Appendix D:
Traffic Memorandum

TRAFFIC WORKS LLC
Traffic Engineering & Transportation Planning

August 18, 2017

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Traffic Analysis for E. 20th Street At-Grade Crossing Alternatives - Chico Bikeway Phase 5

Dear Mr. Burns,

This report summarizes the traffic analysis and recommendations for three at-grade alternatives for the crossing of the SR99 Corridor Bikeway Facility at E. 20th Street in Chico, CA. The analysis focuses on the changes in traffic operations caused by each of the following alternatives:

- ***Alternative A – Existing Crossings at Village Center/ Chico Mall***
  Alternative A uses the existing crosswalks located at the signalized intersection of E. 20th Street and Village Center/ Chico Mall, as shown in **Attachment A**. These crosswalks extend across the north, east, and south legs of the intersection. Because no changes occur to the intersection's existing configuration, the operations for this alternative will be considered the base condition for this intersection.

- ***Alternative B – Additional West Leg Crossing at Village Center/ Chico Mall***
  Alternative B, also shown in **Attachment A**, provides an additional crosswalk on the west leg of the E. 20th Street and Village Center/ Chico Mall intersection. This crossing would add an additional pedestrian phase to the traffic signal.

- ***Alternative C – East Leg Crossing at SR 99 Northbound Ramps***
  Alternative C implements a new crosswalk on the east leg the signalized intersection of the SR 99 northbound ramps and E. 20th Street. This crossing would be signalized, and add an additional pedestrian phase to the traffic signal. Alternative C is shown in **Attachment B**.

ANALYSIS

Methodology

Synchro 9 traffic analysis software was used to perform operational analysis using Highway Capacity Manual 2000 calculation methods. Year 2035 projected traffic volumes were used for analysis as obtained from the City of Chico *East 20th Street Circulation Study,* dated October 2011. It should be noted that these volumes are higher projections that represent peak corridor traffic, such as might be experienced during the December holiday season. These volumes are shown in the Level of Service report sheets in **Attachment C.**

Level of Service

Level of service (LOS) is a term commonly used by transportation practitioners to measure and describe the operational characteristics of intersections, roadway segments, and other facilities. This term equates seconds of delay per vehicle at intersections to letter grades "A" through "F" with "A" representing optimum conditions and "F" representing breakdown or over capacity flows. **Table 1** shows the connection between intersection operations and level of service designations.

Level of service calculations were performed for the study intersections using the Synchro 9.0 software package with analysis and results reported in accordance with the HCM methodologies.

Table 1: Level of Service Definition for Intersections

Level of Service	Brief Description	Un-signalized Intersections (average delay/vehicle in seconds)	Signalized Intersections (average delay/vehicle in seconds)
A	Free flow conditions.	< 10	< 10
B	Stable conditions with some affect from other vehicles.	10 to 15	10 to 20
C	Stable conditions with significant affect from other vehicles.	15 to 25	20 to 35
D	High density traffic conditions still with stable flow.	25 to 35	35 to 55
E	At or near capacity flows.	35 to 50	55 to 80
F	Over capacity conditions.	> 50	> 80

Source: Highway Capacity Manual (2010), Chapters 16 and 17

Acceptable levels of service (LOS) for intersections are designated by the facility's owning agency. For the intersection of East 20th Street and Chico Mall/ Village Center, operated by the City of Chico, the maximum acceptable intersection LOS is "E". The intersection of East 20th Street and SR99 Northbound Ramps is maintained by Caltrans, which aims for a target Level of Service at the transition between LOS C and D. If the existing conditions operate worse than the target LOS, impacts to the intersection are considered acceptable only if they maintain the pre-project level of service.

Results

E. 20th Street and Village Center/ Chico Mall

The results from the traffic analysis for the intersection of E. 20th Street and Village Center/Chico Mall are summarized in **Table 2**. With the addition of the crossing on the west leg of the intersection, overall intersection delay is increased to 70.9 seconds, creating no change in LOS. The most impacted movement is the westbound through movement with an average of 13.3 seconds of increased delay per vehicle. Changes in individual movement delay are shown in **Attachment D**.

Table 2. Operations Results for 20th Street & Chico Mall/Village Center

E. 20th Street & Chico Mall/Village Center – Intersection Total		
Scenario	**Overall Delay (seconds)**	**Intersection Level of Service**
Without West Leg Crossing	65.0	E
With West Leg Crossing	70.9	E
Difference	+5.9	None

With the addition of the west leg crossing, queue lengths increase slightly, more so for the movements with the highest traffic volumes. The southbound movements are an exception to this, as these movements benefit from the longer green time resulting from the added pedestrian clearance time. Approximate 95th percentile queue lengths are shown in **Table 3**.

Table 3. Approximate 95th Percentile Queue Lengths for 20th Street & Chico Mall/Village Center

E. 20th St. & Chico Mall/Village Center								
	EBL	**EBT**	**WBL**	**WBT**	**NBL**	**NBT**	**SBT/L**	**SBR**
	Queue (ft)	Queue (ft)	Queue (ft)	Queue (ft)	Queue (ft)	Queue (ft)	Queue (ft)	Queue (ft)
Without West Leg Crossing	320	726	144	882	283	269	200	63
With West Leg Crossing	329	745	147	903	289	276	199	63
Difference	+9	+19	+3	+21	+6	+7	-1	0

Additional Findings

A west leg crossing at E. 20th St & Chico Mall/Village Center intersection **should be dismissed from further consideration** due to a hazardous "double threat" situation created by dual permissive southbound right turns conflicting with the crosswalk. A double threat situation occurs when a vehicle in one of the conflicting lanes blocks the view of the pedestrian from the vehicle in the second lane. Changing the lane configuration on the southbound approach to a single right turn lane, a thru lane, and a left turn lane would eliminate this double threat, but would cause increased delays and queueing for the high volume southbound right turn movement. This change is not recommended.

A graphic summary of the key findings for the intersection of E. 20th Street and Chico Mall/ Village Center is provided in **Attachment E**.

E. 20th Street and SR99 Northbound Ramps

The results of the operational analysis performed for the intersection of E. 20th Street and the SR99 northbound ramps is summarized in **Table 4**. The addition of the crossing on the east leg of E. 20th Street increases the overall intersection delay to 46 seconds, creating no change in overall level of service. The most impacted movement is the westbound thru movement with 13.6 seconds of increased average delay per vehicle. Changes in individual movement delay are shown in **Attachment D**.

The addition of the pedestrian crossing to the east leg of the intersection does not cause negative impacts for the SR99 Northbound off-ramp. The increased green time added due to the pedestrian clearance time actually reduces overall delay for this approach by 7.1 seconds.

Table 4. Results for 20th Street & SR99 Northbound Ramps

E. 20th Street & SR99 Northbound Ramps- Intersection Total		
Scenario	**Overall Delay (seconds)**	**Intersection Level of Service**
Without East Leg Crossing	44.7	D
With East Leg Crossing	46.4	D
Difference	+1.7	None

The added crosswalk would however impact eastbound through traffic by increasing queue lengths by approximately 326 feet, backing traffic into the adjacent intersection at the E. 20th St & SR99 Southbound ramps. Queue stacking in the full distance between the SR99 northbound and southbound ramp terminals, over 900 feet, is not an acceptable long-term alternative. Approximate 95th percentile queue lengths are shown in **Table 5**.

Table 5. Approximate 95th Percentile Queue Lengths for 20th Street & SR99 Northbound Ramps

E. 20th St. & SR99 Northbound Ramps							
	EBL	**EBT**	**WBT**	**WBR**	**NBL**	**NBT**	**NBR**
	Queue (ft)	Queue (ft)	Queue (ft)	Queue (ft)	Queue (ft)	Queue (ft)	Queue (ft)
Without East Leg Crossing	205	582	255	924	68	69	179
With East Leg Crossing	263	908	313	934	67	68	180
Difference	+58	**+326**	+58	+10	-1	-1	+1

Additional Findings

The addition of a crosswalk on the east leg of 20th Street would remove about 15 feet of storage length available to westbound traffic. Projected 95th percentile queue lengths for westbound right turn traffic already exceed the available storage, even without the additional east leg crossing. The addition of this crossing would further reduce storage capacity, potentially exacerbating queuing issues in the westbound direction as well.

A graphic summary of the key findings for intersection of E. 20th Street and SR99 is provided in **Attachment F**.

CONCLUSIONS

Alternative A – Existing Crossings at Village Center/ Chico Mall

This crossing location is significantly out of direction from a bikeway running adjacent to SR99. Bicyclists and pedestrians cannot be expected to circumnavigate an entire intersection, making three (3) crosswalk movements at a distant signalized intersection as part of a bikeway. In reality, many users would very likely make an illegal and dangerous crossing movement of E. 20th Street further west (nearer SR99) instead. This is not an effective alternative nor one that promotes user safety.

Alternative B – Additional West Leg Crossing at Village Center/ Chico Mall

A west leg crossing at E. 20th St & Chico Mall/Village Center intersection should be dismissed from further consideration due to a hazardous "double threat" situation to pedestrians and cyclists created by dual permissive southbound right turns conflicting with the contemplated crosswalk.

Alternative C – East Leg Crossing at SR 99 Northbound Ramps

The addition of an east leg crossing at the SR99 Northbound ramps would impact eastbound through traffic by increasing queue lengths by approximately 326 feet, backing traffic into the adjacent intersection at the E. 20th St & SR99 Southbound ramps. Queue stacking in the full

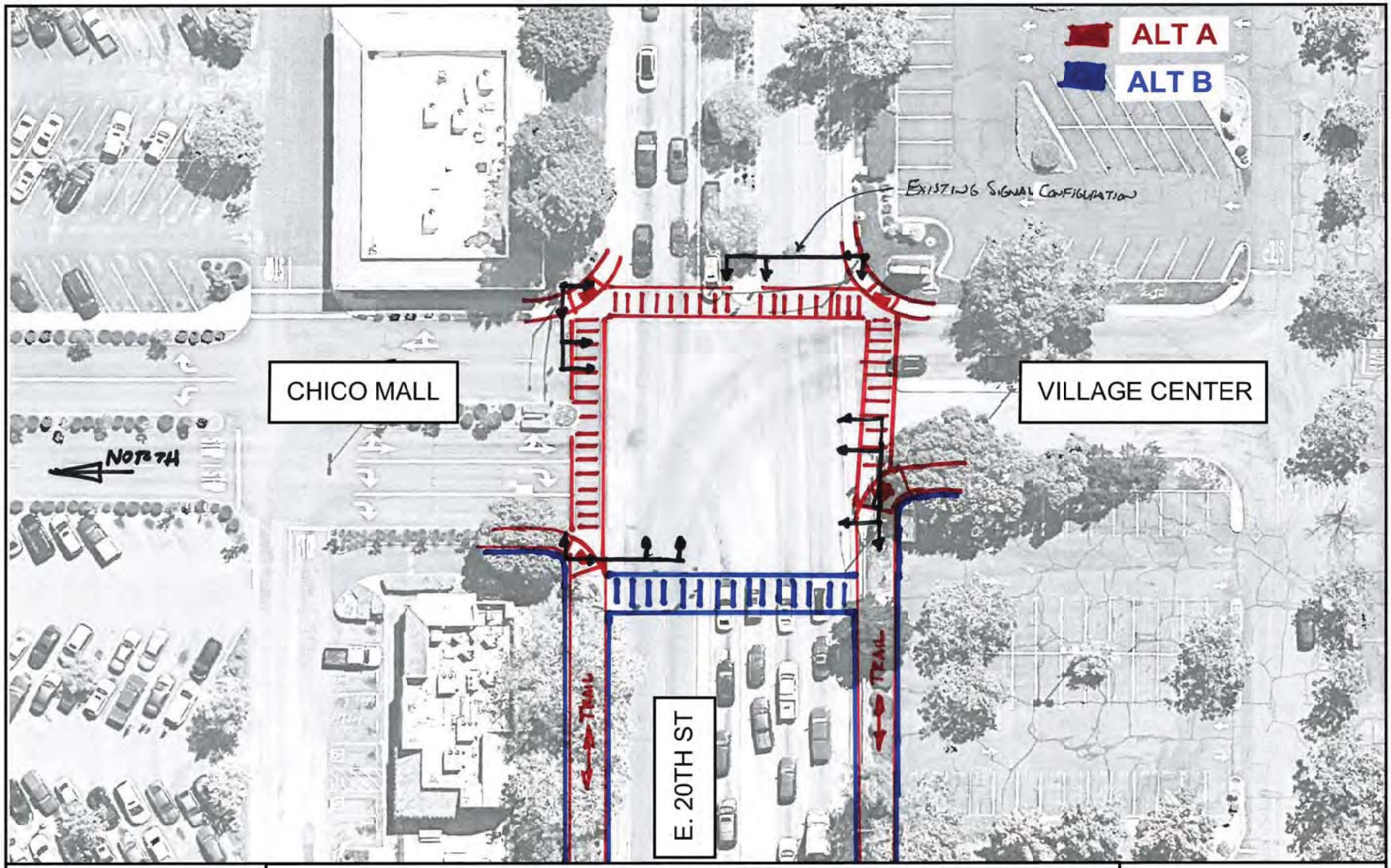
distance between the SR99 northbound and southbound ramp terminals, over 900 feet, is not an acceptable long-term alternative. The addition of this crossing would further reduce storage capacity on the westbound approach, potentially exacerbating queuing issues in the westbound direction as well.

Please do not hesitate to contact us at (775) 322-4300 with any questions.

Sincerely,
TRAFFIC WORKS, LLC

Loren E. Chilson, PE
Principal

Attachments:
A. Crossing Alternatives A & B
B. Crossing Alternative C
C. Level of Service and Queue Length Reports
D. Level of Service and Delay by Movement
E. 20th Street & Chico Mall/Village Center Key Findings
F. 20th Street & SR99 Northbound Ramps Key Findings



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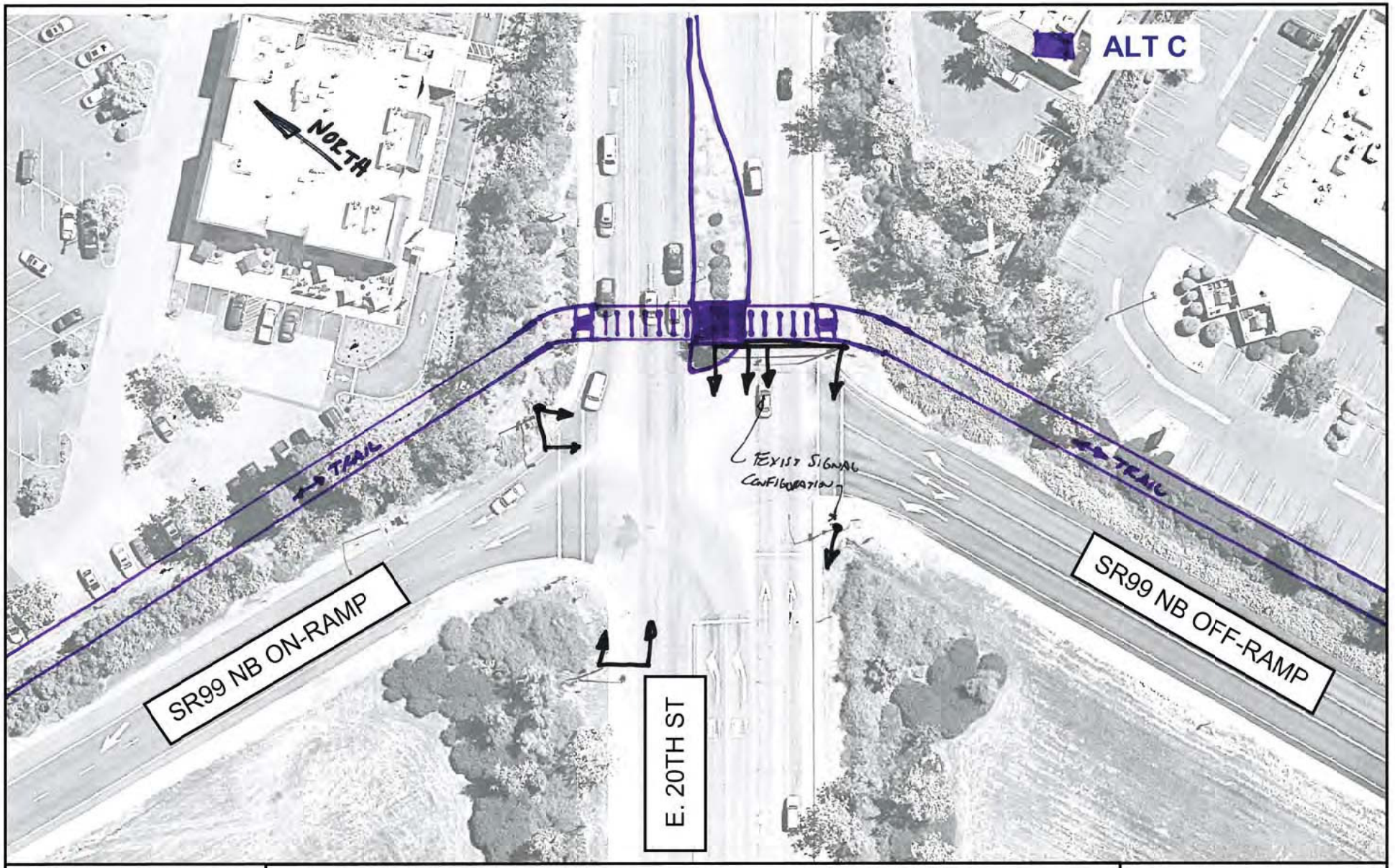
At-Grade Crossing Alternatives A & B

Chico Bikeway Phase 5

Traffic Analysis for At-Grade Crossing Alternatives

Attachment A



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At-Grade Crossing Alternative C

Chico Bikeway Phase 5

Traffic Analysis for At-Grade Crossing Alternatives

Attachment B

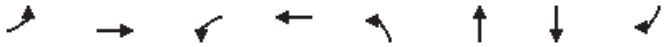
Attachment C

Level of Service and Queue Length Reports

Chico Bikeway Phase 5
Traffic Analysis for At-Grade Crossing Alternatives

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	529	1071	171	120	1319	70	425	52	65	131	53	400
Future Volume (vph)	529	1071	171	120	1319	70	425	52	65	131	53	400
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	12	12	11	11	11	12	12	12
Total Lost time (s)	4.0	4.1		3.5	4.1		4.1	4.1			4.0	4.0
Lane Util. Factor	0.97	0.95		1.00	0.95		0.95	0.95			1.00	0.88
Frt	1.00	0.98		1.00	0.99		1.00	0.96			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	0.97			0.97	1.00
Satd. Flow (prot)	3433	3466		1770	3512		1625	1603			1799	2787
Flt Permitted	0.95	1.00		0.95	1.00		0.95	0.97			0.97	1.00
Satd. Flow (perm)	3433	3466		1770	3512		1625	1603			1799	2787
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	529	1071	171	120	1319	70	425	52	65	131	53	400
RTOR Reduction (vph)	0	9	0	0	3	0	0	11	0	0	0	304
Lane Group Flow (vph)	529	1233	0	120	1386	0	272	259	0	0	184	96
Turn Type	Prot	NA		Prot	NA		Split	NA		Split	NA	Perm
Protected Phases	5	2		1	6		8	8		4	4	
Permitted Phases												4
Actuated Green, G (s)	17.0	46.8		11.6	40.9		23.3	23.3			15.8	15.8
Effective Green, g (s)	17.0	46.8		11.6	40.9		23.3	23.3			15.8	15.8
Actuated g/C Ratio	0.15	0.41		0.10	0.36		0.21	0.21			0.14	0.14
Clearance Time (s)	4.0	4.1		3.5	4.1		4.1	4.1			4.0	4.0
Vehicle Extension (s)	2.0	2.5		2.0	2.0		2.0	2.0			2.0	2.0
Lane Grp Cap (vph)	515	1432		181	1268		334	329			251	388
v/s Ratio Prot	c0.15	0.36		0.07	c0.39		c0.17	0.16			c0.10	
v/s Ratio Perm												0.03
v/c Ratio	1.03	0.86		0.66	1.09		0.81	0.79			0.73	0.25
Uniform Delay, d1	48.1	30.2		48.9	36.2		42.9	42.6			46.7	43.4
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	1.00
Incremental Delay, d2	46.8	7.0		6.9	54.6		13.4	10.9			9.2	0.1
Delay (s)	94.9	37.2		55.8	90.7		56.3	53.5			55.8	43.5
Level of Service	F	D		E	F		E	D			E	D
Approach Delay (s)		54.4			88.0			54.9			47.4	
Approach LOS		D			F			D			D	

Intersection Summary			
HCM 2000 Control Delay	65.0	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.96		
Actuated Cycle Length (s)	113.2	Sum of lost time (s)	16.2
Intersection Capacity Utilization	85.7%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBT	SBR
Lane Group Flow (vph)	529	1242	120	1389	272	270	184	400
v/c Ratio	1.03	0.86	0.66	1.09	0.81	0.79	0.73	0.58
Control Delay	94.3	39.8	66.0	90.6	61.3	56.6	63.3	10.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	94.3	39.8	66.0	90.6	61.3	56.6	63.3	10.6
Queue Length 50th (ft)	~212	436	85	~624	198	186	129	17
Queue Length 95th (ft)	#320	#726	144	#882	283	269	200	63
Internal Link Dist (ft)		570		1022		112	64	
Turn Bay Length (ft)	380		250		115			80
Base Capacity (vph)	515	1440	234	1269	430	435	317	783
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	1.03	0.86	0.51	1.09	0.63	0.62	0.58	0.51

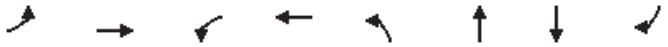
Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	529	1071	171	120	1319	70	425	52	65	131	53	400
Future Volume (vph)	529	1071	171	120	1319	70	425	52	65	131	53	400
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	12	12	11	11	11	12	12	12
Total Lost time (s)	4.0	4.1		3.5	4.1		4.1	4.1			4.0	4.0
Lane Util. Factor	0.97	0.95		1.00	0.95		0.95	0.95			1.00	0.88
Frt	1.00	0.98		1.00	0.99		1.00	0.96			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	0.97			0.97	1.00
Satd. Flow (prot)	3433	3466		1770	3512		1625	1603			1799	2787
Flt Permitted	0.95	1.00		0.95	1.00		0.95	0.97			0.97	1.00
Satd. Flow (perm)	3433	3466		1770	3512		1625	1603			1799	2787
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	529	1071	171	120	1319	70	425	52	65	131	53	400
RTOR Reduction (vph)	0	9	0	0	3	0	0	10	0	0	0	298
Lane Group Flow (vph)	529	1233	0	120	1386	0	272	260	0	0	184	102
Turn Type	Prot	NA		Prot	NA		Split	NA		Split	NA	Perm
Protected Phases	5	2		1	6		8	8		4	4	
Permitted Phases												4
Actuated Green, G (s)	17.0	46.3		11.7	40.5		23.6	23.6			17.9	17.9
Effective Green, g (s)	17.0	46.3		11.7	40.5		23.6	23.6			17.9	17.9
Actuated g/C Ratio	0.15	0.40		0.10	0.35		0.20	0.20			0.16	0.16
Clearance Time (s)	4.0	4.1		3.5	4.1		4.1	4.1			4.0	4.0
Vehicle Extension (s)	2.0	2.5		2.0	2.0		2.0	2.0			2.0	2.0
Lane Grp Cap (vph)	506	1393		179	1234		332	328			279	433
v/s Ratio Prot	c0.15	0.36		0.07	c0.39		c0.17	0.16			c0.10	
v/s Ratio Perm												0.04
v/c Ratio	1.05	0.89		0.67	1.12		0.82	0.79			0.66	0.24
Uniform Delay, d1	49.1	32.0		49.9	37.4		43.8	43.5			45.8	42.6
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	1.00
Incremental Delay, d2	52.4	8.5		7.5	66.6		13.8	11.5			4.3	0.1
Delay (s)	101.5	40.5		57.4	104.0		57.6	55.0			50.0	42.8
Level of Service	F	D		E	F		E	D			D	D
Approach Delay (s)		58.7			100.3			56.3			45.0	
Approach LOS		E			F			E			D	

Intersection Summary			
HCM 2000 Control Delay	70.9	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	115.2	Sum of lost time (s)	16.2
Intersection Capacity Utilization	85.7%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBT	SBR
Lane Group Flow (vph)	529	1242	120	1389	272	270	184	400
v/c Ratio	1.05	0.89	0.67	1.12	0.82	0.80	0.66	0.55
Control Delay	100.1	43.0	67.4	102.1	62.9	58.4	56.5	9.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	100.1	43.0	67.4	102.1	62.9	58.4	56.5	9.8
Queue Length 50th (ft)	~219	~478	87	~691	202	190	124	16
Queue Length 95th (ft)	#329	#745	147	#903	289	276	199	63
Internal Link Dist (ft)		570		1022		112	64	
Turn Bay Length (ft)	380		250		115			80
Base Capacity (vph)	506	1402	230	1237	423	427	343	817
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	1.05	0.89	0.52	1.12	0.64	0.63	0.54	0.49

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	533	2188	0	0	926	1218	124	5	250	0	0	0
Future Volume (vph)	533	2188	0	0	926	1218	124	5	250	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.5	5.0			5.0	5.0	4.1	4.1	4.1			
Lane Util. Factor	0.97	0.95			0.95	1.00	0.95	0.95	1.00			
Frpb, ped/bikes	1.00	1.00			1.00	0.97	1.00	1.00	1.00			
Flpb, ped/bikes	1.00	1.00			1.00	1.00	1.00	1.00	1.00			
Frt	1.00	1.00			1.00	0.85	1.00	1.00	0.85			
Flt Protected	0.95	1.00			1.00	1.00	0.95	0.96	1.00			
Satd. Flow (prot)	3433	3539			3539	1539	1681	1692	1583			
Flt Permitted	0.95	1.00			1.00	1.00	0.95	0.96	1.00			
Satd. Flow (perm)	3433	3539			3539	1539	1681	1692	1583			
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	533	2188	0	0	926	1218	124	5	250	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	266	0	0	56	0	0	0
Lane Group Flow (vph)	533	2188	0	0	926	952	64	65	194	0	0	0
Confl. Peds. (#/hr)	15					15						
Turn Type	Prot	NA			NA	Perm	Split	NA	Perm			
Protected Phases	5	2			6		8	8				
Permitted Phases						6			8			
Actuated Green, G (s)	16.7	65.8			45.6	45.6	14.2	14.2	14.2			
Effective Green, g (s)	16.7	65.8			45.6	45.6	14.2	14.2	14.2			
Actuated g/C Ratio	0.19	0.74			0.51	0.51	0.16	0.16	0.16			
Clearance Time (s)	3.5	5.0			5.0	5.0	4.1	4.1	4.1			
Vehicle Extension (s)	2.0	1.0			1.0	1.0	2.0	2.0	2.0			
Lane Grp Cap (vph)	643	2613			1811	787	267	269	252			
v/s Ratio Prot	0.16	c0.62			0.26		0.04	0.04				
v/s Ratio Perm						c0.62			c0.12			
v/c Ratio	0.83	0.84			0.51	1.21	0.24	0.24	0.77			
Uniform Delay, d1	34.8	8.0			14.4	21.7	32.7	32.7	35.9			
Progression Factor	1.00	1.00			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2	8.3	3.4			1.0	106.3	0.2	0.2	11.9			
Delay (s)	43.1	11.4			15.4	128.0	32.9	32.9	47.8			
Level of Service	D	B			B	F	C	C	D			
Approach Delay (s)		17.6			79.4			42.7			0.0	
Approach LOS		B			E			D			A	

Intersection Summary			
HCM 2000 Control Delay	44.7	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.06		
Actuated Cycle Length (s)	89.1	Sum of lost time (s)	12.6
Intersection Capacity Utilization	106.6%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBT	WBT	WBR	NBL	NBT	NBR
Lane Group Flow (vph)	533	2188	926	1218	64	65	250
v/c Ratio	0.83	0.84	0.51	1.16	0.24	0.24	0.81
Control Delay	46.6	13.0	16.7	97.4	33.2	33.3	46.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	46.6	13.0	16.7	97.4	33.2	33.3	46.3
Queue Length 50th (ft)	146	381	182	~665	32	33	99
Queue Length 95th (ft)	#205	582	255	#924	68	69	#179
Internal Link Dist (ft)		949	570			1245	
Turn Bay Length (ft)	250			200	520		520
Base Capacity (vph)	693	2614	1810	1053	339	341	373
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.77	0.84	0.51	1.16	0.19	0.19	0.67

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	533	2188	0	0	926	1218	124	5	250	0	0	0
Future Volume (vph)	533	2188	0	0	926	1218	124	5	250	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.5	5.0			5.0	5.0	4.1	4.1	4.1			
Lane Util. Factor	0.97	0.95			0.95	1.00	0.95	0.95	1.00			
Frpb, ped/bikes	1.00	1.00			1.00	0.97	1.00	1.00	1.00			
Flpb, ped/bikes	1.00	1.00			1.00	1.00	1.00	1.00	1.00			
Frt	1.00	1.00			1.00	0.85	1.00	1.00	0.85			
Flt Protected	0.95	1.00			1.00	1.00	0.95	0.96	1.00			
Satd. Flow (prot)	3433	3539			3539	1536	1681	1692	1583			
Flt Permitted	0.95	1.00			1.00	1.00	0.95	0.96	1.00			
Satd. Flow (perm)	3433	3539			3539	1536	1681	1692	1583			
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.92
Adj. Flow (vph)	533	2188	0	0	926	1218	124	5	250	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	347	0	0	46	0	0	0
Lane Group Flow (vph)	533	2188	0	0	926	871	64	65	204	0	0	0
Confl. Peds. (#/hr)	15					15						
Turn Type	Prot	NA			NA	Perm	Split	NA	Perm			
Protected Phases	5	2			6		8	8				
Permitted Phases						6			8			
Actuated Green, G (s)	17.5	70.0			49.0	49.0	22.0	22.0	22.0			
Effective Green, g (s)	17.5	70.0			49.0	49.0	22.0	22.0	22.0			
Actuated g/C Ratio	0.17	0.69			0.48	0.48	0.22	0.22	0.22			
Clearance Time (s)	3.5	5.0			5.0	5.0	4.1	4.1	4.1			
Vehicle Extension (s)	2.0	1.0			1.0	1.0	2.0	2.0	2.0			
Lane Grp Cap (vph)	594	2450			1715	744	365	368	344			
v/s Ratio Prot	0.16	c0.62			0.26		0.04	0.04				
v/s Ratio Perm						c0.57			c0.13			
v/c Ratio	0.90	0.89			0.54	1.17	0.18	0.18	0.59			
Uniform Delay, d1	40.9	12.5			18.2	26.0	32.2	32.2	35.5			
Progression Factor	1.00	1.00			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2	15.8	5.5			1.2	90.7	0.1	0.1	1.8			
Delay (s)	56.7	18.0			19.4	116.7	32.3	32.3	37.3			
Level of Service	E	B			B	F	C	C	D			
Approach Delay (s)		25.6			74.7			35.6			0.0	
Approach LOS		C			E			D			A	

Intersection Summary			
HCM 2000 Control Delay	46.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	101.1	Sum of lost time (s)	12.6
Intersection Capacity Utilization	106.6%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBT	WBT	WBR	NBL	NBT	NBR
Lane Group Flow (vph)	533	2188	926	1218	64	65	250
v/c Ratio	0.90	0.89	0.54	1.12	0.18	0.18	0.64
Control Delay	60.0	21.2	21.5	79.8	29.9	29.9	33.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	60.0	21.2	21.5	79.8	29.9	29.9	33.4
Queue Length 50th (ft)	174	673	245	~676	32	32	101
Queue Length 95th (ft)	#263	#908	313	#934	67	68	180
Internal Link Dist (ft)		949	570			1245	
Turn Bay Length (ft)	250			200	520		520
Base Capacity (vph)	611	2451	1714	1091	498	502	511
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.87	0.89	0.54	1.12	0.13	0.13	0.49

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

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Level of Service and Delay by Movement

Chico Bikeway Phase 5

Traffic Analysis for At-Grade Crossing Alternatives

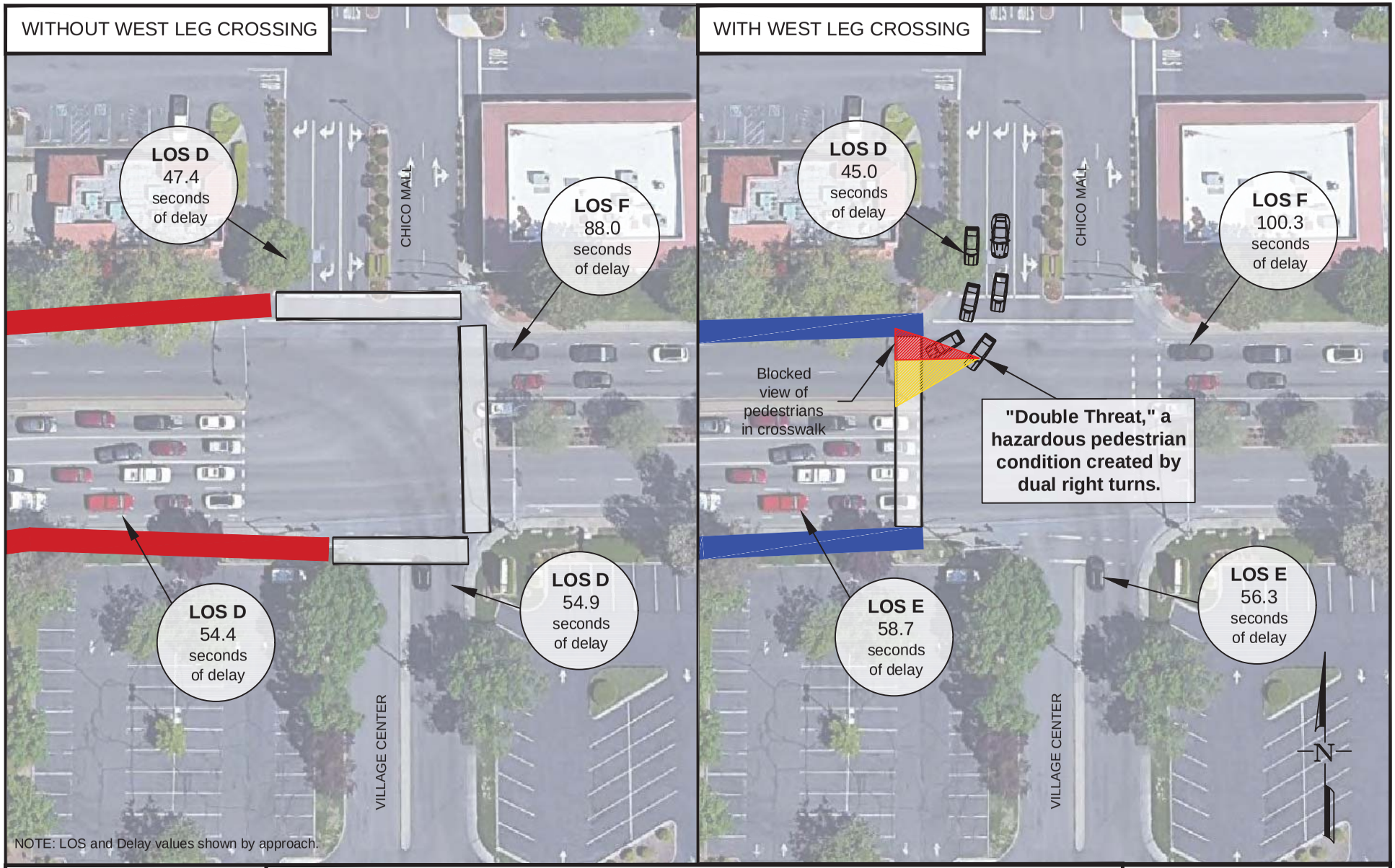
Attachment D

E. 20th St. & Chico Mall/Village Center																
	EBL		EBT		WBL		WBT		NBL		NBT		SBT/L		SBR	
	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS
Alternative A	94.9	F	37.2	D	55.8	E	90.7	F	56.3	E	53.5	D	55.8	E	43.5	D
Alternative B	101.5	F	40.5	D	57.4	E	104	F	57.6	E	55.0	D	50.0	D	42.8	D
Difference	6.6		3.3		1.6		13.3		1.3		1.5		-5.8		-0.7	

Based on HCM 2000 Methodologies

E. 20th St. & SR99 Northbound Ramps														
	EBL		EBT		WBT		WBR		NBL		NBT		NBR	
	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS
Alternative A	43.1	D	11.4	B	15.4	B	128.0	F	32.9	C	32.9	C	47.8	D
Alternative C	56.7	E	18.0	B	19.4	B	116.7	F	32.3	C	32.3	C	37.3	D
Difference	13.6		6.6		4.0		-11.3		-0.6		-0.6		-10.5	

Based on HCM 2000 Methodologies



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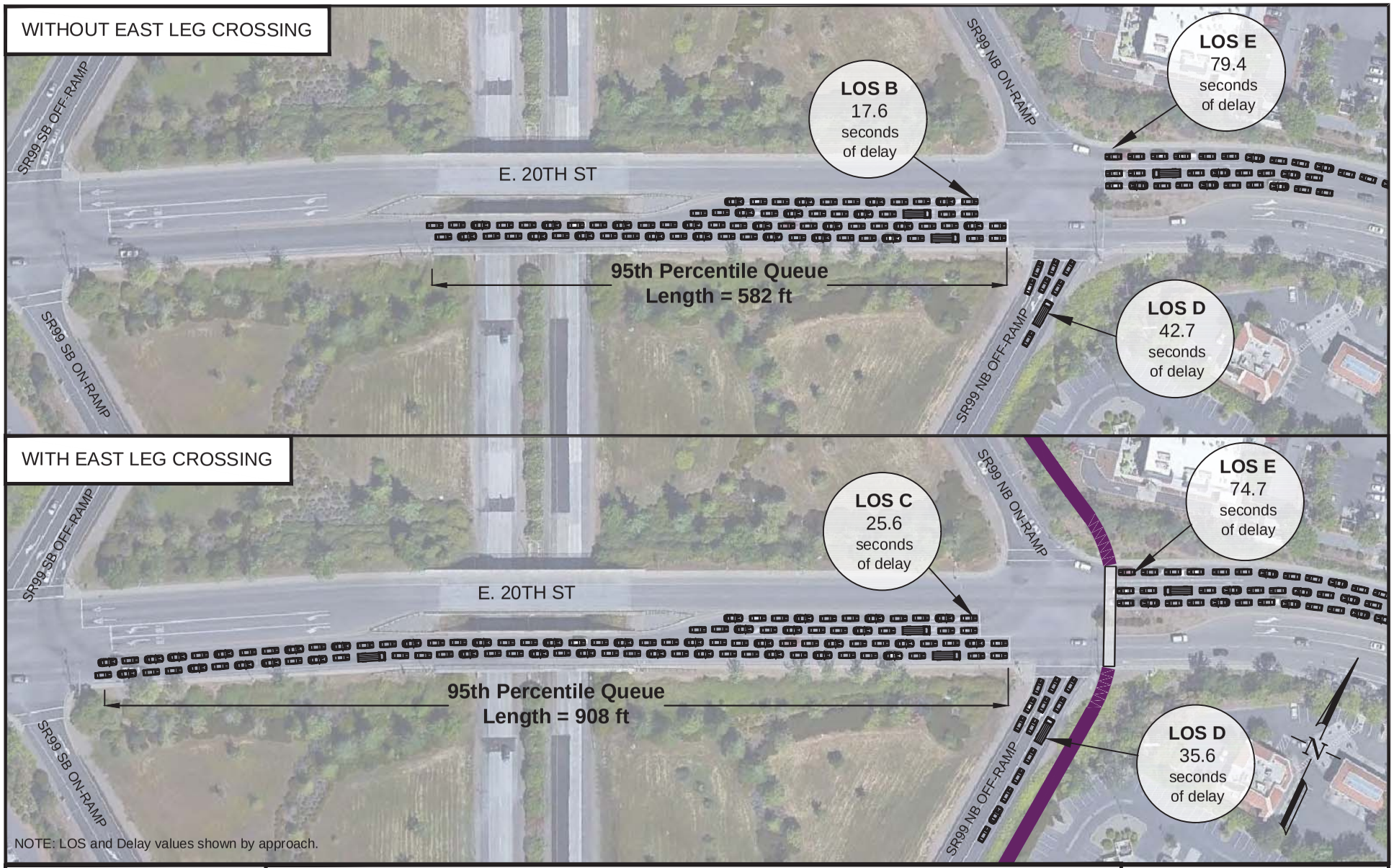
Key Findings: At-Grade Crossing Alternatives A & B

Chico Bikeway Phase 5

Traffic Analysis for At-Grade Crossing Alternatives

Attachment E



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Key Findings: At-Grade Crossing Alternative C

Chico Bikeway Phase 5

Traffic Analysis for At-Grade Crossing Alternatives

Attachment F