Agenda Item A.2
PRESENTATION
Meeting Date: March 20, 2018

TO: Mayor and Councilmembers

FROM: Robert Woodward and Masoud Mahmoud, Interim Public Works Director

CONTACT: James Winslow, Senior Project Engineer
Michael Becker, Planning Division Manager, SBCAG

SUBJECT: SBCAG's Goleta Ramp Metering Study

RECOMMENDATION:

Receive a presentation by SBCAG on the Draft Goleta Ramp Metering Study.

BACKGROUND:

This staff report is a summary of the Santa Barbara County Association of Governments' (SBCAG) staff report for the Regional Technical Transportation Advisory Committee (TTAC) on the Goleta Ramp Metering Study, and provides Council with background information about the study in advance of the presentation by SBCAG staff.

The Goleta Ramp Metering Study is a response to Caltrans indicating they were considering including a candidate project in their State Highway Operations and Protection Program (SHOPP). The Caltrans candidate project included installing a ramp meter at the State Route (SR) 217 on-ramp to southbound US 101. In response, SBCAG applied for and received a Caltrans Transportation Planning Grant to study and objectively evaluate the potential effectiveness of metering systems along US 101, as well as to learn of any impacts to the local street network, through the City of Goleta and unincorporated Eastern Goleta Valley (Turnpike Avenue to Cathedral Oaks Road).

SBCAG formed a Goleta Ramp Metering Study Technical Advisory Committee (TAC), composed of staff from SBCAG and its consultant, the County of Santa Barbara, City of Goleta, Caltrans, UCSB, and SBMTD, which steered the development of the study methodology, selection of count locations, and the framing of various scenario alternatives. This TAC held a kickoff meeting along with twelve periodic meetings since the study's inception. Meeting minutes and related documents are available on SBCAG's website at http://www.sbcag.org/goleta_rms.html. The team held a public workshop on October 27, 2016, in the City of Goleta Community Center.

The study is presented in draft form as Attachment 1. Staff anticipates minor changes based on refinements and analysis in response to SBCAG's Board of Directors and

regional TTAC, and the second public workshop which will be held in the evening of April 19, 2018, with a presentation to the SBCAG Board of Directors in the morning of the same day.

SBCAG's draft report details the Goleta Ramp Metering Study process up to this point, including existing (2016) and future year (2035) alternative scenario results. The study does not commit to any direct actions; instead, it analyzes whether various metering options can achieve system-wide benefits by reducing existing and future peak-period freeway congestion while balancing the benefits and impacts to transit and local roads.

As part of the Christmas Tree Farm development in the County of Santa Barbara on Patterson Avenue, Caltrans had a ramp meter installed on the south-bound 101 onramp at Patterson Avenue. Just prior to preparing this staff report, Caltrans activated the ramp meter, making it operational. This is now the new Alternative 1 – Do nothing, metering at Patterson Avenue south-bound onramp that is provided in the study report.

DISCUSSION:

SBCAG invited City staff to join the Goleta Ramp Metering TAC in the fall of 2015. On February 22, 2016, City staff provided SBCAG a list of general and specific concerns with the proposed project and their Request for Proposals. Staff identified several concerns including recommending a comprehensive and holistic approach to the US 101 corridor, local streets traffic implications, issues with routes and ridership, and methodologies.

To gather additional traffic data, the SBCAG team conducted intersection and roadway segments counts, including counts on US 101 and SR 217. The team selected the locations based on availability of traffic data and the likelihood of diversion impacts due to ramp metering. Both the study area (defined by the grant scope of work) and count locations are illustrated in Attachment 2. The TAC helped select the operational performance measures, which provide the basis for objectively evaluating existing data and ramp metering scenarios' potential impacts. The team conducted the traffic count data collection the same month as the first public workshop in the Fall of 2016. The workshop gathered local citizen input to help identify existing operational and safety issues on US 101, SR 217, and local streets. SBCAG staff circulated an online survey after the workshop and received over 200 responses, expanding on the public workshop results and confirming the count data analysis.

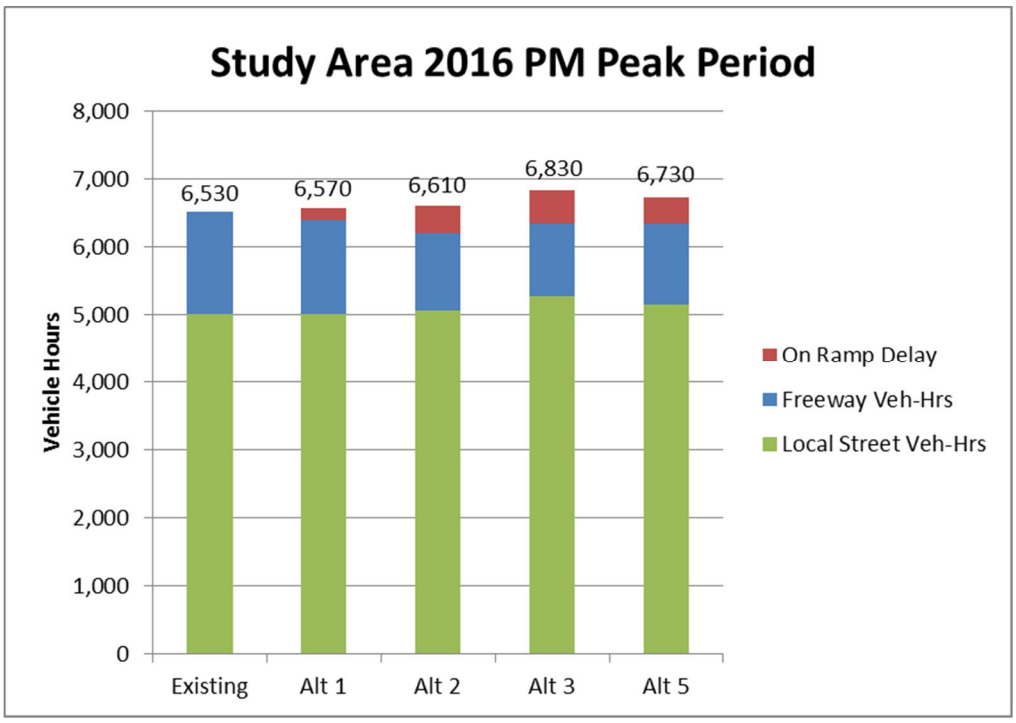
The report includes the following: the study area, the methodology and count locations for the traffic counts along the US 101, State Route (SR) 217, and local street intersections; the operational performance measures; a discussion of the community workshops; an analysis of the data, including a discussion of the regional data and the City of Goleta's Traffic Model; the potential impacts of ramp metering; and the conclusions. The consultant and the TAC developed and analyzed scenarios utilizing the existing traffic counts and future City of Goleta traffic model volumes. The scenario alternatives are detailed below and are illustrated in Attachment 3:

- Alternative 1: Do Nothing - Continued metering at Patterson SB on-ramp only
- Alternative 2: Targeted - Metering at SR 217 SB on-ramp and Patterson SB on-ramp only
- Alternative 3: Maximum - Metering at all on-ramps
- Alternative 4: SR 217 Only - Metering at Hollister on-ramps to SR 217 only
- Alternative 5: US 101 North of SR 217 Only - Metering at all on-ramps north of SR 217

During initial testing, it was determined that Alternative 4 – metering on the Hollister on-ramps to SR 217 – would not provide significant changes to freeway operations. Therefore, only Alternatives 1, 2, 3, and 5 were included in the analysis.

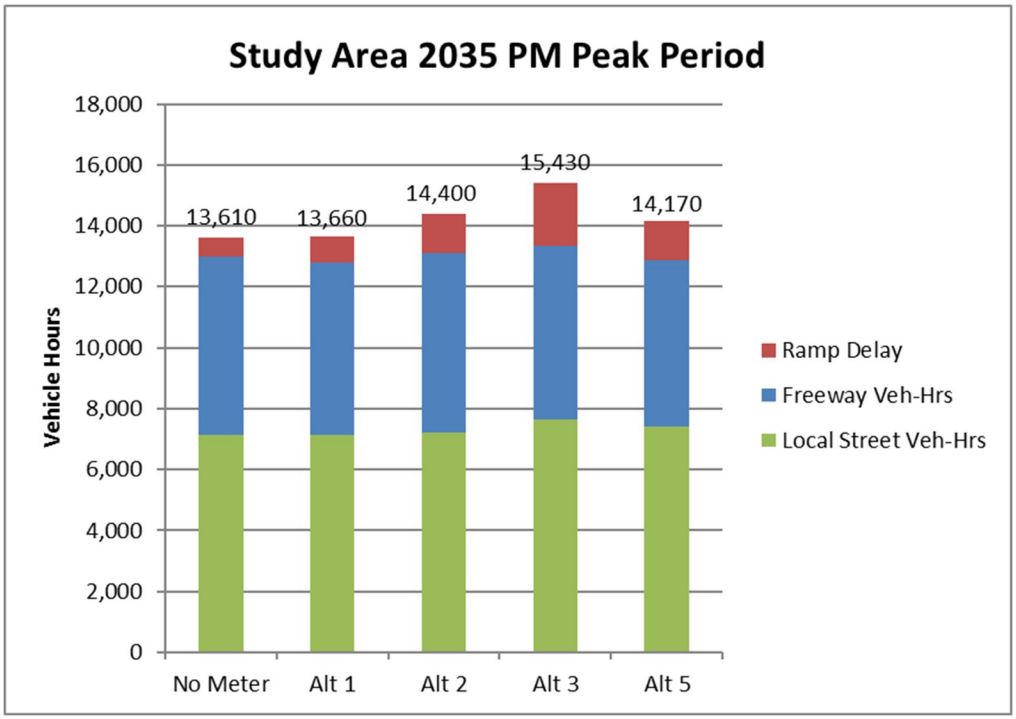
The results SBCAG presents in the draft report include a scenario analysis for traffic counts. This analysis indicates that ramp metering on southbound US 101 could increase average PM peak period freeway speeds by up to 27 percent, from 44 to 62 miles per hour (mph). While total vehicle delay would be decreased on the freeway, the decreases would be more than offset by increases in delay at the metered on-ramps and on local streets due to traffic diversion and congestion (illustrated in Figure 1).

Figure 1: Base Year (2016) Total Vehicle Hours, PM Peak Period



The results of the scenario analysis utilizing future (2035) traffic volumes generated by the City of Goleta traffic model indicate significant congestion on the freeway. With the projected amount of congestion, ramp metering would not be able to significantly increase freeway speeds. As with the base year evaluation, any decreases in freeway delay due to ramp metering would be more than offset by increases in delay at metered on-ramps and on local streets due to diversion (illustrated in Figure 2).

Figure 2: Total Vehicle Hours, 2035 PM Peak Period



The consultant also evaluated the operations at nine study intersections for base year and 2035 traffic levels and with traffic diversions induced by each of the ramp metering alternatives. The results indicate an increase in congestion and a change in the Level of Service (LOS) (a downgrade of the LOS) at multiple intersections for most, if not all, of the scenario alternatives. The degree of impacts varies depending on the base year or the future (2035) conditions, the scenario alternatives, and the intersection locations as indicated in the draft report.

Conclusion:

Ramp metering alone could provide some short-term benefits to the US 101 freeway through Goleta, but would not provide overall benefits to the transportation system in the Goleta study area. Both the draft Study and the City's contract Traffic Engineer, Stantec Consultants (Attachment 4), have identified that system-wide ramp metering, while providing short-term freeway benefits, would result in net delays to drivers in the Goleta area. Delays caused by ramp meters would cause traffic diversions with adverse impacts to City roadways and intersections.

City staff agrees with the analysis results that ramp meters do not provide an overall benefit. As mentioned in the draft report, any modest improvement in freeway operations would be more than offset by increased congestion on local streets at the highway ramps. Of interest, the report notes that a large portion of US 101 traffic through the City either originates at, or is destined for locations within the City. Ramp meters have been found to be more effective when a larger portion of the freeway traffic is passing through the

City. Therefore, City staff does not recommend installing ramp meters at this time. However, the decision to install ramp meters would ultimately be made by Caltrans. Further study and analysis of the expanded study area is necessary to holistically understand the impacts. A combination of capacity increasing projects, ramp metering, other Intelligent Transportation Systems (ITS) and Transportation Demand Management (TDM) strategies, including ridesharing, telecommuting, and alternative work schedules, and increased local and commuter bus service, could potentially achieve meaningful reductions in congestion and increased travel time reliability.

Next Steps:
SBCAG staff will present the draft to regional Technical Transportation Advisory Committee (TTAC) and SBCAG's Board of Directors (April 19). The second public workshop will be held in the evening of April 19, 2018. SBCAG staff will incorporate any comments and suggestions received from today's Council meeting, from the Study TAC, TTAC, from the SBCAG Board of Directors, and from the public at the second workshop. Staff will then present a final draft study to TTAC in May for recommendation to the SBCAG Board to accept the results of the study.

FISCAL IMPACTS:

There is no fiscal impact associated with this item.

Reviewed By:

Carmen Nichols
Deputy City Manager

Approved By:

Michelle Greene
City Manager

ATTACHMENTS:

1. Draft Goleta Ramp Metering Study
2. Study Area & Count Locations
3. Scenario Alternatives
4. Stantec Memo – Goleta Ramp Metering Study – DRAFT Ramp Metering Analysis Results

ATTACHMENT 1

Draft Goleta Ramp Metering Study

SANTA BARBARA COUNTY ASSOCIATION OF GOVERNMENTS

GOLETA RAMP METERING STUDY

DRAFT REPORT

MARCH 5, 2018

KITTELSON & ASSOCIATES

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TABLE OF CONTENTS

1. INTRODUCTION

The Goleta Ramp Metering Study is exploring the feasibility and potential impacts of installing ramp meters along US 101 and State Route 217 (SR 217) to regulate the flow of vehicles entering the freeway, which could allow the freeways to flow better during periods of higher traffic volumes. The focus area of the study is US 101 between Turnpike Road and Cathedral Oaks Road and SR 217 from Sandspit Road to US 101 (Figure 1). The study also includes evaluation of parallel facilities and intersections to determine potential diversion impacts.

IN THIS REPORT>>

- Data collected
- Existing transportation operations
- Effects of alternative ramp metering strategies
- Evaluation based on performance measures

1.1 SUMMARY

The data collection and key findings are summarized below.

Data Collection

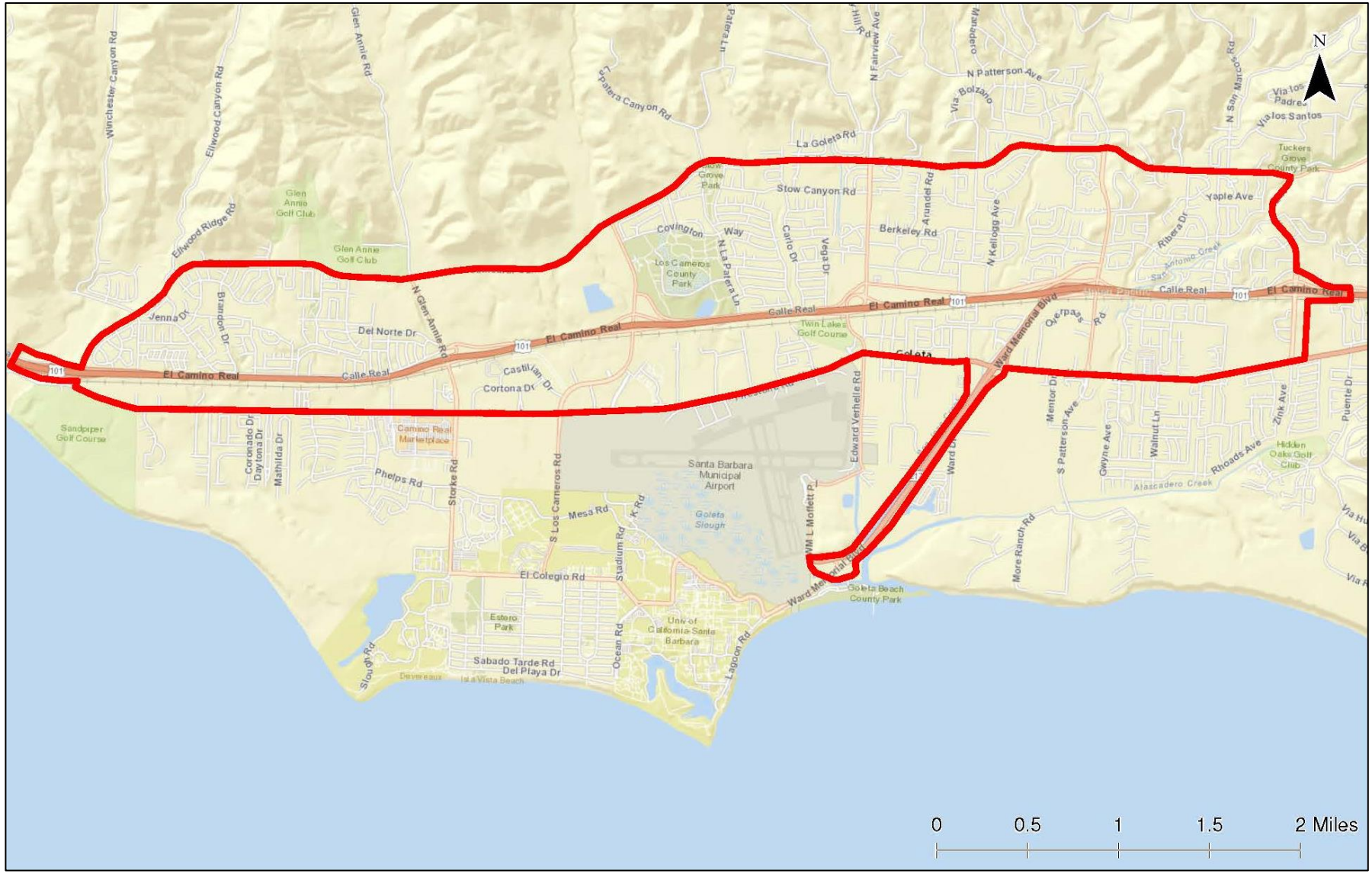
Several types of new data were collected in the Fall of 2016:

- Traffic counts on the US 101 and SR 217 freeways
- Traffic counts on all freeway on and off ramps in the study area
- Vehicle occupancies and classifications on SR 217
- Travel times and speeds using floating car surveys

Additional information was compiled from available sources:

- Freeway mainline traffic counts on US 101 from the Caltrans PeMS system
- Arterial and intersection traffic counts from the City of Goleta
- Collision data from the Caltrans TASAS system

Figure 1: Goleta Ramp Metering Study Area



Baseline Analysis

Freeway Mainline Operations

The travel time surveys, level of service analysis based on density and visual field observations all confirmed the key congestion locations, with speeds less than 35 mph and LOS F densities:

AM Peak Period (between 7:00 and 9:00 AM)

- SB US 101 at the Los Carneros Road Interchange, from 7:30 AM to 8:00 AM
- SB US 101 near the Turnpike Road interchange from 7:30 AM to 8:15 AM

PM Peak Period (between 4:00 and 7:00 PM)

- SB US 101 near the Turnpike Road interchange from 4:00 PM to 6:30 PM
- NB SR 217 approaching US 101 from 4:00 PM to 6:30 PM

Freeway Speeds

- Median speeds on US 101 were 67 to 70 mph, with 85 percent of vehicles driving at 77 mph or less.
- The speeds on SR 217 at Sandspit Road were slower (median speeds of 53 to 59 mph and 85th percentile speeds of 64 to 67 mph), as this location is near the endpoint of freeway operations.

Vehicle Occupancies

- High-occupancy vehicles (autos and buses) account for about 13 percent of the vehicles on northbound SR 217, including 2.0 percent bus/shuttle in the AM peak period and 0.6 percent bus/shuttle in the PM peak period.

Intersection Operations

- Based on a Highway Capacity Manual operations analysis, the intersection of Fairview Avenue and Calle Real operates at LOS E during the PM peak hour, and other study intersections currently operate at LOS D or better during the AM and PM peak hours. Individual movements at certain intersections may have higher delays than the intersection averages.

Collisions

- The collision rates on US 101 and SR 217 in the study area are higher than the statewide averages for similar facilities, although the rates for severe injury accidents are similar to statewide averages.
- The interchange with the highest number of fatal or injury accidents was US 101 at Storke/Glen Annie, with 21 injury crashes between 2012 and 2015.

Transit Service

- Three transit operators and 15 bus routes use one or more freeway interchanges in the study area.

Base Year Evaluation

For 2016 base year traffic levels, ramp metering on southbound US 101 could increase average PM peak period (between 4:00 and 7:00 PM) freeway speeds by up to 27 percent, from 44 to 62 miles per hour (mph). While total vehicle delay would be decreased on the freeway, the decreases would be more than offset by increases in delay at the metered on-ramps and on local streets due to traffic diversion. Up to two of the nine study intersections would have a change in level of service from D to E due to diversion.

Future Year Evaluation

With 2035 traffic conditions, there would be significant congestion on the freeway during the PM peak period in the southbound direction, and some congestion southbound in the AM period and northbound in the PM period. With the projected amount of congestion, ramp metering would not be able to significantly increase freeway speeds. As with the base year evaluation, any decreases in freeway delay due to ramp metering would be more than offset by increases in delay at metered on-ramps and on local streets due to diversion.

Conclusions

- Ramp metering alone could provide benefits to the US 101 freeway through Goleta, but would not provide overall travel time benefits to the transportation system within the Goleta study area.
- Ramp metering in the Goleta area may or may not provide additional benefits to freeway. operations beyond the Goleta study area (to the south of Turnpike Road) but further study of the extended area would be required.
- A more comprehensive evaluation of ramp metering, beyond the resources of this study, would consider effects on vehicle safety, air quality, and economic effects including goods movement through the US 101 corridor.
- Based on the results included in this report, further study and analysis of the Goleta study area is necessary to achieve impactful reductions in congestion.
- A combination of ramp metering, other Intelligent Transportation Systems (ITS) and Transportation Demand Management (TDM) strategies, including ridesharing, telecommuting, and alternative work schedules, and increased local and commuter bus service, could potentially achieve meaningful reductions in congestion and increased travel time reliability.

2. DATA COLLECTION

IN THIS SECTION>>
- Physical inventory
- Freeway counts and surveys
- Local traffic counts
- Travel time data collection
- Collision data

Several types of data were collected to provide baseline information for the ramp metering study:

- Inventory of freeway and ramp physical features
- Freeway mainline volume and vehicle classification counts
- Freeway ramp volume and vehicle classification counts
- Compilation of arterial traffic counts
- Passenger occupancy counts on State Route (SR) 217
- Freeway mainline travel times using floating car surveys
- Collision data

Data collection locations are summarized in Figure 2.

2.1. FREEWAY AND RAMP PHYSICAL FEATURES

US 101 Freeway

US 101 is a state highway that is considered to be a north-south route through California, and has both controlled-access freeway sections and conventional highway sections. Within Goleta, US 101 runs in an east-west direction and is a controlled access freeway. For this report, the direction towards San Luis Obispo is referred to as "northbound" and the direction towards Santa Barbara is referred to as "southbound."

There are two lanes in each direction in the west part of the study area and three lanes in each direction in the east study area. In the northbound direction, the three lanes merge into two lanes just past the Fairview Avenue off-ramp. In the southbound direction, there is a third auxiliary lane between the Storke Road on-ramp and the Los Carneros Road off-ramp. A full third lane is added at the Fairview Avenue on-ramp.

Ramp Configurations

The physical features of the existing freeway ramps were inventoried based on aerial photography and verified by field review (Table 1). The lengths of ramps were measured from their intersection with the surface network to the merge point. Storage length estimates factor in the number and length of lanes along the ramps. Storage would be reduced with the installation of ramp meters by the amount of setback of the meter from the merge point.

The eastbound and westbound SR 217 ramp intersections at Hollister Avenue will be reconstructed as roundabouts, with design plans at 95 percent constructability review as of February, 2018.

Figure 2: Data Collection Locations

Table 1: Goleta Freeway Ramp Configurations

Interchange	Ramp	Length (ft)	Intake Lanes	Output Lanes	Total Storage (ft)
US 101 Ramps					
Turnpike Road	NB Off-Ramp	1,200	1		2,000
	NB On-Ramp	1,250	2	1: Merge	1,450
	SB Off-Ramp	1,100	1		1,550
	SB On-Ramp	1,250	2	1: Merge	1,600
Patterson Avenue / SR 217	NB US 101 Off-Ramp	775	1		1,175
	NB US 101 On-Ramp	2,150	2: 1 to SR 217 WB	1: Merge	2,150
	WB SR 217 Off-Ramp	1,100	2: 1 to US 101 NB	1: Merge	1,100
	NB US 101 – WB SR 217 Connector	1,050	1	1: Exclusive Lane	1,250
	SB US 101 Off-Ramp	2,025	1	: Left fed by SR 217	2,025
	EB SR 217 – SB US 101 Connector	950	2	1: Merge	1,350
	EB SR 217 Off-Ramp	1,050	1	: Left fed by US 101	1,050
	SB US 101 On-Ramp	1,650	2	1: Merge	2,150
Fairview Avenue	NB Off-Ramp	1,100	1		1,250
	NB On-Ramp	750	2	1: Merge	950
	SB Off-Ramp	1,150	1		1,500
	SB On-Ramp	1,100	2	1: Exclusive Lane	1,425
Los Carneros Road	NB Off-Ramp	1,250	1		1,825
	NB On-Ramp	1,375	2	1: Merge	1,575
	SB Off-Ramp	1,650	1		1,650
	SB On-Ramp	2,125	2	1: Merge	2,725
Glen Annie Road / Storke Road	NB Off-Ramp	2,850	1		4,100
	NB On-Ramp	1,375	1	1: Merge	1,375
	SB Off-Ramp	1,400	1		1,700
	SB On-Ramp	1,425	3	1: Exclusive Lane	3,125

Table 1: Goleta Freeway Ramp Configurations

Interchange	Ramp	Length (ft)	Intake Lanes	Output Lanes	Total Storage (ft)
Winchester Canyon Road / Cathedral Oaks Road	NB Off-Ramp	650	1		650
	NB On-Ramp	1,250	2	1: Merge	1,275
	SB Off-Ramp	2,000	1		2,825
	SB On-Ramp	1,075	1	1: Merge	1,075
SR 217 Ramps					
Hollister Avenue*	WB Off-Ramp	1,300	1		1,950
	WB On-Ramp	1,150	1	1: Merge	1,150
	EB Off-Ramp	1,375	1		1,750
	EB On-Ramp	1,225	2	1: Merge	1,400

*The eastbound and westbound SR 217 ramp intersections at Hollister Avenue will be reconstructed as roundabouts, with design plans at 95 percent constructability review as of February, 2018.

Source: Kittelson & Associates, 2017

2.2. TRAFFIC COUNTS

Traffic counts were compiled for the US 101 and SR 217 mainline freeways, each study area ramp, and arterial segments and intersections in the study area.

Traffic counts were intended to be conducted all during the same week in early October. However, due to equipment issues and the need for recounts, the freeway mainline counts were not completed until late October/early November. Additional data from the Caltrans Performance Measurement System (PeMS) were reviewed to determine if the mainline counts from one week would be compatible with ramp counts from a different week.

Freeway Mainline Counts

Radar-based non-intrusive devices (Wavetronix) were installed to capture vehicular volumes and speeds on the US 101 and SR 217 freeway mainline. The Wavetronix units were deployed at the following three locations:

1. US 101 at Turnpike Road (October 31 – November 7)
2. US 101 at Cathedral Oaks Road (October 24 – October 31)
3. SR 217 at Sandpit Road (October 24 – November 6)

The Wavetronix data is summarized at 15 minute intervals for each day surveyed. The Wavetronix units also collect information on spot speeds and vehicle classifications.

Freeway Detector Counts (PeMS)

The freeway mainline counts, ramp counts and travel time surveys were conducted during several different weeks. The mainline counts were conducted during late October and early November, while the ramp counts were from the first two weeks of October. Therefore, freeway volumes were evaluated for each of the survey weeks to determine if there were any significant differences in traffic conditions during the different data collection efforts. The Caltrans Freeway Performance Measurement System (PeMS) database can provide travel speed and traffic count data for any day for each individual lane at selected locations where loop detectors are operating. The PeMS data were not used as the primary source for reporting average travel speeds and times; the floating car surveys were the primary source for average speeds and times.

Individual loop detectors do not always operate acceptably, so the PeMS data were screened to ensure that the analysis only includes data from detectors with acceptable operation during the survey period. For each detector, the PeMS system reports an estimated "data quality" percentage of acceptable operation during a given time period. If a detector is not providing data, the PeMS system uses information from adjacent detectors and historical records to impute the missing count and speed information. For this study, results for a set of detectors at a specific freeway location during a specific hour were only used if the data quality percentage was reported as 80 percent or higher.

The daily traffic volumes during each of the survey weeks are summarized in Table 2 and Figure 3. There is no clear trend of one week being higher or lower than other weeks throughout the corridor. In general, traffic volumes during each week were within five percent of the average for the survey period. The largest difference was during the second week of October, when the daily volumes were 9.4 percent lower than the period average in the southbound direction west of Fairview Drive.

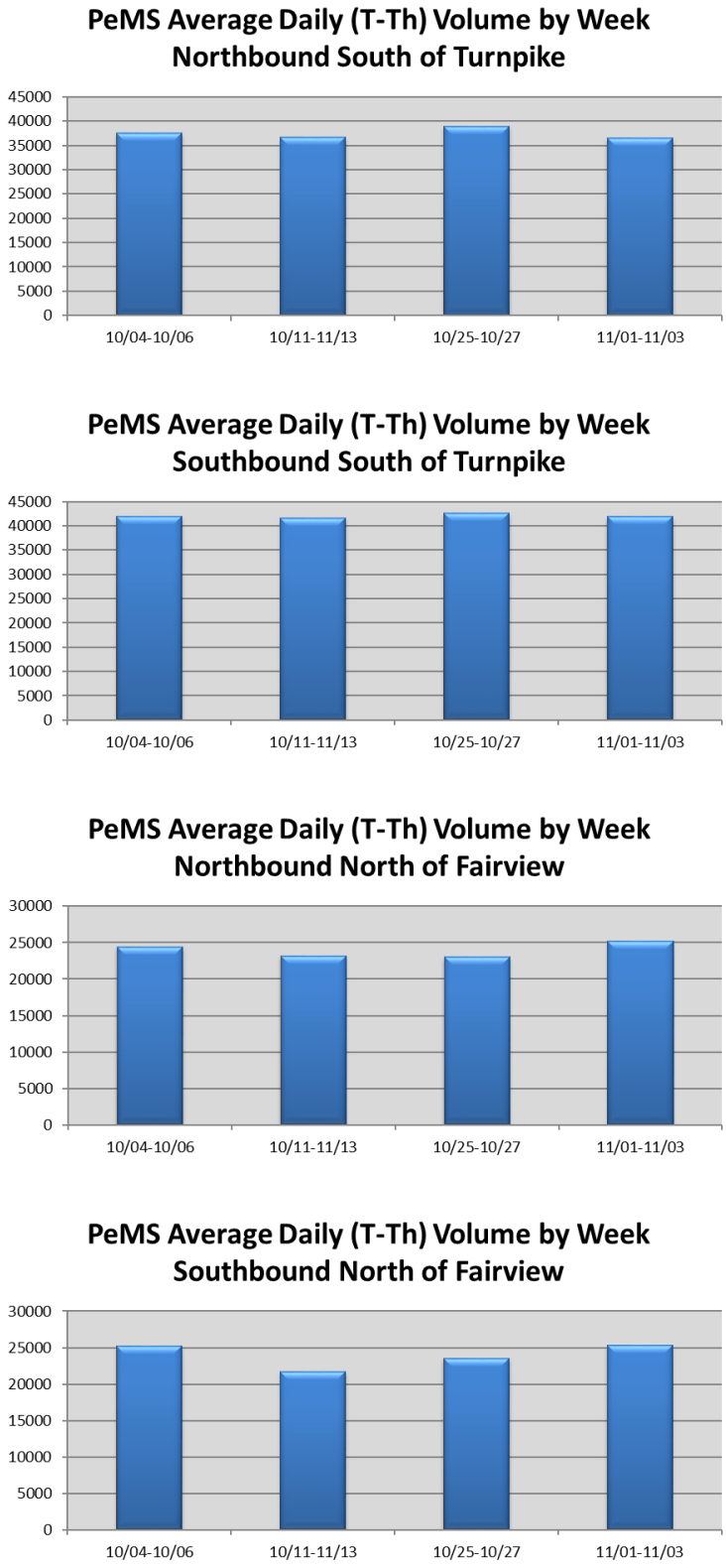
Table 2: Average US 101 Weekday Volumes from PeMS

Week	West of Turnpike Northbound	East of Turnpike Southbound	West of Fairview Northbound	West of Fairview Southbound
10/4-10/6	37,630 (+0.5%)	42,020 (0.0%)	24,460 (+2.1%)	25,270 (+5.5%)
10/11-10/13	36,680 (-2.0%)	41,610 (-1.0%)	23,210 (-3.1%)	21,710 (-9.4%)
10/25-10/27	38,990 (+4.1%)	42,550 (+1.3%)	23,010 (-4.0%)	23,530 (-1.8%)
11/1-11/3	36,480 (-2.6%)	41,880 (-0.3%)	25,170 (+5.0%)	25,315 (+5.7%)
Average	**37,450**	**42,020**	**42,020**	**23,960**

Source: Kittelson & Associates, 2017

Because there were no consistent or significant differences in traffic volumes during the various survey weeks, it is assumed that the surveys from the various weeks can be used together to define the baseline conditions for the corridor.

Figure 3: Average US 101 Weekday Volumes from PeMS



Freeway Ramp Volumes

Traffic volumes at the on and off-ramps in the project area were collected for the mid-weekdays (i.e. Tuesdays, Wednesday and Thursday) for 32 freeway ramps (Table 3).

Table 3: Freeway Ramp Traffic Counts

Location	Ramp	Count Dates
US 101		
Cathedral Oaks Road	SB Off	October 4-7, 2016
Calle Real	NB On	October 4-6, 2016
Cathedral Oaks Road	SB On	October 4-6, 2016
Winchester Canyon Road	NB Off	October 4-6, 2016
Storke Road	SB Off	October 4-6, 2016
Glen Annie Road	NB On	October 11-13, 2016
Storke Road	SB On	October 4-6, 2016
Glen Annie Road	NB Off	October 11-13, 2016
Los Carneros Road	SB Off	October 4-6, 2016
Los Carneros Road	NB On	October 4-6, 2016
Los Carneros Road	NB Off	October 4-6, 2016
Los Carneros Road	SB On	October 4-6, 2016
Fairview Avenue	SB Off	October 4-6, 2016
Fairview Avenue	NB On	October 11-13, 2016
Fairview Avenue	SB On	October 4-6, 2016
Fairview Avenue	NB Off	October 4-6, 2016
Patterson Avenue	SB Off	October 11-13, 2016
Patterson Avenue	NB On	October 4-6, 2016
SR 217	SB On	October 11-13, 2016
SR 217	NB Off	October 11-13, 2016
Patterson Avenue	NB Off	October 4-6, 2016
Patterson Avenue	SB On	October 4-6, 2016
Turnpike Road	SB Off	October 4-6, 2016
Turnpike Road	NB On	October 4-6, 2016
Turnpike Road	NB Off	October 4-6, 2016
Turnpike Road	SB On	October 4-6, 2016
SR 217		
Hollister Avenue	NB Off	October 4-6, 2016
Hollister Avenue	SB Off	October 4-6, 2016
Hollister Avenue	NB On	October 4-6, 2016
Hollister Avenue	SB On	October 4-6, 2016
Patterson Avenue	SB On	October 11-13, 2016
Patterson Avenue	NB OFf	October 4-6, 2016

Arterial Segment Traffic Counts

Traffic counts for ten arterial segments were derived from intersection turn movement counts (Table 4). New traffic counts were not conducted on local arterials as part of the Goleta Ramp Metering Study because recent counts were available throughout the city from the Goleta Travel Demand Model Update.

Table 4: Arterial Segment Traffic Counts

Road	Location	Count Dates
Cathedral Oaks Road	North of US 101	April 2013
Cathedral Oaks Road	West of Fairview Avenue	April 2013
Glen Annie Road	North of US 101	April 2013
Hollister Avenue	West of Storke Road	April 2013
Hollister Avenue	West of Fairview Avenue	April 2013
Hollister Avenue	East of Turnpike Road	April 2013
Calle Real	West of Fairview Avenue	April 2013
Fairview Avenue	South of Hollister Avenue	April 2013
Patterson Avenue	South of US 101	April 2013
Turnpike Road	South of US 101	April 2013

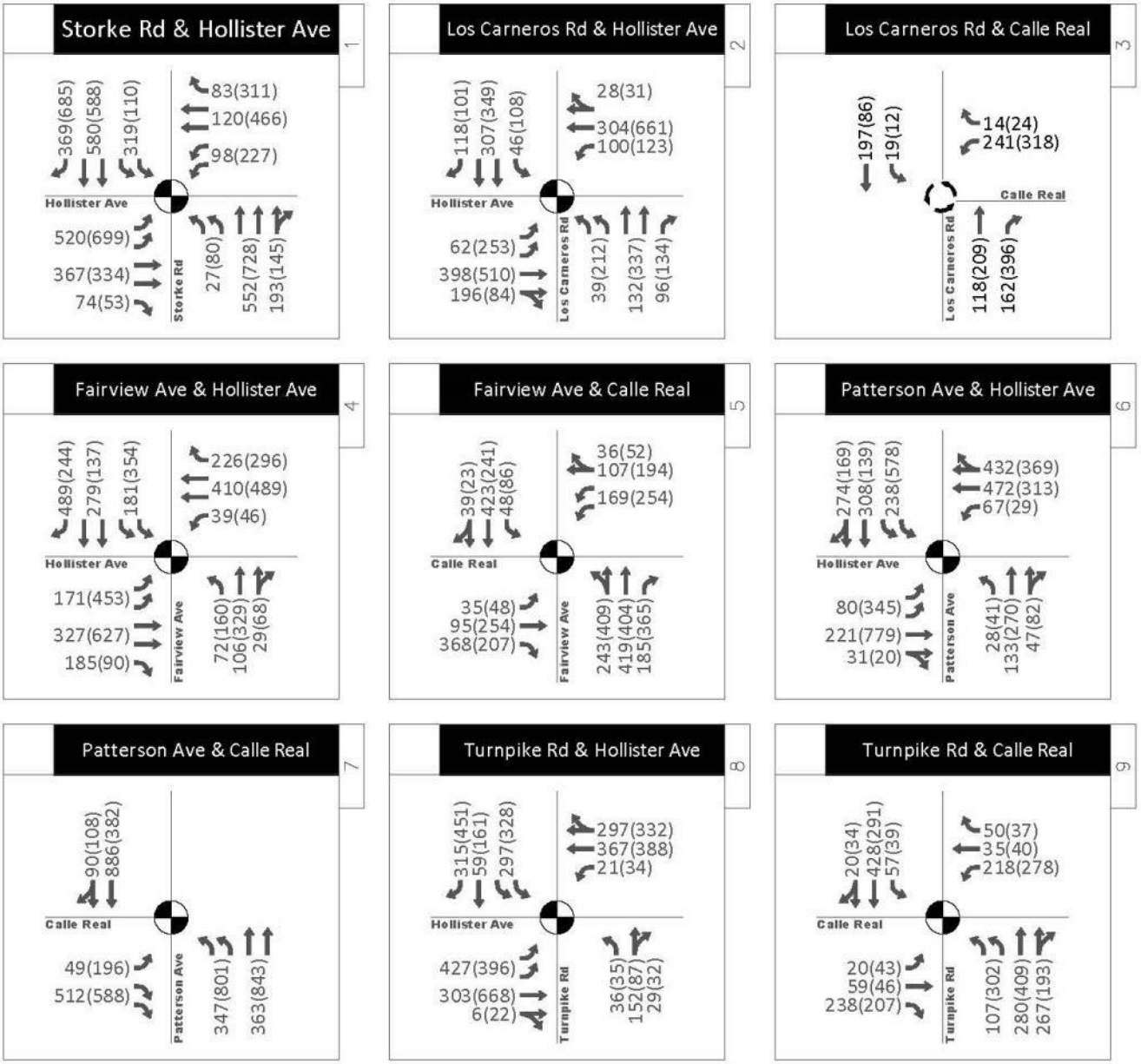
Arterial Intersections

Peak hour turn movement counts were compiled at nine study intersections (Table 5).

Table 5: Intersection Traffic Counts

No.	Intersection	Count Dates
1	Storke Road and Hollister Avenue	May 21, 2013
2	Los Carneros Road and Hollister Avenue	April 2, 2015
3	Los Carneros Road and Calle Real	April 2, 2015
4	Fairview Avenue and Hollister Avenue	April 8, 2015
5	Fairview Avenue and Calle Real	April 3, 2013
6	Patterson Avenue and Hollister Avenue	April 2, 2013
7	Patterson Avenue and Calle Real	April 2, 2013
8	Turnpike Road and Hollister Avenue	April 2, 2013
9	Turnpike Road and Calle Real	April 2, 2013

New traffic counts were not conducted at intersections as part of the Goleta Ramp Metering Study because recent counts were available from the Goleta Travel Demand Model Update and the current fee update study. In order to maintain consistency with other ongoing studies in the City of Goleta, the traffic counts from 2013 and 2015 have not been adjusted (Figure 4).



AM(PM) - Traffic Volume

STOP - All-Way Stop

- Stop Sign

- Traffic Signal

Roundabout

Existing Traffic Volumes
Goleta, CA

Figure **4**

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Traffic Count Summaries

The maximum hourly traffic counts were summarized at each individual location, as an indicator of the maximum volumes that would need to be accommodated by a ramp metering system (Figure 5). The highest on-ramp volumes were recorded at the SB ramp from Storke Road, with peak hour volumes of 1,490 in the AM (7 – 9) and 1,270 in the PM (4 – 6). Other high onramp volumes were also southbound in the PM peak period, from Los Carneros Road (1,010), Fairview Avenue (970), Patterson Avenue (940) and SR 217 (920). Based on field observations, the volumes from SR 217 and Patterson may be constrained by queues during the PM peak hour, with actual demand being higher than the counted throughput.

The mainline freeway and ramp counts were also averaged and adjusted and used to create a balanced flow map from one end of the corridor to another, representing typical weekday conditions (Figure 6). These balanced volumes are used as input to the operations analysis.

2.3. PASSENGER OCCUPANCY COUNTS

A manual vehicle occupancy count survey was conducted on northbound SR 217 upstream of the US 101 junction on September 27 and 28, 2016 during the AM and PM peak periods. The occupancy counts were classified as:

1. Single Occupant Vehicle
2. HOV 2+
3. Motorcycle
4. Heavy Vehicle
5. Bus
6. Shuttle
7. Unknown

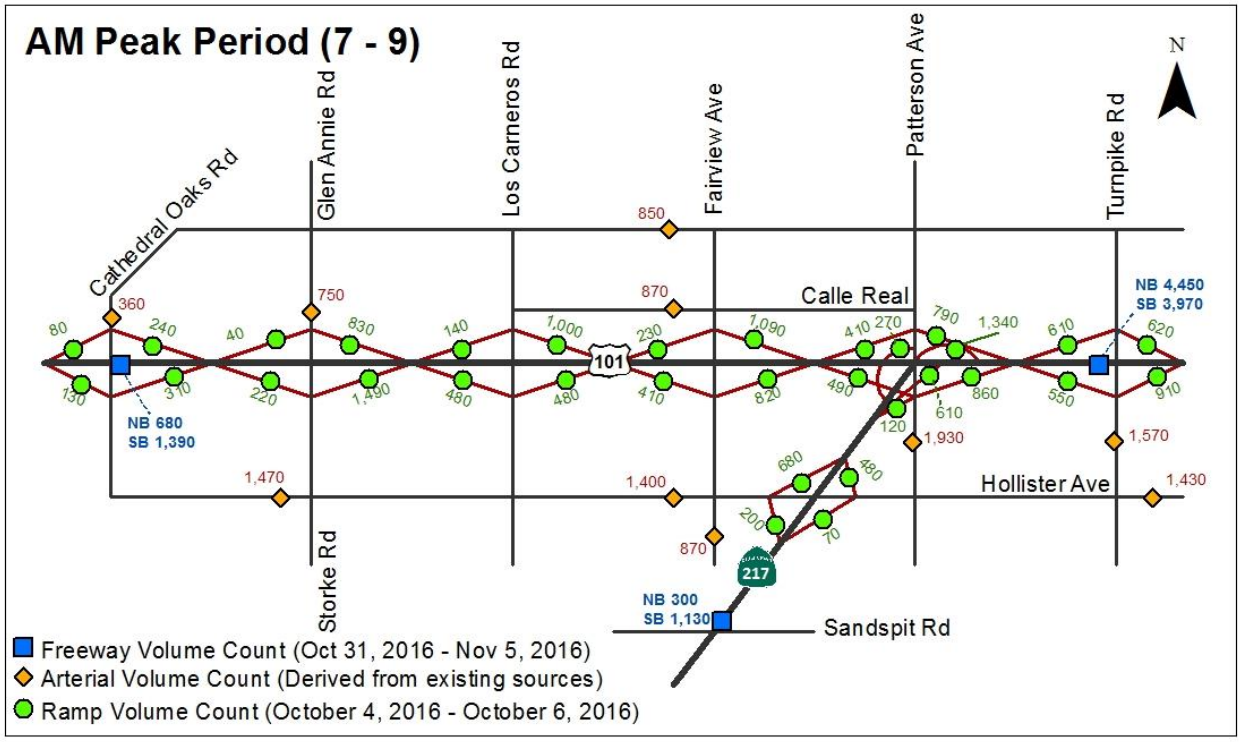
2.4. FREEWAY MAINLINE TRAVEL TIMES

GPS equipped floating cars were used to collect speed, delay and travel time data on the US 101 and SR 217 mainlines. The travel time surveys were conducted on October 4, 5, and 6, 2016. These data were summarized in approximately 15 minute intervals during both the AM and PM peak periods.

2.5. SAFETY DATA

The most recent available three years of collision records for US 101 and SR 217 were acquired from the Traffic Accident Surveillance and Analysis System (TASAS). The TASAS data cover crashes that occurred 2013 – 2015 and represent the only reliable data source used by Caltrans for safety analysis.

Figure 5: Maximum Peak Hour Volumes



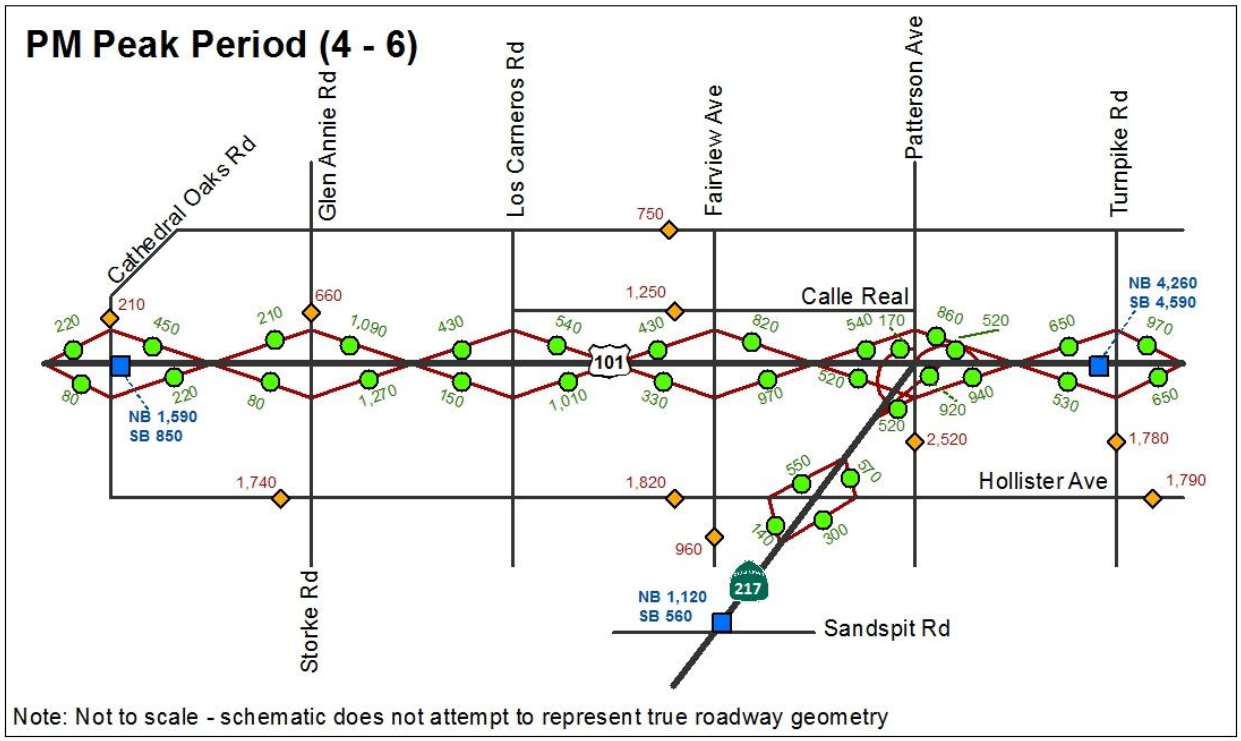
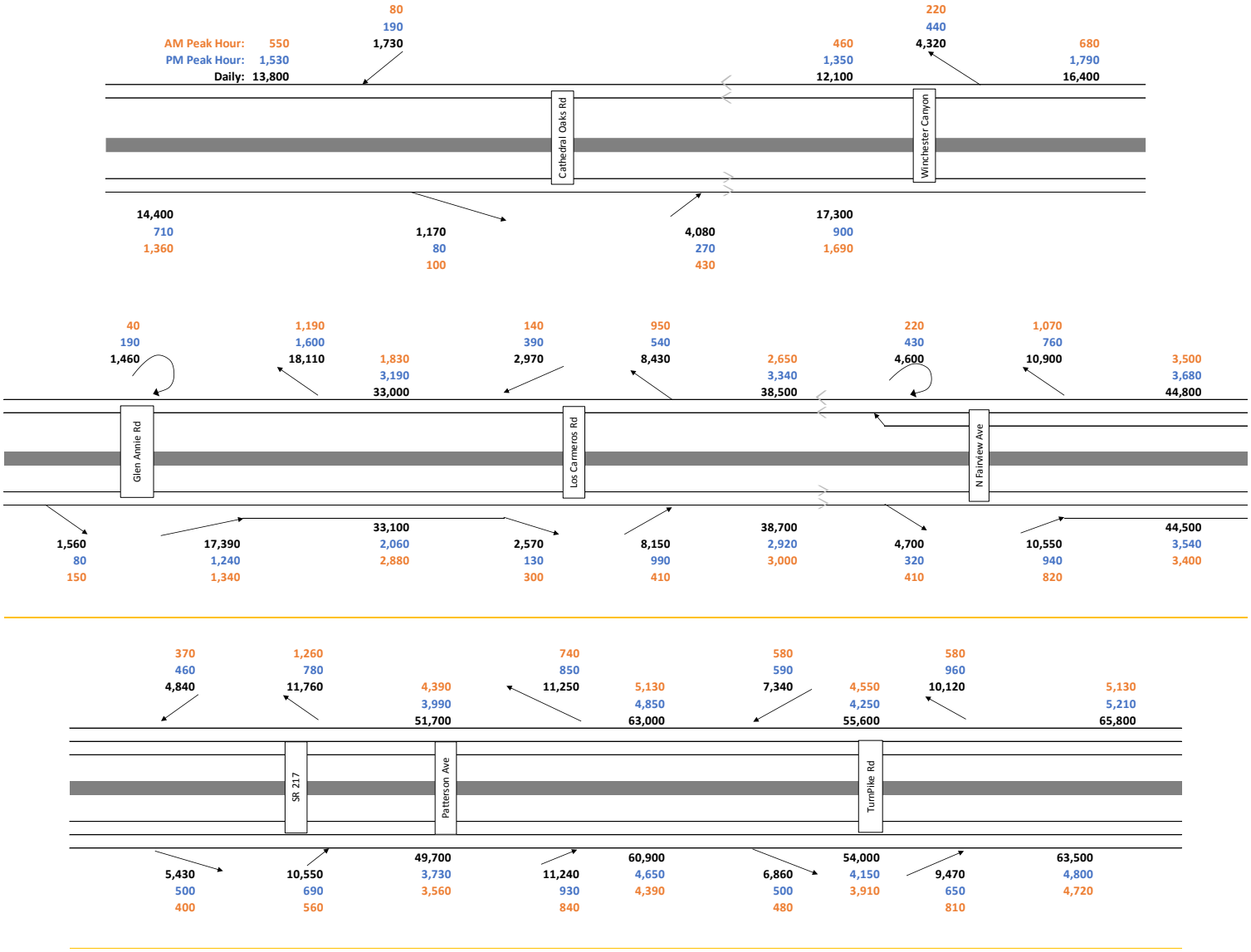


Figure 6: Balanced Daily and Peak Hour Volumes on US 101



For visualization purposes only, less comprehensive geocoded collision data from the Statewide Integrated Traffic System (SWITRS) for injury and fatal collisions were acquired from UC Berkeley's Transportation Injury Mapping System (TIMS). Over the 2013-2015 period, the SWITRS system reported 233 crash records along the study corridors. These data were not used for determination of crash causation or to support recommendations.

2.6. FIELD OBSERVATIONS

Members of the study team surveyed peak period conditions in October 2016 and February 2017. The observations included duration of congestion and the extents of congestion beyond the study area.

3. EXISTING BASELINE ANALYSIS

The existing baseline analysis uses the data described in Section 2 to describe operating conditions on freeways, ramps and streets in the study area. Safety and transit conditions are also described.

IN THIS SECTION>>

- Existing freeway operations
- Local intersection operations
- Transit service

3.1. FREEWAY MAINLINE OPERATIONS

Travel Times

Speed contour charts were created based on the floating car surveys (Appendix A). The speed contour charts show the measured speed in each segment of the freeways on each of the three survey days. The speed charts help to identify bottleneck locations, lengths of queues, and the duration of congestion in each location.

The following general observations were made:

AM Peak Period

- **US 101 Northbound**: Minimal congestion
- **US 101 Southbound**: Two bottlenecks are apparent. The first is at the Los Carneros Road Interchange which begins around 7:30 AM and ends around 8:00 AM. Congestion extends to the Storke Road interchange. The second bottleneck is near the Turnpike Road interchange which begins around 7:30 AM and ends around 8:15 AM. Congestion can extend to the Patterson Avenue off-ramp.
- **SR 217 Eastbound**: AM congestion appears to start at about 7:45 AM and ends 45-60 minutes later. The most congested area was getting on US 101 between the SR 217 merge and the Turnpike Road off-ramp.
- **SR 217 Westbound**: Minimal congestion between Turnpike Road and Patterson Avenue between 7:30 AM and 8:00 AM. Speeds around 50-55 mph.

PM Peak Period

- **US 101 Northbound**: Isolated locations of sporadic congestion within the study area.
- **US 101 Southbound**: Congestion starts between 4 and 4:45 PM and lasts until 6:15-6:30 PM. The congestion is the worst at around 5:15 PM when it stretches from Turnpike Road back to the Los Carneros Road Interchange.
- **SR 217 Eastbound**: PM congestion starts between 4 and 4:45 PM and lasts until 6:15-6:30 PM. The congestion is the worst at around 5:15 PM when it stretches back to the Hollister Interchange.
- **SR 217 Westbound**: Minimal congestion.

Freeway Spot Speed Surveys

The Wavetronix data collection also included speed information at the specific data collection points (Table 6). Median speed (50th percentile) is used to represent average rather than mean speed, as several very fast speeding vehicles can skew the mean to a value that does not represent typical driving

conditions. Median speeds on US 101 were 67 to 70 mph, with 85 percent of vehicles driving at 77 mph or less. The speeds on SR 217 at Sandspit Road were slower, as this location is near the endpoint of freeway operations.

Table 6: Freeway Spot Speed Surveys from Wavetronix Units

Freeway Segment	Median Speed (mph)	85th Percentile Speed (mph)
US 101 at Turnpike Road NB	70	77
US 101 at Turnpike Road SB	67	77
US 101 at Cathedral Oaks NB	n/a	n/a
US 101 at Cathedral Oaks SB	67	76
SR 217 at Sandspit Road NB	53	64
SR 217 at Sandspit Road SB	59	67

Freeway Level of Service

Freeway operations along US 101 and SR 217 were evaluated using traffic density to estimate the level of service (LOS) a given segment is likely to experience during the peak period (Table 7).

Table 7: Freeway Mainline Segment Level of Service Criteria

Level of Service	Maximum Density (passenger cars per mile per lane)
A	≤ 11
B	18
C	26
D	35
E	45
F	> 45

Source: Transportation Research Board, Highway Capacity Manual, 2010.

The Highway Capacity Manual specifies that density is the appropriate measure of LOS rather than speed, so a segment with dense traffic may have a lower LOS even with a relatively high speed. Density is an expression of the number of passenger car equivalents per mile per lane (pce/m/l). Large vehicles such as buses and trucks are given a higher weight in density calculations to better capture their impact on traffic flow.

The densities were calculated directly from measured data rather than using an operational analysis model. The densities for each segment are the peak hour volumes (as shown in Figure 6, page 16), adjusted to passenger car equivalents (pce) using truck percentages reported by Caltrans, divided by number of lanes, and divided by the average speeds measured from the floating car surveys (as shown in the speed contour maps). The resulting units of pce per hour divided by lanes and miles per hour are pce per mile per lane.

The level of service results are generally consistent with the speed results and visual observations (Table 8 and Table 9).

Table 8: Freeway Density and Level of Service, US 101

Location	AM			PM		
	Speed (mph)	Density (pc/m/l)	LOS	Speed (mph)	Density (pc/m/l)	LOS
US 101 Northbound						
Turnpike Road On-Ramp to Patterson Avenue Off-Ramp	59.4	30.6	E	40.9	40.7	F
Patterson Avenue Off-Ramp to SR 217 Off-Ramp	63.3	24.1	E	61.0	21.8	C
SR 217 Off-Ramp to Patterson Avenue On-Ramp	65.8	16.8	B	62.3	17.3	B
Patterson Avenue On-Ramp to Fairview Avenue Off-Ramp	66.3	18.7	C	63.8	19.5	C
Fairview Avenue Off-Ramp to Fairview On-Ramp	66.7	13.0	B	40.0	25.0	C
Fairview Avenue On-Ramp to Los Carneros Road Off-Ramp	61.4	20.8	C	44.2	37.9	F
Los Carneros Road Off-Ramp to Los Carneros Road On-Ramp	64.1	14.1	B	35.6	39.9	F
Los Carneros Road On-Ramp to Glen Annie Road / Storke Road Off-Ramp	61.5	15.0	B	47.1	35.1	F
Glen Annie Road / Storke Road Off-Ramp to Glen Annie Road / Storke Road On-Ramp	64.7	6.2	A	64.1	6.7	A
Glen Annie Road / Storke Road On-Ramp to Winchester Canyon Road Off-Ramp	66.2	6.5	A	66.7	14.9	B
Winchester Canyon Road Off-Ramp to Cathedral Oaks Road On-Ramp	67.4	5.0	A	65.7	11.7	B
US 101 Southbound						
Cathedral Oaks Rd Off-Ramp to Cathedral Oaks Rd On-Ramp	65.0	13.3	B	65.4	7.9	A
Cathedral Oaks Rd On-Ramp to Glen Annie Road / Storke Road Off-Ramp	65.4	14.6	B	67.3	9.0	A
Glen Annie Road / Storke Road Off-Ramp to Glen Annie Road / Storke Road On-Ramp	42.0	19.8	C	64.6	8.1	A
Glen Annie Road / Storke Road On-Ramp to Los Carneros Road Off-Ramp	18.6	57.8	F	64.4	11.9	B
Los Carneros Road Off-Ramp to Los Carneros Road On-Ramp	22.9	51.8	F	33.2	29.0	E
Los Carneros Road On-Ramp to Fairview Ave Off-Ramp	37.5	38.2	F	31.9	47.3	F
Fairview Ave Off-Ramp to Fairview Ave On-Ramp	50.3	33.8	E	26.2	49.6	F

Table 8: Freeway Density and Level of Service, US 101

Location	AM			PM		
	Speed (mph)	Density (pc/m/l)	LOS	Speed (mph)	Density (pc/m/l)	LOS
Fairview Ave On-Ramp to Patterson Ave Off-Ramp	52.1	22.8	C	19.4	60.1	F
Patterson Ave Off-Ramp to SR 217 On-Ramp	38.6	23.0	C	12.7	101.1	F
SR 217 On-Ramp to Patterson Ave On-Ramp	26.8	42.5	F	16.5	86.1	F
Patterson Ave On-Ramp to Turnpike Road Off-Ramp	30.9	45.1	F	28.2	63.5	F

Source: Kittelson & Associates, 2017 – pc/m/l is passenger car equivalent per mile per lane

Table 9: Freeway Density and Level of Service, SR 217

Location	AM			PM		
	Speed (mph)	Density (pc/m/l)	LOS	Speed (mph)	Density (pc/m/l)	LOS
SR 217 Eastbound						
Sandspit Road On-Ramp to Hollister Ave Off-Ramp	56.6	3.1	A	57.0	9.4	A
Hollister Ave Off-Ramp to Hollister Ave On-Ramp	59.2	2.4	A	46.6	8.4	A
Hollister Ave On-Ramp to Patterson Ave Off-Ramp	57.6	6.5	A	5.1	118.7	F
SR 217 Westbound						
Patterson Ave On-Ramp to Hollister Ave Off-Ramp	59.3	15.0	B	57.3	8.5	A
Hollister Ave Off-Ramp to Hollister Ave On-Ramp	65.6	7.7	A	60.2	3.7	A
Hollister Ave On-Ramp to Sandspit Road Off-Ramp	65.6	9.8	A	59.4	4.8	A

Source: Kittelson & Associates, 2017 – pc/m/l is passenger car equivalent per mile per lane

In the northbound direction, LOS F densities were measured during the PM peak hour approaching the Patterson Avenue off-ramp and the Glen Annie/Storke off-ramp, although the freeway speeds were generally above 35 mph. In the southbound direction, the LOS F locations were consistent with the locations where slow speeds were measured. In the AM peak hour, the LOS F densities occurred approaching the Los Carneros interchange where the through lanes are reduced from 3 to 2, and after the SR 217 on-ramp. In the PM peak hour, LOS F conditions were all related to the backup from the SR 217 and Patterson on-ramp merges.

The LOS on SR 217 was always LOS B or better, except for the segment approaching the US 101 merge during the PM peak hour where LOS F densities were measured.

Vehicle Occupancy

Manual observations of vehicle types and number of occupants (for passenger cars) were collected for two days on northbound SR 217 near the Hollister off-ramp. The average values excluding unknown vehicles are listed in Table 10. High-occupancy vehicles (HOV) and buses accounted for 13.4 percent of all vehicles in the AM peak period and 13.7 percent of PM peak period vehicles.

Table 10: Vehicle Occupancies on Northbound SR 217

Vehicle Class	AM Peak Period (7-9 AM)	PM Peak Period (4-7 PM)
Auto – Single occupant	83.0%	84.9%
Auto –Two or more occupants (HOV)	11.4%	13.1%
Motorcycle	0.4%	1.0%
Heavy Vehicles (trucks)	3.2%	0.4%
Bus/Shuttle	2.0%	0.6%
TOTAL	**100.0%**	**100.0%**

Source: Manual observations by Metro Traffic Group, September 27 and 28, 2016.

3.2. INTERSECTION OPERATIONS

Study intersections were evaluated to determine existing average delays and level of service. Intersections in the City of Goleta have typically been evaluated using an Intersection Capacity Utilization (ICU) method which provided a standard measure of capacity usage and impacts of added traffic. For this study, a *Highway Capacity Manual* (HCM) operations analysis is used as it also provides information on average vehicle delays on each approach and for the intersection as a whole. This provides the information required to estimate system delay for the various ramp metering alternatives. The level of service thresholds associated with each level of delay are summarized in Table 11.

Table 11: Level of Service Definition for Signalized Intersections

Level of Service	Description	Vehicle Delay (seconds per vehicle)
A	Very low delay	≤ 10
B	Minimal delay	> 10 – 20
C	Acceptable delay	> 20 – 35
D	Approaching unstable delay	> 35 – 55
E	Unstable operations and substantial delay	> 55 – 80
F	Excessive delay	> 80

Source: Transportation Research Board, *Highway Capacity Manual*, 2000 and 2010.

The analysis was conducted using the HCM 2000 methodology with Synchro 9.0 software. The HCM 2000 analysis was used as the HCM 2010 implementation in Synchro software did not properly evaluate the lane configurations for all of the Goleta study intersections.

The roundabout intersection at Los Carneros and Calle Real was analyzed using the HCM 2010 methodology which was the most current HCM methodology at the time that the methodologies for this study were established. It is recommended that further analysis of this roundabout location apply the Highway Capacity Manual 6th Edition (HCM 6) which includes updated critical and follow-up headway values that are more in line with California single-lane roundabout operating characteristics.

Typical actuated signal timing parameters were assumed for minimum green times, yellow and all-red clearance times. The cycle lengths were assumed to be optimized based on traffic demand.

The existing operations analysis (Table 12) indicates that the intersection of Fairview Avenue and Calle Real operates at LOS E during the PM peak hour, indicating that it is at capacity. The other study intersections currently operate at LOS D or better during peak hours. This implies that the intersections are busy, but most vehicles can get through the intersections without waiting for more than one cycle. Individual movements at certain intersections may have higher delays than the intersection averages.

Table 12: Existing Intersection Operations

ID	Intersection	Control	Peak Hour	Existing	
				LOS	Delay (sec)
1	Storke Road and Hollister Avenue	Signalized	AM	D	45.6
			PM	D	48.0
2	Los Carneros Road and Hollister Avenue	Signalized	AM	D	38.7
			PM	D	42.2
3	Los Carneros Road and Calle Real	Roundabout	AM	A	7.0
			PM	B	10.8
4	Fairview Avenue and Hollister Avenue	Signalized	AM	C	33.9
			PM	D	47.8
5	Fairview Avenue and Calle Real	Signalized	AM	D	39.1
			PM	E	56.2
6	Patterson Avenue and Hollister Avenue	Signalized	AM	D	35.5
			PM	D	52.9
7	Patterson Avenue and Calle Real	Signalized	AM	C	24.4
			PM	C	28.1
8	Turnpike Road and Hollister Avenue	Signalized	AM	D	50.7
			PM	D	48.2
9	Turnpike Road and Calle Real	Signalized	AM	D	38.5
			PM	D	52.7

Source: Kittelson & Associates, 2017

3.3. SAFETY EVALUATION

Official Caltrans statistics reported by the Traffic Accident Surveillance and Analysis System (TASAS) state that US 101 mainline between Turnpike Road and Cathedral Oaks Road had 287 reported crashes during the three year period between April 2012 and March 2015. That indicates a crash rate of 0.56 per MVMT (million vehicle miles traveled) which compares with the statewide average for similar facilities of 0.50 per MVMT. The average rate of severe crashes was 0.17 per MVMT which is exactly on par with the statewide average.

SR 217 had 28 reported crashes for the same period which indicates a crash rate of 0.58 per MVMT which compares to the statewide average of 0.52 per MVMT on similar facilities. Severe crashes were reported at a rate of 0.19 per MVMT comparted with the statewide average of 0.18.

The TASAS data represent the only reliable data source used by Caltrans for safety analysis. For visualization purposes only, less comprehensive geocoded collision data from the Statewide Integrated Traffic System (SWITRS) from the Transportation Injury Mapping System are mapped and shown in Appendix B.

3.4. TRANSIT OPERATIONS

Transit operations may be impacted by changing traffic patterns for routes using or crossing US 101 and/or SR 217. Therefore, it is crucial to consider HOV bypass lanes at metered ramps to minimize impacts to transit operations when the ramp is used as part of a transit route. An inventory of routes using or passing through potentially impacted interchanges are noted in this section and are shown in Figure 7 through Figure 10.

Santa Barbara Metropolitan Transit District (MTD)

Route 6

Route 6 uses Hollister Avenue with 20 minute headways during peak periods. 29 westbound and 36 eastbound weekday trips are made through the Hollister Avenue/SR 217 interchange.

Route 7

Route 7 uses Fairview Avenue with 30 minute headways during peak periods. 26 westbound and 25 eastbound weekday trips are made through the Fairview Avenue/US 101 interchange.

Route 10

Route 10 uses Glen Annie/Storke Road with >60 minute headways during peak periods. 5 westbound and 6 eastbound weekday trips are made through the Glen Annie/Storke Road/US 101 interchange.

Route 11

Route 11 uses Hollister Avenue with 20 minute headways during peak periods. 39 westbound and 38 eastbound weekday trips are made through the Hollister Avenue/SR 217 interchange.

Figure 7: Transit Routes Using US 101/SR 217 and Interchanges

Figure 8: Santa Barbara MTD Route 12x Map

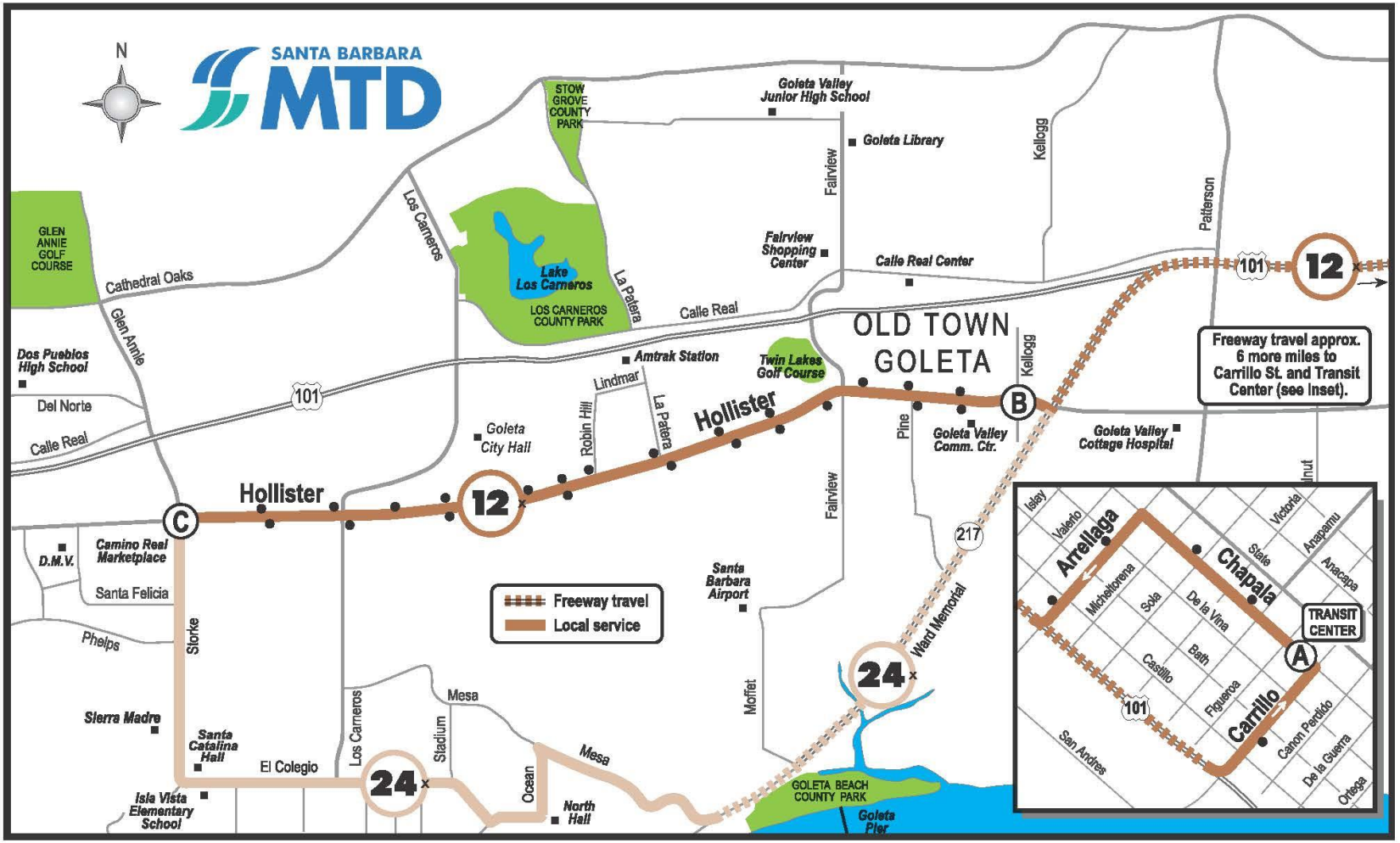


Figure 9: Santa Barbara MTD Route 15x Map

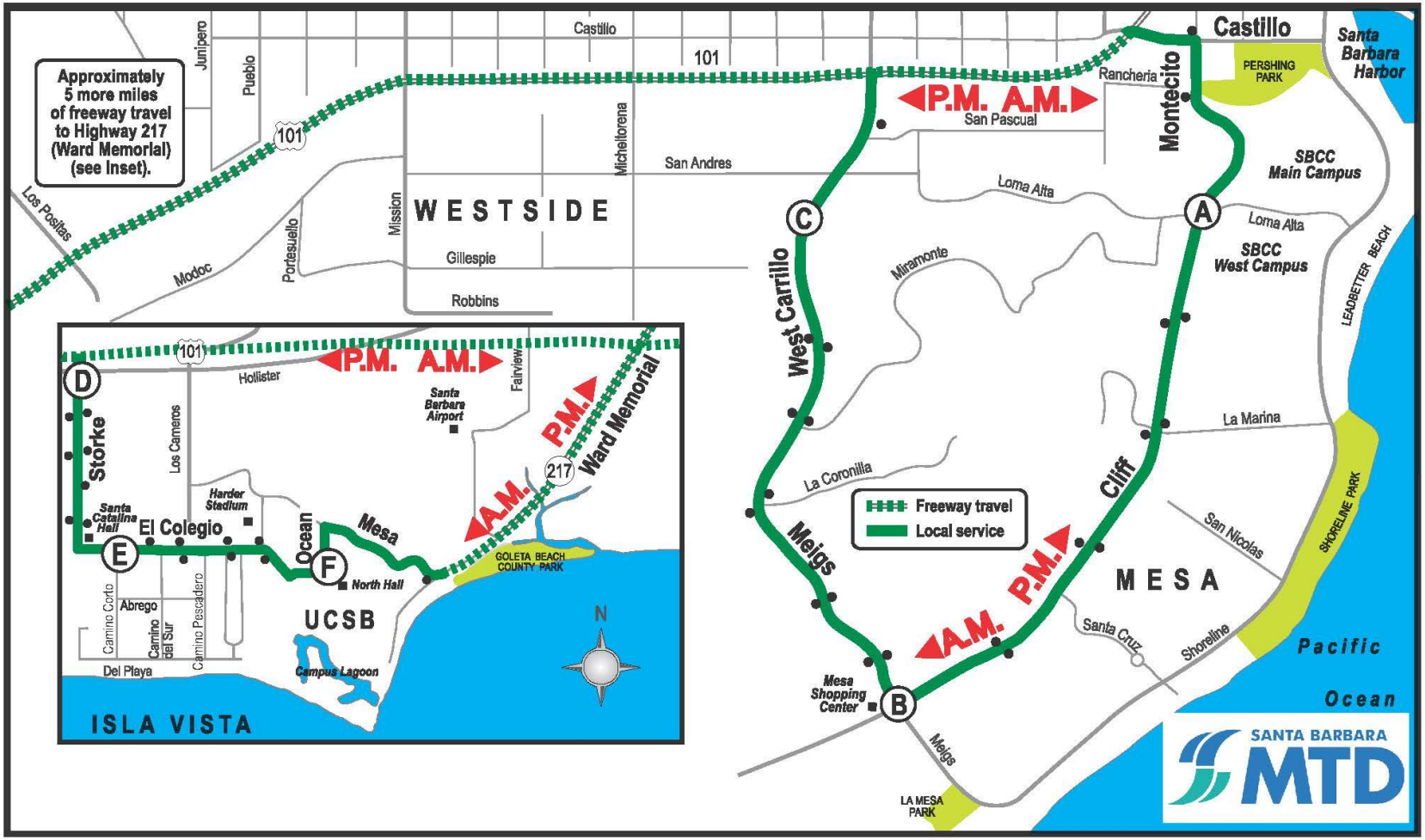
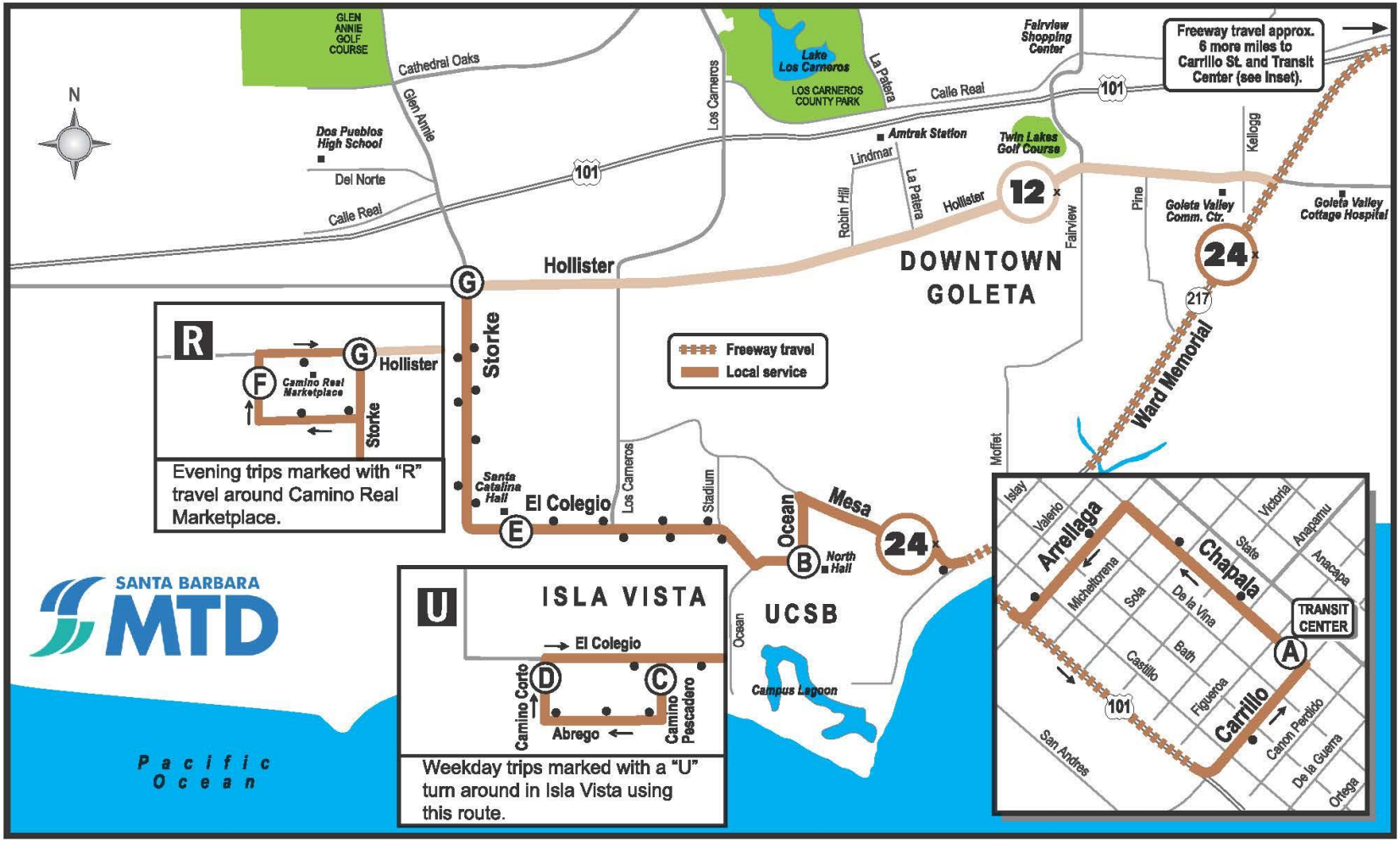


Figure 10: Santa Barbara RTD Route 24x Map



Route 12x

Route 12x uses both US 101 and SR 217 as well as both the US 101/SR 217 interchange and the Hollister Avenue/SR 217 interchange (Figure x). Headways are 30 minutes during peak periods. 18 westbound and 20 eastbound weekday trips are made.

Route 15x

Route 15x uses both US 101 and SR 217 as well as both the US 101/SR 217 interchange and the Glen Annie Road/Stork Road/US 101 interchange. Headways are approximately 30 minutes during peak periods. 37 westbound and 35 eastbound weekday trips are made.

Route 23

Route 23 uses Glen Annie/Storke Road with 60 minute headways during peak periods. 17 weekday trips are made in each direction through the Glen Annie/Storke Road/US 101 interchange.

Route 24x

Route 12x uses both US 101 and SR 217 as well as both the US 101/SR 217 interchange and the Sandspit Road/SR 217 interchange. Headways are 30 minutes during peak periods. 34 westbound and 36 eastbound weekday trips are made.

Route 25

Route 25 uses Cathedral Oaks Road and circulates along Winchester Canyon Road and Calle Real within the Cathedral Oaks Road interchange impact area. Headways are 30 minutes during peak periods. 14 westbound and 25 eastbound weekday trips are made.

Clean Air Express

Lompoc to Goleta

There are 5 daily southbound trips from Lompoc in the AM peak period and 5 northbound trips to Lompoc in the PM peak. 3 of those trips use the Cathedral Oaks Road/US 101 interchange, and 2 use the Glen Annie Road/Storke Road/US 101 interchange.

Lompoc to Santa Barbara

There are 2 daily southbound trips from Lompoc in the AM peak period and 2 northbound trips to Lompoc in the PM peak period. These trips do not use any interchanges in Goleta.

Santa Maria to Goleta

There are 3 daily southbound trips from Santa Maria in the AM peak period and 3 northbound trips to Santa Maria in the PM peak. These trips use the Cathedral Oaks Road/US 101 interchange.

Santa Maria to Santa Barbara

There are 2 daily southbound trips from Santa Maria in the AM peak period and 2 northbound trips to Santa Maria in the PM peak period. One of these trips uses the Turnpike Road/US 101 interchange, and one continues through the study area on US 101.

Santa Ynez Valley to Goleta and Santa Barbara

There are 2 daily southbound trips from Buellton in the AM peak period and 2 northbound trips in the PM peak period. One of these trips uses the Cathedral Oaks Road/US 101 interchange, and one uses the Turnpike Road/US 101 interchange.

Coastal Express

The Coastal Express runs 8 buses each weekday north to Goleta, and 6 south to Ventura. One additional AM trip on the Santa Barbara line also continues to UCSB. These trips use both US 101 and SR 217 through the study area, as well as the Turnpike Road/US 101 interchange, the Patterson Avenue/US 101 interchange and the Hollister Avenue/SR 217 interchange.

4. EVALUATION OF ALTERNATIVES

This section provides results of the analysis of ramp metering alternatives in the City of Goleta study area with both 2016 base year and 2035 future traffic volumes.

IN THIS SECTION>>

- Alternative ramp metering strategies
- Evaluation methodologies
- Effects of alternative ramp metering strategies on base year operations
- Future conditions

4.1. ALTERNATIVES

Several alternative ramp metering strategies were proposed for evaluation. The study alternatives are summarized in Figure 11:

- Alternative 1: Metering at Patterson SB on-ramp only
- Alternative 2: Metering at SR 217 SB on-ramp and Patterson SB on-ramp only
- Alternative 3: Metering at all on-ramps
- Alternative 4: Metering at Hollister on-ramps to SR 217 only
- Alternative 5: Metering at all on-ramps north of SR 217

Alternative 1 represents the ramp meter that has been installed on the southbound on-ramp from Patterson Avenue and was operational as of February, 2018.

Alternative 2 would include the existing ramp meter at Patterson and a proposed meter at SR 217, focusing on the current maximum congestion points.

Alternative 3 would meter all on-ramps in the study area, both northbound and southbound.

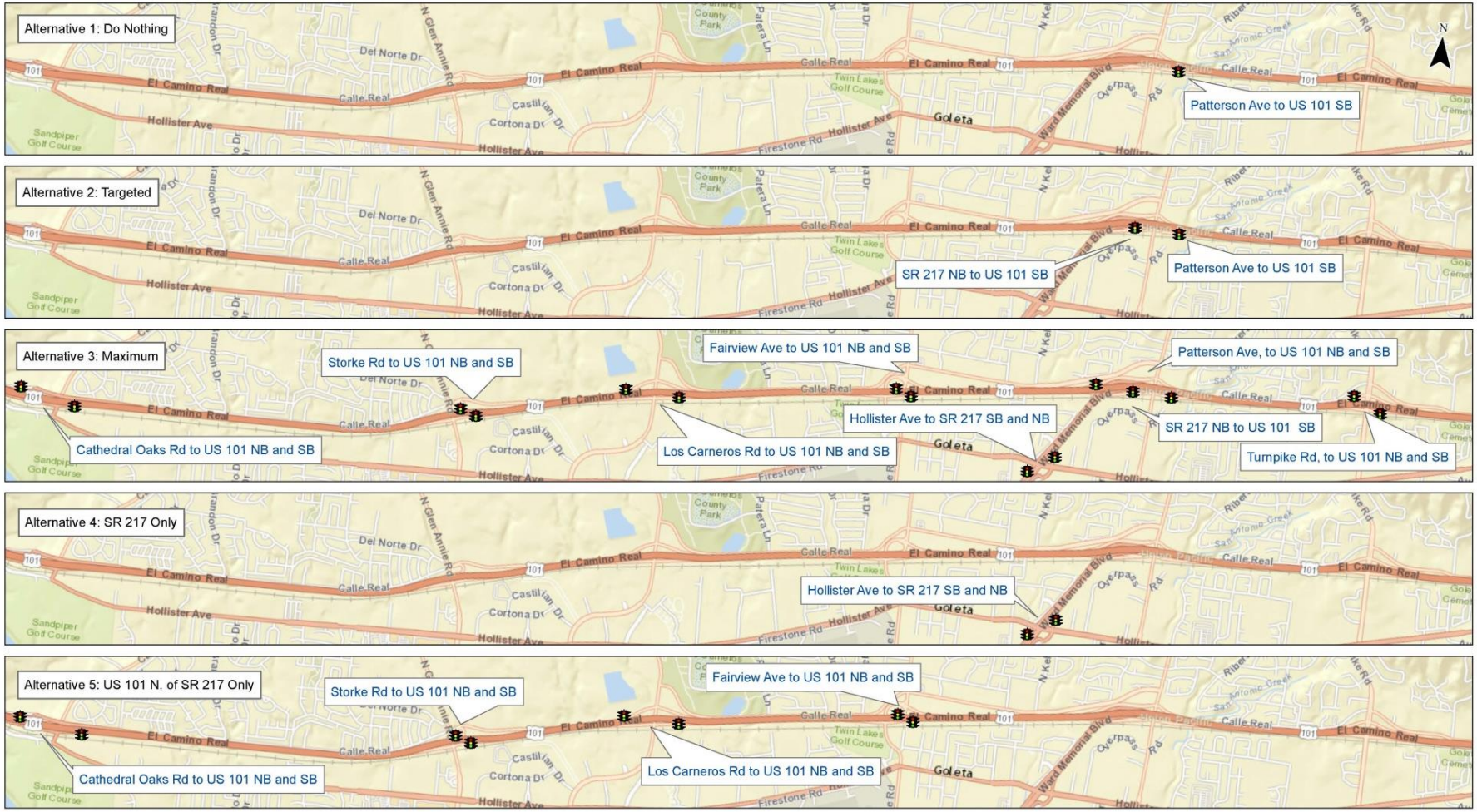
Alternatives 4 and 5 would test if traffic operations could be improved by metering on-ramps prior to the peak congestion points rather than directly at the peak congestion points. During initial testing, it was determined that Alternative 4, metering on the Hollister on-ramps to SR 217, would not provide significant changes to freeway operations. Therefore, the evaluation focuses on Alternatives 1, 2, 3 and 5.

4.2. METHODOLOGY

The evaluation of the ramp metering alternatives involved several modeling steps:

- A freeway operations model using the FREQ software was used to identify the most effective rates for ramp metering and to report freeway speeds and ramp meter delays.
- Local streets were evaluated using the Goleta traffic forecasting model which can predict vehicle diversions to alternative routes that would be induced by delays at ramp meters.
- An intersection operations analysis was conducted at selected indicator intersections to identify delay impacts caused by traffic diversion.

Figure 11: Goleta Ramp Metering Alternatives



Freeway Analysis

A simulation model using the FREQ software[1] was calibrated to replicate observed travel speeds in each segment of the US 101 study corridor during each 15-minute section of the AM and PM peak periods. The FREQ model was then applied with different on-ramps designated for ramp metering. The FREQ model optimizes the metering rates to best improve freeway operations, subject to typical Caltrans minimum rates of 240 vehicles per hour and maximum rates of 900 vehicles per lane per hour. The FREQ model was set to control queues at ramp meters so that no queues would spill back past the entrance to the on-ramp and affect local street flows.

The FREQ model reports freeway speeds, total vehicle-hours of travel on the freeway and on-ramp delays at meters for each 15-minute period and for the total peak period.

Source of FREQ Model

The FREQ model used for this study is the FREQ model originally developed and calibrated for the South Coast 101 (SC101) HOV Traffic Study in 2009. Input assumptions on speeds and capacities were maintained from the SC101 study for consistency. The lane geometries, input traffic volumes and observed speeds and queues were updated to 2016 conditions for this ramp metering study.

Calibration of FREQ Model

Before its application for future operations analysis, FREQ must be calibrated to reflect local conditions. The calibration methodology is consistent with the SC101 HOV Traffic Study and the Caltrans Freeway Analysis Manual. The calibration was performed by iteratively running FREQ under the existing condition and comparing the model predicted queues and travel times with those observed in the field. Capacity adjustments are made to the freeway sections until the congestion onset time, congestion clearance time, and length of queues match observed field data.

Observed corridor travel times and simulated travel times were compared for each 15 minute time interval during the AM and PM peak periods (Figure 12 to Figure 15). The model generally matches the peaking characteristics of the observed

Additional calibration comparisons including speed contours, percent of time intervals within 15% of observed travel times, and chi-square differences of the simulated versus observed speed are presented in Appendix C. The chi-square comparison is a general measure of goodness of fit and is calculated by taking the square of the differences between observed and simulated speeds, divided by observed speeds. Values are computed for each freeway segment and each time interval. The lower the chi-square value, the better the fit between the predicted and observed speed.

Overall, simulated speeds match reasonably well with observed speeds.

[1] Software version FREQ 12 PE Release 3.02

Figure 12: Observed and Simulated Corridor Travel Times, AM Peak Period, Northbound US 101

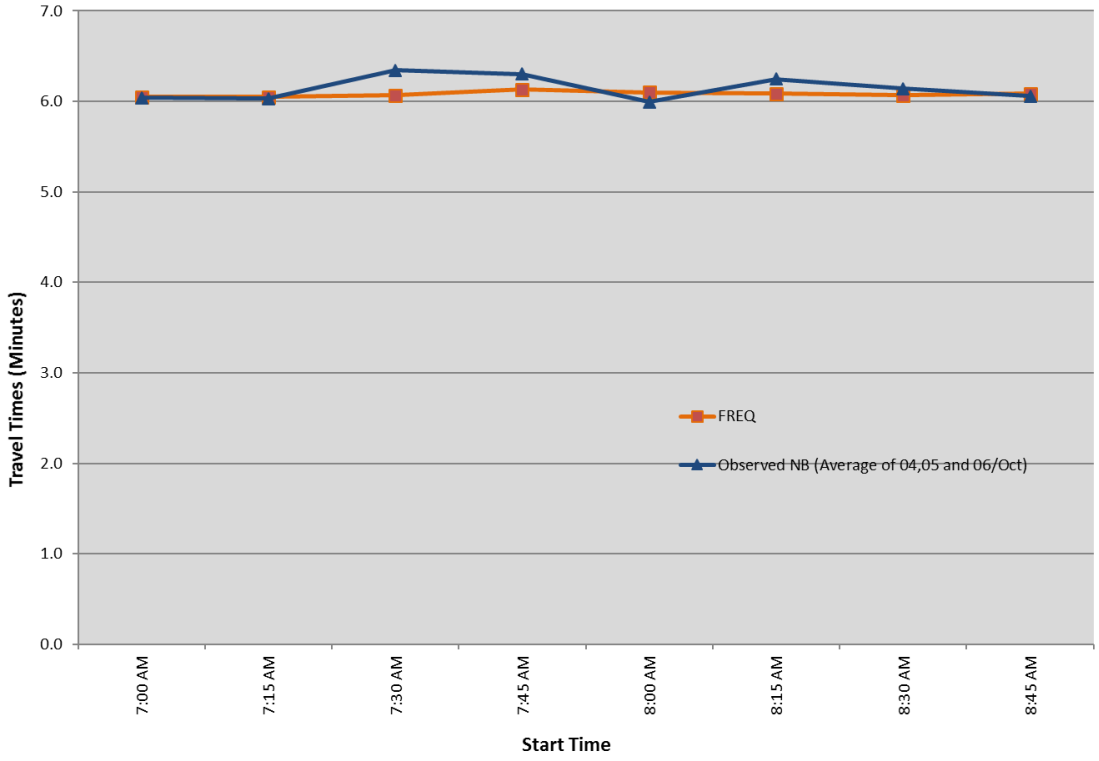


Figure 13: Observed and Simulated Corridor Travel Times, AM Peak Period, Southbound US 101

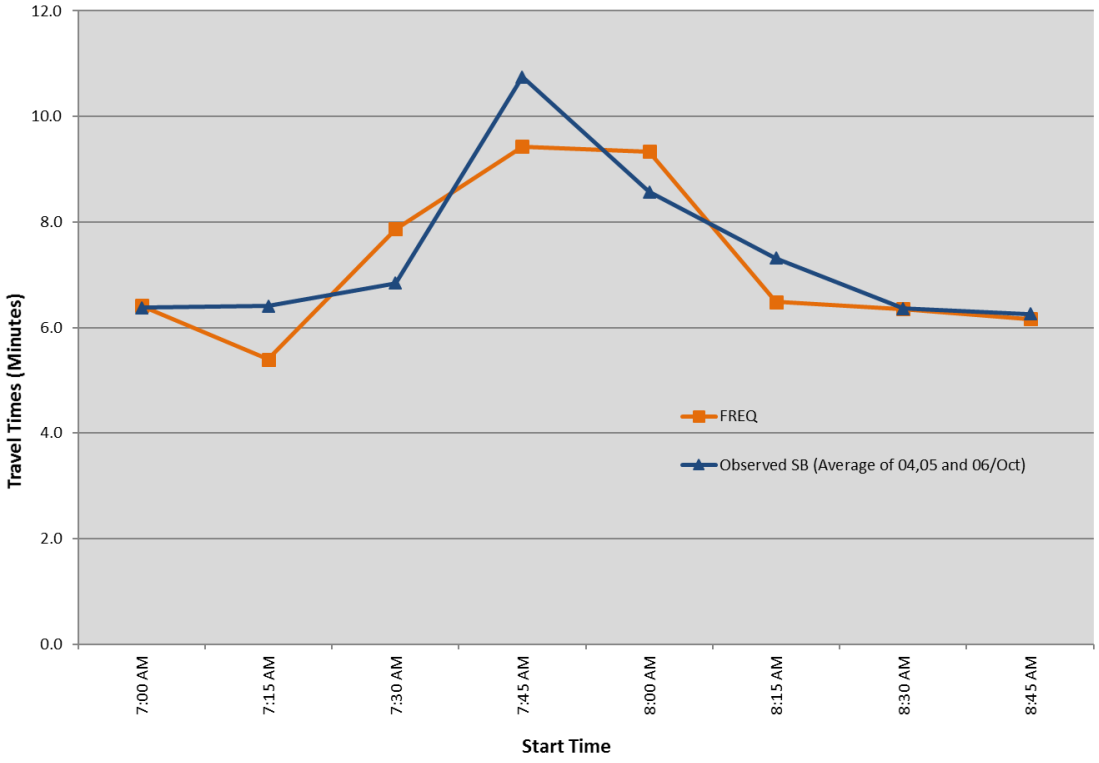


Figure 14: Observed and Simulated Corridor Travel Times, PM Peak Period, Northbound US 101

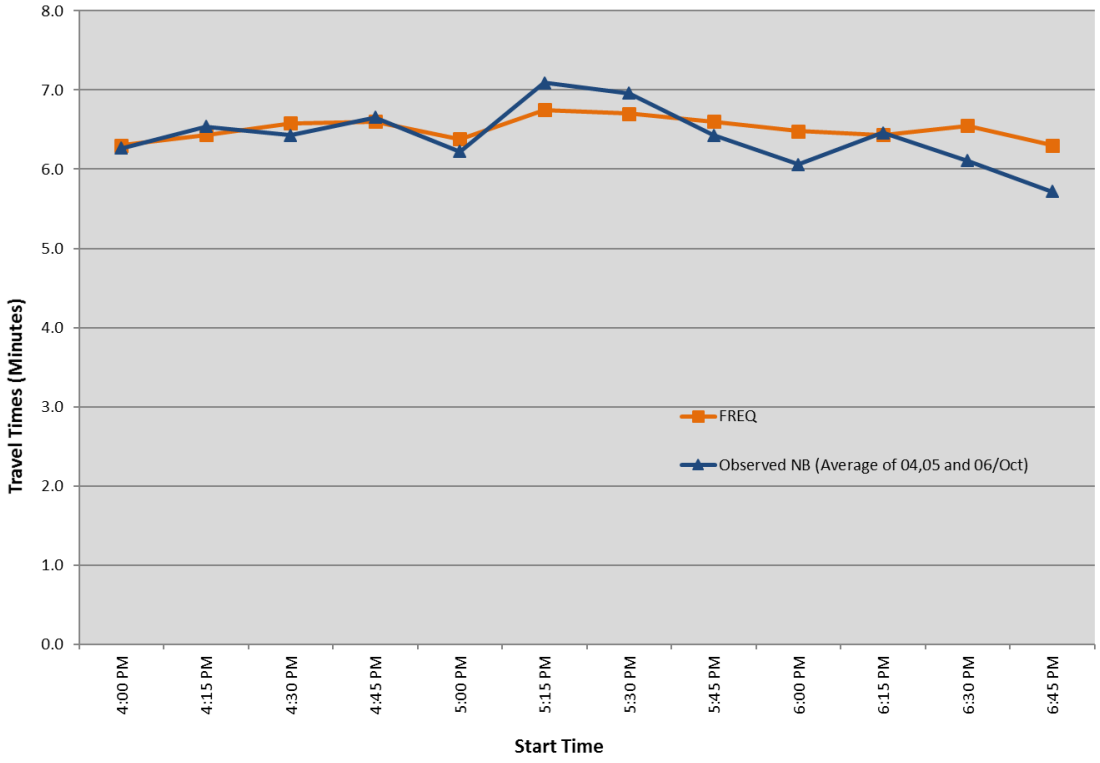
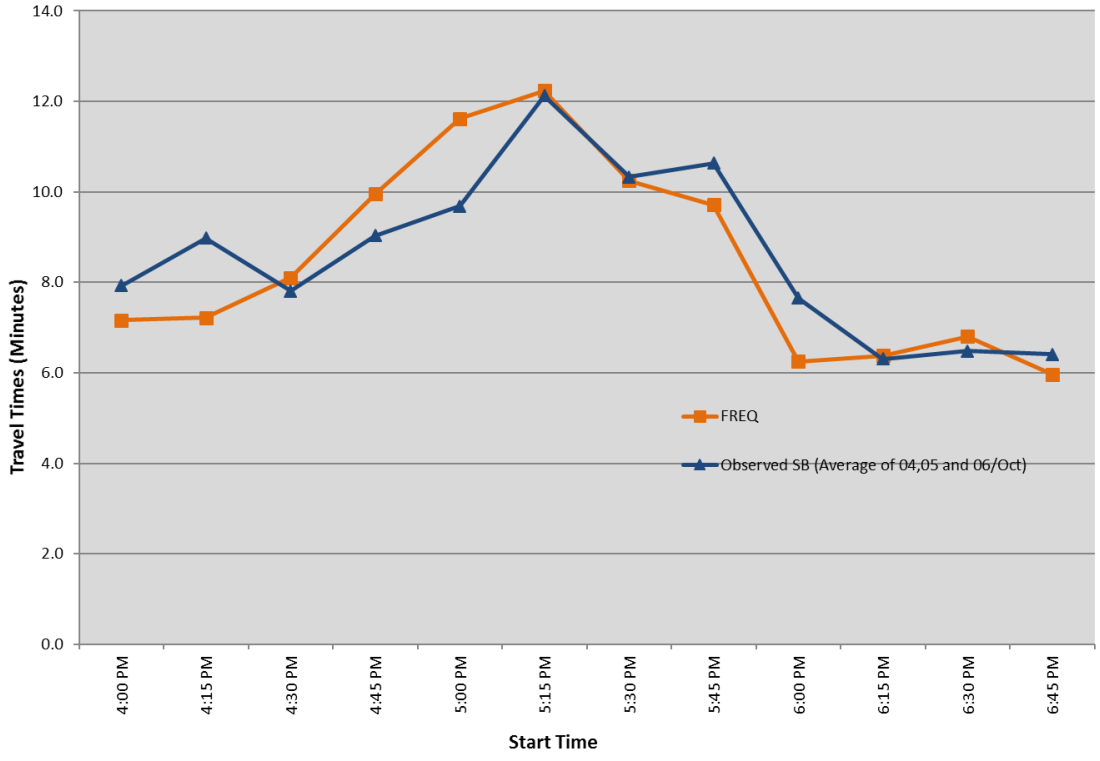


Figure 15: Observed and Simulated Corridor Travel Times, PM Peak Period, Southbound US 101



Local Street Analysis

The Goleta traffic forecasting model uses the Visum software to estimate traffic volumes on all major freeways and streets in the Goleta area based on land uses and the attributes of the road segments. The model was calibrated to 2013 conditions, and a 2035 General Plan Update (GPU) buildout forecast scenario was completed in September, 2017.

A special delay function was programmed and added to the Goleta model to represent the delay characteristics at metered on-ramps. For each scenario with ramp metering, the appropriate on-ramps were given an attribute that would indicate that the steeper delay function should be used. The capacities were set for each individual metered on-ramp for each scenario based on the average peak hour metering rates determined through the FREQ analysis.

The predicted volumes on each road segment were used, along with the average segment capacities coded in the model, to determine the congested speed for each segment. The congested travel times were calculated based on the ratio of volume to capacity, and applying formulas from the *Planning and Preliminary Engineering Applications Guide* to the 6th Edition of the *Highway Capacity Manual* (2017). The segment length, speed and volume were then used to calculate the total vehicle-hours of travel on each segment.

The vehicle hours were summed for all segments in the study area, excluding the freeway and ramp segments as their delays were calculated during the FREQ analysis. Factors of 1.87 for the AM and 2.74 for the PM were used to convert peak hour vehicle-hours into peak period vehicle hours, based on the proportions of existing peak period/peak hour traffic counts on the freeway corridor.

Intersection Analysis

Existing (2013 and 2015) intersection turn movement counts were used as a base for the intersection analysis for the nine study intersections. For alternatives and/or future conditions, the adjusted intersection turn movements were estimated by applying the increment of the 2013 base year model validation scenario to the alternative and/or future scenario to the 2013 traffic count:

> Alternative Turn Movement = 2013 Base Year Traffic Count + (Alternative Model Turn Movement – 2013 Base Year Model Turn Movement)

Study intersections were evaluated to determine average delays and level of service. As described earlier, Intersections in the City of Goleta have typically been evaluated using an Intersection Capacity Utilization (ICU) method which provided a standard measure of capacity usage and impacts of added traffic, but for this study, a *Highway Capacity Manual* (HCM) operations analysis is used as it also provides information on average vehicle delays on each approach and for the intersection as a whole. This provides the information required to estimate system delay for the various ramp metering alternatives.

4.3. BASE YEAR EVALUATION

Ramp metering was tested using 2016 base year traffic volumes for both northbound and southbound US 101 during the AM and PM peak periods. The testing indicated that ramp metering would only be effective during the PM peak period in the southbound direction. Therefore, the base year evaluation focuses on the PM peak period. The evaluation of 2035 conditions considers metering during both peak periods and in both directions on the freeway.

Number of Lanes

The Caltrans Ramp Meter Design Manual specifies that all metered ramps should include a bypass lane for high-occupancy vehicles (HOVs). Two general purpose lanes should be provided for hourly volumes greater than 900.

In Goleta, all southbound on-ramps except Cathedral Oaks have hourly volumes exceeding 900 during the PM peak hour. Therefore, two general purpose lanes plus an HOV bypass lane would be recommended at all ramps except Cathedral Oaks.

The physical layout of each on-ramp was evaluated to determine the difficulty of providing the recommended number of lanes. The Turnpike on-ramp is very constrained, and would be difficult to provide three total approach lanes. Therefore, this ramp was assumed to have one general purpose lane and one HOV bypass lane. At the other ramps, it appears to be physically feasible to provide two general purpose lanes and one HOV bypass, but a certain amount of construction work would be required. For a short-term analysis, it is assumed that these ramps provide two general purpose lanes and no HOV bypass, which would be more feasible to implement in the short term.

The numbers of lanes on each ramp are summarized in Table 13. Approximate costs to construct the recommended numbers of lanes will be provided later in this study.

Table 13: Southbound Ramp Meter Lanes

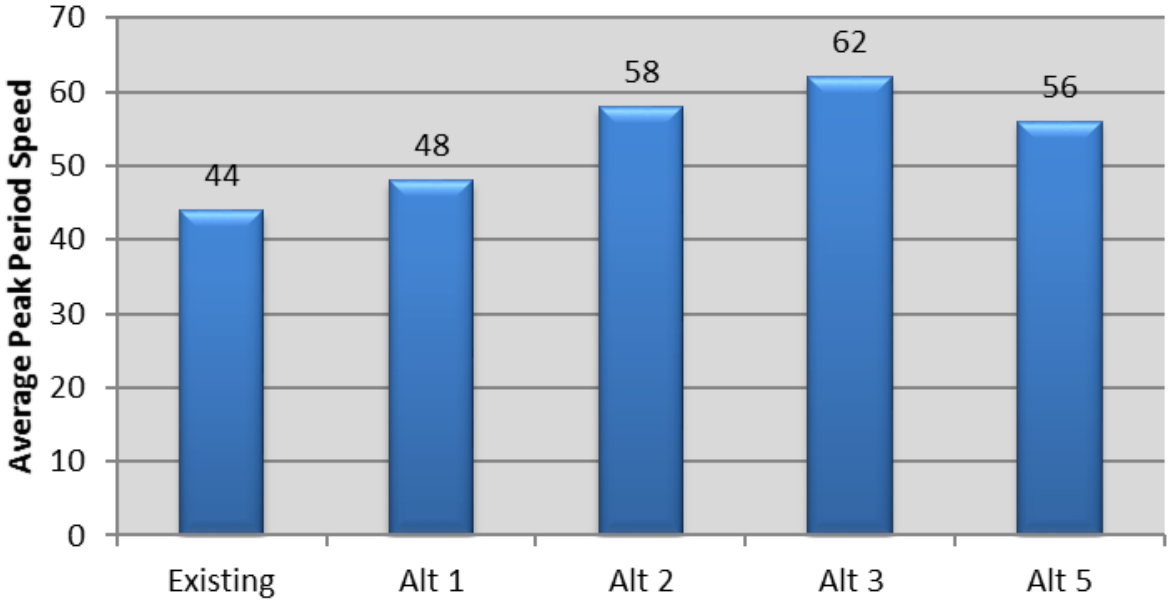
Ramp	Maximum Hourly Volume	Recommended Lanes	Short-Term Assumed Lanes	Maximum Vehicle Storage
Cathedral Oaks SB On	550	1 GP + HOV	1 GP + HOV	17
Storke SB On	1,490	2 GP + HOV	2 GP	72
Los Carneros SB On	1,010	2 GP + HOV	2 GP	80
Fairview SB On	970	2 GP + HOV	2 GP	46
SR 217 SB On	930	2 GP + HOV	2 GP	152
Patterson SB On	940	2 GP + HOV	2 GP	80
Turnpike SB On	910	2 GP + HOV	1 GP + HOV	44

The numbers of vehicles that could be stored in the assumed lanes are also listed. The storage is based on the length of ramp lanes behind the probable location of the ramp meter stop bar, divided by 30 feet per vehicle. The metering plans would be set so that the queues would not exceed these storage distances for any 15-minute analysis period.

Freeway Operations

Each of the ramp metering alternatives is projected to decrease peak congestion and increase freeway travel speeds (Figure 16). The maximum metering plan, Alternative 3, would have the largest beneficial impact on freeway speeds, increasing average peak period speeds by 27 percent.

Figure 16: Base Year Average Freeway Speeds, US 101 Southbound PM Peak Period



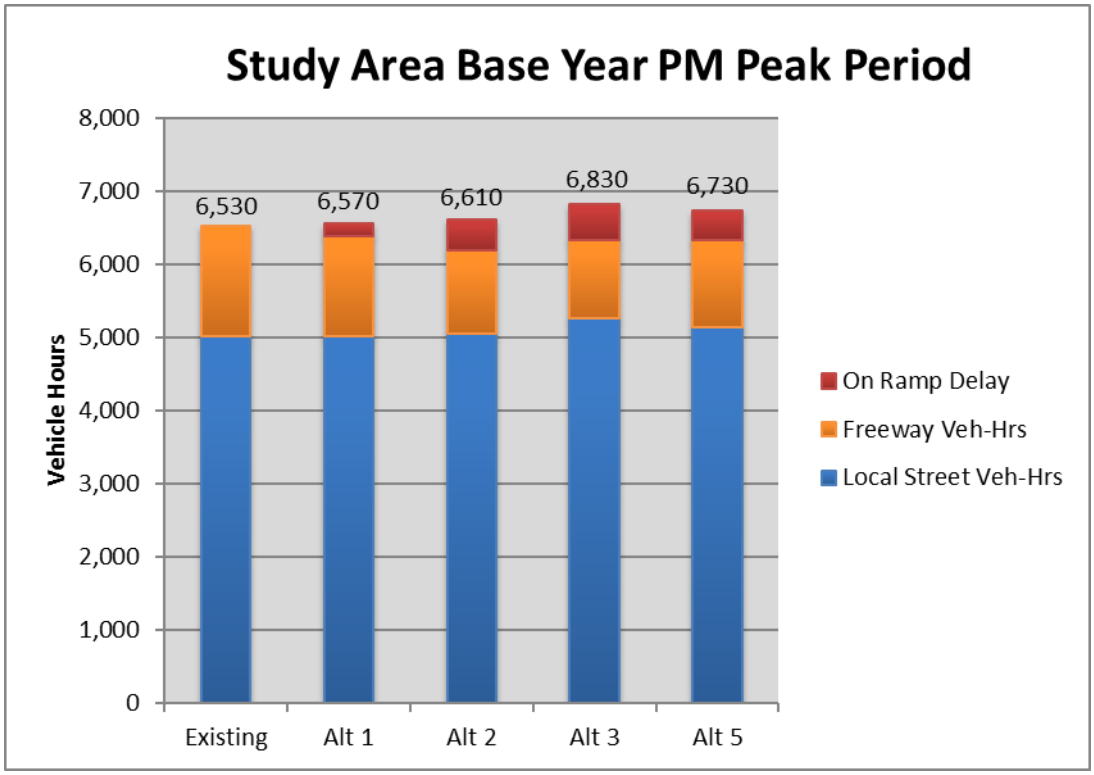
Total Vehicle Hours

Total vehicle hours includes the hours spent driving on the freeway, delay caused by metered ramps and vehicle hours on the local street system (Table 14 and Figure 17).

Table 14: Base Year PM Peak Period Vehicle Hours

Vehicle-Hours	Existing	Alternative 1: Patterson	Alternative 2: SR 217/ Patterson	Alternative 3: All	Alternative 5: All N. of SR 217
Freeway (change from existing)	1,510	1,380 (-8.6%)	1,140 (-24.5%)	1,070 (-29.1%)	1,190 (-21.2%)
Ramp Delay	0	170	410	490	390
Subtotal Freeway/Ramps (change from existing)	1,510	1,550 (+2.7%)	1,550 (+2.7%)	1,560 (+3.3%)	1,580 (+4.6%)
Local Streets (change from existing)	5,020	5,020 (+0.0%)	5,060 (+0.8%)	5,270 (+5.0%)	5,150 (+2.6%)
TOTAL (change from existing)	**6,530**	**6,570 (+0.6%)**	**6,610 (+1.2%)**	**6,830 (+4.6%)**	**6,730 (+3.1%)**

Figure 17: Base Year Total PM Vehicle Hours



While the maximum metering plan, Alternative 3, would have the maximum benefit on the freeway, it would also introduce the most on-ramp delay. The diversions on local streets induced by ramp meter delays would also increase total vehicle hours on local streets. In this analysis, the total vehicle-hours would be higher than existing for all of the ramp metering strategies.

Intersection Operations

Operations were evaluated at the nine study intersections for base year traffic levels and with traffic diversions induced by each of the ramp metering alternatives (Table 15).

Table 15: Base Year Intersection Operations with Metering Alternatives

ID	Intersection	Control	Peak Hour	Existing	Alt. 1	Alt. 2	Alt. 3	Alt. 5
1	Storke Rd. and Hollister Ave.	Signalized	AM	D (45.6)				
			PM	D (48.0)	D (48.0)	D (47.9)	D (46.3)	D (46.6)
2	Los Carneros Rd. and Hollister Ave.	Signalized	AM	D (38.7)				
			PM	D (42.2)	D (42.2)	D (40.9)	D (43.6)	D (46.5)
3	Los Carneros Rd. and Calle Real	Roundabout	AM	A (7.0)				
			PM	B (10.8)	B (10.8)	B (10.7)	B (12.8)	B (12.8)
4	Fairview Ave. and Hollister Ave.	Signalized	AM	C (33.9)				
			PM	D (47.8)	D (47.8)	D (44.2)	D (44.2)	D (44.7)
5	Fairview Ave. and Calle Real	Signalized	AM	D (39.1)				
			PM	E (56.2)	E (56.2)	E (71.9)	E (60.4)	E (68.7)
6	Patterson Ave. and Hollister Ave.	Signalized	AM	D (35.5)				
			PM	D (52.9)	D (53.1)	D (54.8)	E (58.3)	D (53.3)
7	Patterson Ave. and Calle Real	Signalized	AM	C (24.4)				
			PM	C (28.1)	C (28.1)	C (28.1)	C (30.1)	C (30.5)
8	Turnpike Rd. and Hollister Ave.	Signalized	AM	D (50.7)				
			PM	D (48.6)	D (48.6)	E (58.5)	E (64.6)	D (49.0)
9	Turnpike Rd. and Calle Real	Signalized	AM	D (38.5)				
			PM	D (52.7)	D (52.0)	D (51.8)	D (53.6)	D (53.1)

Source: Kittelson & Associates, 2017

The maximum ramp metering alternative, Alternative 3, would cause diversions that would change the LOS from D to E at two intersections on Hollister Avenue, at Patterson Avenue and at Turnpike Road. Alternative 2, with meters at SR 217 and Patterson Avenue, would cause the intersection of Turnpike Road and Hollister Avenue to change from LOS D to LOS E. The ramp metering alternatives would cause delay increases at other study intersections, but the LOS would remain the same as existing conditions.

4.4. FUTURE YEAR EVALUATION

Traffic forecasts for 2035 General Plan Update (GPU) buildout conditions were projected using the Goleta traffic forecast model. Growth factors for each freeway and ramp segment were obtained from the model forecasts and applied to the 2016 base year freeway and ramp counts. The ramp metering alternatives were evaluated using these 2035 forecast volumes.

Number of Lanes

On-ramps were evaluated assuming implementation of the recommended lanes listed in Table 13..

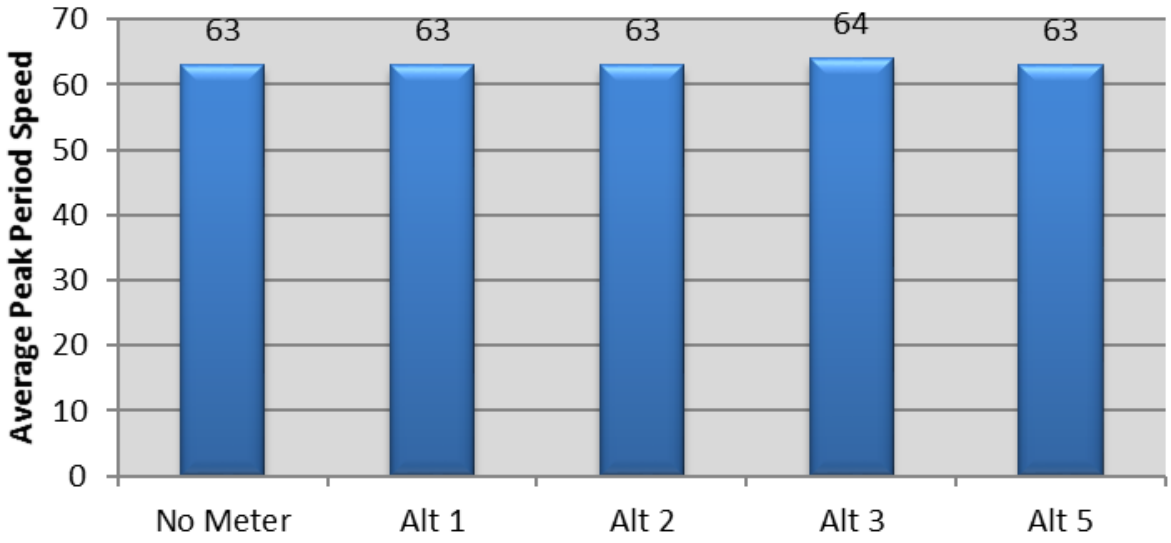
Freeway Operations

Freeway operations were evaluated for each of the ramp metering alternatives with 2035 volumes.

AM Peak Period

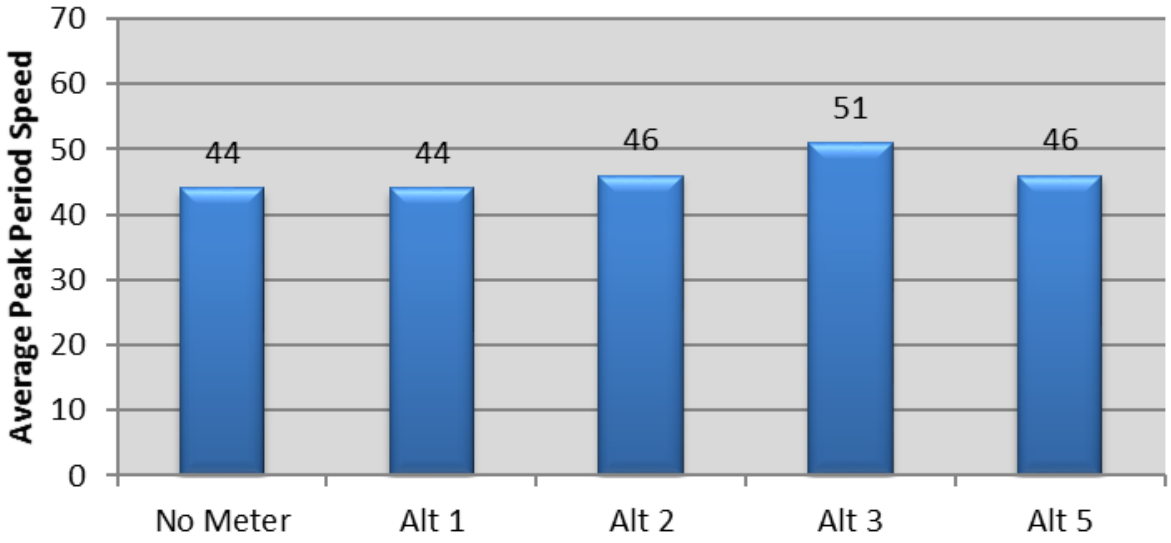
During the AM peak period (between 7:00 and 9:00 AM), there is little congestion forecast in the northbound direction with 2035 volumes. Therefore, relatively high speeds can be maintained without or with ramp metering (Figure 18).

Figure 18: US 101 Northbound Speeds, 2035 AM Peak Period



In the southbound direction, there would be some congestion with speeds averaging 44 mph (Figure 19). The maximum ramp metering alternative, Alternative 3, would allow average speeds to increase by 16 percent to 51 mph.

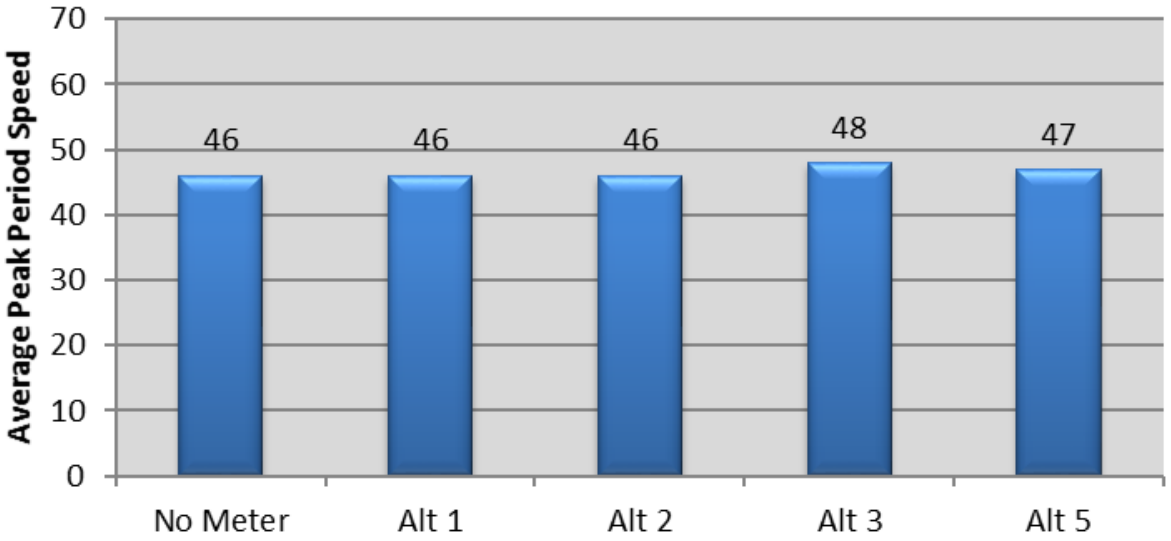
Figure 19: US 101 Southbound Speeds, 2035 AM Peak Period



PM Peak Period

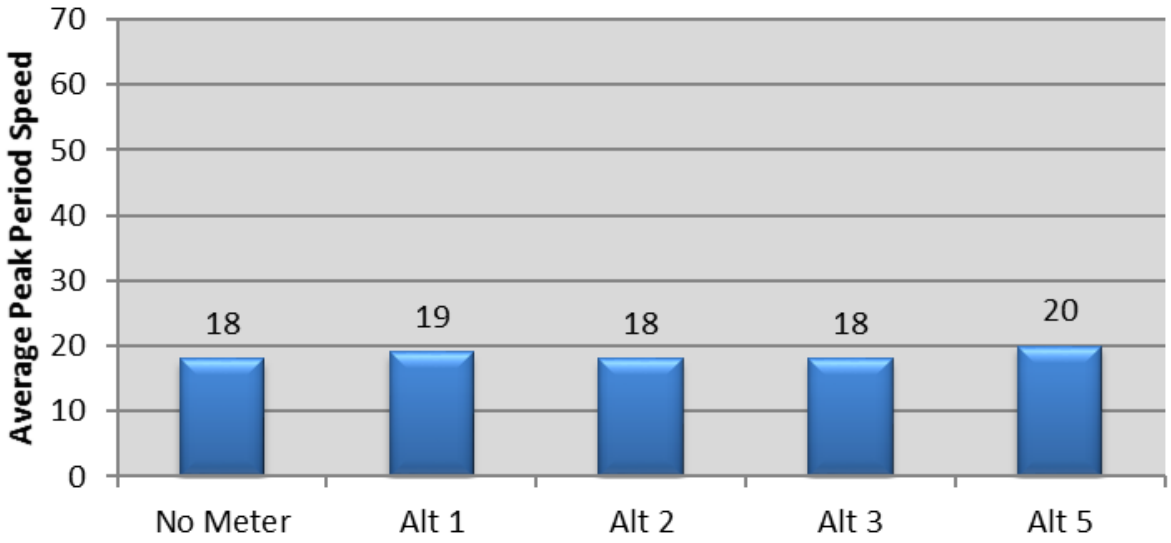
There would be some congestion in the northbound direction in the 2035 PM peak period, with speeds averaging 46 mph (Figure 20). None of the ramp metering alternatives would significantly increase northbound speeds, with Alternative 3 providing a four percent increase to 48 mph.

Figure 20: US 101 Northbound Speeds, 2035 PM Peak Period



Significant congestion with average speeds of 18 mph are projected for 2035 in the southbound direction (Figure 21). None of the ramp metering alternatives would provide significant speed improvements at that level of congestion, with Alternative 5 (metering north of SR 217) providing an 11 percent increase in average speed from 18 to 20 mph.

Figure 21: US 101 Southbound Speeds, 2035 PM Peak Period



Total Vehicle Hours

Total vehicle hours includes the hours spent driving on the freeway, delay caused by metered ramps and vehicle hours on the local street system. For 2035, vehicle hours were evaluated for both the AM and PM peak periods, and for metering in both directions on the US 101 freeway.

2035 AM Peak Period

Total vehicle hours were compiled for the northbound freeway and ramps, southbound freeway and ramps, and then totals including local street vehicle hours with traffic diversions (Table 16 and Figure 22). While ramp metering would reduce vehicle-hours on the freeway, the reductions would be more than offset by increased delays at the metered on-ramps and on the local streets. Local street delays due to traffic diversions are not projected to be significant (maximum of 1.4 percent increase) during the 2035 AM peak period.

2035 PM Peak Period

Total vehicle hours for the PM peak period are shown in Table 17 and Figure 23. As with the AM peak period, any reductions in vehicle-hours on the freeway caused by ramp metering would be more than offset by increased delays at the metered on-ramps and on the local streets. Local street delays due to traffic diversions are projected to be up to 6.7 percent with Alternative 3.

Some ramp delay is projected in the northbound direction even without ramp metering, due to merge conflicts.

Table 16: 2035 Vehicle Hours. AM Peak Period

Vehicle-Hours	No Meters	Alternative 1: Patterson	Alternative 2: SR 217/ Patterson	Alternative 3: All	Alternative 5: All N. of SR 217
NORTHBOUND					
Freeway	760	760	760	740	760
Ramp Delay	0	0	0	10	0
Northbound Total	**760**	**760**	**760**	**750**	**760**
SOUTHBOUND					
Freeway	1,260	1,260	1,210	1,100	1,210
Ramp Delay	0	120	260	460	220
Southbound Total	**1,260**	**1,380**	**1,470**	**1,560**	**1,430**
TOTAL					
Freeway (change from no meters)	2,020	2,020 (0.0%)	1,970 (-2.5%)	1,850 (-8.4%)	1,970 (-2.5%)
Ramp Delay	0	120	260	470	220
Subtotal Freeway/Ramps (change from no meters)	*2,020*	*2,140 (+5.9%)*	*2,230 (+10.4%)*	*2,320 (+14.9%)*	*2,190 (+8.4%)*
Local Streets (change from no meters)	4,450	4,460 (+0.2%)	4,480 (+0.7%)	4,510 (+1.4%)	4,490 (+0.9%)
TOTAL (change from no meters)	**6,470**	**6,600 (+2.0%)**	**6,710 (+3.7%)**	**6,830 (+5.6%)**	**6,680 (+3.3%)**

Figure 22: Total Vehicle Hours, 2035 AM Peak Period

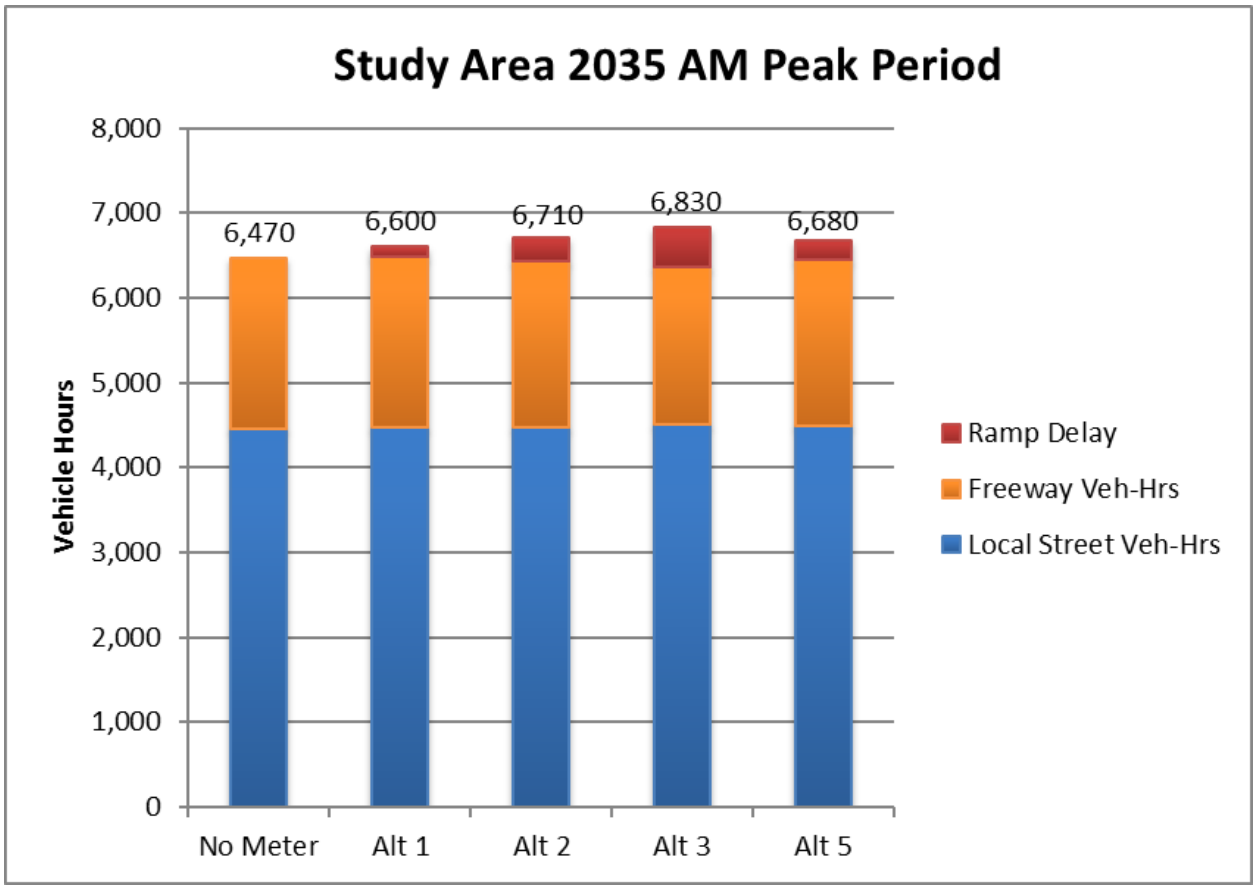
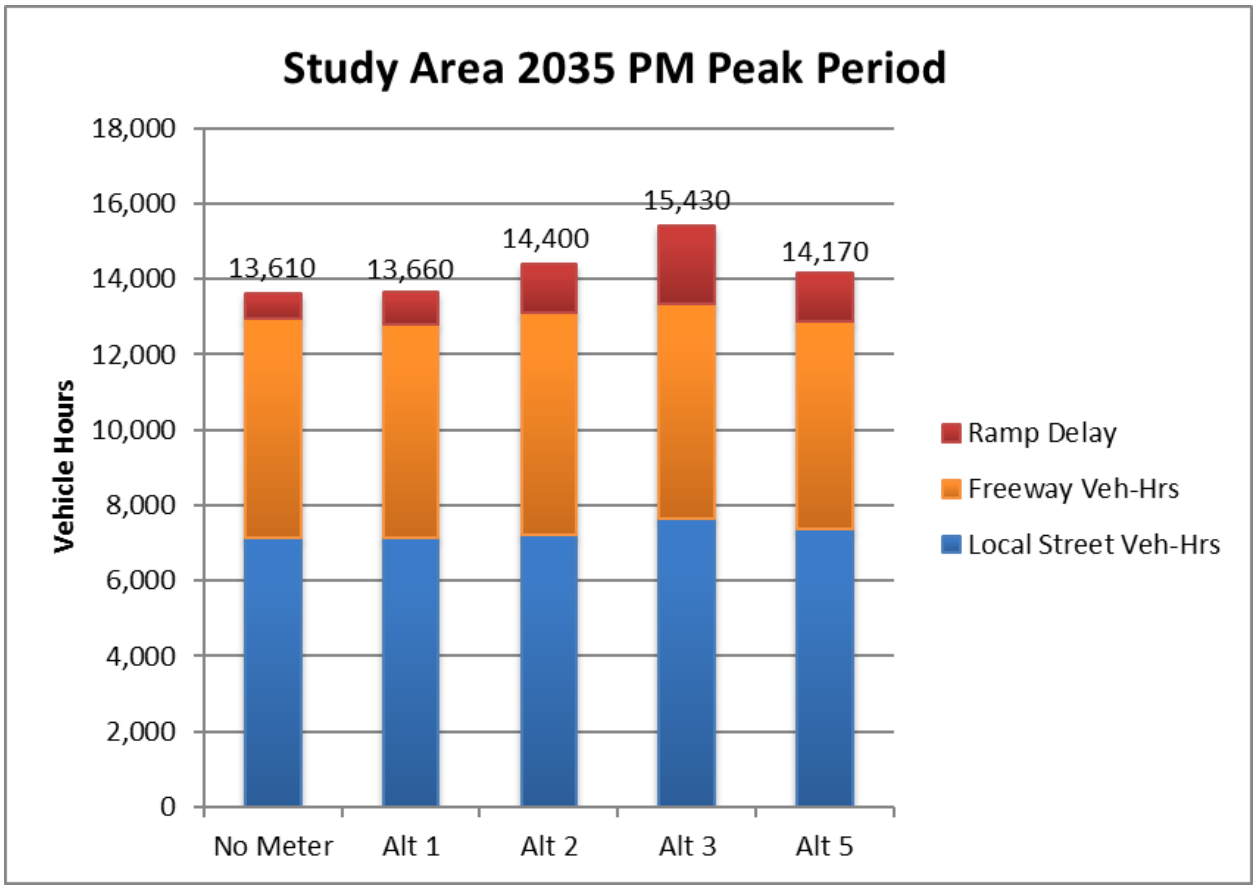


Table 17: 2035 Vehicle Hours, PM Peak Period

Vehicle-Hours	No Meters	Alternative 1: Patterson	Alternative 2: SR 217/ Patterson	Alternative 3: All	Alternative 5: All N. of SR 217
NORTHBOUND					
Freeway	1,850	1,850	1,850	1,750	1,820
Ramp Delay	630	630	630	830	680
Northbound Total	**2,480**	**2,480**	**2,480**	**2,580**	**2,500**
SOUTHBOUND					
Freeway	3,980	3,800	4,030	3,960	3,660
Ramp Delay	0	230	670	1,260	620
Southbound Total	**3,980**	**4,030**	**4,700**	**5,220**	**4,280**
TOTAL					
Freeway (change from no meters)	5,830	5,650 (-3.1%)	5,880 (+0.9%)	5,710 (-2.1%)	5,480 (-6.0%)
Ramp Delay	630	860	1,300	2,090	1,300
Subtotal Freeway/Ramps (change from no meters)	*6,460*	*6,510 (+0.8%)*	*7,180 (+11.2%)*	*7,800 (+20.7%)*	*6,780 (+5.0%)*
Local Streets (change from no meters)	7,150	7,150 (+0.0%)	7,220 (+1.0%)	7,630 (+6.7%)	7,390 (+3.4%)
TOTAL (change from no meters)	**13,610**	**13,660 (+0.4%)**	**14,400 (+5.8%)**	**15,430 (+13.4%)**	**14,170 (+4.1%)**

Figure 23: Total Vehicle Hours, 2035 PM Peak Period



Intersection Operations

Operations were evaluated at the nine study intersections for 2035 traffic levels and with traffic diversions induced by each of the ramp metering alternatives (Table 15).

Table 18: 2035 Intersection Operations with Metering Alternatives

ID	Intersection	Control	Peak Hour	No Meters	Alt. 1	Alt. 2	Alt. 3	Alt. 5
1	Storke Rd. and Hollister Ave.	Signalized	AM	D (42.1)	D (41.8)	D (41.9)	D (42.0)	D (41.9)
			PM	F (93.0)	F (93.0)	F (98.3)	D (47.7)	F (135.0)
2	Los Carneros Rd. and Hollister Ave.	Signalized	AM	D (43.7)	D (43.2)	D (43.1)	D (44.8)	D (43.6)
			PM	E (64.5)	E (64.3)	E (59.5)	E (56.2)	F (84.6)
3	Los Carneros Rd. and Calle Real	Roundabout	AM	B (10.8)	B (11.5)	B (11.3)	B (11.6)	B (11.0)
			PM	C (20.8)	C (20.4)	C (20.3)	E (45.2)	F (170.7)
4	Fairview Ave. and Hollister Ave.	Signalized	AM	D (37.1)	D (37.5)	D (37.4)	D (37.0)	D (36.5)
			PM	E (67.0)	E (65.8)	E (61.1)	F (122.2)	F (100.1)
5	Fairview Ave. and Calle Real	Signalized	AM	D (45.6)	D (47.9)	D (49.1)	D (51.1)	D (43.7)
			PM	F (87.8)	E (74.5)	F (86.7)	F (121.4)	F (158.5)
6	Patterson Ave. and Hollister Ave.	Signalized	AM	F (89.3)	F (81.9)	F (80.7)	F (104.6)	F (89.7)
			PM	E (71.3)	E (72.2)	F (90.2)	F (276.4)	E (78.2)
7	Patterson Ave. and Calle Real	Signalized	AM	C (27.3)	C (28.1)	C (27.7)	C (27.9)	C (27.6)
			PM	C (28.7)	C (28.7)	C (28.7)	E (61.2)	C (25.6)
8	Turnpike Rd. and Hollister Ave.	Signalized	AM	E (73.8)	F (81.2)	F (83.1)	E (77.1)	E (75.3)
			PM	E (69.2)	E (69.1)	F (80.1)	F (128.0)	E (58.9)
9	Turnpike Rd. and Calle Real	Signalized	AM	D (53.6)	D (54.2)	D (53.8)	E (58.6)	D (54.6)
			PM	D (51.8)	D (52.2)	D (52.4)	F (80.2)	C (33.2)

Source: Kittelson & Associates, 2017

The 2035 forecasts indicate congestion at many study intersections without intersection improvements, with LOS F projected at three of the study intersections and LOS E at three intersections. The alternatives with ramp metering would cause LOS impacts at study intersections along Calle Real and Hollister Avenue. Alternative 5, with metering only north of SR 217, would have stronger diversion impacts on intersections in the west part of Goleta. Alternative 3, with metering at all on-ramps, would have more impact on intersections in the east part of Goleta. In some locations (such as Fairview/Hollister in the AM peak hour), ramp metering alternatives may result in slightly lower average delays due to traffic diversion patterns.

5. CONCLUSIONS

Ramp metering alone could provide benefits to the US 101 freeway through Goleta, but would not provide overall benefits to the transportation system within the Goleta study area. Ramp metering in the Goleta area may or may not provide additional benefits to freeway. operations beyond the Goleta study area (to the south of Turnpike Road) but further study of the extended area would be required.

Further study and analysis of the Goleta study area is necessary to achieve impactful reductions in congestion. A combination of ramp metering, other Intelligent Transportation Systems (ITS)[2] and Transportation Demand Management (TDM) strategies, including ridesharing, telecommuting, and alternative work schedules, and increased local and commuter bus service, could potentially achieve meaningful reductions in congestion and increased travel time reliability.

One defining characteristic of the US 101 freeway in Goleta is that the majority of the traffic at the south end of the study corridor is traveling to and from the Goleta area, rather than traffic that passes through Goleta. In freeway corridors where a higher percentage of the traffic is passing through the area, ramp metering can have more beneficial net impacts because the gains for freeway vehicles may outweigh delays to local traffic. However, where ramp traffic is more significant than through freeway volumes, as in Goleta, the benefits on the freeway do not necessarily result in net benefits for the total system.

A more comprehensive evaluation of ramp metering, beyond the resources of this study, would consider effects on vehicle safety, air quality, and economic effects including goods movement through the US 101 corridor.

[2] Systems that use modern detection, communications and computing technology to collect data on system operations and performance, communicate that information to system managers and users, and use that information to manage and adjust the transportation system to respond to changing operating conditions, congestion, or accidents. ITS technology can be applied to arterials, freeways, transit, trucks, and private vehicles.

APPENDIX A: FREEWAY SPEED CONTOURS

Speed contour charts were created based on the floating car surveys (Figure 24 to Figure 31). The speed contour charts show the measured speed in each segment of the freeways on each of the three survey days. The speeds are color coded as follows:

Green	Greater than 55 mph
Yellow	45 to 55 mph
Orange	35 to 45 mph
Red	Less than 35 mph

Figure 24: Speed Contours, US 101 Northbound, AM Peak Period

Time	Turnpike Road On-ramp to Patterson Ave Off-ramp	Patterson Ave Off-ramp to SR 217 Off-ramp	SR 217 Off-ramp to Patterson Ave On-ramp	Patterson Ave On-ramp to Fairview Ave Off-ramp	Fairview Ave Off-ramp to Fairview Ave On-ramp	Fairview Ave On-ramp to Los Carneros Road Off-ramp	Los Carneros Road Off-ramp to Los Carneros Road On-ramp	Los Carneros Road On-ramp to Stork Road Off-ramp	Stork Road Off-ramp to Stork Road On-ramp	Stork Road On-ramp to Winchester Canyon Road Off-ramp	Winchester Canyon Road Off-ramp to Cathedral Oaks Rd On-ramp
Tuesday, October 04, 2016											
7:00	69.2	72.5	70.9	70.0	70.0	68.9	72.4	71.5	70.6	72.0	70.6
7:15	62.3	70.5	70.8	68.8	68.4	68.4	72.3	67.4	66.3	66.5	66.5
7:30	62.8	67.5	67.1	66.1	66.2	64.4	61.4	53.7	61.5	65.5	66.2
7:45	64.3	68.0	69.7	70.0	64.8	60.3	67.3	69.1	67.7	70.4	72.5
8:00	59.6	61.2	65.9	68.4	67.5	67.8	66.3	69.5	67.1	67.9	68.3
8:15	65.0	67.0	68.4	69.5	69.9	60.6	62.6	63.0	64.6	65.3	66.8
8:30	58.9	61.9	69.2	71.7	71.8	68.9	69.3	71.6	71.6	70.5	70.4
8:45	56.3	68.4	68.9	67.5	64.5	66.4	68.6	67.5	68.8	69.3	68.4
Wednesday, October 05, 2016											
7:00	56.5	58.8	65.0	68.9	69.2	68.7	66.4	67.4	68.4	67.9	68.7
7:15	64.2	70.1	70.8	70.2	71.2	68.0	71.9	71.9	70.7	71.9	69.6
7:30	62.4	67.2	65.7	68.1	67.8	59.2	63.0	65.8	65.6	66.5	67.4
7:45	64.9	68.6	67.1	69.0	69.1	67.4	69.3	60.1	65.8	67.1	65.9
8:00	61.9	71.5	70.7	69.1	66.4	67.1	70.5	71.4	72.3	73.8	73.1
8:15	66.8	69.1	69.8	68.3	69.6	59.2	69.8	68.2	69.3	68.5	72.0
8:30	62.3	65.2	64.6	66.7	70.7	66.3	66.3	63.8	67.1	66.4	69.9
8:45	68.2	73.1	71.1	70.3	64.6	67.6	75.0	71.0	75.0	76.2	73.3
Thursday, October 06, 2016											
7:00	60.6	60.3	67.0	70.1	73.0	69.9	69.6	69.2	69.6	69.5	72.1
7:15	69.0	72.6	67.2	68.2	70.6	66.1	66.1	64.6	69.6	72.3	70.0
7:30	63.2	66.0	64.8	64.7	68.0	67.9	68.2	67.0	67.2	66.6	68.6
7:45	51.2	61.9	65.0	67.0	68.1	61.1	68.6	65.9	60.8	63.7	67.2
8:00	63.4	70.5	70.4	71.4	72.9	75.3	73.0	73.4	77.9	67.3	68.8
8:15	60.4	64.5	67.5	67.0	67.7	64.6	67.2	67.2	67.4	66.9	68.4
8:30	58.9	65.3	68.2	70.0	69.6	67.7	63.1	65.9	68.4	68.5	69.5
8:45	61.6	64.9	67.3	68.5	71.7	70.3	69.7	68.0	68.2	66.2	63.3

Green	Greater than 55 mph
Yellow	45 to 55 mph
Orange	35 to 45 mph
Red	Less than 35 mph

Figure 25: Speed Contours, US 101 Southbound, AM Peak Period

Time	Cathedral Oaks Rd Off-ramp to Cathedral Oaks Rd On-ramp	Cathedral Oaks Rd On-ramp to Storke Road Off-ramp	Storke Road Off-ramp to Storke Road On-ramp	Storke Road On-ramp to Los Carneros Road Off-ramp	Los Carneros Road Off-ramp to Los Carneros Road On-ramp	Los Carneros Road On-ramp to Fairview Ave Off-ramp	Fairview Ave Off-ramp to Fairview Ave On-ramp	Fairview Ave On-ramp to Patterson Ave Off-ramp	Patterson Ave Off-ramp to SR 217 On-ramp	SR 217 On-ramp to Patterson Ave On-ramp	Patterson Ave On-ramp to Turnpike Road Off-ramp
Tuesday, October 04, 2016											
7:00	66.2	67.6	70.4	70.9	71.1	64.7	61.8	65.6	65.4	63.4	63.5
7:15	64.2	72.4	71.8	66.7	69.5	64.4	64.5	65.9	66.3	61.6	55.5
7:30	67.6	70.5	68.3	71.3	70.7	68.6	63.0	61.0	61.6	62.8	53.6
7:45	66.4	69.5	39.2	14.1	21.6	30.5	48.0	54.7	46.5	24.5	26.5
8:00	65.8	71.5	70.8	22.8	30.8	37.2	54.6	63.4	45.1	15.0	25.8
8:15	69.5	71.1	67.9	60.7	62.3	61.3	65.9	65.9	28.5	13.3	23.4
8:30	64.1	67.2	67.1	68.4	68.1	66.7	65.2	65.7	65.4	62.8	52.2
8:45	66.1	68.8	68.2	66.5	67.0	68.2	66.9	67.7	64.5	59.0	57.1
Wednesday, October 05, 2016											
7:00	66.7	68.7	67.4	69.2	68.8	61.7	63.1	65.0	59.6	53.9	51.4
7:15	66.2	67.5	68.1	66.0	69.1	73.3	75.5	69.4	65.4	63.6	61.8
7:30	68.4	70.3	71.6	68.9	70.4	47.7	35.7	60.9	61.7	50.3	30.1
7:45	64.8	66.8	34.8	18.9	21.9	43.1	58.5	43.7	26.0	22.8	39.2
8:00	67.4	57.6	69.1	53.2	31.8	39.3	51.0	55.1	61.3	39.7	30.9
8:15	70.9	71.0	70.6	61.8	70.2	57.5	69.0	70.0	72.6	56.7	36.3
8:30	64.2	68.7	67.7	68.0	69.2	66.0	67.4	68.6	66.8	64.9	54.4
8:45	68.5	71.3	65.4	68.2	69.5	68.8	67.6	64.5	66.2	65.9	58.6
Thursday, October 06, 2016											
7:00	67.3	67.5	66.8	66.6	66.9	65.9	65.5	63.6	62.8	59.6	57.5
7:15	65.1	67.5	62.8	59.8	61.3	55.4	58.2	58.4	57.6	52.9	55.9
7:30	68.3	71.5	68.9	68.3	59.8	40.4	63.6	65.0	58.7	58.9	57.9
7:45	64.8	65.8	58.4	26.3	25.6	41.5	53.4	60.9	56.3	36.9	29.4
8:00	65.5	69.0	69.2	71.5	61.8	49.6	51.7	59.4	63.9	60.1	58.2
8:15	69.3	73.8	70.4	67.3	68.6	65.0	62.8	63.0	63.5	58.7	49.9
8:30	66.7	68.8	66.9	60.7	67.1	67.2	66.2	64.2	66.1	63.6	55.5
8:45	67.4	69.0	65.5	65.3	66.2	65.4	65.4	65.2	64.6	61.3	62.7

Green	Greater than 55 mph
Yellow	45 to 55 mph
Orange	35 to 45 mph
Red	Less than 35 mph

Figure 26: Speed Contours, SR 217 Eastbound, AM Peak Period

Time	Sandspit Road On-ramp to Hollister Ave Off-ramp	Hollister Ave Off-ramp to Hollister Ave On-ramp	Hollister Ave On-ramp to Patterson Ave Off-ramp	Patterson Ave Off-ramp to 101 South Merge	101 South Merge to Patterson Ave On-ramp	Patterson Ave On-ramp to Turnpike Road Off-ramp
Tuesday, October 04, 2016						
7:00	58.0	61.7	58.2	58.5	57.8	62.6
7:15	62.3	69.4	64.5	60.7	50.5	56.6
7:30	53.7	58.2	59.1	52.4	50.4	52.5
7:45	63.6	68.4	65.5	55.1	24.2	28.6
8:00	62.7	68.4	65.8	64.0	16.2	20.5
8:15	62.7	66.3	62.6	53.5	11.0	29.2
8:30	62.7	65.0	60.3	56.8	20.4	38.4
8:45	62.7	68.7	61.5	58.7	61.7	60.1
Wednesday, October 05, 2016						
7:00	64.4	71.5	66.4	64.0	65.6	62.5
7:15	55.8	59.6	55.5	57.3	52.0	56.6
7:30	61.2	61.9	60.1	56.3	56.1	61.0
7:45	57.7	59.2	55.7	34.2	13.5	28.1
8:00	60.2	61.0	63.3	50.8	17.3	28.4
8:15	58.5	62.4	59.6	57.0	22.2	38.4
8:30	58.4	62.4	58.5	60.9	66.0	65.9
8:45	69.5	71.4	65.6	62.3	60.9	59.1
Thursday, October 06, 2016						
7:00	57.1	56.1	53.8	53.4	59.5	62.3
7:15	58.9	60.0	58.2	57.2	57.1	67.7
7:30	55.4	57.6	57.3	58.0	64.1	65.1
7:45	57.4	62.4	58.3	58.4	56.2	33.0
8:00	61.4	57.1	51.8	51.1	57.0	53.0
8:15	61.6	64.0	58.0	60.6	63.7	61.0
8:30	59.4	59.6	54.3	53.4	59.0	58.1
8:45	58.3	66.0	61.3	61.0	60.1	62.0

Green	Greater than 55 mph
Yellow	45 to 55 mph
Orange	35 to 45 mph
Red	Less than 35 mph

Figure 27: Speed Contours, SR 217 Westbound, AM Peak Period

Time	Turnpike Road On-ramp to Patterson Ave Off-ramp	Patterson Ave Off-ramp to 217 West Off-ramp	217 West Off-ramp to Patterson Ave On-ramp	Patterson Ave On-ramp to Hollister Ave Off-ramp	Hollister Ave Off-ramp to Hollister Ave On-ramp	Hollister Ave On-ramp to Sandspit Road Off-ramp
Tuesday, October 04, 2016						
7:00	65.7	68.8	62.2	60.8	70.3	67.9
7:15	67.6	69.7	64.3	62.8	69.8	67.3
7:30	57.6	62.3	64.1	64.5	71.7	69.1
7:45	61.0	64.2	34.6	65.2	74.3	73.7
8:00	52.2	54.0	58.9	60.7	60.4	67.0
8:15	58.3	56.1	56.5	59.5	69.4	71.6
8:30	57.7	62.4	60.9	53.3	64.4	74.1
8:45	55.6	58.8	61.7	64.6	73.5	72.0
Wednesday, October 05, 2016						
7:00	64.9	62.5	60.0	59.4	63.0	64.7
7:15	59.9	63.9	63.8	62.3	73.0	73.1
7:30	55.3	60.5	58.0	57.3	66.8	66.2
7:45	53.7	57.4	64.9	61.8	72.1	65.9
8:00	66.1	67.9	68.6	68.2	70.2	69.1
8:15	58.3	61.2	63.1	65.0	71.9	70.7
8:30	60.4	59.8	62.7	64.4	75.1	72.4
8:45	58.6	60.1	61.1	59.4	69.2	71.1
Thursday, October 06, 2016						
7:00	63.9	63.2	56.9	57.7	64.0	64.4
7:15	65.3	67.9	62.7	58.4	67.8	66.6
7:30	54.3	60.2	59.6	61.1	65.3	66.5
7:45	52.3	56.2	59.3	62.1	69.4	72.4
8:00	57.8	64.5	65.0	65.4	69.2	65.6
8:15	60.4	66.9	66.2	62.5	68.7	65.1
8:30	61.8	63.6	63.0	62.7	65.5	63.8
8:45	54.4	57.5	55.4	56.8	67.9	70.1

Green	Greater than 55 mph
Yellow	45 to 55 mph
Orange	35 to 45 mph
Red	Less than 35 mph

Figure 28: Speed Contours, US 101 Northbound, PM Peak Period

Time	Turnpike Road On-ramp to Patterson Ave Off-ramp	Patterson Ave Off-ramp to SR 217 Off-ramp	SR 217 Off-ramp to Patterson Ave On-ramp	Patterson Ave On-ramp to Fairview Ave Off-ramp	Fairview Ave Off-ramp to Fairview Ave On-ramp	Fairview Ave On-ramp to Los Carneros Road Off-ramp	Los Carneros Road Off-ramp to Los Carneros Road On-ramp	Los Carneros Road On-ramp to Stork Road Off-ramp	Stork Road Off-ramp to Stork Road On-ramp	Stork Road On-ramp to Winchester Canyon Road Off-ramp	Winchester Canyon Road Off-ramp to Cathedral Oaks Rd On-ramp
Tuesday, October 04, 2016											
16:00	63.2	60.3	64.1	67.5	66.3	65.9	67.2	67.3	67.5	67.7	67.8
16:15	61.6	65.5	61.9	64.6	63.5	60.0	69.6	68.8	72.2	73.4	71.6
16:30	64.3	64.7	66.0	67.1	65.8	67.4	64.8	63.5	65.7	65.2	66.2
16:45	60.8	60.6	65.6	66.1	65.3	63.8	70.1	69.3	68.5	67.5	68.0
17:00	61.1	65.5	70.0	71.2	64.6	59.9	62.5	56.2	70.8	70.1	69.6
17:15	65.8	66.4	65.6	66.9	67.0	55.9	18.3	30.7	64.1	66.7	69.3
17:30	57.4	63.7	65.8	66.0	66.3	60.1	62.5	64.7	65.9	66.3	65.0
17:45	60.6	69.0	68.6	65.4	68.5	68.2	68.5	68.4	68.8	72.9	69.2
18:00	62.9	64.2	64.3	67.3	68.0	61.7	65.8	66.0	65.4	67.2	68.8
18:15	62.0	67.5	69.1	70.0	69.7	70.8	66.8	45.5	62.7	67.1	71.6
18:30	57.2	67.3	63.4	66.2	67.8	67.1	66.5	64.9	64.6	69.5	69.1
18:45	65.5	71.8	69.1	68.9	66.7	70.2	70.1	71.1	70.2	69.4	71.2
Wednesday, October 05, 2016											
16:00	64.2	67.0	67.8	69.2	68.8	63.5	64.8	54.4	65.0	68.2	68.1
16:15	32.0	52.4	58.1	61.1	60.4	62.6	66.9	64.4	69.4	69.8	70.4
16:30	24.4	67.4	69.7	74.5	74.6	63.9	73.0	73.3	74.0	73.2	72.9
16:45	38.7	57.9	61.1	65.0	59.6	53.5	60.4	57.5	63.0	68.6	69.4
17:00	61.1	61.0	64.0	64.3	63.1	56.6	62.0	62.8	71.4	70.6	70.9
17:15	61.7	70.4	73.0	76.0	74.8	55.4	69.5	66.2	69.0	73.2	73.3
17:30	56.8	62.2	62.2	65.3	63.5	59.7	59.8	67.1	68.1	64.5	64.1
17:45	67.0	70.6	71.2	73.0	71.8	67.0	62.0	58.2	66.8	72.2	73.4
18:00	55.9	64.1	63.7	69.2	72.5	70.0	71.7	70.7	73.2	70.8	72.5
18:15	60.7	62.9	62.5	68.1	67.6	64.6	66.4	56.5	65.6	68.5	67.9
18:30	59.8	66.7	68.9	69.7	65.9	67.5	69.2	70.2	72.0	73.0	70.4
18:45	67.0	74.6	73.5	74.4	76.3	74.3	75.4	73.1	73.9	71.5	72.9
Thursday, October 06, 2016											
16:00	64.0	68.6	68.2	67.3	67.7	63.6	63.8	63.4	65.2	67.0	66.2
16:15	58.4	67.7	67.7	66.0	66.8	56.0	69.9	62.7	66.0	69.6	66.7
16:30	59.5	68.3	69.8	70.3	65.1	62.1	70.2	66.0	74.4	73.0	77.0
16:45	63.3	64.8	65.5	63.6	66.6	66.0	47.4	42.2	61.3	66.3	68.8
17:00	60.9	70.1	71.2	70.0	71.9	68.0	65.6	66.3	73.4	70.1	71.1
17:15	60.1	66.3	70.3	65.1	25.6	31.3	65.1	62.3	70.1	74.9	75.9
17:30	55.7	66.5	65.3	66.8	22.6	31.5	64.0	58.0	66.4	69.7	68.1
17:45	53.5	64.8	69.1	65.3	34.2	36.2	64.8	68.0	71.8	70.7	67.4
18:00	66.5	69.4	68.8	70.0	69.8	66.8	71.7	72.5	74.7	72.7	74.0
18:15	52.1	59.2	61.6	60.3	54.1	55.0	56.2	50.5	66.0	70.4	69.1
18:30	65.3	66.8	68.9	70.1	66.5	63.8	72.7	70.8	70.9	69.6	68.7
18:45	66.7	69.5	69.4	76.4	77.1	74.5	76.7	76.7	78.2	75.1	75.9

Green	Greater than 55 mph
Yellow	45 to 55 mph
Orange	35 to 45 mph
Red	Less than 35 mph

Figure 29: Speed Contours, US 101 Southbound, PM Peak Period

Time	Cathedral Oaks Rd Off-ramp to Cathedral Oaks Rd On-ramp	Cathedral Oaks Rd On-ramp to Storke Road Off-ramp	Storke Road Off-ramp to Storke Road On-ramp	Storke Road On-ramp to Los Carneros Road Off-ramp	Los Carneros Road Off-ramp to Los Carneros Road On-ramp	Los Carneros Road On-ramp to Fairview Ave Off-ramp	Fairview Ave Off-ramp to Fairview Ave On-ramp	Fairview Ave On-ramp to Patterson Ave Off-ramp	Patterson Ave Off-ramp to SR 217 On-ramp	SR 217 On-ramp to Patterson Ave On-ramp	Patterson Ave On-ramp to Turnpike Road Off-ramp
Tuesday, October 04, 2016											
16:00	64.8	66.4	65.8	66.3	65.8	65.4	68.0	67.6	65.5	64.2	61.7
16:15	67.3	65.1	59.9	59.8	61.0	60.7	59.6	60.7	61.3	58.0	56.8
16:30	67.5	72.4	72.6	66.7	68.4	61.2	64.6	62.0	64.4	62.7	48.0
16:45	65.5	67.7	69.0	68.1	67.3	58.6	59.9	53.7	20.8	29.7	29.9
17:00	66.0	65.1	66.7	66.9	63.7	59.8	58.0	54.2	15.9	15.8	26.6
17:15	67.8	68.3	67.5	69.3	67.3	53.0	34.1	16.8	14.3	17.8	28.4
17:30	67.1	67.9	67.0	66.2	65.0	62.4	61.4	39.7	10.8	20.9	31.2
17:45	66.8	67.7	66.9	67.1	66.0	59.6	63.9	26.2	15.3	18.9	25.0
18:00	66.1	67.7	64.9	65.9	62.6	60.4	62.9	62.0	59.8	38.3	36.7
18:15	65.5	66.7	68.7	66.0	56.6	53.3	65.7	65.3	63.7	56.9	58.7
18:30	65.6	65.8	67.6	68.3	65.4	62.4	61.2	63.4	64.5	60.3	52.5
18:45	63.2	65.4	62.9	60.8	65.4	69.7	66.1	63.0	61.9	61.2	57.0
Wednesday, October 05, 2016											
16:00	74.5	82.4	79.5	78.8	78.4	81.4	72.4	44.2	12.5	10.3	25.4
16:15	66.5	69.1	69.3	68.4	65.2	60.7	58.9	27.6	9.9	15.9	32.2
16:30	70.1	70.6	67.8	61.0	61.1	57.8	60.7	62.9	17.6	17.7	28.9
16:45	73.1	71.5	75.7	74.2	71.5	56.4	61.9	32.9	27.1	14.9	27.6
17:00	65.9	69.3	67.3	67.4	66.7	60.9	51.4	35.8	12.3	18.9	31.0
17:15	70.2	73.1	72.3	70.6	32.2	33.4	22.0	20.3	16.2	21.0	28.8
17:30	68.7	76.2	73.5	73.5	69.1	63.8	59.1	23.2	16.0	18.5	33.2
17:45	67.0	66.2	66.6	69.4	68.0	62.5	59.6	52.5	18.4	13.6	34.3
18:00	73.8	69.3	66.9	68.9	67.6	63.8	62.7	60.7	62.6	55.7	48.1
18:15	69.0	75.9	75.9	69.2	67.5	66.1	68.0	68.3	66.0	67.0	65.6
18:30	66.2	71.2	69.8	66.7	63.4	61.2	59.8	61.8	61.8	64.7	65.6
18:45	66.5	70.2	67.4	73.1	75.2	72.1	67.5	63.6	59.0	56.0	54.5
Thursday, October 06, 2016											
16:00	69.1	73.8	73.0	63.5	64.5	64.2	68.8	68.1	55.4	16.3	33.6
16:15	64.7	67.8	69.0	68.5	67.7	63.6	63.2	49.4	11.5	14.6	29.3
16:30	67.2	69.6	64.5	66.0	64.9	64.6	64.0	61.0	36.8	18.5	27.4
16:45	75.7	78.7	83.0	80.5	77.7	72.9	70.8	27.7	10.7	17.6	27.3
17:00	66.9	69.3	66.0	70.2	60.6	53.5	59.9	32.6	10.8	18.8	31.4
17:15	62.5	68.4	65.7	60.3	48.9	22.1	25.2	21.9	9.9	14.4	34.0
17:30	74.4	80.3	83.8	76.0	16.5	29.6	28.2	31.5	27.8	16.8	27.3
17:45	67.2	70.2	70.4	69.1	21.2	25.9	46.4	25.1	9.6	18.2	31.1
18:00	64.8	68.1	67.2	62.9	65.1	62.3	64.6	29.7	13.0	25.4	37.6
18:15	71.1	74.4	70.9	70.6	73.0	71.8	73.5	70.2	66.5	47.8	41.0
18:30	67.2	66.2	66.8	65.4	62.5	59.0	61.0	63.0	66.7	59.4	58.3
18:45	66.5	67.6	63.7	66.7	65.4	65.2	64.5	63.6	61.9	56.6	60.8

Green	Greater than 55 mph
Yellow	45 to 55 mph
Orange	35 to 45 mph
Red	Less than 35 mph

Figure 30: Speed Contours, SR 217 Eastbound, PM Peak Period

Time	Sandspit Road On-ramp to Hollister Ave Off-ramp	Hollister Ave Off-ramp to Hollister Ave On-ramp	Hollister Ave On-ramp to Patterson Ave Off-ramp	Patterson Ave Off-ramp to 101 South Merge	101 South Merge to Patterson Ave On-ramp	Patterson Ave On-ramp to Turnpike Road Off-ramp
Tuesday, October 04, 2016						
16:00	59.5	68.1	61.5	59.9	63.6	61.8
16:15	62.2	65.6	58.7	51.0	55.2	52.0
16:30	59.8	61.0	59.5	58.4	59.9	60.3
16:45	64.5	56.0	56.3	22.0	15.0	32.6
17:00	59.2	65.3	60.8	11.2	11.3	30.7
17:15	63.2	61.2	5.0	3.3	12.5	31.0
17:30	56.0	55.9	8.1	2.7	13.9	29.4
17:45	65.6	68.1	54.3	6.0	13.5	28.4
18:00	64.7	70.0	60.9	25.9	19.3	31.5
18:15	54.5	61.1	64.7	62.0	68.5	67.9
18:30	63.8	64.6	61.2	57.0	60.0	60.3
18:45	64.6	68.6	62.8	61.3	62.3	62.1
Wednesday, October 05, 2016						
16:00	60.5	63.1	60.4	60.4	65.5	64.0
16:15	60.5	68.9	42.8	6.3	11.8	26.1
16:30	60.0	68.2	39.6	5.3	13.5	29.8
16:45	65.7	68.7	36.5	4.5	22.9	30.1
17:00	65.2	67.8	59.3	9.4	13.9	25.1
17:15	62.8	50.9	7.5	4.2	14.5	30.7
17:30	59.6	62.8	22.3	3.5	15.8	32.4
17:45	64.0	70.6	51.1	6.8	10.8	23.5
18:00	61.5	67.4	62.2	60.3	58.3	37.3
18:15	66.8	72.5	65.0	61.7	62.7	58.4
18:30	57.8	58.4	56.0	55.9	60.3	60.3
18:45	64.7	64.2	60.7	59.1	63.5	60.6
Thursday, October 06, 2016						
16:00	60.3	64.5	59.2	57.6	32.3	24.3
16:15	64.3	69.4	63.0	8.0	15.6	30.1
16:30	51.9	57.1	59.4	38.2	12.9	29.7
16:45	64.7	65.7	51.0	3.6	13.3	27.1
17:00	56.7	60.3	50.8	5.6	12.2	29.0
17:15	64.9	35.3	4.0	3.2	13.3	20.4
17:30	59.1	51.5	6.3	3.1	21.7	34.3
17:45	63.5	70.8	61.5	5.4	18.2	25.3
18:00	61.9	61.9	53.1	45.5	16.9	30.9
18:15	61.7	67.4	63.7	58.1	18.3	30.0
18:30	60.7	62.2	59.8	57.6	62.2	59.3
18:45	59.2	65.4	60.6	59.8	60.2	60.8

Green	Greater than 55 mph
Yellow	45 to 55 mph
Orange	35 to 45 mph
Red	Less than 35 mph

Figure 31: Speed Contours, SR 217 Westbound, PM Peak Period

Time	Turnpike Road On-ramp to Patterson Ave Off-ramp	Patterson Ave Off-ramp to 217 West Off-ramp	217 West Off-ramp to Patterson Ave On-ramp	Patterson Ave On-ramp to Hollister Ave Off-ramp	Hollister Ave Off-ramp to Hollister Ave On-ramp	Hollister Ave On-ramp to Sandspit Road Off-ramp
Tuesday, October 04, 2016						
16:00	56.6	55.7	58.7	58.9	69.4	73.8
16:15	63.6	69.0	68.1	61.7	62.4	61.3
16:30	62.2	59.6	64.3	62.0	74.8	71.5
16:45	59.9	63.1	60.4	58.1	64.2	61.1
17:00	61.4	69.9	65.1	62.6	69.1	61.5
17:15	57.3	57.8	56.9	60.0	60.9	58.2
17:30	55.2	61.0	48.9	54.1	63.4	70.5
17:45	59.2	64.0	63.0	59.7	64.9	65.8
18:00	51.5	63.3	63.2	59.5	69.1	67.7
18:15	62.9	61.5	59.7	62.2	66.3	63.5
18:30	54.4	60.8	62.0	63.9	76.4	76.7
18:45	67.4	67.2	61.2	62.0	69.1	73.4
Wednesday, October 05, 2016						
16:00	54.5	54.1	60.0	59.2	64.8	69.7
16:15	17.6	48.7	51.8	52.8	59.0	60.9
16:30	20.2	45.1	55.3	58.1	64.4	63.9
16:45	23.7	49.8	56.8	60.6	67.6	67.7
17:00	60.7	63.7	63.2	62.8	68.7	66.7
17:15	50.9	59.7	60.4	61.0	65.2	66.1
17:30	62.3	68.2	66.8	63.6	70.1	69.5
17:45	55.6	57.2	64.0	57.0	62.9	63.4
18:00	64.3	69.8	66.7	64.5	69.6	71.9
18:15	61.8	64.4	58.2	58.2	63.9	58.7
18:30	68.1	68.5	67.5	66.6	73.1	68.6
18:45	56.2	59.9	61.3	59.8	65.3	63.4
Thursday, October 06, 2016						
16:00	59.3	55.9	59.5	60.6	74.0	59.9
16:15	50.0	57.1	58.2	58.0	59.2	56.3
16:30	57.4	60.4	64.4	56.4	69.1	74.1
16:45	57.6	58.9	61.3	61.2	64.3	61.0
17:00	67.1	66.8	67.6	64.4	70.8	69.4
17:15	61.8	58.1	56.6	56.9	61.0	61.3
17:30	55.5	57.1	55.4	57.9	69.2	65.7
17:45	57.0	64.0	61.8	58.3	64.5	64.2
18:00	56.8	60.5	63.8	64.0	69.1	65.0
18:15	58.3	63.2	63.7	59.2	62.6	58.9
18:30	52.5	56.9	62.4	64.3	71.0	70.1
18:45	66.6	56.5	62.1	62.2	66.1	60.2

Green	Greater than 55 mph
Yellow	45 to 55 mph
Orange	35 to 45 mph
Red	Less than 35 mph

APPENDIX B: CRASH MAPS BASED ON TIMS

For visualization purposes only, geocoded crash data from the Statewide Integrated Traffic System (SWITRS) for injury and fatal crashes were acquired from UC Berkeley's Transportation Injury Mapping System (TIMS). Caltrans specifies that data from TIMS and SWITRS cannot be used to perform safety analysis due to its lack of details like in the Traffic Collision Report (TCR) produced by the California Highway Patrol (CHP). There is not enough data resolution to make correlation and causation determinations on safety. Caltrans cannot accept any safety analysis results based on other data sources beside TASAS.

The TIMS website includes the following disclaimer under the Terms of Use:

> *Note to Users from California Department of Transportation (Caltrans): In making any decision, especially any engineering decision, Caltrans employees and those acting on Caltrans's behalf shall not rely upon this website, the data and information accessed through this website, or any document created using this website. The website, data, information, and documents may be inaccurate, false, out of date, uncorrected, and/or otherwise unreliable. The website, data, information, and documents are informational only and are not to be relied upon in any way.*

The following data summaries from TIMS are intended only to provide a visualization of reported severe crashes by type in the study area (Table 19 and Figure 32 to Figure 38).

Table 19: Fatal and Injury Crashes by Ramp, 2012 to 2015, from TIMS Data

Associated Ramp	Fatal/Injury Crashes	Fatality	Serious Injury	Crash Types
Turnpike Road Interchange				
NB Off-Ramp	3	-	-	Rear End (2); Broadside (1)
NB On-Ramp	3	-	1	Broadside (2); Rear End (1)
SB Off-Ramp	5	-	-	Broadside (4); Rear End (1)
SB On-Ramp	3	-	-	Rear End (3)
Patterson Avenue Interchange				
NB Off-Ramp	4	-	-	Rear End (4)
NB On-Ramp	1	-	-	Sideswipe (1)
SB Off-Ramp	3	-	-	Rear End (1); Broadside (1); Other (1)
SB On-Ramp	1	-	-	Broadside (1)
SR 217 / US 101 Interchange				
NB US 101 – WB SR 217	1	-	-	Rear End (1)
EB SR 217 – SB US 101	2	-	-	Rear End (1); Sideswipe (1)
Fairview Avenue Interchange				
NB Off-Ramp	5	-	-	Rear End (3); Broadside (1); Other (1)
NB On-Ramp	5	-	1	Sideswipe (1); Rear End (2); Broadside (2)
SB Off-Ramp	3	-	-	Rear End (2); Broadside (1)
SB On-Ramp	3	-	-	Rear End (1); Broadside (2)
Los Carneros Road Interchange				
NB Off-Ramp	1	1	-	Pedestrian (1)
NB On-Ramp	5	-	-	Head On (1); Rear End (4)
SB Off-Ramp	1	-	-	Other (1)
SB On-Ramp	2	-	1	Sideswipe (1); Rear End (1)
Glen Annie Road / Storke Road Interchange*				
NB Off-Ramp	3	-	-	Rear End (3)
NB On-Ramp	5	-	-	Rear End (3); Broadside (2)
SB Off-Ramp	4	1	-	Rear End (1); Broadside (2); Other (1)
SB On-Ramp	9	-	-	Rear End (5); Broadside (3); Overturn (1)
Cathedral Oaks Road / Winchester Canyon Road / Calle Real Interchange				
NB Off-Ramp	-	-	-	
NB On-Ramp	1	-	-	Sideswipe (1)
SB Off-Ramp	-	-	-	
SB On-Ramp	1	-	1	Overturn (1)

Table 19: Fatal and Injury Crashes by Ramp, 2012 to 2015, from TIMS Data

Associated Ramp	Fatal/Injury Crashes	Fatality	Serious Injury	Crash Types
Hollister Avenue / SR 217 Interchange				
WB Off-Ramp	2	-	-	Rear End (2)
WB On-Ramp	-	-	-	
EB Off-Ramp	-	-	-	
EB On-Ramp	3	-	-	Sideswipe (1); Rear End (1); Broadside (1)

* The Storke Road southbound on ramp has been modified to provide additional channelization for vehicles entering the freeway since these data were collected.

Figure 32: Turnpike Road Fatal/Injury Crashes from TIMS Data, 2012 to 2015

Figure 33: Patterson Avenue/SR 217 Interchange Fatal/Injury Crashes from TIMS Data, 2012 to 2015

Figure 34: Fairview Avenue Interchange Fatal/Injury Crashes from TIMS Data, 2012 to 2015

Figure 35: Los Carneros Road Interchange Fatal/Injury Crashes from TIMS Data, 2012 to 2015

Figure 36: Glen Annie Road/Storke Road Interchange Fatal/Injury Crashes from TIMS Data, 2012 to 2015

Figure 37: Cathedral Oaks Interchange Fatal/Injury Crashes from TIMS Data, 2012 to 2015

Figure 38: Hollister Avenue Interchange Fatal/Injury Crashes from TIMS Data, 2012 to 2015

APPENDIX C: FREQ CALIBRATION

FREQ MODEL DEVELOPMENT AND INPUT DATA

The FREQ modeling software, developed by the Institute for Transportation Studies at the University of California at Berkeley, was used to simulate peak period traffic operations on US 101 within the study area. FREQ is a macroscopic freeway facility operations simulation model based on the classical speed-flow and density-flow relationships. FREQ evaluates operational performance in one direction of freeway travel at a time by predicting speeds and densities of traffic based on the volume/capacity ratios.

The FREQ model was developed based on a set of comprehensive data including traffic volumes, geometries, and capacities. The freeway capacities reflect the presence of heavy vehicles and profile grades that exist in the corridor.

Before its application for future operations analysis, FREQ must be calibrated to reflect local conditions. This was performed by iteratively running FREQ under the existing conditions and comparing the model predicted speeds and travel times with those observed in the field. Capacity adjustments were made to the freeway sections, fined tune for individual time slice, until the congestion level matches observed field data.

FREQ Model Limits

The FREQ model limits coincide with the corridor study limits described in the introduction. Four FREQ models were developed and calibrated for the purpose of developing ramp metering rates for the corridor:

- Northbound AM Peak Period: 7 AM–9 AM
- Northbound PM Peak Period: 4 PM–7 PM
- Southbound AM Peak Period: 7 AM–9 AM
- Southbound PM Peak Period: 4 PM–7 PM

These time periods include time before congestion occurs, during congested periods, and when queues dissipate. The FREQ model was set up to analyze at 15-minute time intervals.

Selection of Data for FREQ Model Evaluation

Existing midweek peak-period traffic operations were observed for three consecutive days between Tuesday and Thursday in October 2016 during following time periods:

- Midweek AM northbound and southbound: 7 AM–9 AM
- Midweek PM northbound and southbound: 4 PM–7 PM

FREQ Model Free Flow Speeds

Model free flow speeds are set to 65 miles per hour (mph) in both directions on US 101, based on observations during uncongested times. This is also consistent with the posted speed limit along the corridor.

Existing Traffic Volumes

The existing freeway mainline entry counts represent actual demand volumes as they were collected upstream of the freeway queues. All on-ramp counts, as well as off-ramp counts upstream of congestion, represent demand volumes as tube counters were set upstream of queues. Off-ramp counts, downstream of freeway queues, represent constrained traffic counts.

FREQ Model Capacities

Freeway capacities for the FREQ calibration were set based on traffic counts through freeway subsections (SS) operating at capacity (bottleneck section). 2,150 vehicle-per-hour-per-lane (vphpl) is used as a basic mainline subsection capacity for FREQ models and varied depending on the observed traffic operations. This capacity already accounts for factors such as heavy vehicles, grades, typical merging, diverging, and weaving effects. Specific adjustments were made at certain locations and time periods to account for additional factors, described in the next section.

All on-ramp and off-ramp capacities are set using the default value of 2,000 vphpl.

Based on Exhibit 13-10 of HCM 2010, the general capacity of ramp roadways is between 1,800 passenger cars per lane per hour (pcplph) and 2,200 pcplph depending on the free-flow speed of the ramp. The ramp capacity of 2,000 vphpl is conservatively within the HCM 2010 values, which accounts for moderate vehicle adjustments.

Mainline Capacities at Specific Locations

While a majority of freeway subsection capacities were set using an average capacity of 2,150 vphpl, as described above, the capacity for the US 101 mainline both within and downstream of the bottleneck sections was set at reduced capacities for some certain time periods. This reduced capacity was set based on constrained throughput counts on US 101 in both the southbound and northbound directions. This reflects lower capacity due to merging, diverging, and weaving activities within the area.

Final calibrated mainline capacities for all four FREQ models are summarized in Exhibit 1 and Exhibit 2**Error! Reference source not found.** for the northbound AM and PM peak periods, respectively and Exhibit 3 and Exhibit 4 for the southbound AM and PM peak periods, respectively.

Exhibit 1: FREQ Model Input Data for US 101 Northbound AM Peak Period

Subsection No.	No. of Lanes	Subsection Capacity *	Subsection Length	FF Speed	O-D	Subsection Description
1	3	6,450	4,394	65	OD	El.Sueno On toN.TpkOff
2	3	6,450	2,323	65		N.Tpk Off to On
3	3	6,450	3,885	65	OD	N.Tpk On to N.PatsonOf
4	3	6,450	806	65	D	N.Patterson Ofto 217Of
5	3	6,450	2,076	65		217 Ofto N.Patson On
6	3	6,450	3,543	65	OD	N.Patterson On-NFviewOf
7	3	5,700	1,466	65		N.FviewOff toOn
8	2	3,800	5,080	65	OD	N.FviewOn-LCarnerosOff
9	2	3,800	2,559	65		Los Carneros Off to On
10	2	3,793	1,429	65	OD	L.CarnsOn-Glen An Off
11	2	3,800	3,173	65		Glenn Annie Off to On
12	2	3,800	7,996	65	OD	Glen AnOn W.Canyon Off
13	2	3,800	4,103	65		W.Canyon Off to HollOn
14	2	3,800	6,832	65	OD	Holl Onto Mainline

*Indicates capacity range, when applicable, used in the adjustment for some individual time slice.

Exhibit 2: FREQ Model Input Data for US 101 Northbound PM Peak Period

Subsection No.	No. of Lanes	Subsection Capacity *	Subsection Length	FF Speed	O-D	Subsection Description
1	3	6,450	4,394	65	OD	El.Sueno On toN.TpkOff
2	3	6,450	2,323	65		N.Tpk Off to On
3	3	6,450	3,885	65	OD	N.Tpk On to N.PatsonOf
4	3	3,200 – 6,450	806	65	D	N.Patterson Ofto 217Of
5	3	6,450	2,076	65		217 Ofto N.Patson On
6	3	6,450	3,543	65	OD	N.Patterson On-NFviewOf
7	3	3,800 – 5,700	1,466	65		N.FviewOff toOn
8	2	3,480 – 4,400	5,080	65	OD	N.FviewOn-LCarnerosOff
9	2	2,620 – 4,400	2,559	65		Los Carneros Off to On
10	2	3,550 - 4048	1,429	65	OD	L.CarnsOn-Glen An Off
11	2	3,800 – 4,400	3,173	65		Glenn Annie Off to On
12	2	4,400	7,996	65	OD	Glen AnOn W.Canyon Off
13	2	4,400	4,103	65		W.Canyon Off to HollOn
14	2	4,400	6,832	65	OD	Holl Onto Mainline

*Indicates capacity range, when applicable, used in the adjustment for some individual time slice.

Exhibit 3: FREQ Model Input Data for US 101 Southbound AM Peak Periods

Subsection No.	No. of Lanes	Subsection Capacity *	Subsection Length	FF Speed	O-D	Subsection Description
1	2	4,300	6,666	65	OD	C.Real to Hol off
2	2	4,300	2,527	65		Holl of f to Ho ll on
3	2	4,300	8,949	65	OD	Holl on to Sto rke Rdoff
4	2	4,300	2,682	65		Storke off to on
5	3	4,700	2,775	65	OD	Storke on to L carnosOf
6	2	4,500	3,466	65		Lcarnos Off to On
7	2	2,700 – 4,500	3,064	65	OD	L.Crnos on - S Fvw Ave Of
8	2	2,100 – 4,500	2,348	65		S.fvw O ff to O n
9	3	6,600	4,052	65	OD	S Fvw o n to Pa t Off
10	3	5,700	1,688	65		Patt Of f to 21 7 On
11	3	5,000 – 5,700	1,841	65	O	SR 217 On to P aterson On
12	3	4,000 – 4,700	3,196	65	OD	Patt On to Tur npk Off
13	3	3,000 – 5,000	2,406	65		Turnpk Off to On
14	3	4,000 – 5,300	5,137	65	OD	Turnpk on to S tate St of

*Indicates capacity range, when applicable, used in the adjustment for some individual time slice.

Exhibit 4: FREQ Model Input Data for US 101 Southbound PM Peak Periods

Subsection No.	No. of Lanes	Subsection Capacity *	Subsection Length	FF Speed	O-D	Subsection Description
1	2	4,300	6,666	65	OD	C.Real to Hol off
2	2	3,800	2,527	65		Holl of f to Ho ll on
3	2	3,800	8,949	65	OD	Holl on to Sto rke Rdoff
4	2	4,300	2,682	65		Storke off to on
5	3	4,664	2,775	65	OD	Storke on to L carnosOf
6	2	4,000 – 4,300	3,466	65		Lcarnos Off to On
7	2	4,300	3,064	65	OD	L.Crnos on - S Fvw Ave Of
8	2	4,000 – 4,300	2,348	65		S.fvw O ff to O n
9	3	4,000 – 6,600	4,052	65	OD	S Fvw o n to Pa t Off
10	3	4,000 – 5,700	1,688	65		Patt Of f to 21 7 On
11	3	4,000 – 4,500	1,841	65	O	SR 217 On to P aterson On
12	3	4,300 – 4,655	3,196	65	OD	Patt On to Tur npk Off
13	3	3,400 – 4,600	2,406	65		Turnpk Off to On
14	3	5,000 – 5,500	5,137	65	OD	Turnpk on to S tate St of

FREQ MODEL CALIBRATION RESULTS

This section describes the validated FREQ model results and how they compared to field observed data.

Bottlenecks and Queues - Observed

On US 101 northbound, some slowdowns in speeds without queue spillback were observed during the PM peak period at the following locations:

- Between Turnpike Road and Patterson Avenue.
- Between N Fairview Avenue and Los Carneros Road.

On US 101 southbound, the following bottlenecks were observed:

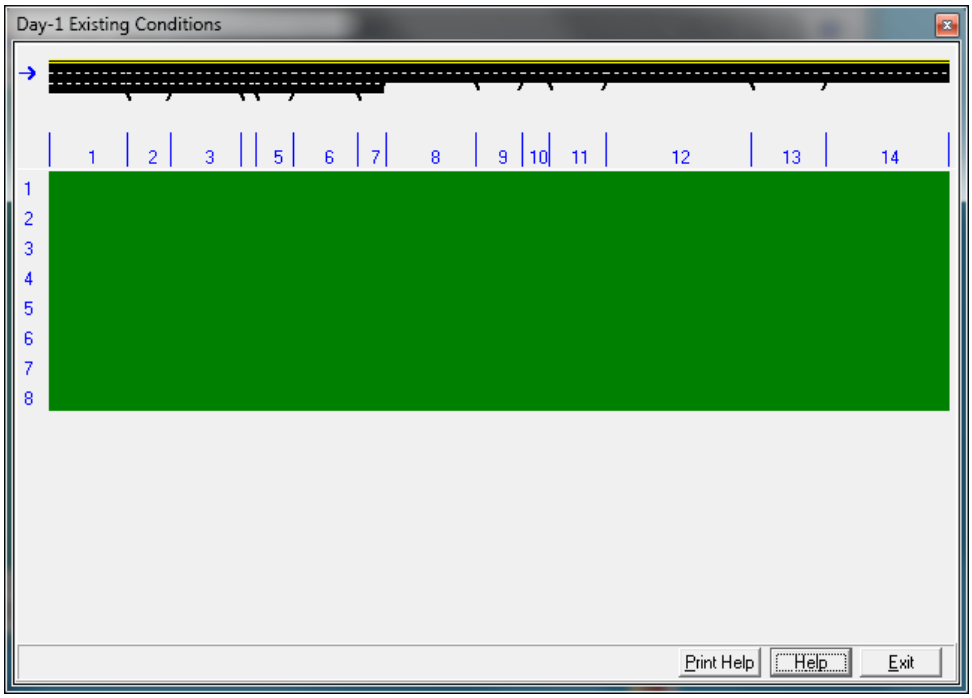
- Between Stoke Road and S Fairview Avenue: During 7:45 AM and 8:00 AM, queues from this bottleneck extended as far as Stoke Road. This bottleneck was not identified during the PM peak period.
- Between Patterson Avenue and Turnpike Road: During the AM peak period, queues from this bottleneck extended north to the interchange influence area at SR217.
- Between Los Carneros Road and Turnpike Road: During the PM peak period, queues from this bottleneck extended over 3 miles as far as Los Carneros Road.

Bottlenecks and Queues – FREQ Simulated

Exhibit 5 through Exhibit 8 show the graphical output from the four calibrated FREQ models. FREQ-simulated bottleneck locations are consistent with the observed ones from the field data collection.

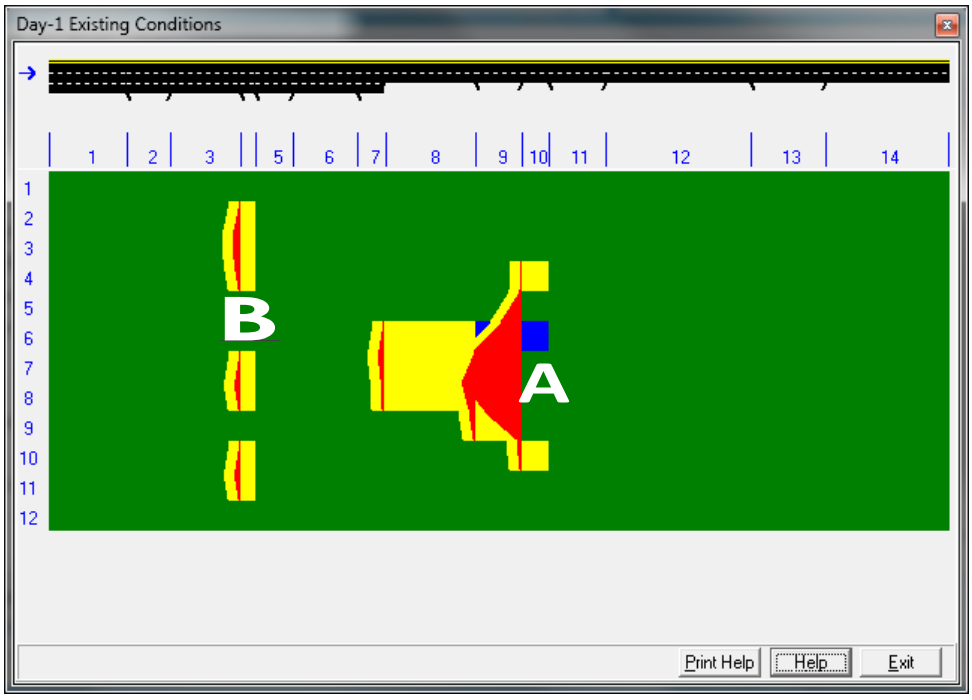
Exhibit 9 provides a comparison of the congestion duration associated with each bottleneck, between observed and FREQ simulated conditions. In general, the FREQ simulation results match well with the observed conditions, with some cases that the model conservatively simulated longer congestion duration by about 15 minutes.

Exhibit 5: FREQ Calibrated Model Graphical Output – US 101 Northbound AM Model



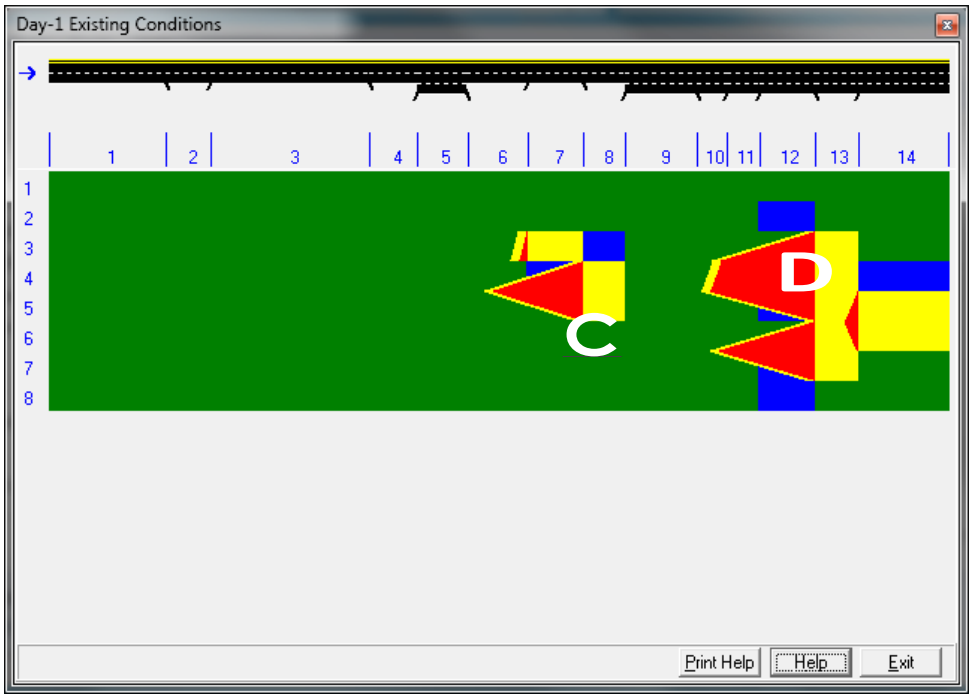
(Note: numbers on the vertical axis represents time intervals, and numbers on the horizontal axis represents FREQ subsection number.)

Exhibit 6: FREQ Calibrated Model Graphical Output – US 101 Northbound PM Model



(Note: numbers on the vertical axis represents time intervals, and numbers on the horizontal axis represents FREQ subsection number.)

Exhibit 7: FREQ Calibrated Model Graphical Output – US 101 Southbound AM Model



(Note: numbers on the vertical axis represents time intervals, and numbers on the horizontal axis represents FREQ subsection number.)

Exhibit 8: FREQ Calibrated Model Graphical Output – US 101 Southbound PM Model

(Note: numbers on the vertical axis represents time intervals, and numbers on the horizontal axis represents FREQ subsection number.)

Exhibit 9: Comparison of Congestion Duration – Observed vs FREQ Calibrated Models

#	Bottleneck Location	Observed Congestion		Simulated Congestion	
		Start	End	Start	End
		Northbound PM			
A	Between Turnpike Road and Patterson Avenue	4:15 PM	6:30 PM	4:15 PM	6:45 PM
B	Between N Fairview Avenue and Los Carneros Road	5:15 PM	6:00 PM	4:45 PM	6:15 PM
		Southbound AM			
C	Between Stoke Road and S Fairview Avenue	7:45 AM	8:15 AM	7:45 AM	8:15 AM
D	Between Patterson Avenue and Turnpike Road	7:45 AM	8:30 AM	7:30 AM	8:45 AM
		Southbound PM			
E	Between Los Carneros Road and Turnpike Road	4:00 PM	7:00 PM	4:00 PM	7:00 PM

Note: Observed conditions are primarily based on October 2016 data.

Speed Contour Map

Exhibit 10 through Exhibit 13 provide a graphical comparison of the FREQ simulated speed contour and observed speed contour maps of the US 101 study corridor. Observed speed contours were obtained from floating car survey data collected between October 4th and 6th, 2016. In general, observed speeds were replicated reasonably well by the calibrated FREQ models in congested locations and duration. As shown in the comparison, FREQ simulated congested speeds in some cases are slower compared to observed speeds, which in turn results in simulated queue lengths that are slightly shorter compared to observed data.

Chi-square differences of the simulated versus observed speed were also computed and are presented in Exhibit 10 through Exhibit 13. This is a general measure of goodness of fit and is calculated by taking the square of the differences between observed and simulated speeds, divided by observed speeds. Values are computed for each freeway segment and each time interval. The lower the chi-square value, the better the fit between the predicted and observed speed. Overall, simulated speeds match reasonably well with observed speeds.

Exhibit 10: US 101 Northbound AM Speed Contour Map – FREQ Simulated versus Observed

	Start Time	N.Tpk On to N.PatsonOf	N.Patterson Ofto 217Of	217 Ofto N.Patson On	N.Patterson On-NFviewOf	N.FviewOff toOn	N.FviewOn-LCarnerosOff	Los Carneros Off to On	L.CarnsOn-Glen An Off	Glenn Annie Off to On	Glen AnOn W.Canyon Off	W.Canyon Off to HollOn
	Length (mi)	0.7	0.2	0.4	0.7	0.3	1.0	0.5	0.3	0.6	1.5	0.8
Observed(Average)	7:00 AM	62	64	68	70	71	69	69	69	70	70	70
	7:15 AM	65	71	70	69	70	68	70	68	69	70	69
	7:30 AM	63	67	66	66	67	64	64	62	65	66	67
	7:45 AM	60	66	67	69	67	63	68	65	65	67	69
	8:00 AM	62	68	69	70	69	70	70	71	72	70	70
	8:15 AM	64	67	69	68	69	61	67	66	67	67	69
	8:30 AM	60	64	67	69	71	68	66	67	69	69	70
	8:45 AM	62	69	69	69	67	68	71	69	71	71	68
Simulated	7:00 AM	68	68	68	68	68	68	68	68	68	68	68
	7:15 AM	68	68	68	68	68	68	68	68	68	68	68
	7:30 AM	67	68	68	68	68	68	68	68	68	68	68
	7:45 AM	62	67	68	68	68	67	68	68	68	68	68
	8:00 AM	64	67	68	68	68	67	68	68	68	68	68
	8:15 AM	65	68	68	68	68	68	68	68	68	68	68
	8:30 AM	66	68	68	68	68	68	68	68	68	68	68
	8:45 AM	65	68	68	68	68	68	68	68	68	68	68
Difference	7:00 AM	-6	-4	0	2	3	1	1	1	2	2	2
	7:15 AM	-3	3	2	1	2	0	2	0	1	2	1
	7:30 AM	-4	-1	-2	-2	-1	-4	-4	-6	-3	-2	-1
	7:45 AM	-2	-1	-1	1	-1	-4	0	-3	-3	-1	1
	8:00 AM	-2	1	1	2	1	3	2	3	4	2	2
	8:15 AM	-1	-1	1	0	1	-7	-1	-2	-1	-1	1
	8:30 AM	-6	-4	-1	1	3	0	-2	-1	1	1	2
	8:45 AM	-3	1	1	1	-1	0	3	1	3	3	0
Chi-Squared	7:00 AM	1	0	0	0	0	0	0	0	0	0	0
	7:15 AM	0	0	0	0	0	0	0	0	0	0	0
	7:30 AM	0	0	0	0	0	0	0	1	0	0	0
	7:45 AM	0	0	0	0	0	0	0	0	0	0	0
	8:00 AM	0	0	0	0	0	0	0	0	0	0	0
	8:15 AM	0	0	0	0	0	1	0	0	0	0	0
	8:30 AM	1	0	0	0	0	0	0	0	0	0	0
	8:45 AM	0	0	0	0	0	0	0	0	0	0	0

Note: Observed data reflect only data collected on October 4th-6th, 2016: No color - freeway at free-flow or near free flow conditions, speeds are greater than 60 mph; Blue - freeway approaches capacity, speeds are between 50 to 59 mph; Orange - freeway generally at capacity: speeds are between 40 to 49 mph; Red - freeway is congested or in queues, speeds are below 40 mph.

Exhibit 11: US 101 Northbound PM Speed Contour Map – FREQ Simulated versus Observed

	Start Time	N.Tpk On to N.PatsonOf	N.Patterson Ofto 217Of	217 Ofto N.Patson On	N.Patterson On-NFviewOf	N.FviewOff toOn	N.FviewOn-LCarnerosOff	Los Carneros Off to On	L.CarnsOn-Glen An Off	Glenn Annie Off to On	Glen AnOn W.Canyon Off	W.Canyon Off to HollOn
	Length (mi)	0.7	0.2	0.4	0.7	0.3	1.0	0.5	0.3	0.6	1.5	0.8
Observed(Average)	4:00 PM	64	65	67	68	68	64	65	62	66	68	67
	4:15 PM	51	62	63	64	64	60	69	65	69	71	70
	4:30 PM	49	67	69	71	68	64	69	68	71	70	72
	4:45 PM	54	61	64	65	64	61	59	56	64	67	69
	5:00 PM	61	66	68	69	67	61	63	62	72	70	71
	5:15 PM	63	68	70	69	56	48	51	53	68	72	73
	5:30 PM	57	64	64	66	51	50	62	63	67	67	66
	5:45 PM	60	68	70	68	58	57	65	65	69	72	70
	6:00 PM	62	66	66	69	70	66	70	70	71	70	72
	6:15 PM	58	63	64	66	64	64	63	51	65	69	70
	6:30 PM	61	67	67	69	67	66	69	69	69	71	69
	6:45 PM	66	72	71	73	73	73	74	74	74	72	73
Simulated	4:00 PM	65	65	65	65	65	65	65	65	65	65	65
	4:15 PM	54	65	65	65	65	65	65	65	65	65	65
	4:30 PM	46	65	65	65	65	65	65	65	65	65	65
	4:45 PM	55	65	65	65	65	61	59	52	65	65	65
	5:00 PM	64	65	65	65	65	64	56	63	65	65	65
	5:15 PM	63	65	65	65	51	52	54	57	65	65	65
	5:30 PM	58	65	65	65	49	52	64	63	65	65	65
	5:45 PM	54	65	65	65	55	58	65	64	65	65	65
	6:00 PM	65	65	65	65	65	54	65	64	65	65	65
	6:15 PM	54	65	65	65	65	65	65	65	65	65	65
	6:30 PM	47	65	65	65	65	65	65	65	65	65	65
	6:45 PM	65	65	65	65	65	65	65	65	65	65	65
Difference	4:00 PM	-1	0	2	3	3	-1	0	-3	1	3	2
	4:15 PM	-3	-3	-2	-1	-1	-5	4	0	4	6	5
	4:30 PM	3	2	4	6	3	-1	4	3	6	5	7
	4:45 PM	-1	-4	-1	0	-1	0	0	4	-1	2	4
	5:00 PM	-3	1	3	4	2	-3	7	-1	7	5	6
	5:15 PM	0	3	5	4	5	-4	-3	-4	3	7	8
	5:30 PM	-1	-1	-1	1	2	-2	-2	0	2	2	1
	5:45 PM	6	3	5	3	3	-1	0	1	4	7	5
	6:00 PM	-3	1	1	4	5	12	5	6	6	5	7
	6:15 PM	4	-2	-1	1	-1	-1	-2	-14	0	4	5
	6:30 PM	14	2	2	4	2	1	4	4	4	6	4
	6:45 PM	1	7	6	8	8	8	9	9	9	7	8
Chi-Squared	4:00 PM	0	0	0	0	0	0	0	0	0	0	0
	4:15 PM	0	0	0	0	0	1	0	0	0	0	0
	4:30 PM	0	0	0	0	0	0	0	0	1	0	1
	4:45 PM	0	0	0	0	0	0	0	0	0	0	0
	5:00 PM	0	0	0	0	0	0	1	0	1	0	0
	5:15 PM	0	0	0	0	0	0	0	0	0	1	1
	5:30 PM	0	0	0	0	0	0	0	0	0	0	0
	5:45 PM	1	0	0	0	0	0	0	0	0	1	0
	6:00 PM	0	0	0	0	0	2	0	0	1	0	1
	6:15 PM	0	0	0	0	0	0	0	4	0	0	0
	6:30 PM	3	0	0	0	0	0	0	0	0	0	0
	6:45 PM	0	1	0	1	1	1	1	1	1	1	1

Note: Observed data reflect only data collected on October 4th-6th, 2016: No color - freeway at free-flow or near free flow conditions, speeds are greater than 60 mph; Blue - freeway approaches capacity, speeds are between 50 to 59 mph; Orange - freeway generally at capacity: speeds are between 40 to 49 mph; Red - freeway is congested or in queues, speeds are below 40 mph.

Exhibit 12: US 101 Southbound AM Speed Contour Map – FREQ Simulated versus Observed

	Start Time	Holl of f to Ho ll on	Holl on to Sto rke Rdoff	Storke off to on	Storke on to L carnosOf	Lcarnos Off to On	L.Crnos on - S Fvw Ave Of	S.fvw O ff to O n	S Fvw o n to Pa t Off	Patt Of f to 21 7 On	SR 217 On to P aterson On	Patt On to Tur npk Off
	Length (mi)	0.5	1.7	0.5	0.5	0.7	0.6	0.4	0.8	0.3	0.3	0.6
Observed(Average)	7:00 AM	67	68	68	69	69	64	63	65	63	59	57
	7:15 AM	65	69	68	64	67	64	66	65	63	59	58
	7:30 AM	68	71	70	69	67	52	54	62	61	57	47
	7:45 AM	65	67	44	20	23	38	53	53	43	28	32
	8:00 AM	66	66	70	49	41	42	52	59	57	38	38
	8:15 AM	70	72	70	63	67	61	66	66	55	43	37
	8:30 AM	65	68	67	66	68	67	66	66	66	64	54
	8:45 AM	67	70	66	67	68	67	67	66	65	62	59
Simulated	7:00 AM	65	65	65	65	65	65	65	65	65	65	65
	7:15 AM	65	65	65	65	65	65	65	65	65	65	58
	7:30 AM	65	65	65	65	54	52	55	65	64	32	35
	7:45 AM	65	65	65	65	23	37	65	65	17	11	38
	8:00 AM	65	65	65	65	30	16	65	65	47	24	35
	8:15 AM	65	65	65	65	65	65	65	65	60	25	26
	8:30 AM	65	65	65	65	65	65	65	65	61	28	43
	8:45 AM	65	65	65	65	65	64	65	65	65	65	54
Difference	7:00 AM	2	3	3	4	4	-1	-2	0	-2	-6	-8
	7:15 AM	0	4	3	-1	2	-1	1	0	-2	-6	0
	7:30 AM	3	6	5	4	13	0	-1	-3	-3	25	12
	7:45 AM	0	2	-21	-45	0	1	-12	-12	26	17	-6
	8:00 AM	1	1	5	-16	11	26	-13	-6	10	14	3
	8:15 AM	5	7	5	-2	2	-4	1	1	-5	18	11
	8:30 AM	0	3	2	1	3	2	1	1	5	36	11
	8:45 AM	2	5	1	2	3	3	2	1	0	-3	5
Chi-Squared	7:00 AM	0	0	0	0	0	0	0	0	0	1	1
	7:15 AM	0	0	0	0	0	0	0	0	0	1	0
	7:30 AM	0	0	0	0	3	0	0	0	0	11	3
	7:45 AM	0	0	10	103	0	0	3	3	16	10	1
	8:00 AM	0	0	0	5	3	16	3	1	2	5	0
	8:15 AM	0	1	0	0	0	0	0	0	0	7	3
	8:30 AM	0	0	0	0	0	0	0	0	0	20	2
	8:45 AM	0	0	0	0	0	0	0	0	0	0	1

Note: Observed data reflect only data collected on October 4th-6th, 2016: No color - freeway at free-flow or near free flow conditions, speeds are greater than 60 mph; Blue - freeway approaches capacity, speeds are between 50 to 59 mph; Orange - freeway generally at capacity: speeds are between 40 to 49 mph; Red - freeway is congested or in queues, speeds are below 40 mph.

Exhibit 13: US 101 Southbound PM Speed Contour Map – FREQ Simulated versus Observed

	Start Time	Holl off to Holl on	Holl on to Storke Rdoff	Storke off to on	Storke on to Lcarnos Of	Lcarnos Off to On	L.Crnos on - S Fvw Ave Of	S.fvw Off to On	S Fvw on to Patt Off	Patt Off to 217 On	SR 217 On to Paterson On	Patt On to Turnpk Off
	Length (mi)	0.5	1.7	0.5	0.5	0.7	0.6	0.4	0.8	0.3	0.3	0.6
Observed(Average)	4:00 PM	69	74	73	70	70	70	70	60	44	30	40
	4:15 PM	66	67	66	66	65	62	61	46	28	30	39
	4:30 PM	68	71	68	65	65	61	63	62	40	33	35
	4:45 PM	71	73	76	74	72	63	64	38	20	21	28
	5:00 PM	66	68	67	68	64	58	56	41	13	18	30
	5:15 PM	67	70	69	67	49	36	27	20	14	18	30
	5:30 PM	70	75	75	72	50	52	50	31	18	19	31
	5:45 PM	67	68	68	69	52	49	57	35	14	17	30
	6:00 PM	68	68	66	66	65	62	63	51	45	40	41
	6:15 PM	69	72	72	69	66	64	69	68	65	57	55
	6:30 PM	66	68	68	67	64	61	61	63	64	61	59
	6:45 PM	65	68	65	67	69	69	66	63	61	58	57
Simulated	4:00 PM	65	65	65	65	65	65	65	65	47	25	52
	4:15 PM	65	65	65	65	65	65	65	65	33	19	35
	4:30 PM	65	65	65	65	65	65	65	65	22	23	34
	4:45 PM	65	65	65	65	65	65	65	47	14	19	26
	5:00 PM	65	65	65	65	65	59	20	24	12	18	32
	5:15 PM	65	65	65	65	65	59	15	22	14	20	32
	5:30 PM	65	65	65	65	65	65	48	28	14	20	29
	5:45 PM	65	65	65	65	65	65	65	46	13	19	24
	6:00 PM	65	65	65	65	65	65	65	65	37	28	35
	6:15 PM	65	65	65	65	65	65	65	65	65	19	35
	6:30 PM	65	65	65	65	65	65	65	65	65	29	16
	6:45 PM	65	65	65	65	65	65	65	65	65	48	17
Difference	4:00 PM	4	9	8	5	5	5	5	-5	-3	5	-12
	4:15 PM	1	2	1	1	0	-3	-4	-19	-5	11	4
	4:30 PM	3	6	3	0	0	-4	-2	-3	18	10	1
	4:45 PM	6	8	11	9	7	-2	-1	-9	6	2	2
	5:00 PM	1	3	2	3	-1	-1	36	17	1	0	-2
	5:15 PM	2	5	4	2	-16	-23	12	-2	0	-2	-2
	5:30 PM	5	10	10	7	-15	-13	2	3	4	-1	2
	5:45 PM	2	3	3	4	-13	-16	-8	-11	1	-2	6
	6:00 PM	3	3	1	1	0	-3	-2	-14	8	12	6
	6:15 PM	4	7	7	4	1	-1	4	3	0	38	20
	6:30 PM	1	3	3	2	-1	-4	-4	-2	-1	32	43
	6:45 PM	0	3	0	2	4	4	1	-2	-4	10	40
Chi-Squared	4:00 PM	0	1	1	0	0	0	0	0	0	1	3
	4:15 PM	0	0	0	0	0	0	0	8	1	4	0
	4:30 PM	0	0	0	0	0	0	0	0	8	3	0
	4:45 PM	1	1	2	1	1	0	0	2	2	0	0
	5:00 PM	0	0	0	0	0	0	24	7	0	0	0
	5:15 PM	0	0	0	0	5	14	5	0	0	0	0
	5:30 PM	0	1	1	1	4	3	0	0	1	0	0
	5:45 PM	0	0	0	0	3	5	1	4	0	0	1
	6:00 PM	0	0	0	0	0	0	0	4	1	4	1
	6:15 PM	0	1	1	0	0	0	0	0	0	26	7
	6:30 PM	0	0	0	0	0	0	0	0	0	17	31
	6:45 PM	0	0	0	0	0	0	0	0	0	2	28

Note: Observed data reflect only data collected on October 4th-6th, 2016: No color - freeway at free-flow or near free flow conditions, speeds are greater than 60 mph; Blue - freeway approaches capacity, speeds are between 50 to 59 mph; Orange - freeway generally at capacity: speeds are between 40 to 49 mph; Red - freeway is congested or in queues, speeds are below 40 mph.

Travel Times

Exhibit 14 and Exhibit 15 provide comparisons of FREQ simulated versus observed travel times through the US 101 northbound corridor during AM peak period. As shown, differences are within ±15 percent in all cases when compared to observed floating car data. Simulated travel times are slightly lower than the observed data.

Exhibit 15 and
Exhibit 16 provide comparisons of FREQ simulated versus observed travel times through the US 101 northbound corridor during PM peak period. As shown, differences are within ±15 percent in all cases, when compared to observed floating car data. Simulated travel times are slightly higher than the observed data in most cases.

Exhibit 18 and Exhibit 19 provide comparisons of FREQ simulated versus observed travel times through the US 101 southbound corridor during AM peak period. As shown, differences are within ±15 percent in most cases, except for two time intervals, when compared to observed floating car data.

Exhibit 20 and Exhibit 21 provide comparisons of FREQ simulated versus observed travel times through the US 101 southbound corridor during PM peak period. As shown, differences are within ±15 percent in all cases except for three time intervals, when compared to observed floating car data. Simulated travel times are either higher or lower than the observed data.

Exhibit 14: Comparison of Observed versus Simulated Travel Times – US 101 Northbound AM

Start Time	Observed (October 4th-6th, 2016)	FREQ	Difference	
	Minutes	Minutes	Minutes	Percent
7:00 AM	6.0	6.1	0.0	0%
7:15 AM	6.0	6.1	0.0	0%
7:30 AM	6.3	6.1	-0.3	-4%
7:45 AM	6.3	6.1	-0.2	-3%
8:00 AM	6.0	6.1	0.1	2%
8:15 AM	6.2	6.1	-0.2	-3%
8:30 AM	6.1	6.1	-0.1	-1%
8:45 AM	6.1	6.1	0.0	0%
			Total Cases	8
			Cases Met (15% criteria)	8
			% Met (15% criteria)	100%

Note: Travel times are measured between Turnpike Road and Cathedral Oaks Road, a total distance of approximately 6.85 miles.

Exhibit 15: Graphical Comparison of Observed vs Simulated Travel Times – US 101 Northbound AM

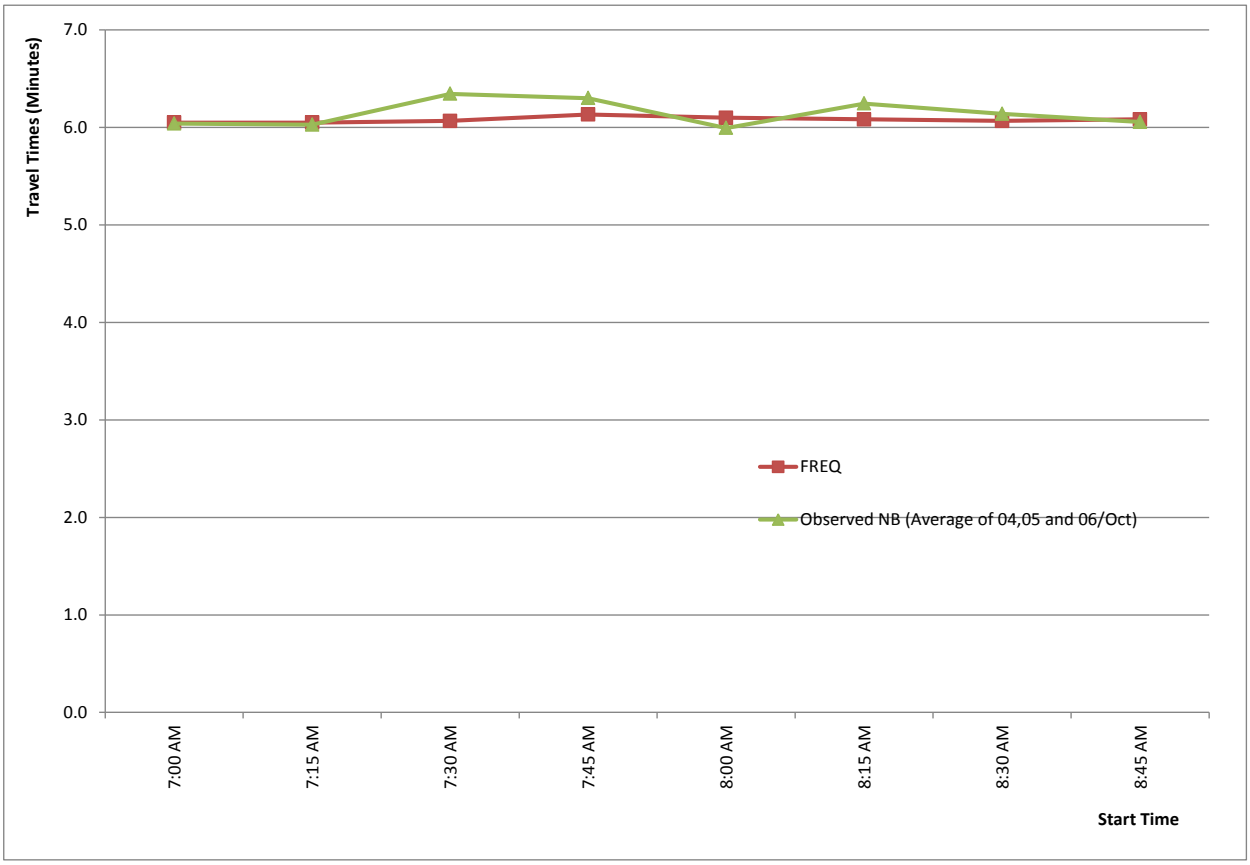


Exhibit 16: Comparison of Observed versus Simulated Travel Times – US 101 Northbound PM

Start Time	Observed (Wednesday 5/1)	FREQ	Difference	
	Minutes	Minutes	Minutes	Percent
4:00 PM	6.3	6.3	0.0	1%
4:15 PM	6.5	6.4	-0.1	-2%
4:30 PM	6.4	6.6	0.2	2%
4:45 PM	6.7	6.6	-0.1	-1%
5:00 PM	6.2	6.4	0.2	3%
5:15 PM	7.1	6.8	-0.3	-5%
5:30 PM	7.0	6.7	-0.3	-4%
5:45 PM	6.4	6.6	0.2	3%
6:00 PM	6.1	6.5	0.4	7%
6:15 PM	6.5	6.4	0.0	0%
6:30 PM	6.1	6.6	0.4	7%
6:45 PM	5.7	6.3	0.6	10%
			Total Cases	12
			Cases Met (15% criteria)	12
			% Met (15% criteria)	100%

Note: Travel times are measured between Turnpike Road and Cathedral Oaks Road, a total distance of approximately 6.85 miles.

Exhibit 17: Graphical Comparison of Observed vs Simulated Travel Times – US 101 Northbound PM

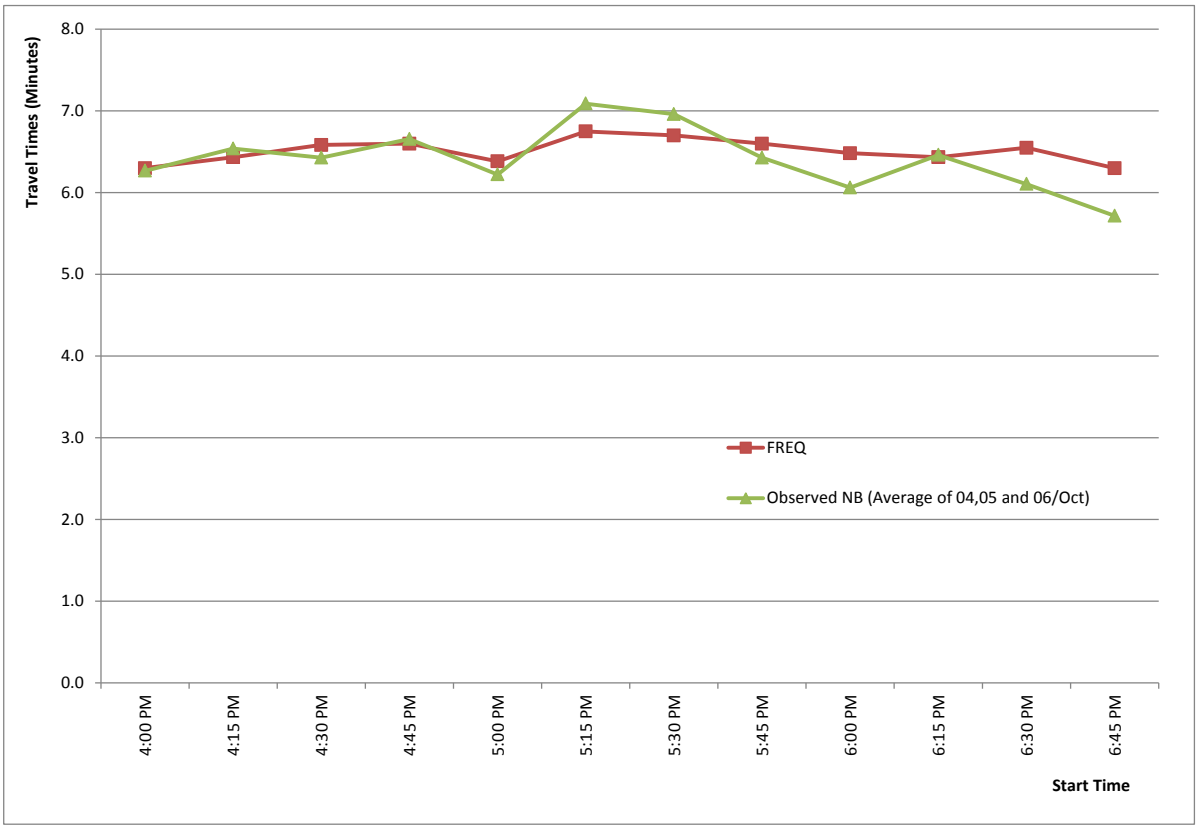


Exhibit 18: Comparison of Observed versus Simulated Travel Times – US 101 Southbound AM

Start Time	Observed (Wednesday 5/1)	FREQ	Difference	
	Minutes	Minutes	Minutes	Percent
7:00 AM	6.4	6.4	0.0	1%
7:15 AM	6.4	5.4	-1.0	-16%
7:30 AM	6.8	7.9	1.0	15%
7:45 AM	10.7	9.4	-1.3	-12%
8:00 AM	8.6	9.3	0.8	9%
8:15 AM	7.3	6.5	-0.8	-11%
8:30 AM	6.4	6.4	0.0	0%
8:45 AM	6.3	6.2	-0.1	-2%
			Total Cases	8
			Cases Met (15% criteria)	6
			% Met (15% criteria)	75%

Note: Travel times are measured between Cathedral Oaks Road and Turnpike Road, a total distance of approximately 6.88 miles.

Exhibit 19: Graphical Comparison of Observed vs Simulated Travel Times – US 101 Southbound AM

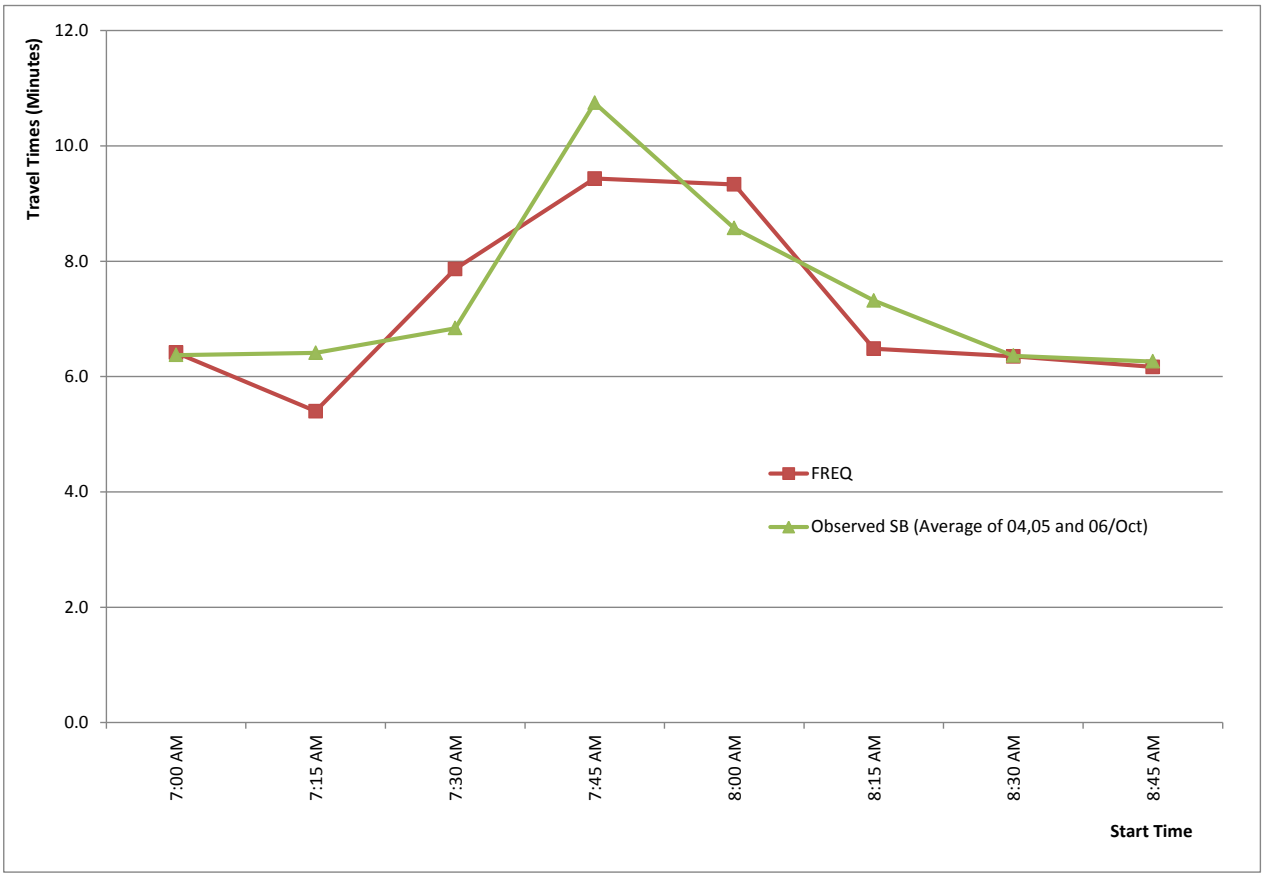


Exhibit 20: Comparison of Observed versus Simulated Travel Times – US 101 Southbound PM

Start Time	Observed (Wednesday 5/1)	FREQ	Difference	
	Minutes	Minutes	Minutes	Percent
4:00 PM	7.9	7.2	-0.8	-10%
4:15 PM	9.0	7.2	-1.8	-20%
4:30 PM	7.8	8.1	0.3	4%
4:45 PM	9.0	10.0	0.9	10%
5:00 PM	9.7	11.6	1.9	20%
5:15 PM	12.1	12.2	0.1	1%
5:30 PM	10.3	10.3	-0.1	-1%
5:45 PM	10.6	9.7	-0.9	-9%
6:00 PM	7.7	6.3	-1.4	-18%
6:15 PM	6.3	6.4	0.1	1%
6:30 PM	6.5	6.8	0.3	5%
6:45 PM	6.4	6.0	-0.4	-7%
			Total Cases	12
			Cases Met (15% criteria)	9
			% Met (15% criteria)	75%

Note: Travel times are measured between Cathedral Oaks Road and Turnpike Road, a total distance of approximately 6.88 miles.

Exhibit 21: Graphical Comparison of Observed vs Simulated Travel Times – US 101 Southbound PM

Traffic Volumes

FREQ simulated (or processed) origin-destination traffic volumes were compared to actual traffic volume counts at on-ramps and off-ramps, as well as input traffic volumes at the beginning (entry) and ending (exit) subsections of the freeway mainline. Comparison summary tables are provided in Exhibit 22 through Exhibit 25. In general, simulated traffic volumes matched actual counts reasonably well.

Exhibit 22: Comparison of Observed versus Simulated Traffic Volumes – US 101 Northbound AM

TS	Mainline s/o N Tumpike Rd	N Turnpike Rd On	N Patterson Ave On	N Fairview Ave On	N Los Carneros Rd On	Glen Annie Rd On	Cathedral Oaks Rd/Calle Real On	N Turnpike Rd Off	N Patterson Ave Off	SR217 Off	N Fairview Ave Off	N Los Carneros Rd Off	Glen Annie Rd Off	Winchester Canyon Rd/Calle Real Off	Mainline n/o Cathedral Oaks Rd
	Final FREQ Input Volumes - Hourly Flow Data (15-minute data x 4)														
1	3272	272	192	140	64	28	104	340	476	760	616	548	768	132	432
2	3712	412	236	144	104	48	60	416	568	1012	616	636	808	188	472
3	4904	528	368	176	120	44	84	764	704	1124	852	748	1280	200	552
4	5640	652	416	244	140	32	76	676	900	1564	1052	1024	1256	292	436
5	5284	628	408	216	112	28	64	504	756	1364	1176	1080	1136	220	504
6	5084	592	396	200	188	40	108	536	812	1148	1128	1000	1332	224	428
7	4956	580	400	256	140	40	92	592	672	1268	996	884	1228	204	620
8	5264	516	284	196	100	48	64	668	720	1264	976	836	1064	224	720
Total	38,116	4,180	2,700	1,572	968	308	652	4,496	5,608	9,504	7,412	6,756	8,872	1,684	4,164
	FREQ Output Volumes - Hourly Flow Data														
SS	1	3	6	8	10	12	14	1	3	4	6	8	10	14	0
1	3272	272	192	136	64	28	104	340	476	760	616	548	768	128	432
2	3716	412	236	144	100	48	60	416	568	1012	612	640	804	192	472
3	4904	528	368	176	120	44	84	764	704	1124	848	748	1280	200	556
4	5640	648	416	248	136	32	76	676	900	1564	1052	1024	1256	296	428
5	5284	628	404	216	112	28	64	504	756	1364	1172	1080	1136	220	504
6	5084	588	400	204	188	40	108	536	812	1148	1128	1004	1332	224	428
7	4952	584	396	252	140	40	92	592	672	1268	996	884	1224	204	616
8	5260	520	280	200	100	48	64	668	720	1264	976	836	1064	224	720
	Percent Simulated in FREQ (Simulated/Observed Volumes)														
SS	1	3	6	8	10	12	14	1	3	4	6	8	10	12	14
1	100%	100%	100%	97%	100%	100%	100%	100%	100%	100%	100%	100%	100%	97%	100%
2	100%	100%	100%	100%	96%	100%	100%	100%	100%	100%	99%	101%	100%	102%	100%
3	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	101%
4	100%	99%	100%	102%	97%	100%	100%	100%	100%	100%	100%	100%	100%	101%	98%
5	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
6	100%	99%	101%	102%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
7	100%	101%	99%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99%
8	100%	101%	99%	102%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
TOTAL	100%	100%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Exhibit 23: Comparison of Observed versus Simulated Traffic Volumes – US 101 Northbound PM

TS	Mainline s/o N Tumpike Rd	N Tumpike Rd On	N Patterson Ave On	N Fairview Ave On	N Los Carneros Rd On	Glen Annie Rd On	Cathedral Oaks Rd/Calle Real On	N Tumpike Rd Off	N Patterson Ave Off	SR217 Off	N Fairview Ave Off	N Los Carneros Rd Off	Glen Annie Rd Off	Winchester Canyon Rd/Calle Real Off	Mainline n/o Cathedral Oaks Rd
	Final FREQ Input Volumes - Hourly Flow Data (15-minute data x 4)														
1	4864	652	472	420	324	204	204	880	856	816	772	532	1344	388	1552
2	4704	508	476	416	312	184	232	792	796	680	812	424	1348	404	1576
3	4368	680	532	420	428	176	224	964	752	672	836	392	1308	332	1572
4	5116	580	560	400	392	200	212	908	860	808	868	440	1576	432	1568
5	4904	720	564	492	460	228	204	920	836	736	776	512	1696	468	1628
6	5520	616	484	404	444	216	156	1072	880	768	804	544	1672	484	1616
7	5504	516	452	420	340	188	216	928	844	824	788	552	1580	436	1684
8	5148	512	348	388	312	132	164	904	856	776	684	536	1440	364	1444
9	4576	484	312	388	288	108	144	780	692	660	652	468	1364	372	1312
10	4304	436	260	392	276	120	152	744	716	612	568	388	1432	356	1124
11	3888	476	248	328	208	104	124	676	660	532	524	396	1316	260	1012
12	3716	476	192	328	180	104	100	692	592	604	560	340	1252	252	804
Total	56,612	6,656	4,900	4,796	3,964	1,964	2,132	10,260	9,340	8,488	8,644	5,524	17,328	4,548	16,892
	FREQ Output Volumes - Hourly Flow Data														
SS	1	3	6	8	10	12	14	1	3	4	6	8	10	14	0
1	4864	652	472	420	328	204	204	880	856	816	772	532	1344	388	1556
2	4704	512	476	416	312	184	232	792	796	665	797	421	1329	403	1555
3	4368	680	532	424	428	176	224	964	752	676	840	398	1312	333	1576
4	5120	580	560	400	392	200	212	908	860	813	873	446	1500	431	1566
5	4908	720	568	492	460	228	204	920	836	736	776	512	1500	454	1574
6	5524	616	484	408	444	216	156	1072	880	768	804	544	1500	453	1526
7	5504	516	448	424	340	188	216	928	844	815	780	551	1500	428	1641
8	5148	508	348	384	312	132	164	904	856	781	688	537	1500	383	1509
9	4576	488	312	388	288	108	144	780	692	660	656	468	1500	408	1427
10	4300	436	260	392	272	120	152	744	716	598	556	381	1500	350	1118
11	3888	476	248	332	208	104	124	676	660	538	529	399	1500	262	1018
12	3716	480	192	324	180	104	100	692	592	604	564	340	1252	252	800
	Percent Simulated in FREQ (Simulated/Observed Volumes)														
SS	1	3	6	8	10	12	14	1	3	4	6	8	10	12	14
1	100%	100%	100%	100%	101%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
2	100%	101%	100%	100%	100%	100%	100%	100%	100%	98%	98%	99%	99%	100%	99%
3	100%	100%	100%	101%	100%	100%	100%	100%	100%	101%	100%	102%	100%	100%	100%
4	100%	100%	100%	100%	100%	100%	100%	100%	100%	101%	101%	101%	95%	100%	100%
5	100%	100%	101%	100%	100%	100%	100%	100%	100%	100%	100%	100%	88%	97%	97%
6	100%	100%	100%	101%	100%	100%	100%	100%	100%	100%	100%	100%	90%	94%	94%
7	100%	100%	99%	101%	100%	100%	100%	100%	100%	99%	99%	100%	95%	98%	97%
8	100%	99%	100%	99%	100%	100%	100%	100%	100%	101%	101%	100%	104%	105%	105%
9	100%	101%	100%	100%	100%	100%	100%	100%	100%	100%	101%	100%	110%	110%	109%
10	100%	100%	100%	100%	99%	100%	100%	100%	100%	98%	98%	98%	105%	98%	99%
11	100%	100%	100%	101%	100%	100%	100%	100%	100%	101%	101%	101%	114%	101%	101%
12	100%	101%	100%	99%	100%	100%	100%	100%	100%	100%	101%	100%	100%	100%	100%
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Exhibit 24: Comparison of Observed versus Simulated Traffic Volumes – US 101 Southbound AM

TS	Mainline n/o Cathedral Oaks Rd	Cathedral Oaks Rd On	Storke Rd On	S Los Cameros Rd On	S Fairview Ave On	SR217 On	S Patterson Ave On	S Tumpike Rd On	Cathedral Oaks Rd Off	Storke Rd Off	S Los Cameros Rd Off	S Fairview Ave Off	S Patterson Ave Off	S Tumpike Rd Off	Mainline s/o S Tumpike Rd
	Final FREQ Input Volumes - Hourly Flow Data (15-minute data x 4)														
1	1384	332	940	256	516	392	512	524	120	184	240	288	260	280	3484
2	1320	488	1420	428	696	580	688	784	124	196	268	344	320	412	4740
3	1440	624	1756	612	832	692	908	992	152	212	412	340	416	488	5836
4	1408	592	1484	524	840	584	876	988	124	280	812	384	644	708	4344
5	1432	484	1288	360	756	596	784	860	120	188	448	480	460	528	4336
6	1196	464	1348	360	824	492	884	812	72	140	252	412	420	460	4624
7	1200	380	1356	412	848	552	872	752	100	152	240	384	340	460	4696
8	1616	376	1376	500	832	592	812	820	96	116	240	376	380	484	5232
Total	10,996	3,740	10,968	3,452	6,144	4,480	6,336	6,532	908	1,468	2,912	3,008	3,240	3,820	37,292
	FREQ Output Volumes - Hourly Flow Data														
SS	1	3	5	7	9	11	12	14	1	3	5	7	9	12	14
1	1384	336	940	256	516	392	512	524	120	184	240	292	264	276	3484
2	1320	484	1420	428	696	580	688	784	124	196	268	344	320	408	4740
3	1440	624	1756	608	832	692	908	992	152	212	412	331	411	484	5392
4	1408	592	1488	524	840	584	876	988	124	280	812	375	583	661	3988
5	1428	488	1292	356	756	596	784	860	120	188	448	480	500	558	5000
6	1196	464	1348	360	824	492	884	812	72	140	252	416	416	460	4012
7	1196	380	1356	412	848	552	872	752	100	152	240	384	340	456	5122
8	1612	376	1376	500	832	592	812	820	96	116	240	376	380	484	5228
	Percent Simulated in FREQ (Simulated/Observed Volumes)														
SS	1	3	5	7	9	11	12	14	1	3	5	7	9	12	14
1	100%	101%	100%	100%	100%	100%	100%	100%	100%	100%	100%	101%	102%	99%	100%
2	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99%	100%
3	100%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	97%	99%	99%	92%
4	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	98%	91%	93%	92%
5	100%	101%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	109%	106%	115%
6	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	101%	99%	100%	87%
7	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99%	109%
8	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99%	99%

Exhibit 25: Comparison of Observed versus Simulated Traffic Volumes – US 101 Southbound PM

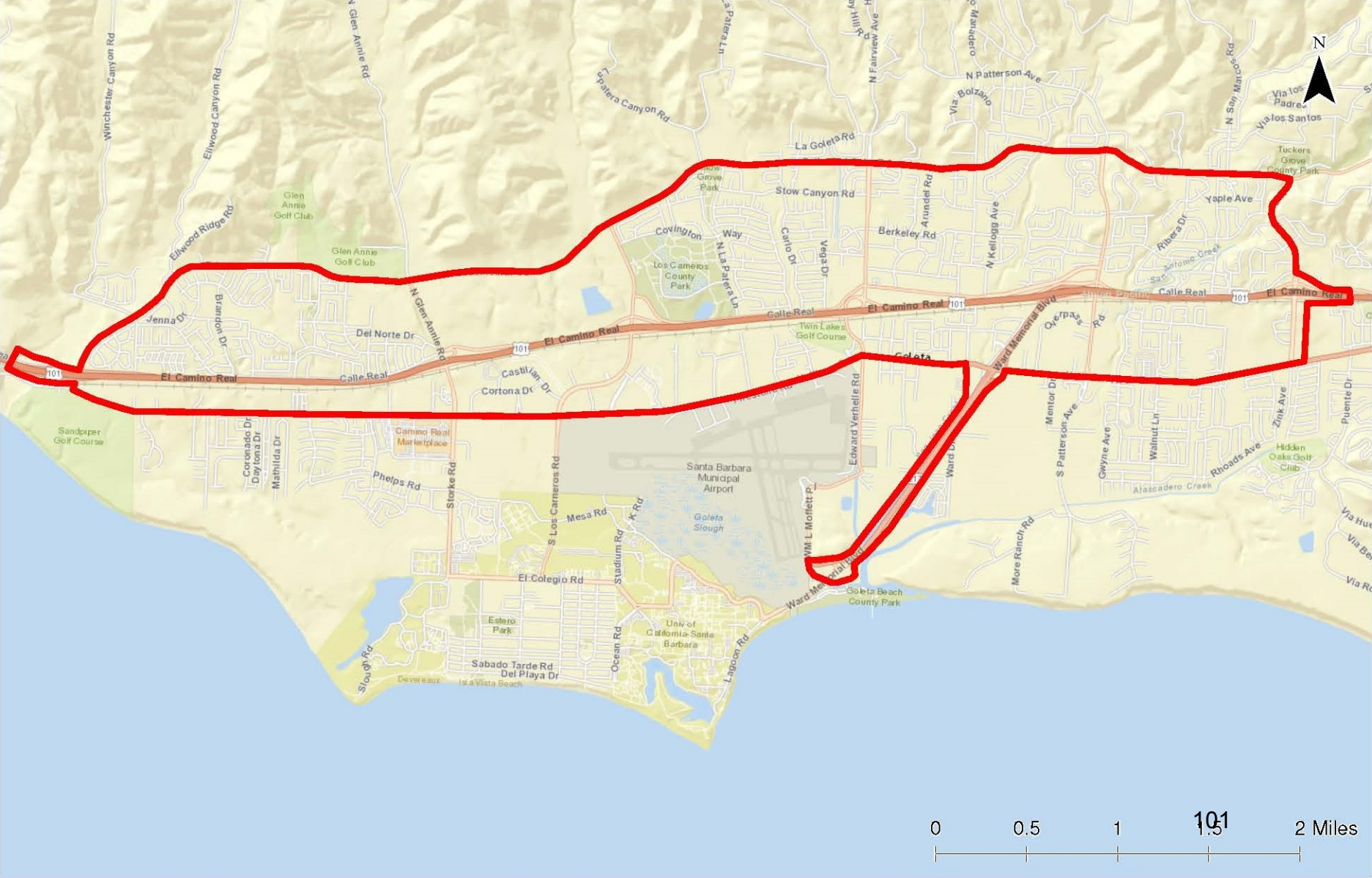
TS	Mainline n/o Cathedral Oaks Rd	Cathedral Oaks Rd On	Storke Rd On	S Los Carneros Rd On	S Fairview Ave On	SR217 On	S Patterson Ave On	S Turnpike Rd On	Cathedral Oaks Rd Off	Storke Rd Off	S Los Carneros Rd Off	S Fairview Ave Off	S Patterson Ave Off	S Turnpike Rd Off	Mainline s/o S Turnpike Rd
	Final FREQ Input Volumes - Hourly Flow Data (15-minute data x 4)														
1	724	272	1328	728	888	1016	900	672	80	60	132	268	348	548	5092
2	836	296	1244	700	832	916	896	648	72	84	148	344	416	484	4820
3	796	312	1240	936	936	948	900	592	72	76	136	276	476	520	5104
4	1012	296	1248	848	876	820	836	592	60	76	164	352	504	412	4960
5	756	344	1352	1188	1168	696	1028	688	80	80	132	268	496	500	5664
6	696	220	1244	1068	884	632	972	672	84	84	120	408	544	508	4640
7	656	260	1208	936	908	680	920	640	72	72	140	280	520	460	4664
8	724	260	1140	768	808	732	792	584	76	88	124	308	448	536	4228
9	676	228	1140	748	788	896	760	612	56	68	96	256	400	536	4436
10	620	284	1184	604	656	840	676	588	64	64	104	252	324	544	4100
11	628	236	1132	616	644	800	640	704	36	60	100	244	324	488	4148
12	576	204	1212	540	632	740	552	544	56	48	92	284	296	520	3704
Total	8,700	3,212	14,672	9,680	10,020	9,716	9,872	7,536	808	860	1,488	3,540	5,096	6,056	55,560
	FREQ Output Volumes - Hourly Flow Data														
SS	1	3	5	7	9	11	12	14	1	3	5	7	9	12	14
1	728	272	1328	728	888	1016	900	672	80	60	132	272	352	514	4813
2	832	300	1244	704	836	916	896	648	72	84	152	344	416	488	4648
3	792	312	1240	940	936	948	900	592	72	76	132	276	476	512	4992
4	1012	296	1248	848	872	820	836	592	60	76	164	352	504	412	4792
5	756	348	1348	1188	1168	696	1028	688	80	80	132	268	473	445	4988
6	696	220	1248	1068	884	632	972	672	84	84	120	408	544	512	4972
7	656	264	1208	936	912	680	920	640	72	72	136	284	524	460	4940
8	720	260	1144	768	808	732	792	584	76	88	124	312	444	532	4584
9	672	232	1136	752	788	896	760	612	56	68	96	256	400	536	4576
10	620	280	1184	600	660	840	676	588	64	64	104	248	320	548	4340
11	628	232	1132	616	648	800	640	704	36	60	100	244	324	488	4104
12	576	200	1212	540	632	740	556	544	56	48	92	284	292	524	3944
	Percent Simulated in FREQ (Simulated/Observed Volumes)														
SS	1	3	5	7	9	11	12	14	1	3	5	7	9	12	14
1	101%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	101%	101%	94%	95%
2	100%	101%	100%	101%	100%	100%	100%	100%	100%	100%	103%	100%	100%	101%	96%
3	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%	97%	100%	100%	98%	98%
4	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	97%
5	100%	101%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	95%	89%	88%
6	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	101%	107%
7	100%	102%	100%	100%	100%	100%	100%	100%	100%	100%	97%	101%	101%	100%	106%
8	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	101%	99%	99%	108%
9	99%	102%	100%	101%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	103%
10	100%	99%	100%	99%	101%	100%	100%	100%	100%	100%	100%	98%	99%	101%	106%
11	100%	98%	100%	100%	101%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99%
12	100%	98%	100%	100%	100%	100%	101%	100%	100%	100%	100%	100%	99%	101%	106%
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99%	99%	101%

CONCLUSIONS

The FREQ models developed and calibrated for US 101 are satisfactorily validated. Major bottleneck locations, lengths of queues, and duration of congestion were shown to match reasonably well with observed conditions on the speed contour maps. Simulated travel times were within 15 percent of the floating car run travel times in most cases. Finally, traffic volumes processed by FREQ matched reasonably well with traffic counts at origins (on-ramps) and destinations (off-ramps) along the freeway corridor.

ATTACHMENT 2

Study Area & Count Locations


N
Winchester Canyon Rd
Elwood Canyon Rd
Glen Annie Rd
Tepatera Canyon Rd
La Goleta Rd
N Patterson Ave
Via Bolzano
Via Los Santos
Stow Canyon Rd
Berkeley Rd
Yaple Ave
Tuckers Grove County Park
Glen Annie Golf Club
Elwood Ridge Rd
Covington Way
Los Carneros County Park
Carlo Dr
Vega Dr
Arundel Rd
N Kellogg Ave
Ribera Dr
Calle Real
El Camino Real
101
Jenna Dr
Brandon Dr
Del Norte Dr
N Glen Annie Rd
Twin Lakes Golf Course
Goleta
Ward Memorial Blvd
Overpass Rd
Castilian Dr
Cortona Dr
Sandpiper Golf Course
Camino Real Marketplace
Coronado Dr
Daytona Dr
Mathilda Dr
Phelps Rd
Storke Rd
Santa Barbara Municipal Airport
Goleta Slough
S Los Carneros Rd
Mesa Rd
K Rd
Stadium Rd
El Colegio Rd
Edward Verhelle Rd
W L Moffett Pl
Ward Memorial Blvd
Goleta Beach County Park
Mentor Dr
S Patterson Ave
Gwynne Ave
Walnut Ln
Zink Ave
Puente Dr
Rhoads Ave
Hidden Oaks Golf Club
Atascadero Creek
More Ranch Rd
Estero Park
Univ of California Santa Barbara
Ocean Rd
Lagoon Rd
Slough Rd
Sabado Tarde Rd
Del Playa Dr
Isla Vista Beach
Devereaux
0
0.5
1
1.5
2 Miles


Project Area and Study Locations
Goleta Ramp Metering Study
Legend
Local Intersections
Local Segments
Project Area
Del Norte Dr
Storke Rd
Phelps Rd
S Los Carneros Rd
El Colegio Rd
Cross Town Route
S Fairview Ave
N Fairview Ave
Moffett Pl
Mesa Rd
Calle Real
N Patterson Ave
S Patterson Ave
University Dr
N San Marcos Rd
N Turnpike
Hollister Ave
Rhoads Ave
217
1
Google earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Data CSUMB SFML, CA OPC
Data MBARI
N
102
1 mi

ATTACHMENT 3

Scenario Alternatives


Alternative 1: Do Nothing
Patterson Ave to US 101 SB
Alternative 2: Targeted
SR 217 NB to US 101 SB
Patterson Ave to US 101 SB
Alternative 3: Maximum
Storke Rd to US 101 NB and SB
Fairview Ave to US 101 NB and SB
Patterson Ave, to US 101 NB and SB
Cathedral Oaks Rd to US 101 NB and SB
Los Carneros Rd to US 101 NB and SB
Hollister Ave to SR 217 SB and NB
SR 217 NB to US 101 SB
Turnpike Rd, to US 101 NB and SB
Alternative 4: SR 217 Only
Hollister Ave to SR 217 SB and NB
Alternative 5: US 101 N. of SR 217 Only
Storke Rd to US 101 NB and SB
Fairview Ave to US 101 NB and SB
Cathedral Oaks Rd to US 101 NB and SB
Los Carneros Rd to US 101 NB and SB
Goleta
El Camino Real
Hollister Ave
Calle Real
Del Norte Dr
N Glen Annie Rd
Cortona Dr
Castilian Dr
Firestone Rd
Ward Memorial Blvd
Overpass Rd
Twin Lakes Golf Course
Sandpiper Golf Course
N

ATTACHMENT 4

Stantec Memo – Goleta Ramp Metering Study – DRAFT Ramp Metering Analysis Results

Stantec

Memo

To:	James Winslow, PE Public Works Department, City of Goleta	From:	Derek Rapp, TE Stantec
File:	2064139500	Date:	January 12, 2018

Reference: Goleta Ramp Metering Study - DRAFT Ramp Metering Alternatives Results

Stantec reviewed the *DRAFT Ramp Metering Alternatives Results* memorandum (Kittelson Associates, January 9, 2018). The memorandum provides draft results of the analysis of ramp metering alternatives in the City of Goleta study area with existing and 2035 traffic volumes. The following provides a summary of the results.

The following alternatives were included, after which Alternative 4 was excluded from further analysis as it would not provide significant changes to freeway operations:

- Alternative 1: Metering at Patterson SB on-ramp only (now constructed)
- Alternative 2: Metering at SR 217 SB on-ramp and Patterson SB on-ramp
- Alternative 3: Metering at all on-ramps
- Alternative 4: Metering at Hollister on-ramps to SR 217 only (not further analyzed)
- Alternative 5: Metering at all on-ramps north of SR 217

The analysis indicates that ramp metering could benefit the operation of the U.S. 101 freeway through Goleta, by up to 29%, at the expense of operation of adjacent surface street intersection operation. The report finds that a combination of ramp metering, Intelligent Transportation Systems (ITS) and Transportation Demand Management (TDM) strategies, including ridesharing, telecommuting, and alternative work schedules, and increased local and commuter bus service, could potentially achieve meaningful reductions in congestion and increased travel time reliability.

Existing Conditions

Alternative 1 – With the recent construction of the Patterson Avenue SB On-Ramp Meter, this alternative reflects existing conditions.

Alternative 2
- Improves southbound freeway operation by approximately 20%
- Increases delay at Fairview and Calle Real by 28%
- Decreases delay at Turnpike Rd & Hollister Ave by 20%.

Alternative 3
- Improves southbound freeway operation by approximately 29%
- Increases delays at Fairview and Calle Real by 7.5%

Reference: Goleta Ramp Metering Study - DRAFT Ramp Metering Alternatives Results

- Increases delays at Patterson Ave & Hollister Ave. by 10%
- Increases delays at Turnpike Rd & Hollister Ave by 33%

Alternative 5

- Improves southbound freeway operation by approximately 16.7%
- Increases delays at Fairview and Hollister by 22%

2035 Conditions. There would be significant congestion on the freeway during the PM peak period in the southbound direction. Ramp metering would have a significantly impact on freeway operation.

This concludes our summary of the analysis.

STANTEC CONSULTING SERVICES INC.

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