FOX engineering

Aspen Business Park | 414 South 17th Street, Suite 107 | Ames, Iowa 50010

Traffic Memorandum

DATE: March 6, 2014

TO: Damion Pregitzer, P.E.

FROM: Scott Williams, P.E.

RE: Left-Turn Lane Warrants
Quarry Estates Subdivision, Ames, IA
FOX P/N 5343-12A

1.0 BACKGROUND

This memorandum summarizes the results of a traffic analysis for the proposed Quarry Estates Subdivision located southeast of the intersection of W 190th Street and Grant Avenue in Ames, Iowa. A proposed layout of Quarry Estates Subdivision is included as Figure 1.

This study is based on a Traffic Impact Study completed for the Rose Prairie Subdivision by HWS Consulting Group in May 2008. That study evaluated future traffic impacts within the area bounded by GW Carver Avenue on the west, Grand Avenue (US 69) on the east, Bloomington Road on the south, and 190th Street on the north. The proposed Quarry Estates Subdivision is located within the boundary of the previous study area.

The purpose of this study is to evaluate whether dedicated left-turn lanes are warranted at entrances to the proposed subdivision. The approach of this study is to evaluate the intersections based on Year 2030 Full Build traffic volumes from the 2008 Rose Prairie Traffic Impact Study (which were modeled but not included in that earlier report). Synchro output from the earlier study is included as Appendix A. A previous Traffic Memorandum by FOX Engineering titled, "*Trip Generation Rates, Quarry Estates Subdivision, Ames, IA, July 25, 2014*", confirmed that trip generation rates estimated for Quarry Estates in the 2008 Rose Prairie Traffic Impact Study are similar to rates based on the current planned development.

Figure 1 - Quarry Estates Subdivision

2.0 FUTURE TRAFFIC CONDITIONS

2.1 Year 2030 Full Build - Traffic Volumes

This scenario includes not only the full build out of Quarry Estates Subdivision, but full build out of all development areas within the limits of the 2008 Rose Prairie Traffic Impact Study. Peak hour volumes for the W 190th Street and Grant Avenue intersection are shown in Appendix B. Year 2030 Full Build volumes were superimposed (in red) on the Year 2030 Base Traffic Volumes figure from the earlier study. Those peak hour turn volumes were used to estimate peak hour volumes on the roadway segments adjacent to the W 190th Street and Grant Avenue intersection, as shown on the figure. As the proposed entrances to the Quarry Estates Subdivision are all near this intersection, advancing and opposing volumes for each entrance were based on these peak hour volumes.

2.1 Year 2030 Full Build - Trip Distribution

Trip distribution for the Full Build scenario was included in the 2008 Rose Prairie Traffic Impact Study, and is included in Appendix C. At that time, it was estimated that 35% of the site generated traffic would enter the roadway network onto Grant Avenue, and 65% of the site generated traffic would enter the network onto W 190th Street. As currently planned, the development includes a single entrance to the subdivision from Grant Avenue and two entrances from W 190th Street. Based on the proposed site layout, this distribution seems reasonable. For purposes of this study, we've assumed a similar distribution:

Grant Avenue / Ada Hayden Road intersection - 34%
W 190th Street / McFarland Avenue intersection - 33%
W 190th Street / Ada Hayden Road intersection - 33%

Table 1: Comparison of Peak Hour Trips

	Trips			
	AM		PM	
	In	Out	In	Out
Quarry Estates Subdivision	32	105	113	64
(from Trip Generation - Quarry Estates Subdivision, Ames, IA, July 25, 2014)				
Intersection				
Grant Ave. / Ada Hayden Rd. intersection (34%)	11	36	38	22
W 190th St. / McFarland Ave. intersection (33%)	11	35	37	21
W 190th St. / Ada Hayden Rd. intersection (33%)	11	35	37	21

2.3 Left Turn Lane Warrants

Evaluation of whether dedicated left turn lanes are warranted at proposed entrances to the Quarry Estates Subdivision is based on Chapter 2 of "*National Cooperative Highway Research Program (NCHRP) Report 457 - Evaluating Intersection Improvements: An Engineering Study Guide*".

This guidance document "suggests the following guidelines should be used to determine when to provide a left-turn bay on the major road of a two-way stop-controlled intersection:

1. A left-turn lane should be considered at any median crossover on a divided, high-speed road.
2. A left-turn lane should be provided on the unstopped approach of a high-speed rural highway when it intersects with other arterials or collectors.
3. A left-turn lane is recommended on the unstopped approach of any intersection when the combination of intersection volumes intersect above or to the right of the appropriate trend line shown in Figure 2-5".

Of the three guidelines described, only item 3 applies to the proposed entrances to Quarry Estates Subdivision. Use of Figure 2-5 requires determination of opposing volume, the advancing volume, and the operating speed. Advancing and opposing volumes for each entrance were based on calculations described in Section 2.1. Percentage of left-turning vehicles were based on calculations described in Section 2.2. It should be noted that 100% of AM and PM trips into the proposed development were assumed to be left-turns. This results in conservative results, as a portion of the trips into the development are likely not left-turns. 85th percentile speeds were assumed to be 5 mph above the posted speed limits for Grant Avenue and W 190th Street. Results of the analysis described in NCHRP 457 are included in Appendix D.

3.0 CONCLUSIONS

The results of this analysis indicate that dedicated left-turn lanes are not warranted on Grant Avenue or W 190th Street, at proposed entrances to Quarry Estates Subdivision.

Appendix A

Synchro Output

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	16	159	24	40	68	8	46	45	61	6	20	8
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
Hourly flow rate (vph)	17	173	26	43	74	9	50	49	66	7	22	9
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	83			199			405	390	186	477	399	78
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	83			199			405	390	186	477	399	78
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			97			90	91	92	98	96	99
cM capacity (veh/h)	1515			1373			516	522	856	413	516	982

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	216	126	165	37
Volume Left	17	43	50	7
Volume Right	26	9	66	9
cSH	1515	1373	616	554
Volume to Capacity	0.01	0.03	0.27	0.07
Queue Length 95th (ft)	1	2	27	5
Control Delay (s)	0.7	2.8	13.0	12.0
Lane LOS	A	A	B	B
Approach Delay (s)	0.7	2.8	13.0	12.0
Approach LOS			B	B

Intersection Summary			
Average Delay	5.7		
Intersection Capacity Utilization	38.1%	ICU Level of Service	A
Analysis Period (min)	15		

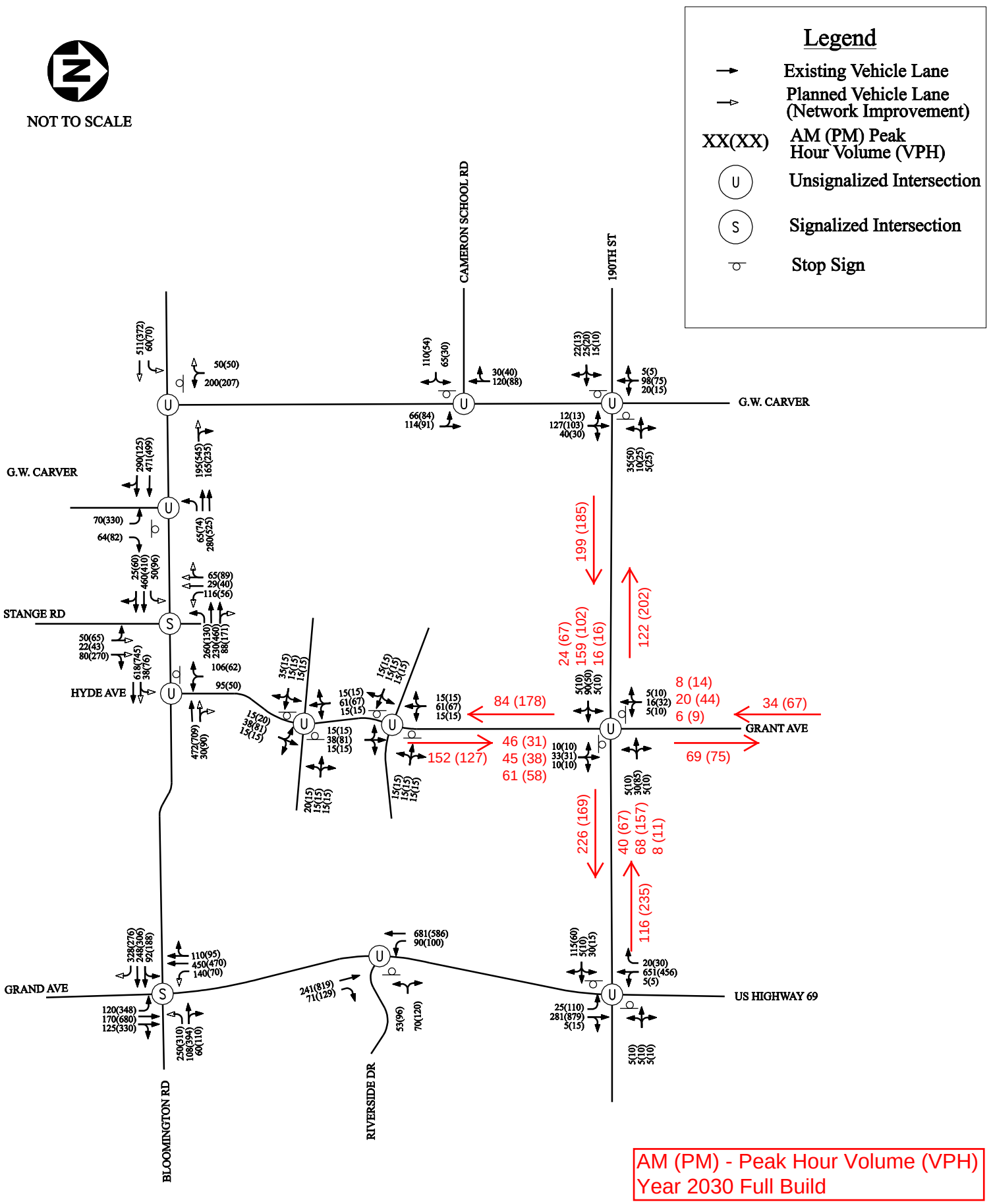
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	16	102	67	67	157	11	31	38	58	9	44	14
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	17	111	73	73	171	12	34	41	63	10	48	15
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	183			184			543	510	147	588	541	177
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	183			184			543	510	147	588	541	177
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			95			91	91	93	97	89	98
cM capacity (veh/h)	1392			1391			384	436	900	345	419	866

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	201	255	138	73
Volume Left	17	73	34	10
Volume Right	73	12	63	15
cSH	1392	1391	547	455
Volume to Capacity	0.0	0.05	0.25	0.16
Queue Length 95th (ft)	1	4	25	14
Control Delay (s)	0.8	2.5	13.8	14.4
Lane LOS	A	A	B	B
Approach Delay (s)	0.8	2.5	13.8	14.4
Approach LOS			B	B

Intersection Summary			
Average Delay	5.6		
Intersection Capacity Utilization	45.3%	ICU Level of Service	A
Analysis Period (min)	15		

Appendix B

Peak Hour Volumes



Rose Prairie Subdivision
Ames, IA

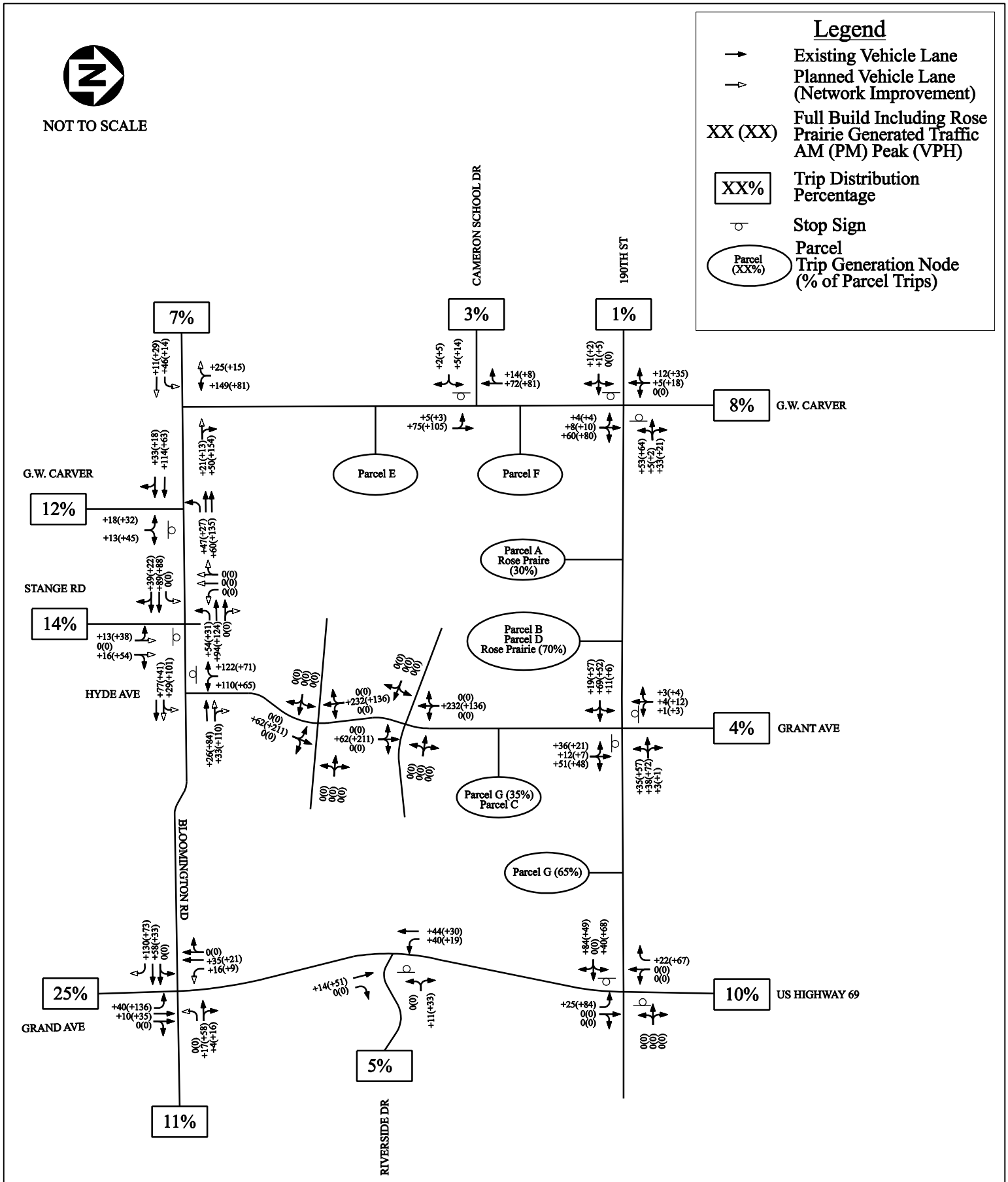
Year 2030
Base Traffic Volumes

AMES OFFICE
223 S. Walnut Ave., Ste D
Ames, Iowa 50010
(515) 232-1103
www.hws.com

Figure 6

Appendix C

Trip Distribution



Rose Prairie Subdivision
Ames, IA

Trip Distribution and Full Build Generated Traffic

AMES OFFICE
223 S. Walnut Ave., Ste D
Ames, Iowa 50010
(515) 232-1103
www.hws.com

Figure 5

Appendix D

Left-Turn Warrants

(from NCHRP 457)

Figure 2 - 5. Guideline for determining the need for a major-road left-turn bay at a two-way stop-controlled intersection.

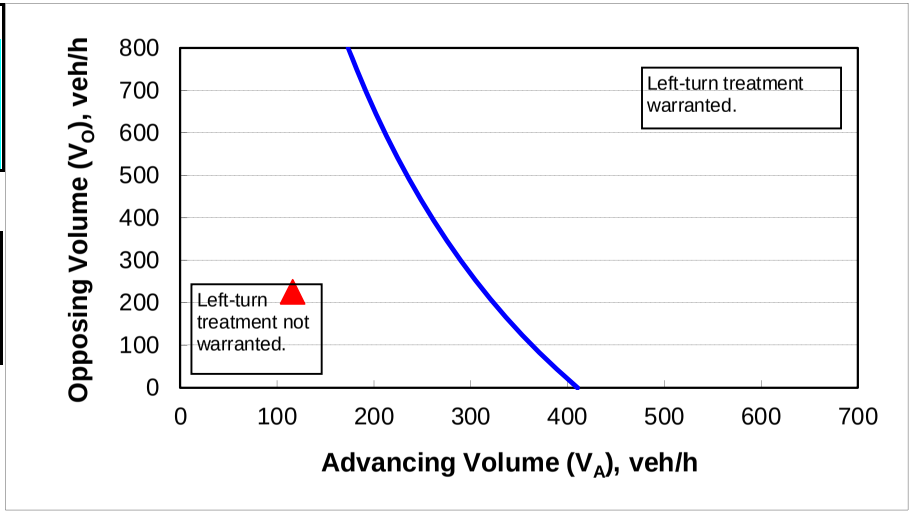
2-lane roadway (English)

INPUT

Variable	Value
85th percentile speed, mph:	60
Percent of left-turns in advancing volume (V_A), %:	10%
Advancing volume (V_A), veh/h:	116
Opposing volume (V_O), veh/h:	226

OUTPUT

Variable	Value
Limiting advancing volume (V_A), veh/h:	314
Guidance for determining the need for a major-road left-turn bay:	
Left-turn treatment NOT warranted.	



CALIBRATION CONSTANTS

Variable	Value
Average time for making left-turn, s:	3.0
Critical headway, s:	5.0
Average time for left-turn vehicle to clear the advancing lane , s:	1.9

Guidelines from NCHRP 457

W 190th St. intersections with McFarland Ave. and Ada Hayden Rd.
AM Peak Hour Volume (VPH)
Year 2030 Full Build

Figure 2 - 5. Guideline for determining the need for a major-road left-turn bay at a two-way stop-controlled intersection.

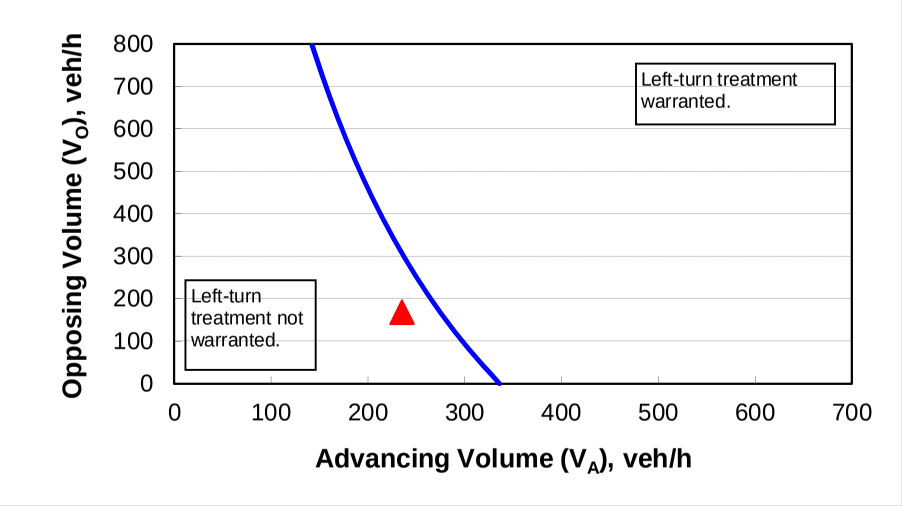
2-lane roadway (English)

INPUT

Variable	Value
85th percentile speed, mph:	60
Percent of left-turns in advancing volume (V_A), %:	16%
Advancing volume (V_A), veh/h:	235
Opposing volume (V_O), veh/h:	169

OUTPUT

Variable	Value
Limiting advancing volume (V_A), veh/h:	274
Guidance for determining the need for a major-road left-turn bay:	
Left-turn treatment NOT warranted.	



CALIBRATION CONSTANTS

Variable	Value
Average time for making left-turn, s:	3.0
Critical headway, s:	5.0
Average time for left-turn vehicle to clear the advancing lane , s:	1.9

Guidelines from NCHRP 457

W 190th St. intersections with McFarland Ave. and Ada Hayden Rd.
PM Peak Hour Volume (VPH)
Year 2030 Full Build

Figure 2 - 5. Guideline for determining the need for a major-road left-turn bay at a two-way stop-controlled intersection.

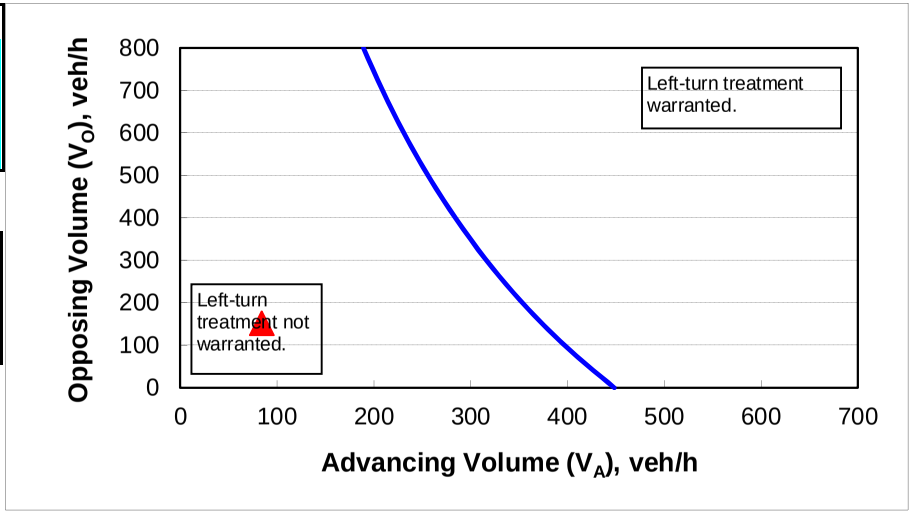
2-lane roadway (English)

INPUT

Variable	Value
85th percentile speed, mph:	50
Percent of left-turns in advancing volume (V_A), %:	13%
Advancing volume (V_A), veh/h:	84
Opposing volume (V_O), veh/h:	152

OUTPUT

Variable	Value
Limiting advancing volume (V_A), veh/h:	374
Guidance for determining the need for a major-road left-turn bay:	
Left-turn treatment NOT warranted.	



CALIBRATION CONSTANTS

Variable	Value
Average time for making left-turn, s:	3.0
Critical headway, s:	5.0
Average time for left-turn vehicle to clear the advancing lane , s:	1.9

Guidelines from NCHRP 457

Grant Ave. intersection with Ada Hayden Rd.
AM Peak Hour Volume (VPH)
Year 2030 Full Build

Figure 2 - 5. Guideline for determining the need for a major-road left-turn bay at a two-way stop-controlled intersection.

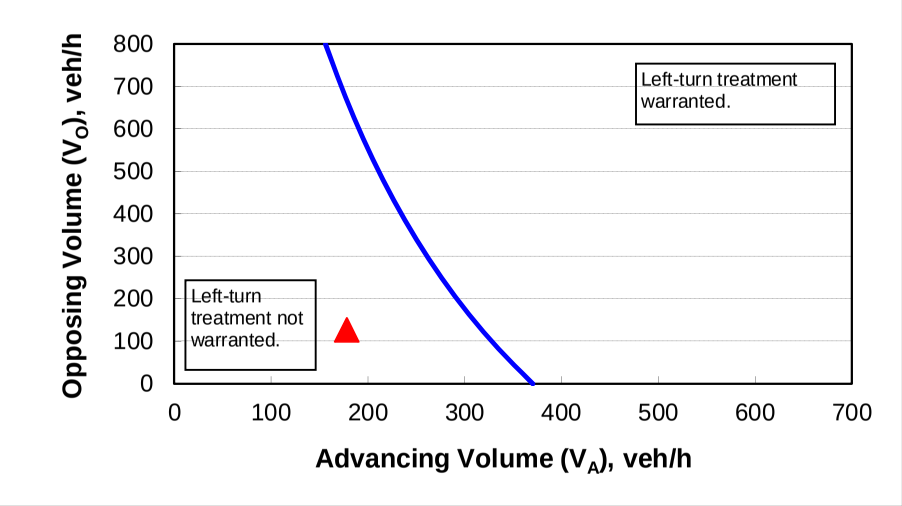
2-lane roadway (English)

INPUT

Variable	Value
85th percentile speed, mph:	50
Percent of left-turns in advancing volume (V_A), %:	21%
Advancing volume (V_A), veh/h:	178
Opposing volume (V_O), veh/h:	127

OUTPUT

Variable	Value
Limiting advancing volume (V_A), veh/h:	318
Guidance for determining the need for a major-road left-turn bay:	
Left-turn treatment NOT warranted.	



CALIBRATION CONSTANTS

Variable	Value
Average time for making left-turn, s:	3.0
Critical headway, s:	5.0
Average time for left-turn vehicle to clear the advancing lane , s:	1.9

Guidelines from NCHRP 457

Grant Ave. intersection with Ada Hayden Rd.
PM Peak Hour Volume (VPH)
Year 2030 Full Build