

Memorandum

Date: November 10, 2021
To: Lilith Vespier, City of Leavenworth
From: Kara Hall and Michael Adamson, Fehr & Peers
Subject: **Land Capacity Supplemental Analysis for the Comprehensive Plan Update**

SE20-0747

The City of Leavenworth is considering an update to the Comprehensive Plan Land Use Designations that would combine the current Residential Low Density 12,000 District (RL 12) and Residential Low Density 10,000 District (RL 10) and designate the districts as Residential Low Density 8,000 (RL 8).

To supplement this Comprehensive Plan update and address questions raised by the community regarding how changes in residential density might increase traffic congestion, a traffic analysis based on work completed for the Transportation Element (TE) update in 2020 has been completed.

The traffic analysis to supplement the zoning change to RL 8 was based on a land capacity analysis completed by the City and 2040 traffic forecasts developed for the TE update. Data from the land capacity analysis and 2040 traffic forecasts was used to develop new traffic forecasts that reflect the development potential within the City and regional growth expected to occur over the next 20 years. Updated traffic forecasts were then used to analyze how key intersections within the City will operate in 2040.

This memorandum includes a summary of the land capacity analysis completed by the City, which was used to estimate the number of new vehicle trips that might be generated during the weekday PM peak hour, defined as the hour with the highest traffic volumes between 4PM and 6PM, and the weekend peak hour, defined as the hour with the highest traffic volumes on a summer Sunday between 11AM and 3PM. This is followed by the changes in delay and Level of Service (LOS) at key intersections with the addition of new trips from the increase in housing.

Land Capacity Analysis

The City completed a land capacity analysis to understand the availability of land to accommodate the projected population over the next 20 years. The analysis was based on



existing and under-utilized parcels within the existing City limits. While the results of the analysis will be impacted by external influences such as fluctuating market factors, regional economy, and landowner choice, it provides a basis for the City to plan and prepare for future growth. This includes understanding the ability of the transportation system to accommodate this potential growth.

To estimate residential land capacity, net developable land within the City and Urban Growth Area (UGA), vacant and under-utilized land was identified based on information available from the County Assessor's office. A factor of 0.70 was applied to land within the City to account for right-of-way (ROW), market factors, and an environmental factor. Within the UGA a factor of 0.9 was applied. The net developable land was then multiplied by the maximum density in each land use designation to determine the potential number of residential units that may be added. The results of the City's analysis are shown in **Table 1**. As shown, it was assumed that 25% of new developments would include an accessory dwelling unit (ADU) based on changes to the City's ordinances to allow for a more streamlined process when constructing ADUs. The analysis found that a total of 1,330 new housing units could be constructed within the City and UGA.

Table 1. Land Capacity Analysis Summary

Zoning	Total Acres	ROW 10%	Market 50%	Environment 10%	Net Developable	Density ²	Potential Units
RL6 Vacant	45.21	4.52	22.61	4.52	13.56	7.26	98
RL6 Underutilized	155.43	15.54	77.72	15.54	46.63	7.26	339
MF Vacant	66.93	6.69	33.47	6.69	20.08	21.78	437
MF Underutilized	11.1	1.11	5.55	1.11	3.33	21.78	73
UGA ¹	Total Acres	ROW 20%	Market 50%	Environment 20%	Net Developable	Density ²	Potential Units
RL8 Vacant land	108.07	21.61	54.04	21.61	10.81	5.45	59
RL8 Underutilized	107.72	21.54	53.86	21.54	10.77	5.45	59
TOTAL:					105.18		1,064
Total with 25% ADUs:							1,330

¹Approximately ten acres within the City on undeveloped land

²Density is defined as dwelling units (lot size) per acre: RL 6 = (43560/6000); RL 8 = (43560/8000); MF = (43560/2000)

Source: City of Leavenworth



Estimated 2040 Traffic Conditions with Rezoning

Developing Updated Forecast

To adjust the 2040 forecasts developed for the TE update, the growth caused by rezoning was compared to growth expected between 2020 and 2040 at key intersections. Intersections evaluated as part of this assessment include:

- US 2 and Ski Hill Drive
- US 2 and 9th Street
- US 2 and Chumstick Highway
- Ski Hill Drive and Pine Street

Traffic forecasts for the TE update were based on anticipated population growth within Chelan County and Leavenworth. An annual growth rate of 1% per year was applied on regional routes (US 2 and Chumstick Highway) and 0.5% per year was assumed for all City streets.

For the supplemental analysis, the potential growth based on rezoning was compared to 2040 forecasts developed for the TE update. In instances where the growth forecast was lower than the calculated growth caused by rezoning the forecast was adjusted upward to reflect development conditions under the proposed rezoning.

The number of new trips expected to occur from the potential increase in residential units was calculated using trip generations for single-family homes and multi-family homes in the Institute of Transportation Engineers' (ITE) *Trip Generation Manual, 10th Edition*. As shown in **Table 2**, a total of 983 new trips could be expected from the increase in density.

Table 2. Trip Generation Summary

Land use	Units	Trip Generation Rates			Trips Generated			
		Trips per unit	Percent Entering	Percent Exiting	Total	Enter	Exit	
Single-Family Homes	555	0.99	63%	37%	549	346	203	
Multi-Family Homes (Includes ADUs)	775	0.56	63%	37%	434	273	161	
					Total	983	619	364



2040 Rezoning Conditions

Using the updated 2040 forecasts, traffic conditions were evaluated at the intersections identified as the primary locations that would be impacted by rezoning. **Table 3** shows the results of this analysis compared with the results of the baseline 2040 forecast from the TE update. The technical results are also included as **Attachment A** to this memorandum. Any areas where delay and LOS differs from the baseline are bolded and italicized. As shown, with the increase in residential units, delay would increase substantially at two intersections, US 2 and Ski Hill Drive, where delay experienced by vehicles on Ski Hill Drive would increase, and US 2 and 9th Street. While delay would increase slightly at the US 2 and Chumstick Highway intersection, the analysis indicates that the local intersection of Pine Street and Ski Hill has sufficient capacity to accommodate the potential growth. It should be noted that as part of the TE update, the City identified a project to install traffic control at the US 2 and Ski Hill Drive intersection and restriping and traffic signal upgrades at US 2 and Chumstick Highway intersection. When constructed, these improvements would decrease delay and improve operations at these intersections under both the Baseline and Rezoning conditions.

Table 3. 2040 LOS Results Comparison

Intersection	Intersection Control	Baseline Forecast (TE Update)		With Rezoning Forecast	
		Delay (seconds)	LOS	Delay (seconds)	LOS
Summer Sunday Peak					
US 2 and Ski Hill Drive ¹	SSSC ²	>180	F	>180	F
US 2 and 9th Street	Signal	67	E	103	F
US 2 and Chumstick Highway	Signal	138	F	139	F
Ski Hill Drive and Pine Street	SSSC ²	10	B	10	B
Weekday Peak					
US 2 and Ski Hill Drive	SSSC ²	23	C	37	E
US 2 and 9th Street	Signal	22	C	54	D
US 2 and Chumstick Highway	Signal	33	C	36	D
Ski Hill Drive and Pine Street	SSSC ²	9	A	10	B

¹Intersection is expected to experience high-levels of delay due to the side-street stop control. With an increase in vehicles using the side-street, delay is expected to increase under the rezoned scenario.

²SSC=Side-Street Stop Control



Summary

Findings from the rezoning analysis indicate that an increase in density would result in higher delay at the primary US 2 intersections within the City of Leavenworth, while capacity at the Ski Hill Drive and Pine Street intersection could accommodate an increase in development with minimal changes in delay or LOS. Intersection improvements identified in the TE Update would decrease delay and improve operations at two intersections on US 2 under the Rezoning scenario. While this analysis considers growth within the City based on the land capacity analysis, as development occurs a Traffic Impact Analysis should be completed to understand the direct impacts that may result from specific developments.

Attachments:

A. 2040 Level of Service & Delay Calculations

Attachment A

HCM 6th TWSC
1: Icicle Rd & US 2

Future (2040) Weekday PM Peak Hour
10/29/2021

Intersection

Int Delay, s/veh 2.9

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↗	↘	↑	↘	↗
Traffic Vol, veh/h	370	40	110	320	20	120
Future Vol, veh/h	370	40	110	320	20	120
Conflicting Peds, #/hr	0	19	19	0	34	19
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	80	135	-	40	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	5	2	2	5	2	2
Mvmt Flow	381	41	113	330	21	124

Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	441
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	-	4.12
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	-	2.218
Pot Cap-1 Maneuver	-	-	1119
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	-	1099
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	0	2.2	13.8
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	233	611	-	-	1099	-
HCM Lane V/C Ratio	0.088	0.202	-	-	0.103	-
HCM Control Delay (s)	21.9	12.4	-	-	8.7	-
HCM Lane LOS	C	B	-	-	A	-
HCM 95th %tile Q(veh)	0.3	0.8	-	-	0.3	-

Attachment A

HCM 6th TWSC
2: 3rd St/Ski Hill Dr & US 2

Future (2040) Weekday PM Peak Hour

10/29/2021

Intersection

Int Delay, s/veh 5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	60	380	50	20	400	30	10	10	20	40	10	50
Future Vol, veh/h	60	380	50	20	400	30	10	10	20	40	10	50
Conflicting Peds, #/hr	89	0	64	64	0	89	0	0	77	77	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	125	-	-	120	-	160	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	99	99	99	99	99	99	99	99	99	99	99	99
Heavy Vehicles, %	2	5	2	2	5	2	2	2	2	2	2	2
Mvmt Flow	61	384	51	20	404	30	10	10	20	40	10	51

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	523	0	0	499	0	0	1086	1159	551	1157	1154	493
Stage 1	-	-	-	-	-	-	596	596	-	533	533	-
Stage 2	-	-	-	-	-	-	490	563	-	624	621	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
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	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1043	-	-	1065	-	-	194	196	534	173	197	576
Stage 1	-	-	-	-	-	-	490	492	-	531	525	-
Stage 2	-	-	-	-	-	-	560	509	-	473	479	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	955	-	-	1000	-	-	147	154	465	125	155	527
Mov Cap-2 Maneuver	-	-	-	-	-	-	147	154	-	125	155	-
Stage 1	-	-	-	-	-	-	431	432	-	455	471	-
Stage 2	-	-	-	-	-	-	486	457	-	383	421	-

Approach	EB			WB			NB			SB		
HCM Control Delay, s	1.1			0.4			24.3			37.4		
HCM LOS							C			E		























Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	227	955	-	-	1000	-	-	209
HCM Lane V/C Ratio	0.178	0.063	-	-	0.02	-	-	0.483
HCM Control Delay (s)	24.3	9	-	-	8.7	-	-	37.4
HCM Lane LOS	C	A	-	-	A	-	-	E
HCM 95th %tile Q(veh)	0.6	0.2	-	-	0.1	-	-	2.4

Attachment A

HCM 6th Signalized Intersection Summary
4: 9th St/Evans St & US 2

Future (2040) Weekday PM Peak Hour

10/29/2021

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	30	330	30	70	320	40	110	20	100	110	10	60
Future Volume (veh/h)	30	330	30	70	320	40	110	20	100	110	10	60
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.95		0.89	0.96		0.91	1.00		0.82	1.00		0.82
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	1826	1870	1870	1826	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	32	347	32	74	337	42	116	21	105	116	11	63
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	2	5	2	2	5	2	2	2	2	2	2	2
Cap, veh/h	465	657	508	509	797	626	97	10	452	100	5	451
Arrive On Green	0.04	0.36	0.36	0.12	0.44	0.44	0.35	0.35	0.35	0.35	0.35	0.35
Sat Flow, veh/h	1781	1826	1412	1781	1826	1434	0	28	1297	0	15	1295
Grp Volume(v), veh/h	32	347	32	74	337	42	137	0	105	127	0	63
Grp Sat Flow(s),veh/h/ln	1781	1826	1412	1781	1826	1434	28	0	1297	15	0	1295
Q Serve(g_s), s	0.8	10.3	1.0	1.5	8.8	1.2	0.0	0.0	3.9	0.0	0.0	2.3
Cycle Q Clear(g_c), s	0.8	10.3	1.0	1.5	8.8	1.2	24.0	0.0	3.9	24.0	0.0	2.3
Prop In Lane	1.00		1.00	1.00		1.00	0.85		1.00	0.91		1.00
Lane Grp Cap(c), veh/h	465	657	508	509	797	626	106	0	452	105	0	451
V/C Ratio(X)	0.07	0.53	0.06	0.15	0.42	0.07	1.29	0.00	0.23	1.21	0.00	0.14
Avail Cap(c_a), veh/h	548	743	574	585	875	688	106	0	452	105	0	451
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	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	13.0	17.4	14.4	10.2	13.4	11.3	32.2	0.0	15.9	33.2	0.0	15.3
Incr Delay (d2), s/veh	0.0	1.4	0.1	0.0	0.8	0.1	182.9	0.0	0.3	153.6	0.0	0.1
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	0.3	4.3	0.3	0.5	3.4	0.4	7.2	0.0	1.2	6.2	0.0	0.7
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	13.0	18.8	14.5	10.3	14.2	11.4	215.1	0.0	16.2	186.9	0.0	15.5
LnGrp LOS	B	B	B	B	B	B	F	A	B	F	A	B
Approach Vol, veh/h		411			453			242				190
Approach Delay, s/veh		18.0			13.3			128.8				130.0
Approach LOS		B			B			F				F
Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	12.1	28.8		28.0	6.8	34.0		28.0				
Change Period (Y+Rc), s	4.5	5.0		4.5	4.5	5.0		4.5				
Max Green Setting (Gmax), s	10.5	27.0		23.5	5.5	32.0		23.5				
Max Q Clear Time (g_c+I1), s	3.5	12.3		26.0	2.8	10.8		26.0				
Green Ext Time (p_c), s	0.0	3.4		0.0	0.0	4.0		0.0				
Intersection Summary												
HCM 6th Ctrl Delay					53.5							
HCM 6th LOS					D							

Attachment A

HCM 6th Signalized Intersection Summary
5: Front St/Chumstick Hwy & US 2

Future (2040) Weekday PM Peak Hour

10/29/2021



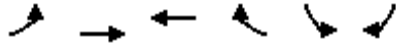
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	50	450	20	60	370	210	20	40	120	130	20	100
Future Volume (veh/h)	50	450	20	60	370	210	20	40	120	130	20	100
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.97	1.00		0.99	1.00		0.99	1.00		0.97
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		No		No
Adj Sat Flow, veh/h/ln	1870	1826	1870	1870	1826	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	51	459	20	61	378	214	20	41	122	133	20	102
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Percent Heavy Veh, %	2	5	2	2	5	2	2	2	2	2	2	2
Cap, veh/h	364	654	29	328	697	601	76	121	598	107	9	585
Arrive On Green	0.05	0.38	0.35	0.05	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
Sat Flow, veh/h	1781	1734	76	1781	1826	1575	0	317	1566	0	23	1532
Grp Volume(v), veh/h	51	0	479	61	378	214	61	0	122	153	0	102
Grp Sat Flow(s),veh/h/ln	1781	0	1809	1781	1826	1575	317	0	1566	23	0	1532
Q Serve(g_s), s	1.1	0.0	14.1	1.3	10.1	6.1	0.0	0.0	3.3	0.0	0.0	2.8
Cycle Q Clear(g_c), s	1.1	0.0	14.1	1.3	10.1	6.1	24.0	0.0	3.3	24.0	0.0	2.8
Prop In Lane	1.00		0.04	1.00		1.00	0.33		1.00	0.87		1.00
Lane Grp Cap(c), veh/h	364	0	683	328	697	601	197	0	598	116	0	585
V/C Ratio(X)	0.14	0.00	0.70	0.19	0.54	0.36	0.31	0.00	0.20	1.32	0.00	0.17
Avail Cap(c_a), veh/h	424	0	1123	382	1133	977	197	0	598	116	0	585
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	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	12.2	0.0	16.6	13.0	15.1	13.9	15.6	0.0	13.0	29.6	0.0	12.9
Incr Delay (d2), s/veh	0.1	0.0	2.8	0.1	1.4	0.8	0.9	0.0	0.2	191.4	0.0	0.1
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	0.4	0.0	5.7	0.5	4.0	2.1	0.6	0.0	1.1	7.9	0.0	0.9
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	12.3	0.0	19.4	13.1	16.6	14.7	16.5	0.0	13.2	221.0	0.0	13.0
LnGrp LOS	B	A	B	B	B	B	B	A	B	F	A	B
Approach Vol, veh/h		530			653			183			255	
Approach Delay, s/veh		18.7			15.6			14.3			137.8	
Approach LOS		B			B			B			F	
Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	7.1	27.7		28.0	6.9	28.0		28.0				
Change Period (Y+Rc), s	4.5	5.5		5.0	4.5	5.5		5.0				
Max Green Setting (Gmax), s	4.5	37.5		23.0	4.5	37.5		23.0				
Max Q Clear Time (g_c+1), s	13.3	16.1		26.0	3.1	12.1		26.0				
Green Ext Time (p_c), s	0.0	5.7		0.0	0.0	6.5		0.0				
Intersection Summary												
HCM 6th Ctrl Delay												35.7
HCM 6th LOS												D

Attachment A

HCM 6th Signalized Intersection Summary 6: US 2 & River Bend Dr

Future (2040) Weekday PM Peak Hour

10/29/2021



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↖	↑	↗	↗	↖	↖
Traffic Volume (veh/h)	160	570	510	110	90	160
Future Volume (veh/h)	160	570	510	110	90	160
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00			0.99	1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No	No		No	
Adj Sat Flow, veh/h/ln	1870	1826	1826	1870	1870	1870
Adj Flow Rate, veh/h	167	594	531	115	94	167
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	2	5	5	2	2	2
Cap, veh/h	538	1209	845	723	301	268
Arrive On Green	0.12	0.66	0.46	0.46	0.17	0.17
Sat Flow, veh/h	1781	1826	1826	1563	1781	1585
Grp Volume(v), veh/h	167	594	531	115	94	167
Grp Sat Flow(s),veh/h/ln	1781	1826	1826	1563	1781	1585
Q Serve(g_s), s	1.9	7.7	10.4	2.0	2.2	4.6
Cycle Q Clear(g_c), s	1.9	7.7	10.4	2.0	2.2	4.6
Prop In Lane	1.00			1.00	1.00	1.00
Lane Grp Cap(c), veh/h	538	1209	845	723	301	268
V/C Ratio(X)	0.31	0.49	0.63	0.16	0.31	0.62
Avail Cap(c_a), veh/h	710	2430	1890	1618	1091	971
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	6.1	4.0	9.6	7.4	17.3	18.3
Incr Delay (d2), s/veh	0.2	0.5	1.3	0.2	0.4	1.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	1.5	3.4	0.6	0.9	1.7
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	6.3	4.5	11.0	7.6	17.7	20.0
LnGrp LOS	A	A	B	A	B	C
Approach Vol, veh/h		761	646		261	
Approach Delay, s/veh		4.9	10.4		19.2	
Approach LOS		A	B		B	
Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	9.4	25.9			35.3	12.0
Change Period (Y+Rc), s	5.0	5.5			5.5	5.0
Max Green Setting (Gmax), s	47.5				61.5	28.0
Max Q Clear Time (g_c+I), s	12.4				9.7	6.6
Green Ext Time (p_c), s	0.1	7.7			8.5	0.6
Intersection Summary						
HCM 6th Ctrl Delay			9.3			
HCM 6th LOS			A			

Attachment A

HCM 6th TWSC
7: Ski Hill Dr & Pine Street

Future (2040) Weekday PM Peak Hour
10/29/2021

Intersection

Int Delay, s/veh 3.3

Movement

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↔		↔			↔
Traffic Vol, veh/h	40	30	50	50	20	60
Future Vol, veh/h	40	30	50	50	20	60
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	42	32	53	53	21	63

Major/Minor

	Minor1	Major1	Major2		
Conflicting Flow All	185	80	0	0	106
Stage 1	80	-	-	-	-
Stage 2	105	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12
Critical Hdwy Stg 1	5.42	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218
Pot Cap-1 Maneuver	804	980	-	-	1485
Stage 1	943	-	-	-	-
Stage 2	919	-	-	-	-
Platoon blocked, %			-	-	-
Mov Cap-1 Maneuver	792	980	-	-	1485
Mov Cap-2 Maneuver	792	-	-	-	-
Stage 1	943	-	-	-	-
Stage 2	905	-	-	-	-

Approach

	WB	NB	SB
HCM Control Delay, s	9.6	0	1.9
HCM LOS	A		

Minor Lane/Major Mvmt

	NBT	NBRWBLn1	SBL	SBT
Capacity (veh/h)	-	-	863	1485
HCM Lane V/C Ratio	-	-	0.085	0.014
HCM Control Delay (s)	-	-	9.6	7.5
HCM Lane LOS	-	-	A	A
HCM 95th %tile Q(veh)	-	-	0.3	0

Attachment A

HCM 6th TWSC
1: Icicle Rd & US 2

Future (2040) Summer Friday PM Peak
10/29/2021

Intersection

Int Delay, s/veh 6.8

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↗	↘	↑	↗	↘
Traffic Vol, veh/h	670	70	200	510	40	220
Future Vol, veh/h	670	70	200	510	40	220
Conflicting Peds, #/hr	0	19	19	0	34	19
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	80	135	-	40	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	5	2	2	5	2	2
Mvmt Flow	691	72	206	526	41	227

Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	782
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	-	4.12
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	-	2.218
Pot Cap-1 Maneuver	-	-	836
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	-	821
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	0	3.1	36.4
HCM LOS			E

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	74	408	-	-	821	-
HCM Lane V/C Ratio	0.557	0.556	-	-	0.251	-
HCM Control Delay (s)	102.8	24.3	-	-	10.8	-
HCM Lane LOS	F	C	-	-	B	-
HCM 95th %tile Q(veh)	2.4	3.3	-	-	1	-

Attachment A

HCM 6th TWSC
2: 3rd St/Ski Hill Dr & US 2

Future (2040) Summer Friday PM Peak
10/29/2021

Intersection												
Int Delay, s/veh	48.9											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↶	↷		↶	↷	↶		↷			↷	↷
Traffic Vol, veh/h	90	740	60	30	680	60	10	10	30	50	10	70
Future Vol, veh/h	90	740	60	30	680	60	10	10	30	50	10	70
Conflicting Peds, #/hr	89	0	64	64	0	89	0	0	77	77	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	125	-	-	120	-	160	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	99	99	99	99	99	99	99	99	99	99	99	99
Heavy Vehicles, %	2	5	2	2	5	2	2	2	2	2	2	2
Mvmt Flow	91	747	61	30	687	61	10	10	30	51	10	71

Major/Minor	Major1		Major2		Minor1		Minor2					
Conflicting Flow All	837	0	0	872	0	0	1842	1921	919	1893	1890	776
Stage 1	-	-	-	-	-	-	1024	1024	-	836	836	-
Stage 2	-	-	-	-	-	-	818	897	-	1057	1054	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
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	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	797	-	-	773	-	-	58	67	329	53	70	397
Stage 1	-	-	-	-	-	-	284	313	-	362	382	-
Stage 2	-	-	-	-	-	-	370	358	-	272	303	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	729	-	-	726	-	-	33	48	286	~ 30	50	363
Mov Cap-2 Maneuver	-	-	-	-	-	-	33	48	-	~ 30	50	-
Stage 1	-	-	-	-	-	-	233	257	-	290	335	-
Stage 2	-	-	-	-	-	-	277	314	-	189	249	-

Approach	EB		WB		NB		SB	
HCM Control Delay, s	1.1		0.4		104.9		\$ 642.5	
HCM LOS					F		F	

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	81	729	-	-	726	-	-	63
HCM Lane V/C Ratio	0.624	0.125	-	-	0.042	-	-	2.084
HCM Control Delay (s)	104.9	10.6	-	-	10.2	-	-	\$ 642.5
HCM Lane LOS	F	B	-	-	B	-	-	F
HCM 95th %tile Q(veh)	2.8	0.4	-	-	0.1	-	-	12.5

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

Attachment A

HCM 6th Signalized Intersection Summary
4: 9th St/Evans St & US 2

Future (2040) Summer Friday PM Peak
10/29/2021

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	30	620	40	100	610	60	150	30	140	150	20	80
Future Volume (veh/h)	30	620	40	100	610	60	150	30	140	150	20	80
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.98		0.90	1.00		0.91	0.92		0.80	1.00		0.80
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	1826	1870	1870	1826	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	32	653	42	105	642	63	158	32	147	158	21	84
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	2	5	2	2	5	2	2	2	2	2	2	2
Cap, veh/h	283	690	536	335	849	671	90	10	396	92	7	395
Arrive On Green	0.03	0.38	0.38	0.12	0.47	0.47	0.31	0.31	0.31	0.31	0.31	0.31
Sat Flow, veh/h	1781	1826	1419	1781	1826	1442	0	33	1268	0	22	1265
Grp Volume(v), veh/h	32	653	42	105	642	63	190	0	147	179	0	84
Grp Sat Flow(s),veh/h/ln	1781	1826	1419	1781	1826	1442	33	0	1268	22	0	1265
Q Serve(g_s), s	0.8	25.5	1.4	2.2	21.4	1.8	0.0	0.0	6.6	0.0	0.0	3.6
Cycle Q Clear(g_c), s	0.8	25.5	1.4	2.2	21.4	1.8	23.0	0.0	6.6	23.0	0.0	3.6
Prop In Lane	1.00		1.00	1.00		1.00	0.83		1.00	0.88		1.00
Lane Grp Cap(c), veh/h	283	690	536	335	849	671	100	0	396	99	0	395
V/C Ratio(X)	0.11	0.95	0.08	0.31	0.76	0.09	1.90	0.00	0.37	1.81	0.00	0.21
Avail Cap(c_a), veh/h	346	694	539	363	849	671	100	0	396	99	0	395
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	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	14.6	22.2	14.7	14.6	16.3	11.0	34.5	0.0	19.7	35.3	0.0	18.7
Incr Delay (d2), s/veh	0.1	22.4	0.1	0.2	4.6	0.1	441.8	0.0	0.7	402.6	0.0	0.3
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	0.3	14.3	0.4	0.8	9.1	0.6	14.0	0.0	2.0	12.8	0.0	1.1
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	14.7	44.6	14.8	14.8	20.9	11.1	476.3	0.0	20.4	437.9	0.0	18.9
LnGrp LOS	B	D	B	B	C	B	F	A	C	F	A	B
Approach Vol, veh/h		727			810			337				263
Approach Delay, s/veh		41.6			19.3			277.4				304.1
Approach LOS		D			B			F				F
Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	13.3	32.8		27.5	6.9	39.3		27.5				
Change Period (Y+Rc), s	4.5	5.0		4.5	4.5	5.0		4.5				
Max Green Setting (Gmax), s	10.0	28.0		23.0	5.0	33.0		23.0				
Max Q Clear Time (g_c+I1), s	4.2	27.5		25.0	2.8	23.4		25.0				
Green Ext Time (p_c), s	0.1	0.3		0.0	0.0	5.1		0.0				
Intersection Summary												
HCM 6th Ctrl Delay	102.6											
HCM 6th LOS	F											

Attachment A

HCM 6th Signalized Intersection Summary 5: Front St/Chumstick Hwy & US 2

Future (2040) Summer Friday PM Peak

10/29/2021



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	80	800	10	110	710	300	30	60	250	240	40	150
Future Volume (veh/h)	80	800	10	110	710	300	30	60	250	240	40	150
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.97	1.00		0.99	1.00		0.98	0.99		0.96
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		No		No
Adj Sat Flow, veh/h/ln	1870	1826	1870	1870	1826	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	82	816	10	112	724	306	31	61	255	245	41	153
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Percent Heavy Veh, %	2	5	2	2	5	2	2	2	2	2	2	2
Cap, veh/h	251	863	11	215	893	771	61	92	434	85	0	425
Arrive On Green	0.04	0.48	0.48	0.05	0.49	0.49	0.28	0.28	0.28	0.28	0.28	0.28
Sat Flow, veh/h	1781	1799	22	1781	1826	1577	0	331	1559	0	0	1524
Grp Volume(v), veh/h	82	0	826	112	724	306	92	0	255	286	0	153
Grp Sat Flow(s),veh/h/ln	1781	0	1821	1781	1826	1577	331	0	1559	0	0	1524
Q Serve(g_s), s	1.8	0.0	34.1	2.5	26.5	9.7	0.0	0.0	11.1	0.0	0.0	6.4
Cycle Q Clear(g_c), s	1.8	0.0	34.1	2.5	26.5	9.7	22.0	0.0	11.1	22.0	0.0	6.4
Prop In Lane	1.00		0.01	1.00		1.00	0.34		1.00	0.86		1.00
Lane Grp Cap(c), veh/h	251	0	873	215	893	771	153	0	434	85	0	425
V/C Ratio(X)	0.33	0.00	0.95	0.52	0.81	0.40	0.60	0.00	0.59	3.38	0.00	0.36
Avail Cap(c_a), veh/h	277	0	888	224	893	771	153	0	434	85	0	425
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	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	14.4	0.0	19.6	17.8	17.1	12.8	23.7	0.0	24.6	39.5	0.0	22.8
Incr Delay (d2), s/veh	0.3	0.0	18.8	0.7	6.4	0.7	6.4	0.0	2.1	1100.0	0.0	0.5
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	0.7	0.0	17.4	0.9	11.6	3.3	1.5	0.0	4.3	27.5	0.0	2.3
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	14.7	0.0	38.4	18.5	23.5	13.5	30.1	0.0	26.6	1139.5	0.0	23.4
LnGrp LOS	B	A	D	B	C	B	C	A	C	F	A	C
Approach Vol, veh/h		908			1142			347			439	
Approach Delay, s/veh		36.2			20.3			27.5			750.5	
Approach LOS		D			C			C			F	
Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	8.6	43.4		27.0	7.8	44.1		27.0				
Change Period (Y+Rc), s	4.5	5.5		5.0	4.5	5.5		5.0				
Max Green Setting (Gmax), s	4.5	38.5		22.0	4.5	38.5		22.0				
Max Q Clear Time (g_c+1), s	4.5	36.1		24.0	3.8	28.5		24.0				
Green Ext Time (p_c), s	0.0	1.8		0.0	0.0	6.7		0.0				

Intersection Summary

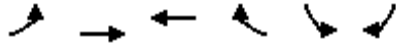
HCM 6th Ctrl Delay	139.3
HCM 6th LOS	F

Attachment A

HCM 6th Signalized Intersection Summary 6: US 2 & River Bend Dr

Future (2040) Summer Friday PM Peak

10/29/2021



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↖	↑	↗	↗	↖	↖
Traffic Volume (veh/h)	310	1040	870	180	150	300
Future Volume (veh/h)	310	1040	870	180	150	300
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00			0.99	1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No	No		No	
Adj Sat Flow, veh/h/ln	1870	1826	1826	1870	1870	1870
Adj Flow Rate, veh/h	323	1083	906	188	156	312
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	2	5	5	2	2	2
Cap, veh/h	286	1218	906	777	393	350
Arrive On Green	0.12	0.67	0.50	0.50	0.22	0.22
Sat Flow, veh/h	1781	1826	1826	1564	1781	1585
Grp Volume(v), veh/h	323	1083	906	188	156	312
Grp Sat Flow(s),veh/h/ln	1781	1826	1826	1564	1781	1585
Q Serve(g_s), s	11.0	45.4	46.5	6.4	7.0	17.9
Cycle Q Clear(g_c), s	11.0	45.4	46.5	6.4	7.0	17.9
Prop In Lane	1.00			1.00	1.00	1.00
Lane Grp Cap(c), veh/h	286	1218	906	777	393	350
V/C Ratio(X)	1.13	0.89	1.00	0.24	0.40	0.89
Avail Cap(c_a), veh/h	286	1218	906	777	513	457
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	30.7	12.7	23.6	13.5	31.2	35.4
Incr Delay (d2), s/veh	92.3	8.7	29.8	0.3	0.5	15.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	10.4	18.3	25.9	2.2	3.1	8.3
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	122.9	21.4	53.3	13.8	31.7	50.6
LnGrp LOS	F	C	D	B	C	D
Approach Vol, veh/h		1406	1094		468	
Approach Delay, s/veh		44.7	46.5		44.3	
Approach LOS		D	D		D	
Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	60.0	52.0			68.0	25.7
Change Period (Y+Rc), s	5.0	5.5			5.5	5.0
Max Green Setting (Gmax), s	60.0	46.5			62.5	27.0
Max Q Clear Time (g_c+I), s	60.0	48.5			47.4	19.9
Green Ext Time (p_c), s	0.0	0.0			10.9	0.8
Intersection Summary						
HCM 6th Ctrl Delay			45.3			
HCM 6th LOS			D			

Attachment A

HCM 6th TWSC
7: Ski Hill Dr & Pine Street

Future (2040) Summer Friday PM Peak
10/29/2021

Intersection

Int Delay, s/veh 3.4

Movement

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↖		↗			↘
Traffic Vol, veh/h	40	60	100	60	40	90
Future Vol, veh/h	40	60	100	60	40	90
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	42	63	105	63	42	95

Major/Minor

	Minor1	Major1	Major2		
Conflicting Flow All	316	137	0	0	168
Stage 1	137	-	-	-	-
Stage 2	179	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12
Critical Hdwy Stg 1	5.42	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218
Pot Cap-1 Maneuver	677	911	-	-	1410
Stage 1	890	-	-	-	-
Stage 2	852	-	-	-	-
Platoon blocked, %			-	-	-
Mov Cap-1 Maneuver	656	911	-	-	1410
Mov Cap-2 Maneuver	656	-	-	-	-
Stage 1	890	-	-	-	-
Stage 2	826	-	-	-	-

Approach

	WB	NB	SB
HCM Control Delay, s	10.3	0	2.3
HCM LOS	B		

Minor Lane/Major Mvmt

	NBT	NBRWBLn1	SBL	SBT
Capacity (veh/h)	-	-	788	1410
HCM Lane V/C Ratio	-	-	0.134	0.03
HCM Control Delay (s)	-	-	10.3	7.6
HCM Lane LOS	-	-	B	A
HCM 95th %tile Q(veh)	-	-	0.5	0.1