WESTLAND CREEK SUBDIVISION

Traffic Impact Study
Westland Drive
Knoxville, TN

A Traffic Impact Study for the Proposed Westland Creek Subdivision

Submitted to

Knoxville – Knox County Metropolitan Planning Commission

Revised March 29, 2017
February 27, 2017
FMA Project No. 330.012

Submitted By:

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ATTACHMENTS

Executive Summary

S & E Properties, LLC proposes a residential development with single family homes. The project is located east of Ebenezer Road near the intersection of Westland Drive and Gothic Manor Way in Knox County. The development will consist of 82 single family homes. Construction is proposed to take place this year and this study assumes full build out for the development will occur in 2020.

The driveway for the proposed development will tie into Westland Drive 905 feet east of the intersection of Westland Drive and Gothic Manor Way. The proposed lane configuration is a single lane out of the development.

In order to maintain or provide an acceptable level-of-service for each of the intersections studied, some recommendations are presented.

Westland Drive @ Project Entrance
A westbound left turn lane is warranted at the intersection of Westland Drive and the proposed project entrance. FMA recommends a 50 foot storage length and a 150 foot bay taper for the proposed left turn lane per Knox County policy. Assuming the installation of an 11 foot turn lane; a 300 foot approach/departure taper will need to be installed on Westland Drive per TDOT guidelines.

The northbound approach is expected to operate at a LOS C during the AM peak hour and a LOS D during the PM peak hour after the completion of the Westland Creek Subdivision. The unsignalized intersection capacity analyses show a 95% queue length of less than one car length (25 feet) during both the AM and PM peak hours; therefore, the proposed geometry of one 13 foot lane exiting the subdivision will be adequate.

Westland Drive @ Gothic Manor Way
At the intersection of Westland Drive and Gothic Manor Way, the westbound approach will continue to operate at a LOS A and the northbound approach will continue to operate at a LOS C after the completion of the Westland Creek Subdivision.

1 Introduction

1.1 Project Description

This report provides a summary of a traffic impact study that was performed for the proposed Westland Creek Subdivision on Westland Drive. The project site is located east of Ebenezer Road near the intersection of Westland Drive and Gothic Manor Way in Knox County. The location of the site is shown in Figure 1.

The proposed Westland Creek Subdivision will consist of 82 single family lots. Full Buildout is expected to occur within three years, or by the year 2020. The proposed site layout is shown in Figure 2.

The purpose of this study is to evaluate the impacts to the traffic conditions caused by the development of the proposed subdivision.

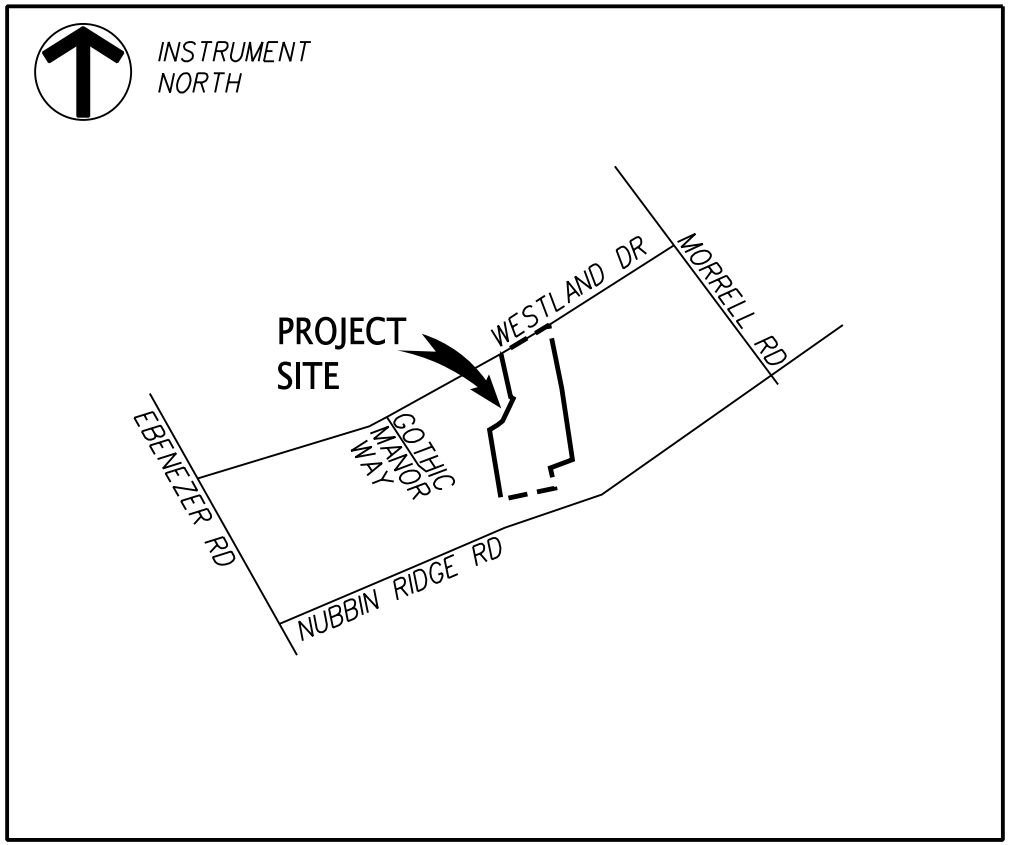
1.2 Existing Site Conditions

The proposed subdivision site access will tie into Westland Drive approximately 905 feet east of the intersection of Westland Drive and Gothic Manor Way and approximately 1,490 feet west of the intersection of Westland Drive and S Gallaher View Road.

During a site visit it was determined that Westland Drive is a two-lane road at the proposed project entrance. The Knoxville-Knox County Metropolitan Planning Commission classifies Westland Drive as a minor arterial per the Major Road Plan. The posted speed limit on Westland Drive is 40 mph. The intersection sight distance at the proposed driveway was measured to be in excess of 400-ft east and west of the intersection.

Gothic Manor Way is a two-lane road and does not have a posted speed. The Knoxville-Knox County Metropolitan Planning Commission does not list a classification for Gothic Manor Way per the Major Road Plan; therefore it is considered a local street.

FIGURE 1



LOCATION MAP
(NOT TO SCALE)

Project 330.012	Proj. Mgr.	Designed By	Drawn By	Reference	
Date 2/27/17	0	ISSUED FOR REVIEW			2/27/17
Scale N.T.S.	1	REVISED PER MPC COMMENTS			3/29/17
Sheet FIGURE 1					
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LOCATION MAP

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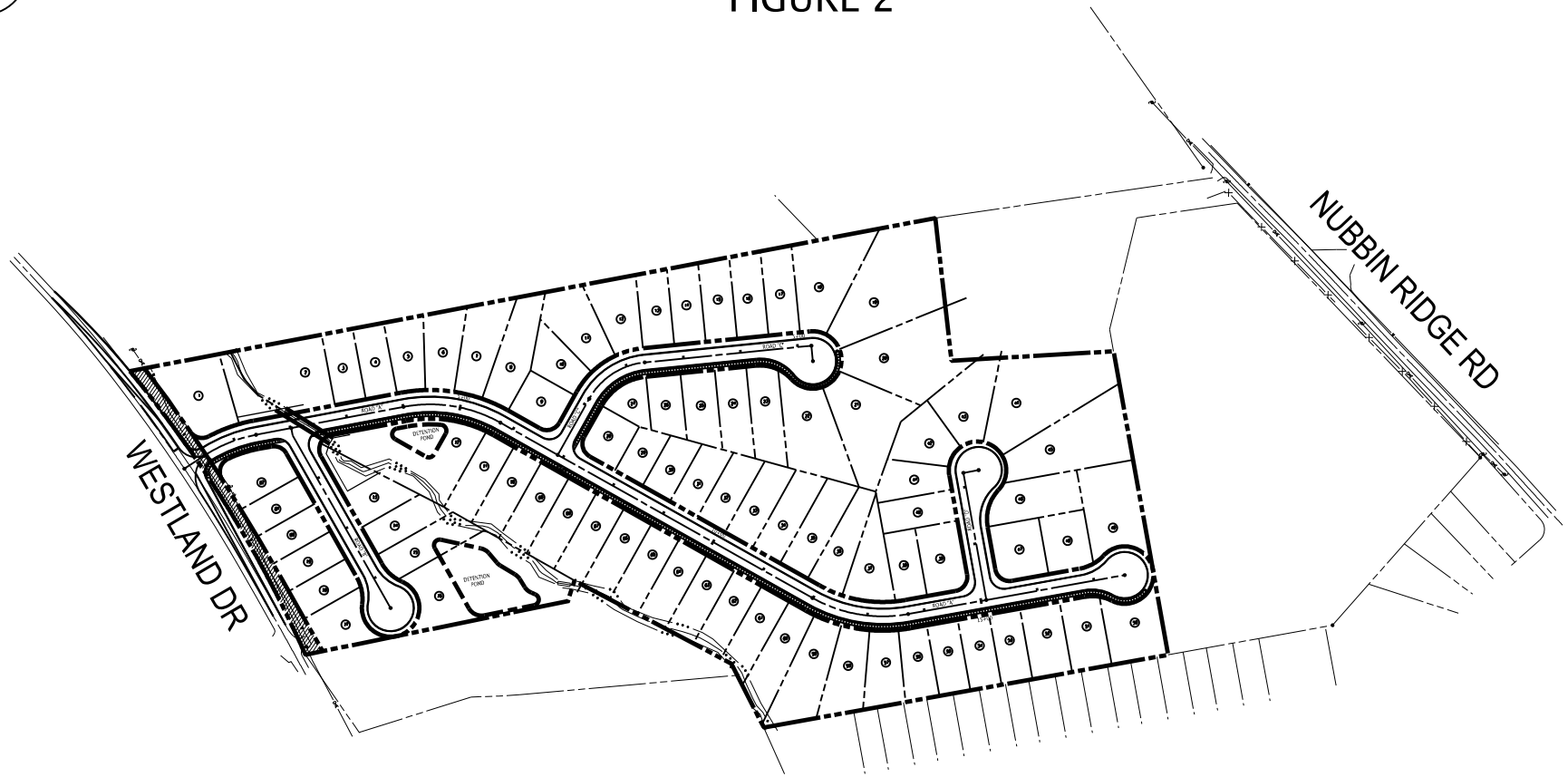
FIGURE 2



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SITE PLAN

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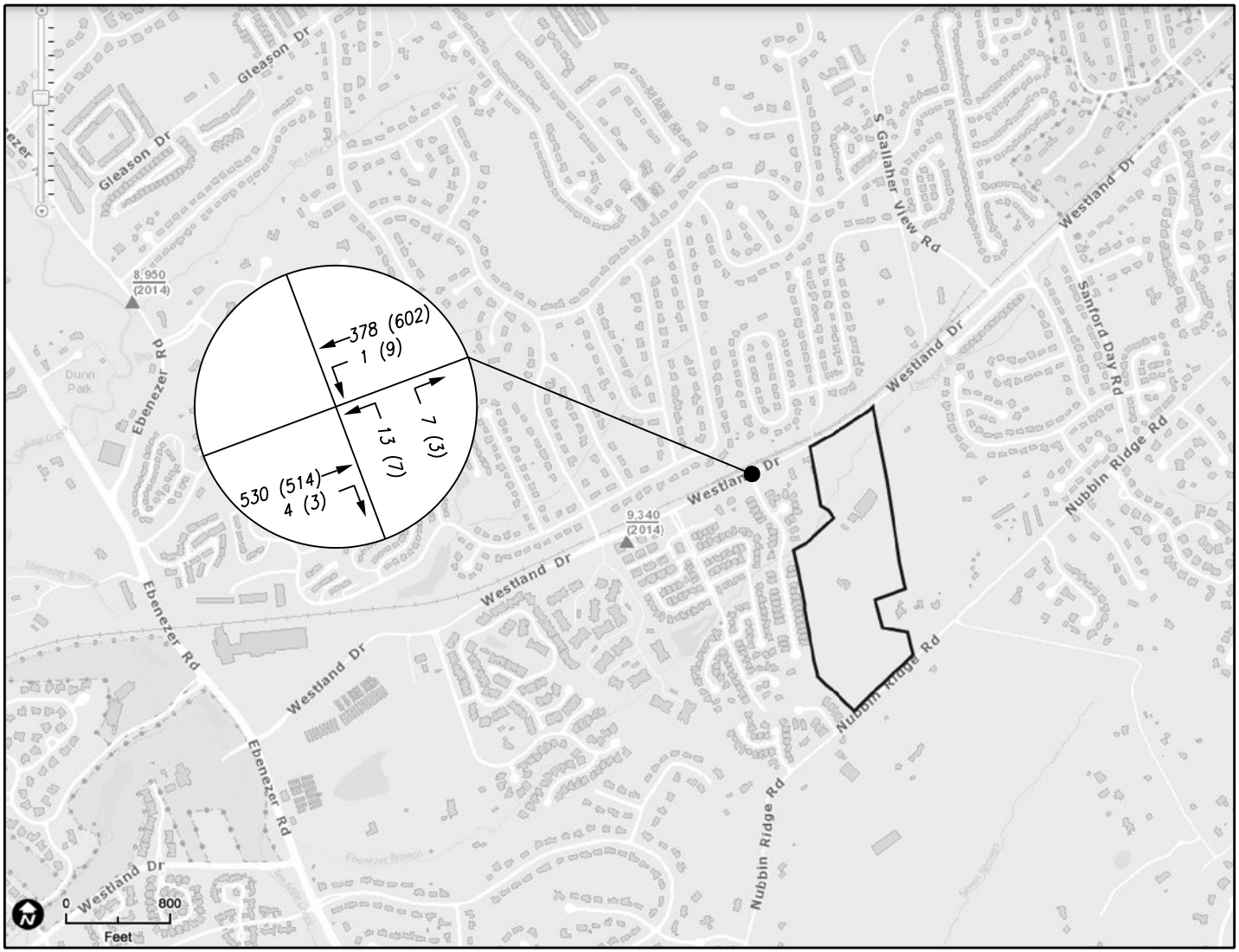
2 Existing Traffic Volumes

FMA conducted a turning movement count at the intersection of Westland Drive and Gothic Manor Way on Thursday February 16, 2017. The existing volumes including the AM and PM peak hour traffic volumes at the count location is shown in Figure 3, and the count data collected is included in Attachment 1.

The current AM peak hour and PM peak hour were determined using the turning movement count that FMA conducted. The AM peak hour occurred between 7:30 am and 8:30 am, and the PM peak hour occurred between 5:00 pm and 6:00 pm.



LEGEND:

← 5 (16) TURNING MOVEMENT VOLUME AM (PM)

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2017 EXISTING PEAK HOUR TRAFFIC

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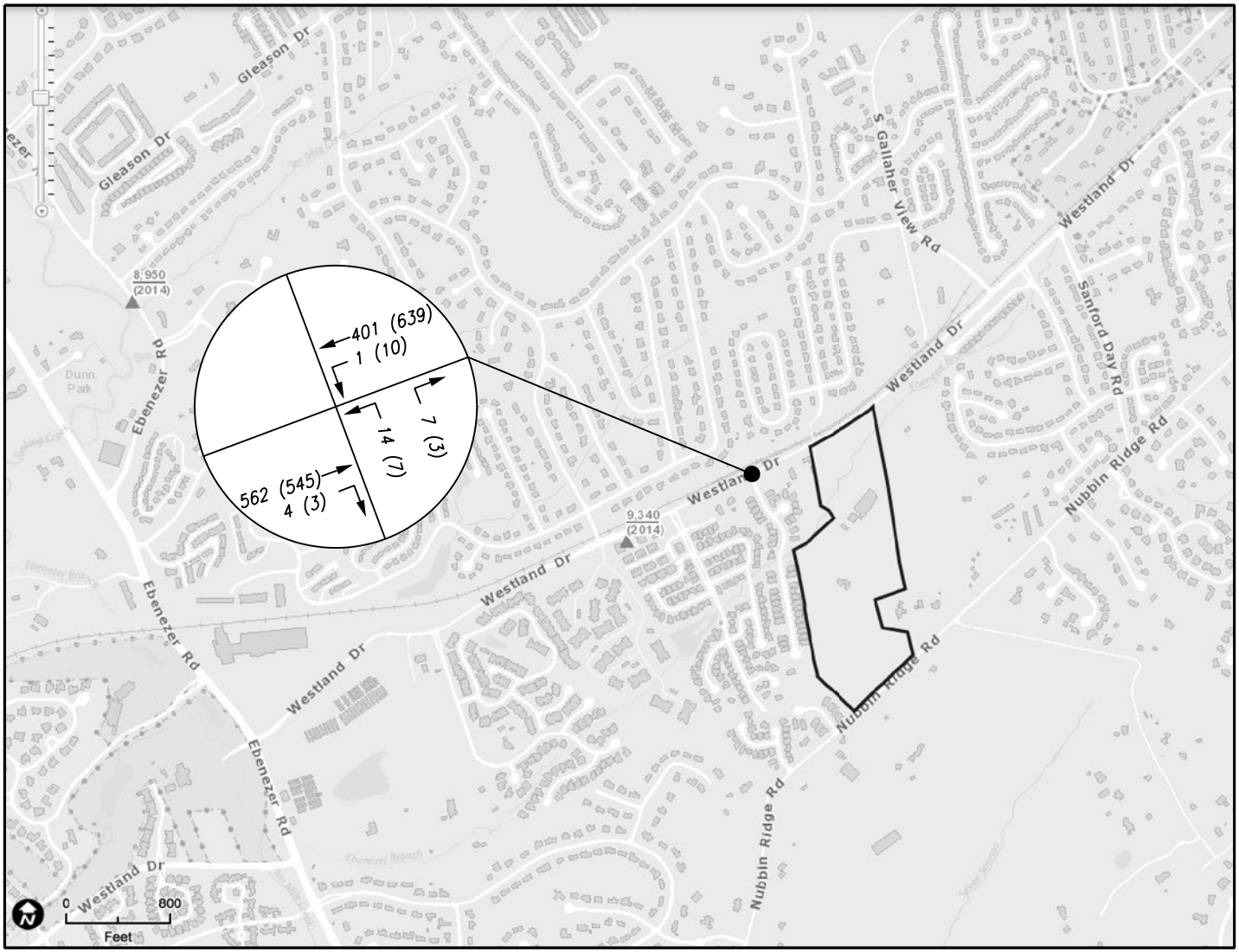
3 Background Growth

The Tennessee Department of Transportation (TDOT) maintains a count station on Westland Drive west of Dartford Road. The annual traffic growth rate for this station between 2000 and 2015 is approximately 1.23%.

The Transportation Planning Organization (TPO) maintains a count station on Westland Drive 1000 feet east of Villa Crest Drive. The annual traffic growth rate for this station between 2000 and 2015 is approximately 0.92%.

For the purpose of this study, an annual growth rate of 2.0% for traffic at the intersection of Westland Drive and Gothic Manor Way was assumed until full occupancy is reached in 2020.

Attachment 2 shows the trend line growth charts for the TDOT count station and for the TPO count station. Figure 4 demonstrates the projected future peak hour volumes at the intersection after applying this background growth rate to the existing conditions.



LEGEND:

← 5 (16) TURNING MOVEMENT VOLUME AM (PM)

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Scale N.T.S.				
Sheet **FIGURE 4**				

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2020 BACKGROUND PEAK HOUR TRAFFIC

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4 Trip Generation and Trip Distribution

Single-Family Detached Housing or Land Use 210 was used to calculate site trips for the proposed single family housing using the fitted curve equations from *Trip Generation, 9th Edition,* published by the Institute of Transportation Engineers. The land use worksheets are included in Attachment 3.

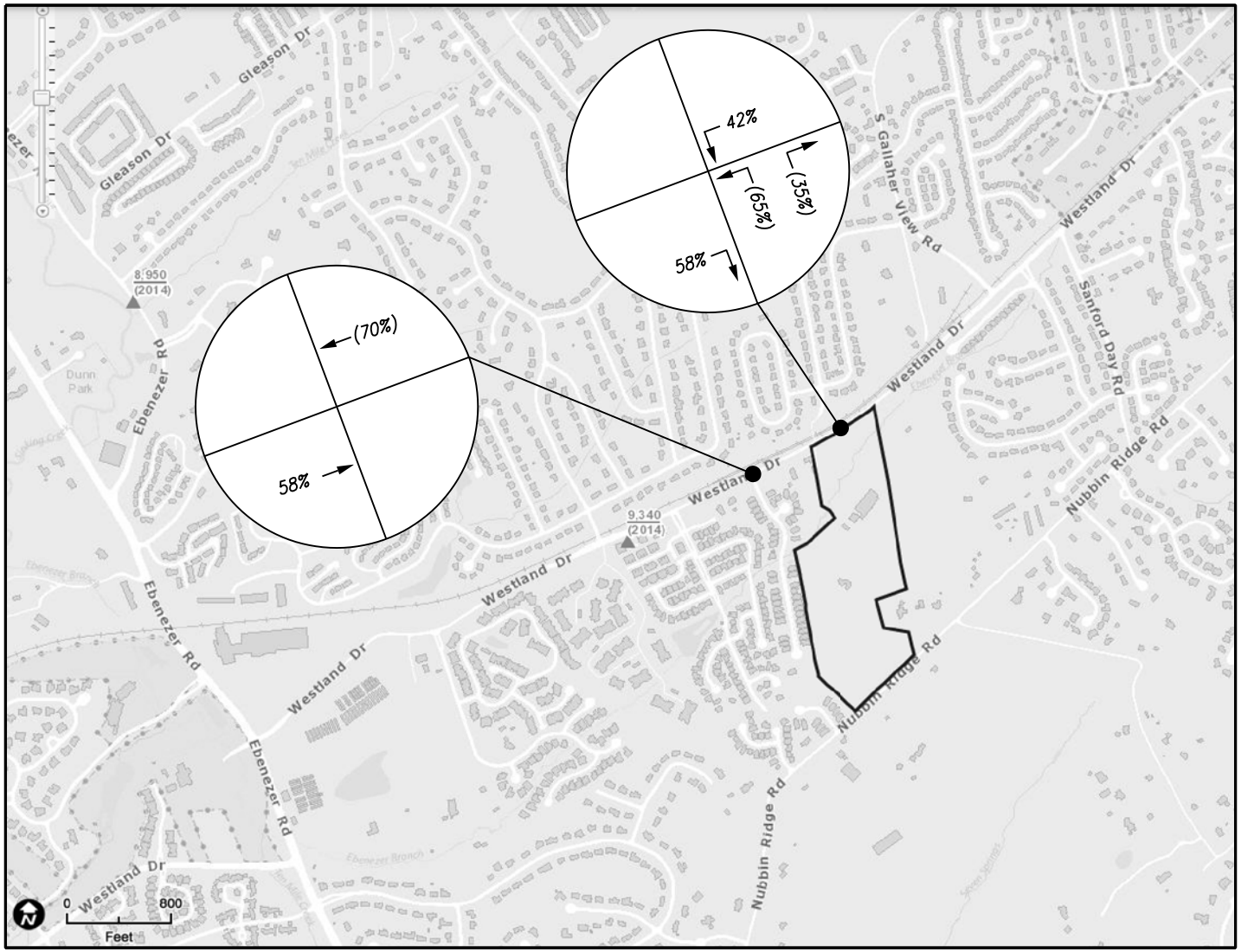
The total number of trips generated by the proposed single family housing was estimated to be 875 daily trips. The estimated trips are 67 trips during the AM peak hour and 88 trips during the PM peak hour. A trip generation summary is shown in Table 4-1.

Table 4-1
Trip Generation Summary

	Single-Family Detached Housing (Land Use 210)				
	Total New Trips	% Entering	%Exiting	Number Entering	Number Exiting
Weekday	875	50	50	438	438
A.M. Peak	67	25	75	17	50
P.M. Peak	88	63	37	55	33

The directional distribution of the traffic generated by the proposed Westland Creek Subdivision was determined using the traffic data collected for the existing conditions. The typical weekday traffic pattern is for traffic to flow heavier in one direction in the morning peak period and then for the traffic to be heavier in the opposite direction during the evening peak period. Westland Drive at the proposed Project Entrance has a trip distribution of 58% Eastbound and 42% Westbound during the AM peak hour and 46% Eastbound and 54% Westbound during the PM peak hour. The trip distribution for the Westland Creek Subdivision is shown in Figure 5 and Figure 6.

Using the existing trip distribution the trips generated from the Westland Creek Subdivision are shown in Figure 7. Figure 8 shows the combined peak hour traffic from the background growth and the full build out of the Westland Creek Subdivision.



LEGEND:

← 50% (50%) TRIP DISTRIBUTION ENTERING (EXITING)

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AM PEAK HOUR TRIP DISTRIBUTION

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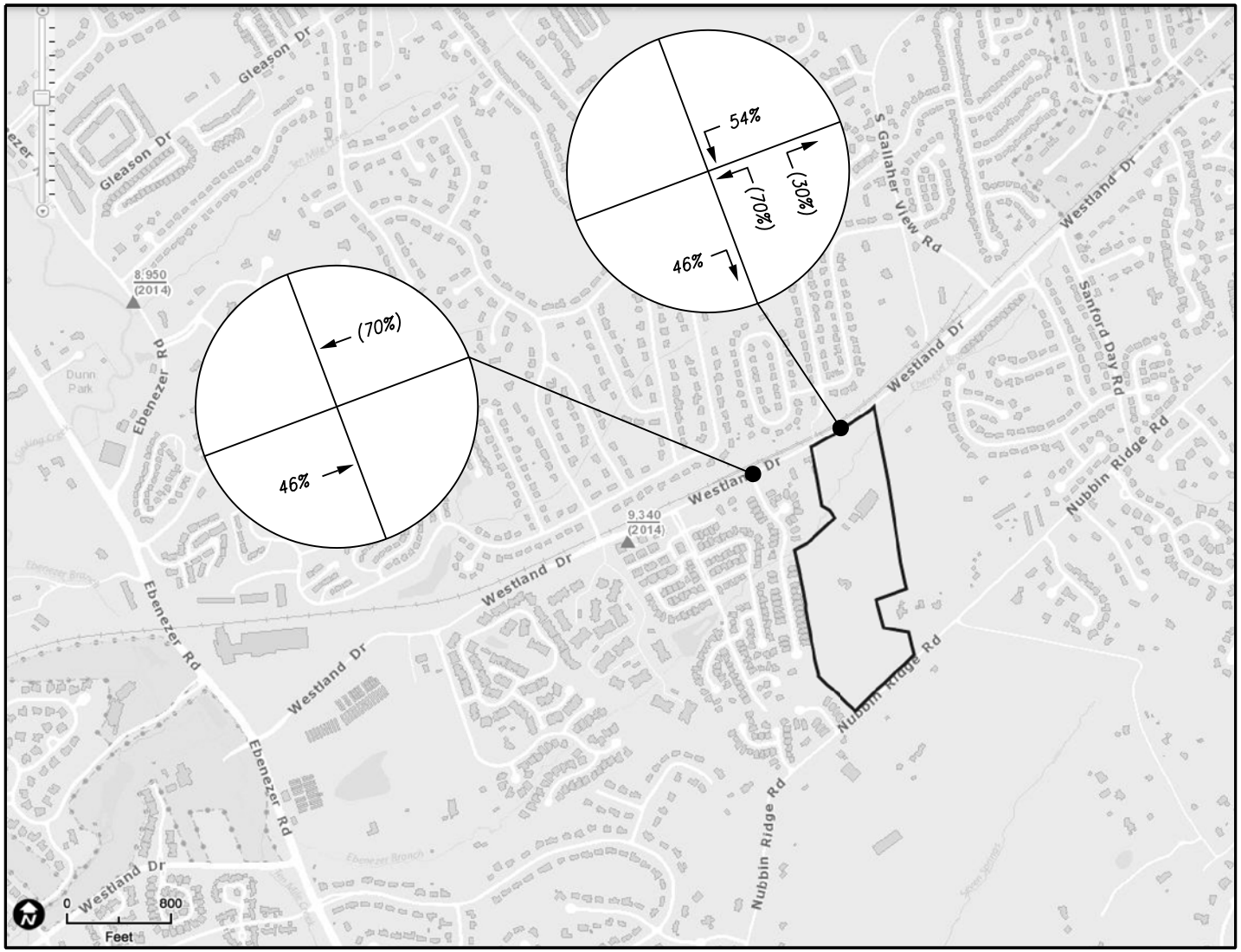

LEGEND:

← 50% (50%) TRIP DISTRIBUTION ENTERING (EXITING)

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Sheet FIGURE 6				

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PM PEAK HOUR TRIP DISTRIBUTION

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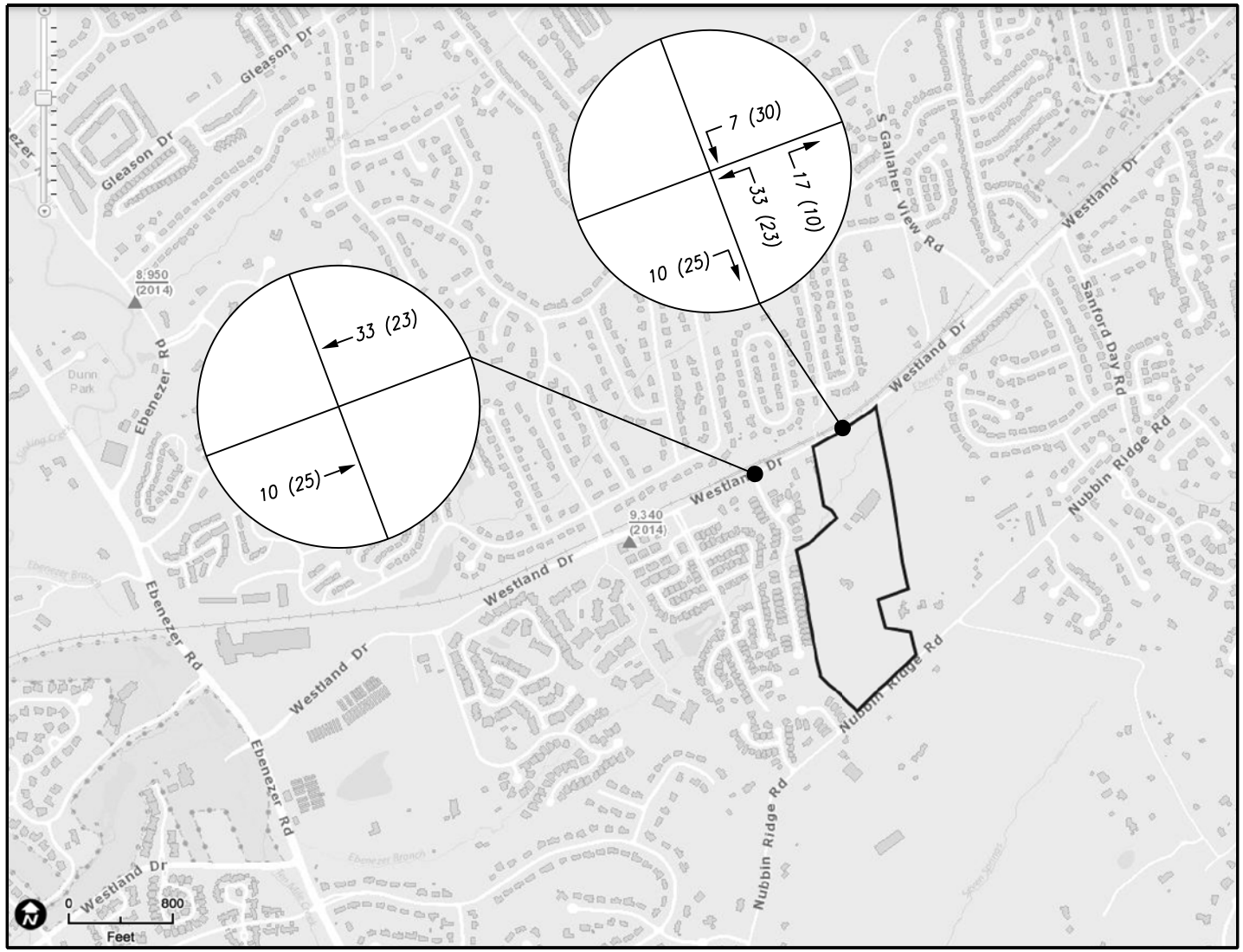

LEGEND:

← 5 (16) TURNING MOVEMENT VOLUME AM (PM)

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PEAK HOUR SUBDIVISION TRAFFIC

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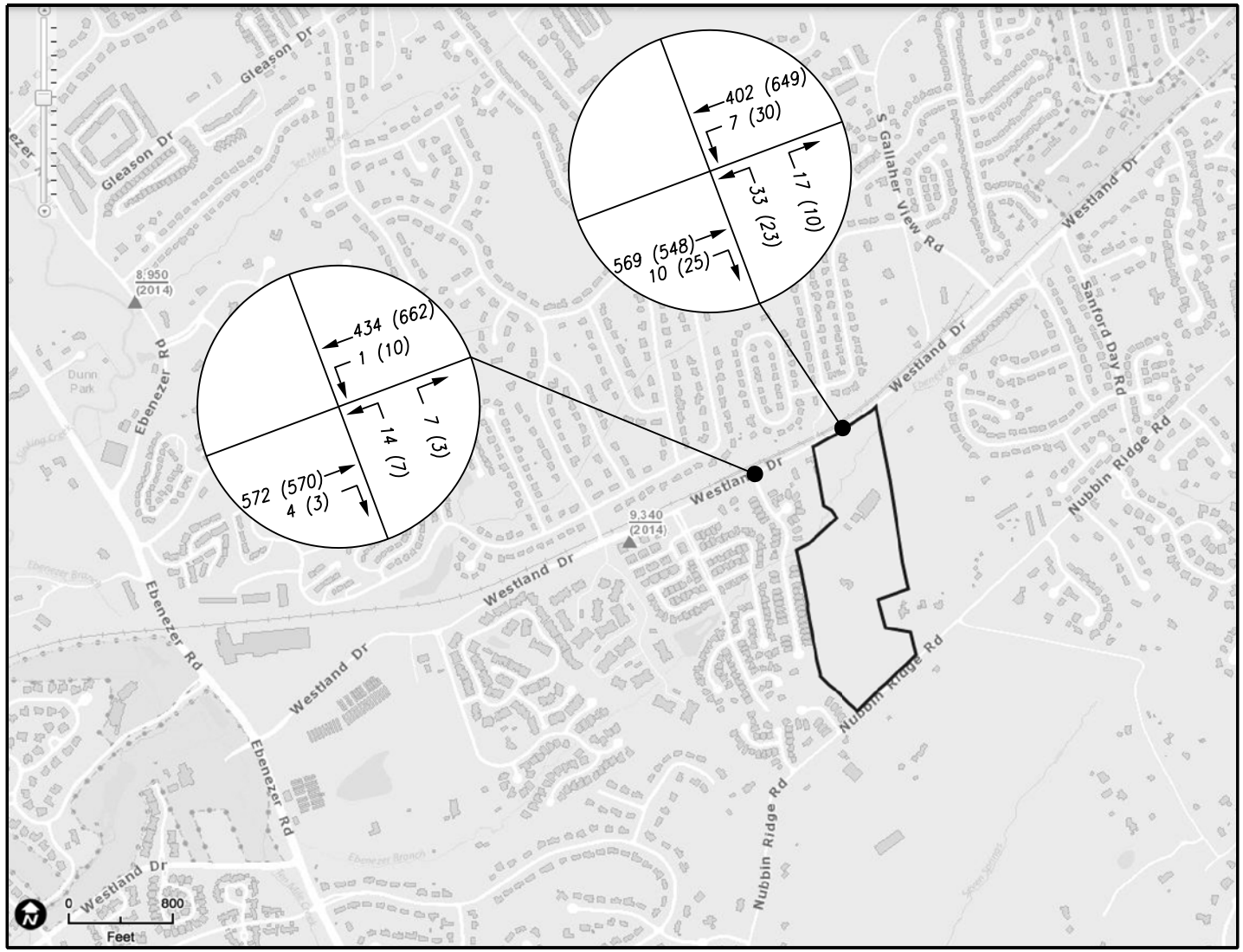

LEGEND:

← 5 (16) TURNING MOVEMENT VOLUME AM (PM)

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2020 PEAK HOUR TRAFFIC FULL BUILDOUT

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5 Projected Capacity and Level of Service

Unsignalized intersection capacity analyses were performed for the AM and PM peak hours to evaluate the traffic conditions at the intersections of Westland Drive and Gothic Manor Way and the intersection of Westland Drive and the proposed project entrance.

The results from the analyses are expressed with a term "level of service" (LOS), which is based on the amount of delay experienced at the intersection. The LOS index ranges from LOS A, indicating excellent traffic conditions with minimal delay, to LOS F indicating very congested conditions with excessive delay. LOS D generally is considered the minimum acceptable condition in urban areas. Table 5-1 shows the results of the capacity analyses.

Table 5-1

Intersection Analysis
Level of Service (LOS) Summary

		Delay (sec)/LOS
Westland Drive @ Gothic Manor Way (Existing 2017)		
AM Peak	WB LT	8.7 / A
	NB LR	17.7 / C
PM Peak	WB LT	8.6 / A
	NB LR	21.3 / C
Westland Drive @ Gothic Manor Way (Background Growth 2020)		
AM Peak	WB LT	8.9 / A
	NB LR	19.0 / C
PM Peak	WB LT	8.7 / A
	NB LR	23.1 / C
Westland Drive @ Gothic Manor Way (Full Buildout 2020)		
AM Peak	WB LT	8.9 / A
	NB LR	19.9 / C
PM Peak	WB LT	8.8 / A
	NB LR	24.5 / C

Westland Drive @ Project Entrance (Full Buildout 2020)		
AM Peak	WB LT NB LR	8.8 / A 20.4 / C
PM Peak	WB LT NB LR	8.9 / A 27.8 / D
Westland Drive @ Project Entrance (Full Buildout w/ Left Turn 2020)		
AM Peak	WB LT NB LR	8.8 / A 20.4 / C
PM Peak	WB LT NB LR	8.9 / A 27.8 / D

6 Turn Lane Warrant Analysis

The intersection of Westland Drive and the Project Entrance was evaluated to determine if an eastbound right turn lane or a westbound left turn lane on Westland Drive was warranted. The Knox County Department of Engineering and Public Works handbook, "Access Control and Driveway Design Policy," was used to analyze the information. An eastbound right turn lane on Westland Drive is not warranted during the AM or PM peak hour. A westbound left turn lane on Westland Drive is warranted during the PM peak hour. The turn lane warrant worksheets and analysis are included in Attachment 7.

7 Conclusions and Recommendations

7.1 Westland Drive @ Gothic Manor Way

At the intersection of Westland Drive and Gothic Manor Way, the westbound approach will continue to operate at a LOS A and the northbound approach will continue to operate at a LOS C after the completion of the Westland Creek Subdivision.

7.2 Westland Drive @ Project Entrance

Westland Drive is classified as a minor arterial. The minimum intersection spacing required for an arterial is 400 feet per the "Minimum Subdivision Regulations" for Knoxville and Knox County. The nearest road intersection to the project entrance is currently 905 feet west at the intersection of Westland Drive and Gothic Manor Way. This intersection exceeds the typical minimum separation of 400 feet between roads on a minor arterial; therefore, no change is necessary.

The minimum required sight distance for a road with a posted speed limit of 40 mph is 400 feet in each direction in accordance with the "Minimum Subdivision Regulations" for Knoxville and Knox County. The proposed intersection of Westland Drive and the project entrance has a measured sight distance that exceeds 400-ft east and west of the intersection, which meets the requirement. FMA recommends any landscaping be installed so as to maintain the sight distance and continue to comply with Knox County Engineering & Public Works requirements.

An eastbound right turn lane is not warranted at the intersection of Westland Drive and the proposed project entrance.

A westbound left turn lane is warranted at the intersection of Westland Drive and the proposed project entrance. The unsignalized intersection capacity analyses shows a 95% queue length for the westbound left turning movement of less than one car length (25 feet) during both the AM and PM peak hours. FMA recommends a 50 foot storage length and a 150 foot bay taper for the proposed left turn lane per Knox County policy. Assuming the installation of an 11 foot turn lane; a 300 foot approach/departure taper will need to be installed on Westland Drive per the TDOT guidelines.

At the intersection of Westland Drive and the Project Entrance, the westbound left turning movement is expected to operate at a LOS A during both the AM and PM peak hours and the northbound approach is expected to operate at a LOS C during the AM peak hour and a LOS D during the PM peak hour after the completion of the Westland Creek Subdivision. The unsignalized intersection capacity analyses shows a 95% queue length for the northbound approach of less than one car length during both the AM and PM peak hours; therefore, the proposed geometry of one 13 foot lane exiting the subdivision will be adequate.

Attachment 1
Traffic Counts

Attachment 1
Traffic Counts

Project: Westland Creek Subdivision
Date Conducted: 02/16/2017

	Westland Drive Eastbound			Westland Drive Westbound			Gothic Manor Way Northbound			
Start	Thru	Right	Total	Left	Thru	Total	Left	Right	Total	Int. Total
7:00 AM	55	0	55	0	53	53	4	0	4	112
7:15 AM	104	1	105	0	82	82	3	2	5	192
7:30 AM	130	0	130	0	90	90	1	3	4	224
7:45 AM	147	3	150	0	110	110	3	3	6	266
Total	436	4	440	0	335	335	11	8	19	794
8:00 AM	145	0	145	0	94	94	8	0	8	247
8:15 AM	108	1	109	1	84	85	1	1	2	196
8:30 AM	81	1	82	0	79	79	1	1	2	163
8:45 AM	87	0	87	0	86	86	2	0	2	175
Total	421	2	423	1	343	344	12	2	14	781
3:00 PM	84	1	85	0	94	94	2	0	2	181
3:15 PM	71	4	75	0	89	89	0	2	2	166
3:30 PM	65	2	67	1	132	133	2	1	3	203
3:45 PM	82	3	85	1	134	135	2	0	2	222
Total	302	10	312	2	449	451	6	3	9	772
4:00 PM	105	1	106	0	108	108	1	0	1	215
4:15 PM	110	2	112	2	130	132	1	0	1	245
4:30 PM	95	1	96	1	133	134	1	2	3	233
4:45 PM	113	2	115	0	149	149	0	0	0	264
Total	423	6	429	3	520	523	3	2	5	957
5:00 PM	113	1	114	1	159	160	2	0	2	276
5:15 PM	127	1	128	1	164	165	2	1	3	296
5:30 PM	133	1	134	4	150	154	3	1	4	292
5:45 PM	141	0	141	3	129	132	0	1	1	274
Total	514	3	517	9	602	611	7	3	10	1138
Grand Total	2096	25	2121	15	2249	2264	39	18	57	4442
Approach %	98.8	1.2		0.7	99.3		68.4	31.6		
Total %	47.2	0.6	47.7	0.3	50.6	51.0	0.9	0.4	1.3	

Project: Westland Creek Subdivision
Date Conducted: 2/16/2017

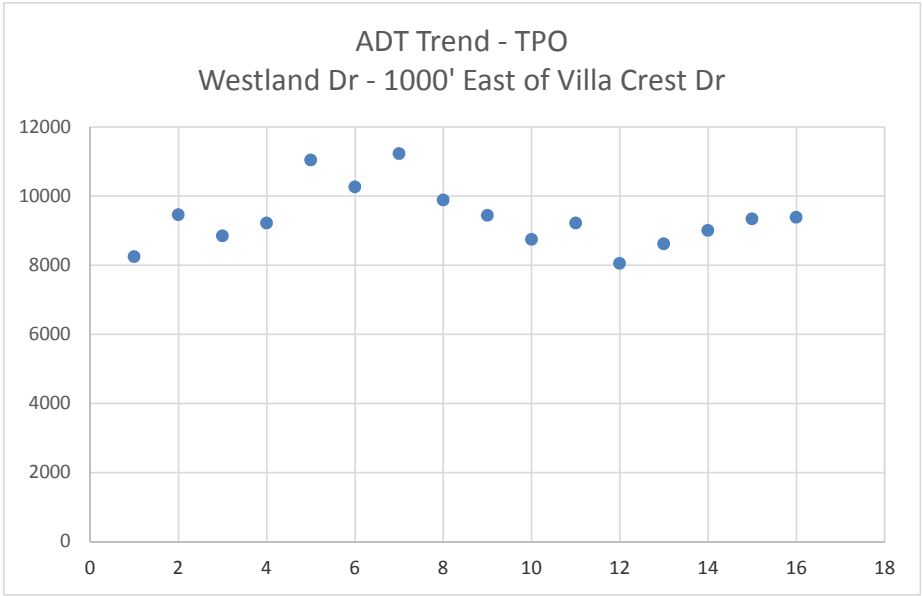
AM Peak Hour	7:30 AM - 8:30 AM	933
PM Peak Hour	5:00 PM - 6:00 PM	1138

	Westland Drive Eastbound			Westland Drive Westbound			Gothic Manor Way Northbound			
Start	Thru	Right	App. Total	Left	Thru	App. Total	Left	Right	App. Total	Int. Total
Peak Hour Analysis from 7:00 AM to 9:00 AM										
AM Peak Hour begins at 7:30 AM										
7:30 AM	130	0	130	0	90	90	1	**3**	4	224
7:45 AM	**147**	**3**	150	0	**110**	110	3	3	6	**266**
8:00 AM	145	0	145	0	94	94	**8**	0	8	247
8:15 AM	108	1	109	**1**	84	85	1	1	2	196
Total Volume	530	4	534	1	378	379	13	7	20	933
Future (2% over 3 yrs)	562	4		1	401		14	7		990
PHF	0.90	0.33		0.25	0.86		0.41	0.58		0.88
Peak Hour Analysis from 3:00 PM to 6:00 PM										
PM Peak Hour begins at 5:00 PM										
5:00 PM	113	**1**	114	1	159	160	2	0	**2**	276
5:15 PM	127	1	128	1	**164**	165	2	**1**	3	**296**
5:30 PM	133	1	134	**4**	150	154	**3**	1	4	292
5:45 PM	**141**	0	141	3	129	132	0	1	1	274
Total Volume	514	3	517	9	602	611	7	3	10	1138
Future (2% over 3 yrs)	545	3		10	639		7	3		1208
PHF	0.91	0.75		0.56	0.92		0.58	0.75		0.96

Attachment 2
ADT Trends

Attachment 2
ADT Trends

	Year	Adjusted Average Daily Traffic
1	2000	8250
2	2001	9460
3	2002	8850
4	2003	9220
5	2004	11040
6	2005	10267
7	2006	11230
8	2007	9890
9	2008	9440
10	2009	8750
11	2010	9220
12	2011	8050
13	2012	8620
14	2013	9010
15	2014	9340
	2015	9390



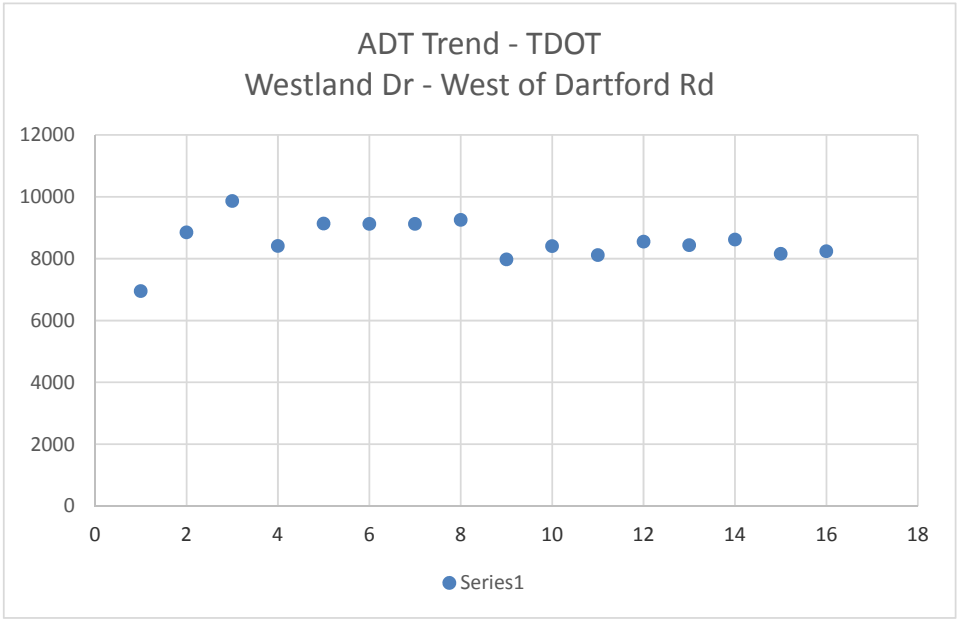
Most Recent Trend Line Growth

Year	ADT
2000	8250
2015	9390

Annual Percent Growth	0.92%

Attachment 2
ADT Trends

	Year	Adjusted Average Daily Traffic
1	2000	6948
2	2001	8845
3	2002	9858
4	2003	8406
5	2004	9129
6	2005	9121
7	2006	9122
8	2007	9250
9	2008	7972
10	2009	8401
11	2010	8110
12	2011	8547
13	2012	8433
14	2013	8613
15	2014	8152
16	2015	8234



Most Recent Trend Line Growth

Year	ADT
2000	6948
2015	8234

Annual Percent Growth	1.23%

Attachment 3
Trip Generation

Project: Westland Creek Subdivision **Attachment 3**
Date Conducted: 2/22/2017 **Trip Generation**

Single-Family Detached Housing - 82 Units
(Land Use 210)

Average Daily Traffic
Ln(T) = 0.92 Ln(X) + 2.72
Ln(T) = 0.92 Ln(82 units) + 2.72
T = 875

Peak Hour of Adjacent Street Traffic
One Hour Between 7 and 9 a.m.
T = 0.70(X) + 9.74
T = 0.70(82 units) + 9.74
T = 67

Peak Hour of Adjacent Street Traffic
One Hour Between 4 and 6 p.m.
Ln(T) = 0.90 Ln(X) +0.51
Ln(T) = 0.90 Ln(82 units) +0.51
T = 88

Time Period	Total Trips	Percent		Number	
		Enter	Exit	Enter	Exit
Weekday (24 hours)	875	50%	50%	438	438
AM Peak Hour	67	25%	75%	17	50
PM Peak Hour	88	63%	37%	55	33

Single-Family Detached Housing
(210)

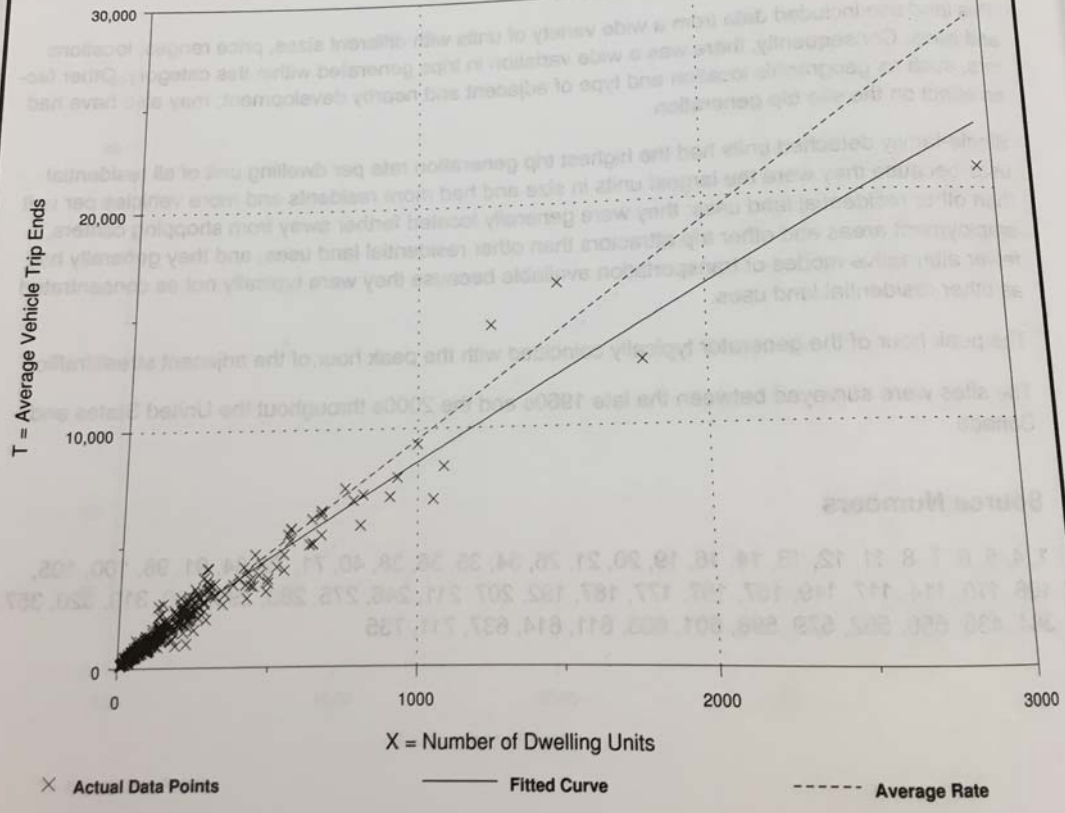
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Number of Studies: 355
Avg. Number of Dwelling Units: 198
Directional Distribution: 50% entering, 50% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
9.52	4.31 - 21.85	3.70

Data Plot and Equation



Fitted Curve Equation: $Ln(T) = 0.92\ Ln(X) + 2.72$

$R^2 = 0.95$

Single-Family Detached Housing
(210)

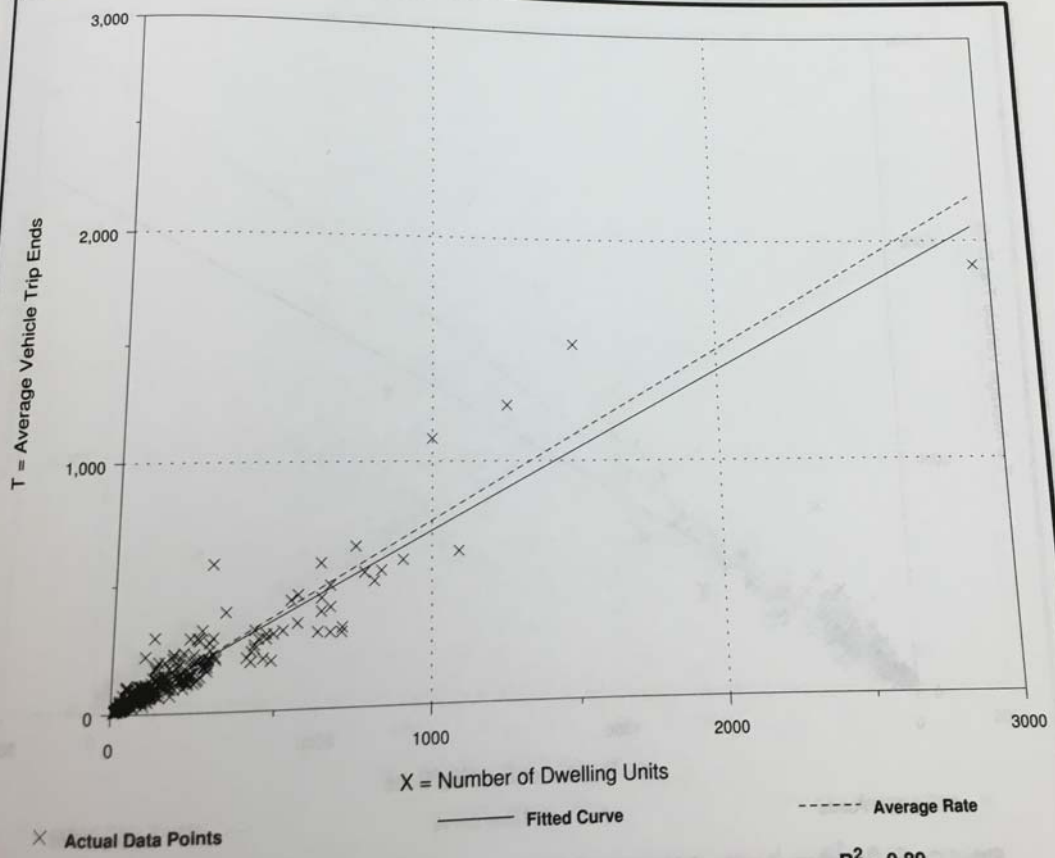
Average Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday,**
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.

Number of Studies: 292
Avg. Number of Dwelling Units: 194
Directional Distribution: 25% entering, 75% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.75	0.33 - 2.27	0.90

Data Plot and Equation



$R^2 = 0.89$

Fitted Curve Equation: T = 0.70(X) + 9.74

Single-Family Detached Housing
(210)

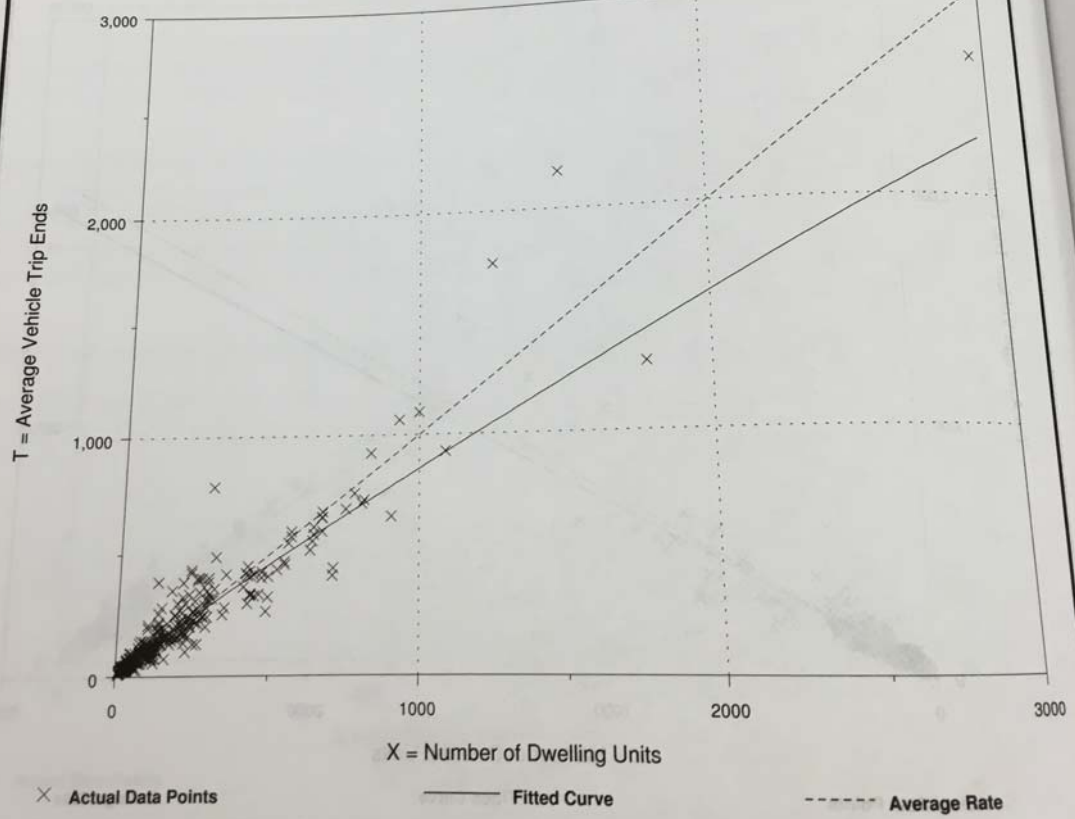
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.

Number of Studies: 321
Avg. Number of Dwelling Units: 207
Directional Distribution: 63% entering, 37% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
1.00	0.42 - 2.98	1.05

Data Plot and Equation



Fitted Curve Equation: $Ln(T) = 0.90\ Ln(X) + 0.51$

$R^2 = 0.91$

Attachment 4
Intersection Worksheets
Existing AM/PM Peaks

HCS7 Two-Way Stop-Control Report

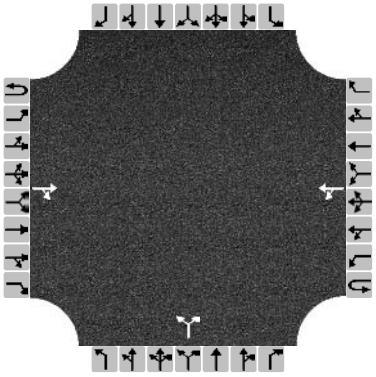
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	2/22/2017
Analysis Year	2017
Time Analyzed	AM Peak
Intersection Orientation	East-West
Project Description	330.012 Westland Creek

Site Information

Intersection	Westland @ Gothic Manor W
Jurisdiction	Knox County
East/West Street	Westland Drive
North/South Street	Gothic Manor Way
Peak Hour Factor	0.88
Analysis Time Period (hrs)	0.25

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	0	0
Configuration				TR		LT					LR					
Volume, V (veh/h)			530	4		1	378			13		7				
Percent Heavy Vehicles (%)						3				3		3				
Proportion Time Blocked																
Percent Grade (%)										0						
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)						4.1				7.1		6.2				
Critical Headway (sec)						4.13				6.43		6.23				
Base Follow-Up Headway (sec)						2.2				3.5		3.3				
Follow-Up Headway (sec)						2.23				3.53		3.33				

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						1					23					
Capacity, c (veh/h)						965					307					
v/c Ratio						0.00					0.07					
95% Queue Length, Q_{95} (veh)						0.0					0.2					
Control Delay (s/veh)						8.7					17.7					
Level of Service, LOS						A					C					
Approach Delay (s/veh)						0.0				17.7						
Approach LOS										C						

HCS7 Two-Way Stop-Control Report

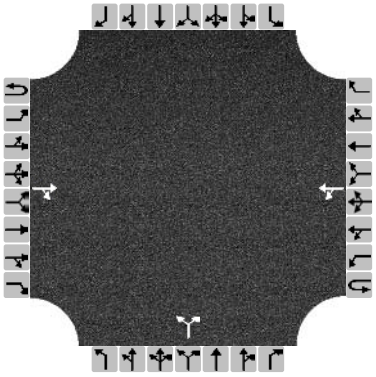
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	2/22/2017
Analysis Year	2017
Time Analyzed	PM Peak
Intersection Orientation	East-West
Project Description	330.012 Westland Creek

Site Information

Intersection	Westland @ Gothic Manor W
Jurisdiction	Knox County
East/West Street	Westland Drive
North/South Street	Gothic Manor Way
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	0	0
Configuration				TR		LT					LR					
Volume, V (veh/h)			514	3		9	602			7		3				
Percent Heavy Vehicles (%)						3				3		3				
Proportion Time Blocked																
Percent Grade (%)										0						
Right Turn Channelized		No				No				No				No		
Median Type/Storage			Undivided													

Critical and Follow-up Headways

Base Critical Headway (sec)						4.1				7.1		6.2				
Critical Headway (sec)						4.13				6.43		6.23				
Base Follow-Up Headway (sec)						2.2				3.5		3.3				
Follow-Up Headway (sec)						2.23				3.53		3.33				

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						10					11					
Capacity, c (veh/h)						1003					232					
v/c Ratio						0.01					0.05					
95% Queue Length, Q_{95} (veh)						0.0					0.1					
Control Delay (s/veh)						8.6					21.3					
Level of Service, LOS						A					C					
Approach Delay (s/veh)						0.3				21.3						
Approach LOS										C						

Attachment 5
Intersection Worksheets
Background AM/PM Peaks

HCS7 Two-Way Stop-Control Report

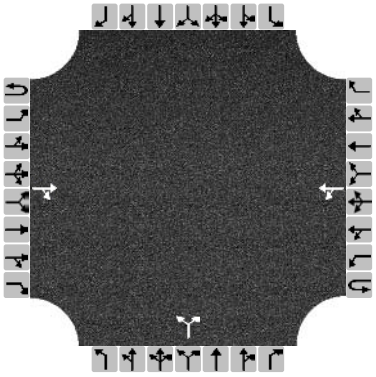
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	2/22/2017
Analysis Year	2020
Time Analyzed	AM Peak Background
Intersection Orientation	East-West
Project Description	330.012 Westland Creek

Site Information

Intersection	Westland @ Gothic Manor W
Jurisdiction	Knox County
East/West Street	Westland Drive
North/South Street	Gothic Manor Way
Peak Hour Factor	0.88
Analysis Time Period (hrs)	0.25

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	0	0
Configuration				TR		LT					LR					
Volume, V (veh/h)			562	4		1	401			14		7				
Percent Heavy Vehicles (%)						3				3		3				
Proportion Time Blocked																
Percent Grade (%)										0						
Right Turn Channelized		No				No				No				No		
Median Type/Storage			Undivided													

Critical and Follow-up Headways

Base Critical Headway (sec)						4.1				7.1		6.2				
Critical Headway (sec)						4.13				6.43		6.23				
Base Follow-Up Headway (sec)						2.2				3.5		3.3				
Follow-Up Headway (sec)						2.23				3.53		3.33				

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						1					24					
Capacity, c (veh/h)						935					281					
v/c Ratio						0.00					0.09					
95% Queue Length, Q_{95} (veh)						0.0					0.3					
Control Delay (s/veh)						8.9					19.0					
Level of Service, LOS						A					C					
Approach Delay (s/veh)						0.0				19.0						
Approach LOS										C						

HCS7 Two-Way Stop-Control Report

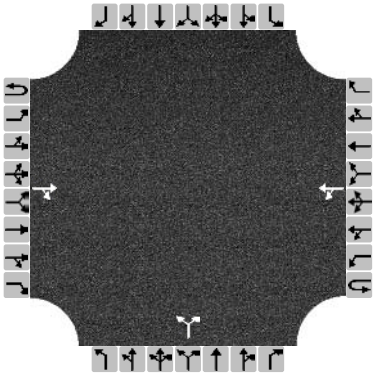
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	2/22/2017
Analysis Year	2020
Time Analyzed	PM Peak Background
Intersection Orientation	East-West
Project Description	330.012 Westland Creek

Site Information

Intersection	Westland @ Gothic Manor W
Jurisdiction	Knox County
East/West Street	Westland Drive
North/South Street	Gothic Manor Way
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	0	0
Configuration				TR		LT					LR					
Volume, V (veh/h)			545	3		10	639			7		3				
Percent Heavy Vehicles (%)						3				3		3				
Proportion Time Blocked																
Percent Grade (%)										0						
Right Turn Channelized		No				No				No				No		
Median Type/Storage			Undivided													

Critical and Follow-up Headways

Base Critical Headway (sec)						4.1				7.1		6.2				
Critical Headway (sec)						4.13				6.43		6.23				
Base Follow-Up Headway (sec)						2.2				3.5		3.3				
Follow-Up Headway (sec)						2.23				3.53		3.33				

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						11					11					
Capacity, c (veh/h)						975					210					
v/c Ratio						0.01					0.05					
95% Queue Length, Q_{95} (veh)						0.0					0.2					
Control Delay (s/veh)						8.7					23.1					
Level of Service, LOS						A					C					
Approach Delay (s/veh)						0.3				23.1						
Approach LOS										C						

Attachment 6
Intersection Worksheet
Full Buildout AM/PM Peaks

HCS7 Two-Way Stop-Control Report

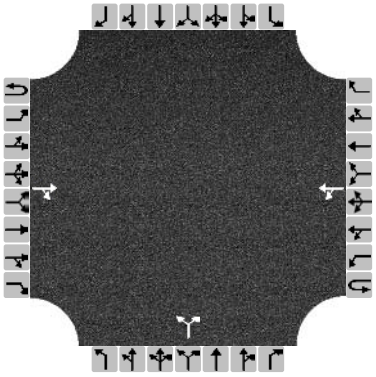
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	3/29/2017
Analysis Year	2020
Time Analyzed	AM Peak Full Buildout
Intersection Orientation	East-West
Project Description	330.012 Westland Creek

Site Information

Intersection	Westland @ Gothic Manor W
Jurisdiction	Knox County
East/West Street	Westland Drive
North/South Street	Gothic Manor Way
Peak Hour Factor	0.88
Analysis Time Period (hrs)	0.25

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	0	0
Configuration				TR		LT					LR					
Volume, V (veh/h)			572	4		1	434			14		7				
Percent Heavy Vehicles (%)						3				3		3				
Proportion Time Blocked																
Percent Grade (%)										0						
Right Turn Channelized		No				No				No				No		
Median Type/Storage			Undivided													

Critical and Follow-up Headways

Base Critical Headway (sec)						4.1				7.1		6.2				
Critical Headway (sec)						4.13				6.43		6.23				
Base Follow-Up Headway (sec)						2.2				3.5		3.3				
Follow-Up Headway (sec)						2.23				3.53		3.33				

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						1					24					
Capacity, c (veh/h)						927					265					
v/c Ratio						0.00					0.09					
95% Queue Length, Q_{95} (veh)						0.0					0.3					
Control Delay (s/veh)						8.9					19.9					
Level of Service, LOS						A					C					
Approach Delay (s/veh)						0.0				19.9						
Approach LOS										C						

HCS7 Two-Way Stop-Control Report

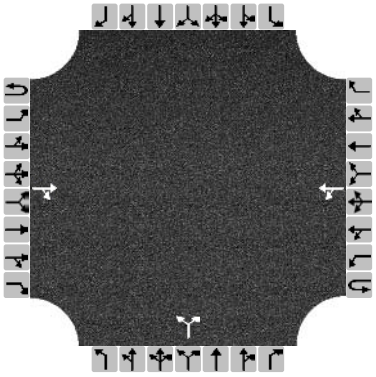
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	2/22/2017
Analysis Year	2020
Time Analyzed	PM Peak Full Buildout
Intersection Orientation	East-West
Project Description	330.012 Westland Creek

Site Information

Intersection	Westland @ Gothic Manor W
Jurisdiction	Knox County
East/West Street	Westland Drive
North/South Street	Gothic Manor Way
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	0	0
Configuration				TR		LT					LR					
Volume, V (veh/h)			570	3		10	662			7		3				
Percent Heavy Vehicles (%)						3				3		3				
Proportion Time Blocked																
Percent Grade (%)										0						
Right Turn Channelized		No				No				No				No		
Median Type/Storage			Undivided													

Critical and Follow-up Headways

Base Critical Headway (sec)						4.1				7.1		6.2				
Critical Headway (sec)						4.13				6.43		6.23				
Base Follow-Up Headway (sec)						2.2				3.5		3.3				
Follow-Up Headway (sec)						2.23				3.53		3.33				

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						11					11					
Capacity, c (veh/h)						952					196					
v/c Ratio						0.01					0.06					
95% Queue Length, Q_{95} (veh)						0.0					0.2					
Control Delay (s/veh)						8.8					24.5					
Level of Service, LOS						A					C					
Approach Delay (s/veh)						0.3				24.5						
Approach LOS										C						

HCS7 Two-Way Stop-Control Report

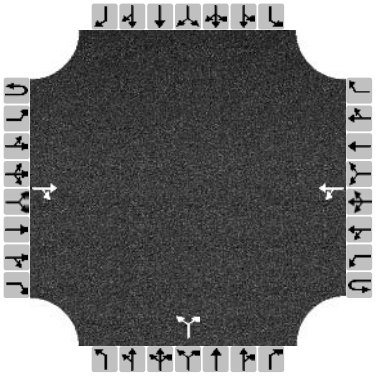
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	3/29/2017
Analysis Year	2020
Time Analyzed	AM Peak Full Buildout
Intersection Orientation	East-West
Project Description	330.012 Westland Creek

Site Information

Intersection	Westland @ Project Entran
Jurisdiction	Knox County
East/West Street	Westland Drive
North/South Street	Project Entrance
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	0	0
Configuration				TR		LT					LR					
Volume, V (veh/h)			569	10		7	402			33		17				
Percent Heavy Vehicles (%)						3				3		3				
Proportion Time Blocked																
Percent Grade (%)										0						
Right Turn Channelized		No				No				No				No		
Median Type/Storage			Undivided													

Critical and Follow-up Headways

Base Critical Headway (sec)						4.1				7.1		6.2				
Critical Headway (sec)						4.13				6.43		6.23				
Base Follow-Up Headway (sec)						2.2				3.5		3.3				
Follow-Up Headway (sec)						2.23				3.53		3.33				

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						8					54					
Capacity, c (veh/h)						947					288					
v/c Ratio						0.01					0.19					
95% Queue Length, Q_{95} (veh)						0.0					0.7					
Control Delay (s/veh)						8.8					20.4					
Level of Service, LOS						A					C					
Approach Delay (s/veh)						0.3				20.4						
Approach LOS										C						

HCS7 Two-Way Stop-Control Report

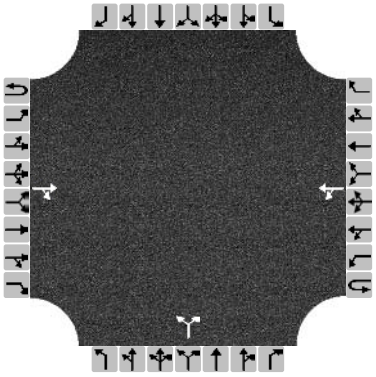
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	2/22/2017
Analysis Year	2020
Time Analyzed	PM Peak Full Buildout
Intersection Orientation	East-West
Project Description	330.012 Westland Creek

Site Information

Intersection	Westland @ Project Entran
Jurisdiction	Knox County
East/West Street	Westland Drive
North/South Street	Project Entrance
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	0	0
Configuration				TR		LT					LR					
Volume, V (veh/h)			548	25		30	649			23		10				
Percent Heavy Vehicles (%)						3				3		3				
Proportion Time Blocked																
Percent Grade (%)										0						
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)						4.1				7.1		6.2				
Critical Headway (sec)						4.13				6.43		6.23				
Base Follow-Up Headway (sec)						2.2				3.5		3.3				
Follow-Up Headway (sec)						2.23				3.53		3.33				

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						33					36					
Capacity, c (veh/h)						952					194					
v/c Ratio						0.03					0.19					
95% Queue Length, Q_{95} (veh)						0.1					0.7					
Control Delay (s/veh)						8.9					27.8					
Level of Service, LOS						A					D					
Approach Delay (s/veh)						0.9				27.8						
Approach LOS										D						

HCS7 Two-Way Stop-Control Report

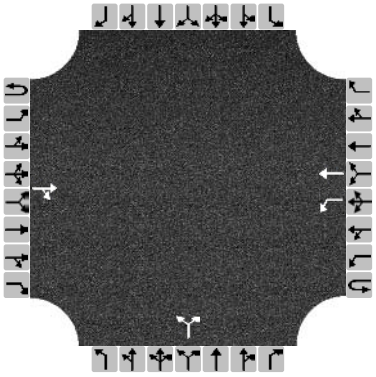
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	3/29/2017
Analysis Year	2020
Time Analyzed	AM Peak Full Buildout
Intersection Orientation	East-West
Project Description	330.012 Westland Creek

Site Information

Intersection	Westland @ Project Entran
Jurisdiction	Knox County
East/West Street	Westland Drive
North/South Street	Project Entrance
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	1	1	0		0	0	0		0	0	0
Configuration				TR		L	T				LR					
Volume, V (veh/h)			569	10		7	402			33		17				
Percent Heavy Vehicles (%)						3				3		3				
Proportion Time Blocked																
Percent Grade (%)										0						
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)						4.1				7.1		6.2				
Critical Headway (sec)						4.13				6.43		6.23				
Base Follow-Up Headway (sec)						2.2				3.5		3.3				
Follow-Up Headway (sec)						2.23				3.53		3.33				

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						8					54					
Capacity, c (veh/h)						947					288					
v/c Ratio						0.01					0.19					
95% Queue Length, Q_{95} (veh)						0.0					0.7					
Control Delay (s/veh)						8.8					20.4					
Level of Service, LOS						A					C					
Approach Delay (s/veh)						0.2				20.4						
Approach LOS										C						

HCS7 Two-Way Stop-Control Report

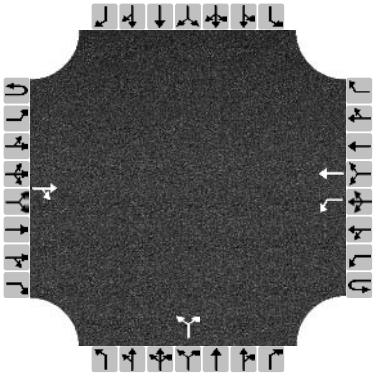
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	3/29/2017
Analysis Year	2020
Time Analyzed	PM Peak Full Buildout
Intersection Orientation	East-West
Project Description	330.012 Westland Creek

Site Information

Intersection	Westland @ Project Entran
Jurisdiction	Knox County
East/West Street	Westland Drive
North/South Street	Project Entrance
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	1	1	0		0	0	0		0	0	0
Configuration				TR		L	T				LR					
Volume, V (veh/h)			548	25		30	649			23		10				
Percent Heavy Vehicles (%)						3				3		3				
Proportion Time Blocked																
Percent Grade (%)										0						
Right Turn Channelized		No				No				No				No		
Median Type/Storage			Undivided													

Critical and Follow-up Headways

Base Critical Headway (sec)						4.1				7.1		6.2				
Critical Headway (sec)						4.13				6.43		6.23				
Base Follow-Up Headway (sec)						2.2				3.5		3.3				
Follow-Up Headway (sec)						2.23				3.53		3.33				

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						33					36					
Capacity, c (veh/h)						952					194					
v/c Ratio						0.03					0.19					
95% Queue Length, Q_{95} (veh)						0.1					0.7					
Control Delay (s/veh)						8.9					27.8					
Level of Service, LOS						A					D					
Approach Delay (s/veh)						0.4				27.8						
Approach LOS										D						

Attachment 7
Turn Lane Warrant Analysis

Attachment 7
Turn Lane Warrant Analysis

Project: Westland Creek Subdivision

Westland Drive at Project Entrance	VOLUMES				
LEFT TURN	Opposing	Thru	LT	LT MAX	Warrant Met
AM	579	402	7	20	NO
PM	573	649	30	15	YES

Westland Drive at Project Entrance	VOLUMES			
RIGHT TURN	Thru	RT	RT MAX	Warrant Met
AM	569	10	99	NO
PM	548	25	49	NO

TABLE 5A

LEFT-TURN LANE VOLUME THRESHOLDS
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 36 TO 45 MPH

(If the left-turn volume exceeds the table value a left -turn lane is needed)

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	100 - 149	150 - 199	200 - 249	250 - 299	300 - 349	350 - 399
100 - 149 150 - 199	250 200	180 140	140 105	110 90	80 70	70 60
200 - 249 250 - 299	160 130	115 100	85 75	75 65	65 60	55 50
300 - 349 350 - 399	110 100	90 80	70 65	60 55	55 50	45 40
400 - 449 450 - 499	90 80	70 65	60 55	50 45	45 40	35 30
500 - 549 550 - 599	70 65	60 55	45 40	35 35	35 30	25 25
600 - 649 650 - 699	60 55	45 35	35 35	30 30	25 25	25 20
700 - 749 750 or More	50 45	35 35	30 25	25 25	20 20	20 20

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 599	=/ > 600
100 - 149 150 - 199	70 60	60 55	50 45	45 40	40 35	35 30
200 - 249 250 - 299	55 50	50 45	40 35	35 30	30 30	30 30
300 - 349 350 - 399	45 40	40 35	35 30	30 25	25 25	25 20
400 - 449 450 - 499	35 30	30 25	30 25	25 20	20 20	20 20
500 - 549 550 - 599	25 25	25 20	20 20	20 20	20	15 15
600 - 649 650 - 699	25 20	20 20	20 20	20 20	20 20	15 15
700 - 749 750 or More	20 20	20 20	20 20	15 15	15 15	15 15

AM Peak

PM Peak

* Or through volume only if a right-turn lane exists

TABLE 5B

RIGHT-TURN LANE VOLUME THRESHOLDS
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 36 TO 45 MPH

RIGHT-TURN VOLUME	THROUGH VOLUME PLUS LEFT-TURN VOLUME *					
	< 100	100 - 199	200 - 249	250 - 299	300 - 349	350 - 399
Fewer Than 25 25 - 49 50 - 99						
100 - 149 150 - 199						
200 - 249 250 - 299					Yes	Yes Yes
300 - 349 350 - 399			Yes	Yes Yes	Yes Yes	Yes Yes
400 - 449 450 - 499		Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
500 - 549 550 - 599	Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

RIGHT-TURN VOLUME	THROUGH VOLUME PLUS LEFT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 600	+ / > 600
Fewer Than 25 25 - 49 50 - 99			PM Peak	Yes	AM Peak Yes Yes	Yes Yes
100 - 149 150 - 199		Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
200 - 249 250 - 299	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
300 - 349 350 - 399	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
400 - 449 450 - 499	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
500 - 549 550 - 599	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

* Or through volume only if a left-turn lane exists.