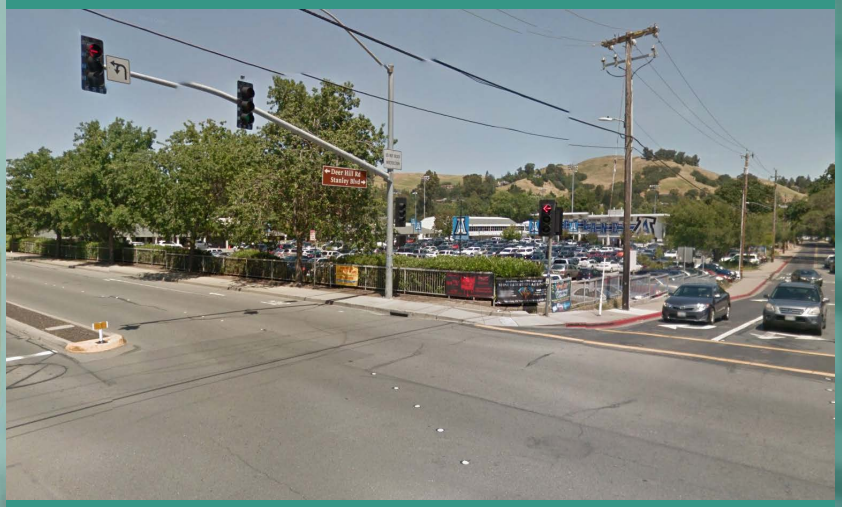
Pleasant Hill Road Corridor Study

City of Lafayette

Final Project Report

February 2017



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EXECUTIVE SUMMARY

This study evaluates the existing traffic operations along Pleasant Hill Road between Rancho View Drive and Deer Hill Road-Stanley Boulevard and provides recommendations for traffic operations at the five intersections within the City of Lafayette. The study also evaluates the cut-through traffic traveling on Reliez Valley Road in the City of Lafayette from neighboring municipalities north of Lafayette. The main goals of the study include: reducing overall travel time, delay and stops per vehicle during the a.m. peak period, reducing spillover to upstream intersections, minimizing impacts to side streets mobility and assessing and mitigating the diversion of traffic to alternate routes within the City of Lafayette.

Three strategies were explored during the course of the study including

1. Increasing the throughput at the intersection of Deer Hill Road-Stanley Boulevard;
2. Metering Traffic at Rancho View Drive - Manage the amount of traffic entering the corridor from the north so that progression through the signalized segment between Rancho View Drive and Deer Hill Road can be enhanced; and
3. Extension of southbound right-turn lane at the intersection of Pleasant Hill Road/Deer Hill Road.

The first strategy is to reassess the existing split phasing at Deer Hill Road-Stanley Boulevard with the intent of achieving a higher throughput of traffic at the intersection by converting the intersection to operate with concurrent east-west signal phases. Analysis indicated that this would not be effective at this location. The primary reason is the heavy volumes of conflicting movements in various directions, resulting in the need for high "green" time for some movements that could not be utilized by a potential concurrent phase.

The second strategy is to manage the amount of traffic entering the Pleasant Hill Road corridor from locations north of and outside the City limits to enhance traffic progression on southbound Pleasant Hill Road. Timing plans were developed for the a.m. peak period to meter through traffic at Rancho View Drive and Reliez Valley Road. Cycle lengths of the signal system were also increased to provide additional green time for the southbound movement south of Reliez Valley Road. This strategy achieved a higher bandwidth for the southbound movement, and secondarily also relieved the congestion along Reliez Valley Road. There was approximately an average reduction of 36% in stop delay, 24% in travel time and 33% in stops per vehicle and an average increase by 38% in speed in the southbound direction with the field trial of the proposed timing plans.

Finally, TJKM also evaluated the southbound right-turn at Pleasant Hill Road/Deer Hill Road-Stanley Boulevard intersection to assess the feasibility of extending the southbound right-turn storage lane, as it is perceived that doing so will lessen delay for overall southbound traffic. The optimized timing plans developed under Strategy 2 – Metering Traffic at Rancho View Drive and implemented as of November 2016 have improved the southbound through and right-turn operation reducing the delay and the v/c ratios. Extending the southbound right-turn lane, will not translate to higher throughput for the southbound through movement at this point. The reduction in delay would only be a matter of a few seconds and perhaps one or two more vehicles can move through the intersection as compared to

current conditions. Based on this analysis, the conclusion is that under highly congested situations like this one, further lengthening of the right-turn lane or even adding an additional right turn lane will not have any material benefit on the southbound through movement, as one would typically expect.

Prior to the implementation of field trials of the proposed timing plans, TJKM conducted an Origin-Destination (O-D) survey along Pleasant Hill Road and Reliez Valley Road to evaluate the extent to which vehicles travelling southbound on Taylor Boulevard divert to Reliez Valley Road and exit at the intersection of Pleasant Hill Road/Reliez Valley Road. The O-D survey analyses indicated that the percentage of diverted traffic was approximately 4%. TJKM also collected turning movement counts at Reliez Valley Road/Withers Avenue/Ivanhoe Avenue before and after implementation of the recommended timing plans. This was done to evaluate whether there is an increase in the southbound traffic diversion from Taylor Boulevard onto Reliez Valley Road due to the metering at Rancho View Drive. Based on the traffic volumes, there is no conclusive evidence that this has occurred. However, the volumes do indicate a potential diversion from a point north of Withers Avenue such as Grayson Road.

It is still possible that there would be a potentially significant diversion of traffic onto Reliez Valley Road via Withers Avenue in the future. If this scenario occurs, it is recommended to signalize the intersection of Reliez Valley Road/Withers Avenue/Ivanhoe Avenue to manage the congestion on Reliez Valley Road.

It is suggested that City of Lafayette monitors traffic at this location over a period of time to identify potential diversion and additional steps that would need to be taken should that occur in the future.

PROJECT OVERVIEW

Pleasant Hill Road is a major four-lane, north-south arterial in the City of Lafayette providing a parallel connection to State Route 24 in the south from Interstate 680 in the north via Taylor Boulevard. South of Taylor Boulevard, Pleasant Hill Road provides connectivity to the residential neighborhoods along side streets such as Reliez Valley Road, Springhill Road-Quandt Road and Deer Hill Road-Stanley Boulevard. Additionally, it provides access to Springhill Elementary and Acalanes High School.

During the a.m. peak period, Pleasant Hill Road experiences severe congestion in the southbound direction along the one-mile stretch from north of Rancho View Drive to Deer Hill Road-Stanley Boulevard. At times, the traffic congestion extends beyond Greenhills Drive on Taylor Boulevard in the north. The heavy demand experienced by this corridor between Rancho View Drive and Deer Hill Road-Stanley Boulevard results in a delay of approximately 10 to 15 minutes during the peak commute hours and higher from the intersection of Taylor Boulevard/Greenhills Drive. Additionally, due to the severe congestion experienced along Pleasant Hill Road under existing conditions, side streets such as Reliez Valley Road experiences severe congestion as a result of the lack of available gaps to merge onto Pleasant Hill Road.

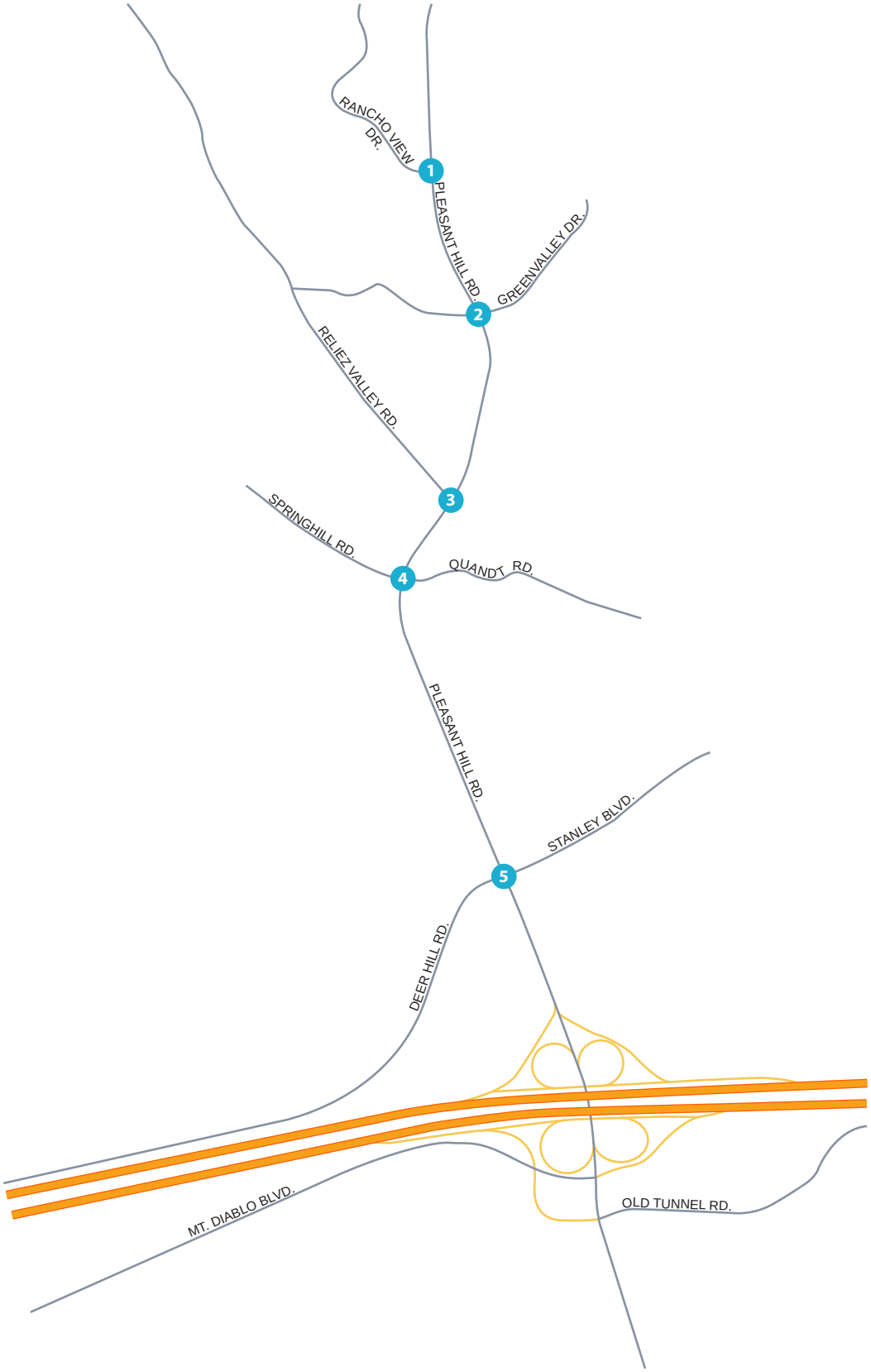
This study evaluates the existing traffic operations along Pleasant Hill Road between Rancho View Drive and Deer Hill Road-Stanley Boulevard and provides recommendations for traffic operations at the five intersections within the City of Lafayette. The study also evaluates the cut-through traffic traveling on Reliez Valley Road in the City of Lafayette from neighboring municipalities. The main goals of the study include: reducing overall travel time, delay and stops per vehicle during the a.m. peak period, reducing spillover to upstream intersections, minimizing impacts to side streets mobility and assessing and mitigating the diversion of traffic to alternate routes within the City of Lafayette.

The corridor analysis evaluates the following study intersections:

1. Pleasant Hill Road/Rancho View Drive
2. Pleasant Hill Road/Greenvalley Drive
3. Pleasant Hill Road/Reliez Valley Road
4. Pleasant Hill Road/Spring Hill Road-Quandt Road
5. Pleasant Hill Road/Deer Hill Road-Stanley Boulevard

Figure 1 illustrates the project study area and the intersections included in the study.

Vicinity Map



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X Study Intersection

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Figure 1

EXISTING CONDITIONS ANALYSIS

Before providing traffic signal timing recommendations such as the development of optimized signal coordination plans, it is crucial to evaluate the study intersections based on existing lane geometry, traffic volumes, signal timing information, and to observe traffic patterns and behavior in the field. Computer models are then created with the existing data and observations collected for the study intersections. Synchro software was used to evaluate existing and proposed conditions. An iterative refinement process was used to validate and calibrate the model to reasonably reflect field conditions. The validated and calibrated Existing Conditions models were then utilized for evaluating various scenarios of coordination plans to develop recommendations for enhancing traffic operations along the study corridor.

This section summarizes existing roadway network, data collection, development, validation and calibration of the project Synchro models. This section also summarizes the signal system performance along the study corridor under Existing Conditions. It also serves as a baseline for comparing proposed recommendations with the existing signal system performance.

EXISTING ROADWAY NETWORK

This section describes existing roadway facilities including pedestrian and bicycle facilities within the study area.

Pleasant Hill Road is a major four-lane, north-south arterial providing a parallel connection to State Route 24 in the south from Interstate 680 in the north via Taylor Boulevard. South of Taylor Boulevard, Pleasant Hill Road provides connectivity to the residential neighborhoods along side streets such as Reliez Valley Road, Springhill Road-Quandt Road and Deer Hill Road-Stanley Boulevard. Additionally, it provides access to Springhill Elementary and Acalanes High School. Pleasant Hill Road has a posted speed limit of 35 to 40 miles per hour (mph) and supports Class II bike lanes in both directions within the study area. It has continuous sidewalks along the east side but not on the west side. The weekday average daily traffic (ADT) along this corridor ranges from approximately 30,400 vehicles per day (vpd) near Rancho View Drive to 36,000 vpd near Deer Hill Road. This corridor experiences a directional traffic peak in the southbound direction during the a.m. peak period.

Rancho View Drive is a two-lane, east-west local roadway providing access to residential neighborhood west of Pleasant Hill Road and has a posted speed limit of 25 mph. There are no bike lanes and sidewalks along this roadway and it is not a through street. Rancho View Drive does not experience heavy vehicular demand during the a.m. peak period on a typical weekday.

Greenvalley Drive is a two-lane, east-west local roadway providing access to residential developments on both sides of Pleasant Hill Road and has a posted speed limit of 25 mph. This roadway has discontinuous sidewalks and no bike lanes along its length. It connects to Reliez Valley Road in the east via a privately-owned segment of the road. Greenvalley Drive does not experience heavy vehicular demand during the a.m. peak period on a typical weekday.

Reliez Valley Road is a two-lane, east-west thoroughfare providing access to residential neighborhoods within Lafayette as well as jurisdictions to the north. It has a posted speed limit of 30 mph. There are no

bike lanes along this roadway but it has a continuous pathway on the south side. Reliez Valley Road has a channelized right-turn at its intersection with Pleasant Hill Road. During the a.m. peak period on a typical weekday, the eastbound right-turn movement from Reliez Valley Road onto Pleasant Hill Road experiences significant delay due to the limited gaps available for vehicles to merge onto Pleasant Hill Road as a result of the congested southbound direction. The queue at Reliez Valley Road occasionally backs up to McGraw Lane during the a.m. peak period. The weekday ADT along Reliez Valley Road ranges from approximately 1900 vpd at the north end near Withers Avenue to 3700 vpd at the south end near PHR.

Springhill Road-Quandt Road is a two-lane, east-west local roadway providing access to Springhill Elementary School and residential neighborhoods. It has a posted speed limit of 25 mph. This roadway has a continuous sidewalk but no bike lanes along its length. The intersection of Pleasant Hill Road/Springhill Road-Quandt Road experiences high pedestrian activities and heavy northbound left-turn vehicle demands during the school drop-off hour in the morning.

Deer Hill Road-Stanley Boulevard is a two-lane, east-west thoroughfare providing access to Acalanes High School and residential neighborhoods west of Pleasant Hill Road. Pleasant Hill Road also connects to Downtown Lafayette and BART to the east. Near Pleasant Hill Road, Deer Hill Road has a posted speed limit of 45 mph. There are continuous sidewalks along Stanley Boulevard connecting to Acalanes High School from the east, but no sidewalk on Deer Hill Road to the west. Bike lanes are present along Deer Hill Road. During the a.m. peak period, the congestion along southbound Pleasant Hill Road dissipates after the intersection of Deer Hill Road-Stanley Boulevard, which acts as the bottleneck to the corridor. During the morning peak hours, the Pleasant Hill Road/Deer Hill Road-Stanley Boulevard intersection experiences heavy southbound right-turn demand related to commuter traffic. Additionally, the intersection experiences heavy southbound left-turn and westbound demand due to school related traffic.

DATA COLLECTION

Average Daily Traffic (ADT) and Turning Movement Counts (TMC)

TJKM collected 24-hour bi-directional tube counts for three days from Tuesday, February 9, 2016 through Thursday, February 11, 2016 at the following five locations:

1. Pleasant Hill Road, north of Rancho View Road
2. Pleasant Hill Road, north of Reliez Valley Road
3. Pleasant Hill Road, north of Deer Hill Road-Stanley Boulevard
4. Reliez Valley Road, east of Vals Lane
5. Reliez Valley Road, south of Ivanhoe Avenue

The ADT data collected was analyzed to estimate the a.m. peak periods, during which additional intersection TMC data collection, travel time floating car surveys and other field review and observations were made.

Table 1 summarizes the 24-hour traffic volumes collected averaged over the number of days of data collection. Detailed results of the 24-hour traffic volumes are presented in **Appendix A**.

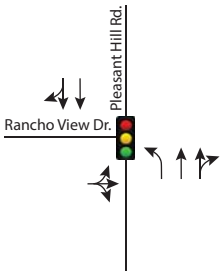
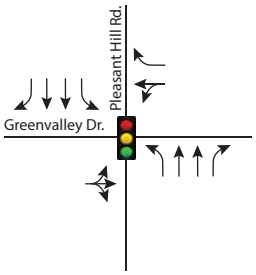
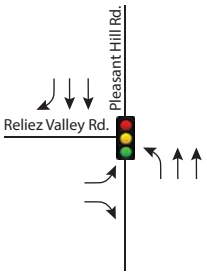
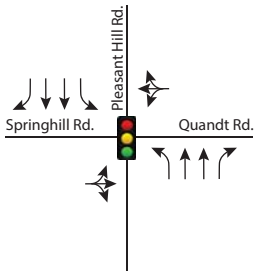
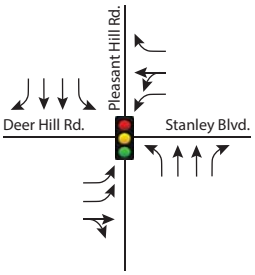
Table 1: 24-Hour Traffic Volumes Summary

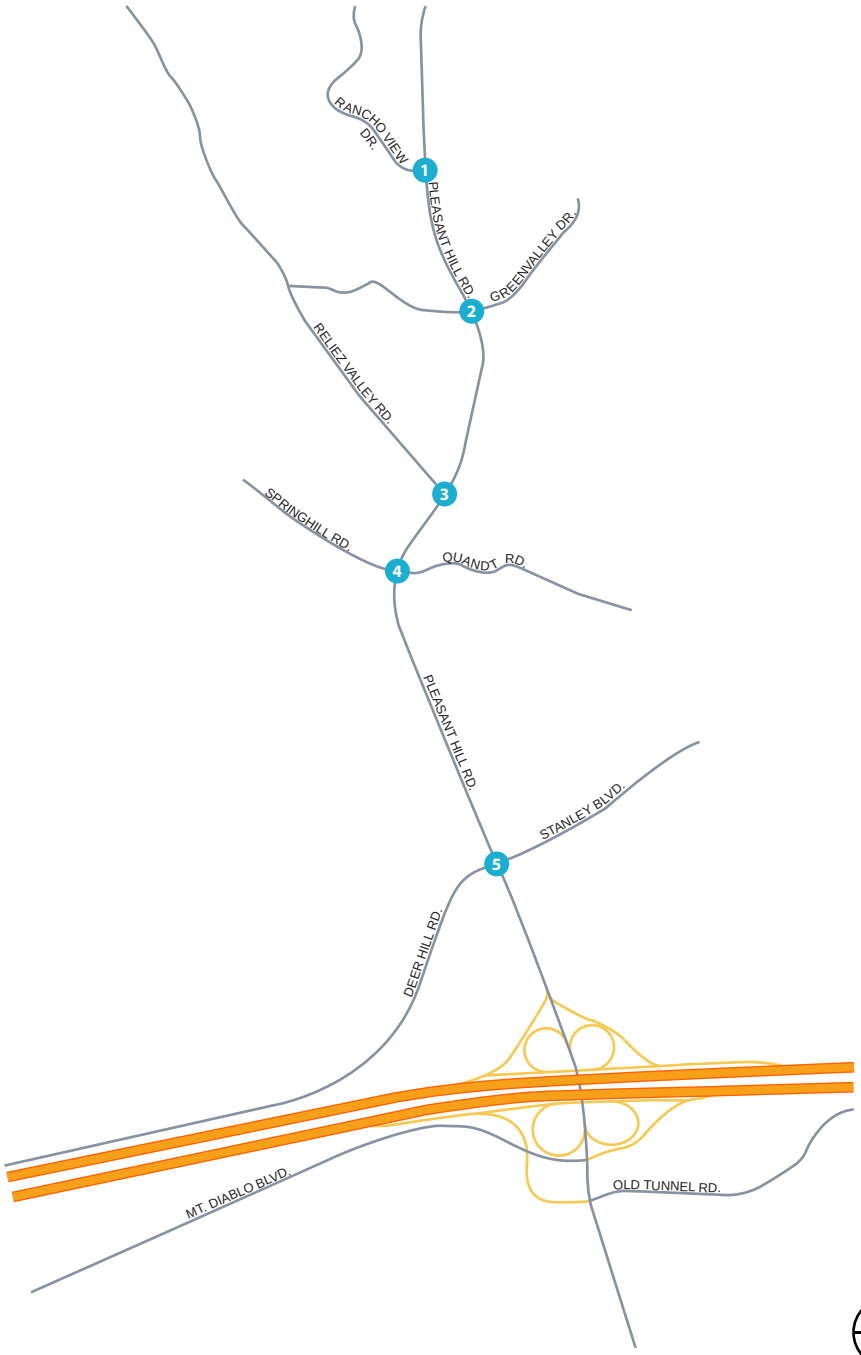
Location	*Period*	*NB/WB Average Volumes*	*SB/EB Average Volumes*	*Total*
Pleasant Hill Road, north of Rancho View Road	Weekday (Tues - Thurs)	16,103	14,392	30,495
Pleasant Hill Road, north of Reliez Valley Road	Weekday (Tues - Thurs)	16,369	14,293	30,662
Pleasant Hill Road, north of Stanley Boulevard/Deer Hill Road	Weekday (Tues - Thurs)	19,113	16,887	36,000
Reliez Valley Road, east of Vals Lane	Weekday (Tues - Wed)*	1,581	2,101	3,682
Reliez Valley Road, south of Ivanhoe Avenue	Weekday (Tues-Thurs)	710	1,266	1976

Note: *Data for Thursday was omitted due to equipment issues.

TJKM collected the intersection TMCs for vehicles, pedestrians and bicycles on Tuesday, April 19, 2016 for the a.m. (6:30 a.m. – 8:30 a.m.) peak period. **Figures 2, 3 and 4a** illustrate the existing lane geometry, vehicular, pedestrian, and bicycle turning movement counts during the vehicular peak hour respectively at the study intersections. **Figure 4b** illustrates the existing pedestrian and bicycle peak hour volumes which occur from 7:30 a.m. to 8:30 a.m. **Appendix A** contains the TMC data collected for the project.

Existing Lane Geometry and Controls

Intersection #1 Pleasant Hill Rd./ Rancho View Dr.	Intersection #2 Pleasant Hill Rd./ Greenvalley Dr.	Intersection #3 Pleasant Hill Rd./ Reliez Valley Rd.	Intersection #4 Pleasant Hill Rd./ Springhill Rd./Quandt Rd.	Intersection #5 Pleasant Hill Rd./ Deer Hill Rd./Stanley Blvd.
				
Signal Cycle Length				
62 Seconds	62 Seconds	124 Seconds	124 Seconds	124 Seconds



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X Study Intersection
Traffic Signal

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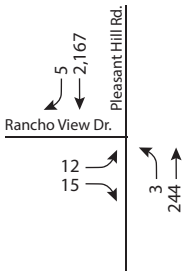
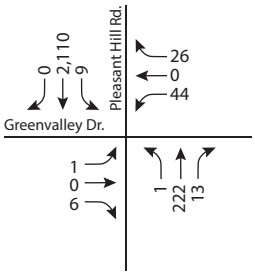
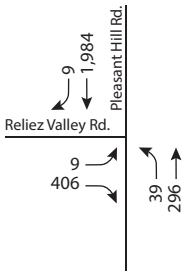
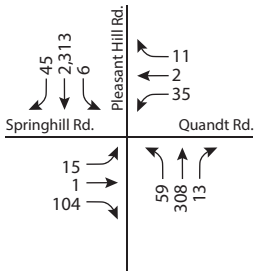
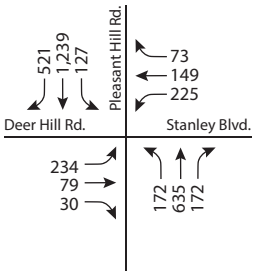
Figure 2

Existing Conditions AM Peak Hour Traffic Volumes

Intersection #1 Pleasant Hill Rd./ Rancho View Dr.	Intersection #2 Pleasant Hill Rd./ Greenvalley Dr.	Intersection #3 Pleasant Hill Rd./ Reliez Valley Rd.	Intersection #4 Pleasant Hill Rd./ Springhill Rd./Quandt Rd.	Intersection #5 Pleasant Hill Rd./ Deer Hill Rd./Stanley Blvd.
				
Peak Hour: 6:30 a.m. - 7:30 a.m.	Peak Hour: 6:30 a.m. - 7:30 a.m.	Peak Hour: 6:30 a.m. - 7:30 a.m.	Peak Hour: 6:45 a.m. - 7:45 a.m.	Peak Hour: 7:30 a.m. - 8:30 a.m.

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X Study Intersection

XX AM Peak Hour Volumes

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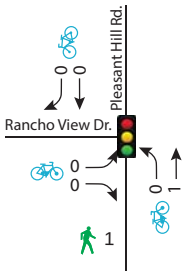
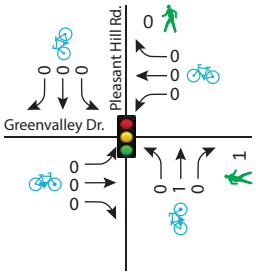
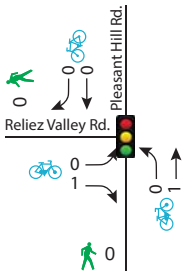
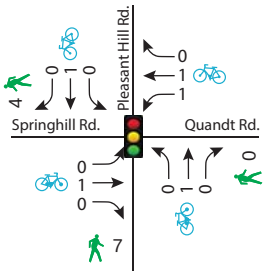
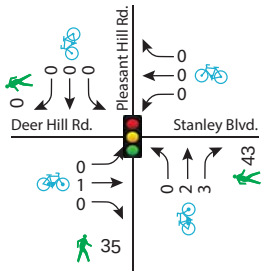
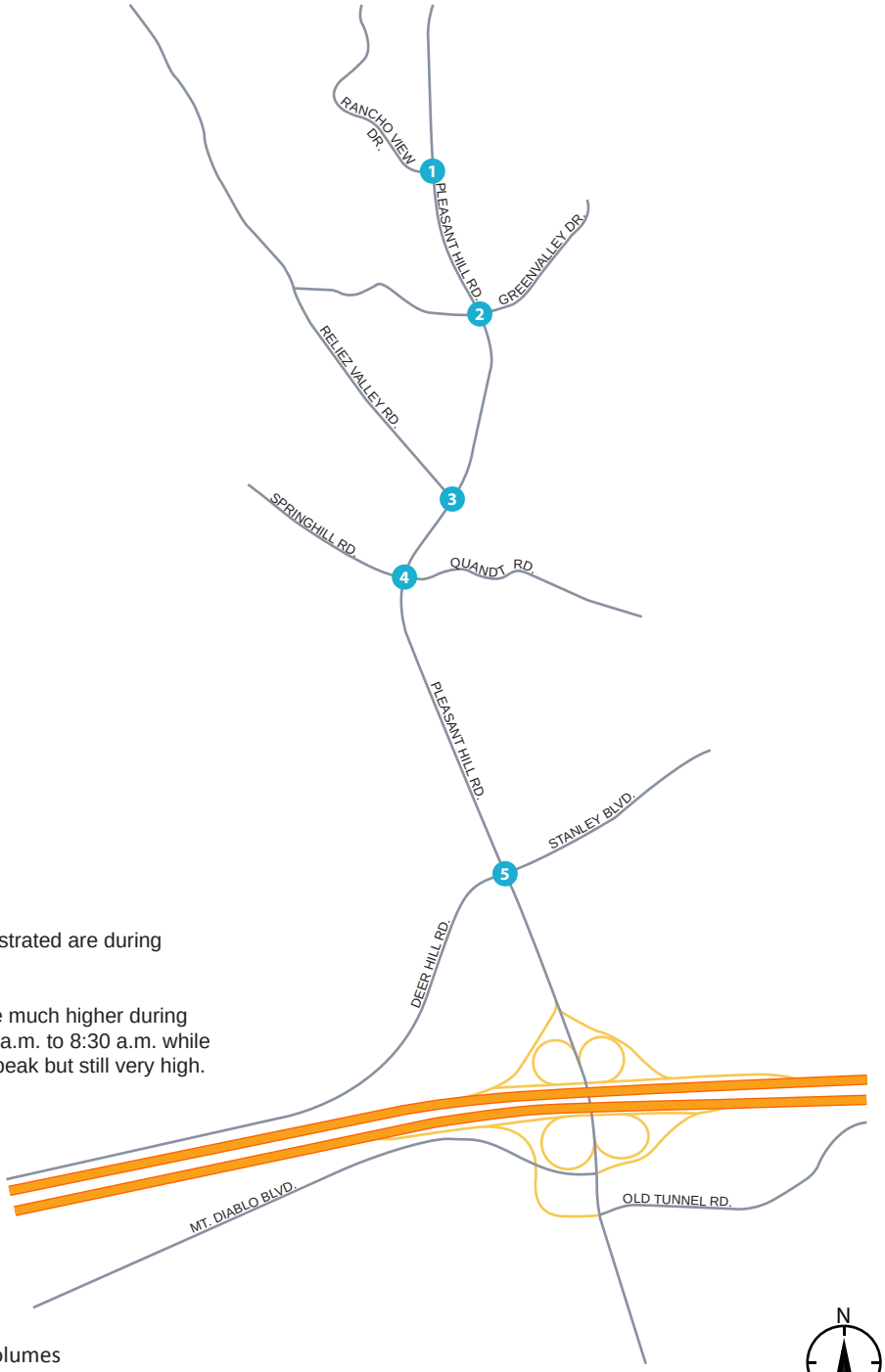
Figure 3

Existing Pedestrian and Bicycle Counts (Vehicular Peak Hour)

Intersection #1 Pleasant Hill Rd./ Rancho View Dr.	Intersection #2 Pleasant Hill Rd./ Greenvalley Dr.	Intersection #3 Pleasant Hill Rd./ Reliez Valley Rd.	Intersection #4 Pleasant Hill Rd./ Springhill Rd./Quandt Rd.	Intersection #5 Pleasant Hill Rd./ Deer Hill Rd./Stanley Blvd.
				



Notes:
1. Pedestrian/bicycle volumes illustrated are during vehicular traffic peak hour.

2. Pedestrian/bicycle volumes are much higher during school drop-off hour from 7:30 a.m. to 8:30 a.m. while vehicular traffic may not be at peak but still very high.

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- X Study Intersection
- Pedesrian AM Peak Hour Volumes
- Bicycle AM Peak Hour Volumes

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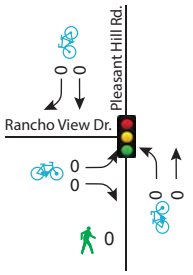
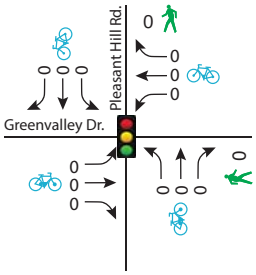
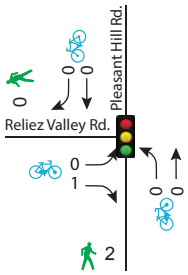
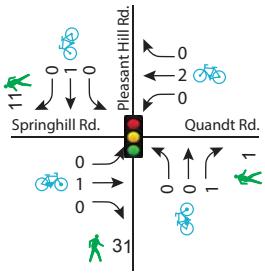
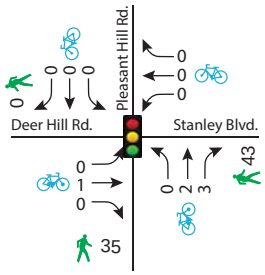
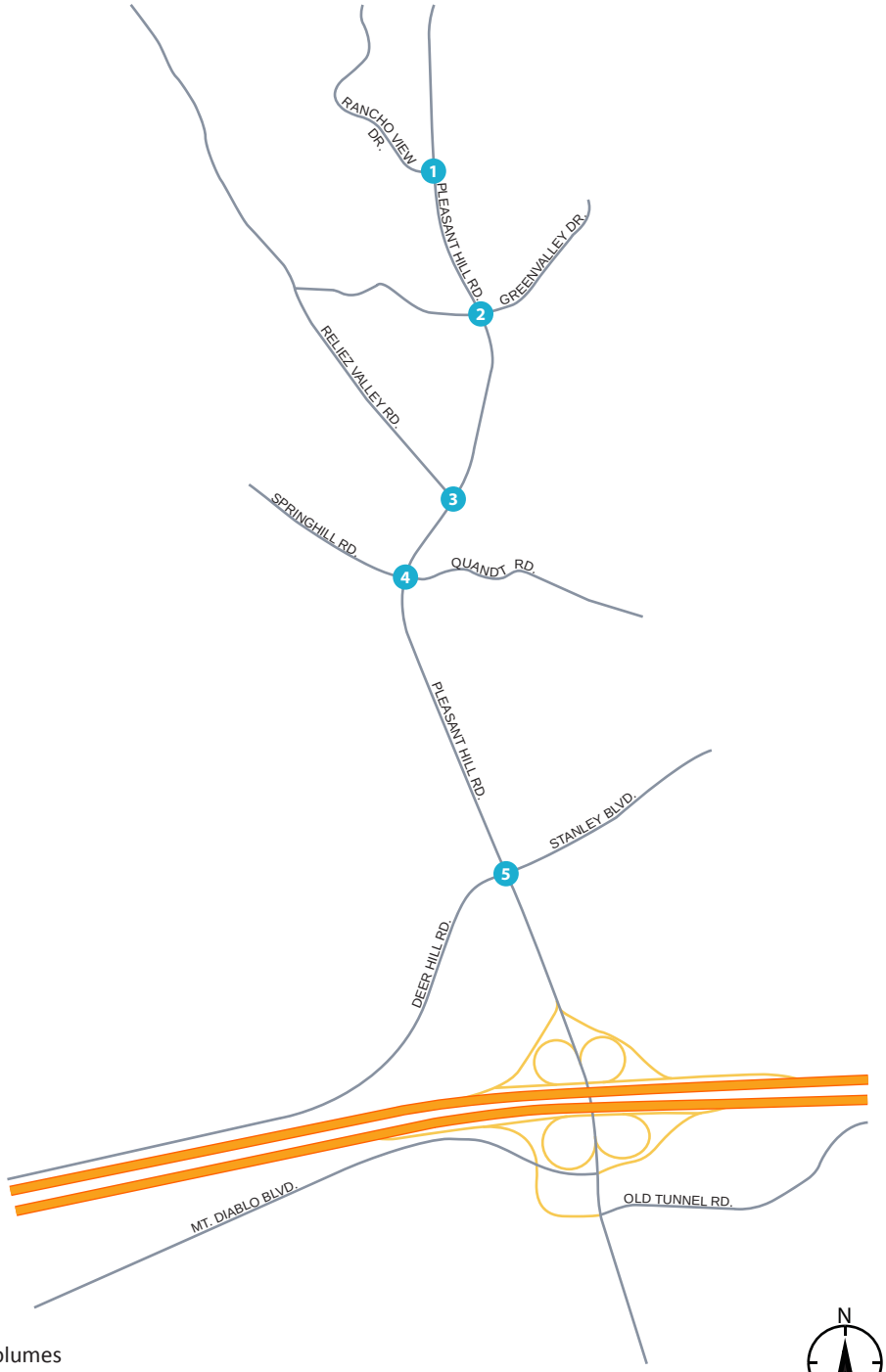
Figure 4a

Existing Pedestrian and Bicycle Counts (7:30 a.m. - 8:30 a.m.)

Intersection #1 Pleasant Hill Rd./ Rancho View Dr.	Intersection #2 Pleasant Hill Rd./ Greenvalley Dr.	Intersection #3 Pleasant Hill Rd./ Reliez Valley Rd.	Intersection #4 Pleasant Hill Rd./ Springhill Rd./Quandt Rd.	Intersection #5 Pleasant Hill Rd./ Deer Hill Rd./Stanley Blvd.
				



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- X Study Intersection
- Pedesrian AM Peak Hour Volumes
- Bicycle AM Peak Hour Volumes

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Figure 4b

"Before" Floating Car Surveys

Floating Car Surveys, also known as Travel Time Runs are collected to obtain an understanding of average delay, number of stops, travel time and travel speed experienced by vehicles moving through the corridor. "Before" Floating Car Surveys form the baseline for "Existing Conditions" validation and calibration of the Synchro model. This baseline is also later used to measure improvements that can be achieved by proposed changes.

A floating car run covers a one-way trip of the defined length of a study corridor. As aforementioned, these runs capture the travel time, speed, stopping time, number of stops, and other delays on an individual direction along the study corridor. Four floating car runs were conducted during the weekday a.m. peak period for the "Before" and "After" conditions. The weekday "Before" surveys were conducted in the month of February and April 2016 along Pleasant Hill Road and the "After" surveys were conducted in the month of November 2016 after the implementation of the proposed changes along the study corridor. The floating car survey data was analyzed to obtain overall averages of travel time, delay, and computed travel speed for the entire length of the corridor. These parameters help to quantitatively describe the existing traffic conditions, specifically, how well platoons of vehicles are able to move through the corridor and the corresponding amount of congestion/delay encountered.

The results as an average of all the floating car surveys conducted under existing conditions are summarized in **Table 2**. **Table 3** summarizes the worst run collected during the day of the survey. The results of the "Before" floating car surveys will be compared to the "After" floating car surveys that are conducted after implementation of the proposed changes. The floating car worksheets are contained in **Appendix B**.

The floating car survey was conducted from 6:30 a.m. to 9:00 a.m. to capture the varying traffic patterns during the peak period and estimate the highest travel time, delay and speeds that can be encountered on a typical weekday. The survey runs start when the survey vehicle enters the first study intersection, in this case, Pleasant Hill Road/Rancho View Drive and stops when the survey vehicle leaves the last study intersection of Pleasant Hill Road/Deer Hill Road-Stanley Boulevard. This does not account for the time that the vehicle spends in queue to reach Pleasant Hill Road/Rancho View Drive, and only accounts for the time it takes to traverse the signalized corridor. However, as a part of the field review, the travel time from Taylor Boulevard/Greenhills Drive intersection to Pleasant Hill Road was separately noted during field review and is estimated to be approximately 10 to 15 minutes during the highest-trafficked 15-minute interval during the morning peak period.

Additionally, the floating car data would vary slightly based on the lane travelled along the corridor. The floating car survey runs for this study were collected in the left-most through lane. The travel time in the right-most lane was measured to be approximately one to two minutes more depending on the traffic flow. This is due to friction from side streets merging traffic and turning movements into Pleasant Hill Road including driveways.

Table 2: Weekday "Before" Floating Car Survey (Average), Pleasant Hill Road between Rancho View Drive and Deer Hill Road-Stanley Boulevard

Roadway	*Approach*	*Peak Hour*	*Average Stop Delay[3] (min:sec)*	*Average Travel Time (min:sec)*	*Average # of Stops[2]*	*Average Speed[1] (mph)*
Pleasant Hill Road (Length of Segment – 1.05 miles)	SB	A.M.	4:58	7:18	6	10

Notes:

[1]Average speed along the corridor including stop delays, not reflective of actual speeds of vehicles while moving.

[2]Average number of stops made by a car from all the travel time runs collected on the study corridor including stops at red lights as well as other stops between intersections due to congestion.

[3]Stop Delay includes delay experienced with a full stop at the intersection as well as travel time when the vehicle speed is less than 10 mph.

*There are five signalized intersections along this corridor and the free flow travel time with zero delay is under three minutes.

Table 3: Weekday "Before" Floating Car Survey (Worst Run), Pleasant Hill Road between Rancho View Drive and Deer Hill Road-Stanley Boulevard

Roadway	*Approach*	*Peak Hour*	*Worst Run Stop Delay[3] (min:sec)*	*Worst Run Travel Time (min:sec)*	*Worst Run # of Stops[2]*	*Worst Run Speed[1] (mph)*
Pleasant Hill Road (Length of Segment – 1.05 miles)	SB	A.M.	13:26	14:45	7	4

Notes:

[1]Speed along the corridor including stop delays, not reflective of actual speeds of vehicles while moving.

[2]Number of stops made by a car from the worst travel time run collected on the study corridor including stops at red lights as well as other stops between intersections due to congestion.

[3]Stop Delay includes delay experienced with a full stop at the intersection as well as travel time when the vehicle speed is less than 10 mph.

*There are five signalized intersections along this corridor and the free flow travel time with zero delay is under three minutes.

As summarized in **Table 2** above, the average travel time along the study corridor during the a.m. peak period is seven minutes and eighteen seconds equating to an average travel speed of 10 miles per hour (mph). It should also be noted that under existing conditions, during the a.m. peak period on an average six stops are experienced while travelling along the study corridor.

During the peak 15-minute of travel along the study corridor the average travel time is approximately fourteen minutes and forty five seconds, approximately double than the average travel time. During the peak 15-minute of travel the speed drops to four mph compared to the average speed of ten mph during the peak period.

Origin-Destination (O-D) Survey

Anecdotally, it has been reported that congestion on Pleasant Hill Road could be diverting traffic from southbound Taylor Boulevard onto Reliez Valley Road as a cut-through route. To verify this, an origin-destination survey was conducted by collecting license plates over a two-hour period from 6:30 a.m. to 8:30 a.m. on Tuesday, April 19, 2916 at six locations as listed below.

1. Taylor Boulevard, north of Withers Avenue (Origin)
2. Withers Avenue, east of Reliez Valley Road (Origin and Destination)
3. Reliez Valley Road, north of Withers Avenue (Origin)
4. Reliez Valley Road, west of Pleasant Hill Road (Destination)
5. Pleasant Hill Road, north of Springhill Road/Quandt Road (Origin and Destination)
6. SR 24 (West) On Ramp, at the Deer Hill Road/Laurel Road/ SR 24 (West) On/Off Ramps Intersection (Destination)
7. Deer Hill Road, east of Orchard Road (For BART users) (Destination)

The O-D survey data was used to estimate the percentage of traffic deviating from Taylor Boulevard onto Reliez Valley Road and continuing onto Pleasant Hill Road at the intersection of Pleasant Hill Road/Reliez Valley Road. **Table 4** summarizes the O-D survey traffic data along Pleasant Hill Road and Reliez Valley Road. **Appendix C** contains the O-D survey data collected for the project.

Based on the survey conducted and analysis of the data, it was observed that approximately 4% of the traffic from Taylor Boulevard, north of Withers Avenue diverts to Reliez Valley Road by turning right at Withers Avenue and continues onto Pleasant Hill Road from Reliez Valley Road. Approximately 79% of the traffic travels through Taylor Boulevard onto Pleasant Hill Road. Out of the remaining 17%, approximately 14% turn left to go east on Withers Avenue and approximately 3% turn right to utilize the neighboring land uses. Out of the 79% of the traffic that goes through onto Pleasant Hill Road, 59% is captured at Reliez Valley Road. The remaining 20% consists of vehicles dissipating to the existing land uses between Taylor Boulevard, south of Withers Avenue and the intersection of Pleasant Hill Road/Reliez Valley Road and vehicles stuck in congestion between Rancho View Drive and Green Hills Drive, north of Reliez Valley Road. Under existing conditions, the queues experienced were observed to extend a mile south of Rancho View Drive. It should be noted that due to the severe congestion experienced along Pleasant Hill Road, it is likely that the traffic on Pleasant Hill Road between the intersections of Taylor Boulevard/Withers Avenue and Pleasant Hill Road/Reliez Valley Road may not be able to travel during the same 15-minute interval. Based on the data collected and evaluated, it is certain that the percentage of traffic diverting to use Reliez Valley Road as a cut-through route is 4%.

Table 4: O-D Survey Analysis for the 6:30 a.m. to 8:30 a.m. Peak Period

Location	*From Taylor Boulevard, north of Withers Avenue*	*From Taylor Boulevard to Reliez Valley Road, west of Pleasant Hill Road*	*From Taylor Boulevard to Pleasant Hill Road, north of Springhill Road/Quandt Road*
Traffic Demand	2154	90	1013
Percentage of Traffic	-	4%	59%

Additionally, evaluation of the O-D survey data showed that approximately 20% of the captured traffic volumes at Reliez Valley Road from Withers Avenue travel to BART and less than one percent take the SR 24 (West) On Ramp from Deer Hill Road.

Field Review of Signal Operations

TJKM observed traffic operations at the study intersections and along the study corridor to identify over-saturated intersections, uneven lane utilization, spill-over of turn-pockets into through lanes due to heavy (left and/or right-turning) demands, signal timing settings, phasing sequences, current progression along the corridor and other potential issues with the existing signal timings.

Based on the field reviews conducted, it was noted that during the highest peak commute hour between 6:45 a.m. and 7:45 a.m., traffic in the southbound direction along Pleasant Hill Road often backs up to the Taylor Boulevard/Greenhills Drive intersection, north of Rancho View Drive. The intersections of Pleasant Hill Road/Rancho View Drive and Pleasant Hill Road/Greenvalley Drive experience little side street traffic, maintaining an almost continuous green time for the through phases, resulting in heavy demands at the downstream intersections. Due to downstream congestion, vehicles often wait in queues while unable to progress during a green phase. The intersections of Pleasant Hill Road/Reliez Valley Road, Pleasant Hill Road/Springhill Road-Quandt Road and Pleasant Hill Road/Deer Hill Road-Stanley Boulevard experience heavier side street traffic. Pleasant Hill Road/Deer Hill Road-Stanley Boulevard acts as the bottleneck along the corridor with heavy side street traffic, split-phase operation and insufficient cycle length to accommodate the demand.

Due to competing demands from multiple conflicting vehicle, bicycle and pedestrian movements at the intersection of Deer Hill Road-Stanley Boulevard, the throughput for southbound traffic is constrained. This results in queues extending throughout the study corridor and stop-and-go traffic conditions. Heavy queues extending from this intersection in the southbound direction creates secondary congestion along Reliez Valley Road, as the vehicles turning right from Reliez Valley Road cannot find gaps to merge onto Pleasant Hill Road, resulting in queuing past McGraw Lane on Reliez Valley Road.

SYNCHRO MODEL DEVELOPMENT

To document existing traffic conditions and develop/evaluate recommendations, Synchro and SimTraffic (macro and micro-simulation) softwares were used. The software uses procedures documented under Chapter 18 (Signalized Intersections) of the Highway Capacity Manual, 2000 Edition (HCM 2000), published by the Transportation Research Board. The Synchro and SimTraffic traffic operational models for Pleasant Hill Road were calibrated and validated based on field observations and data collected as part of this project.

The micro-simulation model, SimTraffic, was used to simulate where traffic congestion was occurring as well as to identify potential causes of congestion. The macroscopic simulation model, Synchro, is used to evaluate proposed improvements (such as signal optimization and signal phasing) at the study intersections.

The development of the operational models includes three basic components: (1) setup; (2) calibration; and (3) validation, organized as part of an integrated modeling process. The Synchro model was calibrated and validated and the same data set was used to run micro-simulation in SimTraffic for this project.

Factors such as field reconnaissance, existing lane geometry, traffic volumes, and signal settings are used for the development of the Synchro model. The calibration process aims at eliminating errors in the model and adjusting traffic parameters to a point that the model can simulate existing operations with reasonable accuracy. The turning movement counts collected during the peak period do not always reflect the actual field conditions, especially when the corridor is over-capacity and experiences spillover to upstream intersections and stop-and-go traffic flow. The Synchro model is adjusted to reflect the field observed conditions and is calibrated per the worst run collected during the "Before" floating car survey.

Table 5 summarizes the model output for some basic traffic operational parameters under existing conditions. **Appendix D** contains the detailed Synchro model output results for the arterial Levels of Service (LOS) and the MOEs for the study corridor under existing conditions.

Table 5: System Measures of Effectiveness (MOEs) from Synchro Model

Roadway	*Approach*	*Peak Hour*	*Signal Delay/ Vehicle (min:sec)*	*Total Travel Time[1] (min:sec)*	*Average Speed[2] (mph)*
Pleasant Hill Road (Length of Segment – 1.05 miles)	SB	A.M.	12:36	14:43	4

Notes:

[1]Total Travel Time = the total time for vehicles to travel through the corridor.

[2]Average Speed results are taken from Arterial LOS Synchro Output.

As illustrated, the average speed and signal delay based on the validated and calibrated Synchro model is almost the same as those measured in the field during the floating car survey (**Table 3**). Based on this comparison of the MOE's and data collected in the field, it can be concluded that the traffic operational

models are validated and calibrated to replicate existing conditions and can be used to evaluate proposed conditions.

OVERSATURATED CONDITIONS

The model output also helps to identify locations on the corridor where traffic demand exceeds capacity. An intersection with oversaturated conditions can be defined as one where the arrival flow rate exceeds the intersection capacity, resulting in unserved traffic demand within a specific amount of time. These may be locations where additional green time needs to be provided to serve the existing demand during development of proposed timings. **Table 6** shows the critical intersection movements identified from field review and the calibrated existing conditions Synchro models where demand exceeds capacity during the a.m. peak hour.

Table 6: Oversaturated Intersection Locations

Peak Period	*Intersections (Movements) with v/c>1.0*
A.M. Peak	Pleasant Hill Road/Rancho View Drive (SBT)
	Pleasant Hill Road/Greenvalley Drive (SBT)
	Pleasant Hill Road/Reliez Valley Road (EBR and SBT)
	Pleasant Hill Road/Springhill Road-Quandt Road (SBT)
	Pleasant Hill Road/Deer Hill Road-Stanley Boulevard (NBL, SBT and SBR)

TRAFFIC OPERATIONS ENHANCEMENT STRATEGIES

Based on the Existing Conditions review, it was observed that majority of the traffic on southbound Pleasant Hill Road originated from points north of Rancho View Drive intersection and outside the City of Lafayette's City limits. This can potentially be rerouted traffic demands from the heavily congested southbound I-680 corridor during the a.m. peak period. Additionally, the intersection of Pleasant Hill Road/Deer Hill Road-Stanley Boulevard acts as the bottleneck along the study corridor, with limited green time available for the heavy southbound demand as almost all other conflicting movements at this intersection are heavily utilized.

Based on the field observations and evaluation of existing conditions, three signal strategies were evaluated to potentially improve traffic operations along southbound Pleasant Hill Road. The three strategies evaluated are:

4. Increase the throughput at the intersection of Deer Hill Road-Stanley Boulevard;
5. Metering Traffic at Rancho View Drive - Manage the amount of traffic entering the corridor from the north so that progression through the signalized segment between Rancho View Drive and Deer Hill Road can be enhanced; and
6. Extension of southbound right-turn lane at the intersection of Pleasant Hill Road/Deer Valley Road.

EVALUATION OF TRAFFIC OPERATIONS ENHANCEMENT STRATEGIES

This section summarizes the evaluation of the above referenced strategies considered to enhance traffic operations within the study corridor.

Strategy 1: Increase the throughput through Deer Hill Road-Stanley Boulevard

The first strategy is to reassess the existing signal phasing at Deer Hill Road-Stanley Boulevard with the intent of achieving a higher throughput of traffic at the intersection. Initial evaluation of the existing signal phasing explored converting the intersection to operate without the east-west split phases. In other words, east-west left-turn and through movements can overlap with their corresponding counterparts. Generally, this would potentially result in higher throughput. However, analysis indicated that this would not be the case at Pleasant Hill Road/Deer Hill Road-Stanley Boulevard intersection. The primary reason for this is the heavy westbound left-turn traffic demand, which would require higher green time to be provided. At the same time, the through movement on the eastbound approach would also require higher green time to accommodate the pedestrian clearance times in accordance with current safety standards. These two movements are in conflict with each other and both demand high amounts of green time. The pedestrian crossing also results in wastage of green time along the eastbound and westbound approaches because the pedestrian time is much more than what is required to serve the vehicle demand, creating the need for a much higher cycle length without actually benefitting the intersection as a whole. This impacts the other intersections upstream of Deer Hill Road, as they would need to operate at the same cycle length and would result in higher delay on side streets. Based on the outcome of this analysis, it is recommended that the current split-phasing operation be retained considering the competitive

demands at the intersection. The only change recommended is to increase the current signal cycle length slightly to create longer green time for the southbound movement, as described in a later section.

Strategy 2: Metering Traffic at Rancho View Drive

Since the strategy to increase throughput at the Deer Hill Road-Stanley Boulevard intersection does not yield sufficient improvement for the entire corridor, TJKM examined the second strategy to manage the amount of traffic entering the Pleasant Hill Road corridor from locations north of and outside the City limits to enhance overall traffic progression. Before undertaking the study, City of Lafayette received public feedback and concerns about the ability of side-street traffic to turn onto Pleasant Hill Road, especially at the intersection of Reliez Valley Road. Lafayette also heard concerns of erratic behavior of traffic around the two area schools affecting pedestrian crossing and access to the schools. Based on the field observations, identification of points of bottleneck, and feedback received from the public, emphasis was given to maximize enhancements to the south end of the corridor, south of Reliez Valley Road.

Using the computer models developed for the study, new signal coordination plans were developed for the five intersections between Rancho View Drive and Deer Hill Road. The underlying approach is to manage the throughput into the corridor at the north end by implementing maximum green time for the side street movements at the intersections of Rancho View Drive and Reliez Valley Road. At the intersection of Rancho View Drive, this has the effect of managing the amount of southbound traffic entering the corridor, thus providing the opportunity to alleviate the saturated conditions at the downstream intersections. This strategy also allows more frequent and long gaps at Reliez Valley Road, to allow side street traffic to turn onto Pleasant Hill Road, thus reducing congestion and queue lengths on Reliez Valley Road. Additional changes were developed for the three signals between Reliez Valley Road and Deer Hill Road, including increasing the time per cycle to provide additional green time for the southbound through phase, and resynchronizing the start of green between these intersections to maximize traffic progression. The aim is that once the head of a traffic queue that has been stopped at a signal begins to move, it is able to move continuously through the downstream intersections. Lastly, the time during which the revised coordination plans are set to run would also change. In response to the traffic peaking characteristics observed in the field, TJKM proposes to operate two slightly different coordination plans, one starting at 6:30 a.m. and a second starting at 7:00 a.m. The technical parameters for these plans are summarized in **Table 8**. The metering parameters are implemented only with Plan 2, which starts at 7:00 a.m.

Strategy 3: Extension of southbound right-turn lane at Pleasant Hill Road/Deer Valley Road

TJKM also evaluated the southbound right-turn at Pleasant Hill Road/Deer Hill Road-Stanley Boulevard intersection to assess the feasibility of extending the southbound right-turn storage lane if it could help mitigate the existing traffic conditions. This option was raised during past public meetings to discuss traffic on Pleasant Hill Road. It is perceived that increasing the southbound right-turn lane will allow more right-turn traffic approaching Deer Hill Road to clear out from the through lane closest to the street curb and reduce delay for the southbound traffic.

Evaluation of the existing conditions revealed that the southbound through and the right-turn lane operate at over-saturated conditions with volume to capacity ratio (v/c) greater than 1.0 for both

movements. As illustrated in **Figure 3**, both the southbound through and the right-turn movements have heavy peak hour volumes, approximately 1200 and 500 vehicles respectively.

The optimized timing plans developed under Strategy 2 – Metering Traffic at Rancho View Drive, which have already been implemented and continuously monitored since November 2016 included increasing the cycle length and adjusting the green split at all locations including Deer Hill Road. This has improved the southbound through and right-turn operation to reduce the delay and the v/c ratio. **Table 7** summarizes the existing and proposed conditions delay and v/c ratios for the southbound through and right-turn movements. Extending the southbound right-turn lane, will not translate to higher throughput for the southbound through movement at this point. The reduction in delay would only be a matter of a few seconds and perhaps one or two more vehicles can move through the intersection as compared to current conditions. Based on this analysis, the conclusion is that under highly congested situations like this one, further lengthening of the right-turn lane or even adding an additional right turn lane will not have any material benefit on the southbound through movement, as one would typically expect.

Table 7: Comparison of Existing and Proposed Conditions Delay and v/c Ratios

Intersection	*Scenario*	*Movement*	*Delay*	*v/c*
Pleasant Hill Road/Deer Hill Road-Stanley Boulevard	Existing Conditions	SBT	363.2	1.72
		SBR	85.6	1.10
	Proposed Conditions (Strategy 2)	SBT	81.0	1.06
		SBR	57.4	0.74

OPTIMIZED TIMING PLANS

The sections below present the proposed signal timing plans recommended and field-tested (Strategy 2) as well as the minimum timing parameters updated to be in accordance with the current 2014 California Manual on Uniform Traffic Control Devices (CA MUTCD).

Recommended Signal Timing Plans and Time of Day Coordination Schedule

The following recommended timing plans were developed based on the results obtained from the signal timing evaluation; Plan 1 for the weekday a.m. peak period (6:30 a.m. – 7:00 a.m.) and Plan 2 for weekday a.m. peak period (7:00 a.m. – 9:00 a.m.). Essentially, Plan 1 and Plan 2 are the same with the exception of the addition of maximum recall on Rancho View Drive to meter the southbound traffic between 7:00 a.m. and 9:00 a.m. **Table 8** summarizes the existing and recommended weekday a.m. and p.m. peak period plans including cycle length and offsets for each study intersection along Pleasant Hill Road.

Table 8: Existing and Recommended Cycle Lengths and Offsets for Weekday Timing Plans along Pleasant Hill Road

#	Intersection	Scenario	Weekday A.M.	
			Cycle Length (sec)	Offset (sec)
1	Pleasant Hill Road/Rancho View Drive	Existing	62.0	8
		Proposed	75.0	43
2	Pleasant Hill Road/Greenvalley Drive	Existing	62.0	8
		Proposed	75.0	67
3	Pleasant Hill Road/Reliez Valley Road	Existing	124.0	25
		Proposed	150.0	97
4	Pleasant Hill Road/Springhill Road-Quandt Road	Existing	124.0	51
		Proposed	150.0	111
5	Pleasant Hill Road/Deer Hill Road-Stanley Boulevard	Existing	124.0	63
		Proposed	150.0	75

Pedestrian Timings

As a part of the signal timing changes, TJKM took the opportunity to review the existing pedestrian timing at each intersection to verify that they conform to current standards. The following methodology was used to review the Flashing Don't Walk (FDW) intervals at the study intersections based on current 2014 CA MUTCD and City guidelines:

$$FDW\ (\text{sec}) = \frac{(Shortest\ Crosswalk\ Distance)(ft)}{3.5\frac{ft}{s}\ Walking\ Time} - Yellow\ (\text{sec}) - All\ Red\ (\text{sec})$$

Based on this analysis, the existing FDW setting is recommended to be updated at locations as provided in **Table 9**. **Appendix E** contains the existing and proposed FDW analysis spreadsheet for all study intersections.

Table 9: Existing and Proposed FDW Intervals

#	Intersection	Direction	Phase	Existing FDW Interval (sec)	Proposed FDW Interval (sec)
1	Pleasant Hill Road/Rancho View Drive	EB	4	20	22
3	Pleasant Hill Road/Reliez Valley Road	EB	8	16	18
4	Pleasant Hill Road/Springhill Road-Quandt Road	EB	8	18	19
5	Pleasant Hill Road/Deer Hill Road-Stanley Boulevard	EB	8	20	21

In addition, a review of the walk intervals was conducted at each intersection. Currently, the existing walk intervals range from five to seven seconds. Seven seconds is the recommended walk time according to the CA MUTCD, although four seconds is the minimum allowable walk time. Generally, a walk time of four seconds provides sufficient time for pedestrians to enter the intersection safely. At intersections with heavier pedestrian activity, such as near schools, higher walk times are beneficial to give additional time for groups of pedestrians to enter the intersection prior to the FDW. However, for a corridor already with high congestion such as Pleasant Hill Road, increasing walk time could have the drawback of exacerbating congestion. All existing walk intervals are greater than the minimum allowable. Hence, no changes to walk intervals are recommended at this time. **Table 10** summarizes the existing walk intervals along the signalized corridor.

Table 10: Existing Walk Intervals

#	Intersection	Direction	Phase	Existing FDW Interval (sec)
1	Pleasant Hill Road/Rancho View Drive	EB/WB	4	7
2	Pleasant Hill Road/Greenvalley Drive	NB	6	7
		EB/WB	4	5
3	Pleasant Hill Road/Reliez Valley Road	NB	6	5
		EB	8	7
4	Pleasant Hill Road/Springhill Road-Quandt Road	NB	6	7
		SB	2	7
		EB	8	7
5	Pleasant Hill Road/Deer Hill Road-Stanley Boulevard	NB	6	5
		SB	2	5
		EB	8	5

Minimum Green Intervals for Vehicles and Bicycles

The study intersections operate with a range of minimum green times from four to 10.0 seconds, with most left-turn movements having minimum green times of four seconds and most through movements having minimum green times of 10.0 seconds. These settings comply with recommendations for vehicle operation. It is also necessary to verify conformance with standards for bicycle minimum green settings.

The CA MUTCD, within section 4D.105 (CA), requires that minimum green time be sufficient for a stopped bicycle to cross the road when the light turns green at locations where bicycle detection exists. Even where bicycle specific detection does not exist, it is recommended the minimum green be sufficient for bicycles crossing at locations with dedicated bicycle lanes or locations without detection. Therefore, the minimum green times were reviewed at study intersections based on the following methodology:

$$G_{min} + Y + R_{clear} \geq 6 \text{ sec} + (W+6\text{ft})/14.7\text{ft/sec}$$

Where:

G = Length of minimum green interval (sec) (Calculated as shown or 8 seconds, whichever is greater)

W= Distance from limit line to far side of last conflicting lane (ft)

R = Length of red clearance interval (sec)

Y = Length of yellow interval (sec)

Table 11 summarizes the locations where existing minimum green intervals are recommended to be updated. **Appendix E** contains the existing and proposed minimum green interval analysis spreadsheet for all study intersections.

Table 11: Existing and Proposed Minimum Green Intervals for Bicycles

#	Intersection	Direction	Phase	Existing Minimum Green Interval (sec)	Proposed Minimum Green Interval (sec)
1	Pleasant Hill Road/Rancho View Drive	NBL	5	4.0	7.0
		EB-WB	4	4.0	10.0
2	Pleasant Hill Road/Greenvalley Drive	NBL	1	4.0	9.0
		SBL	5	4.0	8.0
		EB-WB	4	4.0	12.0
3	Pleasant Hill Road/Reliez Valley Road	NBL	1	4.0	9.0
		EBL	8	4.0	8.0
4	Pleasant Hill Road/Springhill Road/Quandt Road	NBL	1	4.0	9.0
		SBL	5	4.0	8.0
		EBTL	8	4.0	11.0
		WBTL	4	4.0	11.0
5	Pleasant Hill Road/Deer Hill Road-Stanley Boulevard	NBL	1	4.0	7.0
		SBL	5	4.0	8.0
		EBTL	8	4.0	10.0
		WBTL	4	4.0	9.0

Yellow Intervals

The yellow intervals for all movements were reviewed to be consistent with the 2014 CA MUTCD requirements. **Table 12** summarizes locations where yellow intervals are recommended to be updated. **Appendix E** contains the existing and proposed yellow interval analysis spreadsheet for all study intersections.

Table 12: Existing and Proposed Yellow Intervals

#	Intersection	Direction	Phase	Existing Yellow Interval (sec)	Proposed Yellow Interval (sec)
1	Pleasant Hill Road/Rancho View Drive	NB	2	4.0	4.4
		SB	6	4.0	4.1
		EB	4	3.0	3.6
		WB	4	3.0	3.6
2	Pleasant Hill Road/Greenvalley Drive	NB	6	4.0	4.4
		SB	2	4.0	4.1
		EB	4	3.0	3.6
		WB	4	3.0	3.6
3	Pleasant Hill Road/Reliez Valley Road	NB	6	4.0	4.4
		SB	2	4.0	4.1
		EB	8	3.0	3.7
4	Pleasant Hill Road/Springhill Road-Quandt Road	NB	6	3.6	4.1
		SB	2	3.6	4.1
		EB	8	3.0	3.6
		WB	4	3.0	3.6
5	Pleasant Hill Road/Deer Hill Road-Stanley Boulevard	NB	6	4.0	4.1
		SB	2	4.0	4.1
		EB	8	3.0	4.1
		WB	4	3.0	3.6

Optimized Timing Plan Implementation

TJKM in collaboration with the City staff initiated the implementation and fine-tuning of the proposed timings during the months of May and October 2016. This was done as a field trial to observe and validate the delay improvements projected by the traffic models. After implementation of the proposed timings, TJKM fine-tuned the offsets and green times where needed based on in-person field observations of traffic conditions operating under the revised timing parameters and optimized timing plans. TJKM also conducted driving trips along the study corridor, identifying locations where vehicles stop. This led to further refining the offsets and green times to improve traffic flow. This process was performed for the a.m. peak period over a number of weekdays.

The first iteration of timing updates were performed only at Deer Hill Road intersection with the assumption that changing the timings at this intersection, which is the bottleneck, would improve the progression along the corridor. TJKM observed the flow of traffic over a number of weekdays during this phase of the implementation and the City monitored the effect of the recommendations via GPS-based travel time data provided by INRIX. These changes did not result in significant improvements. With the commencement of schools in September 2016, TJKM revisited the timing plan recommendations and proposed the changes with an underlying approach of managing the throughput into the corridor at the north end consistent with Strategy 2 presented previously.

The latest evolution of the original plans have been in implementation since mid-November 2016.

Evaluation of Results from Field Trials

Field Observations and "Before" and "After" Floating Car Survey Results

Based on field observations and data collected after the implementation of the new signal timing plans, the new program has achieved noticeable improvements in a number of areas. First, traffic progression on Pleasant Hill Road south of Reliez Valley Road has improved, and the overall travel time and average delay through the corridor has reduced during peak hour as evident in the travel time surveys that were conducted after installing the revised coordination plans.

The "After" travel time survey was conducted over a number of days for the same duration from 6:30 a.m. to 9:00 a.m. as the "Before" travel time survey. The results expressed as an average are summarized in **Table 13**. **Table 14** summarizes the results of the worst run on the day of survey. Detailed "After" travel time summary sheets are contained in **Appendix B**.

Table 13: Weekday "After" Floating Car Survey (Average), Pleasant Hill Road between Rancho View Drive and Deer Hill Road-Stanley Boulevard

Roadway	*Approach*	*Peak Hour*	*Average Stop Delay[3] (min:sec)*	*Average Travel Time (min:sec)*	*Average # of Stops[2]*	*Average Speed[1] (mph)*
Pleasant Hill Road (Length of Segment – 1.05 miles)	SB	A.M.	3:12	5:32	4	14

Notes:

[1]Average speed along the corridor including stop delays, not reflective of actual speeds of vehicles while moving.

[2]Average number of stops made by a car from all the travel time runs collected on the study corridors including stops at red lights as well as other stops between intersections due to congestion.

[3]Stop Delay includes delay experienced with a full stop at the intersection as well as travel time when the vehicle speed is less than 10 mph.

*There are five signalized intersections along this corridor and the free flow travel time with zero delay is under three minutes.

Table 14: Weekday "After" Floating Car Survey (Worst Run), Pleasant Hill Road between Rancho View Drive and Deer Hill Road-Stanley Boulevard

Roadway	*Approach*	*Peak Hour*	*Worst Run Stop Delay[3] (min:sec)*	*Worst Run Travel Time (min:sec)*	*Worst Run # of Stops[2]*	*Worst Run Speed[1] (mph)*
Pleasant Hill Road (Length of Segment – 1.05 miles)	SB	A.M.	6:23	9:03	8	7

Notes:

[1]Speed along the corridor including stop delays, not reflective of actual speeds of vehicles while moving.

[2]Number of stops made by a car from the worst travel time run collected on the study corridor including stops at red lights as well as other stops between intersections due to congestion.

[3]Stop Delay includes delay experienced with a full stop at the intersection as well as travel time when the vehicle speed is less than 10 mph.

*There are five signalized intersections along this corridor and the free flow travel time with zero delay is under three minutes.

To gauge the effect of the new timing plans, basic traffic operation parameters of the "Before" and "After" conditions were compared in **Tables 15** and **16**. **Appendix E** contains additional Synchro model output results and comparisons of other Levels of Service and Measures of Effectiveness parameters for the study corridor. As the tables show, the implementation of recommended signal timing plan has generally resulted in reductions of signal delay per vehicle, stops per vehicle, and total travel time along the study corridor. The average speed along the study corridor during the peak hour has increased compared to 'Before" Conditions.

Table 15: "Before" and "After" Comparison of System Measures of Effectiveness (MOEs) for Pleasant Hill Road (Average of Floating Car Survey Runs)

Roadway	*Approach*	*Peak Hour*	*Scenario*	*Average Stop Delay[1] (min:sec)*	*Average Travel Time[1] (min:sec)*	*Average # of Stops[1]*	*Average Speed[1] (mph)*
Pleasant Hill Road (Length of Segment – 1.05 miles)	SB	A.M.	Existing	4:58	7:18	6	10
			Proposed	3:12	5:32	4	14
			% Change	-36%	-24%	-33%	38%

Notes:

[1]Stop Delay, Travel Time, # of Stops and Speed = Average of all "Before" and "After" floating car survey runs collected during the a.m. peak period.

Table 16: "Before" and "After" Comparison of System Measures of Effectiveness (MOEs) for Pleasant Hill Road (Worst Floating Car Survey Run)

Roadway	*Approach*	*Peak Hour*	*Scenario*	*Stop Delay[1] (min:sec)*	*Travel Time[1] (min:sec)*	*# of Stops[1]*	*Speed[1] (mph)*
Pleasant Hill Road (Length of Segment – 1.05 miles)	SB	A.M.	Existing	13:26	14:45	7	4
			Proposed	6:23	9:03	8	7
			% Change	-52%	-39%	14%	78%

Notes:

[1]Stop Delay, Travel Time, # of Stops and Speed = Worst of the "Before" and "After" floating car survey runs collected during the a.m. peak period.

As illustrated in tables above, during the weekday a.m. peak period, Strategy 2 has resulted in:

- Reduction of 36% in average stop delay;
- Reduction in travel time by approximately 24%;
- Reduction in stops per vehicle by approximately 33%; and
- Increase in average travel speed by approximately 38%.

However, it should be acknowledged that congestion still occurs throughout the corridor with the revised signal timings, which are not expected to produce "free flow" conditions in traffic given that peak demand far exceeds the available capacity.

The new signal timing plans have also decreased duration of congestion on Reliez Valley Road. By providing more frequent and longer gaps for traffic on Reliez Valley Road to merge into Pleasant Hill Road, queues are less frequent and those that develop are short and dissipate more quickly compared to prior conditions.

These improvements do come with trade-offs. As referenced previously, the improvements at the south end are made possible by managing the amount of traffic coming through from points north of Rancho View Drive. The new timing plans theoretically have incrementally increased the queuing and delay approaching the first Lafayette signal at Rancho View Drive. Given the heavy congestion throughout the corridor under pre-existing conditions, this section of the roadway already experienced

noticeable queuing and delay. That delay appears to have worsened and occurs more consistently and is spread out over a longer duration within the peak period. Lafayette staff reports GPS-based travel time data indicating an increase in delay in the range of three minutes.

Another trade-off that could develop over time is additional diversion of traffic onto Reliez Valley Road. Theoretically, the more persistent delay approaching Lafayette on Taylor Boulevard might cause some drivers to divert via Withers Avenue at the Lafayette border. TJKM collected TMCs at Reliez Valley Road/Withers Avenue intersection for the "Before" and "After" studies. The traffic counts currently do not reflect the diversion discussed above but this is a condition worth on-going monitoring. At the point where diversion is determined to be so substantial that it negates the improvements gained from the new signal plans, additional actions may be considered, including traffic management measures at the intersection of Reliez Valley Road/Withers Avenue.

Diversion of Traffic "Before" and "After" Implementation

As a part of the study, TJKM collected turning movement counts at Reliez Valley Road/Withers Avenue/Ivanhoe Avenue "Before" and "After" implementation to determine whether there was any significant diversion of traffic from Pleasant Hill Road onto Reliez Valley Road after the new signal plans were field-tested. The counts were collected on Tuesday, April 19, 2016 before implementation and on Tuesday, December 6, 2016 after implementation of the proposed timing plans. Generally, the traffic is expected to fluctuate within a 10% range on a typical weekday. The traffic volumes collected after implementation show an increase of approximately 4% in the turning movement from Withers Avenue onto Reliez Valley Road. This falls within the general range of fluctuation. Therefore, it is not possible yet to conclude definitively that diversion has occurred via Withers Avenue onto Reliez Valley Road. The traffic volumes collected for southbound through on Reliez Valley Road show an increase of approximately 18%. This suggests that the traffic is potentially diverting onto Reliez Valley Road from a point further north of Withers Avenue, such as Grayson Road. This could be the regional through traffic diverting to avoid I-680 or residents in the immediate vicinity of Grayson Road, opting to commute via Reliez Valley Road rather than Taylor Boulevard. This intersection should be monitored over a period of time to observe potential diversion. Additional steps could be taken should significant diversion of traffic occur in the future. This could include signalizing the intersection at Reliez Valley Road/Withers Avenue to manage the congestion on Reliez Valley Road. **Table 17** summarizes the "Before" and "After" conditions traffic volumes collected at this intersection. **Appendix A** contains the "Before" and "After" implementation turning movement counts for the a.m. peak period.

Table 17: Traffic Volume Comparison "Before" and "After" Implementation at Reliez Valley Road/Withers Avenue

Location	*Approach*	*Peak Period*	*Scenario*	*Approach Volumes*
Reliez Valley Road/Withers Avenue	Westbound Left-turn onto Reliez Valley Road	A.M.	Before Implementation	167
			After Implementation	174
	Southbound Through on Reliez Valley Road		Before Implementation	247
			After Implementation	292

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