Memorandum

Date: January 24, 2024

Project: Penngrove Intersection Improvements
C23602 (SOX796)

To: Carmen Rodriguez
County of Sonoma

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Subject: Intersection Control Evaluation for Old Redwood Highway North/Railroad Avenue

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In support of improving capacity and operation at the intersection of Old Redwood Highway North/ Railroad Avenue, current and projected future operation under various control and lane configuration alternatives has been evaluated. The purpose of this memorandum is to set forth the background data collected, assumptions applied, analysis performed, and findings to help County of Sonoma (County) staff make informed decisions regarding planned intersection layout and control improvements.

Setting

Old Redwood Highway North/Railroad Avenue is a four-legged intersection with stop controls on the Railroad Avenue approaches. There are single through lanes on all four approaches plus left-turn lanes on both Old Redwood Highway approaches (Plate 1).

Plate 1 Existing Conditions

Collision History

The collision history for the study area was reviewed to determine any trends or patterns that may indicate a safety issue. Collision rates were calculated based on records available from the California Highway Patrol as published in their Statewide Integrated Traffic Records System (SWITRS) reports. The most current five-year period available is January 1, 2018, through December 31, 2022. The calculated collision rate for the study intersection was compared to the average collision rate for similar facilities statewide, as indicated in *2021 Collision Data on California State Highways*, California Department of Transportation (Caltrans). These average rates statewide are for intersections in the same environment (urban, suburban, or rural), with the same number of approaches (three or four), and the same controls (all-way stop, two-way stop, or traffic signal).

Between January 2018 and December 2022, 23 collisions were documented at the study intersection. This equates to a collision rate of 1.01 crashes per million vehicles entering the intersection (c/mve). The statewide average collision rate for four-legged stop-controlled intersections in a suburban setting is 0.36 c/mve and therefore the study intersection has a collision rate that is substantially higher than the statewide average. Copies of the collision data and collision rate calculations are attached.

Of the 23 collisions that occurred during the study period, 16 were broadside, three were collisions with an object, two were head-on, one was rear-end, and one was a sideswipe. All 16 broadside collisions were due to right-of-way violations. Further, the injury rate at the intersection was 65.2 percent, which is higher than the Statewide

average of 42.6 percent, indicating a potential safety concern. Through a change in intersection control such as signalization or conversion to a roundabout, 21 of the 23 collisions (91 percent) would become less probable. Further, changes in intersection control would likely reduce speeds through the intersection. This in turn would reduce collision severity and the injury rate.

Operation Under Existing Controls

Traffic counts obtained at the study intersection during the morning and evening peak periods were used to evaluate current operation. Future volumes in the horizon year of 2040 were projected using information obtained from the Sonoma County Transportation Authority's (SCTA) travel demand model and application of the Furness method, which is an iterative process that employs existing turn movement data, existing link volumes and future link volumes to project likely turning future movement volumes at intersections.

With the existing two-way stop controls, the intersection is currently operating acceptably at LOS A overall during the a.m. and p.m. peak hours, though it is noted that the eastbound approach is operating unacceptably at LOS E. Under the projected future volumes operation would be expected to deteriorate with delays increasing and operation becoming LOS F overall during the p.m. peak hour. These results are summarized in Table 1.

Table 1 – Peak Hour Intersection Levels of Service Under Existing Controls

	Study Intersection	**Existing Volumes**				**Future Volumes**			
	Approach	**AM Peak**		**PM Peak**		**AM Peak**		**PM Peak**	
		Delay	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**
1.	Old Redwood Hwy N/Railroad Ave	4.7	A	7.4	A	7.8	A	80.3	F
	Eastbound (Railroad Ave) Approach	*28.1*	*D*	*48.5*	*E*	*55.5*	*F*	*>120*	*F*
	Westbound (Railroad Ave) Approach	*24.0*	*C*	*23.5*	*C*	*36.4*	*E*	*39.9*	*E*

Notes: Delay is measured in average seconds per vehicle; LOS = Level of Service; Results for minor approaches to two-way stop-controlled intersections are indicated in *italics*

Signal Warrants

The potential need for a traffic signal was evaluated using criteria published in the California *Manual on Uniform Traffic Control Devices* (CA-MUTCD). Based on the data gathered, Warrants 2, 3, and 7 were assessed and a spreadsheet indicating the analysis is attached.

Warrant 2 is met when an engineering study finds that, for each of any four hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor street approach (one direction only) all fall above the applicable curve in Figure 4C-1 for the existing combination of approach lanes. On the minor street, the higher volume shall not be required to be on the same approach during each of these four hours.

Volumes during all four hours of the morning and evening peak periods (7:00 a.m. to 9:00 a.m. and 4:00 p.m. to 6:00 p.m.) satisfy the requirements to meet Warrant 2.

Warrant 3 is often the first warrant to be met. Under the Peak Hour Warrant the need for a traffic control signal shall be considered if an engineering study finds that the criteria in either of the following two categories are met:

A. If all three of the following conditions exist for the same one hour (any four consecutive 15-minute periods) of an average day:

1. The total stopped time delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equals or exceeds: four vehicle-hours for a one-lane approach; or five vehicle-hours for a two-lane approach; and
2. The volume on the same minor-street approach (one direction only) equals or exceeds 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes; and
3. The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour for intersections with three approaches or 800 vehicles per hour for intersections with four or more approaches.

B. The plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) for one hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4C-3 for the existing combination of approach lanes.

Warrant 3 is based on vehicle delay and volumes occurring during the peak hour at an intersection. The existing volumes at the study intersection exceed the threshold established in the warrant for both the a.m. and p.m. peak hours. Based on the operation analysis detailed above, delay exceeds two hours on the eastbound Railroad Avenue approach.

Warrant 7 addresses the collision history of a location. The need for a traffic control signal shall be considered if an engineering study finds that all of the following criteria are met:

A. Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency; and

B. Five or more reported crashes, of types susceptible to correction by a traffic control signal, have occurred within a 12-month period, each crash involving personal injury or property damage apparently exceeding the applicable requirements for a reportable crash; and

C. For each of any eight hours of an average day, the vehicles per hour (vph) given in both of the 80 percent columns of Condition A in Table 4C-1 (see Section 4C.02), or the vph in both of the 80 percent columns of Condition B in Table 4C-1 exists on the major-street and the higher-volume minor-street approach, respectively, to the intersection, or the volume of pedestrian traffic is not less than 80 percent of the requirements specified in the Pedestrian Volume warrant. These major-street and minor-street volumes shall be for the same eight hours. On the minor street, the higher volume shall not be required to be on the same approach during each of the eight hours.

Warrant 7 depends both on collision history and traffic volumes over an eight-hour period. Over the past five years, there was one instance where the number of collisions of types susceptible to correction by a traffic signal (e.g., broadside, head-on) in a 12-month period met the threshold required by the warrant. Between November 3, 2019, and November 7, 2020, there were seven reported collisions. Of those, six were broadside and one was a sideswipe. The six broadside collisions are considered susceptible to correction by a traffic signal, meeting the minimum requirement of five. It is noted that only four hours of volume data was collected for this study, though the four hours meet the threshold described in the warrant. Due to lack of data, this warrant is inconclusive, but it appears that it would be met if additional count data were obtained.

Finding – Based on analysis of Warrants 2, 3 and 7, a signal is warranted at Old Redwood Highway North/ Railroad Avenue.

Alternatives Analysis

Options considered for improving operation at the study intersection included a traffic signal and a modern roundabout. The alternatives evaluated were as follows.

- Signalized with Existing Lane Configuration (Plate 2)
- Roundabout (Plate 3)

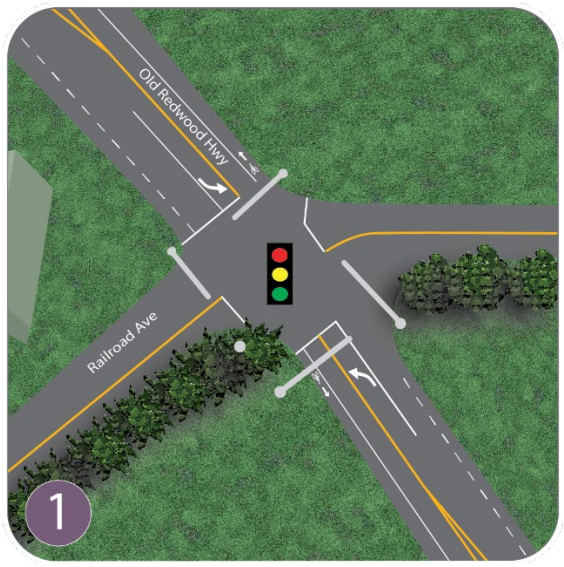


Plate 2 Signalized with Existing Lanes

Plate 3 Roundabout

Operation with Alternative Controls

The adequacy of each of the alternatives considered to achieve acceptable operation (LOS D or better) was evaluated. For the alternative involving signalization, optimized timing provided by the Synchro software package was used.

As shown in Table 2, each alternative would improve operations when compared to the existing condition. When compared to the roundabout alternative, signalizing the intersection would result in more delay overall in both the short-term and future conditions. Summaries of the individual operational analyses are attached.

Table 2 – Peak Hour Intersection Levels of Service at Old Redwood Highway/Railroad Avenue

Control Alternative	Existing Volumes				Future Volumes			
	AM Peak		PM Peak		AM Peak		PM Peak	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Signalized with Existing Lanes	10.8	B	11.9	B	12.8	B	17.1	B
Roundabout	7.1	A	7.8	A	9.4	A	10.9	B

Notes: Delay is measured in average seconds per vehicle; LOS = Level of Service

Crash Reduction

The safety benefits of each alternative were evaluated using Crash Modification Factors (CMFs) published by the Federal Highway Administration (FHWA). CMFs represent the crash reduction (or inflation) that could be expected due to implementation of a specific countermeasure based on studies that have occurred on similar roadways within the United States. CMFs can also provide information regarding specific crash types. A common example is implementation of a signal where rear-end crashes would be expected to increase though collisions overall would be expected to decrease.

Applying CMFs to the observed crash frequency obtained can provide an estimated number of crashes after implementation of a countermeasure. CMFs can also be converted to Crash Reduction Factors (CRFs) and presented in that form. CRFs represent a percent reduction (or inflation) expected from a specific countermeasure and are generally more comprehensible and easier to directly compare.

As summarized in Table 3, the countermeasures applied to the two alternatives include installation of a traffic signal or conversion of a stop-controlled intersection to a modern roundabout. Based on these countermeasures, the alternative involving signalization would be expected to reduce collisions overall by 23 percent. As is typical of signalization, this alternative would likely result in an increase in the number of rear-end crashes of about 38 percent, but a decrease in broadside crashes of about 67 percent. The roundabout alternative would be expected to have the greatest beneficial effect on crashes, with an expected reduction of 72 percent.

Table 3 – Expected Crash Reduction for Each Alternative

Control Alternative	All Crashes		Rear-End Crashes		Broadside Crashes	
	CMF	CRF	CMF	CRF	CMF	CRF
Signalized with Existing Lanes	0.77	23%	1.38	-38%	0.33	67%
Roundabout	0.28	72%	-	-	-	-

Life Cycle Costs

Costs associated with each alternative were evaluated based on the anticipated construction, planning, design, environmental clearance, right-of-way acquisition, and operating/maintenance costs, supplemented by costs associated with operational delay and collisions at the intersection. These costs were applied through 2040, the future year used for the operations analysis. To compare costs on an equivalent scale, all costs accrued during the study period were converted to present value costs, or 2024 dollars. For the purposes of evaluating each component of the planning and construction costs, environmental clearance was estimated as two percent of the total construction cost; planning and design as 25 percent; and construction management as 13 percent. Table 4 provides a summary of the planning and construction costs per alternative. Environmental mitigation costs are included in the total construction cost. A spreadsheet containing a further breakdown of the anticipated construction cost per alternative is attached.

Table 4 – Expected Planning and Construction Costs

Cost Category	Control Alternative	
	Signalized with Existing Lanes	Roundabout
Construction[1]	$1,083,150	$1,449,345
Environmental Clearance (2%)	$21,663	$28,987
Planning (5%)	$54,158	$72,467
Design (20%)	$216,630	$289,869
Right-of-Way Acquisition[1]	$3,000	$190,800
Construction Easements (1%)	$10,832	$14,493
Construction Management (12%)	$129,978	$173,921
Present Value	**$1,519,410**	**$2,219,883**

Notes: [1] Refer to attached cost estimate spreadsheet for a breakdown of construction and Right-of-Way costs

Table 5 provides the anticipated operations and maintenance costs associated with each alternative, based on cost information provided by the County for existing facilities. These costs are applied in the cost model at recurring intervals, as noted in the table, with a four percent increase in cost per year. For the No Build alternative,

these costs would begin immediately. For all other alternatives, a two-year delay in operation and maintenance is expected to account for the time needed for construction activities.

Table 5 – Expected Operation and Maintenance Costs

Cost Category	Control Alternative		
	No Build	Signalized with Existing Lanes	Roundabout
Inspection ($/2 yr)	$1,000	$1,000	$1,000
Repaving ($/5 yr)	$100,000	$100,000	$100,000
Signing & Striping ($/yr)	$1,200	$1,200	$1,200
Signal Maintenance ($/yr)	-	$3,000	-
Electrical Maintenance ($/yr)	-	$1,000	$2,000
Vegetation Maintenance ($/yr)	$1,000	$1,000	$1,000
Present Value	**$340,952**	**$357,422**	**$335,014**

Notes: yr = year

Costs attributable to collisions and operational delay were calculated for each alternative using data provided by Caltrans in the *California Life-Cycle Benefit/Cost Analysis Model*. This model applies a cost of $13 million to fatal collisions, $173,000 to collisions resulting in injury, and $10,400 to collisions resulting in property damage only. For delay, a cost of $16.45 is assumed per person-hour, and $37.55 is assumed per truck-hour.

Table 6 summarizes the total present value of costs for all alternatives, including costs attributable to collisions and delay. Converting Old Redwood Highway North/Railroad Avenue to a signalized intersection or a roundabout would provide cost benefits in the long-term since both options have a cheaper present value than maintaining existing conditions. The present value of the roundabout alternative is significantly less than the other options, which is attributable primarily to the expected collision reduction associated with that option.

Table 6 – Present Value of Expected Costs

Cost Category	Control Alternative		
	No Build	Signalized with Existing Lanes	Roundabout
Planning and Construction	-	$1,519,410	$2,219,883
Operations and Maintenance	$340,952	$357,422	$335,014
Collisions	$7,781,717	$5,991,922	$2,178,881
Delay	$157,119	$277,915	$190,097
Total Present Value	**$8,279,787**	**$8,146,669**	**$4,923,874**

Benefit/Cost Ratio

Benefit/Cost ratios (BCR) are used in transportation economics to compare alternatives on as similar a scale as possible, with the present value of benefits being directly compared to the present value of costs for a particular alternative. Net present values, or the difference between the present value of the alternative and the No Build, are used in BCR calculations. BCR values greater than one indicate that the benefits of a potential alternative outweigh the costs associated with that alternative. Conversely, BCR values less than one suggest that an alternative is not economically beneficial. Given that benefits and costs are calculated relative to the No Build

alternative, the BCR of doing nothing is always equal to one. Net Present values of benefits and costs, as well as calculated BCR values, are summarized in Table 7.

Table 7 – Benefits and Costs

	Control Alternative		
	No Build	**Signalized with Existing Lanes**	**Roundabout**
NPV of Benefits	-	$1,668,998	$5,569,858
NPV of Costs	-	$1,535,880	$2,213,945
Present Value of Net Benefits	-	$133,118	$3,355,913
Benefit/Cost Ratio	**1.00**	**1.09**	**2.52**

Notes: NPV = Net Present Value

Conclusions

Old Redwood Highway North/Railroad Avenue, while currently operating acceptably, is expected to operate at an unacceptable LOS F in the future. It also has a collision rate higher than the statewide average. Two solutions to address deficient operation and safety concerns were analyzed and compared to a No Build alternative: converting the intersection to signalized control or converting it to a modern roundabout. Both options would improve future operation to an acceptable LOS A or B and be expected to reduce the number of collisions at the intersection. The concern about environmental impacts for this project is associated with roadside drainage ditches being classified as wetlands. The roundabout alternative would have much more impact on these perceived wetlands, resulting in the potential for a much longer environmental process dealing with the significant permitting and mitigation impacts expected with that alternative. The costs for completing this process may exceed the costs contained within this evaluation, and the timeline for the project could exceed what is currently anticipated. It is noted that the County is currently working with the San Francisco Bay Regional Water Quality Control Board to determine the applicability of the wetland designation on the roadside ditches. Although the roundabout alternative would have more initial cost than signalization and would require the more robust environmental process, the greater reduction in collisions provides a notable economic advantage, resulting in that option having a higher BCR. It is noted that either option would be more economically beneficial than the No Build alternative.

DJW/ngb/SOX796.M3

Attachments: Collision Rate Calculations, Signal Warrant Analysis, Operational Analyses, Construction Cost Spreadsheet

Intersection Collision Rate Worksheet

Penngrove Intersection Improvements

Intersection # 1: Old Redwood Highway North & Railroad Avenue
Date of Count: Thursday, September 28, 2023

Number of Collisions: 23
Number of Injuries: 15
Number of Fatalities: 0
Average Daily Traffic (ADT): 12500
Start Date: January 1, 2018
End Date: December 31, 2022
Number of Years: 5

Intersection Type: Four-Legged
Control Type: Stop & Yield Controls
Area: Suburban

$$\text{Collision Rate} = \frac{\text{Number of Collisions x 1 Million}}{\text{ADT x Days per Year x Number of Years}}$$

$$\text{Collision Rate} = \frac{23 \times 1{,}000{,}000}{12{,}500 \times 365 \times 5}$$

	Collision Rate	Fatality Rate	Injury Rate
Study Intersection	**1.01 c/mve**	**0.0%**	**65.2%**
Statewide Average*	**0.36 c/mve**	**1.5%**	**42.6%**

Notes
ADT = average daily total vehicles entering intersection
c/mve = collisions per million vehicles entering intersection
* 2020 Collision Data on California State Highways, Caltrans

Warrant 2: Four-Hour Vehicular Volume
Old Redwood Hwy & Railroad Ave
Sonoma County

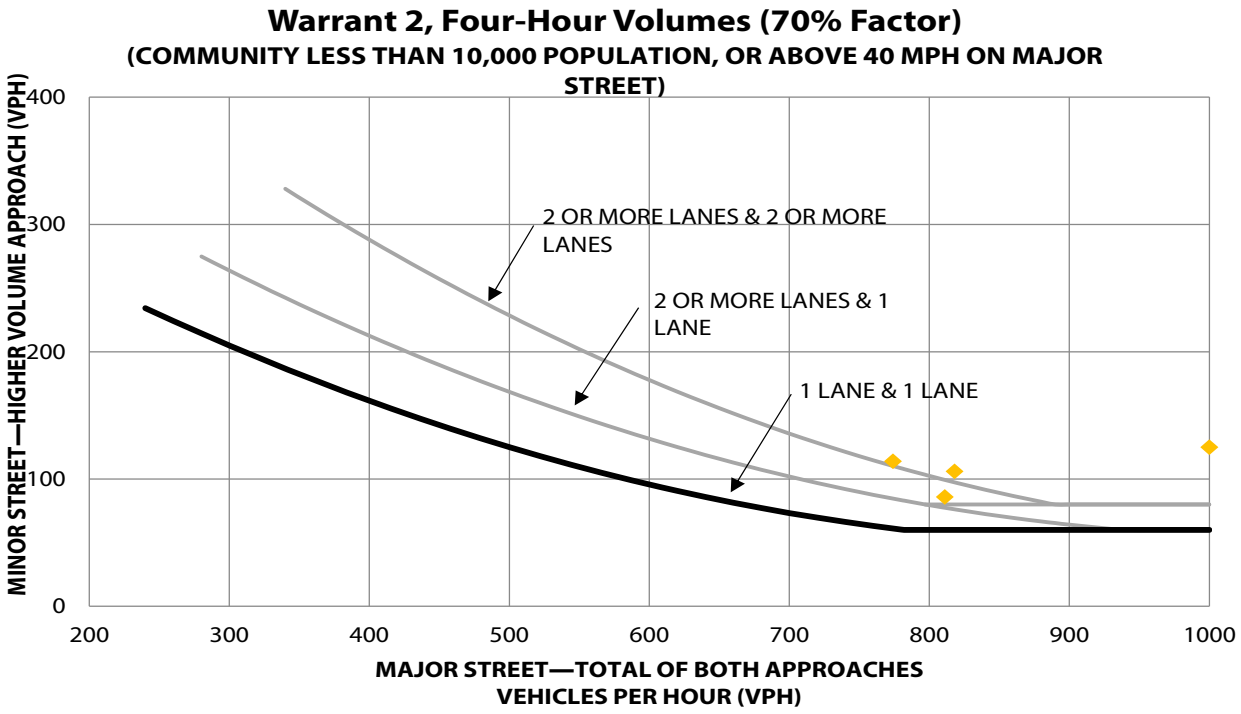
Project Name: SOX796
Intersection: 2
Scenario: Existing
Date of Count: 9/28/2023

	Major Street	Minor Street
Street Name:	Old Redwood Hwy	Railroad Ave
Direction:	N-S	E-W
Number of Lanes:	1	1
Approach Speed:	50	45

Community with population < 10,000? No

WARRANT MET? **Yes**

Hour	Both Approaches Major Street	Highest Approach Minor Street
1	1019	125
2	818	106
3	811	86
4	774	114



Warrant 3: Peak-Hour Volumes and Delay

Old Redwood Hwy & Railroad Ave
Sonoma County

Project Name: SOX796

Intersection: 2

	Major Street	Minor Street
Street Name	Old Redwood Hwy	Railroad Ave
Direction	N-S	E-W
Number of Lanes	1	1
Approach Speed	50	45

Population less than 10,000? No
Date of Count: Thursday, September 28, 2023
Scenario: Existing

Warrant 3 Met?: Met when either Condition A or B is met	**Yes**
Condition A: Met when conditions A1, A2, and A3 are met	Not Met
Condition A1	Not Met

The total delay experienced by traffic on one minor street approach (one direction only) controlled by a STOP sign equals or exceeds four vehicle-hours for a one lane approach, or five vehicle-hours for a two-lane approach

Minor Approach Delay: 2.05 vehicle-hours

Condition A2 — Met

The volume on the same minor street approach (one direction only) equals or exceeds 100 vph for one moving lane of traffic of 150 vph for two moving lanes

Minor Approach Volume: 152 vph

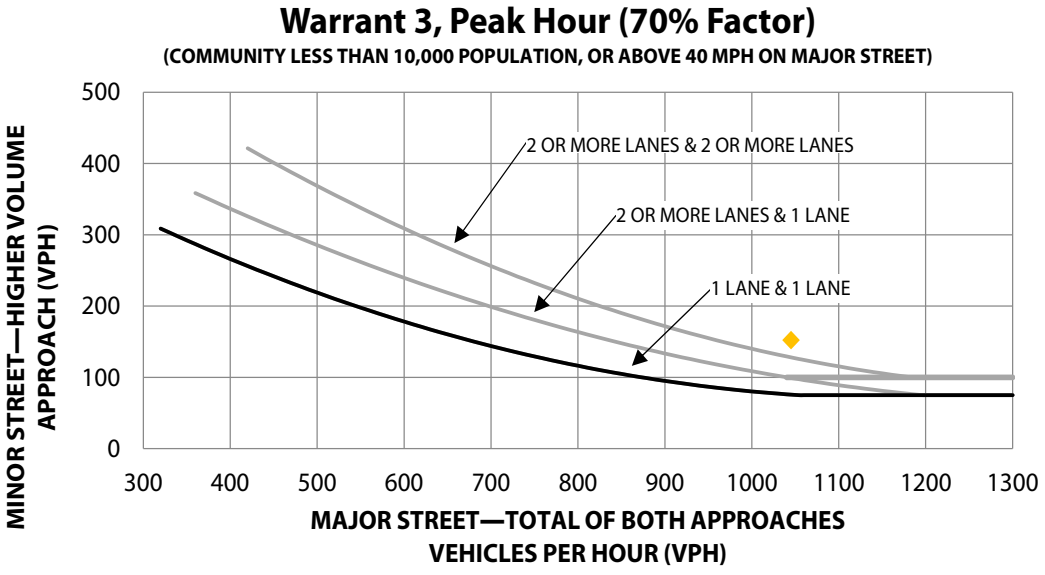
Condition A3 — Met

The total entering volume serviced during the hour equals or exceeds 800 vph for intersections with four or more appraches or 650 vph for intersections with three approaches

Total Entering Volume: 1253 vph

Condition B — Met

The plotted point falls above the curve



Intersection	
Int Delay, s/veh	4.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	41	24	39	16	43	21	32	273	3	19	563	51
Future Vol, veh/h	41	24	39	16	43	21	32	273	3	19	563	51
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	130	-	-	90	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	100	100	100	100	100	100	100	100	100	100	100	100
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	41	24	39	16	43	21	32	273	3	19	563	51

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	998	967	589	997	991	275	614	0	0	276	0	0
Stage 1	627	627	-	339	339	-	-	-	-	-	-	-
Stage 2	371	340	-	658	652	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	223	254	508	223	246	764	965	-	-	1287	-	-
Stage 1	471	476	-	676	640	-	-	-	-	-	-	-
Stage 2	649	639	-	453	464	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	180	242	508	184	234	764	965	-	-	1287	-	-
Mov Cap-2 Maneuver	180	242	-	184	234	-	-	-	-	-	-	-
Stage 1	455	469	-	654	619	-	-	-	-	-	-	-
Stage 2	568	618	-	391	457	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	28.1	24	0.9	0.2
HCM LOS	D	C		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	965	-	-	258	268	1287	-	-
HCM Lane V/C Ratio	0.033	-	-	0.403	0.299	0.015	-	-
HCM Control Delay (s)	8.9	-	-	28.1	24	7.8	-	-
HCM Lane LOS	A	-	-	D	C	A	-	-
HCM 95th %tile Q(veh)	0.1	-	-	1.8	1.2	0	-	-

Intersection	
Int Delay, s/veh	7.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	65	37	50	9	21	26	39	615	14	27	316	34
Future Vol, veh/h	65	37	50	9	21	26	39	615	14	27	316	34
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	130	-	-	90	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	100	100	100	100	100	100	100	100	100	100	100	100
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	65	37	50	9	21	26	39	615	14	27	316	34

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	1111	1094	333	1131	1104	622	350	0	0	629	0	0
Stage 1	387	387	-	700	700	-	-	-	-	-	-	-
Stage 2	724	707	-	431	404	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	186	214	709	181	211	487	1209	-	-	953	-	-
Stage 1	637	610	-	430	441	-	-	-	-	-	-	-
Stage 2	417	438	-	603	599	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	155	201	709	138	199	487	1209	-	-	953	-	-
Mov Cap-2 Maneuver	155	201	-	138	199	-	-	-	-	-	-	-
Stage 1	617	593	-	416	427	-	-	-	-	-	-	-
Stage 2	363	424	-	511	582	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	48.5	23.5	0.5	0.6
HCM LOS	E	C		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1209	-	-	226	250	953	-	-
HCM Lane V/C Ratio	0.032	-	-	0.673	0.224	0.028	-	-
HCM Control Delay (s)	8.1	-	-	48.5	23.5	8.9	-	-
HCM Lane LOS	A	-	-	E	C	A	-	-
HCM 95th %tile Q(veh)	0.1	-	-	4.2	0.8	0.1	-	-

Intersection	
Int Delay, s/veh	7.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕		↰	↱		↰	↱	
Traffic Vol, veh/h	51	25	39	16	53	22	41	279	3	26	662	105
Future Vol, veh/h	51	25	39	16	53	22	41	279	3	26	662	105
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	130	-	-	90	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	100	100	100	100	100	100	100	100	100	100	100	100
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	51	25	39	16	53	22	41	279	3	26	662	105

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	1167	1131	715	1162	1182	281	767	0	0	282	0	0
Stage 1	767	767	-	363	363	-	-	-	-	-	-	-
Stage 2	400	364	-	799	819	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	171	203	431	172	190	758	847	-	-	1280	-	-
Stage 1	395	411	-	656	625	-	-	-	-	-	-	-
Stage 2	626	624	-	379	389	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	121	189	431	133	177	758	847	-	-	1280	-	-
Mov Cap-2 Maneuver	121	189	-	133	177	-	-	-	-	-	-	-
Stage 1	376	403	-	625	595	-	-	-	-	-	-	-
Stage 2	527	594	-	317	381	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	55.5	36.4	1.2	0.3
HCM LOS	F	E		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	847	-	-	179	203	1280	-	-
HCM Lane V/C Ratio	0.048	-	-	0.642	0.448	0.02	-	-
HCM Control Delay (s)	9.5	-	-	55.5	36.4	7.9	-	-
HCM Lane LOS	A	-	-	F	E	A	-	-
HCM 95th %tile Q(veh)	0.2	-	-	3.7	2.1	0.1	-	-

Intersection	
Int Delay, s/veh	80.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕		↰	↱		↰	↱	
Traffic Vol, veh/h	126	66	81	9	33	32	56	700	14	33	352	57
Future Vol, veh/h	126	66	81	9	33	32	56	700	14	33	352	57
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	130	-	-	90	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	100	100	100	100	100	100	100	100	100	100	100	100
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	126	66	81	9	33	32	56	700	14	33	352	57

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	1299	1273	381	1339	1294	707	409	0	0	714	0	0
Stage 1	447	447	-	819	819	-	-	-	-	-	-	-
Stage 2	852	826	-	520	475	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	138	167	666	130	163	435	1150	-	-	886	-	-
Stage 1	591	573	-	369	389	-	-	-	-	-	-	-
Stage 2	354	387	-	539	557	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	~ 99	153	666	71	149	435	1150	-	-	886	-	-
Mov Cap-2 Maneuver	~ 99	153	-	71	149	-	-	-	-	-	-	-
Stage 1	562	552	-	351	370	-	-	-	-	-	-	-
Stage 2	284	368	-	401	536	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	$ 445.2	39.9	0.6	0.7
HCM LOS	F	E		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1150	-	-	150	175	886	-	-
HCM Lane V/C Ratio	0.049	-	-	1.82	0.423	0.037	-	-
HCM Control Delay (s)	8.3	-	-	$ 445.2	39.9	9.2	-	-
HCM Lane LOS	A	-	-	F	E	A	-	-
HCM 95th %tile Q(veh)	0.2	-	-	20.4	1.9	0.1	-	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

HCM 6th Signalized Intersection Summary
7: Old Redwood Hwy & W Railroad Ave/E Railroad Ave

11/14/2023

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	41	24	39	16	43	21	32	273	3	19	563	51
Future Volume (veh/h)	41	24	39	16	43	21	32	273	3	19	563	51
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	41	24	39	16	43	21	32	273	3	19	563	51
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	146	46	59	103	101	44	63	1165	13	41	1045	95
Arrive On Green	0.10	0.10	0.10	0.10	0.10	0.10	0.04	0.63	0.63	0.02	0.62	0.62
Sat Flow, veh/h	553	479	619	239	1056	461	1781	1846	20	1781	1690	153
Grp Volume(v), veh/h	104	0	0	80	0	0	32	0	276	19	0	614
Grp Sat Flow(s),veh/h/ln	1651	0	0	1756	0	0	1781	0	1867	1781	0	1843
Q Serve(g_s), s	0.9	0.0	0.0	0.0	0.0	0.0	1.0	0.0	3.4	0.6	0.0	10.3
Cycle Q Clear(g_c), s	3.1	0.0	0.0	2.3	0.0	0.0	1.0	0.0	3.4	0.6	0.0	10.3
Prop In Lane	0.39		0.37	0.20		0.26	1.00		0.01	1.00		0.08
Lane Grp Cap(c), veh/h	251	0	0	248	0	0	63	0	1178	41	0	1140
V/C Ratio(X)	0.41	0.00	0.00	0.32	0.00	0.00	0.51	0.00	0.23	0.46	0.00	0.54
Avail Cap(c_a), veh/h	619	0	0	648	0	0	169	0	1178	169	0	1140
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	23.4	0.0	0.0	23.1	0.0	0.0	25.5	0.0	4.3	26.0	0.0	5.9
Incr Delay (d2), s/veh	1.1	0.0	0.0	0.7	0.0	0.0	6.2	0.0	0.5	8.0	0.0	1.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.3	0.0	0.0	0.9	0.0	0.0	0.5	0.0	1.0	0.3	0.0	3.2
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	24.5	0.0	0.0	23.8	0.0	0.0	31.7	0.0	4.8	33.9	0.0	7.7
LnGrp LOS	C	A	A	C	A	A	C	A	A	C	A	A
Approach Vol, veh/h		104			80			308			633	
Approach Delay, s/veh		24.5			23.8			7.6			8.5	
Approach LOS		C			C			A			A	
Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	5.7	38.5		9.6	6.4	37.8		9.6				
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5				
Max Green Setting (Gmax), s	5.1	33.3		18.1	5.1	33.3		18.1				
Max Q Clear Time (g_c+I1), s	2.6	5.4		5.1	3.0	12.3		4.3				
Green Ext Time (p_c), s	0.0	1.7		0.4	0.0	4.3		0.3				
Intersection Summary												
HCM 6th Ctrl Delay			10.8									
HCM 6th LOS			B									

HCM 6th Signalized Intersection Summary
7: Old Redwood Hwy & W Railroad Ave/E Railroad Ave

11/14/2023

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	65	37	50	9	21	26	39	615	14	27	316	34
Future Volume (veh/h)	65	37	50	9	21	26	39	615	14	27	316	34
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	65	37	50	9	21	26	39	615	14	27	316	34
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	179	66	70	102	104	106	74	1030	23	56	921	99
Arrive On Green	0.13	0.13	0.13	0.13	0.13	0.13	0.04	0.57	0.57	0.03	0.55	0.55
Sat Flow, veh/h	568	498	522	139	780	797	1781	1821	41	1781	1660	179
Grp Volume(v), veh/h	152	0	0	56	0	0	39	0	629	27	0	350
Grp Sat Flow(s),veh/h/ln	1588	0	0	1716	0	0	1781	0	1863	1781	0	1838
Q Serve(g_s), s	3.1	0.0	0.0	0.0	0.0	0.0	1.1	0.0	11.1	0.7	0.0	5.2
Cycle Q Clear(g_c), s	4.5	0.0	0.0	1.5	0.0	0.0	1.1	0.0	11.1	0.7	0.0	5.2
Prop In Lane	0.43		0.33	0.16		0.46	1.00		0.02	1.00		0.10
Lane Grp Cap(c), veh/h	315	0	0	313	0	0	74	0	1053	56	0	1020
V/C Ratio(X)	0.48	0.00	0.00	0.18	0.00	0.00	0.52	0.00	0.60	0.48	0.00	0.34
Avail Cap(c_a), veh/h	664	0	0	683	0	0	214	0	1053	182	0	1020
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	20.7	0.0	0.0	19.4	0.0	0.0	23.5	0.0	7.1	23.8	0.0	6.1
Incr Delay (d2), s/veh	1.1	0.0	0.0	0.3	0.0	0.0	5.6	0.0	2.5	6.4	0.0	0.9
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.6	0.0	0.0	0.6	0.0	0.0	0.5	0.0	3.7	0.4	0.0	1.7
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	21.8	0.0	0.0	19.7	0.0	0.0	29.1	0.0	9.6	30.2	0.0	7.0
LnGrp LOS	C	A	A	B	A	A	C	A	A	C	A	A
Approach Vol, veh/h		152			56			668			377	
Approach Delay, s/veh		21.8			19.7			10.8			8.7	
Approach LOS		C			B			B			A	
Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	6.1	32.8		11.2	6.6	32.3		11.2				
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5				
Max Green Setting (Gmax), s	5.1	28.3		18.1	6.0	27.4		18.1				
Max Q Clear Time (g_c+I1), s	2.7	13.1		6.5	3.1	7.2		3.5				
Green Ext Time (p_c), s	0.0	3.8		0.6	0.0	2.1		0.2				
Intersection Summary												
HCM 6th Ctrl Delay			11.9									
HCM 6th LOS			B									

HCM 6th Signalized Intersection Summary
7: Old Redwood Hwy & W Railroad Ave/E Railroad Ave

11/14/2023

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	51	25	39	16	53	22	41	279	3	26	662	105
Future Volume (veh/h)	51	25	39	16	53	22	41	279	3	26	662	105
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	51	25	39	16	53	22	41	279	3	26	662	105
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	160	47	58	98	117	44	75	1146	12	53	958	152
Arrive On Green	0.10	0.10	0.10	0.10	0.10	0.10	0.04	0.62	0.62	0.03	0.61	0.61
Sat Flow, veh/h	631	457	558	201	1138	427	1781	1847	20	1781	1575	250
Grp Volume(v), veh/h	115	0	0	91	0	0	41	0	282	26	0	767
Grp Sat Flow(s),veh/h/ln	1646	0	0	1766	0	0	1781	0	1867	1781	0	1825
Q Serve(g_s), s	0.9	0.0	0.0	0.0	0.0	0.0	1.2	0.0	3.7	0.8	0.0	15.6
Cycle Q Clear(g_c), s	3.5	0.0	0.0	2.6	0.0	0.0	1.2	0.0	3.7	0.8	0.0	15.6
Prop In Lane	0.44		0.34	0.18		0.24	1.00		0.01	1.00		0.14
Lane Grp Cap(c), veh/h	265	0	0	259	0	0	75	0	1158	53	0	1110
V/C Ratio(X)	0.43	0.00	0.00	0.35	0.00	0.00	0.54	0.00	0.24	0.49	0.00	0.69
Avail Cap(c_a), veh/h	606	0	0	641	0	0	166	0	1158	176	0	1110
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	23.5	0.0	0.0	23.2	0.0	0.0	25.7	0.0	4.6	26.2	0.0	7.3
Incr Delay (d2), s/veh	1.1	0.0	0.0	0.8	0.0	0.0	6.0	0.0	0.5	6.8	0.0	3.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.4	0.0	0.0	1.1	0.0	0.0	0.6	0.0	1.1	0.4	0.0	5.2
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	24.7	0.0	0.0	24.0	0.0	0.0	31.7	0.0	5.1	33.0	0.0	10.8
LnGrp LOS	C	A	A	C	A	A	C	A	A	C	A	B
Approach Vol, veh/h		115			91			323			793	
Approach Delay, s/veh		24.7			24.0			8.5			11.5	
Approach LOS		C			C			A			B	

Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	6.1	38.5		10.2	6.8	37.8		10.2				
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5				
Max Green Setting (Gmax), s	5.4	33.0		18.1	5.1	33.3		18.1				
Max Q Clear Time (g_c+I1), s	2.8	5.7		5.5	3.2	17.6		4.6				
Green Ext Time (p_c), s	0.0	1.7		0.4	0.0	5.1		0.3				

Intersection Summary	
HCM 6th Ctrl Delay	12.8
HCM 6th LOS	B

HCM 6th Signalized Intersection Summary
7: Old Redwood Hwy & W Railroad Ave/E Railroad Ave

11/14/2023

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	126	66	81	9	33	32	56	700	14	33	352	57
Future Volume (veh/h)	126	66	81	9	33	32	56	700	14	33	352	57
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	126	66	81	9	33	32	56	700	14	33	352	57
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	231	99	100	90	194	161	93	926	19	64	771	125
Arrive On Green	0.22	0.22	0.22	0.22	0.22	0.22	0.05	0.51	0.51	0.04	0.49	0.49
Sat Flow, veh/h	634	461	462	81	902	749	1781	1827	37	1781	1570	254
Grp Volume(v), veh/h	273	0	0	74	0	0	56	0	714	33	0	409
Grp Sat Flow(s),veh/h/ln	1557	0	0	1732	0	0	1781	0	1864	1781	0	1825
Q Serve(g_s), s	7.3	0.0	0.0	0.0	0.0	0.0	1.7	0.0	17.1	1.0	0.0	8.2
Cycle Q Clear(g_c), s	9.2	0.0	0.0	2.0	0.0	0.0	1.7	0.0	17.1	1.0	0.0	8.2
Prop In Lane	0.46		0.30	0.12		0.43	1.00		0.02	1.00		0.14
Lane Grp Cap(c), veh/h	430	0	0	446	0	0	93	0	945	64	0	895
V/C Ratio(X)	0.64	0.00	0.00	0.17	0.00	0.00	0.60	0.00	0.76	0.52	0.00	0.46
Avail Cap(c_a), veh/h	594	0	0	624	0	0	204	0	945	163	0	895
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	20.7	0.0	0.0	17.9	0.0	0.0	25.9	0.0	11.0	26.4	0.0	9.3
Incr Delay (d2), s/veh	1.6	0.0	0.0	0.2	0.0	0.0	6.2	0.0	5.6	6.3	0.0	1.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.3	0.0	0.0	0.7	0.0	0.0	0.8	0.0	7.0	0.5	0.0	3.1
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	22.2	0.0	0.0	18.1	0.0	0.0	32.1	0.0	16.6	32.8	0.0	11.0
LnGrp LOS	C	A	A	B	A	A	C	A	B	C	A	B
Approach Vol, veh/h		273			74			770			442	
Approach Delay, s/veh		22.2			18.1			17.7			12.6	
Approach LOS		C			B			B			B	

Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	6.5	32.8		16.5	7.4	31.9		16.5				
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5				
Max Green Setting (Gmax), s	5.1	28.3		18.1	6.4	27.0		18.1				
Max Q Clear Time (g_c+I1), s	3.0	19.1		11.2	3.7	10.2		4.0				
Green Ext Time (p_c), s	0.0	3.4		0.9	0.0	2.3		0.2				

Intersection Summary	
HCM 6th Ctrl Delay	17.1
HCM 6th LOS	B

Intersection	
Intersection Delay, s/veh	7.1
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	104	80	308	633
Demand Flow Rate, veh/h	106	81	314	645
Vehicles Circulating, veh/h	609	353	85	93
Vehicles Exiting, veh/h	129	46	630	341
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	6.5	4.5	5.1	8.5
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	106	81	314	645
Cap Entry Lane, veh/h	741	963	1265	1255
Entry HV Adj Factor	0.977	0.989	0.979	0.981
Flow Entry, veh/h	104	80	308	633
Cap Entry, veh/h	724	952	1239	1231
V/C Ratio	0.143	0.084	0.248	0.514
Control Delay, s/veh	6.5	4.5	5.1	8.5
LOS	A	A	A	A
95th %tile Queue, veh	0	0	1	3

Intersection	
Intersection Delay, s/veh	7.8
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	152	56	668	377
Demand Flow Rate, veh/h	155	57	681	385
Vehicles Circulating, veh/h	359	733	132	70
Vehicles Exiting, veh/h	96	80	382	720
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	5.4	6.6	9.7	5.6
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	155	57	681	385
Cap Entry Lane, veh/h	957	653	1206	1285
Entry HV Adj Factor	0.982	0.975	0.980	0.978
Flow Entry, veh/h	152	56	668	377
Cap Entry, veh/h	940	637	1182	1257
V/C Ratio	0.162	0.087	0.565	0.300
Control Delay, s/veh	5.4	6.6	9.7	5.6
LOS	A	A	A	A
95th %tile Queue, veh	1	0	4	1

Intersection	
Intersection Delay, s/veh	9.4
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	115	91	323	793
Demand Flow Rate, veh/h	118	92	330	809
Vehicles Circulating, veh/h	718	379	104	112
Vehicles Exiting, veh/h	203	55	731	359
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	7.6	4.8	5.4	11.8
Approach LOS	A	A	A	B

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	118	92	330	809
Cap Entry Lane, veh/h	663	937	1241	1231
Entry HV Adj Factor	0.979	0.988	0.980	0.980
Flow Entry, veh/h	115	91	323	793
Cap Entry, veh/h	649	927	1216	1206
V/C Ratio	0.178	0.098	0.266	0.657
Control Delay, s/veh	7.6	4.8	5.4	11.8
LOS	A	A	A	B
95th %tile Queue, veh	1	0	1	5

Intersection	
Intersection Delay, s/veh	10.9
Intersection LOS	B

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	273	74	770	442
Demand Flow Rate, veh/h	279	76	785	451
Vehicles Circulating, veh/h	402	900	230	100
Vehicles Exiting, veh/h	149	115	451	876
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	7.3	8.4	15.1	6.4
Approach LOS	A	A	C	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	279	76	785	451
Cap Entry Lane, veh/h	916	551	1091	1246
Entry HV Adj Factor	0.977	0.978	0.981	0.980
Flow Entry, veh/h	273	74	770	442
Cap Entry, veh/h	895	539	1070	1221
V/C Ratio	0.305	0.138	0.719	0.362
Control Delay, s/veh	7.3	8.4	15.1	6.4
LOS	A	A	C	A
95th %tile Queue, veh	1	0	7	2

Old Redwood Highway N/Railroad Avenue Preliminary Construction Cost Summary							
		Signal			Roundabout		
Item	**Unit**	**Unit Cost**	**Quantity**	**Total Cost**	**Unit Cost**	**Quantity**	**Total Cost**
R/W Acquisition	SF	$ 30.00	100	$ 3,000.00	$ 30.00	6360	$ 190,800.00
Environmental Impact Mitigation	SF	$ 100.00	0	$ -	$ 100.00	1650	$ 165,000.00
Environmental Consulting	LS	$ 61,000.00	1	$ 61,000.00	$ 61,000.00	1	$ 61,000.00
Roadway Excavation	LS	$ -	0	$ -	$ 67,000.00	1	$ 67,000.00
Road Widening	SF	$ 25.00	0	$ -	$ 25.00	7775	$ 194,375.00
Curb Installation	LF	$ 75.00	0	$ -	$ 75.00	475	$ 35,625.00
Minor Concrete, Medians/Sidewalks	SF	$ 20.00	0	$ -	$ 20.00	720	$ 14,400.00
Landscaping	SF	$ 10.00	0	$ -	$ 10.00	4770	$ 47,700.00
Truck Apron	SF	$ 40.00	0	$ -	$ 40.00	3400	$ 136,000.00
Guardrail Installation	LF	$ 50.00	0	$ -	$ 50.00	120	$ 6,000.00
Guardrail Removal	LF	$ 15.00	0	$ -	$ 15.00	120	$ 1,800.00
Culvert Repair/Replacement	LF	$ 300.00	200	$ 60,000.00	$ 300.00	200	$ 60,000.00
Tree Removal	EA	$ 1,500.00	1	$ 1,500.00	$ 1,500.00	20	$ 30,000.00
Fence Removal	LF	$ 15.00	0	$ -	$ 15.00	330	$ 4,950.00
Sign Removal	EA	$ 200.00	0	$ -	$ 200.00	10	$ 2,000.00
Utility Pole Relocation	EA	$ 10,000.00	0	$ -	$ 10,000.00	8	$ 80,000.00
Signalization	LS	$ 550,000.00	1	$ 550,000.00	$ -	0	$ -
Roadway Striping	LS	$ 5,000.00	1	$ 5,000.00	$ 10,000.00	1	$ 10,000.00
Signage	LS	$ 5,000.00	1	$ 5,000.00	$ 5,000.00	1	$ 5,000.00
Street Lighting	LS	$ 150,000.00	1	$ 150,000.00	$ 150,000.00	1	$ 150,000.00

Contingency:	**30%**		
TOTAL CONSTRUCTION COST PER ALTERNATIVE		**$ 1,086,150.00**	**$ 1,640,145.00**