



ALDRIDGE TRANSPORTATION CONSULTANTS, LLC

Advanced Transportation Planning and Traffic Engineering

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December 7, 2022

Mr. Eric Pearson
Cage Civil Engineering
999 18th St. S2110
Denver, CO 80202

RE: Transportation Impact Study - Revised
The Aurora Highlands – Planning Area 70 (Century)

Dear Mr. Pearson:

Aldridge Transportation Consultants (ATC) is pleased to present this traffic impact study for the proposed residential development of Planning Area 70 of The Aurora Highlands.

ATC is professional service firm specializing in traffic engineering and transportation planning. ATC's principal, John M.W. Aldridge is a Colorado licensed professional engineer. In the past 20 years, ATC has prepared over 1,200 traffic impact studies, designed over 100 traffic signals, and has provided expert witness testimony on engineering design and access issues on multi-million-dollar interchange and highway projects in Kansas and Colorado.

We acknowledge that City of Aurora's review of this study is only for typical performance with submittal requirements, current design criteria, and standard engineering principles and practice.

ATC appreciates the opportunity to be of service. Please call if you have any questions. We can be reached at 303-703-9112.

Respectfully submitted,
Aldridge Transportation Consultants, LLC

John M.W. Aldridge, P.E.
Principal





INTRODUCTION

This Traffic Impact Study examines the impact on traffic caused by the development of Planning Area 70 in The Aurora Highlands. This area is defined by Highlands Creek Pkwy. on the west, 32nd Ave. on the south and the Highlands Creek Park on the northeast side. Figure 1 shows the full development of The Aurora Highlands with village and street names. Please note that the graphic is for illustrative purposes only and subject to change as planning and design is further developed.

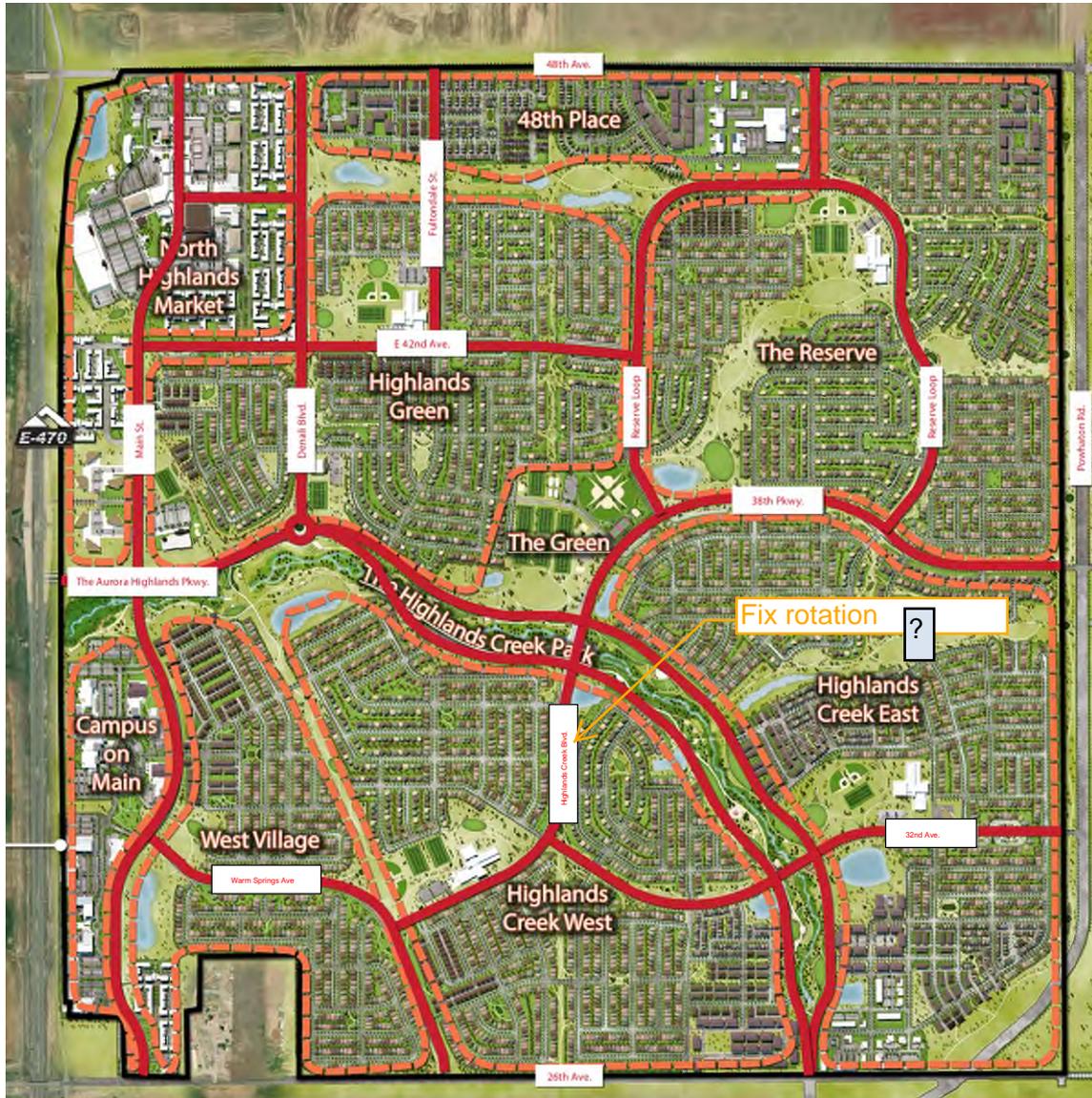


Figure 1 Village and Street Naming Plan

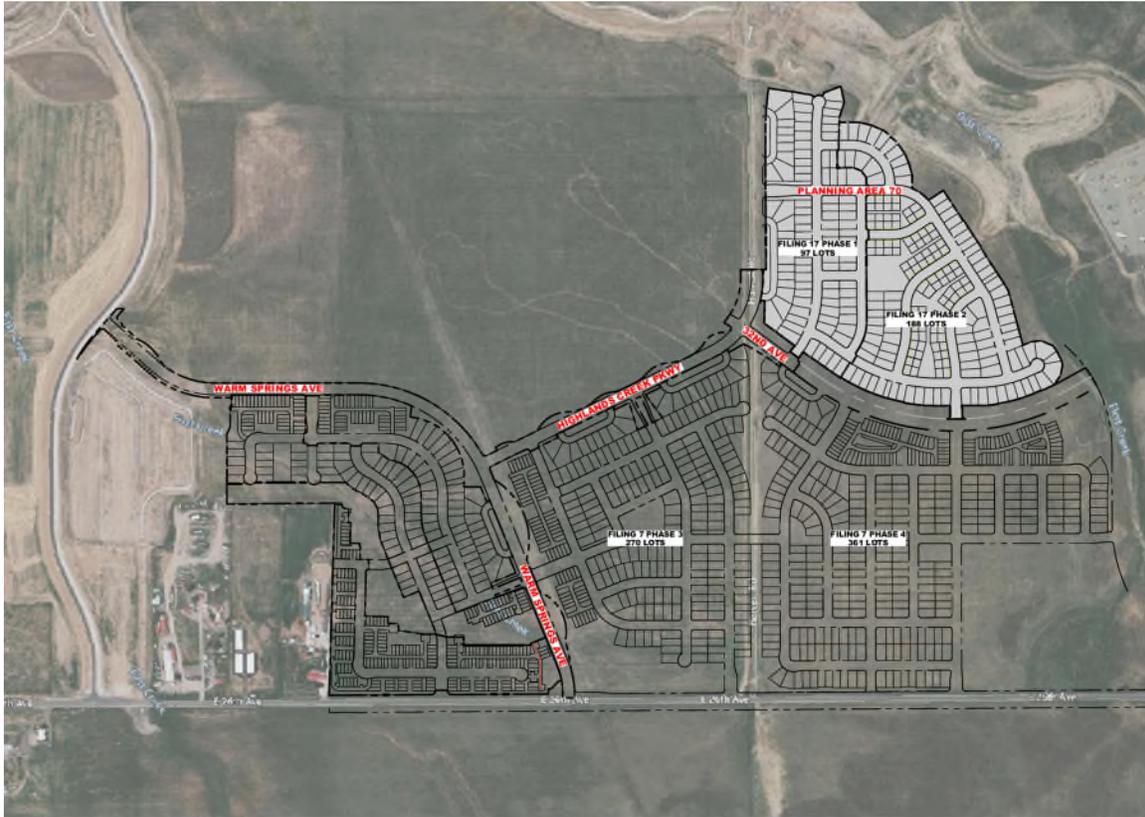


Figure 2 Subject Area and Streets

The section that is the subject of this development application is shown in Figure 2. The proposed development plan features 280 units on approximately 68.3 acres. The density is about 4.4 du/ac. Of the 280 units, 184 are single-family detached and 96 are single-family attached. Note that Figure 2 shows the Phases 1-3 development which was studied by this firm in May 2020.

The **Aurora Highlands Traffic Impact Study** prepared by FHU in July 2018 supplies an overall examination of the approximate 3,100-acre development plan shown in Figure 1. The FHU study focused on the long-term (2040) transportation needs not only for the full-build out but also for the areas that surround Aurora Highlands. The long-term analysis was based on the DRCOG planning using the Compass model and 2040 NEATS travel demand modeling. The **Northeast Area Transportation Study** (NEATS) transportation plan refresh was completed in October 2018 and is inclusive of the Aurora Highlands master development plan again as depicted in Figure 1. While adjustments to the land use and street layout are inevitable, these documents nonetheless supply a sound foundation and basis for this study and its improvement recommendations. Another important document is the Technical Memo prepared by HRGreen in September 2018 that determined the peak hour volumes and provided a peak hour capacity analysis for several planned intersections in The Aurora Highlands development. The memo assumed full development of The Aurora Highlands and based the AM and PM peak hour volumes on standard percentages of the daily volumes determined by FHU. The intersections of relevance to Planning Area 70 are:



1. Main St. at 26th Ave.
2. 38th Ave./The Aurora Highlands Parkway/at Denali Blvd. (Roundabout)
3. 38th Ave./The Aurora Highlands Parkway/at Main St.
4. The Aurora Highlands Parkway – Eastbound Direction at Highlands Creek Blvd.
5. The Aurora Highlands Parkway – Westbound Direction at Highlands Creek Blvd.

Except for the roundabout, all relevant intersections are signalized and per the HRGreen analysis will operate at the benchmark LOS D or better at full-build out of the development with their recommended geometric configuration.

Per the FHU study, more refined traffic impact study could be prepared for each individual development application, such as this, to refine the specifics needed as development occurs. The FHU study sets the stage with respect to the roadway needs, layout, and classifications.

EXISTING CONDITIONS

Since the study for the Phase 1-3 development there have been significant changes to the infrastructure. Main St. is now functional as a four-lane street and sections of The Aurora Highlands Parkway are in place including the roundabout at Denali Blvd. The intersections with The Aurora Highlands Parkway and Highlands Creek Pkwy. should be finished by the time Planning Area 70 begins construction. Although there is no construction yet on the infrastructure for Phases 1-3, we assume it will begin in the short-term including the extension of The Aurora Highlands Parkway to 26th Ave. and in the long terms its proposed connection to the Harvest Road interchange with I-70.

26th Ave. is a 2-Lane Minor Arterial that extends from Picadilly Road to Watkins Road. It is undivided and in the subject area includes a 6-foot gravel shoulder. There is no sidewalk on either side. It carries approximately 1,000 ADT per NEATS, and the posted speed limit is 45 mph.

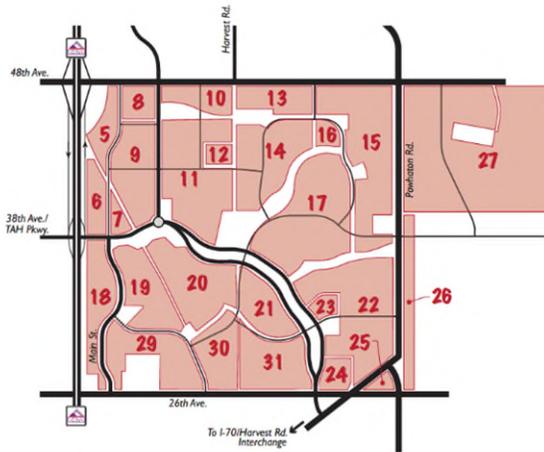
ACCESS LOCATIONS

There will be three primary access locations to Planning Area 70 from the interior collector streets. One on Highlands Creek Blvd. and two on 32nd Ave. All are full movement.

LAND USE and TRIP GENERATION

The site will be developed with 184 single-family detached and 96 single-family attached units. The trip generation rates are from the *ITE Trip Generation Manual, 11th Edition*. The following worksheet supplies the ADT and AM/PM Peak Hour traffic volumes. The planning areas are subtotaled by the incremental traffic analysis zones (TAZ) as provided in the FHU master traffic study. Figure 3 following the worksheet depicts the applicable zones and zone number.

Trip Generation Worksheet											
ITE CODE	PLANNING AREA	LAND USE	UNIT	QUANTITY	ADT	AM			PM		
						IN	OUT	TOTAL	IN	OUT	TOTAL
215	70	Single-Family Attached	DU	96	7.20	0.15	0.33		0.33	0.25	
					691	14	32	46	32	24	56
210	70	Single-Family Detached	DU	184	9.43	0.19	0.52		0.59	0.35	
					1735	35	96	130	109	64	173
Total Trips					2426	49	127	177	140	88	229



In this case, the TAZ is 21. In comparing the zone data, the FHU traffic study programmed 369 single-family homes that produces 3,480 daily trips. This application for Planning Area 70 is less at 280 units and produces 2,426 daily trips – a reduction of 1,000 trips daily.

Figure 3 Traffic Analysis Zones

TRAFFIC DISTRIBUTION & ASSIGNMENT

The traffic distribution will be oriented to/from the west on 26th Ave. via Main St. at about 25 percent of the traffic and 30 percent to 38th Ave. via The Aurora Highlands Parkway. The other 35 percent will go east on 26th Ave. or south on The Aurora Parkway to the future Harvest Road/I-70 interchange. This analysis focuses only on the long-term 2040 FHU master plan. The short-term infrastructure is too much in flux to reliably analyze the impact. Figure 4 shows the AM and PM Trip Assignment to each of the subject intersections.

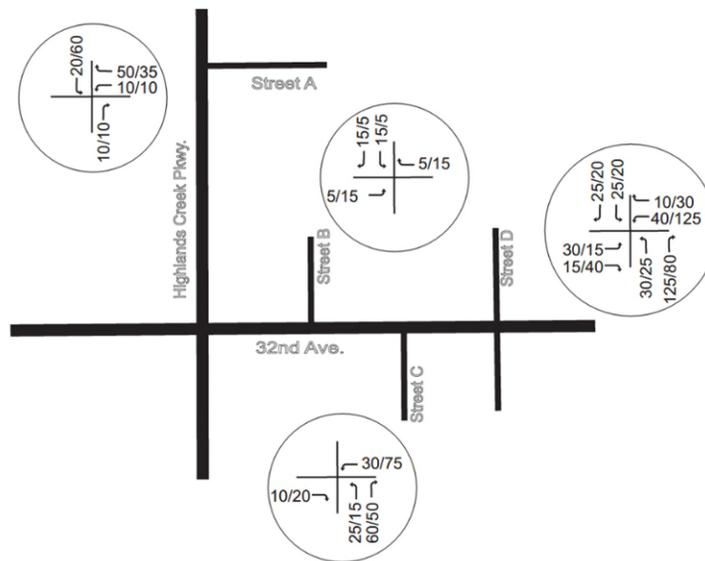


Figure 4 AM/PM Peak Hour Trip Assignment



Still have issues with this paragraph. If anything, the FHU study was more aggressive with timeline, as it presumes the full build out of the area to occur prior to 2040, whereas NEATS assumes build condition to be post-2040 (i.e. NEATS Figure 10 showing buildout ADT at ~22k). This paragraph is using this discrepancy to presume that less traffic will be anticipated for 26th than the FHU study projected. Revise this paragraph as such.

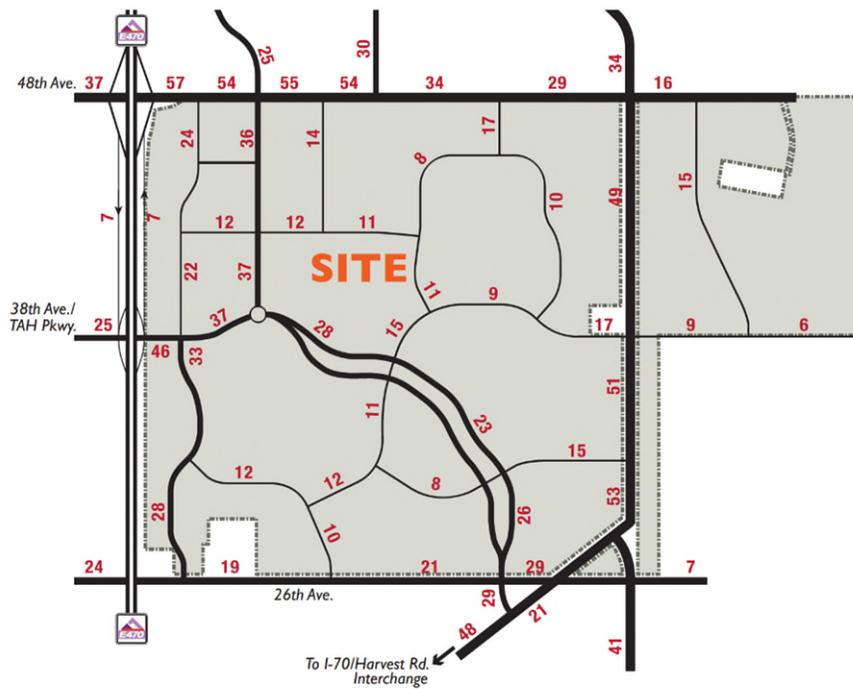
LC
f12

FUTURE TRAFFIC VOLUMES

The future (2040) traffic volumes for The Aurora Highlands have been modeled using the FHU study and NEATS travel modeling. The forecast volumes include the Aurora Highlands and land uses surrounding the Aurora Highlands are being modeled by city staff in the preparation of the NEATS travel model according to the FHU study and shows the 2040 Total Traffic. It should be noted that the FHU study projects 19-21,000 ADT on 26th Ave. NEATS projects about 117,000 trips from the same traffic analysis zones. This explains that their travel modelling assumes build out of Aurora Highlands to its maximum potential although not a likely scenario. They did so to give the developer flexibility in the development of each planning area and to meet the City's requirement in preparing a traffic impact study. To wit, the zones in this phase are being developed with 280 units vs. the 369 units programmed by FHU. Overall, the FHU study forecast 203,000 trips generated by the full build out. NEATS on the other hand forecast 117,000 trips from the same traffic analysis zones.

The paragraph explains the discrepancy. We added a sentence saying that the Synchro models use and are consistent with the FHU study forecasting.

FHU
Aurora
with
6 is
study
FHU



LEGEND
 XXXX = Volumes in 1000's
 - - - - = Aurora Highlands

Figure 5 2040 Total Traffic per the FHU Study

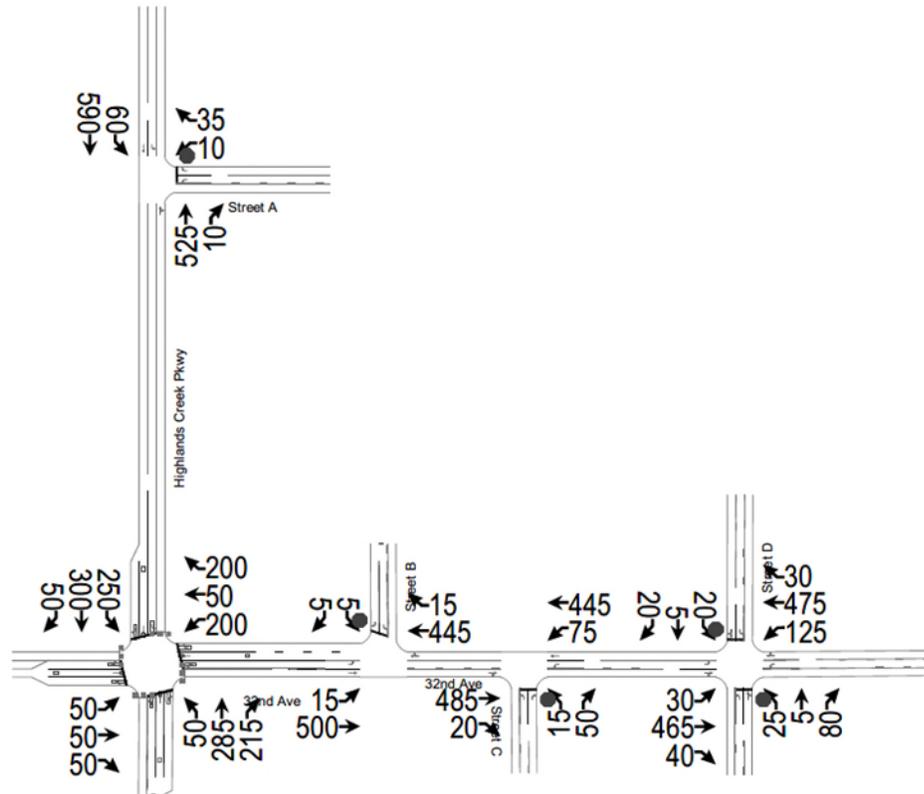


Figure 7 2040 PM Total

PEAK HOUR INTERSECTION LEVEL OF SERVICE

ATC uses Synchro v.10 for operations analyses. The Synchro method is based on the 6th Edition of the Highway Capacity Manual (HCM). The table summarizes the 2040 AM and PM peak hour LOS at the three intersections serving Planning Area 70. As there are no existing intersections in the subject area, no analysis of the exiting conditions or background conditions is possible. Synchro reports for each timeframe are provided in the appendix.

The HCM states that, “LOS is used to translate complex numerical performance rating into a simple A-F system representative of the travelers’ perception of the quality of service provided by a facility or service. Practitioners and decision makers alike must understand that the LOS letter result hides much of the complexity of facility performance¹.” LOS is a letter rating from A to F. LOS A shows free-flow traffic conditions and little to no delay at intersections. LOS F is heavy

¹ HCM version 6, Chapter 5, pages 5-3 – 5-6.



Modify:
 Street A = 34th Ave
 Street B = Irvington St
 Street C = Street B
 (temporary name, but acceptable for now)

Done.

traffic congestion with significant delay. LOS is supplied for the overall operations at signalized intersections. LOS D is generally the benchmark for acceptable signalized intersection operations during the weekday peak hours. The critical movement, not the overall, shows the LOS rating for unsignalized intersections, which is generally a left turn out from the minor street approach. Caution must be used when evaluating the LOS at unsignalized intersections particularly when LOS F is shown. In case of LOS F, the HCM recommends that other evaluation methods should be considered such as the volume over capacity ratios, the 95th percentile queue length, and duration of LOS F to make the most effective traffic control decision². LOS F at unsignalized intersections is typically normal during the weekday peak hours as the duration of the LOS F condition is relatively short.

Unsignalized Intersection LOS & 95%ile Summary			
LOS (Control Delay (secs) A=0-10, B=>10-15, C=>15-25, D=>25-35, E=>35-50, F=>50) / 95%ile Q (veh)			
		2040	
Intersection	Movement	AM	PM
Highlands Creek / 34th Ave.	Critical Movement WBL	C/15.5	C/17.9
32nd Ave. / Irvington St.	Critical Movement SBL	B/11.9	B/14.7
32nd Ave. / Street B	Critical Movement NBL	B/12.5	C/16.5
32nd Ave. / Street D	Critical Movement SBL	C/21.7	F/68.1/1

The operations analysis demonstrates that the Street A intersection on Highlands Creek Pkwy. operate with two-way stop sign control at an acceptable LOS C/C. Likewise at the intersections of 32nd Ave./Street B and 32nd Ave. / Street C, they will operate acceptably at LOS B/B and LOS B/C, respectively. The intersection of 32nd Ave. and Street D reports LOS C in the AM peak hour and LOS F in the PM peak hour. In this case the 95th percentile queue is just one vehicle per hour and volume over capacity ratio is less than 0.2. In traffic engineering terms this is acceptable operations.

The intersection of Highlands Creek Blvd. and 32nd Ave. reports LOS F/F if left unsignalized. In this case the 95th percentile queue is 9 vehicles and the volume over capacity ratio is 1.01. These do not meet the LOS D benchmark. However, per the COA traffic impact guidelines LOS F can be allowed if there is an alternate route is available. Upon build-out there will be many options, but if the volumes as projected come to fruition, a traffic signal warrant is probable. With a signal the intersection would operate at LOS C/C.

Signalized Intersection LOS Summary		
LOS/Control Delay (secs) A=0-10, B=>10-20, C=>20-35, D=>35-55, E=>55-80, F=>80		
Intersection	2040 Total	
	AM	PM
Highlands Creek/32nd Ave.	C/22.4	C/21.8

Cross checking this against latest review for the Filing 9 study, that study has determined traffic signalization will be warranted (also analysis is provided for Signalized LOS below this paragraph). Please revise this text to indicate that 2040 intersection for Highlands Creek/32nd is projected to met signal warrants, per warrant analysis provided in appendices.

Paragraph revised.

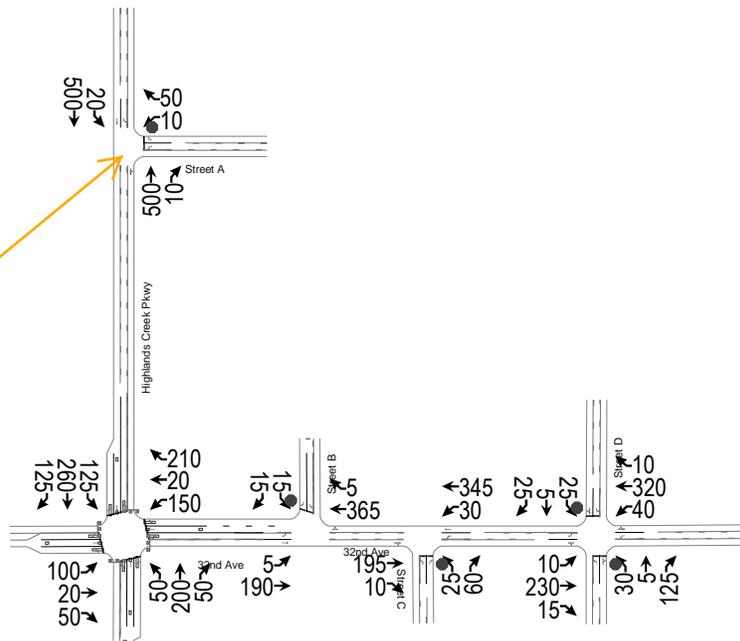


CONCLUSIONS & RECOMMENDATIONS

The analysis and recommendations contained herein demonstrate that the development of Planning Area 70 is consistent with the approved land use planning and roadway and intersection improvement recommendations in the FHU study and NEATS. This refined operations analysis show that the proposed roadways and intersections will function at an acceptable level of service.



APPENDIX



I believe there is a 4th leg to this intersection as well. Add four legs to all models, typical all appendices.

Intersection						
Int Delay, s/veh	1.7					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↶		↷	↶	↷	↶
Traffic Vol, veh/h	195	10	30	345	25	60
Future Vol, veh/h	195	10	30	345	25	60
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	50	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	212	11	33	375	27	65

Major/Minor	Major1	Major2	Minor1	Minor2	Minor3
Conflicting Flow All	0	0	223	0	659
Stage 1	-	-	-	-	218
Stage 2	-	-	-	-	441
Critical Hdwy	-	-	4.12	-	6.42
	-	-	-	-	5.42
	-	-	-	-	5.42
	-	-	2.218	-	3.518
	-	-	1346	-	429
	-	-	-	-	818
	-	-	-	-	648
	-	-	-	-	-
	-	-	1346	-	418
	-	-	-	-	509
	-	-	-	-	818
Stage 2	-	-	-	-	632

Thru lane geometry needed, which implies either shared left/thru or shared right/thru movements for these intersections, or separate lanes for each movement.

Approach	EB	WB	NB			
HCM Control Delay, s	0	0.6	10.6			
HCM LOS			B			
Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	509	822	-	-	1346	-
HCM Lane V/C Ratio	0.053	0.079	-	-	0.024	-
HCM Control Delay (s)	12.5	9.8	-	-	7.7	-
HCM Lane LOS	B	A	-	-	A	-
HCM 95th %tile Q(veh)	0.2	0.3	-	-	0.1	-

Intersection						
Int Delay, s/veh	0.9					
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↙	↗	↖		↙	↗
Traffic Vol, veh/h	10	50	500	10	20	500
Future Vol, veh/h	10	50	500	10	20	500
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	50	0	-	-	50	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	11	54	543	11	22	543

Major/Minor	Minor1	Major1	Major2		
Conflicting Flow All	1136	549	0	0	554
Stage 1	549	-	-	-	-
Stage 2	587	-	-	-	-
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	223	535	-	-	1016
Stage 1	579	-	-	-	-
Stage 2	556	-	-	-	-
Platoon blocked, %			-	-	-
Mov Cap-1 Maneuver	218	535	-	-	1016
Mov Cap-2 Maneuver	355	-	-	-	-
Stage 1	579	-	-	-	-
Stage 2	544	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	13	0	0.3
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	355	535	1016	-
HCM Lane V/C Ratio	-	-	0.031	0.102	0.021	-
HCM Control Delay (s)	-	-	15.5	12.5	8.6	-
HCM Lane LOS	-	-	C	B	A	-
HCM 95th %tile Q(veh)	-	-	0.1	0.3	0.1	-

Intersection						
Int Delay, s/veh	0.6					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↙	↑	↗		↙	↗
Traffic Vol, veh/h	5	190	365	5	15	15
Future Vol, veh/h	5	190	365	5	15	15
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	100	-	-	-	100	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	207	397	5	16	16

Major/Minor	Major1	Major2	Minor2		
Conflicting Flow All	402	0	-	0	617 400
Stage 1	-	-	-	-	400 -
Stage 2	-	-	-	-	217 -
Critical Hdwy	4.12	-	-	-	6.42 6.22
Critical Hdwy Stg 1	-	-	-	-	5.42 -
Critical Hdwy Stg 2	-	-	-	-	5.42 -
Follow-up Hdwy	2.218	-	-	-	3.518 3.318
Pot Cap-1 Maneuver	1157	-	-	-	453 650
Stage 1	-	-	-	-	677 -
Stage 2	-	-	-	-	819 -
Platoon blocked, %		-	-	-	
Mov Cap-1 Maneuver	1157	-	-	-	451 650
Mov Cap-2 Maneuver	-	-	-	-	538 -
Stage 1	-	-	-	-	674 -
Stage 2	-	-	-	-	819 -

Approach	EB	WB	SB
HCM Control Delay, s	0.2	0	11.3
HCM LOS			B

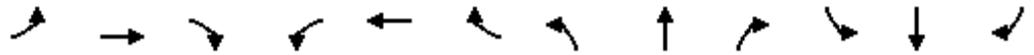
Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	1157	-	-	-	538	650
HCM Lane V/C Ratio	0.005	-	-	-	0.03	0.025
HCM Control Delay (s)	8.1	-	-	-	11.9	10.7
HCM Lane LOS	A	-	-	-	B	B
HCM 95th %tile Q(veh)	0	-	-	-	0.1	0.1

Intersection												
Int Delay, s/veh	3.9											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↶	↷		↶	↷		↶	↷		↶	↷	
Traffic Vol, veh/h	10	230	15	40	320	10	30	5	125	25	5	25
Future Vol, veh/h	10	230	15	40	320	10	30	5	125	25	5	25
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None									
Storage Length	50	-	-	50	-	-	50	-	-	50	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	11	250	16	43	348	11	33	5	136	27	5	27

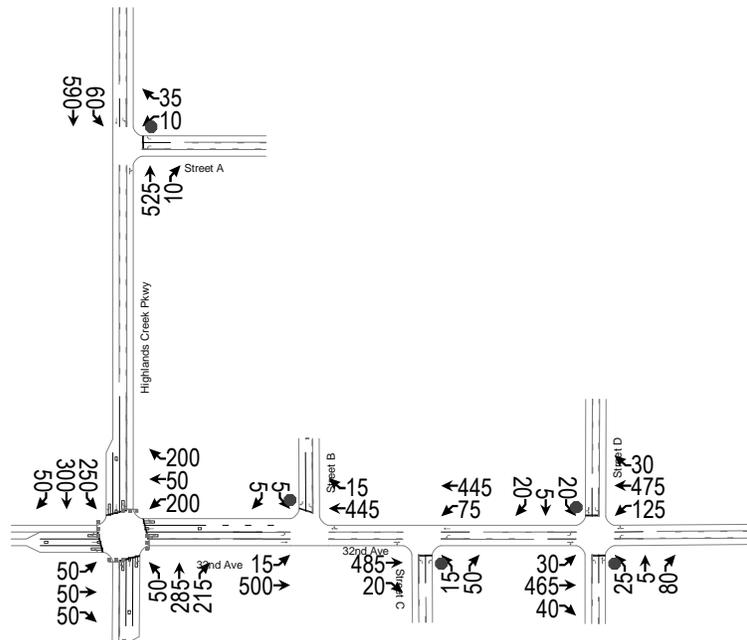
Major/Minor	Major1		Major2		Minor1		Minor2					
Conflicting Flow All	359	0	0	266	0	0	736	725	258	791	728	354
Stage 1	-	-	-	-	-	-	280	280	-	440	440	-
Stage 2	-	-	-	-	-	-	456	445	-	351	288	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
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	1200	-	-	1298	-	-	335	352	781	307	350	690
Stage 1	-	-	-	-	-	-	727	679	-	596	578	-
Stage 2	-	-	-	-	-	-	584	575	-	666	674	-
Platoon blocked, %	-	-	-	-	-	-	-	-	-	-	-	-
Mov Cap-1 Maneuver	1200	-	-	1298	-	-	308	337	781	243	335	690
Mov Cap-2 Maneuver	-	-	-	-	-	-	308	337	-	243	335	-
Stage 1	-	-	-	-	-	-	720	673	-	591	559	-
Stage 2	-	-	-	-	-	-	537	556	-	541	668	-

Approach	EB		WB		NB		SB	
HCM Control Delay, s	0.3		0.9		12.3		16.1	
HCM LOS					B		C	

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	308	743	1200	-	-	1298	-	-	243	586
HCM Lane V/C Ratio	0.106	0.19	0.009	-	-	0.033	-	-	0.112	0.056
HCM Control Delay (s)	18.1	11	8	-	-	7.9	-	-	21.7	11.5
HCM Lane LOS	C	B	A	-	-	A	-	-	C	B
HCM 95th %tile Q(veh)	0.4	0.7	0	-	-	0.1	-	-	0.4	0.2



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↖	↑	↗	↖	↑	↗	↖	↑	↗	↖	↑	↗
Traffic Volume (veh/h)	100	20	50	150	20	210	50	200	50	125	260	125
Future Volume (veh/h)	100	20	50	150	20	210	50	200	50	125	260	125
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	109	22	54	163	22	228	54	217	54	136	283	136
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	369	259	220	443	323	274	466	582	494	735	924	783
Arrive On Green	0.07	0.14	0.14	0.10	0.17	0.17	0.04	0.31	0.31	0.23	0.49	0.49
Sat Flow, veh/h	1781	1870	1585	1781	1870	1585	1781	1870	1585	1781	1870	1585
Grp Volume(v), veh/h	109	22	54	163	22	228	54	217	54	136	283	136
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1781	1870	1585	1781	1870	1585	1781	1870	1585
Q Serve(g_s), s	4.2	0.8	2.5	6.2	0.8	11.4	1.7	7.4	2.0	3.0	7.4	3.9
Cycle Q Clear(g_c), s	4.2	0.8	2.5	6.2	0.8	11.4	1.7	7.4	2.0	3.0	7.4	3.9
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	369	259	220	443	323	274	466	582	494	735	924	783
V/C Ratio(X)	0.30	0.08	0.25	0.37	0.07	0.83	0.12	0.37	0.11	0.18	0.31	0.17
Avail Cap(c_a), veh/h	408	423	358	682	697	590	509	582	494	735	924	783
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(l)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	27.3	30.7	31.4	25.6	28.3	32.7	17.6	22.0	20.1	9.1	12.3	11.5
Incr Delay (d2), s/veh	0.4	0.1	0.6	0.5	0.1	6.5	0.1	1.8	0.4	0.6	0.9	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	1.8	0.4	1.0	2.6	0.4	4.7	0.7	3.4	0.8	1.1	3.1	1.4
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	27.7	30.9	32.0	26.1	28.4	39.2	17.7	23.8	20.5	9.7	13.2	11.9
LnGrp LOS	C	C	C	C	C	D	B	C	C	A	B	B
Approach Vol, veh/h		185			413			325			555	
Approach Delay, s/veh		29.4			33.5			22.2			12.0	
Approach LOS		C			C			C			B	
Timer - Assigned Phs	1	2	3	4	5	6	7	8				
Phs Duration (G+Y+Rc), s	23.0	30.0	13.0	15.9	8.0	45.0	10.2	18.7				
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5				
Max Green Setting (Gmax), s	18.5	25.5	19.5	18.5	5.5	38.5	7.5	30.5				
Max Q Clear Time (g_c+I1), s	5.0	9.4	8.2	4.5	3.7	9.4	6.2	13.4				
Green Ext Time (p_c), s	0.3	1.2	0.3	0.2	0.0	2.2	0.0	0.8				
Intersection Summary												
HCM 6th Ctrl Delay				22.4								
HCM 6th LOS				C								



Intersection						
Int Delay, s/veh	1.4					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↶		↷	↶	↷	↷
Traffic Vol, veh/h	485	20	75	445	15	50
Future Vol, veh/h	485	20	75	445	15	50
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	50	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	527	22	82	484	16	54

Major/Minor	Major1	Major2	Minor1			
Conflicting Flow All	0	0	549	0	1186	538
Stage 1	-	-	-	-	538	-
Stage 2	-	-	-	-	648	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1021	-	208	543
Stage 1	-	-	-	-	585	-
Stage 2	-	-	-	-	521	-
Platoon blocked, %	-	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	1021	-	191	543
Mov Cap-2 Maneuver	-	-	-	-	326	-
Stage 1	-	-	-	-	585	-
Stage 2	-	-	-	-	479	-

Approach	EB	WB	NB
HCM Control Delay, s	0	1.3	13.4
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	326	543	-	-	1021	-
HCM Lane V/C Ratio	0.05	0.1	-	-	0.08	-
HCM Control Delay (s)	16.6	12.4	-	-	8.8	-
HCM Lane LOS	C	B	-	-	A	-
HCM 95th %tile Q(veh)	0.2	0.3	-	-	0.3	-

Intersection						
Int Delay, s/veh	0.9					
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↙	↗	↖		↙	↗
Traffic Vol, veh/h	10	35	525	10	60	590
Future Vol, veh/h	10	35	525	10	60	590
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	50	0	-	-	50	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	11	38	571	11	65	641

Major/Minor	Minor1	Major1	Major2		
Conflicting Flow All	1348	577	0	0	582
Stage 1	577	-	-	-	-
Stage 2	771	-	-	-	-
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	166	516	-	-	992
Stage 1	562	-	-	-	-
Stage 2	456	-	-	-	-
Platoon blocked, %			-	-	-
Mov Cap-1 Maneuver	155	516	-	-	992
Mov Cap-2 Maneuver	290	-	-	-	-
Stage 1	562	-	-	-	-
Stage 2	426	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	13.7	0	0.8
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	290	516	992	-
HCM Lane V/C Ratio	-	-	0.037	0.074	0.066	-
HCM Control Delay (s)	-	-	17.9	12.5	8.9	-
HCM Lane LOS	-	-	C	B	A	-
HCM 95th %tile Q(veh)	-	-	0.1	0.2	0.2	-

Intersection						
Int Delay, s/veh	0.2					
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↙	↑	↗		↙	↗
Traffic Vol, veh/h	15	500	445	15	5	5
Future Vol, veh/h	15	500	445	15	5	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	100	-	-	-	100	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	16	543	484	16	5	5

Major/Minor	Major1	Major2	Minor2		
Conflicting Flow All	500	0	-	0	1067 492
Stage 1	-	-	-	-	492 -
Stage 2	-	-	-	-	575 -
Critical Hdwy	4.12	-	-	-	6.42 6.22
Critical Hdwy Stg 1	-	-	-	-	5.42 -
Critical Hdwy Stg 2	-	-	-	-	5.42 -
Follow-up Hdwy	2.218	-	-	-	3.518 3.318
Pot Cap-1 Maneuver	1064	-	-	-	246 577
Stage 1	-	-	-	-	615 -
Stage 2	-	-	-	-	563 -
Platoon blocked, %		-	-	-	
Mov Cap-1 Maneuver	1064	-	-	-	242 577
Mov Cap-2 Maneuver	-	-	-	-	377 -
Stage 1	-	-	-	-	606 -
Stage 2	-	-	-	-	563 -

Approach	EB	WB	SB
HCM Control Delay, s	0.2	0	13
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	1064	-	-	-	377	577
HCM Lane V/C Ratio	0.015	-	-	-	0.014	0.009
HCM Control Delay (s)	8.4	-	-	-	14.7	11.3
HCM Lane LOS	A	-	-	-	B	B
HCM 95th %tile Q(veh)	0	-	-	-	0	0

Intersection												
Int Delay, s/veh	4.5											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↶	↷		↶	↷		↶	↷		↶	↷	
Traffic Vol, veh/h	30	465	40	125	475	30	25	5	80	20	5	20
Future Vol, veh/h	30	465	40	125	475	30	25	5	80	20	5	20
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None									
Storage Length	50	-	-	50	-	-	50	-	-	50	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	33	505	43	136	516	33	27	5	87	22	5	22

Major/Minor	Major1		Major2		Minor1		Minor2					
Conflicting Flow All	549	0	0	548	0	0	1411	1414	527	1444	1419	533
Stage 1	-	-	-	-	-	-	593	593	-	805	805	-
Stage 2	-	-	-	-	-	-	818	821	-	639	614	-
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	1021	-	-	1021	-	-	116	138	551	110	137	547
Stage 1	-	-	-	-	-	-	492	493	-	376	395	-
Stage 2	-	-	-	-	-	-	370	389	-	464	483	-
Platoon blocked, %	-	-	-	-	-	-	-	-	-	-	-	-
Mov Cap-1 Maneuver	1021	-	-	1021	-	-	94	116	551	78	115	547
Mov Cap-2 Maneuver	-	-	-	-	-	-	94	116	-	78	115	-
Stage 1	-	-	-	-	-	-	476	477	-	364	342	-
Stage 2	-	-	-	-	-	-	303	337	-	374	468	-

Approach	EB		WB		NB		SB	
HCM Control Delay, s	0.5		1.8		24.8		40	
HCM LOS					C		E	

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	94	451	1021	-	-	1021	-	-	78	312
HCM Lane V/C Ratio	0.289	0.205	0.032	-	-	0.133	-	-	0.279	0.087
HCM Control Delay (s)	58.2	15	8.6	-	-	9.1	-	-	68.1	17.6
HCM Lane LOS	F	C	A	-	-	A	-	-	F	C
HCM 95th %tile Q(veh)	1.1	0.8	0.1	-	-	0.5	-	-	1	0.3



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↖	↑	↗	↖	↑	↗	↖	↑	↗	↖	↑	↗
Traffic Volume (veh/h)	50	50	50	200	50	200	50	285	215	250	300	50
Future Volume (veh/h)	50	50	50	200	50	200	50	285	215	250	300	50
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	54	54	54	217	54	217	54	310	234	272	326	54
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	255	144	122	396	316	268	503	623	528	668	966	818
Arrive On Green	0.04	0.08	0.08	0.14	0.17	0.17	0.04	0.33	0.33	0.23	0.52	0.52
Sat Flow, veh/h	1781	1870	1585	1781	1870	1585	1781	1870	1585	1781	1870	1585
Grp Volume(v), veh/h	54	54	54	217	54	217	54	310	234	272	326	54
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1781	1870	1585	1781	1870	1585	1781	1870	1585
Q Serve(g_s), s	2.2	2.2	2.6	8.4	2.0	10.4	1.5	10.5	9.2	5.9	8.1	1.4
Cycle Q Clear(g_c), s	2.2	2.2	2.6	8.4	2.0	10.4	1.5	10.5	9.2	5.9	8.1	1.4
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	255	144	122	396	316	268	503	623	528	668	966	818
V/C Ratio(X)	0.21	0.37	0.44	0.55	0.17	0.81	0.11	0.50	0.44	0.41	0.34	0.07
Avail Cap(c_a), veh/h	291	425	360	560	729	618	539	661	560	668	966	818
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	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	31.6	34.7	34.9	26.3	28.2	31.7	15.9	21.1	20.7	9.5	11.2	9.6
Incr Delay (d2), s/veh	0.4	1.6	2.5	1.2	0.3	5.8	0.1	0.6	0.6	1.8	0.9	0.2
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	0.9	1.0	1.1	3.5	0.9	4.3	0.6	4.5	3.3	2.3	3.3	0.5
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	32.0	36.3	37.4	27.5	28.4	37.5	16.0	21.7	21.3	11.3	12.2	9.8
LnGrp LOS	C	D	D	C	C	D	B	C	C	B	B	A
Approach Vol, veh/h		162			488			598			652	
Approach Delay, s/veh		35.2			32.1			21.0			11.6	
Approach LOS		D			C			C			B	
Timer - Assigned Phs	1	2	3	4	5	6	7	8				
Phs Duration (G+Y+Rc), s	22.5	30.9	15.2	10.6	8.0	45.4	8.0	17.9				
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5				
Max Green Setting (Gmax), s	18.0	28.0	18.0	18.0	5.1	40.9	5.1	30.9				
Max Q Clear Time (g_c+I1), s	7.9	12.5	10.4	4.6	3.5	10.1	4.2	12.4				
Green Ext Time (p_c), s	0.6	2.4	0.4	0.3	0.0	2.3	0.0	0.9				
Intersection Summary												
HCM 6th Ctrl Delay				21.8								
HCM 6th LOS				C								

Traffic Signal Warrant Summary Worksheet

100%

The Worksheet(s) attached are provided as an attachment to the Engineering Investigation Study for:

Intersection: Highlands Creek Pkwy & 32nd Ave.

County:

Town: Aurora

Major Street: Highlands Creek Pkwy

Minor Street: 32nd Ave.

Critical Approach Speed: 35 mph

Critical Approach Speed: 35 mph

Lanes: 2 or more lanes

Lanes: 2 or more lanes

% Right Turns Included

In built-up area of isolated community of < 10,000 population? No

From North (SB) 0%

Total number of approaches at intersection? 4 or more

From East (WB) 0%

If it is a "T" intersection, inflate minor threshold to 150%? No

From South (NB) 100%

Manually set volume level? 100%

From West (EB) 0%

Analysis based on PROJECTED volume data.

Forecast Year	Within 5 Years of Construction?	Time (HH:MM)			
		From	AM / PM	To	AM / PM
2040	No	6	AM	10	PM

Warrant Evaluation Summary	Warrant Met:
Warrant 1: Eight - Hour Vehicular Volume	Yes
Condition A: Minimum Vehicular Volume	Yes
Condition B: Interruption of Continuous Traffic	No
Condition C: Combination: 80% of A and B	No
Warrant 2: Four-Hour Volume	Yes
Warrant 3: Peak Hour Volume	Yes
Warrant 4: Pedestrian Volume	N/A
Criterion A: Four-Hour	
Criterion B: Peak-Hour	
Warrant 5: School Crossing	N/A
Warrant 6: Coordinated Signal System	N/A
Warrant 7: Crash Experience	N/A
Warrant 8: Roadway Network	Yes
Warrant 9: Intersection Near a Grade Crossing	N/A

Warrant Analysis Conducted By:

Name: John Aldridge

Agency: Aldridge Transportation Consultants

Date: 10/6/2022

Warrant 1: Eight - Hour Vehicular Volume

100%

Warrant Evaluated? Yes

Warrant Satisfied? Yes

Manually Set To: Yes

Condition A : Min. Veh. Volume		
Volume Level	100%	80%
Major Rd. Req	600	480
Minor Rd. Req	200	160
Number of Hours	8	12

Satisfied? Yes

Condition B: Interruption of Continuous Traffic		
Volume Level	100%	80%
Major Rd. Req	900	720
Minor Rd. Req	100	80
Number of Hours	3	6

Satisfied? No

Condition C: Combination of A & B at 80%		
---------------------------------------------	--	--

Satisfied? No

Time Period	6:00 AM		Enter Start Time (Military Time) (HH:MM)		Total
	From	To	Major Road: Both App. (VPH)	Minor Road: High App. (VPH)	
1	6:00	7:00	382	215	597
2	7:00	8:00	788	436	1224
3	8:00	9:00	927	466	1393
4	9:00	10:00	654	284	938
5	10:00	11:00	560	205	765
6	11:00	12:00	674	258	932
7	12:00	13:00	724	198	922
8	13:00	14:00	580	178	758
9	14:00	15:00	674	218	892
10	15:00	16:00	654	169	823
11	16:00	17:00	892	235	1127
12	17:00	18:00	1135	211	1346
13	18:00	19:00	1062	258	1320
14	19:00	20:00	654	129	783
15	20:00	21:00	520	129	649
16	21:00	22:00	352	53	405

Warrant 2: Four-Hour Volume

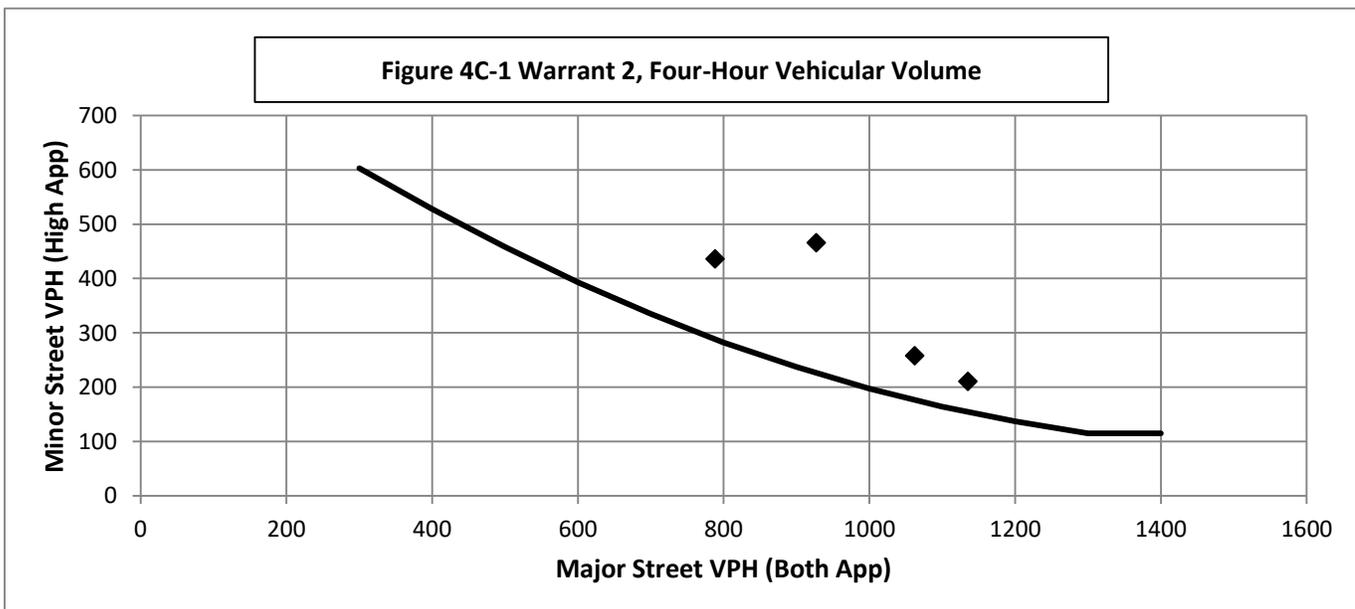
100%

Warrant Evaluated? Yes

Warrant Satisfied? Yes

Manually Set To: Yes

Hour Start	8:00	17:00	18:00	7:00
Major Road Vol.	927	1135	1062	788
Minor Road Vol.	466	211	258	436



Warrant 3: Peak Hour Volume

100%

Warrant Evaluated? Yes

Warrant Satisfied? Yes

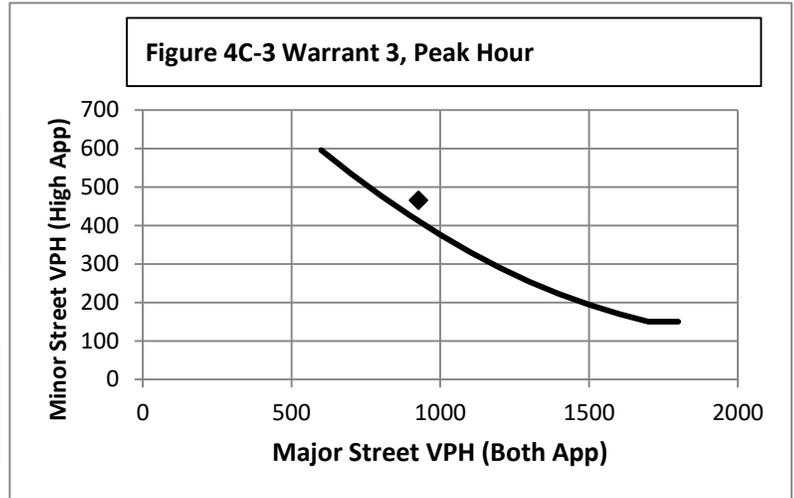
Manually Set To: Yes

Condition justifying use of warrant:

Criteria		Met?
Delay on Minor Approach	5	Yes
Volume on Minor Approach	150	
Total Entering Volume (veh/h)	800	

Manually Set Peak Hour? No

Peak Hour	Major Road Vol. (Both App.)	Minor Road Vol. (High App.)
8:00	927	466



Warrant 4: Pedestrian Volume

100%

Warrant Evaluated?

Warrant Satisfied? N/A

Manually Set To:

Criterion A: Four Hour

Hour (Start)	Pedestrian Volume	Major Road Vol.
0:00	0	#N/A

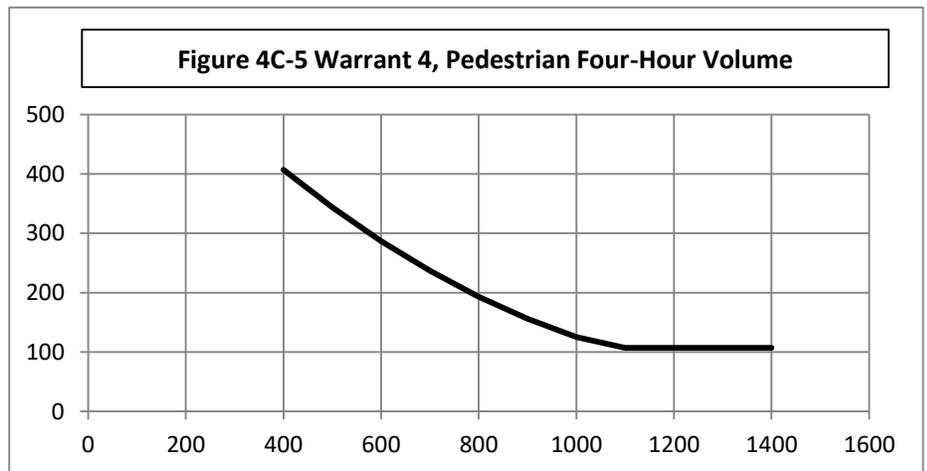
Manually Set Major Rd Vol?

No

Avg. walk speed less than 3.5 ft/s?

No

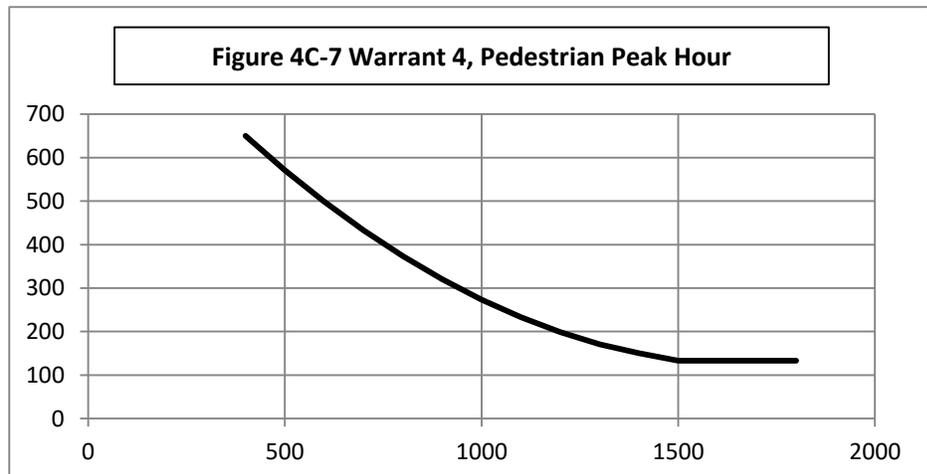
Criterion A Satisfied?



Criterion B: Peak Hour

Peak Hour	Pedestrian Vol.	Major Road Vol.
#N/A	#N/A	#N/A

Criterion B Satisfied?



Warrant 5: School Crossing

100%

Warrant Evaluated?

Warrant Satisfied? N/A

Manually Set To:

Criteria		Fulfilled?
1	There are a MINIMUM of 20 school children during the highest crossing hour.	
2	There are fewer adequate gaps in the major road traffic stream during the period when the school children are using the crossing than the number of minutes in the same period.	
3	The nearest traffic signal along the major road is located more than 300 ft away. Or, the nearest traffic signal is within 300 ft but the proposed traffic signal will not restrict the progressive movement of traffic.	

Warrant 6: Coordinated Signal System

100%

Warrant Evaluated?

Warrant Satisfied? N/A

Manually Set To:

Criteria		Fulfilled?
1	Signal spacing > 1000 ft	
2	On a one-way road or a road that has traffic predominantly in one direction, the adjacent signals are so far apart that they do not provide the necessary degree of vehicle platooning.	
3	On a two-way road, adjacent signals do not provide the necessary degree of platooning and the proposed and the adjacent signals will collectively provide a progressive operation.	

Warrant 7: Crash Experience

100%

Warrant Evaluated?

Warrant Satisfied? N/A

Manually Set To:

Criteria		Met?	Fulfilled?
1	Adequate trial of other remedial measures has failed to reduce crash frequency.		
	Measures Tried:		
2	Five or more reported crashes, of types susceptible to correction by signal, have occurred within a 12 month period.	# of crashes per 12 months	
3	Warrant 1, Condition A (80%)	Yes	#N/A
	Warrant 1, Condition B (80%)	No	
	Warrant 4, Criterion A (80%)	#N/A	
	Warrant 4, Criterion B (80%)	#N/A	

Warrant 8: Roadway Network

100%

Warrant Evaluated? Yes

Warrant Satisfied? Yes

Manually Set To:

Criteria		Met?	Fulfilled?
1	Total entering volume of at least 1,000 veh/h during typical weekday peak hour	1393	Yes
	Five-year projected volumes that satisfy one or more of Warrants 1, 2, or 3.	2	Yes
2	Total entering vol. of at least 1,000 veh/h for each of any 5 hrs of non-normal business day (Sat. or Sun.)		
	Hour		
	Volume		

Characteristics of Major Routes - Select yes if all intersecting routes have characteristic		Fulfilled?
1	Part of the road or highway system that serves as the principal roadway network for through traffic flow	Yes
2	Rural or suburban highway outside of, entering, or traversing a city	Yes
3	Appears as a major route on an official plan	Yes

Warrant 9: Intersection Near a Grade Crossing

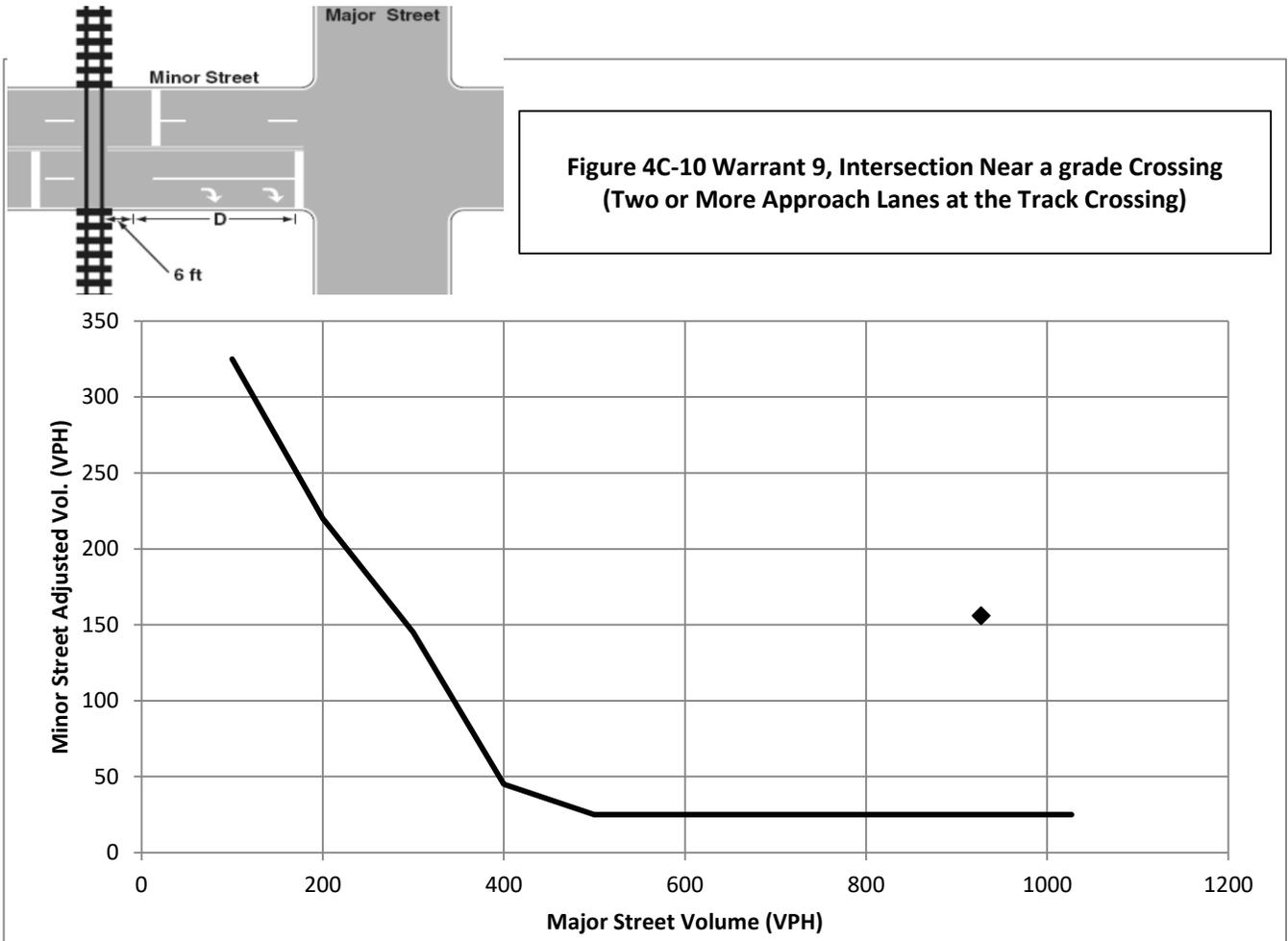
100%

Warrant Evaluated?

Warrant Satisfied? N/A

Manually Set To:

Adjustment Factors			Manually Set Peak Hour?				
Rail Traffic per Day	% High Occupancy Buses on Minor Road	% Tractor-Trailer Trucks on Minor Road	D	Peak Hour	Major Road Vol.	Minor Road Vol.	Adjusted Minor Vol.
1	0	0% to 2.5%	660	8:00	927	466	156.11



Conclusions/Comments:

Updated: 12/6/2017