Traffic Impact Study
Preserve Subdivision
White Oak Avenue, St. John, Indiana

Prepared for: Schilling Development
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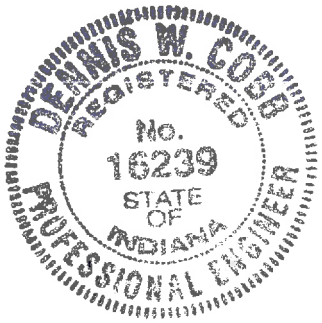
Prepared by
First Group Engineering
January 29, 2016

I certify that this TRAFFIC IMPACT ANALYSIS has been prepared by me or under my immediate supervision in accordance with INDOT's Application Guide to Traffic Impact Studies (2015) and that I have experience and training in the field of traffic and transportation engineering.



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OT\16-0002-02

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Executive Summary

A single family residential development, the Preserve Subdivision, is proposed to be constructed on the west side of White Oak Avenue between 93rd Avenue and 101st Avenue in the Town of St. John. It will contain about 432 home sites. The access plan for the development is for one drive onto 93rd Avenue opposite of Monix Drive and one drive onto White Oak Avenue. The subdivision access will also include a connection to presently vacant property to the west of the subdivision.

This traffic impact study investigated the impacts of the traffic generated by the development on the White Oak Avenue intersections with 93rd Avenue and 101st Avenue and the intersection of 93rd Avenue and Monix Drive.

The operational conditions of these intersections were analyzed and categorized by their Level of Service (LOS) which is a ranking from A to F. Typically, LOS D is the minimum level of service acceptable before improvements are sought. Generally, the intersections and their approaches operated at a Level of Service of A thru C with most of them at Level of Service A or B. The exceptions were as follows:

1. For the Monix Drive intersection, the traffic, from the Preserve in the afternoon peak period will be operating at a Level of Service D.
2. For the White Oak Avenue / 93rd Avenue intersection, the northbound left turn movement (NB Lt E) will slip from D to E in the afternoon peak period. At a point of 50% development, the Level of Service is still a D.

The following is a summary of the recommendations:

1. Widen the south approach at the Monix Drive intersection to two lanes.
2. The area adjacent to all three intersections have vertical curves in the vicinity. Intersection sight distance should be checked by the site civil designer and if not sufficient, "stop ahead" or intersection advisory signs should be installed.
3. At 50% development, the project should be re-studied to determine if the assumptions on distribution were correct and to determine the impacts of the full development.

Traffic Impact Study
Preserve Subdivision
White Oak Avenue, St. John, Indiana

Introduction

This traffic impact study will document the impacts of the traffic generated by the development of a residential subdivision named the Preserve on the west side of White Oak Avenue between 93rd Avenue and 101st Avenue in the Town of St. John, Indiana. The study area will include the White Oak Avenue intersections with 93rd Avenue and 101st Avenue and the intersection of 93rd Avenue and Monix Drive.

Existing Conditions

White Oak Avenue, 93rd Avenue and 101st Avenue are all two lane highways with speed limits of 30 miles per hour (mph). The intersections are controlled as follows:

1. White Oak Avenue and 93rd Avenue is a stop sign for White Oak. The intersection configuration is two lane / two lane with no auxiliary / turn lanes.
2. White Oak Avenue and 101st Avenue is a 4-way stop. The intersection configuration is two lane / two lane with no auxiliary / turn lanes.
3. 93rd Avenue and Monix Drive is a stop sign for Monix Drive. The intersection configuration is two lane / two lane with no auxiliary / turn lanes.

The area adjacent to the proposed development is rural to suburban with some residential lots fronting White Oak Avenue and some subdivision with the back of the lots on these streets. The intersection of 93rd Avenue and White Oak Drive is about one mile west of the intersection of 93rd Avenue and U.S. 41.

The area adjacent to all three intersections have vertical curves in the vicinity. Intersection sight distance should be checked by the site civil designer and if not

sufficient, "stop ahead" or intersection advisory signs should be installed. The posted speed is low so these locations are probably posted correctly now but it would be wise to check the conditions.

101st Avenue feeds west directly to Illinois 394, the Calumet Expressway, which serves as a direct route into the Chicago area. 93rd Avenue runs west to Sheffield Avenue which can be taken south to 101st Avenue or north to U.S 30 and points north of that.

Figure 1 is an aerial photograph of the area.

Manual turning movement counts were collected for the time periods of 6:00 am – 8:00 am and from 4:00 pm - 6:00 pm on a weekday at the following locations:

1. Monix Drive and 93rd Avenue
2. 101st Avenue and White Oak Avenue

Additionally, traffic was counted from 6:00 am to 6:00pm for the intersection of White Oak Avenue and 93rd Avenue also on a weekday.

The am peak hour was 7:00 - 8:00 am. The pm peak hour was from 4:00 - 5:00 pm. The traffic counts are contained in the Appendix.

Figure 2 depicts the traffic volumes for the am and pm peak periods for the subject intersections

The Level of Service (LOS) of an intersection or an approach is the way the operational condition of the intersection or approach is described. Levels of Service are ranked from A to F, with A being very good. Generally LOS D is the minimum acceptable Level of Service

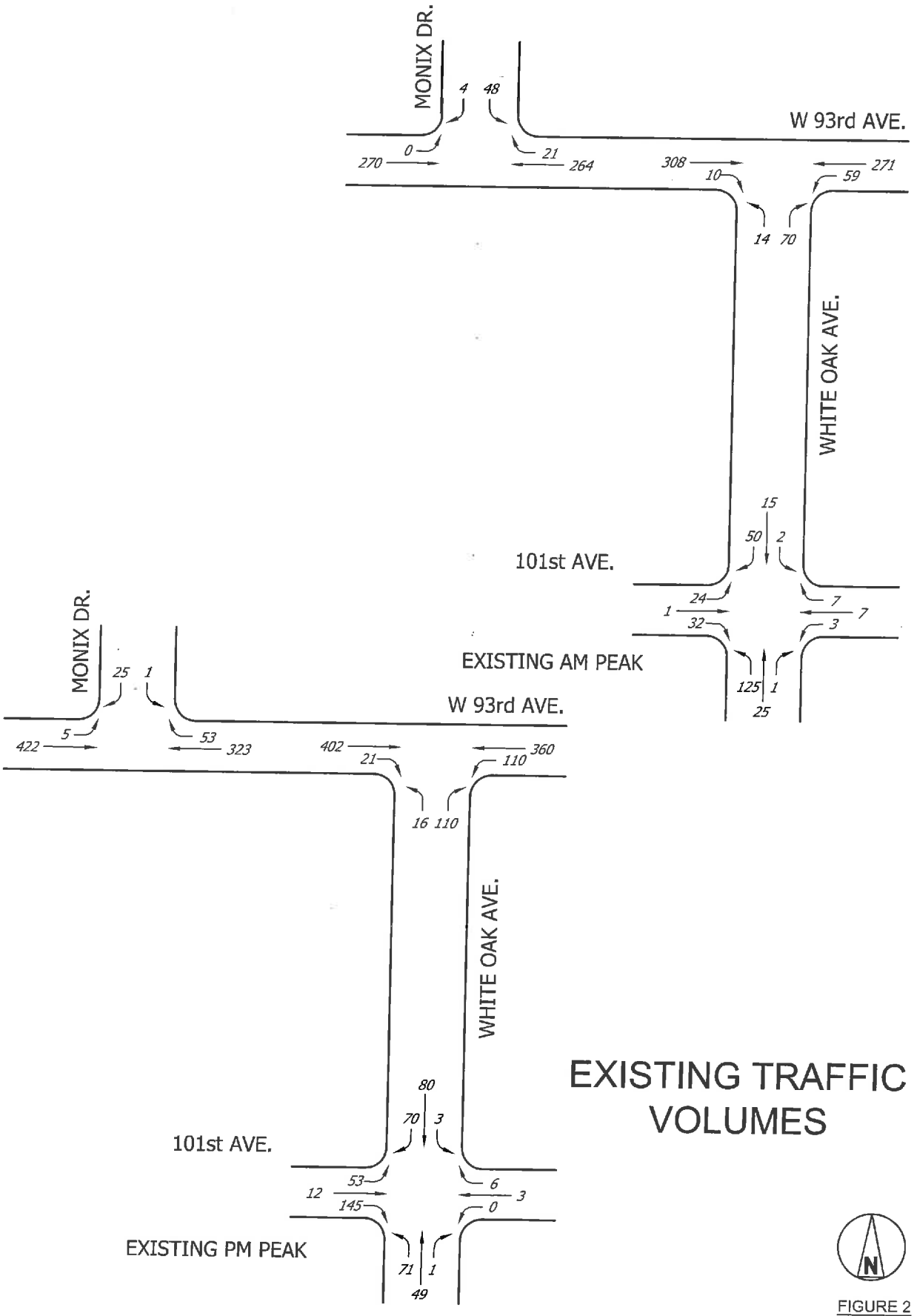
Intersection capacity analysis was performed on all three intersections for the morning and afternoon peak periods. The results showed the following:

Levels of Service:

	AM	PM
Monix Drive	C	B
93rd Avenue (EB Lt)	A	A
White Oak Avenue	B(NB Lt C)	C(NB Lt D)
93rd Avenue (WB Lt)	A	A

SITE AERIAL

FIGURE 1



EXISTING TRAFFIC VOLUMES

FIGURE 2

White Oak Avenue (NB/SB)	A/A	A/A
101st Avenue (EB/WB)	A/A	A/A

Notes:

1. "EB" means Eastbound, "WB Lt" means Westbound Left turn, etc.
2. The format of the analysis is different for two way stop control verses four way stop control hence the difference in the presentation above.
3. The White Oak Avenue approach at 93rd has a Level of Service of B but that included a Level of Service C for the NB left turn in the morning and D in the afternoon.

The intersections are functioning well to very well with the only exception being the NB left turn at 93rd Avenue and White Oak Avenue.

A traffic signal warrant analysis was investigated for the intersections by looking at Warrants 1 (93RD and White Oak), 2, and 3 (all three intersections). The analysis showed that no signal is warranted at this time for any of the intersections.

Proposed Development

A single family residential development, the Preserve Subdivision, is proposed to be constructed on the west side of White Oak Avenue between 93rd Avenue and 101st Avenue. It will contain about 432 home sites. The access plan for the development is for one drive onto 93rd Avenue opposite of Monix Drive and one drive onto White Oak Avenue. The subdivision access will also include a connection to presently vacant property to the west of the subdivision.

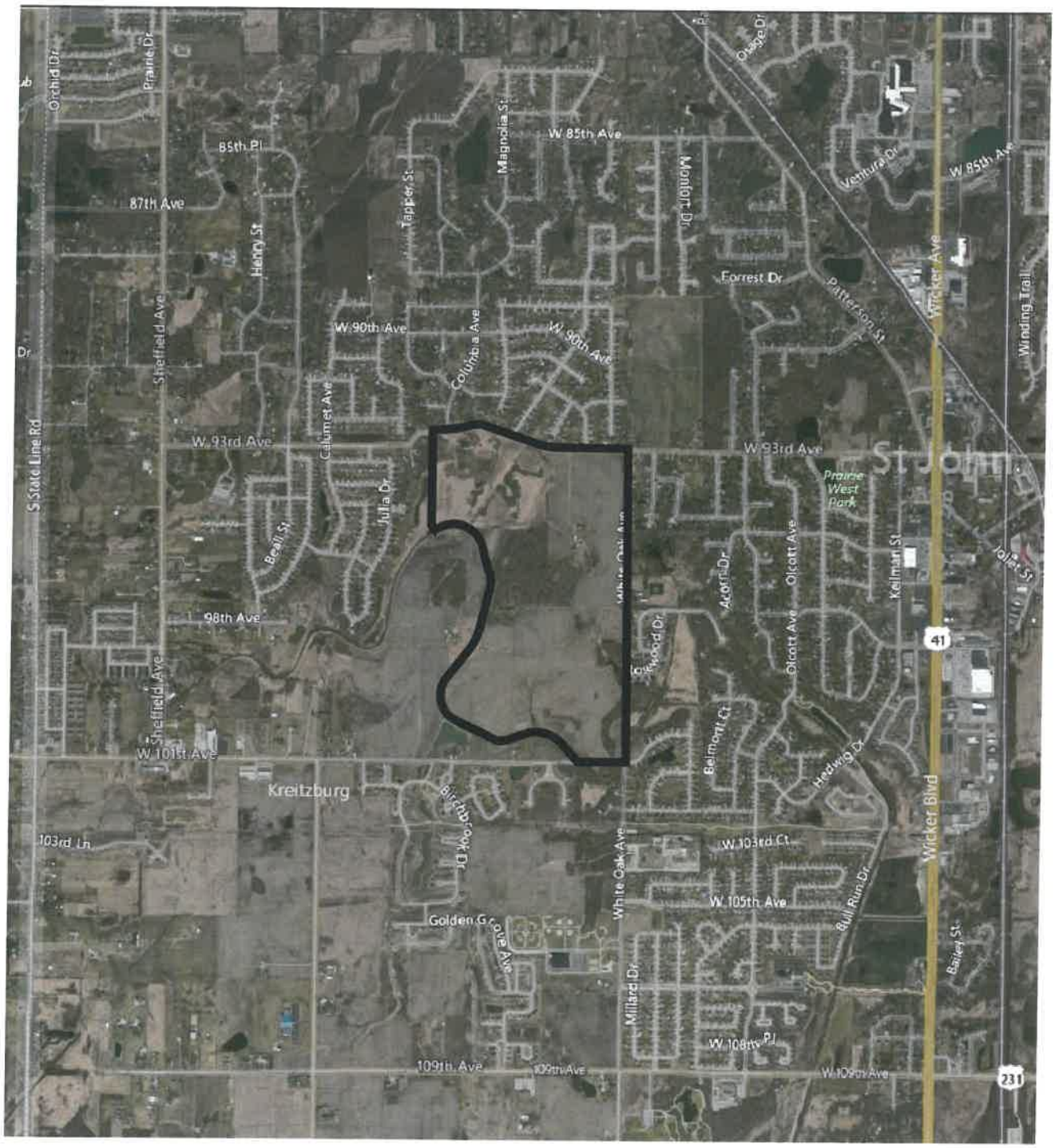
Figure 3 depicts the site plan. Figure 4 is an aerial view of the area with the proposed site shown.

Trip Generation and Distribution

The ITE Trip Generation Manual (9th edition) was used as a resource document to determine the number of trips expected to be generated by this development. Using the Single Family Residential code, the following trips were calculated:

The Preserve

FIGURE 3
SITE PLAN



SITE PLAN AERIAL

FIGURE 4

78 trips in and 234 trips out for the peak hour between 7:00 am – 9:00 am
247 trips in and 145 trips out for the peak hour between 4:00 pm – 6:00 pm

The trips generated were assigned to the two drives serving as access to the development by proximity to those intersections. The reason for this assignment is that drivers typically take the shortest route to their destination. By looking at the area and the opportunities for employment within about a 25 mile radius, the following assumptions and assignments were made:

1. 55% of the peak hour trips would be toward the Chicago area and that traffic would be using the Calumet Expressway. By proximity to the two drives and their travel to 101st Avenue either at White Oak Avenue or via 93rd/Sheffield, it is assumed that 40% will use the 93RD Ave drive and 60% will use the White oak Drive. Of the latter, 50% will go south and 10% will go north, turning left at 93rd Avenue.
2. 30% was assigned to go north from 93rd to US 41 and on north past U.S. 30. 60% of this traffic would use the 93rd Avenue drive and 40% would use the White Oak Avenue drive.
3. 10% was assigned to go north at 93rd and U.S. 41 but then going east at U.S. 30 for points north and east. This traffic split was the same as the 30% above.
4. 5% was assigned to go south to the Crown Point area and beyond. 85% of this traffic would use the White Oak drive and 15% would use the 93rd Avenue drive

The resulting traffic distribution is shown on Figure 5.

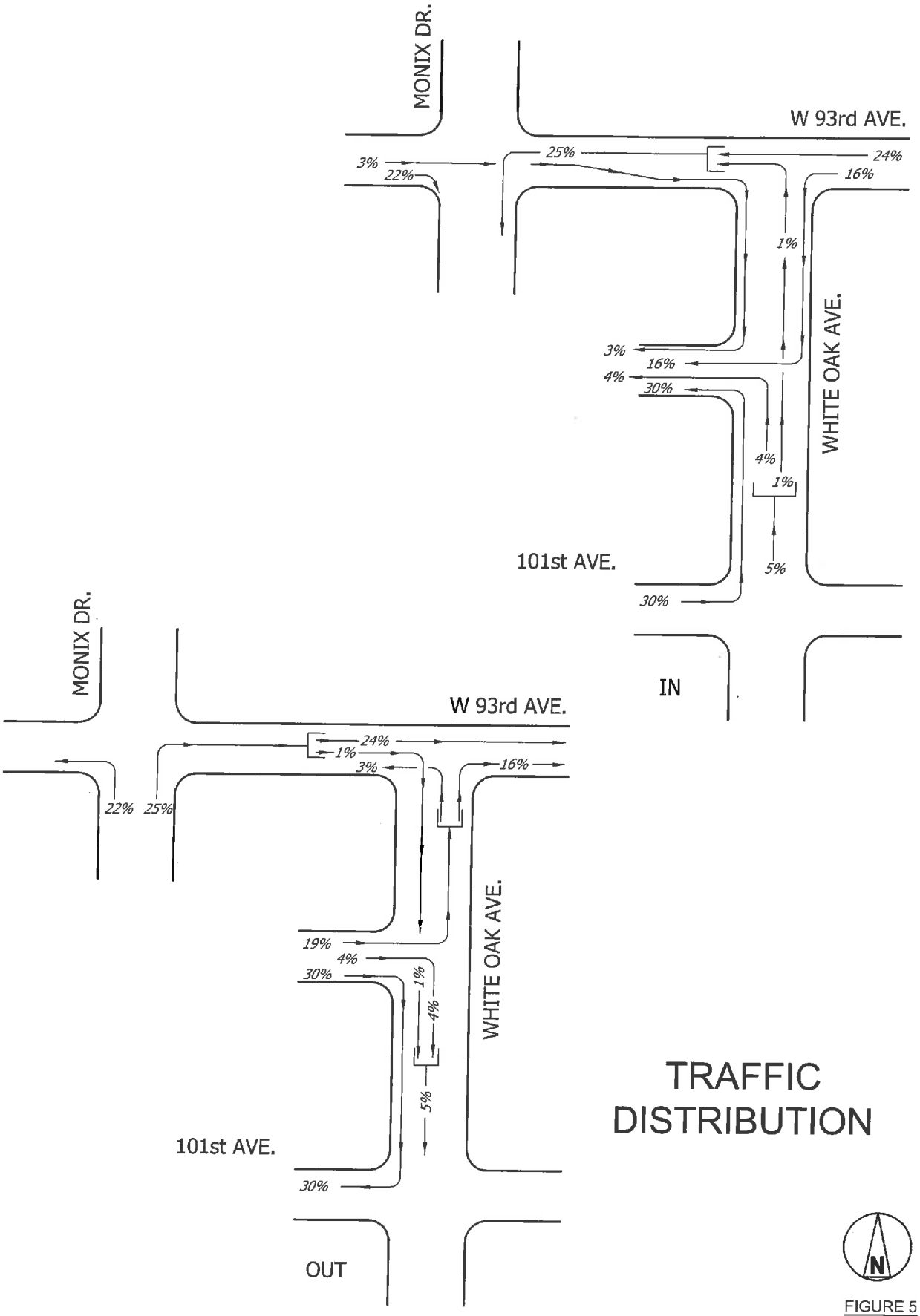
Analysis

The combination of the existing and the expected site generated traffic is shown on Figure 6.

The developer has proposed a number of improvements to the intersections adjacent to the development. These are shown as figures 7-10.

Intersection capacity analysis was performed on the intersections for the morning and afternoon peak period with these volumes from Figure 6 and the improvements planned by the developer. The results showed the following:
Levels of Service:

	AM	PM



TRAFFIC DISTRIBUTION

FIGURE 5

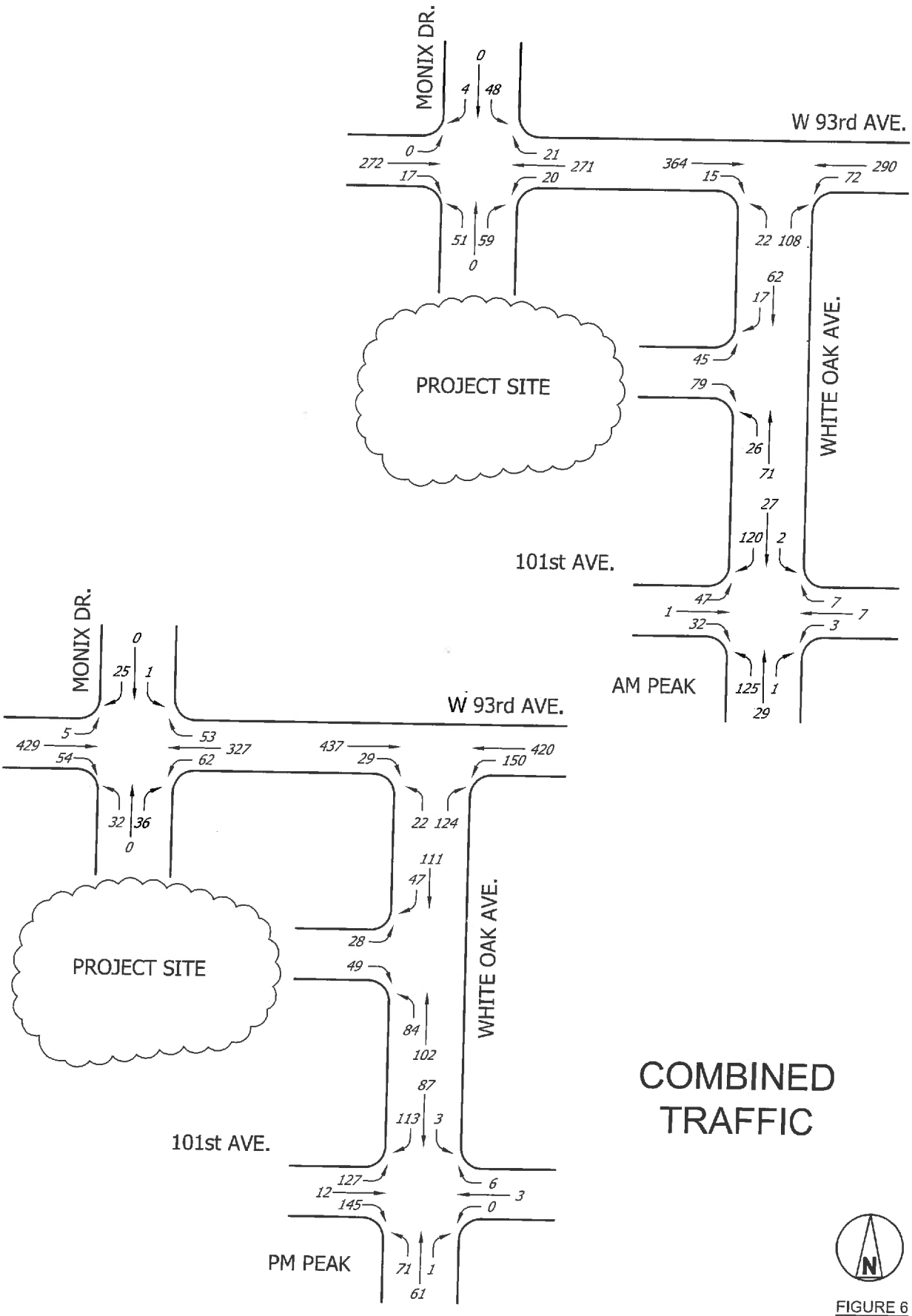
Monix Drive (NB/SB)	C/C	D/B
93rd Avenue (EB/WB)	A/A	A/A
White Oak Avenue	B(NB Lt C)	C(NB Lt E)
93rd Avenue (WB Lt)	A	A
White Oak Avenue (EB/WB)	A/A	B/A
101st Avenue (NB/SB)	B/A	B/B

For the Monix Drive intersection, the traffic from the Preserve in the afternoon peak period will be operating at a Level of Service D. The analysis was run with a single lane approach. It is recommended that the south approach be widened to two lanes approaching 93rd Avenue, providing a lane for the left turning vehicles to store so that they do not impede the thru/right turning traffic. When this is done the left turning traffic will be at a Level of Service E and the right turn traffic at a B. While Level of Service E is less than the desirable Level of Service D, the volume of traffic is low at 32 vehicles in the peak hour. Two options were investigated to rectify this low Level of Service:

1. Traffic signalization. An analysis of the four hours of data collected does not indicate that a traffic signal is warranted at this location with the addition of the development traffic.
2. Another option considered was to construct a roundabout, but the expense of that improvement does not seem to be justified against the delay of such a small number of vehicles.

For the White Oak Avenue/93rd Avenue intersection, the northbound left turn movement (NB Lt E) will slip from D to E in the afternoon peak period. While that is less than a minimum desirable Level of Service D, the projected volume during that time is only 22 vehicles in an hour. The right turning vehicles in the same period is 131 and their Level of Service is B. The developers planned improvements provide a separate left turn lane for the 22 vehicles so they do not hinder the much larger right turning vehicles. Other options that were investigated were:

1. Traffic signalization: With the addition of the left turn lane, the intersection does not meet the warrants for traffic signalization.
2. Roundabout: A roundabout would improve the Level of service for the northbound left turn, but the expense of building a roundabout does not seem justified for the relative improvement to delay for such a small number of vehicles.



COMBINED TRAFFIC

FIGURE 6

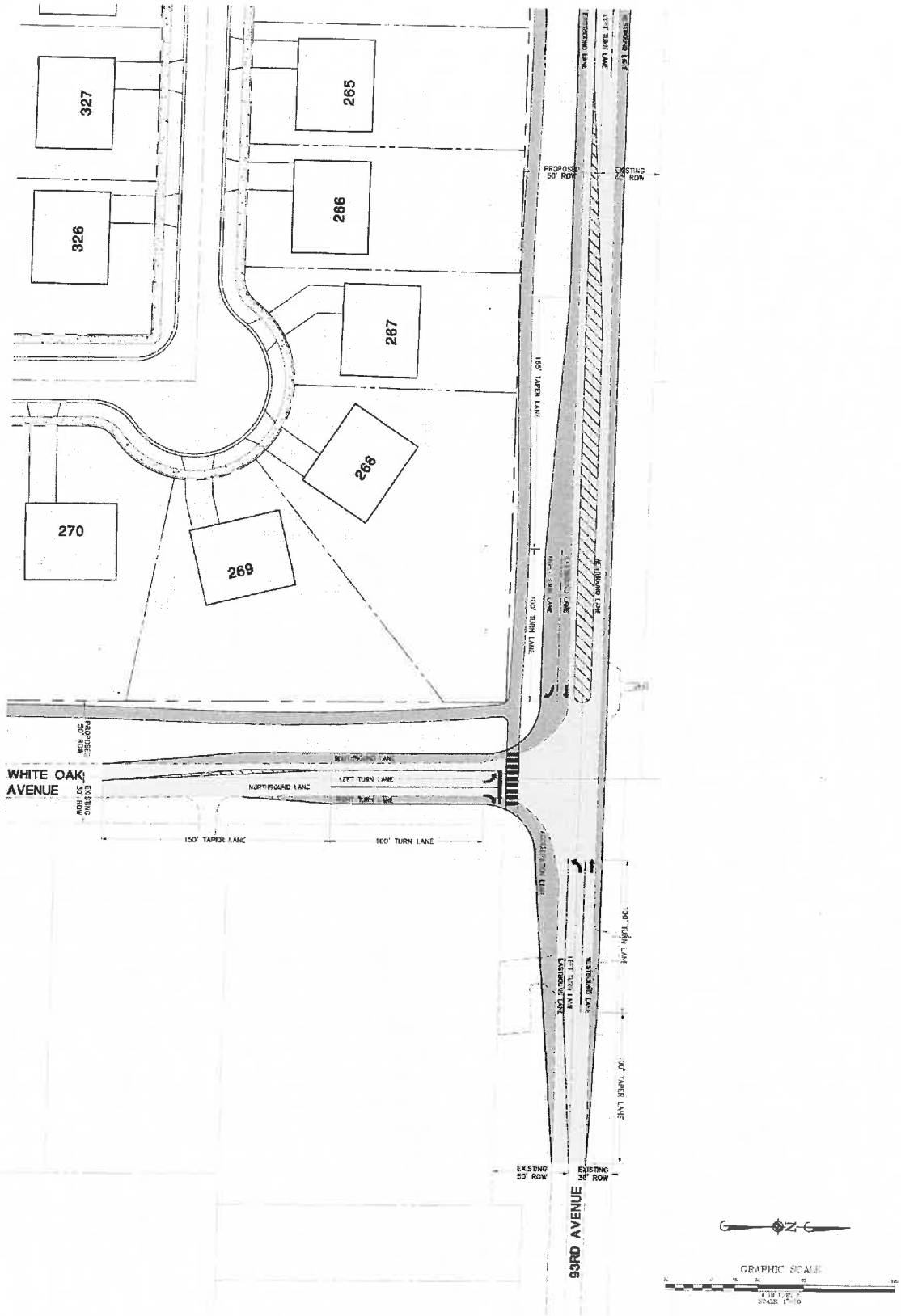

327
326
265
266
267
268
269
270
PROPOSED 50' ROW
EXISTING 50' ROW
WHITE OAK AVENUE
PROPOSED 50' ROW
EXISTING 50' ROW
NORTHBOUND LANE
LEFT TURN LANE
150' TAPER LANE
100' TURN LANE
93RD AVENUE
EXISTING 50' ROW
EXISTING 50' ROW
GRAPHIC SCALE

FIGURE 7

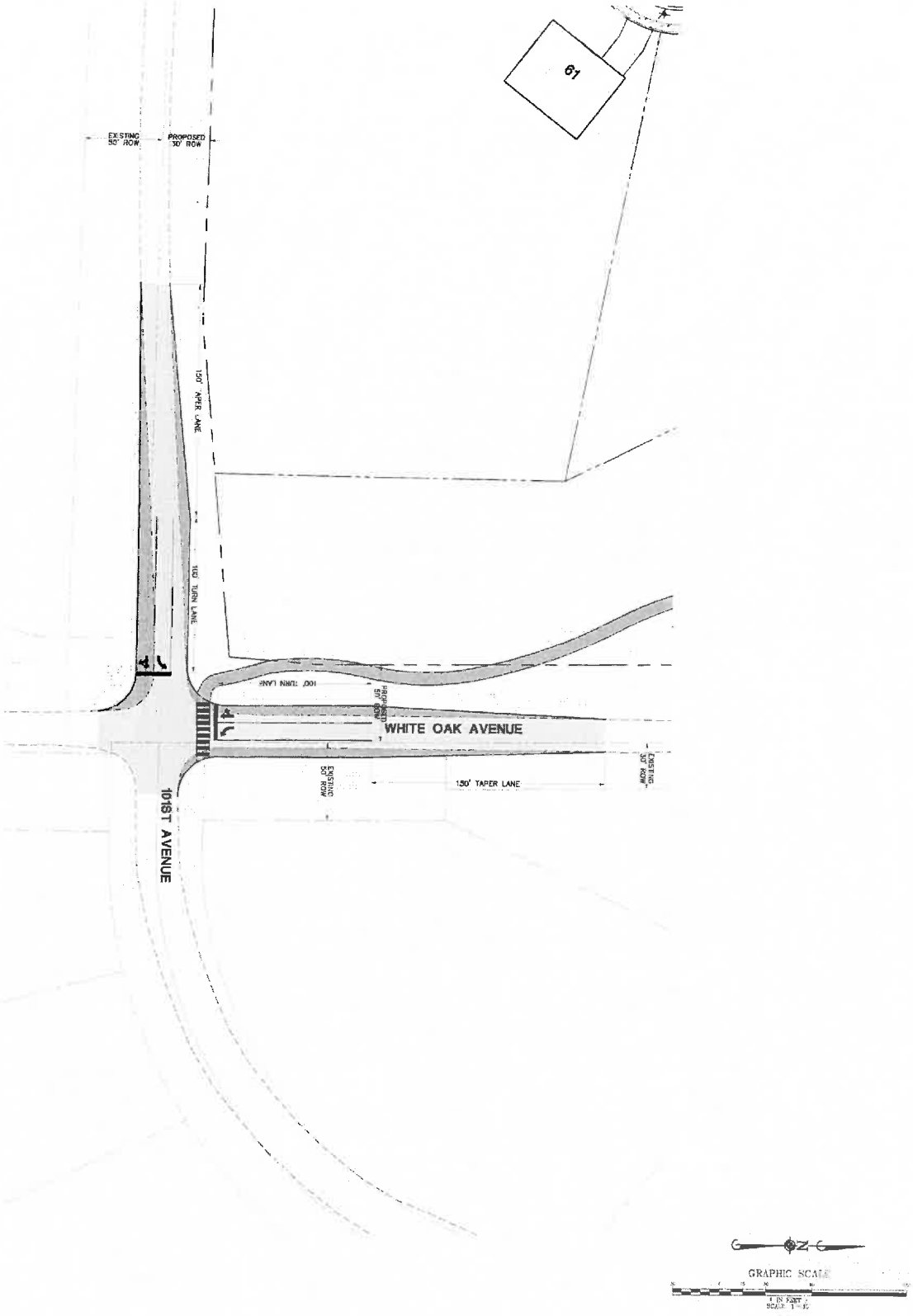

61
EXISTING 50' ROW
PROPOSED 50' ROW
150' APER LANE
100' TURN LANE
100' TURN LANE
WHITE OAK AVENUE
EXISTING 50' ROW
150' TAPER LANE
EXISTING 50' ROW
101ST AVENUE
GRAPHIC SCALE

FIGURE 8

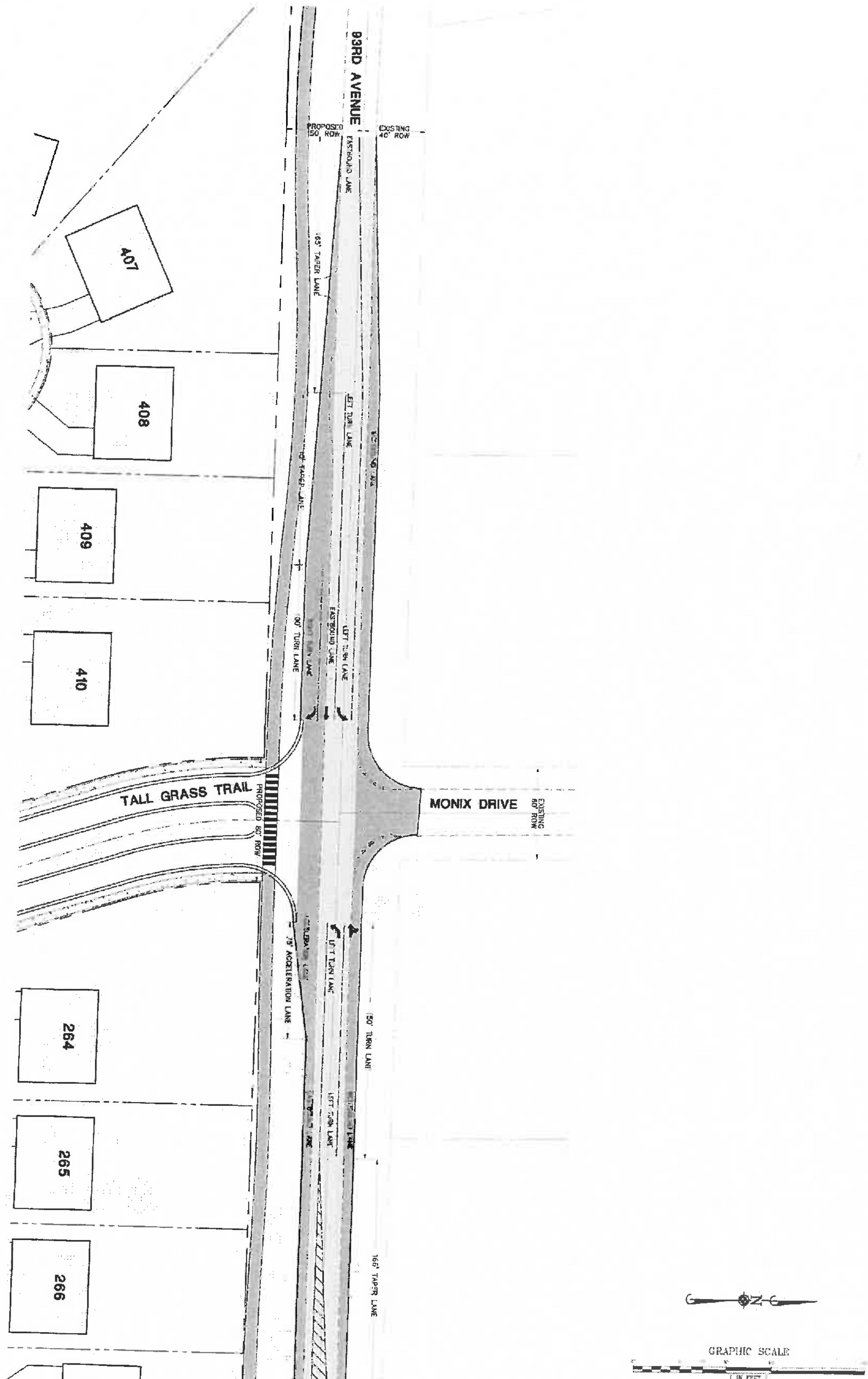

83RD AVENUE
PROPOSED 150' ROW
EXISTING 40' ROW
EASTBOUND LANE
165' TAPER LANE
LEFT TURN LANE
100' TURN LANE
407
408
409
410
TALL GRASS TRAIL
PROPOSED 60' ROW
MONIX DRIVE
EXISTING 60' ROW
175' ACCELERATION LANE
150' TURN LANE
165' TAPER LANE
264
265
266
267
GRAPHIC SCALE

FIGURE 9

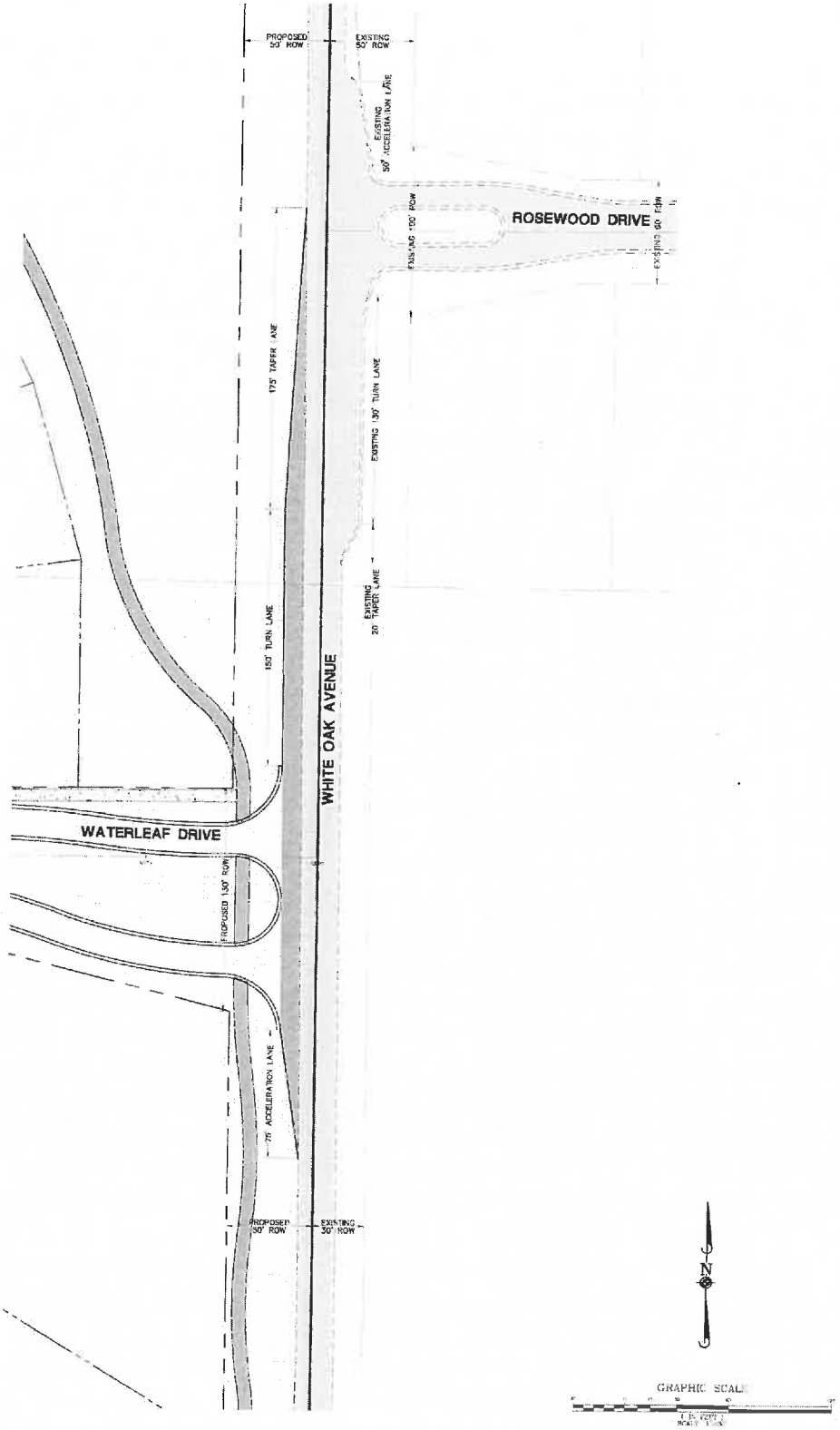

PROPOSED 50' ROW
EXISTING 50' ROW
EXISTING 50' ACCELERATION LANE
ROSEWOOD DRIVE
EXISTING 100' ROW
EXISTING 60' ROW
175' TAPER LANE
EXISTING 150' TURN LANE
150' TURN LANE
EXISTING 20' TAPER LANE
WHITE OAK AVENUE
WATERLEAF DRIVE
PROPOSED 130' ROW
75' ACCELERATION LANE
PROPOSED 50' ROW
EXISTING 50' ROW
N
GRAPHIC SCALE

FIGURE 10

3. The analysis was run at a 50% development level. At that point, the Level of Service was D. The assumptions on the distribution could vary from what the author has assumed and that will have an impact on the Levels of Service. Another option is to revisit the traffic study at that point and see what changes to the distribution there has been from the assumptions as well as determining the final impacts from a more accurate perspective on the distribution.

For the White Oak Avenue/101st Ave intersection, there is some minor drop in Level of Service from A to B for some of the movements, but these are still excellent Levels of Service. An analysis of the four hours of data collected does not indicate that a traffic signal is warranted at this location with the addition of the development traffic.

Summary

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The following is a summary of the recommendations:

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APPENDIX

Traffic Count at Monix Drive and 93 Avenue

APPENDIX 1

TRAFFIC COUNT SUMMARY SHEET

LOCATION: monix and 93rd DATE: 42388

TIME BEGIN	North Approach on monix				East Approach on 93rd				South Approach on monix				West Approach on 93rd				Total N/S	Total E/W	Total	
	Right	Thru	Left	Total	Right	Thru	Left	Total	Right	Thru	Left	Total	Right	Thru	Left	Total				
6:00			1	1	1	45		46						24		24	1	70	71	
6:15			6	6	2	45		47						36		36	6	83	89	
6:30	1		3	4	1	47		48						60	2	62	4	110	114	
6:45			9	9	2	60		62						67		67	9	129	138	
6:00-7:00	1		10	11	4	137		141						120	2	122	11	263	274	
7:00	2		9	11	3	54		57						46		46	11	103	114	
7:15			13	13	4	61		65						52		52	13	117	130	
7:30	2		12	14	9	64		73						89		89	14	162	176	
7:45			14	14	5	80		85						71		71	14	156	170	
7:00-8:00	4		48	52	21	259		280						258		258	52	538	590	Total for hour
	0.50		0.86		0.58	0.81								0.72						
4:00			5	5	9	70		79												
4:15			6	6	20	70		90						71		71	5	150	155	
4:30	1		6	7	9	108		117						114	2	116	6	206	212	
4:45			8	8	15	82		97						94	1	95	7	212	219	
4:00-5:00	1		25	26	53	330		383						132	2	134	8	231	239	
	0.25		0.78		0.66	0.76								411	5	416	26	799	825	Total for hour
5:00	1		7	8	15	87		102						0.90	0.63					
5:15	1		3	4	14	69		83						96		96	8	198	206	
5:30			4	4	11	52		63						85		85	4	168	172	
5:45			7	7	12	61		73						110	1	111	4	174	178	
5:00-6:00	2		21	23	52	269		321						83		83	7	156	163	
														374	1	375	23	696	719	Total for hour

Traffic Signal Warrant Analysis
At Monix Drive and 93rd Avenue

APPENDIX 2

TRAFFIC COUNT SUMMARY SHEET

LOCATION: monix and 93rd

DATE: 42388

TIME BEGIN	North Approach on monix				East Approach on 93rd				South Approach on monix				West Approach on 93rd				Total N/S	Total E/W	Total	
	Right	Thru	Left	Total	Right	Thru	Left	Total	Right	Thru	Left	Total	Right	Thru	Left	Total				
6:00			1	1	1	45		46						24		24	1	70	71	
6:15			6	6	2	45		47						36		36	6	83	89	
6:30	1		3	4	1	47		48						60	2	62	4	110	114	
6:45			9	9	2	60		62						67		67	9	129	138	
6:00-7:00	1		10	11	4	137		141						120	2	122	11	263	274	
7:00	2		9	11	3	54		57												
7:15			13	13	4	61		65						46		46	11	103	114	
7:30	2		12	14	9	64		73						52		52	13	117	130	
7:45			14	14	5	80		85						89		89	14	162	176	
7:00-8:00	4		48	52	21	259		280						71		71	14	156	170	
	0.50		0.86		0.58	0.81								258		258	52	538	590	Total for hour
4:00			5	5	9	70		79						0.72						
4:15			6	6	20	70		90						71		71	5	150	155	
4:30	1		6	7	9	108		117						114	2	116	6	206	212	
4:45			8	8	15	82		97						94	1	95	7	212	219	
4:00-5:00	1		25	26	53	330		383						132	2	134	8	231	239	
	0.25		0.78		0.66	0.76								411	5	416	26	799	825	Total for hour
5:00	1		7	8	15	87		102						0.90	0.63					
5:15	1		3	4	14	69		83						96		96	8	198	206	
5:30			4	4	11	52		63						85		85	4	168	172	
5:45			7	7	12	61		73						110	1	111	4	174	178	
5:00-6:00	2		21	23	52	269		321						83		83	7	156	163	
														374	1	375	23	696	719	Total for hour

Warrant 2

y=377.227-0.679x+.00035xx

y (calc)	Y Actual	NO X	
223	11	263	no
113	52	538	no
58	26	799	no
74	23	696	no

Warrant 3

y=520.0116-.7648x+.000325xx

y (calc)	Y Actual	NO X	
116.4167	25	799	

Highway Capacity Analysis:
Monix Drive and 93rd Avenue,
Existing Condition AM

APPENDIX 3

HCS+: Unsignalized Intersections Release 5.4

TWO-WAY STOP CONTROL SUMMARY

Analyst:
Agency/Co.:
Date Performed: 1/27/2016
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year:
Project ID: Existing
East/West Street: 93rd
North/South Street: Monix
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	0	270			264	21
Peak-Hour Factor, PHF	0.92	0.72			0.81	0.58
Hourly Flow Rate, HFR	0	374			325	36
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1			1	0
Configuration		LT				TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				48	0	4
Peak Hour Factor, PHF				0.86	1.00	0.50
Hourly Flow Rate, HFR				55	0	8
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	0						63	
C(m) (vph)	1209						422	
v/c	0.00						0.15	
95% queue length	0.00						0.52	
Control Delay	8.0						15.0+	
LOS	A						C	
Approach Delay							15.0+	
Approach LOS							C	

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:
Agency/Co.:
Date Performed: 1/27/2016
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year:
Project ID: Existing
East/West Street: 93rd
North/South Street: Monix
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	0	270			264	21
Peak-Hour Factor, PHF	0.92	0.72			0.81	0.58
Peak-15 Minute Volume	0	94			81	9
Hourly Flow Rate, HFR	0	374			325	36
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration		LT				TR
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				48	0	4
Peak Hour Factor, PHF				0.86	1.00	0.50
Peak-15 Minute Volume				14	0	2
Hourly Flow Rate, HFR				55	0	8
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0	
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0	
Percent Blockage	0	0	0	0	

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	374	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1					7.1	6.5	6.2
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	0					0	0	0
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00					0.70	0.00	0.00
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.1					6.4	6.5	6.2
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	361					717	717	343
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.			9			12		
Conflicting Flows						343		
Potential Capacity						704		
Pedestrian Impedance Factor			1.00			1.00		
Movement Capacity						704		
Probability of Queue free St.			1.00			0.99		
Step 2: LT from Major St.			**4**			**1**		
Conflicting Flows						361		
Potential Capacity						1209		
Pedestrian Impedance Factor			1.00			1.00		
Movement Capacity						1209		
Probability of Queue free St.			1.00			1.00		
Maj L-Shared Prob Q free St.						1.00		
Step 3: TH from Minor St.			**8**			**11**		
Conflicting Flows						717		
Potential Capacity						358		
Pedestrian Impedance Factor			1.00			1.00		
Cap. Adj. factor due to Impeding mvmnt			1.00			1.00		
Movement Capacity						358		
Probability of Queue free St.			1.00			1.00		
Step 4: LT from Minor St.			**7**			**10**		
Conflicting Flows						717		
Potential Capacity						399		
Pedestrian Impedance Factor			1.00			1.00		
Maj. L, Min T Impedance factor			1.00					
Maj. L, Min T Adj. Imp Factor.			1.00					
Cap. Adj. factor due to Impeding mvmnt			0.99			1.00		
Movement Capacity						399		

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.			8			11		
Part 1 - First Stage								
Conflicting Flows								
Potential Capacity								
Pedestrian Impedance Factor								
Cap. Adj. factor due to Impeding mvmnt								
Movement Capacity								
Probability of Queue free St.								

Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows			717
Potential Capacity			358
Pedestrian Impedance Factor		1.00	1.00
Cap. Adj. factor due to Impeding mvmnt		1.00	1.00
Movement Capacity			358
Result for 2 stage process:			
a			
y			
C t			358
Probability of Queue free St.		1.00	1.00
Step 4: LT from Minor St.		7	10
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows			717
Potential Capacity			399
Pedestrian Impedance Factor		1.00	1.00
Maj. L, Min T Impedance factor		1.00	
Maj. L, Min T Adj. Imp Factor.		1.00	
Cap. Adj. factor due to Impeding mvmnt		0.99	1.00
Movement Capacity			399
Results for Two-stage process:			
a			
y			
C t			399

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				55	0	8
Movement Capacity (vph)				399	358	704
Shared Lane Capacity (vph)					422	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep				399	358	704
Volume				55	0	8
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					422	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	0						63	
C(m) (vph)	1209						422	
v/c	0.00						0.15	
95% queue length	0.00						0.52	
Control Delay	8.0						15.0+	
LOS	A						C	
Approach Delay							15.0+	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	1.00
v(il), Volume for stream 2 or 5	374	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	1.00	
d(M,LT), Delay for stream 1 or 4	8.0	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.0	

Highway Capacity Analysis:

Monix Drive and 93rd Avenue

Existing Condition PM

APPENDIX 4

HCS+: Unsignalized Intersections Release 5.4

TWO-WAY STOP CONTROL SUMMARY

Analyst:
Agency/Co.:
Date Performed: 1/27/2016
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year:
Project ID: Existing
East/West Street: 93rd
North/South Street: Monix
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	5	422			323	53
Peak-Hour Factor, PHF	0.63	0.90			0.76	0.66
Hourly Flow Rate, HFR	7	468			425	80
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1			1	0
Configuration		LT				TR
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				1	0	25
Peak Hour Factor, PHF				0.25	1.00	0.78
Hourly Flow Rate, HFR				4	0	32
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			No /
Lanes				0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	7						36	
C(m) (vph)	1070						538	
v/c	0.01						0.07	
95% queue length	0.02						0.21	
Control Delay	8.4						12.2	
LOS	A						B	
Approach Delay							12.2	
Approach LOS							B	

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:
Agency/Co.:
Date Performed: 1/27/2016
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year:
Project ID: Existing
East/West Street: 93rd
North/South Street: Monix
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	5	422			323	53
Peak-Hour Factor, PHF	0.63	0.90			0.76	0.66
Peak-15 Minute Volume	2	117			106	20
Hourly Flow Rate, HFR	7	468			425	80
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				1	0	25
Peak Hour Factor, PHF				0.25	1.00	0.78
Peak-15 Minute Volume				1	0	8
Hourly Flow Rate, HFR				4	0	32
Percent Heavy Vehicles				0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	1	0
Configuration					LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0	
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0	
Percent Blockage	0	0	0	0	

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	468	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1					7.1	6.5	6.2
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	0					0	0	0
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00					0.70	0.00	0.00
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.1					6.4	6.5	6.2
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0					0	0	0
t(f)	2.2					3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	505					947	947	465
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		1500
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		465
Potential Capacity		602
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		602
Probability of Queue free St.	1.00	0.95
Step 2: LT from Major St.	4	1
Conflicting Flows		505
Potential Capacity		1070
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1070
Probability of Queue free St.	1.00	0.99
Maj L-Shared Prob Q free St.		0.99
Step 3: TH from Minor St.	8	11
Conflicting Flows		947
Potential Capacity		263
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.99	0.99
Movement Capacity		261
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows		947
Potential Capacity		292
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.99	
Maj. L, Min T Adj. Imp Factor.	0.99	
Cap. Adj. factor due to Impeding mvmnt	0.94	0.99
Movement Capacity		290

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows			947
Potential Capacity			263
Pedestrian Impedance Factor		1.00	1.00
Cap. Adj. factor due to Impeding mvmnt		0.99	0.99
Movement Capacity			261
Result for 2 stage process:			
a			
y			
C t			261
Probability of Queue free St.		1.00	1.00
Step 4: LT from Minor St.		7	10
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows			947
Potential Capacity			292
Pedestrian Impedance Factor		1.00	1.00
Maj. L, Min T Impedance factor		0.99	
Maj. L, Min T Adj. Imp Factor.		0.99	
Cap. Adj. factor due to Impeding mvmnt		0.94	0.99
Movement Capacity			290
Results for Two-stage process:			
a			
y			
C t			290

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)				4	0	32
Movement Capacity (vph)				290	261	602
Shared Lane Capacity (vph)					538	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep				290	261	602
Volume				4	0	32
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					538	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LTR	
v (vph)	7						36	
C(m) (vph)	1070						538	
v/c	0.01						0.07	
95% queue length	0.02						0.21	
Control Delay	8.4						12.2	
LOS	A						B	
Approach Delay							12.2	
Approach LOS							B	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.99	1.00
v(il), Volume for stream 2 or 5	468	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.99	
d(M,LT), Delay for stream 1 or 4	8.4	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.1	

HCS+: Unsignalized Intersections Release 5.4

TWO-WAY STOP CONTROL SUMMARY

Analyst:
Agency/Co.:
Date Performed: 1/27/2016
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year:
Project ID:
East/West Street: 93rd
North/South Street: Monix
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	0	272	17	20	271	21
Peak-Hour Factor, PHF	0.92	0.72	0.72	0.58	0.81	0.58
Hourly Flow Rate, HFR	0	377	23	34	334	36
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type/Storage	Undivided /					
RT Channelized?		No			No	
Lanes	1	1	1	0	1	1
Configuration	L	T	R	LT		R
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	51	0	59	48	0	4
Peak Hour Factor, PHF	0.86	1.00	0.86	0.86	1.00	0.50
Hourly Flow Rate, HFR	59	0	68	55	0	8
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage		No /			No /	
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	L	LT		LTR			LTR	
v (vph)	0	34		127			63	
C(m) (vph)	1200	1170		420			280	
v/c	0.00	0.03		0.30			0.22	
95% queue length	0.00	0.09		1.29			0.86	
Control Delay	8.0	8.2		17.3			21.6	
LOS	A	A		C			C	
Approach Delay				17.3			21.6	
Approach LOS				C			C	

Traffic Count and Signal Warrant Analysis:

Monix Drive and 93rd Avenue

(existing plus site conditions)

APPENDIX 5

TRAFFIC COUNT SUMMARY SHEET

LOCATION: monix and 93rd

DATE: 42388

TIME BEGIN	North Approach on monix				East Approach on 93rd				South Approach on monix				West Approach on 93rd				Total N/S	Total E/W	Total	
	Right	Thru	Left	Total	Right	Thru	Left	Total	Right	Thru	Left	Total	Right	Thru	Left	Total				
6:00			1	1	1	45		46						24		24	1	70	71	
6:15			6	6	2	45		47						36		36	6	83	89	
6:30	1		3	4	1	47		48						60	2	62	4	110	114	
6:45			9	9	2	60		62						67		67	9	129	138	
6:00-7:00	1		10	11	4	137		141						120	2	122	11	263	274	
7:00	2		9	11	3	54		57						46		46	11	103	114	
7:15			13	13	4	61		65						52		52	13	117	130	
7:30	2		12	14	9	64		73						89		89	14	162	176	
7:45			14	14	5	80		85						71		71	14	156	170	
7:00-8:00	4		48	52	21	259		280						258		258	52	538	590	Total for hour
	0.50		0.86		0.58	0.81								0.72						
4:00			5	5	9	70		79						71		71	5	150	155	
4:15			6	6	20	70		90						114	2	116	6	206	212	
4:30	1		6	7	9	108		117						94	1	95	7	212	219	
4:45			8	8	15	82		97						132	2	134	8	231	239	
4:00-5:00	1		25	26	53	330		383						411	5	416	26	799	825	Total for hour
	0.25		0.78		0.66	0.76								0.90	0.63					
5:00	1		7	8	15	87		102						96		96	8	198	206	
5:15	1		3	4	14	69		83						85		85	4	168	172	
5:30			4	4	11	52		63						110	1	111	4	174	178	
5:45			7	7	12	61		73						83		83	7	156	163	
5:00-6:00	2		21	23	52	269		321						374	1	375	23	696	719	Total for hour

Warrant 2

y=377.227-0.679x+.00035xx

y (calc)	Y Actual	NO X	
223	11	263	no
113	52	538	no
58	26	799	no
74	23	696	no

Warrant 3

y=520.0116-.7648x+.000325xx

y (calc)	Y Actual	NO X
116.4167	25	799

AM peak Hour																				
Existing site	4		48	52	21	259		280						258		258	52	538	590	
						7	20	27	59		51	110	17	2		19	110	46	156	
total	4		48	52	21	266	20	307	59		51	110	17	260		277	162	584	746	
Pm Peak Hour																				
Existing site	1		25	26	53	330		383						411	5	416	26	799	825	Total for hour
						4	62	66	36		32	68	54	7		61	68	127	195	
total	1		25	26	53	334	62	449	36		32	68	54	418	5	477	94	926	1020	

Warrant 3

y=520.0116-.7648x+.000325xx

y (calc)	Y Actual	no X
90.4865	68	926

Highway Capacity Analysis:

Monix Drive and 93rd Avenue

Existing plus Site Conditions AM

APPENDIX 6

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:
Agency/Co.:
Date Performed: 1/27/2016
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year:
Project ID:
East/West Street: 93rd
North/South Street: Monix
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	0	272	17	20	271	21
Peak-Hour Factor, PHF	0.92	0.72	0.72	0.58	0.81	0.58
Peak-15 Minute Volume	0	94	6	9	84	9
Hourly Flow Rate, HFR	0	377	23	34	334	36
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type/Storage	Undivided		/			
RT Channelized?			No			No
Lanes	1	1 1		0	1 1	
Configuration	L	T R		LT	R	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	51	0	59	48	0	4
Peak Hour Factor, PHF	0.86	1.00	0.86	0.86	1.00	0.50
Peak-15 Minute Volume	15	0	17	14	0	2
Hourly Flow Rate, HFR	59	0	68	55	0	8
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No /			No /
RT Channelized?						
Lanes	0	1 0		0	1 0	
Configuration		LTR			LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0	
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0	
Percent Blockage	0	0	0	0	

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		334
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1700
Sat flow rate, major rt vehicles:		1700
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	0	0	0	0	0	0	0	0
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30	3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0	0	0	0	0	0	0	0
t(f)	2.2	2.2	3.5	4.0	3.3	3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	370	400	801	815	377	824	802	334
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s	1500		1500		1500		1500	
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	377	334
Potential Capacity	674	712
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	674	712
Probability of Queue free St.	0.90	0.99
Step 2: LT from Major St.	**4**	**1**
Conflicting Flows	400	370
Potential Capacity	1170	1200
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1170	1200
Probability of Queue free St.	0.97	1.00
Maj L-Shared Prob Q free St.	0.96	
Step 3: TH from Minor St.	**8**	**11**
Conflicting Flows	815	802
Potential Capacity	314	320
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity	303	308
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	**7**	**10**
Conflicting Flows	801	824
Potential Capacity	305	294
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	0.96
Maj. L, Min T Adj. Imp Factor.	0.97	0.97
Cap. Adj. factor due to Impeding mvmnt	0.96	0.87
Movement Capacity	293	257

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	815	802
Potential Capacity	314	320
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.96	0.96
Movement Capacity	303	308
Result for 2 stage process:		
a		
y		
C t	303	308
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	801	824
Potential Capacity	305	294
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.96	0.96
Maj. L, Min T Adj. Imp Factor.	0.97	0.97
Cap. Adj. factor due to Impeding mvmnt	0.96	0.87
Movement Capacity	293	257
Results for Two-stage process:		
a		
y		
C t	293	257

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	59	0	68	55	0	8
Movement Capacity (vph)	293	303	674	257	308	712
Shared Lane Capacity (vph)		420			280	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	293	303	674	257	308	712
Volume	59	0	68	55	0	8
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		420			280	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	L	LT		LTR			LTR	
v (vph)	0	34		127			63	
C(m) (vph)	1200	1170		420			280	
v/c	0.00	0.03		0.30			0.22	
95% queue length	0.00	0.09		1.29			0.86	
Control Delay	8.0	8.2		17.3			21.6	
LOS	A	A		C			C	
Approach Delay				17.3			21.6	
Approach LOS				C			C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.97
v(il), Volume for stream 2 or 5		334
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1700
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		0.96
d(M,LT), Delay for stream 1 or 4	8.0	8.2
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.3

HCS+: Unsignalized Intersections Release 5.4

TWO-WAY STOP CONTROL SUMMARY

Analyst:
Agency/Co.:
Date Performed: 1/27/2016
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year:
Project ID: Existing plus site with improvements
East/West Street: 93rd
North/South Street: Monix
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	5	429	54	62	327	53
Peak-Hour Factor, PHF	0.63	0.90	0.63	0.66	0.76	0.66
Hourly Flow Rate, HFR	7	476	85	93	430	80
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?			No			No
Lanes	1	1	1	0	1	1
Configuration	L	T	R	LT		R
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	32	0	36	1	0	25
Peak Hour Factor, PHF	0.65	0.65	0.65	0.25	1.00	0.78
Hourly Flow Rate, HFR	49	0	55	4	0	32
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No /			No /
Lanes	1	1	0	0	1	0
Configuration	L		TR		LTR	

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	L	LT	L		TR		LTR	
v (vph)	7	93	49		55		36	
C(m) (vph)	1065	1020	149		593		452	
v/c	0.01	0.09	0.33		0.09		0.08	
95% queue length	0.02	0.30	1.43		0.31		0.26	
Control Delay	8.4	8.9	40.9		11.7		13.7	
LOS	A	A	E		B		B	
Approach Delay			25.4				13.7	
Approach LOS			D				B	

Highway Capacity Analysis

Monix Drive and 93rd Avenue:,

Existing plus Site Conditions PM

APPENDIX 7

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:
Agency/Co.:
Date Performed: 1/27/2016
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year:
Project ID: Existing plus site with improvements
East/West Street: 93rd
North/South Street: Monix
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	5	429	54	62	327	53
Peak-Hour Factor, PHF	0.63	0.90	0.63	0.66	0.76	0.66
Peak-15 Minute Volume	2	119	21	23	108	20
Hourly Flow Rate, HFR	7	476	85	93	430	80
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type/Storage	Undivided		/			
RT Channelized?			No			No
Lanes	1	1	1	0	1	1
Configuration	L	T	R	LT		R
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	32	0	36	1	0	25
Peak Hour Factor, PHF	0.65	0.65	0.65	0.25	1.00	0.78
Peak-15 Minute Volume	12	0	14	1	0	8
Hourly Flow Rate, HFR	49	0	55	4	0	32
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No /			No /
RT Channelized?						
Lanes	1	1	0	0	1	0
Configuration	L		TR		LTR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0	
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0	
Percent Blockage	0	0	0	0	

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		430
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1700
Sat flow rate, major rt vehicles:		1700
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	0	0	0	0	0	0	0	0
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.1	4.1	7.1	6.5	6.2	7.1	6.5	6.2
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30	3.50	4.00	3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0	0	0	0	0	0	0	0
t(f)	2.2	2.2	3.5	4.0	3.3	3.5	4.0	3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	510	561	1162	1186	476	1176	1191	430
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s	1500		1500		1500		1500	
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	476	430
Potential Capacity	593	629
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	593	629
Probability of Queue free St.	0.91	0.95

Step 2: LT from Major St.	4	1
Conflicting Flows	561	510
Potential Capacity	1020	1065
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1020	1065
Probability of Queue free St.	0.91	0.99
Maj L-Shared Prob Q free St.	0.88	

Step 3: TH from Minor St.	8	11
Conflicting Flows	1186	1191
Potential Capacity	190	189
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.87	0.87
Movement Capacity	166	165
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1162	1176
Potential Capacity	174	170
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.87	0.87
Maj. L, Min T Adj. Imp Factor.	0.90	0.90
Cap. Adj. factor due to Impeding mvmnt	0.86	0.82
Movement Capacity	149	139

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1186	1191
Potential Capacity	190	189
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.87	0.87
Movement Capacity	166	165
Result for 2 stage process:		
a		
y		
C t	166	165
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1162	1176
Potential Capacity	174	170
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.87	0.87
Maj. L, Min T Adj. Imp Factor.	0.90	0.90
Cap. Adj. factor due to Impeding mvmnt	0.86	0.82
Movement Capacity	149	139
Results for Two-stage process:		
a		
y		
C t	149	139

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)	49	0	55	4	0	32
Movement Capacity (vph)	149	166	593	139	165	629
Shared Lane Capacity (vph)			593		452	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	149	166	593	139	165	629
Volume	49	0	55	4	0	32
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh			593		452	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	L	LT	L		TR		LTR	
v (vph)	7	93	49		55		36	
C(m) (vph)	1065	1020	149		593		452	
v/c	0.01	0.09	0.33		0.09		0.08	
95% queue length	0.02	0.30	1.43		0.31		0.26	
Control Delay	8.4	8.9	40.9		11.7		13.7	
LOS	A	A	E		B		B	
Approach Delay				25.4			13.7	
Approach LOS				D			B	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.99	0.91
v(il), Volume for stream 2 or 5		430
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1700
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		0.88
d(M,LT), Delay for stream 1 or 4	8.4	8.9
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		1.1

Traffic Count and signal warrant analysis,

93rd Avenue and

White Oak Avenue (existing conditions)

APPENDIX 8

TRAFFIC COUNT SUMMARY SHEET

LOCATION: White Oak and 93rd Ave

DATE:

TIME BEGIN	North Approach on White Oak				East Approach on 93rd Ave				South Approach on White Oak				West Approach on 93rd Ave				Total N/S	Total E/W	Total	
	Right	Thru	Left	Total	Right	Thru	Left	Total	Right	Thru	Left	Total	Right	Thru	Left	Total				
6:00						43	4	47	6		2	8	1	24		25	8	72	80	
6:15						43	6	49	13		4	17	1	43		44	17	93	110	
6:30						41	7	48	13		5	18	3	54		57	18	105	123	
6:45						58	9	67	8		5	13	3	73		76	13	143	156	
6:00-7:00						127	17	144	32		11	43	5	121		126	43	270	313	
7:00						51	7	58	15		5	20	2	54		56	20	114	134	
7:15						66	15	81	11		4	15	1	65		66	15	147	162	
7:30						72	20	92	20			20	3	96		99	20	191	211	
7:45						82	17	99	24		5	29	4	93		97	29	196	225	
7:00-8:00						271	59	330	70		14	84	10	308		318	84	648	732	Total for hour
PHF						0.82622	0.7375		0.729167		0.7		0.625	0.802083						
8:00						222	60	282	63		10	73	5	229		234	73	516	589	
9:00						144	46	190	56		12	68	8	162		170	68	360	428	
10:00						145	43	188	63		5	68	12	170		182	68	370	438	
11:00						177	71	248	80		5	85	8	154		162	85	410	495	
12:00						164	64	228	62		9	71	9	176		185	71	413	484	
1:00						203	52	255	70		8	78	3	184		187	78	442	520	
2:00						273	74	347	73		11	84	20	284		304	84	651	735	
3:00						287	119	406	72		12	84	25	285		310	84	716	800	
4:00						76	19	95	27		4	31	3	73		76	31	171	202	
4:15						85	22	107	33		3	36	7	108		115	36	222	258	
4:30						106	30	136	24		3	27	6	95		101	27	237	264	
4:45						93	39	132	26		6	32	5	126		131	32	263	295	
4:00-5:00						360	110	470	110		16	126	21	402		423	126	893	1019	Total for hour
5:00						99	42	141	26		3	29	10	100		110	29	251	280	
5:15						72	34	106	26		8	34	6	92		98	34	204	238	
5:30						68	33	101	23		4	27	8	113		121	27	222	249	
5:45						76	30	106	32		1	33	17	76		93	33	199	232	
5:00-6:00						315	139	454	107		16	123	41	381		422	123	876	999	Total for hour
PHF						0.795455	0.827381		0.835938		0.5		0.602941	0.84292						

Warrant 1

			Major St	Minor St	Hrs met	Warrant Met?	
Condition	A ©	350	105	11/2	NO		
Condition	B ©	525	53	6/6	NO		
						combination warrant	
Condition	A (d)	280	84	11/0	NO	NO	
Condition	B (d)	420	42	11/11	yes		

Warrant 2

y=377.227-0.679x+.00035xx

y (calc)	Y Actual	NO X	
219	43	270	no
84	84	648	YES
50	126	893	YES
51	123	876	YES

Warrant 3

y=520.0116-.7648x+.000325xx

Without the right turns

y (calc)	Y Actual	no X	
96.21613	126	893	YES
	16	893	NO

Highway Capacity Analysis:
93rd Avenue and White Oak Avenue
Existing Condition AM

APPENDIX 9

HCS+: Unsignalized Intersections Release 5.4

TWO-WAY STOP CONTROL SUMMARY

Analyst:
Agency/Co.:
Date Performed: 1/27/2016
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year:
Project ID: Existing
East/West Street: 93rd
North/South Street: White Oak
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		308	10	59	271	
Peak-Hour Factor, PHF		0.80	0.63	0.74	0.83	
Hourly Flow Rate, HFR		384	15	79	326	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1 0		0 1		
Configuration		TR		LT		
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	14	0	70			
Peak Hour Factor, PHF	0.70	1.00	0.73			
Hourly Flow Rate, HFR	20	0	95			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No /			/
Lanes	1	1 0				
Configuration	L	TR				

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT	L		TR			
v (vph)		79	20		95			
C(m) (vph)		1171	300		661			
v/c		0.07	0.07		0.14			
95% queue length		0.22	0.21		0.50			
Control Delay		8.3	17.9		11.4			
LOS		A	C		B			
Approach Delay				12.5				
Approach LOS				B				

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:
Agency/Co.:
Date Performed: 1/27/2016
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year:
Project ID: Existing
East/West Street: 93rd
North/South Street: White Oak
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume		308	10	59	271	
Peak-Hour Factor, PHF		0.80	0.63	0.74	0.83	
Peak-15 Minute Volume		96	4	20	82	
Hourly Flow Rate, HFR		384	15	79	326	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	14	0	70			
Peak Hour Factor, PHF	0.70	1.00	0.73			
Peak-15 Minute Volume	5	0	24			
Hourly Flow Rate, HFR	20	0	95			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	1	1	0			
Configuration	L		TR			

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0	
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0	
Percent Blockage	0	0	0	0	

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		326
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1700
Sat flow rate, major rt vehicles:		1700
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1	7.1	6.5	6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0	0	0	0			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00	0.70	0.00	0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage		4.1	6.4	6.5	6.2			
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		0	0	0	0			
t(f)		2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		399	876	876	392			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500				
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	392	
Potential Capacity	661	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	661	
Probability of Queue free St.	0.86	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	399	
Potential Capacity	1171	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1171	
Probability of Queue free St.	0.93	1.00
Maj L-Shared Prob Q free St.	0.92	

Step 3: TH from Minor St.	8	11
Conflicting Flows	876	
Potential Capacity	290	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.92	0.92
Movement Capacity	266	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	876	
Potential Capacity	322	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.92
Maj. L, Min T Adj. Imp Factor.		0.94
Cap. Adj. factor due to Impeding mvmnt	0.93	0.80
Movement Capacity	300	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage						
Conflicting Flows						
Potential Capacity						
Pedestrian Impedance Factor						
Cap. Adj. factor due to Impeding mvmnt						
Movement Capacity						
Part 3 - Single Stage						
Conflicting Flows			876			
Potential Capacity			290			
Pedestrian Impedance Factor			1.00		1.00	
Cap. Adj. factor due to Impeding mvmnt			0.92		0.92	
Movement Capacity			266			
Result for 2 stage process:						
a						
y						
C t			266			
Probability of Queue free St.			1.00		1.00	
Step 4: LT from Minor St.			7		10	
Part 1 - First Stage						
Conflicting Flows						
Potential Capacity						
Pedestrian Impedance Factor						
Cap. Adj. factor due to Impeding mvmnt						
Movement Capacity						
Part 2 - Second Stage						
Conflicting Flows						
Potential Capacity						
Pedestrian Impedance Factor						
Cap. Adj. factor due to Impeding mvmnt						
Movement Capacity						
Part 3 - Single Stage						
Conflicting Flows			876			
Potential Capacity			322			
Pedestrian Impedance Factor			1.00		1.00	
Maj. L, Min T Impedance factor					0.92	
Maj. L, Min T Adj. Imp Factor.					0.94	
Cap. Adj. factor due to Impeding mvmnt			0.93		0.80	
Movement Capacity			300			
Results for Two-stage process:						
a						
y						
C t			300			

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)	20	0	95			
Movement Capacity (vph)	300	266	661			
Shared Lane Capacity (vph)			661			

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	300	266	661			
Volume	20	0	95			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh			661			
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT	L		TR			
v (vph)		79	20		95			
C(m) (vph)		1171	300		661			
v/c		0.07	0.07		0.14			
95% queue length		0.22	0.21		0.50			
Control Delay		8.3	17.9		11.4			
LOS		A	C		B			
Approach Delay				12.5				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.93
v(il), Volume for stream 2 or 5		326
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1700
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		0.92
d(M,LT), Delay for stream 1 or 4		8.3
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.7

Highway Capacity Analysis:

93rd Avenue and White Oak Avenue

Existing Condition PM

APPENDIX 10

HCS+: Unsignalized Intersections Release 5.4

TWO-WAY STOP CONTROL SUMMARY

Analyst:
Agency/Co.:
Date Performed: 1/27/2016
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year:
Project ID: Existing
East/West Street: 93rd
North/South Street: White Oak
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		402	21	110	360	
Peak-Hour Factor, PHF		0.85	0.60	0.83	0.80	
Hourly Flow Rate, HFR		472	34	132	449	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration		TR		LT		
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	16	0	110			
Peak Hour Factor, PHF	0.50	1.00	0.84			
Hourly Flow Rate, HFR	32	0	130			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No /			/
Lanes	1	1	0			
Configuration	L		TR			

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT	L		TR			
v (vph)		132	32		130			
C(m) (vph)		1069	181		583			
v/c		0.12	0.18		0.22			
95% queue length		0.42	0.64		0.86			
Control Delay		8.8	29.1		12.9			
LOS		A	D		B			
Approach Delay				16.1				
Approach LOS				C				

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:
Agency/Co.:
Date Performed: 1/27/2016
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year:
Project ID: Existing
East/West Street: 93rd
North/South Street: White Oak
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume		402	21	110	360	
Peak-Hour Factor, PHF		0.85	0.60	0.83	0.80	
Peak-15 Minute Volume		118	9	33	112	
Hourly Flow Rate, HFR		472	34	132	449	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration		TR		LT		
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	16	0	110			
Peak Hour Factor, PHF	0.50	1.00	0.84			
Peak-15 Minute Volume	8	0	33			
Hourly Flow Rate, HFR	32	0	130			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	1	1	0			
Configuration	L		TR			

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		449
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1700
Sat flow rate, major rt vehicles:		1700
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1	7.1	6.5	6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0	0	0	0			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00	0.70	0.00	0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage		4.1	6.4	6.5	6.2			
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		0	0	0	0			
t(f)		2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(1,prot)	V(t)	V(1,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		506	1202	1202	489			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500				
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	489	
Potential Capacity	583	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	583	
Probability of Queue free St.	0.78	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	506	
Potential Capacity	1069	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1069	
Probability of Queue free St.	0.88	1.00
Maj L-Shared Prob Q free St.	0.83	

Step 3: TH from Minor St.	8	11
Conflicting Flows	1202	
Potential Capacity	186	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.83	0.83
Movement Capacity	155	
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1202	
Potential Capacity	206	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.83
Maj. L, Min T Adj. Imp Factor.		0.87
Cap. Adj. factor due to Impeding mvmnt	0.88	0.68
Movement Capacity	181	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows		1202	
Potential Capacity		186	
Pedestrian Impedance Factor		1.00	1.00
Cap. Adj. factor due to Impeding mvmnt		0.83	0.83
Movement Capacity		155	
Result for 2 stage process:			
a			
y			
C t		155	
Probability of Queue free St.		1.00	1.00
Step 4: LT from Minor St.		7	10
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows		1202	
Potential Capacity		206	
Pedestrian Impedance Factor		1.00	1.00
Maj. L, Min T Impedance factor			0.83
Maj. L, Min T Adj. Imp Factor.			0.87
Cap. Adj. factor due to Impeding mvmnt		0.88	0.68
Movement Capacity		181	
Results for Two-stage process:			
a			
y			
C t		181	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	32	0	130			
Movement Capacity (vph)	181	155	583			
Shared Lane Capacity (vph)			583			

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	181	155	583			
Volume	32	0	130			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh			583			
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT	L		TR			
v (vph)		132	32		130			
C(m) (vph)		1069	181		583			
v/c		0.12	0.18		0.22			
95% queue length		0.42	0.64		0.86			
Control Delay		8.8	29.1		12.9			
LOS		A	D		B			
Approach Delay				16.1				
Approach LOS				C				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.88
v(il), Volume for stream 2 or 5		449
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1700
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		0.83
d(M,LT), Delay for stream 1 or 4		8.8
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		1.5

Traffic Count and signal warrant analysis at 93rd Avenue and White Oak Avenue (existing plus site conditions)

APPENDIX 11

TRAFFIC COUNT SUMMARY SHEET

LOCATION: White Oak and 93rd Ave DATE:

TIME BEGIN	North Approach on White Oak				East Approach on 93rd Ave				South Approach on White Oak				West Approach on 93rd Ave				Total N/S	Total E/W	Total	
	Right	Thru	Left	Total	Right	Thru	Left	Total	Right	Thru	Left	Total	Right	Thru	Left	Total				
6:00						43	4	47	6		2	8	1	24		25	8	72	80	
6:15						43	6	49	13		4	17	1	43		44	17	93	110	
6:30						41	7	48	13		5	18	3	54		57	18	105	123	
6:45						58	9	67	8		5	13	3	73		76	13	143	156	
6:00-7:00						127	17	144	32		11	43	5	121		126	43	270	313	
7:00						51	7	58	15		5	20	2	54		56	20	114	134	
7:15						66	15	81	11		4	15	1	65		66	15	147	162	
7:30						72	20	92	20			20	3	96		99	20	191	211	
7:45						82	17	99	24		5	29	4	93		97	29	198	225	
7:00-8:00						271	59	330	70		14	84	10	308		318	84	648	732	Total for hour
PHF						0.82622	0.7375		0.729167		0.7		0.625	0.802083						
8:00						222	60	282	63		10	73	5	229		234	73	516	589	
9:00						144	46	190	56		12	68	8	162		170	68	360	428	
10:00						145	43	188	63		5	68	12	170		182	68	370	438	
11:00						177	71	248	80		5	85	8	154		162	85	410	495	
12:00						164	64	228	62		9	71	9	176		185	71	413	484	
1:00						203	52	255	70		8	78	3	184		187	78	442	520	
2:00						273	74	347	73		11	84	20	284		304	84	651	735	
3:00						287	119	406	72		12	84	25	285		310	84	716	800	
4:00						76	19	95	27		4	31	3	73		76	31	171	202	
4:15						85	22	107	33		3	36	7	108		115	36	222	258	
4:30						106	30	136	24		3	27	6	95		101	27	237	264	
4:45						93	39	132	26		6	32	5	126		131	32	263	295	
4:00-5:00						360	110	470	110		16	126	21	402		423	126	893	1019	Total for hour
5:00						99	42	141	26		3	29	10	100		110	29	251	280	
5:15						72	34	106	26		8	34	6	92		98	34	204	238	
5:30						68	33	101	23		4	27	8	113		121	27	222	249	
5:45						76	30	106	32		1	33	17	76		93	33	199	232	
5:00-6:00						315	139	454	107		16	123	41	381		422	123	876	999	Total for hour
PHF						0.795455	0.827381		0.835938		0.5		0.602941	0.84292						

Warrant 1

			Major St	Minor St	Hrs met	Warrant Met?	
Condition	A @	350	105	11/2	NO		
Condition	B @	525	53	6/6	NO		
						combination warrent	
Condition	A (d)	280	84	11/0	NO	NO	
Condition	B (d)	420	42	11/11	yes		

Warrant 2

y=377.227-0.679x+.00035xx

y (calc)	Y Actual	X	
219	43	270	no
84	84	648	YES
50	126	893	YES
51	123	876	YES

Warrant 3

y=520.0116-.7648x+.000325xx

Without the right turns

y (calc)	Y Actual	X	
96.21613	126	893	YES
	16	893	NO

AM peak Hour																				
Existing						271	59	330	70		14	84	10	308		318	84	648	732	
site						19	13	32	38		8	46	5	56		61	46	93	139	
total						290	72	362	108		22	130	15	364		379	130	741	871	
Pm Peak Hour																				
Existing						315	139	454	107		16	123	41	381		422	123	876	999	
site						35	8	43	24		6	30	8	35		43	30	86	116	
total						350	147	497	131		22	153	49	416		465	153	962	1115	

Warrant 3

y=520.0116-.7648x+.000325xx

Without the right turns

y (calc)	Y Actual	X	
85.0433	153	962	YES
	22	962	NO

Highway Capacity Analysis:
93rd Avenue and White Oak Avenue,
Existing plus Site Conditions AM

APPENDIX 12

HCS+: Unsignalized Intersections Release 5.4

TWO-WAY STOP CONTROL SUMMARY

Analyst:
Agency/Co.:
Date Performed: 1/27/2016
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year:
Project ID: Existing plus site
East/West Street: 93rd
North/South Street: White Oak
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		364	15	72	290	
Peak-Hour Factor, PHF		0.80	0.63	0.74	0.83	
Hourly Flow Rate, HFR		454	23	97	349	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided		/			
RT Channelized?			No			
Lanes		1	1	1	1	
Configuration		T	R	L	T	
Upstream Signal?		No			No	

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	22	0	108			
Peak Hour Factor, PHF	0.70	1.00	0.73			
Hourly Flow Rate, HFR	31	0	147			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No /			/
Lanes	1	1	0			
Configuration	L		TR			

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		L	L		TR			
v (vph)		97	31		147			
C(m) (vph)		1096	249		610			
v/c		0.09	0.12		0.24			
95% queue length		0.29	0.42		0.95			
Control Delay		8.6	21.5		12.8			
LOS		A	C		B			
Approach Delay				14.3				
Approach LOS				B				

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:
Agency/Co.:
Date Performed: 1/27/2016
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year:
Project ID: Existing plus site
East/West Street: 93rd
North/South Street: White Oak
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume		364	15	72	290	
Peak-Hour Factor, PHF		0.80	0.63	0.74	0.83	
Peak-15 Minute Volume		114	6	24	87	
Hourly Flow Rate, HFR		454	23	97	349	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided		/			
RT Channelized?			No			
Lanes		1 1		1	1	
Configuration		T R		L	T	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	22	0	108			
Peak Hour Factor, PHF	0.70	1.00	0.73			
Peak-15 Minute Volume	8	0	37			
Hourly Flow Rate, HFR	31	0	147			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	1	1 0				
Configuration	L	TR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		
Shared ln volume, major rt vehicles:		
Sat flow rate, major th vehicles:		
Sat flow rate, major rt vehicles:		
Number of major street through lanes:		

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1	7.1	6.5	6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0	0	0	0			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00	0.70	0.00	0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage		4.1	6.4	6.5	6.2			
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		0	0	0	0			
t(f)		2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		477	997	997	454			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500				
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.		9		12
Conflicting Flows		454		
Potential Capacity		610		
Pedestrian Impedance Factor		1.00		1.00
Movement Capacity		610		
Probability of Queue free St.		0.76		1.00
Step 2: LT from Major St.		**4**		**1**
Conflicting Flows		477		
Potential Capacity		1096		
Pedestrian Impedance Factor		1.00		1.00
Movement Capacity		1096		
Probability of Queue free St.		0.91		1.00
Maj L-Shared Prob Q free St.				
Step 3: TH from Minor St.		**8**		**11**
Conflicting Flows		997		
Potential Capacity		246		
Pedestrian Impedance Factor		1.00		1.00
Cap. Adj. factor due to Impeding mvmnt		0.91		0.91
Movement Capacity		224		
Probability of Queue free St.		1.00		1.00
Step 4: LT from Minor St.		**7**		**10**
Conflicting Flows		997		
Potential Capacity		273		
Pedestrian Impedance Factor		1.00		1.00
Maj. L, Min T Impedance factor				0.91
Maj. L, Min T Adj. Imp Factor.				0.93
Cap. Adj. factor due to Impeding mvmnt		0.91		0.71
Movement Capacity		249		

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.		8		11
Part 1 - First Stage				
Conflicting Flows				
Potential Capacity				
Pedestrian Impedance Factor				
Cap. Adj. factor due to Impeding mvmnt				
Movement Capacity				
Probability of Queue free St.				

Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows		997	
Potential Capacity		246	
Pedestrian Impedance Factor		1.00	1.00
Cap. Adj. factor due to Impeding mvmnt		0.91	0.91
Movement Capacity		224	
Result for 2 stage process:			
a			
y			
C t		224	
Probability of Queue free St.		1.00	1.00
Step 4: LT from Minor St.		7	10
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows		997	
Potential Capacity		273	
Pedestrian Impedance Factor		1.00	1.00
Maj. L, Min T Impedance factor			0.91
Maj. L, Min T Adj. Imp Factor.			0.93
Cap. Adj. factor due to Impeding mvmnt		0.91	0.71
Movement Capacity		249	
Results for Two-stage process:			
a			
y			
C t		249	

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)	31	0	147			
Movement Capacity (vph)	249	224	610			
Shared Lane Capacity (vph)			610			

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	249	224	610			
Volume	31	0	147			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh			610			
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		L	L		TR			
v (vph)		97	31		147			
C(m) (vph)		1096	249		610			
v/c		0.09	0.12		0.24			
95% queue length		0.29	0.42		0.95			
Control Delay		8.6	21.5		12.8			
LOS		A	C		B			
Approach Delay				14.3				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.91
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4		8.6
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

Highway Capacity Analysis:
93rd Avenue and White Oak Avenue,
Existing plus Site Conditions PM

APPENDIX 13

HCS+: Unsignalized Intersections Release 5.4

TWO-WAY STOP CONTROL SUMMARY

Analyst:
Agency/Co.:
Date Performed: 1/27/2016
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year:
Project ID:
East/West Street: 93rd
North/South Street: White Oak
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		437	29	150	420	
Peak-Hour Factor, PHF		0.85	0.60	0.83	0.80	
Hourly Flow Rate, HFR		514	48	180	524	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?			No			
Lanes		1	1		1	1
Configuration		T	R		L	T
Upstream Signal?		No				No

Minor Street: Approach	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	22	0	134			
Peak Hour Factor, PHF	0.70	1.00	0.84			
Hourly Flow Rate, HFR	31	0	159			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
Lanes	1	1	0			
Configuration	L		TR			

Delay, Queue Length, and Level of Service

Approach	EB	WB	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		L	L		TR			
v (vph)		180	31		159			
C(m) (vph)		1019	129		564			
v/c		0.18	0.24		0.28			
95% queue length		0.64	0.93		1.17			
Control Delay		9.3	41.7		13.9			
LOS		A	E		B			
Approach Delay				18.4				
Approach LOS				C				

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst:
Agency/Co.:
Date Performed: 1/27/2016
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year:
Project ID:
East/West Street: 93rd
North/South Street: White Oak
Intersection Orientation: EW Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume		437	29	150	420	
Peak-Hour Factor, PHF		0.85	0.60	0.83	0.80	
Peak-15 Minute Volume		129	12	45	131	
Hourly Flow Rate, HFR		514	48	180	524	
Percent Heavy Vehicles		--	--	0	--	--
Median Type/Storage	Undivided			/		
RT Channelized?			No			
Lanes		1	1	1	1	
Configuration		T	R	L	T	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	22	0	134			
Peak Hour Factor, PHF	0.70	1.00	0.84			
Peak-15 Minute Volume	8	0	40			
Hourly Flow Rate, HFR	31	0	159			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	1	1	0			
Configuration	L		TR			

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0	
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0	
Percent Blockage	0	0	0	0	

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		
Shared ln volume, major rt vehicles:		
Sat flow rate, major th vehicles:		
Sat flow rate, major rt vehicles:		
Number of major street through lanes:		

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1	7.1	6.5	6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0	0	0	0			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)		0.00	0.70	0.00	0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage		4.1	6.4	6.5	6.2			
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		0	0	0	0			
t(f)		2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		562	1398	1398	514			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500		1500				
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.		9		12
Conflicting Flows		514		
Potential Capacity		564		
Pedestrian Impedance Factor		1.00		1.00
Movement Capacity		564		
Probability of Queue free St.		0.72		1.00
Step 2: LT from Major St.		**4**		**1**
Conflicting Flows		562		
Potential Capacity		1019		
Pedestrian Impedance Factor		1.00		1.00
Movement Capacity		1019		
Probability of Queue free St.		0.82		1.00
Maj L-Shared Prob Q free St.				
Step 3: TH from Minor St.		**8**		**11**
Conflicting Flows		1398		
Potential Capacity		142		
Pedestrian Impedance Factor		1.00		1.00
Cap. Adj. factor due to Impeding mvmnt		0.82		0.82
Movement Capacity		117		
Probability of Queue free St.		1.00		1.00
Step 4: LT from Minor St.		**7**		**10**
Conflicting Flows		1398		
Potential Capacity		157		
Pedestrian Impedance Factor		1.00		1.00
Maj. L, Min T Impedance factor				0.82
Maj. L, Min T Adj. Imp Factor.				0.86
Cap. Adj. factor due to Impeding mvmnt		0.82		0.62
Movement Capacity		129		

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.		8		11
Part 1 - First Stage				
Conflicting Flows				
Potential Capacity				
Pedestrian Impedance Factor				
Cap. Adj. factor due to Impeding mvmnt				
Movement Capacity				
Probability of Queue free St.				

Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows		1398	
Potential Capacity		142	
Pedestrian Impedance Factor		1.00	1.00
Cap. Adj. factor due to Impeding mvmnt		0.82	0.82
Movement Capacity		117	
Result for 2 stage process:			
a			
y			
C t		117	
Probability of Queue free St.		1.00	1.00
Step 4: LT from Minor St.		7	10
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows		1398	
Potential Capacity		157	
Pedestrian Impedance Factor		1.00	1.00
Maj. L, Min T Impedance factor			0.82
Maj. L, Min T Adj. Imp Factor.			0.86
Cap. Adj. factor due to Impeding mvmnt		0.82	0.62
Movement Capacity		129	
Results for Two-stage process:			
a			
y			
C t		129	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	31	0	159			
Movement Capacity (vph)	129	117	564			
Shared Lane Capacity (vph)			564			

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	129	117	564			
Volume	31	0	159			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh			564			
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		L	L		TR			
v (vph)		180	31		159			
C(m) (vph)		1019	129		564			
v/c		0.18	0.24		0.28			
95% queue length		0.64	0.93		1.17			
Control Delay		9.3	41.7		13.9			
LOS		A	E		B			
Approach Delay				18.4				
Approach LOS				C				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.82
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4		9.3
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

Traffic Count and signal warrant analysis

at 101st Avenue and White Oak Avenue (existing)

APPENDIX 14

TRAFFIC COUNT SUMMARY SHEET

LOCATION: white oak and 101st DATE: ####

	North Approach on white oak				East Approach on 101st				South Approach white oak				West Approach o 101st				Total	Total	Total	
TIME BEGIN	Right	Thru	Left	Total	Right	Thru	Left	Total	Right	Thru	Left	Total	Right	Thru	Left	Total	N/S	E/W		
6:00	4	3		7		2		2	1	4	22	27	2		3	5	34	7	41	
6:15	7	2	1	10	1	2		3	1	4	52	57	8		5	13	67	16	83	
6:30	7	3	1	11		1		1		9	30	39	3	1	4	8	50	9	59	
6:45	7	1		8	4	7		11		13	40	53	3		14	17	61	28	89	
6:00-7:00	18	8	2	28	1	5		6	2	17	104	123	13	1	12	26	151	32	183	
7:00	10	2	1	13	2	1		3		6	37	43	8		5	13	56	16	72	
7:15	10	1		11			1	1		7	37	44	10		3	13	55	14	69	
7:30	12	7		19	2	2	2	6	1	6	26	33	8		1	9	52	15	67	
7:45	18	5	1	24	3	4		7		6	25	31	6	1	15	22	55	29	84	
7:00-8:00	50	15	2	67	7	7	3	17	1	25	125	151	32	1	24	57	218	74	292	Total for hour
PHF	0.69	0.54	0.50	0.70	0.58	0.44	0.38	0.61	0.25	0.89	0.84	0.86	0.80	0.25	0.40	0.65				
	0.71													0.83						
4:00	18	24		42		1		1		13	14	27	31	3	9	43	69	44	113	
4:15	12	16		28	2	1		3		12	17	29	32	3	6	41	57	44	101	
4:30	17	15	3	35	1			1	1	10	19	30	45	5	18	68	65	69	134	
4:45	23	25		48	3	1		4		14	21	35	37	1	20	58	83	62	145	
4:00-5:00	70	80	3	153	6	3		9	1	49	71	121	145	12	53	210	274	219	493	Total for hour
5:00	12	23	2	37		1		1	1	20	21	42	35	4	18	57	79	58	137	
5:15	17	14	1	32	5		1	6		19	16	35	33	3	16	52	67	58	125	
5:30	18	28	3	49	1		1	2		10	15	25	28	2	16	46	74	48	122	
5:45	19	44	2	65		1	1	2		19	17	36	38	4	26	68	101	70	171	
5:00-6:00	66	109	8	183	6	2	3	11	1	68	69	138	134	13	76	223	321	234	555	Total for hour
PHF	0.87	0.62	0.67	0.70	0.30	0.50	0.75	0.46	0.25	0.85	0.82	0.82	0.88	0.81	0.73	0.82				
	0.69													0.875						
	Warrant 2						NO													
		y=377.227-0.679x+.000			y (calc)	Y Actual	X													
					282.68	26	151	NO												
					245.84	57	218	NO												
					217.46	210	274	NO												
					195.33	223	321	YES												
	Warrant 3						no													
		y=520.0116-.7648x+.00			y (calc)	Y Actual	X													
					308	223	321	NO												

Highway Capacity Analysis:

101st Avenue and White Oak Avenue

Existing Condition AM

APPENDIX 15

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst:
Agency/Co.:
Date Performed: 1/27/2016
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year:
Project ID: Existing
East/West Street: 101st
North/South Street: White Oqak

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	24	1	32	3	7	7	125	25	1	2	15	50
% Thrus Left Lane												

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LTR		LTR	
PHF	0.65		0.61		0.86		0.70	
Flow Rate	86		26		175		94	
% Heavy Veh	0		0		0		0	
No. Lanes	1		1		1		1	
Opposing-Lanes	1		1		1		1	
Conflicting-lanes	1		1		1		1	
Geometry group	1		1		1		1	

Duration, T 0.25 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	86		26		175		94	
Left-Turn	36		4		145		2	
Right-Turn	49		11		1		71	
Prop. Left-Turns	0.4		0.2		0.8		0.0	
Prop. Right-Turns	0.6		0.4		0.0		0.8	
Prop. Heavy Vehicle	0.0		0.0		0.0		0.0	
Geometry Group	1		1		1		1	
Adjustments Exhibit 17-33:								
hLT-adj	0.2		0.2		0.2		0.2	

hRT-adj	-0.6	-0.6	-0.6	-0.6
hHV-adj	1.7	1.7	1.7	1.7
hadj, computed	-0.3	-0.2	0.2	-0.4

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	86		26		175		94	
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.08		0.02		0.16		0.08	
hd, final value	4.27		4.37		4.41		3.90	
x, final value	0.10		0.03		0.21		0.10	
Move-up time, m	2.0		2.0		2.0		2.0	
Service Time	2.3		2.4		2.4		1.9	

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	86		26		175		94	
Service Time	2.3		2.4		2.4		1.9	
Utilization, x	0.10		0.03		0.21		0.10	
Dep. headway, hd	4.27		4.37		4.41		3.90	
Capacity	336		276		425		344	
Delay	7.75		7.52		8.61		7.34	
LOS	A		A		A		A	
Approach:								
Delay	7.75		7.52		8.61		7.34	
LOS	A		A		A		A	

Intersection Delay 8.03 Intersection LOS A

Highway Capacity Analysis:
101st Avenue and White Oak Avenue
Existing Condition PM

APPENDIX 16

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst:
Agency/Co.:
Date Performed: 1/27/2016
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year:
Project ID: Existing
East/West Street: 101st
North/South Street: White Oqak

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	53	12	145	0	3	6	71	49	1	3	80	70
% Thrus Left Lane												

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LTR		LTR	
PHF	0.82		0.46		1.00		0.70	
Flow Rate	254		19		121		218	
% Heavy Veh	0		0		0		0	
No. Lanes	1		1		1		1	
Opposing-Lanes	1		1		1		1	
Conflicting-lanes	1		1		1		1	
Geometry group	1		1		1		1	

Duration, T 0.25 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	254		19		121		218	
Left-Turn	64		0		71		4	
Right-Turn	176		13		1		100	
Prop. Left-Turns	0.3		0.0		0.6		0.0	
Prop. Right-Turns	0.7		0.7		0.0		0.5	
Prop. Heavy Vehicle	0.0		0.0		0.0		0.0	
Geometry Group	1		1		1		1	
Adjustments Exhibit 17-33:								
hLT-adj	0.2		0.2		0.2		0.2	

hRT-adj	-0.6	-0.6	-0.6	-0.6
hHV-adj	1.7	1.7	1.7	1.7
hadj, computed	-0.4	-0.4	0.1	-0.3

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	254		19		121		218	
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.23		0.02		0.11		0.19	
hd, final value	4.37		4.62		4.92		4.43	
x, final value	0.31		0.02		0.17		0.27	
Move-up time, m	2.0		2.0		2.0		2.0	
Service Time	2.4		2.6		2.9		2.4	

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	254		19		121		218	
Service Time	2.4		2.6		2.9		2.4	
Utilization, x	0.31		0.02		0.17		0.27	
Dep. headway, hd	4.37		4.62		4.92		4.43	
Capacity	504		269		371		468	
Delay	9.30		7.74		8.89		9.04	
LOS	A		A		A		A	
Approach:								
Delay	9.30		7.74		8.89		9.04	
LOS	A		A		A		A	

Intersection Delay 9.08 Intersection LOS A

Traffic Count and signal warrant analysis

101st Avenue and White Oak Avenue

(existing plus site)

APPENDIX 17

TRAFFIC COUNT SUMMARY SHEET

LOCATION: white oak and 101st DATE: 42389

TIME BEGIN	North Approach on white oak				East Approach on 101st				South Approach white oak				West Approach o 101st				Total	Total	Total	
	Right	Thru	Left	Total	Right	Thru	Left	Total	Right	Thru	Left	Total	Right	Thru	Left	Total	N/S	E/W		
6:00	4	3		7		2		2	1	4	22	27	2		3	5	34	7	41	
6:15	7	2	1	10	1	2		3	1	4	52	57	8		5	13	67	16	83	
6:30	7	3	1	11		1		1		9	30	39	3	1	4	8	50	9	59	
6:45	7	1		8	4	7		11		13	40	53	3		14	17	61	28	89	
6:00-7:00	18	8	2	28	1	5		6	2	17	104	123	13	1	12	26	151	32	183	
7:00	10	2	1	13	2	1		3		6	37	43	8		5	13	56	16	72	
7:15	10	1		11			1	1		7	37	44	10		3	13	55	14	69	
7:30	12	7		19	2	2	2	6	1	6	26	33	8		1	9	52	15	67	
7:45	18	5	1	24	3	4		7		6	25	31	6	1	15	22	55	29	84	
7:00-8:00	50	15	2	67	7	7	3	17	1	25	125	151	32	1	24	57	218	74	292	Total for hour
PHF	0.69	0.54	0.50	0.70	0.58	0.44	0.38	0.61	0.25	0.89	0.84	0.86	0.80	0.25	0.40	0.648				
	0.71													0.83						
4:00	18	24		42		1		1		13	14	27	31	3	9	43	69	44	113	
4:15	12	16		28	2	1		3		12	17	29	32	3	6	41	57	44	101	
4:30	17	15	3	35	1			1	1	10	19	30	45	5	18	68	65	69	134	
4:45	23	25		48	3	1		4		14	21	35	37	1	20	58	83	62	145	
4:00-5:00	70	80	3	153	6	3		9	1	49	71	121	145	12	53	210	274	219	493	Total for hour
5:00	12	23	2	37		1		1	1	20	21	42	35	4	18	57	79	58	137	
5:15	17	14	1	32	5		1	6		19	16	35	33	3	16	52	67	58	125	
5:30	18	28	3	49	1		1	2		10	15	25	28	2	16	46	74	48	122	
5:45	19	44	2	65		1	1	2		19	17	36	38	4	26	68	101	70	171	
5:00-6:00	66	109	8	183	6	2	3	11	1	68	69	138	134	13	76	223	321	234	555	Total for hour
PHF	0.87	0.62	0.67	0.70	0.30	0.50	0.75	0.46	0.25	0.85	0.82	0.82	0.88	0.81	0.73	0.82				
	0.69													0.875						

Warrant 2

y=377.227-0.679x+.000 | y (calc) | Y Actual | X | | NO
---|---|---|---
| 282.68 | 26 | 151 | NO
| 245.84 | 57 | 218 | NO
| 217.46 | 210 | 274 | NO
| 195.33 | 223 | 321 | YES

Warrant 3

y=520.0116-.7648x+.00 | y (calc) | Y Actual | X | no
---|---|---|---
| 308 | 223 | 321 | NO

AM peak Hour																				
Existing	50	15	2	67	7	7	3	17	1	25	125	151	32	1	24	57	218	74	292	
site	70	12		82						4		4			23	23	86	23	109	
total	120	27	2	149	7	7	3	17	1	29	125	155	32	1	47	80	304	97	401	
Pm Peak Hour																				
Existing	70	80	3	153	6	3		9	1	49	71	121	145	12	53	210	274	219	493	
site	43	7		50						12		12			74	74	62	74	136	
total	113	87	3	203	6	3		9	1	61	71	133	145	12	127	284	336	293	629	

Warrant 3

y=520.0116-.7648x+.00 | y (calc) | Y Actual | X | no
---|---|---|---
| 299.73 | 284 | 336 | NO

Highway Capacity Analysis:
101st Avenue and White Oak Avenue,
Existing plus Site Conditions AM

APPENDIX 18

HCS+: Unsignalized Intersections Release 5.4

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst:
Agency/Co.:
Date Performed: 1/27/2016
Analysis Time Period: AM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year:
Project ID: Existing plus site with proposed improvements
East/West Street: 101st
North/South Street: White Oqak

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	47	1	32	3	7	7	125	29	1	2	27	120
% Thrus Left Lane												

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	L	TR	LTR		LTR		L	TR
PHF	0.40	0.83	0.61		0.86		0.50	0.71
Flow Rate	117	39	26		179		4	207
% Heavy Veh	0	0	0		0		0	0
No. Lanes	2		1		1		2	
Opposing-Lanes	1		2		2		1	
Conflicting-lanes	2		2		2		2	
Geometry group	5		4b		4b		5	

Duration, T 0.25 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	117	39	26		179		4	207
Left-Turn	117	0	4		145		4	0
Right-Turn	0	38	11		1		0	169
Prop. Left-Turns	1.0	0.0	0.2		0.8		1.0	0.0
Prop. Right-Turns	0.0	1.0	0.4		0.0		0.0	0.8
Prop. Heavy Vehicle	0.0	0.0	0.0		0.0		0.0	0.0
Geometry Group	5		4b		4b		5	
Adjustments Exhibit 17-33:								
hLT-adj	0.5		0.2		0.2		0.5	

hRT-adj		-0.7		-0.6		-0.6		-0.7
hHV-adj		1.7		1.7		1.7		1.7
hadj, computed	0.5	-0.7	-0.2		0.2		0.5	-0.6

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	117	39	26		179		4	207
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.10	0.03	0.02		0.16		0.00	0.18
hd, final value	6.02	4.83	5.52		5.43		5.73	4.65
x, final value	0.20	0.05	0.04		0.27		0.01	0.27
Move-up time, m	2.3		2.3		2.3		2.3	
Service Time	3.7	2.5	3.2		3.1		3.4	2.3

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	117	39	26		179		4	207
Service Time	3.7	2.5	3.2		3.1		3.4	2.3
Utilization, x	0.20	0.05	0.04		0.27		0.01	0.27
Dep. headway, hd	6.02	4.83	5.52		5.43		5.73	4.65
Capacity	367	289	276		429		254	457
Delay	10.17	7.80	8.45		10.13		8.46	9.04
LOS	B	A	A		B		A	A
Approach:								
Delay	9.58		8.45		10.13		9.03	
LOS	A		A		B		A	

Intersection Delay 9.50 Intersection LOS A

Highway Capacity Analysis:
101st Avenue and White Oak Avenue,
Existing plus Site Conditions PM

APPENDIX 19

Phone: Fax:
E-Mail:

ALL-WAY STOP CONTROL(AWSC) ANALYSIS

Analyst:
Agency/Co.:
Date Performed: 1/27/2016
Analysis Time Period: PM Peak
Intersection:
Jurisdiction:
Units: U. S. Customary
Analysis Year:
Project ID: Existing plus site with proposed improvements
East/West Street: 101st
North/South Street: White Oqak

Worksheet 2 - Volume Adjustments and Site Characteristics

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	127	12	145	0	3	6	71	61	1	3	87	113
% Thrus Left Lane												

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	L	TR	LTR		LTR		L	TR
PHF	0.73	0.88	0.46		0.82		0.67	0.69
Flow Rate	173	177	19		161		4	289
% Heavy Veh	0	0	0		0		0	0
No. Lanes	2		1		1		2	
Opposing-Lanes	1		2		2		1	
Conflicting-lanes	2		2		2		2	
Geometry group	5		4b		4b		5	

Duration, T 0.25 hrs.

Worksheet 3 - Saturation Headway Adjustment Worksheet

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rates:								
Total in Lane	173	177	19		161		4	289
Left-Turn	173	0	0		86		4	0
Right-Turn	0	164	13		1		0	163
Prop. Left-Turns	1.0	0.0	0.0		0.5		1.0	0.0
Prop. Right-Turns	0.0	0.9	0.7		0.0		0.0	0.6
Prop. Heavy Vehicle	0.0	0.0	0.0		0.0		0.0	0.0
Geometry Group	5		4b		4b		5	
Adjustments Exhibit 17-33:								
hLT-adj	0.5		0.2		0.2		0.5	

hRT-adj		-0.7		-0.6		-0.6		-0.7
hHV-adj		1.7		1.7		1.7		1.7
hadj, computed	0.5	-0.6	-0.4		0.1		0.5	-0.4

Worksheet 4 - Departure Headway and Service Time

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow rate	173	177	19		161		4	289
hd, initial value	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
x, initial	0.15	0.16	0.02		0.14		0.00	0.26
hd, final value	6.29	5.13	5.93		6.01		6.25	5.35
x, final value	0.30	0.25	0.03		0.27		0.01	0.43
Move-up time, m	2.3		2.3		2.3		2.3	
Service Time	4.0	2.8	3.6		3.7		3.9	3.0

Worksheet 5 - Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Flow Rate	173	177	19		161		4	289
Service Time	4.0	2.8	3.6		3.7		3.9	3.0
Utilization, x	0.30	0.25	0.03		0.27		0.01	0.43
Dep. headway, hd	6.29	5.13	5.93		6.01		6.25	5.35
Capacity	423	427	269		411		254	539
Delay	11.69	9.56	8.82		10.91		8.99	12.01
LOS	B	A	A		B		A	B
Approach:								
Delay	10.61		8.82		10.91		11.97	
LOS	B		A		B		B	
Intersection Delay 11.11			Intersection LOS B					