67	64	61	59	62	62	64	65	66	66	64	63	61	57	57	21	38	36	47	56	59	32	40	55	61	63	63	60	62	62	66	68	64	66	67	64	66	44
3:30 PM	68	65	66	65	59	60	47	51	56	59	60	59	61	60	57	34	17	22	25	28	45	53	59	26	29	48	55	58	56	56	57	55	56	58	60	66	65	63	65	56
3:45 PM	63	66	68	66	55	60	60	60	60	60	60	53	27	18	24	18	31	20	29	31	44	55	56	38	24	39	52	57	59	56	60	61	69	69	68	71	71	67	66	57
4:00 PM	65	71	66	63	64	61	60	60	61	64	44	19	47	17	19	21	29	34	30	39	50	56	60	31	41	56	59	61	61	60	60	62	66	68	67	65	67	60		
4:15 PM	57	66	64	65	66	68	67	67	68	59	55	41	49	58	30	21	37	32	27	36	37	45	52	35	36	50	53	58	60	56	56	61	60	58	59	60	60	60	69	62
4:30 PM	66	70	71	70	68	65	65	67	67	68	67	66	65	64	43	29	19	24	33	33	45	49	58	55	55	51	37	49	59	54	59	63	65	65	67	71	68	67	69	57
4:45 PM	65	66	67	65	65	63	65	67	68	65	65	64	45	27	26	15	30	23	20	36	42	49	53	60	53	59	64	62	60	60	63	64	66	64	66	66	67	64	66	62
5:00 PM	61	64	64	64	61	63	65	65	66	65	59	23	48	17	11	15	25	17	24	33	45	56	61	60	47	54	58	58	55	42	50	61	62	65	65	68	64	61	63	54
5:15 PM	63	66	63	58	55	61	59	62	53	42	19	16	24	9	20	28	31	21	24	36	42	50	54	29	34	37	18	28	49	44	50	60	61	59	60	58	59	61	62	56
5:30 PM	63	63	68	69	69	70	69	65	58	22	30	54	58	62	49	33	43	21	23	32	48	42	48	31	36	48	55	57	62	59	58	67	62	62	64	67	64	67	64	69
5:45 PM	72	76	75	77	76	71	64	7	13	45	55	59	60	55	58	55	57	61	45	30	50	59	63	65	71	71	72	71	65	65	64	66	69	69	69	68	65	64	69	61
6:00 PM	67	71	68	71	70	72	68	65	65	66	63	63	64	64	60	58	59	61	66	68	62	66	65	60	60	58	65	68	69	73	69	65	66	70	67	67	66	67	68	65
6:15 PM	66	69	67	68	68	69	69	70	70	69	68	67	68	68	67	66	69	68	65	51	47	59	62	61	52	55	64	61	65	67	67	67	69	69	67	66	68	67	68	61
6:30 PM	63	66	67	68	67	66	70	70	69	67	69	67	66	65	63	66	67	67	60	59	61	60	51	54	63	66	65	65	65	65	67	66	65	68	66	68	67	61		
6:45 PM	70	75	75	73	71	72	75	74	74	74	72	69	71	73	72	72	70	70	67	69	68	68	68	65	67	67	68	69	68	67	67	70	71	71	68	74	71	71	69	61

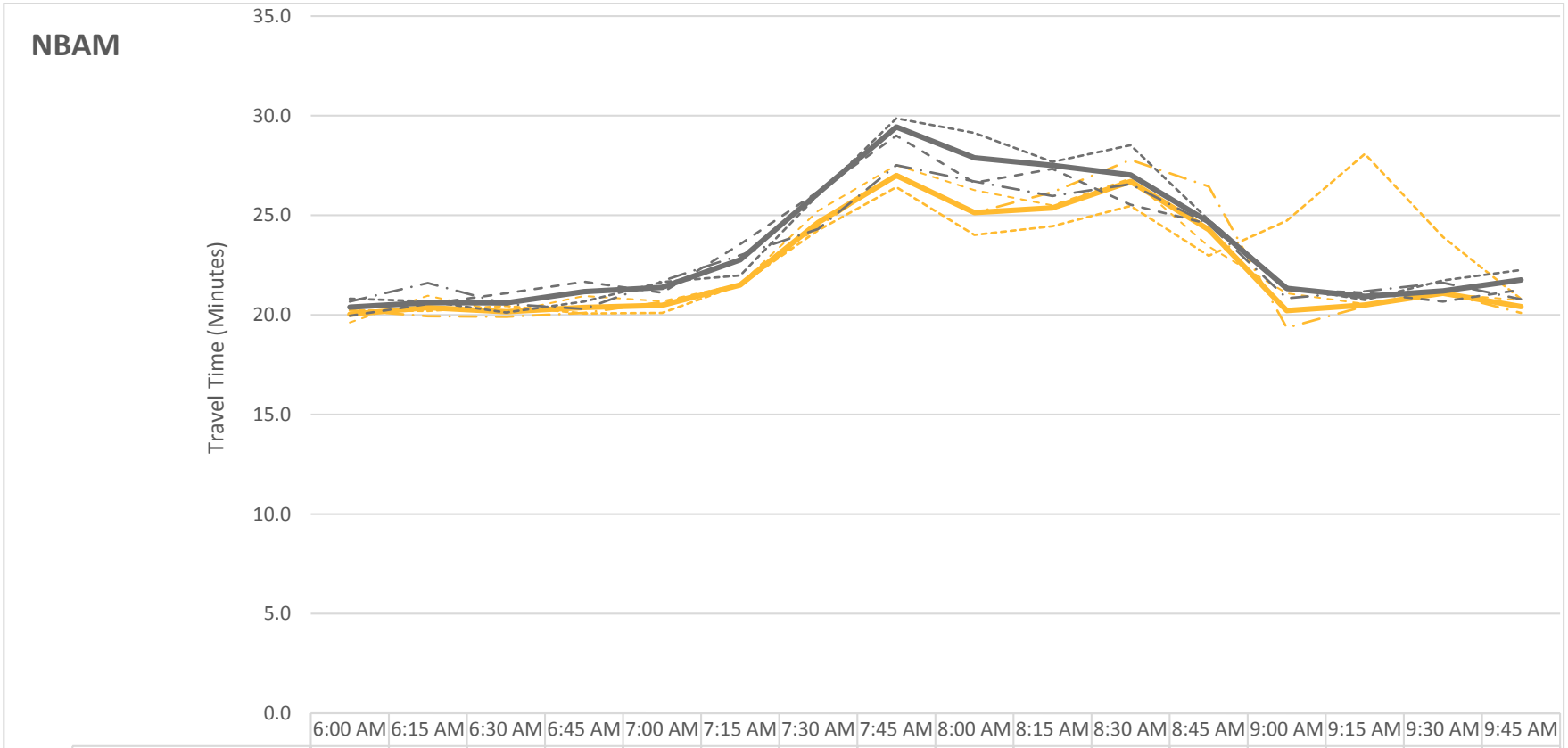
Thu 5/7/2015

3:00 PM	66	71	69	67	67	65	64	63	56	63	66	66	64	57	58	55	53	62	65	44	47	59	61	61	51	53	65	64	60	58	62	70	68	64	66	69	72	71	66	65
3:15 PM	66	65	66	67	63	62	63	67	68	66	60	53	60	60	63	59	50	55	47	25	49	59	65	66	66	59	63	67	62	47	57	61	62	68	67	67	68	68	65	60
3:30 PM	68	68	65	61	62	61	59	59	58	61	58	57	60	60	58	59	18	36	33	30	45	60	65	59	46	48	59	63	68	50	55	63	65	66	69	70	70	65	62	59
3:45 PM	64	69	70	67	66	70	67	63	65	65	60	43	36	36	14	25	23	20	25	37	48	54	57	25	33	48	58	66	65	61	63	60	57	62	67	71	69	70	67	57
4:00 PM	63	65	67	65	66	65	67	66	66	67	66	67	67	25	13	20	18	24	25	28	37	53	53	29	33	49	56	55	53	42	55	59	63	65	64	67	66	65	67	56
4:15 PM	61	64	63	60	61	64	63	63	65	67	60	44	33	16	17	17	22	22	25	33	49	57	19	20	31	49	61	53	58	60	60	63	69	69	69	64	62	63	66	63
4:30 PM	67	69	72	70	70	65	63	63	65	66	65	59	57	44	19	21	33	27	24	28	45	39	10	17	28	38	27	31	49	62	61	68	65	62	65	69	66	60	66	65
4:45 PM	51	59	66	66	66	63	64	64	65	65	60	56	55	19	24	14	25	22	35	31	45	50	19	13	31	43	53	61	62	59	63	61	65	60	62	65	61	62	63	63
5:00 PM	67	68	63	68	66	67	59	61	65	65	53	15	43	39	19	26	26	18	22	33	45	22	13	18	25	47	55	51	59	54	60	61	63	69	71	69	65	62	66	58
5:15 PM	63	68	62	59	56	61	40	36	24	19	27	14	46	66	48	26	18	15	32	30	46	34	20	16	31	40	51	54	64	62	59	62	63	65	67	68	69	67	68	58
5:30 PM	68	70	69	70	68	65	64	59	33	25	17	13	51	65	50	13	24	25	37	29	43	38	18	18	31	51	55	54	60	59	61	62	62	61	63	65	63	63	67	63
5:45 PM	67	65	68	67	68	67	71	69	70	60	21	19	47	62	61	55	59	27	22	29	51	56	65	33	40	44	52	52	56	57	61	63	65	64	65	70	65	62	68	66
6:00 PM	68	71	71	71	69	68	71	71	71	71	66	64	65	63	61	58	59	56	40	39	45	62	68	65	58	62	65	64	64	66	65	69	72	69	69	72	68	67	69	63
6:15 PM	66	66	68	69	68	69	71	72	72	74	72	71	73	71	65	63	61	65	65	68	65	66	69	65	69	68	69	70	68	62	62	66	71	69	68	68	70	69	67	64
6:30 PM	67	70	68	67	65	62	65	74	72	64	65	63	62	63	60	61	61	61	62	64	63	64	66	64	64	66	67	67	68	72	72	68	66	65	67	68	67	67	70	64
6:45 PM	66	68	74	77	77	75	71	73	72	72	73	72	71	73	72	70	70	71	72	68	65	69	69	69	68	69	70	70	70	72	72	71	72	72	73	77	72	69	69	63

Legend
Speed greater than 55 mph
Speed 45 to 55 mph
Speed 35 to 45 mph
Speed less than 35 mph

Data Source: Metro Traffic Data floating car runs during May 2015. | Faded cells were not used to develop the average of typical conditions. See *Deliverable 7.4: Visual Observations Memo* for more details.

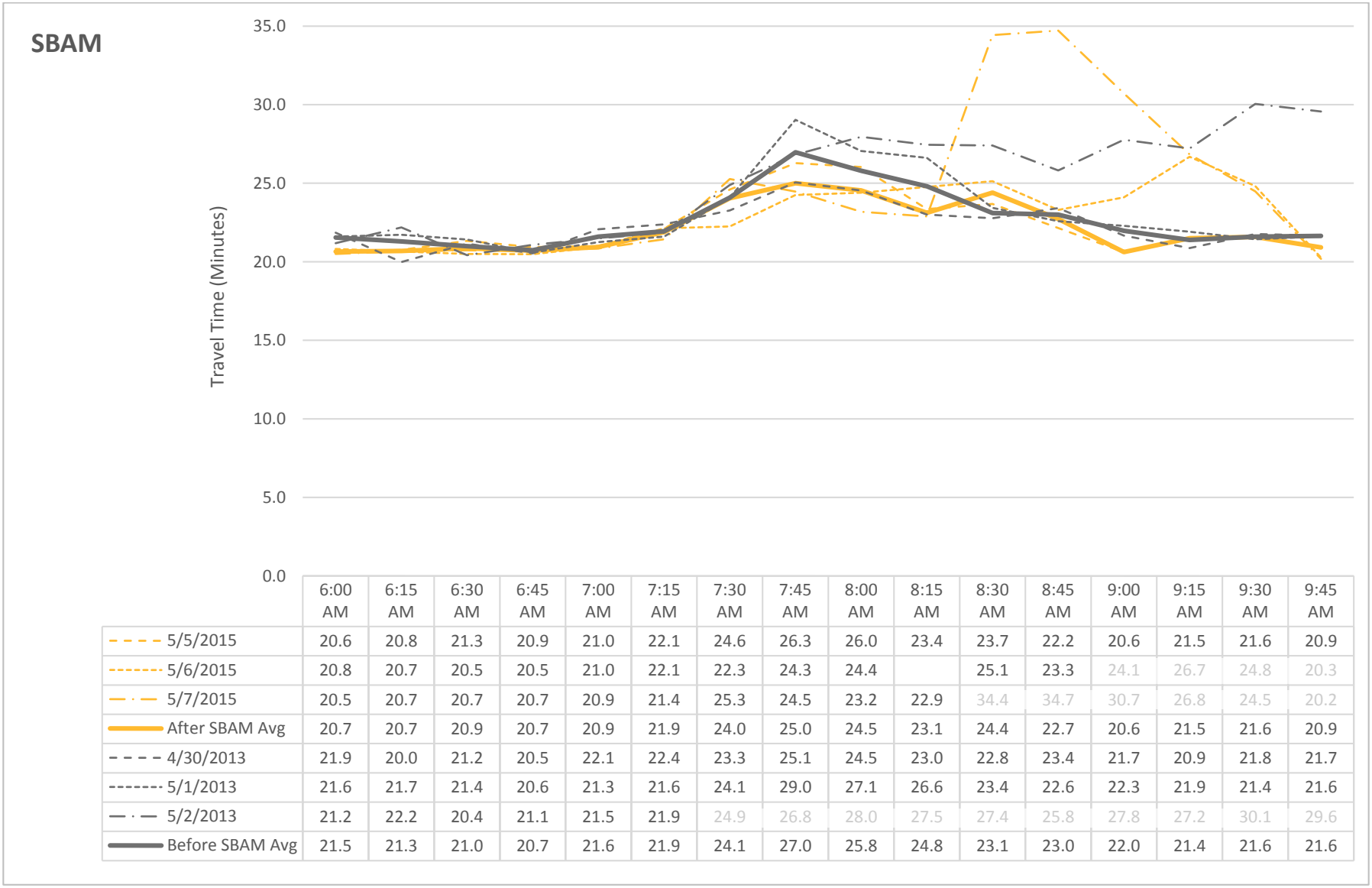
Appendix Exhibit D-10: Expanded Before and After Travel Times, Northbound, AM Peak Period



	6:00 AM	6:15 AM	6:30 AM	6:45 AM	7:00 AM	7:15 AM	7:30 AM	7:45 AM	8:00 AM	8:15 AM	8:30 AM	8:45 AM	9:00 AM	9:15 AM	9:30 AM	9:45 AM
5/5/2015	19.6	21.0	20.1	21.0	20.7	21.6	25.2	27.5	26.3	25.5	26.9	23.4	21.1	20.6	21.1	20.7
5/6/2015	20.2	20.2	20.5	20.1	20.1	21.5	24.3	26.4	24.0	24.5	25.5	23.0	24.7	28.1	23.9	20.8
5/7/2015	20.2	19.9	19.9	20.1	20.7	21.5	24.5	27.1	25.1	26.2	27.8	26.5	19.4	20.4	21.1	20.1
After NBAM Avg	20.0	20.4	20.2	20.4	20.5	21.5	24.6	27.0	25.1	25.4	26.7	24.3	20.2	20.5	21.1	20.4
4/30/2013	20.0	20.6	21.1	21.7	21.1	23.6	26.2	29.0	26.6	27.3	25.5	24.6	21.3	21.1	20.7	21.3
5/1/2013	20.8	20.7	20.1	20.7	21.7	22.0	26.0	29.9	29.1	27.7	28.5	24.8	21.4	20.8	21.7	22.3
5/2/2013	20.7	21.6	20.6	20.3	21.7	23.0	24.3	27.5	26.7	26.0	26.6	24.6	20.8	21.2	21.6	20.8
Before NBAM Avg	20.4	20.6	20.6	21.2	21.4	22.8	26.1	29.4	27.9	27.5	27.0	24.7	21.3	20.9	21.2	21.8

Data Source: Metro Traffic Data (2013 and 2015). Faded cells indicate times that were considered atypical due to incidents.

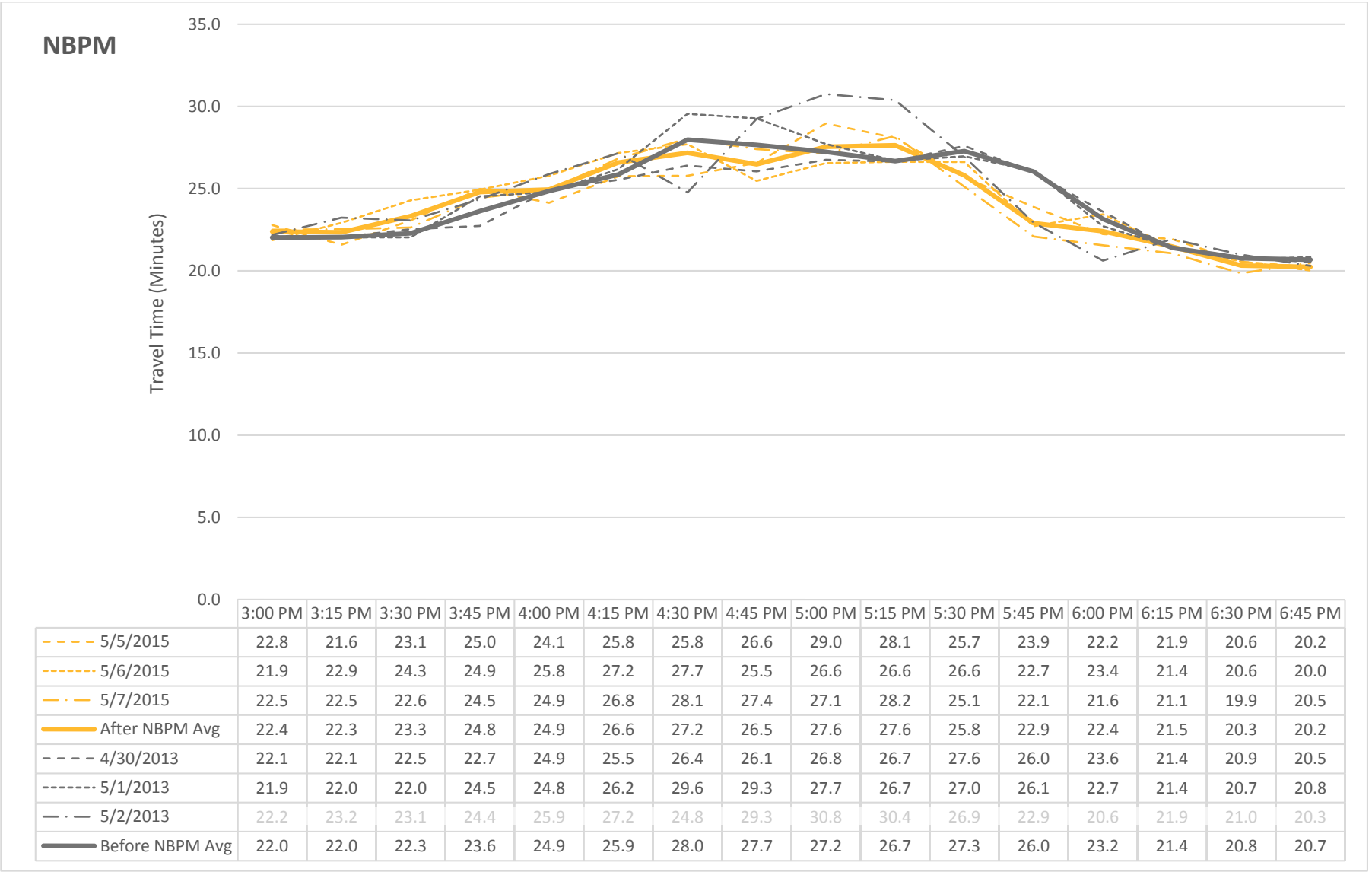
Appendix Exhibit D-11: Expanded Before and After Travel Times, Southbound, AM Peak Period



	6:00 AM	6:15 AM	6:30 AM	6:45 AM	7:00 AM	7:15 AM	7:30 AM	7:45 AM	8:00 AM	8:15 AM	8:30 AM	8:45 AM	9:00 AM	9:15 AM	9:30 AM	9:45 AM
5/5/2015	20.6	20.8	21.3	20.9	21.0	22.1	24.6	26.3	26.0	23.4	23.7	22.2	20.6	21.5	21.6	20.9
5/6/2015	20.8	20.7	20.5	20.5	21.0	22.1	22.3	24.3	24.4		25.1	23.3	24.1	26.7	24.8	20.3
5/7/2015	20.5	20.7	20.7	20.7	20.9	21.4	25.3	24.5	23.2	22.9	34.4	34.7	30.7	26.8	24.5	20.2
After SBAM Avg	20.7	20.7	20.9	20.7	20.9	21.9	24.0	25.0	24.5	23.1	24.4	22.7	20.6	21.5	21.6	20.9
4/30/2013	21.9	20.0	21.2	20.5	22.1	22.4	23.3	25.1	24.5	23.0	22.8	23.4	21.7	20.9	21.8	21.7
5/1/2013	21.6	21.7	21.4	20.6	21.3	21.6	24.1	29.0	27.1	26.6	23.4	22.6	22.3	21.9	21.4	21.6
5/2/2013	21.2	22.2	20.4	21.1	21.5	21.9	24.9	26.8	28.0	27.5	27.4	25.8	27.8	27.2	30.1	29.6
Before SBAM Avg	21.5	21.3	21.0	20.7	21.6	21.9	24.1	27.0	25.8	24.8	23.1	23.0	22.0	21.4	21.6	21.6

Data Source: Metro Traffic Data (2013 and 2015). Faded cells indicate times that were considered atypical due to incidents.

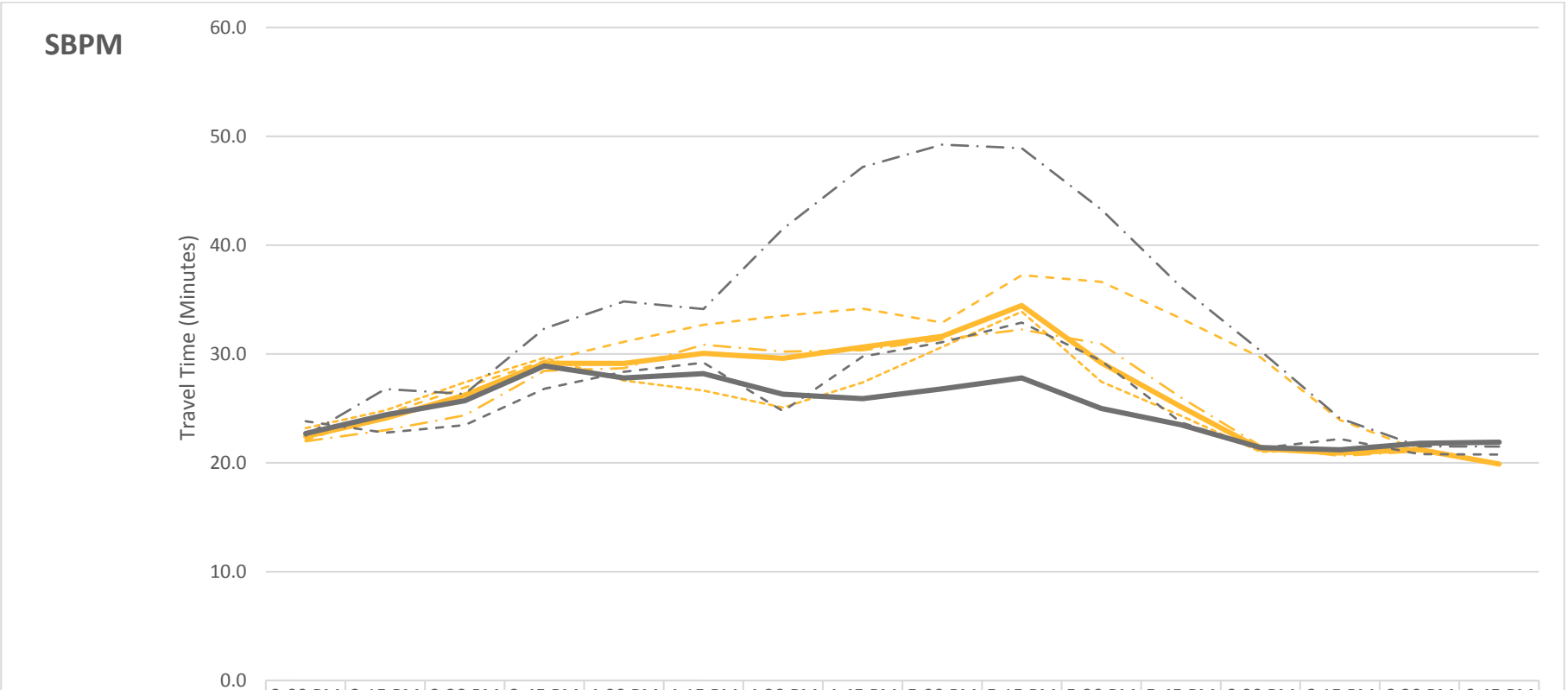
Appendix Exhibit D-12: Expanded Before and After Travel Times, Northbound, PM Peak Period



	3:00 PM	3:15 PM	3:30 PM	3:45 PM	4:00 PM	4:15 PM	4:30 PM	4:45 PM	5:00 PM	5:15 PM	5:30 PM	5:45 PM	6:00 PM	6:15 PM	6:30 PM	6:45 PM
5/5/2015	22.8	21.6	23.1	25.0	24.1	25.8	25.8	26.6	29.0	28.1	25.7	23.9	22.2	21.9	20.6	20.2
5/6/2015	21.9	22.9	24.3	24.9	25.8	27.2	27.7	25.5	26.6	26.6	26.6	22.7	23.4	21.4	20.6	20.0
5/7/2015	22.5	22.5	22.6	24.5	24.9	26.8	28.1	27.4	27.1	28.2	25.1	22.1	21.6	21.1	19.9	20.5
After NBPM Avg	22.4	22.3	23.3	24.8	24.9	26.6	27.2	26.5	27.6	27.6	25.8	22.9	22.4	21.5	20.3	20.2
4/30/2013	22.1	22.1	22.5	22.7	24.9	25.5	26.4	26.1	26.8	26.7	27.6	26.0	23.6	21.4	20.9	20.5
5/1/2013	21.9	22.0	22.0	24.5	24.8	26.2	29.6	29.3	27.7	26.7	27.0	26.1	22.7	21.4	20.7	20.8
5/2/2013	22.2	23.2	23.1	24.4	25.9	27.2	24.8	29.3	30.8	30.4	26.9	22.9	20.6	21.9	21.0	20.3
Before NBPM Avg	22.0	22.0	22.3	23.6	24.9	25.9	28.0	27.7	27.2	26.7	27.3	26.0	23.2	21.4	20.8	20.7

Data Source: Metro Traffic Data (2013 and 2015). Faded cells indicate times that were considered atypical due to incidents.

Appendix Exhibit D-13: Expanded Before and After Travel Times, Southbound, PM Peak Period



	3:00 PM	3:15 PM	3:30 PM	3:45 PM	4:00 PM	4:15 PM	4:30 PM	4:45 PM	5:00 PM	5:15 PM	5:30 PM	5:45 PM	6:00 PM	6:15 PM	6:30 PM	6:45 PM
5/5/2015	22.1	24.5	26.9	29.4	31.1	32.7	33.5	34.2	32.9	37.2	36.6	33.3	29.7	23.9	21.2	19.8
5/6/2015	23.2	24.8	27.4	29.7	27.6	26.6	25.1	27.4	30.7	33.9	27.5	24.3	21.0	21.2	21.4	20.0
5/7/2015	22.0	23.0	24.4	28.5	28.7	30.9	30.2	30.4	31.4	32.3	30.9	26.0	21.6	20.6	21.1	19.8
After SBPM Avg	22.4	24.1	26.2	29.2	29.1	30.1	29.6	30.6	31.6	34.5	29.2	25.2	21.3	20.9	21.2	19.9
4/30/2013	23.8	22.8	23.5	26.8	28.4	29.2	24.8	29.8	31.1	32.9	29.4	23.7	21.4	22.2	20.8	20.8
5/1/2013	22.7	24.4	25.7	28.9	27.8	28.2	26.3	25.9	26.8	27.8	25.0	23.5	21.4	21.2	21.8	21.9
5/2/2013	22.5	26.8	26.3	32.3	34.8	34.1	41.5	47.2	49.2	48.9	43.3	36.2	30.3	24.1	21.5	21.5
Before SBPM Avg	22.7	24.4	25.7	28.9	27.8	28.2	26.3	25.9	26.8	27.8	25.0	23.5	21.4	21.2	21.8	21.9

Data Source: Metro Traffic Data (2013 and 2015). Faded cells indicate times that were considered atypical due to incidents.
May 1, 2013 travel times were adjusted to be more representative of typical travel times based on INRIX data. See Appendix Exhibit D-1 for details.

Appendix Exhibit D-14: Before and After Speed Contours, Northbound, AM Peak Period

Before RM Avg.

Time	Old Redwood Highway WB On-ramp to Railroad Ave Off-ramp	Railroad Ave Off-ramp to Sierra Ave Off-ramp	Sierra Ave Off-ramp to SR 116 Off-ramp	SR 116 Off-ramp to SR 116 On-ramp	SR 116 On-ramp to Rohnert Park Expressway Off-ramp	Rohnert Park Expressway Off-ramp to Rohnert Park Expressway EB On-ramp	Rohnert Park Expressway EB On-ramp to Rohnert Park Expressway WB On-ramp	Rohnert Park Expressway WB On-ramp to Golf Course Drive Off-ramp	Golf Course Drive Off-ramp to Golf Course Drive On-ramp	Golf Course Drive On-ramp to Santa Rosa Ave Off-ramp	Santa Rosa Ave Off-ramp to Todd Road Off-ramp	Todd Road Off-ramp to Todd Road On-ramp	Todd Road On-ramp to Yolanda Ave Off-ramp	Yolanda Ave Off-ramp to Yolanda Ave On-ramp	Yolanda Ave On-ramp to Baker Ave Off-ramp	Baker Ave Off-ramp to Baker Ave On-ramp	Baker Ave On-ramp to SR 12 Off-ramp	SR 12 Off-ramp to 3rd Street Off-ramp	3rd Street Off-ramp to SR 12 On-ramp	SR 12 On-ramp to Morgan / 6th Street On-ramp	Morgan / 6th Street On-ramp to College Ave Off-ramp	College Ave Off-ramp to College Ave On-ramp	College Ave On-ramp to Steele Lane Off-ramp	Steele Lane Off-ramp to Steele Lane On-ramp	Steele Lane On-ramp to Bicentennial Way Off-ramp	Bicentennial Way Off-ramp to Mendocino Ave Off-ramp	Mendocino Ave Off-ramp to Mendocino Ave On-ramp	Mendocino Ave On-ramp to River Road Off-ramp	River Road Off-ramp to River Road EB On-ramp	River Road EB On-ramp to River Road WB On-ramp	River Road WB On-ramp to Fulton Rd Off-ramp	Fulton Rd Off-ramp to Fulton Rd On-ramp	Fulton Rd On-ramp to Airport Blvd Off-ramp	Airport Blvd Off-ramp to Airport Blvd On-ramp	Airport Blvd On-ramp to Shiloh Rd Off-ramp	Shiloh Rd Off-ramp to Shiloh EB On-ramp	Shiloh EB On-ramp to Shiloh WB On-ramp	Shiloh WB On-ramp to Old Redwood Highway Off-ramp	Old Redwood Highway Off-ramp to Old Redwood Highway On-ramp	Old Redwood Highway On-ramp to Arata Lane Off-ramp
Length	2.75	1.30	0.61	0.52	0.68	0.28	0.35	0.43	0.22	0.49	1.06	0.22	1.58	0.30	0.27	0.17	0.39	0.36	0.39	0.35	0.08	0.38	0.59	0.45	0.29	0.47	0.35	1.50	0.24	0.20	0.70	0.21	0.22	0.37	0.83	0.22	0.18	1.37	0.49	0.84
6:00 AM	66	68	67	66	68	65	66	66	66	65	67	64	67	64	65	65	65	66	68	68	68	67	67	66	68	67	67	68	70	72	71	67	67	66	69	66	67	69	66	62
6:15 AM	66	67	68	65	67	66	68	67	68	68	67	65	67	66	68	66	67	67	69	69	69	68	68	67	69	68	66	66	67	66	65	65	64	66	65	64	65	64	62	61
6:30 AM	69	70	68	68	69	68	68	68	67	66	67	64	66	67	66	66	63	65	66	63	63	61	62	65	66	67	65	65	68	69	66	67	67	68	67	61	61	63	64	63
6:45 AM	66	66	66	66	66	64	64	65	67	63	65	64	64	64	63	61	61	62	63	63	65	66	64	64	64	65	66	66	69	68	64	65	64	64	64	63	63	64	61	58
7:00 AM	65	65	66	65	67	65	64	65	62	59	63	63	61	60	62	61	60	60	62	65	65	65	65	63	64	63	64	63	63	65	65	66	67	65	66	64	65	66	62	61
7:15 AM	64	71	65	61	61	59	60	60	55	55	58	58	56	48	45	52	51	57	55	47	52	56	58	57	61	61	64	62	63	66	66	65	60	63	66	67	69	65	59	57
7:30 AM	64	63	63	61	47	59	54	50	51	56	49	52	28	22	29	38	49	53	42	40	48	55	60	60	62	62	63	63	62	64	64	57	51	57	64	57	58	64	65	61
7:45 AM	61	70	67	64	58	61	57	41	38	24	23	42	23	17	28	34	50	52	44	31	40	50	60	64	62	62	66	66	65	66	66	66	66	66	65	65	67	64	63	62
8:00 AM	64	68	66	65	64	65	61	62	62	53	26	33	23	25	34	44	49	47	30	35	44	53	56	62	63	64	67	63	66	64	63	63	62	65	64	64	64	65	62	59
8:15 AM	63	65	64	64	64	61	57	50	37	36	31	38	43	34	32	38	42	28	22	34	47	54	59	60	63	64	64	61	62	62	62	61	58	58	62	64	64	61	54	57
8:30 AM	63	67	67	63	62	62	60	54	41	27	33	49	33	24	29	35	50	36	26	37	47	55	63	67	68	68	67	63	65	66	66	65	64	66	64	61	64	63	63	63
8:45 AM	60	64	57	65	62	65	59	58	57	54	57	36	33	40	38	42	50	51	53	42	50	56	62	58	57	57	60	65	69	71	73	68	63	61	63	62	63	64	59	54
9:00 AM	67	65	64	65	64	64	62	63	64	62	62	58	61	62	63	63	62	60	63	60	62	63	64	63	63	63	65	65	65	66	67	66	66	67	66	64	65	65	64	60
9:15 AM	66	68	68	68	65	63	60	65	67	65	64	60	64	66	66	64	64	62	64	67	69	69	67	66	68	68	68	68	67	69	69	70	68	69	66	61	63	62	60	56
9:30 AM	65	66	68	68	67	65	66	66	66	63	63	62	61	61	63	63	62	64	65	66	65	66	64	62	61	62	63	64	65	64	65	64	63	64	66	66	66	66	64	62
9:45 AM	64	67	66	65	65	64	64	63	62	62	63	62	58	64	64	59	59	59	61	58	58	60	60	59	63	66	68	66	66	63	64	69	64	65	63	64	62	61	62	58

After RM Avg.

Time	Old Redwood Highway WB On-ramp to Railroad Ave Off-ramp	Railroad Ave Off-ramp to Sierra Ave Off-ramp	Sierra Ave Off-ramp to SR 116 Off-ramp	SR 116 Off-ramp to SR 116 On-ramp	SR 116 On-ramp to Rohnert Park Expressway Off-ramp	Rohnert Park Expressway Off-ramp to Rohnert Park Expressway EB On-ramp	Rohnert Park Expressway EB On-ramp to Rohnert Park Expressway WB On-ramp	Rohnert Park Expressway WB On-ramp to Golf Course Drive Off-ramp	Golf Course Drive Off-ramp to Golf Course Drive On-ramp	Golf Course Drive On-ramp to Santa Rosa Ave Off-ramp	Santa Rosa Ave Off-ramp to Todd Road Off-ramp	Todd Road Off-ramp to Todd Road On-ramp	Todd Road On-ramp to Yolanda Ave Off-ramp	Yolanda Ave Off-ramp to Yolanda Ave On-ramp	Yolanda Ave On-ramp to Baker Ave Off-ramp	Baker Ave Off-ramp to Baker Ave On-ramp	Baker Ave On-ramp to SR 12 Off-ramp	SR 12 Off-ramp to 3rd Street Off-ramp	3rd Street Off-ramp to SR 12 On-ramp	SR 12 On-ramp to Morgan / 6th Street On-ramp	Morgan / 6th Street On-ramp to College Ave Off-ramp	College Ave Off-ramp to College Ave On-ramp	College Ave On-ramp to Steele Lane Off-ramp	Steele Lane Off-ramp to Steele Lane On-ramp	Steele Lane On-ramp to Bicentennial Way Off-ramp	Bicentennial Way Off-ramp to Mendocino Ave Off-ramp	Mendocino Ave Off-ramp to Mendocino Ave On-ramp	Mendocino Ave On-ramp to River Road Off-ramp	River Road Off-ramp to River Road EB On-ramp	River Road EB On-ramp to River Road WB On-ramp	River Road WB On-ramp to Fulton Rd Off-ramp	Fulton Rd Off-ramp to Fulton Rd On-ramp	Fulton Rd On-ramp to Airport Blvd Off-ramp	Airport Blvd Off-ramp to Airport Blvd On-ramp	Airport Blvd On-ramp to Shiloh Rd Off-ramp	Shiloh Rd Off-ramp to Shiloh EB On-ramp	Shiloh EB On-ramp to Shiloh WB On-ramp	Shiloh WB On-ramp to Old Redwood Highway Off-ramp	Old Redwood Highway Off-ramp to Old Redwood Highway On-ramp	Old Redwood Highway On-ramp to Arata Lane Off-ramp
6:00 AM	67	67	66	66	69	70	68	68	66	67	68	68	69	68	69	68	67	68	71	71	69	70	68	69	68	70	70	69	68	70	69	68	69	71	68	67	68	68	65	62
6:15 AM	64	69	69	69	68	67	67	67	66	67	68	65	64	67	66	66	67	67	66	66	65	67	68	68	69	69	68	68	68	68	68	70	69	69	69	68	68	68	66	62
6:30 AM	66	71	71	68	68	68	67	68	67	66	69	67	67	66	67	67	68	69	70	69	66	67	66	66	69	69	68	65	66	67	67	66	67	70	71	71	71	69	66	64
6:45 AM	66	69	66	66	63	64	63	65	66	66	64	65	63	63	66	66	68	68	69	67	66	68	69	69	70	69	69	68	69	68	69	68	68	69	69	69	70	69	68	65
7:00 AM	67	71	68	66	68	69	67	69	66	66	66	63	62	62	62	61	61	61	66	67	65	67	66	67	67	67	67	66	69	69	70	69	69	71	70	67	69	69	67	60
7:15 AM	64	69	68	66	67	66	65	64	62	64	60	58	57	56	54	56	57	60	64	64	63	63	63	63	65	62	62	62	63	65	66	66	67	67	67	66	66	65	64	63
7:30 AM	63	66	65	65	65	66	65	48	59	64	37	52	43	28	31	40	49	44	29	35	44	56	60	61	66	63	65	61	66	63	61	57	66	69	66	67	68	68	68	62
7:45 AM	62	68	70	69	68	66	62	48	57	56	50	38	27	23	25	38	30	24	21	29	46	55	59	59	59	59	65	64	65	67	68	67	66	67	67	68	69	69	65	62
8:00 AM	62	69	67	67	65	64	64	68	68	65	61	64	37	21	25	34	34	32	27	34	42	53	59	61	62	62	64	64	64	64	66	66	70	65	63	65	63	61	59
8:15 AM	64	67	67	67	65	66	64	62	60	61	45	39	32	17	33	41	52	47	24	33	41	53	60	64	66	65	63	64	63	64	66	64	67	70	68	67	67	68	67	63
8:30 AM	62	68	66	67	63	66	63	64	63	43	45	19	25	30	29	33	47	46	27	35	42	50	62	61	62	63	64	64	64	65	66	66	66	67	67	68	69	62	58	56
8:45 AM	63	65	67	65	65	66	66	63	61	61	44	49	34	30	35	41	51	56	51	42	50	56	61	62	59	60	60	61	64	65	66	64	65	64	63	62	62	64	65	61
9:00 AM	68	71	68	70	69	70	69	68	68	67	65	62	65	65	64	61	63	65	67	64	63	67	66	66	65	69	69	70	72	72	70	70	71	72	69	68	68	67	65	62
9:15 AM	65	69	68	64	67	70	68	66	63	65	67	69	64	61	64	64	66	66	68	66	64	65	64	63	64	68	68	69	69	70	69	67	69	71	69	68	69	69	65	62
9:30 AM	64	67	66	64	64	64	64	65	64	62	64	64	66	67	67	65	60	63	67	65	65	66	65	64	65	68	65	65	67	64	65	62	64	68	69	69	65	63	59	59
9:45 AM	66	67	66	63	63	67	69	70	68	71	69	64	65	65	66	62	59	63	66	66	66	68	68	68	70	69	69	68	70	68	70	69	70	70	69	68	69	67	64	63

Arithmetic Difference

Time	Old Redwood Highway WB On-ramp to Railroad Ave Off-ramp	Railroad Ave Off-ramp to Sierra Ave Off-ramp	Sierra Ave Off-ramp to SR 116 Off-ramp	SR 116 Off-ramp to SR 116 On-ramp	SR 116 On-ramp to Rohnert Park Expressway Off-ramp	Rohnert Park Expressway Off-ramp to Rohnert Park Expressway EB On-ramp	Rohnert Park Expressway EB On-ramp to Rohnert Park Expressway WB On-ramp	Rohnert Park Expressway WB On-ramp to Golf Course Drive Off-ramp	Golf Course Drive Off-ramp to Golf Course Drive On-ramp	Golf Course Drive On-ramp to Santa Rosa Ave Off-ramp	Santa Rosa Ave Off-ramp to Todd Road Off-ramp	Todd Road Off-ramp to Todd Road On-ramp	Todd Road On-ramp to Yolanda Ave Off-ramp	Yolanda Ave Off-ramp to Yolanda Ave On-ramp	Yolanda Ave On-ramp to Baker Ave Off-ramp	Baker Ave Off-ramp to Baker Ave On-ramp	Baker Ave On-ramp to SR 12 Off-ramp	SR 12 Off-ramp to 3rd Street Off-ramp	3rd Street Off-ramp to SR 12 On-ramp	SR 12 On-ramp to Morgan / 6th Street On-ramp	Morgan / 6th Street On-ramp to College Ave Off-ramp	College Ave Off-ramp to College Ave On-ramp	College Ave On-ramp to Steele Lane Off-ramp	Steele Lane Off-ramp to Steele Lane On-ramp	Steele Lane On-ramp to Bicentennial Way Off-ramp	Bicentennial Way Off-ramp to Mendocino Ave Off-ramp	Mendocino Ave Off-ramp to Mendocino Ave On-ramp	Mendocino Ave On-ramp to River Road Off-ramp	River Road Off-ramp to River Road EB On-ramp	River Road EB On-ramp to River Road WB On-ramp	River Road WB On-ramp to Fulton Rd Off-ramp	Fulton Rd Off-ramp to Fulton Rd On-ramp	Fulton Rd On-ramp to Airport Blvd Off-ramp	Airport Blvd Off-ramp to Airport Blvd On-ramp	Airport Blvd On-ramp to Shiloh Rd Off-ramp	Shiloh Rd Off-ramp to Shiloh EB On-ramp	Shiloh EB On-ramp to Shiloh WB On-ramp	Shiloh WB On-ramp to Old Redwood Highway Off-ramp	Old Redwood Highway Off-ramp to Old Redwood Highway On-ramp	Old Redwood Highway On-ramp to Arata Lane Off-ramp
6:00 AM	1	0	-2	0	1	5	2	2	0	1	1	4	2	3	4	3	3	3	3	3	2	2	2	2	0	3	3	1	-2	-2	-2	0	2	5	-1	1	0	-1	0	0
6:15 AM	-1	2	1	4	0	2	0	0	-2	-1	1	1	-3	1	-1	0	0	-1	-3	-3	-4	-1	0	1	0	1	2	2	1	2	3	5	5	3	4	4	3	4	4	1
6:30 AM	-3	1	3	1	-1	0	-1	0	0	0	2	3	1	-1	0	2	5	4	4	6	4	6	4	1	2	3	3	0	-3	-2	1	-1	0	2	4	10	10	6	2	2
6:45 AM	0	4	0	0	-3	0	-1	0	-1	3	-1	1	-1	0	3	5	7	7	6	4	1	1	5	5	6	4	3	2	1	0	5	3	5	5	6	6	6	5	7	7
7:00 AM	2	5	2	0	0	3	3	4	4	7	4	1	1	1	0	1	0	1	4	1	0	1	1	4	3	4	3	4	6	4	5	4	2	6	4	3	4	3	4	-1
7:15 AM	0	-2	3	6	6	7	5	5	8	9	2	0	1	8	9	4	6	3	9	17	11	8	5	6	4	1	-2	0	0	-2	0	1	6	4	1	-1	-3	1	5	7
7:30 AM	-1	4	2	5	18	7	11	-2	7	8	-12	0	15	6	2	3	-1	-9	-13	-5	-4	1	0	1	4	2	2	-2	5	0	-3	1	15	12	2	11	9	3	3	1
7:45 AM	1	-2	3	5	10	6	5	7	19	32	27	-5	4	6	-3	4	-20	-28	-24	-2	6	6	-1	-5	-3	-3	-1	-2	-1	0	2	1	0	1	2	2	2	5	1	-1
8:00 AM	-2	1	1	1	1	-1	3	6	6	12	34	31	14	-4	-8	-9	-16	-15	-3	-1	-3	-1	4	-1	-2	-2	-3	1	-4	0	1	3	5	5	1	-1	1	-2	-2	0
8:15 AM	1	2	3	3	1	5	7	12	23	25	14	1	-11	-18	1	4	10	19	2	-1	-6	-1	1	4	3	1	-1	2	1	2	4	3	9	12	6	3	3	7	12	6
8:30 AM	0	0	0	3	1	4	3	10	22	16	13	-29	-7	5	0	-2	-4	10	1	-2	-5	-5	-1	-6	-6	-4	-3	1	-2	-1	0	2	2	1	3	7	5	-1	-5	-6
8:45 AM	3	1	9	1	3	1	6	5	4	7	-13	14	1	-9	-3	-2	1	5	-1	0	0	1	-1	4	2	3	0	-3	-4	-6	-7	-3	2	3	0	-1	-1	0	5	7
9:00 AM	1	6	4	5	5	7	7	5	4	5	3	5	4	3	1	-2	2	5	4	4	1	4	2	3	2	5	4	5	7	6	3	3	6	4	3	5	4	2	1	2
9:15 AM	-1	1	0	-4	2	7	8	1	-4	1	3	8	1	-4	-3	0	2	5	4	-1	-5	-3	-4	-2	-4	0	0	1	1	1	0	-2	1	2	3	7	6	6	6	6
9:30 AM	-1	2	-3	-4	-3	-2	-2	-1	-2	-1	1	2	6	6	4	2	-2	-1	2	-1	0	1	1	2	4	6	2	1	2	0	0	-2	1	3	4	4	-1	-3	-4	-3
9:45 AM	2	-1	0	-2	-2	3	4	6	6	9	6	3	7	1	3	3	0	4	6	9	7	8	8	9	7	3	1	2	4	5	6	0	6	5	6	4	7	6	2	6

Legend
Speed increases 20+ mph
Speed constant
Speed decreases 20+ mph

Legend
Speed greater than 55 mph
Speed 45 to 55 mph
Speed 35 to 45 mph
Speed less than 35 mph

Data Source: Metro Traffic Data (2013 and 2015). Average speeds derived from typical conditions.

Appendix Exhibit D-15: Before and After Speed Contours, Southbound, AM Peak Period

Before RM Avg.

Time	Arata Lane On-ramp to Old Redwood Highway Off-ramp	Old Redwood Highway Off-ramp to Old Redwood Highway On-ramp	Old Redwood Highway On-ramp to Shiloh Road Off-ramp	Shiloh Road Off-ramp to Shiloh WB On-ramp	Shiloh WB On-ramp to Shiloh EB On-ramp	Shiloh EB On-ramp to Airport Blvd Off-ramp	Airport Blvd Off-ramp to Airport Blvd On-ramp	Airport Blvd On-ramp to Fulton Road Off-ramp	Fulton Road Off-ramp to Fulton Road On-ramp	Fulton Road On-ramp to River Road Off-ramp	River Road Off-ramp to River Road WB On-ramp	River Road WB On-ramp to River Road On-ramp	River Road On-ramp to Hopper Ave Off-ramp	Hopper Ave Off-ramp to Hopper Ave On-ramp	Hopper Ave On-ramp to Mendocino Ave On-ramp	Mendocino Ave On-ramp to Bicentennial Way On-ramp	Bicentennial Way On-ramp to Guerneville Road Off-ramp	Guerneville Road Off-ramp to Guerneville Road On-ramp	Guerneville Road On-ramp to College Ave Off-ramp	College Ave Off-ramp to College Ave On-ramp	College Ave On-ramp to Downtown Off-ramp	Downtown Off-ramp to SR 12 Off-ramp	SR 12 Off-ramp to 3rd Street On-ramp	3rd Street On-ramp to SR 12 On-ramp	SR 12 On-ramp to Baker Ave Off-ramp	Baker Ave Off-ramp to Baker Ave On-ramp	Baker Ave On-ramp to Corby Ave Off-ramp	Corby Ave Off-ramp to Corby Ave On-ramp	Corby Ave On-ramp to Todd Road Off-ramp	Todd Road Off-ramp to Todd Road On-ramp	Todd Road On-ramp to Golf Course Drive Off-ramp	Golf Course Drive Off-ramp to Golf Course Drive On-ramp	Golf Course Drive On-ramp to Rohnert Park Expressway Off-ramp	Rohnert Park Expressway Off-ramp to Rohnert Park Expressway WB On-ramp	Rohnert Park Expressway WB On-ramp to Rohnert Park Expressway EB On-ramp	Rohnert Park Expressway EB On-ramp to SR 116 Off-ramp	SR 116 Off-ramp to SR 116 On-ramp	SR 116 On-ramp to Sierra Ave On-ramp	Sierra Ave On-ramp to Pepper Road On-ramp	Pepper Road On-ramp to Old Redwood Highway Off-ramp
Length	1.38	0.45	1.30	0.21	0.16	0.93	0.33	0.17	0.20	0.72	0.22	0.20	1.30	0.28	0.36	0.45	0.24	0.64	0.47	0.41	0.12	0.33	0.34	0.42	0.40	0.15	0.26	0.23	1.59	0.17	1.05	0.83	0.64	0.20	0.18	0.75	0.51	0.64	2.97	1.04
6:00 AM	62	67	66	67	67	66	64	64	64	65	65	64	64	63	64	63	65	64	65	64	63	65	65	64	64	65	64	64	66	65	64	65	65	64	65	66	65	63	65	63
6:15 AM	63	66	66	65	66	66	64	65	67	68	68	68	66	65	66	64	66	66	68	67	66	68	68	67	65	65	66	66	67	65	63	64	66	66	67	68	67	67	66	66
6:30 AM	64	66	69	65	65	67	71	70	70	69	69	69	69	65	68	70	67	67	67	63	63	67	68	65	64	65	67	69	67	64	62	65	71	69	68	68	64	63	65	62
6:45 AM	64	67	68	68	67	68	68	67	66	69	68	68	68	66	65	65	67	66	66	66	64	64	67	67	67	65	64	66	67	67	67	66	66	68	69	70	69	70	69	67
7:00 AM	65	63	69	68	66	67	66	66	67	69	69	69	69	68	67	67	66	65	67	64	66	68	68	64	64	63	64	64	63	61	61	63	64	64	64	66	66	65	58	59
7:15 AM	65	65	68	66	65	64	63	64	66	67	66	63	65	64	66	66	67	65	63	63	59	61	65	63	58	59	63	62	63	65	63	63	63	61	63	62	62	63	62	60
7:30 AM	64	66	68	65	65	66	62	61	65	66	66	59	60	64	63	62	60	50	59	57	51	57	54	22	31	46	56	57	60	60	61	64	62	66	68	67	64	59	63	65
7:45 AM	63	65	63	65	63	61	61	58	62	55	53	32	45	56	41	43	48	47	61	57	50	57	30	23	31	41	53	47	49	56	58	64	65	62	63	65	65	62	64	57
8:00 AM	64	63	66	65	65	64	64	63	65	67	66	62	63	58	43	46	51	47	52	56	51	57	58	28	25	42	50	44	49	60	57	60	63	67	67	68	64	60	62	54
8:15 AM	63	67	68	67	68	69	67	66	67	60	53	57	58	63	64	59	55	52	60	55	55	48	45	24	37	50	56	58	59	59	60	63	63	64	63	65	66	66	56	60
8:30 AM	68	69	65	64	62	61	62	58	59	62	59	52	60	62	61	60	61	64	62	61	62	65	48	42	35	40	53	57	63	65	64	64	66	66	65	67	69	65	67	57
8:45 AM	65	66	66	66	65	68	68	66	58	56	51	46	54	63	62	61	61	58	61	62	63	66	65	52	49	54	60	64	63	63	61	63	64	63	62	63	63	62	65	64
9:00 AM	65	67	68	68	68	68	69	69	67	65	67	67	65	63	62	62	65	63	63	62	62	66	65	63	61	58	61	61	61	60	62	64	66	65	64	66	64	65	64	61
9:15 AM	65	66	66	67	66	65	64	63	66	65	66	66	65	65	65	65	66	66	67	65	65	66	67	64	59	61	64	64	65	65	64	66	67	64	65	66	65	65	66	61
9:30 AM	67	65	68	68	69	68	67	67	65	66	61	58	65	65	63	60	62	64	63	62	62	65	63	64	60	61	65	68	67	68	65	61	66	66	66	69	65	63	64	57
9:45 AM	66	67	69	68	66	63	62	61	62	66	68	67	66	64	65	65	64	62	60	60	53	59	62	61	60	62	62	63	66	66	65	67	65	64	64	66	63	64	65	60

After RM Avg.

Time	Arata Lane On-ramp to Old Redwood Highway Off-ramp	Old Redwood Highway Off-ramp to Old Redwood Highway On-ramp	Old Redwood Highway On-ramp to Shiloh Road Off-ramp	Shiloh Road Off-ramp to Shiloh WB On-ramp	Shiloh WB On-ramp to Shiloh EB On-ramp	Shiloh EB On-ramp to Airport Blvd Off-ramp	Airport Blvd Off-ramp to Airport Blvd On-ramp	Airport Blvd On-ramp to Fulton Road Off-ramp	Fulton Road Off-ramp to Fulton Road On-ramp	Fulton Road On-ramp to River Road Off-ramp	River Road Off-ramp to River Road WB On-ramp	River Road WB On-ramp to River Road On-ramp	River Road On-ramp to Hopper Ave Off-ramp	Hopper Ave Off-ramp to Hopper Ave On-ramp	Hopper Ave On-ramp to Mendocino Ave On-ramp	Mendocino Ave On-ramp to Bicentennial Way On-ramp	Bicentennial Way On-ramp to Guerneville Road Off-ramp	Guerneville Road Off-ramp to Guerneville Road On-ramp	Guerneville Road On-ramp to College Ave Off-ramp	College Ave Off-ramp to College Ave On-ramp	College Ave On-ramp to Downtown Off-ramp	Downtown Off-ramp to SR 12 Off-ramp	SR 12 Off-ramp to 3rd Street On-ramp	3rd Street On-ramp to SR 12 On-ramp	SR 12 On-ramp to Baker Ave Off-ramp	Baker Ave Off-ramp to Baker Ave On-ramp	Baker Ave On-ramp to Corby Ave Off-ramp	Corby Ave Off-ramp to Corby Ave On-ramp	Corby Ave On-ramp to Todd Road Off-ramp	Todd Road Off-ramp to Todd Road On-ramp	Todd Road On-ramp to Golf Course Drive Off-ramp	Golf Course Drive Off-ramp to Golf Course Drive On-ramp	Golf Course Drive On-ramp to Rohnert Park Expressway Off-ramp	Rohnert Park Expressway Off-ramp to Rohnert Park Expressway WB On-ramp	Rohnert Park Expressway WB On-ramp to Rohnert Park Expressway EB On-ramp	Rohnert Park Expressway EB On-ramp to SR 116 Off-ramp	SR 116 Off-ramp to SR 116 On-ramp	SR 116 On-ramp to Sierra Ave On-ramp	Sierra Ave On-ramp to Pepper Road On-ramp	Pepper Road On-ramp to Old Redwood Highway Off-ramp
6:00 AM	63	68	70	71	70	70	70	70	71	69	69	68	69	69	69	67	64	68	68	67	66	67	70	68	68	67	69	68	68	66	66	67	68	69	70	68	67	66	67	62
6:15 AM	64	69	69	67	68	70	69	68	68	67	67	67	68	68	66	67	66	67	68	68	68	67	67	68	68	68	67	69	69	67	65	68	69	69	69	69	66	67	67	63
6:30 AM	64	67	70	69	68	68	69	70	69	69	70	68	68	66	67	65	64	65	68	68	67	67	68	67	66	66	67	66	67	69	67	65	66	65	65	68	68	68	68	57
6:45 AM	70	68	70	70	68	69	69	70	69	70	72	70	68	70	71	70	68	69	68	67	66	68	71	71	67	65	66	65	65	65	66	68	68	67	66	68	69	69	66	57
7:00 AM	62	65	69	68	68	69	68	69	69	69	70	68	69	68	67	67	64	68	69	67	64	66	66	64	63	63	65	65	67	66	67	68	67	65	66	67	68	66	66	64
7:15 AM	68	70	70	69	69	63	62	65	64	66	63	62	63	64	65	64	62	60	59	60	63	65	66	65	49	54	58	61	62	64	63	64	69	66	64	65	64	60	65	59
7:30 AM	66	70	68	64	65	60	64	64	61	60	63	61	60	64	59	60	63	64	49	46	48	57	62	42	41	50	59	53	60	59	63	66	66	64	64	58	62	60	57	37
7:45 AM	65	64	66	60	61	60	62	63	56	47	50	40	54	51	33	39	44	49	40	37	46	57	61	38	44	53	54	48	55	53	57	63	68	64	62	65	67	64	66	60
8:00 AM	66	68	69	67	66	62	61	60	59	60	50	48	59	62	52	38	47	51	54	47	52	59	59	35	37	36	48	56	51	57	53	63	64	64	64	65	64	60	62	57
8:15 AM	64	68	68	65	65	65	62	64	65	60	58	60	63	66	62	59	63	66	69	67	60	67	56	33	42	22	46	51	63	58	56	63	65	66	64	63	67	64	64	55
8:30 AM	68	70	67	25	28	47	60	59	61	63	62	58	63	66	64	65	65	62	60	58	58	51	48	19	31	48	56	59	60	64	65	64	65	65	64	66	68	69	65	61
8:45 AM	66	72	69	70	68	63	65	64	66	65	56	50	56	53	29	50	52	57	62	62	60	62	64	52	36	54	61	64	65	67	63	62	68	67	65	67	69	69	67	61
9:00 AM	67	70	72	71	68	68	70	71	72	73	71	70	71	68	66	66	66	69	72	65	63	65	68	66	64	65	65	64	64	64	65	68	69	69	69	71	69	66	67	62
9:15 AM	60	59	67	62	63	67	63	64	62	69	72	70	72	72	73	73	71	73	66	64	67	69	72	67	62	63	65	68	65	66	62	63	65	63	65	68	64	63	59	62
9:30 AM	61	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	63	64	64	63	62	61	61	67	66	64	65	65	65	65	65	65	65	67	62
9:45 AM	66	69	70	69	69	69	69	69	70	69	69	68	68	64	63	59	61	66	64	60	62	65	66	66	64	64	65	65	68	65	60	65	69	68	69	68	67	66	69	67

Arithmetic Difference

Time	Arata Lane On-ramp to Old Redwood Highway Off-ramp	Old Redwood Highway Off-ramp to Old Redwood Highway On-ramp	Old Redwood Highway On-ramp to Shiloh Road Off-ramp	Shiloh Road Off-ramp to Shiloh WB On-ramp	Shiloh WB On-ramp to Shiloh EB On-ramp	Shiloh EB On-ramp to Airport Blvd Off-ramp	Airport Blvd Off-ramp to Airport Blvd On-ramp	Airport Blvd On-ramp to Fulton Road Off-ramp	Fulton Road Off-ramp to Fulton Road On-ramp	Fulton Road On-ramp to River Road Off-ramp	River Road Off-ramp to River Road WB On-ramp	River Road WB On-ramp to River Road On-ramp	River Road On-ramp to Hopper Ave Off-ramp	Hopper Ave Off-ramp to Hopper Ave On-ramp	Hopper Ave On-ramp to Mendocino Ave On-ramp	Mendocino Ave On-ramp to Bicentennial Way On-ramp	Bicentennial Way On-ramp to Guerneville Road Off-ramp	Guerneville Road Off-ramp to Guerneville Road On-ramp	Guerneville Road On-ramp to College Ave Off-ramp	College Ave Off-ramp to College Ave On-ramp	College Ave On-ramp to Downtown Off-ramp	Downtown Off-ramp to SR 12 Off-ramp	SR 12 Off-ramp to 3rd Street On-ramp	3rd Street On-ramp to SR 12 On-ramp	SR 12 On-ramp to Baker Ave Off-ramp	Baker Ave Off-ramp to Baker Ave On-ramp	Baker Ave On-ramp to Corby Ave Off-ramp	Corby Ave Off-ramp to Corby Ave On-ramp	Corby Ave On-ramp to Todd Road Off-ramp	Todd Road Off-ramp to Todd Road On-ramp	Todd Road On-ramp to Golf Course Drive Off-ramp	Golf Course Drive Off-ramp to Golf Course Drive On-ramp	Golf Course Drive On-ramp to Rohnert Park Expressway Off-ramp	Rohnert Park Expressway Off-ramp to Rohnert Park Expressway WB On-ramp	Rohnert Park Expressway WB On-ramp to Rohnert Park Expressway EB On-ramp	Rohnert Park Expressway EB On-ramp to SR 116 Off-ramp	SR 116 Off-ramp to SR 116 On-ramp	SR 116 On-ramp to Sierra Ave On-ramp	Sierra Ave On-ramp to Pepper Road On-ramp	Pepper Road On-ramp to Old Redwood Highway Off-ramp
6:00 AM	2	1	4	4	3	4	6	6	6	4	4	4	5	6	6	3	0	3	3	3	3	2	5	4	3	3	5	4	2	1	1	2	3	5	4	2	2	3	2	-1
6:15 AM	2	3	3	2	2	3	4	3	1	-1	-1	-1	1	3	0	3	0	1	0	0	2	0	2	0	2	3	1	3	2	2	2	4	2	2	2	1	-1	-1	1	-3
6:30 AM	0	0	1	4	3	1	-1	0	0	0	1	-1	-1	2	-1	-5	-3	-2	0	5	4	0	0	2	2	1	-1	-3	0	4	4	0	-4	-4	-2	1	4	5	3	-5
6:45 AM	6	2	2	3	2	1	1	3	3	2	4	2	0	4	5	5	1	2	2	1	2	4	4	4	0	-1	2	-1	-2	-2	-1	1	2	-1	-2	-2	0	-1	-3	-11
7:00 AM	-3	2	-1	1	2	1	3	3	1	0	1	-1	-1	0	0	0	-2	2	2	3	-2	-3	-2	0	-1	-1	1	0	4	5	6	5	3	2	3	0	1	0	9	5
7:15 AM	3	5	3	4	3	-1	-2	1	-2	-1	-3	-1	-2	0	0	-2	-5	-5	-4	-4	4	4	0	1	-9	-5	-5	-1	-1	-1	0	1	6	5	1	3	1	-3	3	-1
7:30 AM	2	3	0	-1	0	-6	2	3	-3	-6	-3	2	0	0	-4	-2	3	14	-9	-11	-2	0	9	20	11	4	3	-4	0	-2	2	3	5	-1	-3	-9	-3	1	-7	-28
7:45 AM	1	-2	3	-4	-2	-1	2	5	-6	-8	-3	8	9	-5	-8	-5	-5	2	-21	-20	-4	0	31	15	13	12	1	0	6	-3	-1	-1	3	2	0	0	2	1	3	3
8:00 AM	2	5	3	2	1	-2	-3	-3	-6	-6	-16	-14	-5	4	9	-7	-4	3	2	-10	1	2	1	6	12	-6	-2	12	2	-3	-4	3	1	-3	-3	-3	0	0	0	2
8:15 AM	1	1	0	-1	-3	-3	-5	-3	-1	0	5	2	5	3	-2	0	9	14	9	12	5	19	12	9	5	-28	-10	-7	4	-1	-4	0	2	2	1	-2	1	-2	8	-5
8:30 AM	0	1	2	-39	-34	-14	-2	1	2	1	3	6	4	4	3	5	5	-1	-2	-3	-3	-14	0	-22	-3	9	3	2	-3	0	1	0	-1	-1	0	-1	-1	4	-2	3
8:45 AM	1	6	3	3	3	-5	-2	-2	8	8	5	4	2	-10	-34	-11	-10	0	1	0	-4	-4	-1	0	-12	0	1	1	2	4	2	-1	3	4	3	3	6	6	2	-3
9:00 AM	2	3	4	3	0	0	1	2	5	8	4	4	6	6	4	4	1	6	9	4	0	-2	3	3	3	6	5	3	3	4	3	5	3	4	5	5	5	2	3	1
9:15 AM	-5	-8	1	-5	-3	2	-1	0	-3	4	6	4	7	7	8	8	5	7	-1	-1	2	4	4	2	3	2	1	3	0	1	-1	-3	-2	-1	0	2	0	-3	-6	1
9:30 AM	-6	-1	-5	-4	-5	-3	-3	-2	-1	-1	3	6	-1	-1	1	4	3	0	1	2	-2	-2	1	1	3	1	-4	-6	1	-1	-1	4	-1	0	-1	-4	1	2	2	5
9:45 AM	0	2	1	1	2	6	7	7	7	3	1	1	2	0	-2	-6	-3	3	4	1	8	6	4	4	4	3	3	3	2	-1	-5	-2	4	3	5	2	4	2	4	7

Legend
Speed increases 20+ mph
Speed constant
Speed decreases 20+ mph

Legend
Speed greater than 55 mph
Speed 45 to 55 mph
Speed 35 to 45 mph
Speed less than 35 mph

Data Source: Metro Traffic Data (2013 and 2015). Average speeds derived from typical conditions.

Appendix Exhibit D-16: Before and After Speed Contours, Northbound, PM Peak Period

Before RM Avg.

Time	Old Redwood Highway WB On-ramp to Railroad Ave Off-ramp	Railroad Ave Off-ramp to Sierra Ave Off-ramp	Sierra Ave Off-ramp to SR 116 Off-ramp	SR 116 Off-ramp to SR 116 On-ramp	SR 116 On-ramp to Rohnert Park Expressway Off-ramp	Rohnert Park Expressway Off-ramp to Rohnert Park Expressway EB On-ramp	Rohnert Park Expressway EB On-ramp to Rohnert Park Expressway WB On-ramp	Rohnert Park Expressway WB On-ramp to Golf Course Drive Off-ramp	Golf Course Drive Off-ramp to Golf Course Drive On-ramp	Golf Course Drive On-ramp to Santa Rosa Ave Off-ramp	Santa Rosa Ave Off-ramp to Todd Road Off-ramp	Todd Road Off-ramp to Todd Road On-ramp	Todd Road On-ramp to Yolanda Ave Off-ramp	Yolanda Ave Off-ramp to Yolanda Ave On-ramp	Yolanda Ave On-ramp to Baker Ave Off-ramp	Baker Ave Off-ramp to Baker Ave On-ramp	Baker Ave On-ramp to SR 12 Off-ramp	SR 12 Off-ramp to 3rd Street Off-ramp	3rd Street Off-ramp to SR 12 On-ramp	SR 12 On-ramp to Morgan / 6th Street On-ramp	Morgan / 6th Street On-ramp to College Ave Off-ramp	College Ave Off-ramp to College Ave On-ramp	College Ave On-ramp to Steele Lane Off-ramp	Steele Lane Off-ramp to Steele Lane On-ramp	Steele Lane On-ramp to Bicentennial Way Off-ramp	Bicentennial Way Off-ramp to Mendocino Ave Off-ramp	Mendocino Ave Off-ramp to Mendocino Ave On-ramp	Mendocino Ave On-ramp to River Road Off-ramp	River Road Off-ramp to River Road EB On-ramp	River Road EB On-ramp to River Road WB On-ramp	River Road WB On-ramp to Fulton Rd Off-ramp	Fulton Rd Off-ramp to Fulton Rd On-ramp	Fulton Rd On-ramp to Airport Blvd Off-ramp	Airport Blvd Off-ramp to Airport Blvd On-ramp	Airport Blvd On-ramp to Shiloh Rd Off-ramp	Shiloh Rd Off-ramp to Shiloh EB On-ramp	Shiloh EB On-ramp to Shiloh WB On-ramp	Shiloh WB On-ramp to Old Redwood Highway Off-ramp	Old Redwood Highway Off-ramp to Old Redwood Highway On-ramp	Old Redwood Highway On-ramp to Arata Lane Off-ramp
Length	2.75	1.30	0.61	0.52	0.68	0.28	0.35	0.43	0.22	0.49	1.06	0.22	1.58	0.30	0.27	0.17	0.39	0.36	0.39	0.35	0.08	0.38	0.59	0.45	0.29	0.47	0.35	1.50	0.24	0.20	0.70	0.21	0.22	0.37	0.83	0.22	0.18	1.37	0.49	0.84
3:00 PM	62	65	59	63	65	62	60	58	56	56	62	61	60	57	60	59	58	61	63	59	61	60	59	61	63	63	62	61	64	65	67	66	63	62	64	63	62	65	66	63
3:15 PM	66	68	68	67	67	63	65	65	60	54	50	55	57	61	49	47	53	61	64	60	57	60	64	65	63	63	66	63	63	66	67	64	59	61	63	66	66	66	61	57
3:30 PM	61	62	62	63	65	64	63	62	63	60	61	60	54	59	51	45	52	57	58	59	60	63	62	63	64	64	64	63	63	65	67	68	65	64	65	68	70	67	65	63
3:45 PM	60	65	64	66	68	67	67	65	65	63	41	50	43	35	29	37	48	55	59	60	61	64	65	65	66	67	67	61	69	69	67	65	62	65	66	68	69	69	68	64
4:00 PM	59	65	70	66	66	69	68	64	53	59	50	23	34	50	38	37	46	55	47	36	42	53	59	61	64	66	68	58	62	64	65	63	65	66	66	64	66	67	59	56
4:15 PM	58	65	63	63	61	62	59	60	60	47	30	35	37	24	28	37	49	57	48	48	51	53	59	58	63	63	65	63	66	69	68	66	67	68	66	65	66	67	65	64
4:30 PM	65	66	64	62	61	60	63	62	62	54	25	17	30	24	25	33	50	56	55	52	57	58	62	62	60	60	64	61	63	64	64	63	63	53	42	57	62	63	62	60
4:45 PM	63	66	65	66	67	65	63	62	58	41	33	21	27	31	30	35	50	56	45	41	54	58	63	63	64	65	65	63	63	64	65	58	47	48	41	58	62	63	60	59
5:00 PM	62	65	65	68	68	60	63	63	65	63	30	32	30	23	28	36	47	58	53	31	37	46	61	64	64	64	64	56	63	66	67	46	42	48	47	59	63	64	63	62
5:15 PM	61	65	65	69	65	63	62	65	64	42	24	21	27	27	31	41	51	59	64	55	53	63	66	64	63	64	65	65	66	66	68	69	67	69	67	65	67	66	65	65
5:30 PM	58	59	59	66	66	63	63	62	63	64	31	27	23	24	23	33	43	55	65	62	61	65	65	66	67	68	66	54	62	64	66	64	59	62	61	61	62	67	67	63
5:45 PM	63	65	64	64	66	64	63	62	61	54	27	33	30	24	30	44	52	60	62	61	60	61	64	65	64	63	64	63	61	64	64	60	57	61	60	62	65	63	60	59
6:00 PM	59	63	64	67	70	68	67	68	66	63	59	46	49	37	27	35	47	56	58	58	58	60	63	60	64	62	61	61	64	66	67	67	64	64	65	63	63	67	65	61
6:15 PM	63	63	64	66	64	64	64	65	65	64	63	64	60	59	60	59	62	64	66	64	59	61	60	62	62	63	65	63	64	65	67	68	68	67	67	66	66	67	66	64
6:30 PM	64	69	68	66	68	67	64	64	65	65	64	65	62	67	67	64	62	64	66	65	61	66	66	64	63	65	65	64	67	69	71	72	71	71	70	68	67	66	65	65
6:45 PM	64	69	68	71	70	71	69	67	68	62	65	64	65	63	63	63	62	64	65	63	62	68	66	66	67	68	68	69	67	69	67	66	67	68	68	67	66	64	61	61

After RM Avg.

Time	Old Redwood Highway WB On-ramp to Railroad Ave Off-ramp	Railroad Ave Off-ramp to Sierra Ave Off-ramp	Sierra Ave Off-ramp to SR 116 Off-ramp	SR 116 Off-ramp to SR 116 On-ramp	SR 116 On-ramp to Rohnert Park Expressway Off-ramp	Rohnert Park Expressway Off-ramp to Rohnert Park Expressway EB On-ramp	Rohnert Park Expressway EB On-ramp to Rohnert Park Expressway WB On-ramp	Rohnert Park Expressway WB On-ramp to Golf Course Drive Off-ramp	Golf Course Drive Off-ramp to Golf Course Drive On-ramp	Golf Course Drive On-ramp to Santa Rosa Ave Off-ramp	Santa Rosa Ave Off-ramp to Todd Road Off-ramp	Todd Road Off-ramp to Todd Road On-ramp	Todd Road On-ramp to Yolanda Ave Off-ramp	Yolanda Ave Off-ramp to Yolanda Ave On-ramp	Yolanda Ave On-ramp to Baker Ave Off-ramp	Baker Ave Off-ramp to Baker Ave On-ramp	Baker Ave On-ramp to SR 12 Off-ramp	SR 12 Off-ramp to 3rd Street Off-ramp	3rd Street Off-ramp to SR 12 On-ramp	SR 12 On-ramp to Morgan / 6th Street On-ramp	Morgan / 6th Street On-ramp to College Ave Off-ramp	College Ave Off-ramp to College Ave On-ramp	College Ave On-ramp to Steele Lane Off-ramp	Steele Lane Off-ramp to Steele Lane On-ramp	Steele Lane On-ramp to Bicentennial Way Off-ramp	Bicentennial Way Off-ramp to Mendocino Ave Off-ramp	Mendocino Ave Off-ramp to Mendocino Ave On-ramp	Mendocino Ave On-ramp to River Road Off-ramp	River Road Off-ramp to River Road EB On-ramp	River Road EB On-ramp to River Road WB On-ramp	River Road WB On-ramp to Fulton Rd Off-ramp	Fulton Rd Off-ramp to Fulton Rd On-ramp	Fulton Rd On-ramp to Airport Blvd Off-ramp	Airport Blvd Off-ramp to Airport Blvd On-ramp	Airport Blvd On-ramp to Shiloh Rd Off-ramp	Shiloh Rd Off-ramp to Shiloh EB On-ramp	Shiloh EB On-ramp to Shiloh WB On-ramp	Shiloh WB On-ramp to Old Redwood Highway Off-ramp	Old Redwood Highway Off-ramp to Old Redwood Highway On-ramp	Old Redwood Highway On-ramp to Arata Lane Off-ramp
3:00 PM	61	66	66	64	62	66	64	63	61	59	52	54	56	54	47	49	54	62	57	45	49	59	57	61	59	58	62	62	65	65	68	67	66	68	68	66	67	66	65	64
3:15 PM	66	65	65	66	67	66	67	65	59	54	40	53	57	62	48	41	52	60	55	40	47	56	61	64	66	63	62	66	67	69	69	69	68	70	69	68	68	68	66	63
3:30 PM	64	66	64	67	67	64	58	56	43	53	47	53	47	29	29	38	44	53	64	63	63	62	62	62	60	61	63	63	67	68	69	70	71	71	67	64	66	69	66	61
3:45 PM	66	67	66	64	61	62	60	63	51	35	34	41	32	28	31	39	52	59	62	53	56	62	67	66	65	64	66	61	63	66	68	66	65	67	68	68	68	69	67	64
4:00 PM	62	66	67	68	64	63	60	66	65	60	37	33	33	22	26	33	49	60	52	48	54	61	59	62	64	65	65	63	65	67	69	67	68	67	65	65	67	68	62	60
4:15 PM	61	66	65	66	63	63	62	62	63	37	26	37	28	23	27	35	48	59	53	51	49	56	62	62	62	61	62	64	65	66	67	67	68	68	65	65	64	64	63	65
4:30 PM	61	65	64	66	69	69	59	54	22	32	27	25	30	26	23	31	48	60	47	36	47	56	63	66	63	62	62	63	66	64	65	66	65	67	63	64	65	64	68	60
4:45 PM	64	66	68	65	60	56	45	39	49	29	30	49	32	28	28	37	46	55	50	48	53	58	61	60	61	60	64	62	63	64	63	65	64	63	64	66	62	62	62	62
5:00 PM	65	70	68	66	66	66	63	65	63	38	21	19	28	22	26	39	52	58	60	48	50	51	61	46	51	52	56	60	57	61	64	66	68	70	68	67	67	66	64	62
5:15 PM	60	69	70	67	70	71	67	67	58	34	22	23	25	21	28	40	50	57	51	43	53	62	63	63	64	63	64	62	64	64	63	61	59	67	66	65	67	69	65	61
5:30 PM	61	67	65	65	64	61	61	65	61	40	31	33	27	27	30	42	52	58	61	58	54	56	56	61	63	64	63	65	64	68	66	64	66	67	67	67	68	65	64	61
5:45 PM	62	67	65	66	68	67	67	65	67	64	41	42	41	32	36	46	57	62	66	63	60	64	66	64	66	66	68	67	67	68	67	66	66	68	69	67	68	68	68	64
6:00 PM	60	64	63	63	63	63	61	60	58	62	48	52	47	55	43	39	53	62	68	64	61	60	66	61	60	64	67	65	70	69	69	67	71	71	68	67	69	68	69	68
6:15 PM	63	67	68	66	66	65	66	66	67	67	63	61	54	40	46	49	57	64	68	63	59	63	64	62	64	65	66	67	68	69	71	69	69	70	68	68	67	66	64	63
6:30 PM	66	68	66	66	69	70	67	67	66	65	66	67	67	66	65	64	63	63	64	67	68	70	71	71	69	69	68	67	67	69	67	66	68	69	70	69	69	70	66	60
6:45 PM	67	67	65	67	69	69	66	65	65	67	66	60	65	64	67	68	64	66	68	69	70	70	70	70	69	68	68	67	67	68	69	69	70	70	69	68	69	69	69	66

Arithmetic Difference

Time	Old Redwood Highway WB On-ramp to Railroad Ave Off-ramp	Railroad Ave Off-ramp to Sierra Ave Off-ramp	Sierra Ave Off-ramp to SR 116 Off-ramp	SR 116 Off-ramp to SR 116 On-ramp	SR 116 On-ramp to Rohnert Park Expressway Off-ramp	Rohnert Park Expressway Off-ramp to Rohnert Park Expressway EB On-ramp	Rohnert Park Expressway EB On-ramp to Rohnert Park Expressway WB On-ramp	Rohnert Park Expressway WB On-ramp to Golf Course Drive Off-ramp	Golf Course Drive Off-ramp to Golf Course Drive On-ramp	Golf Course Drive On-ramp to Santa Rosa Ave Off-ramp	Santa Rosa Ave Off-ramp to Todd Road Off-ramp	Todd Road Off-ramp to Todd Road On-ramp	Todd Road On-ramp to Yolanda Ave Off-ramp	Yolanda Ave Off-ramp to Yolanda Ave On-ramp	Yolanda Ave On-ramp to Baker Ave Off-ramp	Baker Ave Off-ramp to Baker Ave On-ramp	Baker Ave On-ramp to SR 12 Off-ramp	SR 12 Off-ramp to 3rd Street Off-ramp	3rd Street Off-ramp to SR 12 On-ramp	SR 12 On-ramp to Morgan / 6th Street On-ramp	Morgan / 6th Street On-ramp to College Ave Off-ramp	College Ave Off-ramp to College Ave On-ramp	College Ave On-ramp to Steele Lane Off-ramp	Steele Lane Off-ramp to Steele Lane On-ramp	Steele Lane On-ramp to Bicentennial Way Off-ramp	Bicentennial Way Off-ramp to Mendocino Ave Off-ramp	Mendocino Ave Off-ramp to Mendocino Ave On-ramp	Mendocino Ave On-ramp to River Road Off-ramp	River Road Off-ramp to River Road EB On-ramp	River Road EB On-ramp to River Road WB On-ramp	River Road WB On-ramp to Fulton Rd Off-ramp	Fulton Rd Off-ramp to Fulton Rd On-ramp	Fulton Rd On-ramp to Airport Blvd Off-ramp	Airport Blvd Off-ramp to Airport Blvd On-ramp	Airport Blvd On-ramp to Shiloh Rd Off-ramp	Shiloh Rd Off-ramp to Shiloh EB On-ramp	Shiloh EB On-ramp to Shiloh WB On-ramp	Shiloh WB On-ramp to Old Redwood Highway Off-ramp	Old Redwood Highway Off-ramp to Old Redwood Highway On-ramp	Old Redwood Highway On-ramp to Arata Lane Off-ramp
3:00 PM	-1	2	8	2	-3	4	5	4	5	3	-10	-7	-4	-2	-12	-10	-4	1	-5	-14	-12	-1	-2	0	-4	-5	0	1	1	0	0	2	3	6	4	3	5	0	-1	0
3:15 PM	0	-3	-3	0	0	3	3	0	-2	0	-11	-3	0	1	-1	-7	-1	-2	-9	-20	-9	-4	-3	-1	3	0	-4	3	4	3	2	5	9	8	6	1	2	2	5	7
3:30 PM	3	3	2	3	2	0	-5	-6	-20	-7	-14	-7	-7	-30	-22	-6	-8	-3	6	4	3	0	0	-2	-4	-2	-1	0	4	3	2	2	6	7	2	-4	-4	2	1	-2
3:45 PM	5	2	2	-2	-7	-5	-7	-2	-14	-28	-7	-9	-11	-8	3	1	3	3	3	-7	-5	-2	2	2	-1	-2	-1	0	-6	-3	1	1	4	2	2	0	0	1	0	1
4:00 PM	3	1	-3	1	-1	-6	-7	1	12	1	-13	10	-1	-28	-13	-4	3	5	5	13	12	8	0	2	0	-1	-3	5	3	3	4	4	4	1	-1	0	1	1	4	5
4:15 PM	3	1	2	3	2	1	3	1	4	-10	-4	2	-9	-1	-1	-2	-1	2	5	2	-3	2	4	3	-1	-2	-2	1	-1	-2	-2	1	0	0	0	0	-2	-3	-2	1
4:30 PM	-4	0	0	4	7	9	-3	-8	-40	-22	2	8	0	2	-1	-2	-1	4	-8	-16	-10	-3	1	4	3	2	-2	3	2	0	2	3	2	15	22	7	4	1	6	0
4:45 PM	1	0	3	0	-7	-9	-18	-22	-8	-12	-3	28	5	-3	-2	1	-5	-1	5	8	-1	0	-3	-3	-3	-5	-4	-3	1	-2	-2	7	16	17	22	5	2	3	2	3
5:00 PM	3	5	3	-2	-2	5	0	1	-2	-25	-9	-14	-2	0	-1	3	5	0	7	17	13	5	-1	-18	-14	-12	-8	4	-6	-5	-3	20	27	22	21	8	4	2	2	0
5:15 PM	-1	3	5	-2	5	8	5	2	-6	-8	-2	2	-2	-7	-4	-1	-1	-2	-13	-12	0	-1	-2	-2	1	-1	-1	-3	-2	-2	-5	-7	-8	-1	-1	0	-1	3	1	-4
5:30 PM	3	8	7	-1	-2	-2	-2	3	-2	-24	0	6	5	3	7	9	9	3	-4	-4	-7	-9	-8	-5	-4	-3	-3	11	2	4	0	0	7	5	6	6	6	-2	-3	-2
5:45 PM	-1	3	1	3	2	3	4	3	6	10	15	10	11	8	6	2	5	1	4	2	0	3	1	-1	3	4	3	4	5	4	3	6	9	7	9	5	3	5	7	6
6:00 PM	1	1	-1	-4	-7	-5	-6	-7	-8	-1	-11	7	-2	17	15	4	6	6	10	6	4	1	4	1	-3	2	6	3	6	3	2	1	7	7	2	4	5	2	4	7
6:15 PM	0	4	4	0	2	1	2	1	2	3	-1	-2	-6	-20	-14	-11	-5	0	1	-1	0	2	4	0	3	2	1	3	5	4	4	1	2	3	1	1	1	-1	-1	-1
6:30 PM	1	-1	-3	0	0	3	3	3	0	0	2	2	5	-1	-2	0	1	-1	-2	2	7	4	5	7	6	4	3	3	0	0	-4	-5	-3	-2	0	1	2	4	1	-5
6:45 PM	3	-2	-3	-4	-1	-3	-3	-3	-2	5	1	-4	0	1	4	5	2	2	3	5	8	2	3	4	2	0	-1	-2	0	0	2	3	3	2	2	0	3	5	7	5

Legend
Speed increases 20+ mph
Speed constant
Speed decreases 20+ mph

Legend
Speed greater than 55 mph
Speed 45 to 55 mph
Speed 35 to 45 mph
Speed less than 35 mph

Data Source: Metro Traffic Data (2013 and 2015). Average speeds derived from typical conditions.

Appendix Exhibit D-17: Before and After Speed Contours, Southbound, PM Peak Period

Before RM Avg.

Time	Arata Lane On-ramp to Old Redwood Highway Off-ramp	Old Redwood Highway Off-ramp to Old Redwood Highway On-ramp	Old Redwood Highway On-ramp to Shiloh Road Off-ramp	Shiloh Road Off-ramp to Shiloh WB On-ramp	Shiloh WB On-ramp to Shiloh EB On-ramp	Shiloh EB On-ramp to Airport Blvd Off-ramp	Airport Blvd Off-ramp to Airport Blvd On-ramp	Airport Blvd On-ramp to Fulton Road Off-ramp	Fulton Road Off-ramp to Fulton Road On-ramp	Fulton Road On-ramp to River Road Off-ramp	River Road Off-ramp to River Road WB On-ramp	River Road WB On-ramp to River Road On-ramp	River Road On-ramp to Hopper Ave Off-ramp	Hopper Ave Off-ramp to Hopper Ave On-ramp	Hopper Ave On-ramp to Mendocino Ave On-ramp	Mendocino Ave On-ramp to Bicentennial Way On-ramp	Bicentennial Way On-ramp to Guerneville Road Off-ramp	Guerneville Road Off-ramp to Guerneville Road On-ramp	Guerneville Road On-ramp to College Ave Off-ramp	College Ave Off-ramp to College Ave On-ramp	College Ave On-ramp to Downtown Off-ramp	Downtown Off-ramp to SR 12 Off-ramp	SR 12 Off-ramp to 3rd Street On-ramp	3rd Street On-ramp to SR 12 On-ramp	SR 12 On-ramp to Baker Ave Off-ramp	Baker Ave Off-ramp to Baker Ave On-ramp	Baker Ave On-ramp to Corby Ave Off-ramp	Corby Ave Off-ramp to Corby Ave On-ramp	Corby Ave On-ramp to Todd Road Off-ramp	Todd Road Off-ramp to Todd Road On-ramp	Todd Road On-ramp to Golf Course Drive Off-ramp	Golf Course Drive Off-ramp to Golf Course Drive On-ramp	Golf Course Drive On-ramp to Rohnert Park Expressway Off-ramp	Rohnert Park Expressway Off-ramp to Rohnert Park Expressway WB On-ramp	Rohnert Park Expressway WB On-ramp to Rohnert Park Expressway EB On-ramp	Rohnert Park Expressway EB On-ramp to SR 116 Off-ramp	SR 116 Off-ramp to SR 116 On-ramp	SR 116 On-ramp to Sierra Ave On-ramp	Sierra Ave On-ramp to Pepper Road On-ramp	Pepper Road On-ramp to Old Redwood Highway Off-ramp
Length	1.38	0.45	1.30	0.21	0.16	0.93	0.33	0.17	0.20	0.72	0.22	0.20	1.30	0.28	0.36	0.45	0.24	0.64	0.47	0.41	0.12	0.33	0.34	0.42	0.40	0.15	0.26	0.23	1.59	0.17	1.05	0.83	0.64	0.20	0.18	0.75	0.51	0.64	2.97	1.04
3:00 PM	60	64	71	69	70	69	72	71	73	70	68	68	68	66	68	67	65	55	49	54	53	61	59	59	52	55	57	58	60	59	56	56	59	56	56	59	58	58	58	54
3:15 PM	68	64	65	65	65	63	67	70	73	71	71	71	67	61	60	54	55	48	36	39	49	64	43	30	35	45	32	44	53	57	61	61	62	64	66	68	70	62	65	58
3:30 PM	65	63	64	64	65	64	70	65	67	63	65	65	90	91	60	24	29	28	45	45	35	41	45	23	29	48	48	47	57	62	58	53	61	62	65	66	64	59	61	59
3:45 PM	57	60	61	59	60	60	61	64	64	73	76	72	39	51	21	23	39	24	25	22	30	46	33	26	26	47	54	55	59	52	59	61	65	63	64	66	70	67	63	61
4:00 PM	72	71	68	62	61	62	65	65	63	66	69	68	70	57	22	14	14	18	22	23	31	22	25	31	35	41	48	55	64	63	62	64	66	66	66	69	65	67	68	65
4:15 PM	57	65	64	64	60	55	58	57	57	59	60	58	33	10	17	28	14	24	29	25	35	22	22	24	41	55	58	56	57	60	61	61	62	63	63	63	63	64	63	58
4:30 PM	58	66	71	75	71	131	132	125	106	60	58	55	34	35	46	15	15	23	26	27	24	18	17	24	42	55	58	55	61	62	58	62	65	65	68	68	68	64	61	51
4:45 PM	70	74	74	71	70	80	36	54	71	52	51	47	27	27	29	35	18	27	23	23	24	18	20	28	43	47	52	54	55	57	54	57	60	62	61	62	60	62	64	66
5:00 PM	62	66	66	66	65	65	62	50	57	48	50	52	47	48	30	17	16	15	9	17	19	17	21	30	42	52	58	56	53	61	59	60	55	59	64	67	67	67	64	63
5:15 PM	61	64	66	64	63	55	58	60	58	50	49	48	30	27	10	11	16	18	20	22	25	20	21	30	41	46	48	51	54	54	52	51	63	65	68	71	69	70	69	65
5:30 PM	63	60	62	62	56	64	69	68	67	59	41	43	21	18	24	40	15	16	30	21	30	23	21	36	30	45	56	59	57	51	61	65	60	57	60	66	69	61	70	71
5:45 PM	59	64	64	66	67	67	65	63	65	66	63	60	44	35	38	43	23	24	35	23	35	28	28	33	53	51	57	61	56	55	59	57	62	60	59	63	59	58	63	58
6:00 PM	64	65	63	63	63	64	60	62	64	65	63	61	62	60	64	64	62	49	53	61	56	57	52	53	55	56	60	57	63	62	73	103	87	78	76	72	71	68	67	65
6:15 PM	70	70	65	66	67	69	67	68	70	67	66	65	61	63	65	62	64	62	68	63	64	65	70	65	60	60	62	60	63	66	83	83	87	75	71	73	71	68	65	59
6:30 PM	66	67	66	66	67	64	62	64	65	66	63	55	69	71	70	62	63	63	62	61	60	59	61	58	59	60	61	59	60	59	49	36	54	62	65	66	63	65	62	62
6:45 PM	62	64	66	63	63	64	64	63	61	63	62	62	62	63	62	61	61	62	63	64	62	63	63	62	61	62	63	63	63	62	62	63	64	61	60	63	64	66	67	64

After RM Avg.

Time																																								
3:00 PM	67	71	67	66	67	66	65	65	63	65	63	63	61	60	60	59	57	58	56	42	49	58	61	54	42	55	60	59	61	51	61	66	66	64	65	69	68	68	67	59
3:15 PM	65	68	66	64	60	61	60	62	65	66	64	54	63	65	63	60	56	32	30	25	47	57	62	48	53	55	60	63	62	57	61	61	64	67	67	67	67	65	65	54
3:30 PM	65	67	66	64	60	62	56	58	60	62	62	60	62	61	59	31	17	26	26	29	44	54	61	30	33	48	58	62	63	55	58	60	62	61	62	67	66	63	64	57
3:45 PM	65	66	68	65	60	63	63	63	64	60	60	51	30	24	17	22	29	23	27	35	47	52	45	23	27	45	55	60	62	60	62	62	63	66	68	70	70	69	66	56
4:00 PM	64	68	67	65	65	64	63	63	64	64	56	37	53	22	15	21	18	27	25	33	46	40	27	22	34	50	56	58	57	52	57	62	61	63	66	66	65	66	67	59
4:15 PM	60	65	64	61	60	62	63	64	64	63	61	49	36	20	21	19	29	24	28	29	38	28	22	21	30	46	57	58	58	59	59	63	66	64	65	64	63	63	66	61
4:30 PM	67	70	71	67	66	62	63	63	64	67	56	28	55	39	21	20	19	23	27	31	46	27	14	20	38	46	37	42	55	59	60	65	66	65	67	71	68	65	68	62
4:45 PM	60	63	67	65	62	60	63	64	65	63	60	46	33	23	20	17	18	22	28	29	41	32	24	19	37	48	56	60	61	58	61	62	65	62	65	67	65	62	65	62
5:00 PM	64	66	65	65	64	64	63	62	64	59	32	21	45	22	15	18	23	17	24	29	45	37	23	22	33	47	55	55	52	50	56	61	63	65	66	68	65	63	64	56
5:15 PM	64	66	65	62	59	63	53	51	40	33	22	16	26	13	16	19	19	15	23	27	46	45	36	27	38	42	33	43	57	51	55	60	59	60	62	61	61	62	63	57
5:30 PM	66	66	69	70	68	67	66	62	42	24	21	21	54	63	49	18	31	23	28	31	45	40	26	22	34	50	55	55	61	59	60	64	62	61	63	66	63	65	66	66
5:45 PM	69	70	71	71	72	69	68	12	22	51	30	29	53	58	59	55	58	37	29	30	51	58	64	44	51	55	61	60	60	61	62	64	67	66	67	69	65	63	69	63
6:00 PM	68	71	70	71	70	70	69	68	68	69	64	64	64	63	60	58	59	59	50	49	52	64	66	62	59	60	65	66	67	70	67	67	69	69	68	69	67	67	69	64
6:15 PM	66	67	68	69	68	69	70	71	71	71	70	69	70	69	66	64	65	67	65	59	55	62	65	63	59	61	66	65	67	65	64	67	70	69	68	67	69	68	68	63
6:30 PM	65	68	67	67	66	64	67	72	71	66	67	65	65	65	63	63	62	64	64	65	61	61	63	62	57	59	65	67	67	69	68	66	66	66	66	68	67	67	69	62
6:45 PM	68	71	74	75	74	73	73	74	73	73	72	71	71	73	72	71	70	70	69	68	66	68	68	67	67	68	69	70	69	69	70	70	72	71	70	75	71	70	69	62

Arithmetic Difference

Time																																								
3:00 PM	7	7	-4	-3	-2	-3	-6	-5	-10	-5	-5	-5	-7	-7	-8	-9	-8	2	8	-12	-4	-3	2	-5	-10	0	3	1	1	-8	5	10	7	8	9	10	11	9	9	5
3:15 PM	-3	4	1	-1	-4	-2	-7	-8	-8	-5	-7	-17	-3	4	3	6	1	-16	-6	-14	-2	-7	19	18	18	11	28	19	10	0	1	0	1	4	0	-1	-3	3	0	-3
3:30 PM	0	4	2	0	-5	-2	-14	-7	-7	-1	-4	-5	-28	-30	-2	7	-11	-2	-19	-16	9	14	16	7	4	0	10	15	6	-7	0	7	1	-1	-2	1	2	4	3	-1
3:45 PM	8	6	7	6	0	3	2	-1	-1	-12	-15	-21	-9	-27	-4	-1	-10	-2	2	13	17	6	12	-3	2	-2	1	5	3	8	3	1	-2	3	3	4	-1	2	3	-5
4:00 PM	-8	-4	0	3	5	2	-2	-2	1	-2	-12	-31	-17	-35	-7	7	4	9	4	11	15	18	2	-8	-1	9	8	2	-7	-11	-5	-2	-5	-3	0	-3	0	-2	0	-6
4:15 PM	3	0	0	-2	0	7	5	6	7	3	0	-9	4	10	4	-9	15	-1	0	5	4	7	0	-3	-10	-9	-1	2	1	-1	-2	2	4	1	2	1	0	-1	3	3
4:30 PM	9	4	0	-7	-5	-68	-70	-62	-42	7	-2	-27	21	3	-25	5	4	0	1	4	23	9	-4	-4	-4	-9	-21	-13	-6	-2	2	2	1	0	0	2	0	0	6	11
4:45 PM	-10	-11	-8	-6	-9	-20	27	10	-5	11	9	-1	5	-4	-8	-18	0	-5	5	5	17	15	4	-9	-6	0	4	6	6	0	7	5	6	1	3	6	5	0	1	-4
5:00 PM	3	-1	-1	-1	-2	-1	1	13	7	11	-17	-31	-2	-26	-16	0	7	2	14	13	26	20	2	-9	-9	-5	-3	-1	0	-11	-3	1	8	6	3	1	-2	-4	0	-7
5:15 PM	4	2	-1	-2	-4	8	-5	-10	-18	-17	-27	-32	-4	-13	7	8	3	-3	2	5	21	25	15	-3	-3	-3	-16	-8	3	-3	4	9	-4	-5	-5	-9	-8	-8	-6	-8
5:30 PM	3	6	7	7	13	3	-3	-6	-25	-35	-19	-22	33	45	25	-22	17	6	-2	10	15	17	5	-13	3	5	-1	-4	3	8	-1	-1	2	4	4	0	-6	4	-4	-4
5:45 PM	10	6	8	6	5	2	2	-51	-43	-15	-33	-31	9	23	22	12	34	13	-5	7	15	30	35	11	-1	4	3	-1	5	5	3	7	5	6	7	6	6	6	5	5
6:00 PM	4	6	6	7	6	6	9	6	4	4	1	3	2	3	-4	-6	-3	10	-3	-12	-5	6	14	9	3	4	5	9	4	7	-6	-36	-18	-9	-8	-3	-4	-1	1	-1
6:15 PM	-4	-3	2	3	1	0	3	3	1	4	4	4	9	6	1	2	1	4	-2	-4	-10	-2	-5	-3	0	1	5	5	3	-1	-18	-17	-17	-6	-3	-5	-2	0	2	3
6:30 PM	-1	1	1	1	0	0	5	8	6	0	4	10	-4	-5	-7	1	-1	1	2	5	1	2	2	4	-2	-1	3	8	7	9	19	30	12	4	1	3	4	2	6	0
6:45 PM	6	8	8	11	11	10	9	10	13	10	11	9	9	10	10	10	9	8	7	4	4	5	5	5	6	6	7	7	6	7	7	7	7	10	10	12	7	4	2	-2

Legend
Speed increases 20+ mph
Speed constant
Speed decreases 20+ mph

Legend
Speed greater than 55 mph
Speed 45 to 55 mph
Speed 35 to 45 mph
Speed less than 35 mph

Data Source: Metro Traffic Data (2013 and 2015) and INRIX (April 2013). Average speeds derived from typical conditions. Refer to Appendix Exhibit D-1 for the INRIX-based adjustment process for the Before speeds.

APPENDIX E - ARTERIAL SEGMENT COUNT DATA

See separate attachment.

APPENDIX F - INTERSECTION COUNT DATA

See separate attachment.

APPENDIX G - INTERSECTION LOS WORKSHEETS

See separate attachment.