WESTLAND OAKS SUBDIVISION
UNITS 1-3
Traffic Impact Study
Westland Drive
Knoxville, TN

A Traffic Impact Study for the Westland Oaks Subdivision

Submitted to

Knoxville – Knox County
Planning Commission

Revised August 31, 2020
FMA Project No. 525.004

Submitted By:

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TABLE OF CONTENTS

FIGURES

ATTACHMENTS

Executive Summary

Mesana Invesments, LLC is proposing a residential development with single family housing located in Knox County. The project is located on Westland Drive west of Pellissippi Parkway (I-140). The new addition to the development will consist of 68 attached condominium lots in Unit 3. Construction is proposed to take place this year and this study assumes full build out for the development will occur in 2021.

Traffic from the Westland Oaks Subdivision – Unit 3 will enter/exit Westland Drive at Ridge Climber Road.

The proposed roadway connection for the Heritage Woods Subdivision – Unit 2 will tie into both Heritage Lake Boulevard and to Ridge Climber Road. Westland Oaks Subdivision – Unit 1 and Heritage Woods Subdivision – Unit 2 have an approved concept plan for a total of 207 single family lots. Traffic from both Unit 1 and Unit 2 will be able to enter/exit from either Westland Drive at Heritage Lake Boulevard or Westland Drive at Ridge Climber Road.

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

Westland Drive at Heritage Lake Boulevard

The full buildout traffic conditions at the usignalized intersection of Westland Drive at Heritage Lake Boulevard were analyzed using the Highway Capacity Software (HCS7). The eastbound and westbound approaches operate at a LOS A during both the AM and PM peak hours. The northbound approach operates at a LOS C during both the AM and PM peak hours. The southbound left turn lane operates at a LOS F during both the AM and PM peak hours and the southbound thru/right lane operates at a LOS B during both the AM and PM peak hours.

After the completion of both the Westland Oaks Subdivision Units 1-3 an eastbound right turn lane is not warranted at the intersection of Westland Drive at Heritage Lake Boulevard.

Westland Drive at Ridge Climber Road

The full buildout traffic conditions at the usignalized intersection of Westland Drive at Ridge Climber Road were analyzed using the Highway Capactiy Software (HCS7). The westbound approach operates at a LOS A during both the AM and PM peak hours. The northbound approach operates at a LOS C during the AM peak hour and a LOS B during the PM peak hour.

After the completion of the Westland Oaks Subdivision Units 1-3 an eastbound right turn lane is not warranted and a westbound left turn lane is warranted during the PM peak hour due to the high volume of thru traffic on Westland Drive.

Per the "TDOT – Roadway Design Guidelines" an approach taper of 293 feet, a bay taper of 147 feet and a storage length of 100 feet for an 11 foot turn lane on a 40 mph road is recommended. FMA recommends the turn lane be built prior to the start of Westland Oaks Subdivision – Unit 3 and that the detailed design be coordinated with Knox County Engineering and Public Works.

Westland Drive

Knox County provided crash data from the year 2015 to 2017 on Westland Drive within the vicinity of Andover View Lane to Heritage Lake Boulevard. There were 10 crashes reported for this stretch of Westland Drive during the time frame stated. There are not any recommended improvements for Westland Drive at this time due to the relatively low number of crashes reported.

1 Introduction

1.1 Project Description

This report provides a summary of a traffic impact study that was performed for the proposed Westland Oaks Subdivision Units 1-3. The project is located on Westland Drive west of Pellissippi Parkway (I-140). The location of the site is shown in Figure 1.

The full buildout of the development will consist of 74 single family housing lots in Unit 1, 133 single family housing lots in Unit 2 and an additional 68 attached condominium lots in Unit 3. Unit 1 is already under construction and construction for Unit 2 and Unit 3 is proposed to take place this year. This study assumes full build out for the development will occur in 2021.

Traffic from the Westland Oaks Subdivision – Unit 3 will enter/exit Westland Drive at Ridge Climber Road.

The proposed roadway connection for the Heritage Woods Subdivision – Unit 2 will tie into both Heritage Lake Boulevard and to Ridge Climber Road. Westland Oaks Subdivision – Unit 1 and Heritage Woods Subdivision – Unit 2 have an approved concept plan for a total of 207 single family lots. Traffic from both Unit 1 and Unit 2 will be able to enter/exit from either Westland Drive at Heritage Lake Boulevard or Westland Drive at Ridge Climber Road. 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 proposed subdivision and to review the "Heritage Lake Traffic Impact Study" prepared by Wilbur Smith Associates dated February 1999.

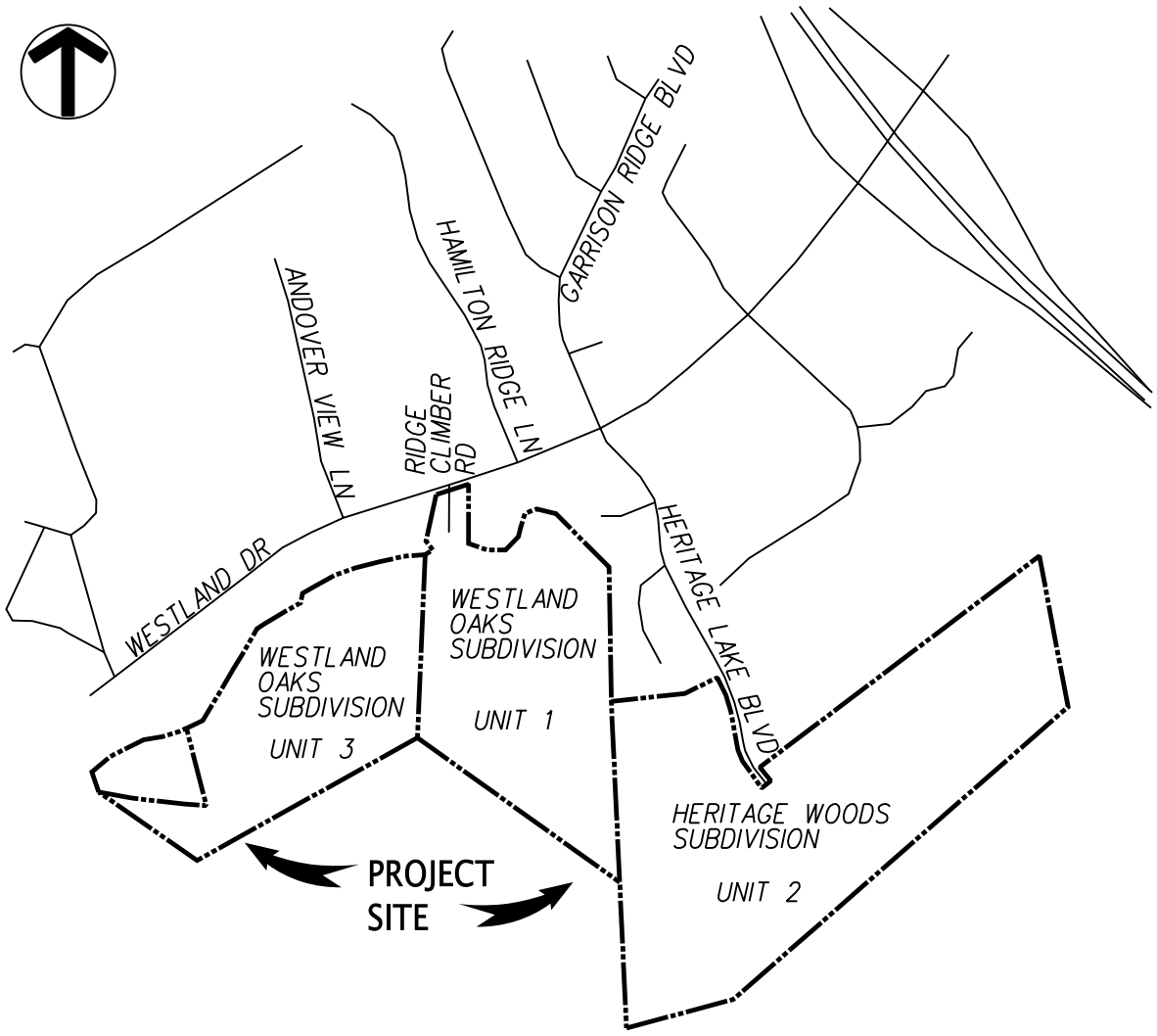


Figure 1: Location Map

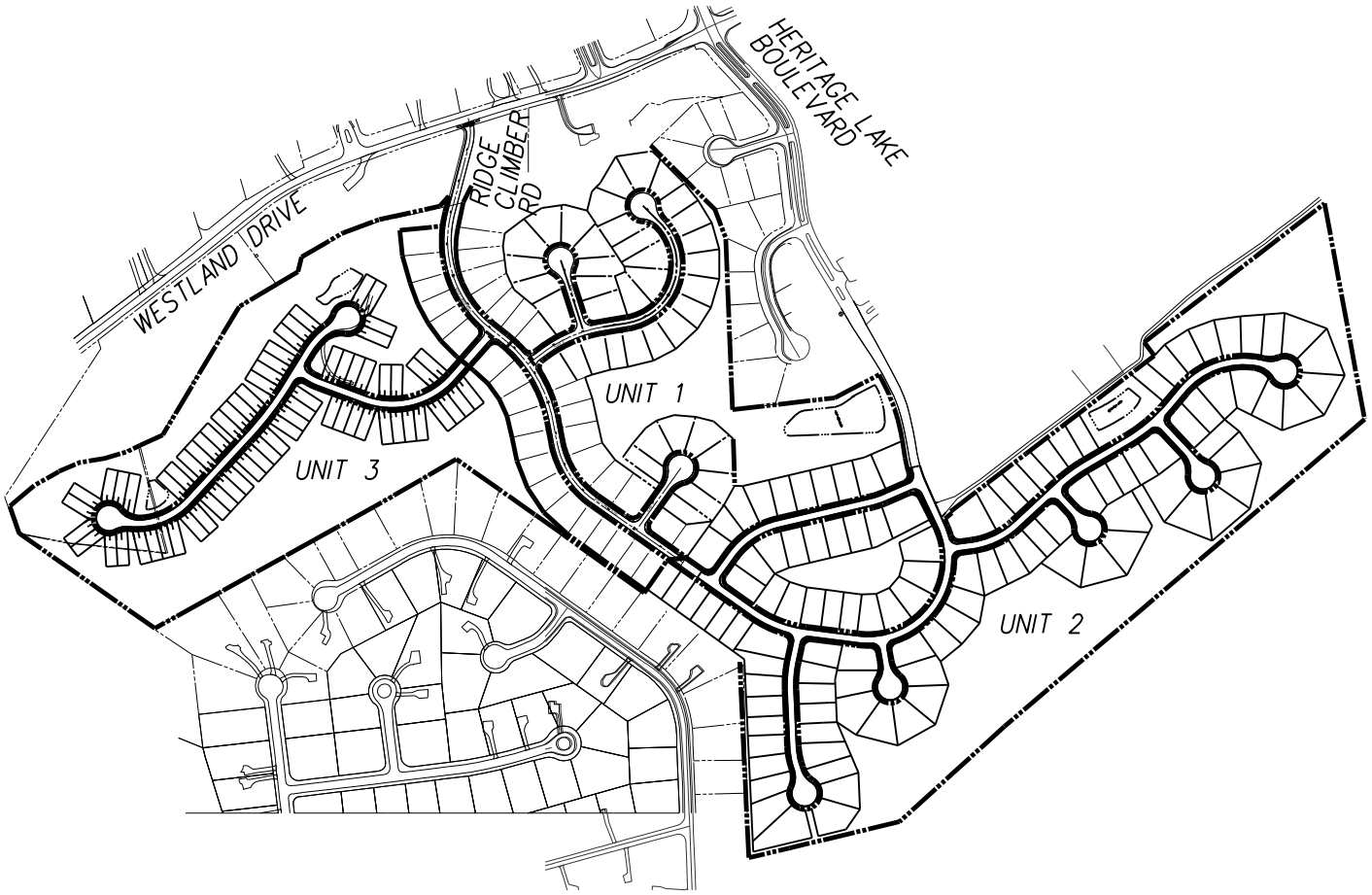


Figure 2: Site Plan

1.2 Existing Site Conditions

Westland Drive at the intersection with Heritage Lake Boulevard is a two-lane road with a left turn lane of 225 feet storage length and a 135 feet taper. The Knoxville-Knox County Planning Commission classifies Westland Drive as a minor arterial with an 88 foot right-of-way per the Major Road Plan. The posted speed limit on Westland Drive is 40 mph.

Heritage Lake Boulevard is a two-lane road with a 10-foot wide boulevard at the intersection with Westland Drive. The Knoxville-Knox County Planning Commission does not classify Heritage Lake Boulevard per the Major Road Plan therefore; it is considered a local street. The posted speed limit on Heritage Lake Boulevard is 25 mph. The measured sight distance at the intersection with Westland Drive is 425 feet eastbound and greater than 500 feet westbound.

Garrison Ridge Boulevard is a two-lane road with a left turn lane with a 100-foot storage length and a 25-foot taper. Westland Drive at the intersection with Garrison Ridge Boulevard also has an existing right turn lane with an 80-foot storage length and a 65-foot taper length. The Knoxville-Knox County Planning Commission does not classify Garrison Ridge Boulevard per the Major Road Plan therefore; it is considered a local street. The posted speed limit on Garrison Ridge Boulevard is 25 mph.

Ridge Climber Road is a two-lane road at the intersection with Westland Drive. The Knoxville-Knox County Planning Commission does not classify Ridge Climber Road per the Major Road Plan therefore; it is considered a local street. The sight distance at this intersection was measured in April 2017 prior to the approval of the concept plan. The required sight distance on a road with a speed limit of 40 mph is 400 feet. The measured sight distance at this intersection was 450 feet westbound and greater than 450 feet eastbound.

Aerial photos of the existing intersections are included in Attachment 1.

1.3 Heritage Lake Development

A Level II traffic impact study was done for the mixed use Heritage Lake Development located on Westland Drive within Knox County. The "Heritage Lake Traffic Impact Study" was prepared by Wilbur Smith Associates dated February 1999. The scope of this traffic impact study included the intersections of Westland Drive at the I-140 northbound and southbound ramps, Westland Drive at the shared office/commercial access, Westland Drive at the shared apartment/commercial access and Westland Drive at Garrison Ridge Boulevard.

Heritage Lake is a mixed use project containing both residential and commercial development. The residential development was expected to include 77 single family units, 262 multi-family units and a 126 unit assisted living facility. The commercial development includes a 1.84 acre site with a nonspecified use at the time that the traffic impact study was conducted. The anticipated completion date was the year 2005.

As of November 2018, the following has been built within the Heritage Lake Development: 262 apartment units, 20 single family housing units, 51,000 SF Cornerstone Church and a 11,900 SF Law Office.

The parcel at the southeast corner of the intersection of Westland Drive at Heritage Lake Boulevard is the location for the 126 unit assisted living facility. As of November 2018 that parcel is still unused and there are no plans to build on that parcel at this time.

The recommendations for the 2005 project traffic conditions at the intersection of Westland Drive at Garrison Ridge Boulevard were to "provide a 50 foot westbound left-turn lane on Westland Drive".

A copy of the recommendations for the Wilbur Smith Associates "Heritage Lake Traffic Impact Study" dated February 1999 is included in Attachment 2.

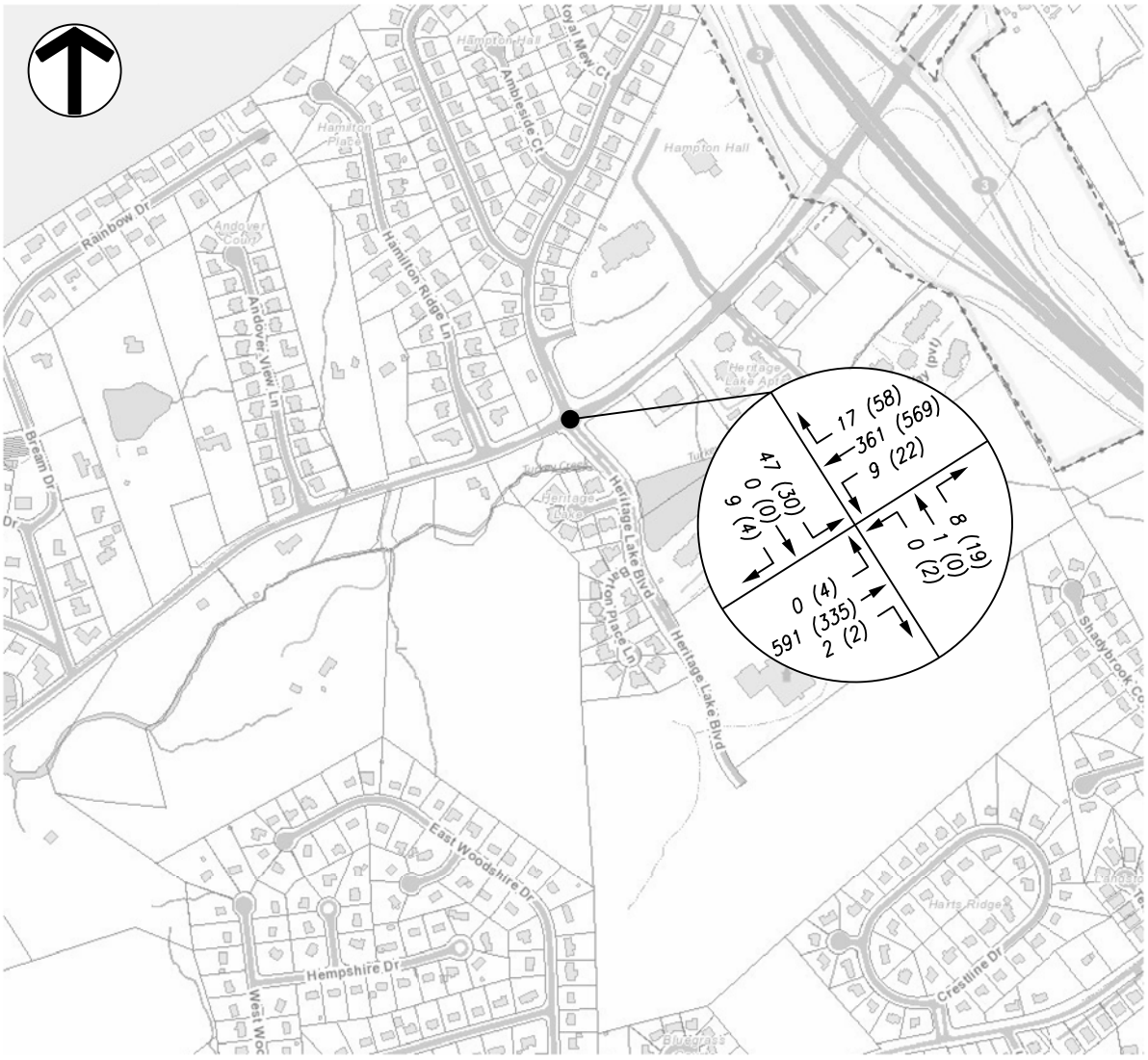
2 Existing Traffic Volumes

Due to the altered traffic patterns from COVID-19 FMA did not collect any new turning movement counts for the Westland Oaks Subdivision Units 1-3 traffic impact study.

FMA conducted a turning movement count at the intersection of Westland Drive at Heritage Lake Boulevard from 7:00 a.m. to 9:00 a.m. and 11:00 a.m. to 1:00 p.m. on Wednesday November 7, 2018 and from 2:00 p.m. to 6:00 p.m. and on Tuesday November 13, 2018.

The current AM peak hour and PM peak hour were determined using the turning movement count that FMA conducted. At the intersection of Westland Drive at Heritage Lake Lane the AM peak hour occurred between 8:00 a.m. and 9:00 a.m., and the PM peak hour occurred between 4:45 p.m. and 5:45 p.m.

The existing volumes including the AM and PM peak hour traffic volumes at the count locations are shown in Figure 3, and the count data collected is included in Attachment 3.



LEGEND:

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

Figure 3: 2018 Existing Peak Hour Traffic

3 Background Growth

The Tennessee Department of Transportation (TDOT) and the Knoxville Regional Transportation Planning Organization (TPO) maintain count stations in the vicinity of the proposed development.

TDOT count station #000437 is located on Westland Drive west of project location and east of S Northshore Drive. The annual growth rate for this station over the last five years is approximately 2.43% and the 2017 ADT was 8,246 vehicles per day.

Knoxville TPO count station ID: 093M085 is located on Westland Drive just east of the intersection with Heritage Lake Boulevard. The annual growth rate for this station over the last five years is approximately 3.04% and the 2016 ADT was 11,520 vehicles per day.

For the purpose of this study, an annual growth rate of 3.0% was assumed for traffic at the intersection of Westland Drive at Heritage Lake Boulevard until full occupancy is reached in 2021. Attachment 4 shows the trend line growth charts for the Knoxville TPO and TDOT count stations.

Figure 4 demonstrates the projected background peak hour volumes at the intersection of Westland Drive at Heritage Lake Boulevard after applying the background growth rate to the existing conditions.

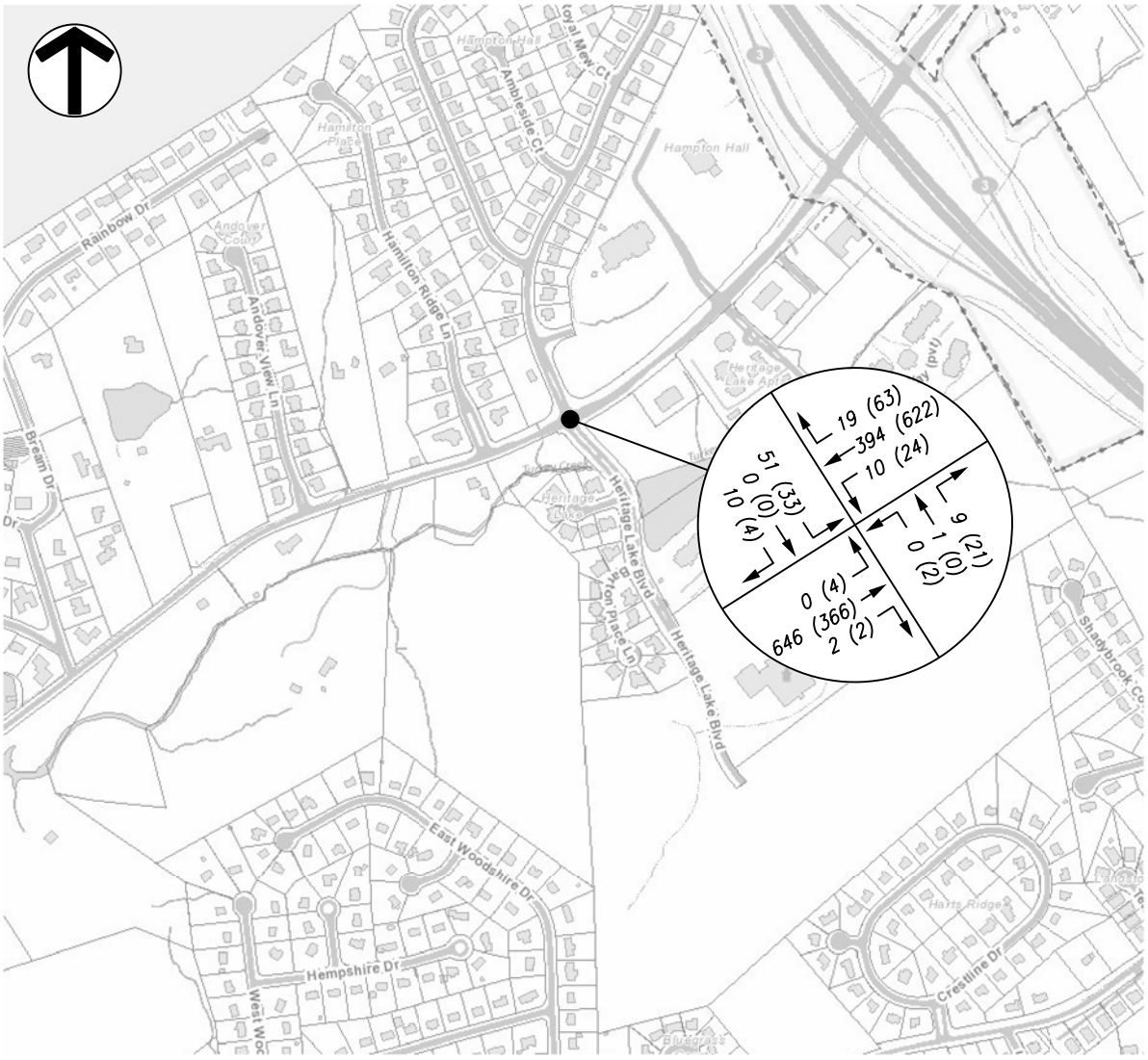


Figure 4: 2021 Background Peak Hour Traffic

3.1 Hamilton Place Subdivision

Hamilton Place Subdivision is an existing subdivision located west of the proposed Heritage Woods Subdivision at the intersection of Westland Drive at Hamilton Ridge Lane. Hamilton Place Subdivision has 32 existing single family lots.

Due to an equipment malfunction FMA estimated the traffic generated at the intersection of Westland Drive at Hamilton Ridge Lane instead of collecting the data using a traffic counting device. Single- Family Detached Housing or Land Use 210 was used to calculate site trips for the subdivision using the fitted curve equations from the *Trip Generation, 10th Edition,* published by the Institute of Transportation Engineers. The land use worksheets are included in Attachment 5.

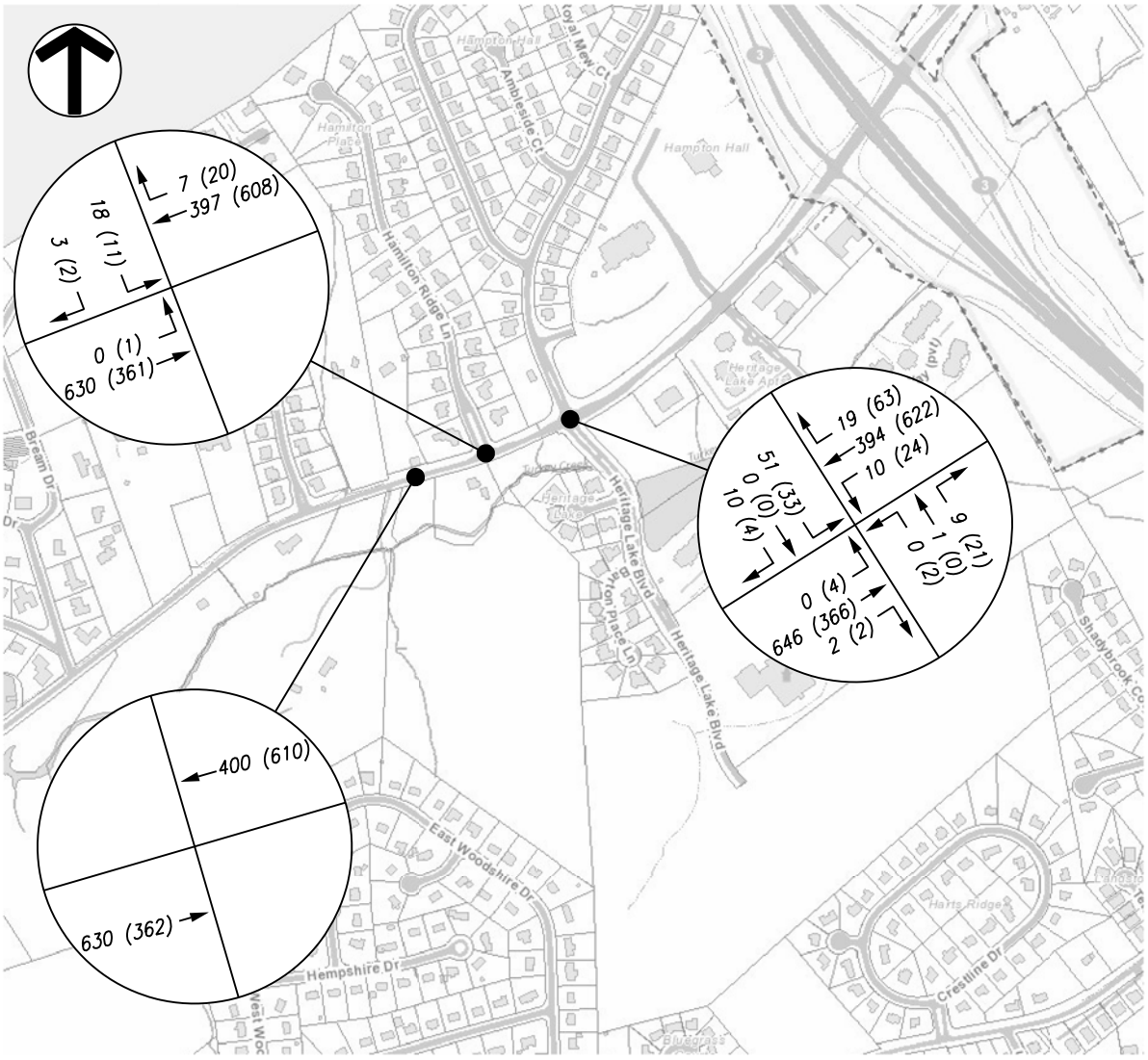
Table 3.1-1
Trip Generation Summary

	Hamilton Place Subdivision 32 Units - LUC 210				
	Total New Trips	% Entering	%Exiting	Number Entering	Number Exiting
Weekday	364	50	50	182	182
A.M. Peak	28	25	75	7	21
P.M. Peak	34	63	37	21	13

The directional distribution of the traffic generated by the Hamilton Place Subdivision was determined using the existing traffic volumes at the intersection with Westland Drive at Garrison Ridge Boulevard. At the existing intersection of Westland Drive at Garrison Ridge Boulevard the entering traffic was 100% westbound during the AM peak hour and 90% westbound during the PM peak hour. The exiting traffic was 85% eastbound and 15% westbound during both the AM and PM peak hours.

In order to get an estimate of the thru traffic at the intersection of Westland Drive at Ridge Climber Road, FMA took the background traffic at the intersection of Westland Drive at Heritage Lake Boulevard / Garrison Ridge Boulevard and added and/or subtracted the trip generation from the existing Hamilton Place Subdivision.

Figure 5 shows the Hamilton Ridge Lane background peak hour traffic along with the projected thru volume for the intersection of Westland Drive at Ridge Climber Road.



LEGEND:

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

Figure 5: Hamilton Ridge Lane Background Peak Hour Traffic

4 Trip Generation and Trip Distribution

The Westland Oaks Subdivision – Unit 3 proposes an additional 68 attached condominium lots. The Westland Oaks Subdivision – Unit 1 has an approved concept plan for 74 single family lots and the Heritage Woods Subdivision – Unit 2 has an approved concept plan for 133 single family lots. Single- Family Detached Housing or Land Use 210 was used to calculate site trips for Unit 1 and Unit 2 using the fitted curve equations from the *Trip Generation, 10th Edition,* published by the Institute of Transportation Engineers. The Knoxville-Knox County Planning Commission published a memorandum ("Local Trip Generation Rates for Multi-Family Residential Uses", August 14, 2000) for the purpose of providing locally collected data for all multi-family residential developments. The fitted curve equations from the local study were used to calculate site trips for Unit 3. The land use worksheets are included in Attachment 5.

The total trips generated by the Westland Oaks Subdivision – Unit 3 was estimated to be 729 daily trips and the combined total trips generated by the Westland Oaks Subdivision Units 1-3 was estimated to be 2,869 daily trips. A trip generation summary is shown in Table 4-1.

Table 4-1
Trip Generation Summary

Westland Oaks Subdivision – Unit 3 68 Units – Local Apartment Study					
	Total New Trips	% Entering	%Exiting	Number Entering	Number Exiting
Weekday	675	50	50	338	338
A.M. Peak	37	22	78	8	29
P.M. Peak	56	55	45	31	25
Heritage Woods Subdivision – Unit 2 133 Units - LUC 210					
	Total New Trips	% Entering	%Exiting	Number Entering	Number Exiting
Weekday	1352	50	50	676	676
A.M. Peak	99	25	75	25	74
P.M. Peak	134	63	37	84	50

Westland Oaks Subdivision – Unit 1 74 Units - LUC 210					
	Total New Trips	% Entering	%Exiting	Number Entering	Number Exiting
Weekday	788	50	50	394	394
A.M. Peak	57	25	75	14	43
P.M. Peak	76	63	37	48	28
Total Combined					
Weekday	2,815			1408	1408
A.M. Peak	193			47	146
P.M. Peak	266			163	103

Westland Drive at Ridge Climber Road has a trip distribution of 60% eastbound and 40% westbound during the AM peak hour and 40% eastbound and 60% westbound during the PM peak hour.

The directional distribution of the traffic generated by the Westland Oaks Subdivision Units 1-3 was determined using the existing traffic volumes at the intersection with Westland Drive at Heritage Lake Boulevard / Garrison Ridge Boulevard. At the existing intersection the entering traffic was 85% westbound and 15% eastbound during both the AM and PM peak hours. The exiting traffic was 85% eastbound and 15% westbound during both the AM and PM peak hours.

FMA assumed that approximately 50% of the westbound entering traffic from the Westland Oaks Subdivision – Unit 1 would enter at the intersection with Heritage Lake Boulevard. This assumption was based on the high percentage of westbound traffic on Westland Drive coming from Pellissippi Parkway and that westbound traffic would utilize the existing westbound left turn lane.

Traffic from the Heritage Woods Subdivision – Unit 2 will enter/exit Westland Drive at Heritage Lake Boulevard and traffic from the Westland Oaks Subdivision – Unit 3 will enter/exit Westland Drive at Ridge Climber Road.

Figures 6 shows the peak hour trip distribution for Westland Oaks Subdivision – Unit 1, Figure 7 shows the peak hour trip distribution for the Heritage Woods Subdivision – Unit 2 and Figure 8 shows the peak hour trip distribution for Westland Oaks Subdivision – Unit 3.

Figure 9 shows the peak hour site traffic for Units 1-3 and Figure 10 shows the peak hour full buildout traffic.

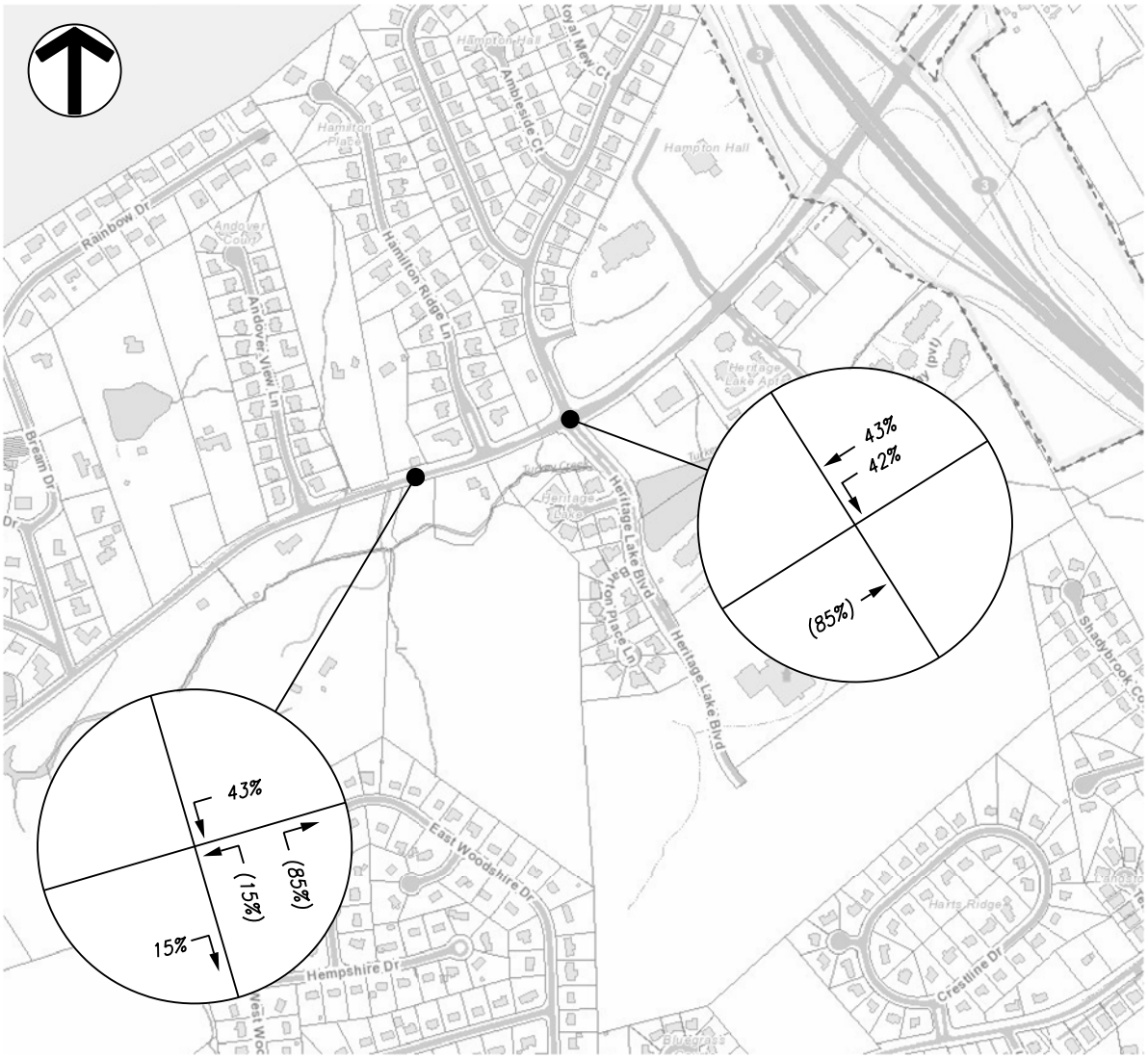


Figure 6: Peak Hour Trip Distribution Westland Oaks - Unit 1

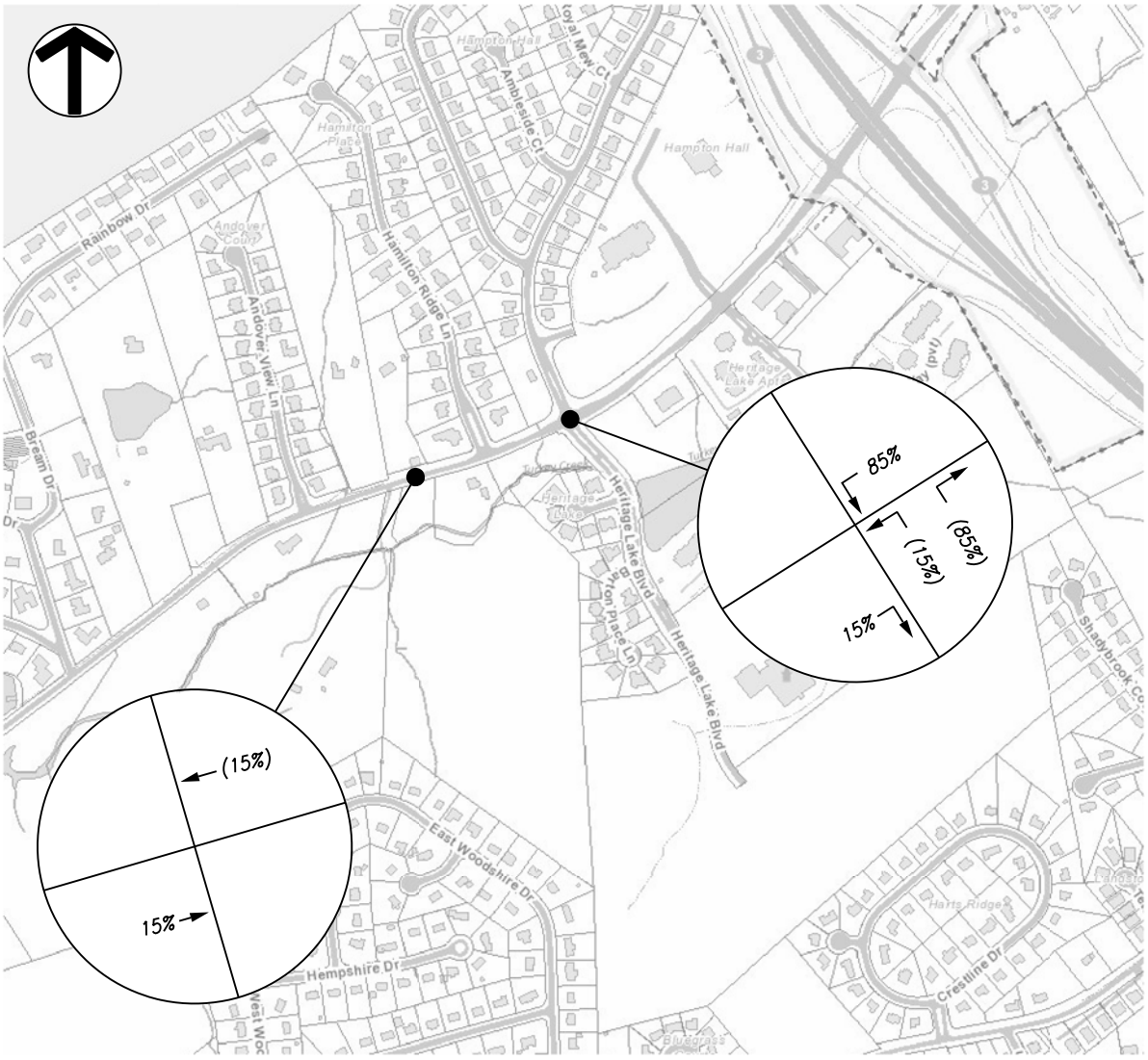


Figure 7: Peak Hour Trip Distribution Heritage Woods - Unit 2

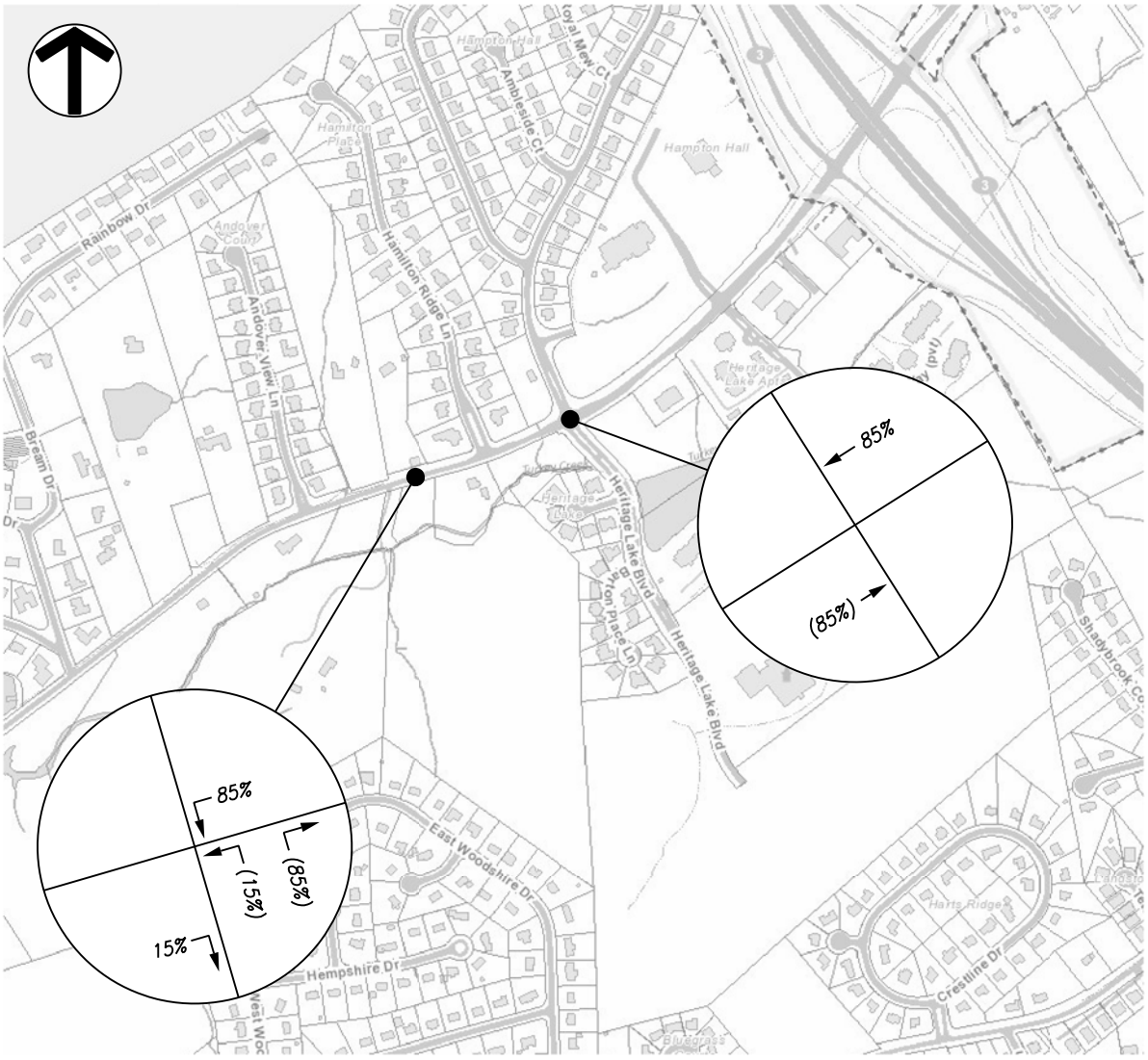


Figure 8: Peak Hour Trip Distribution Westland Oaks - Unit 3

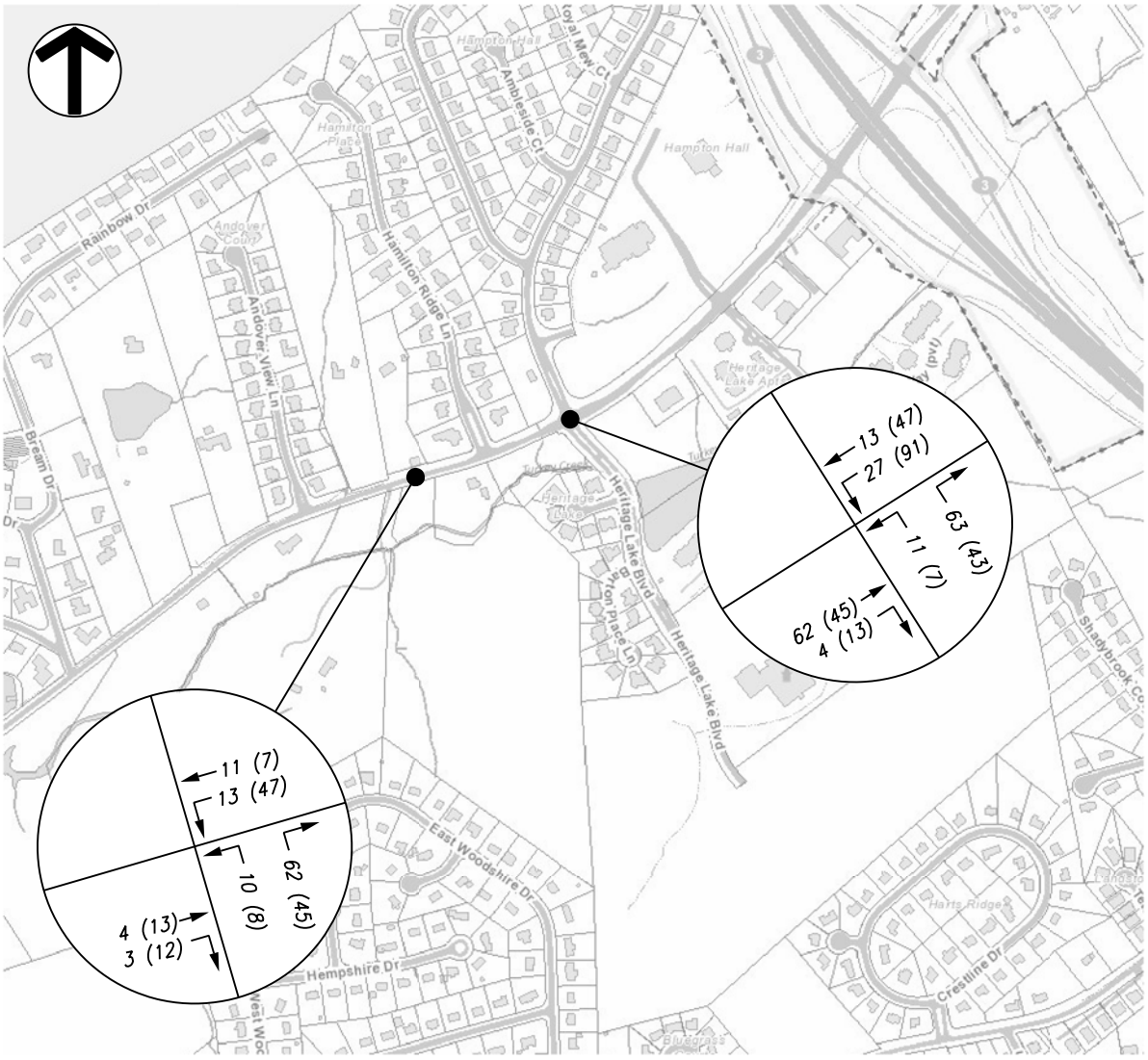


Figure 9: Peak Hour Site Traffic

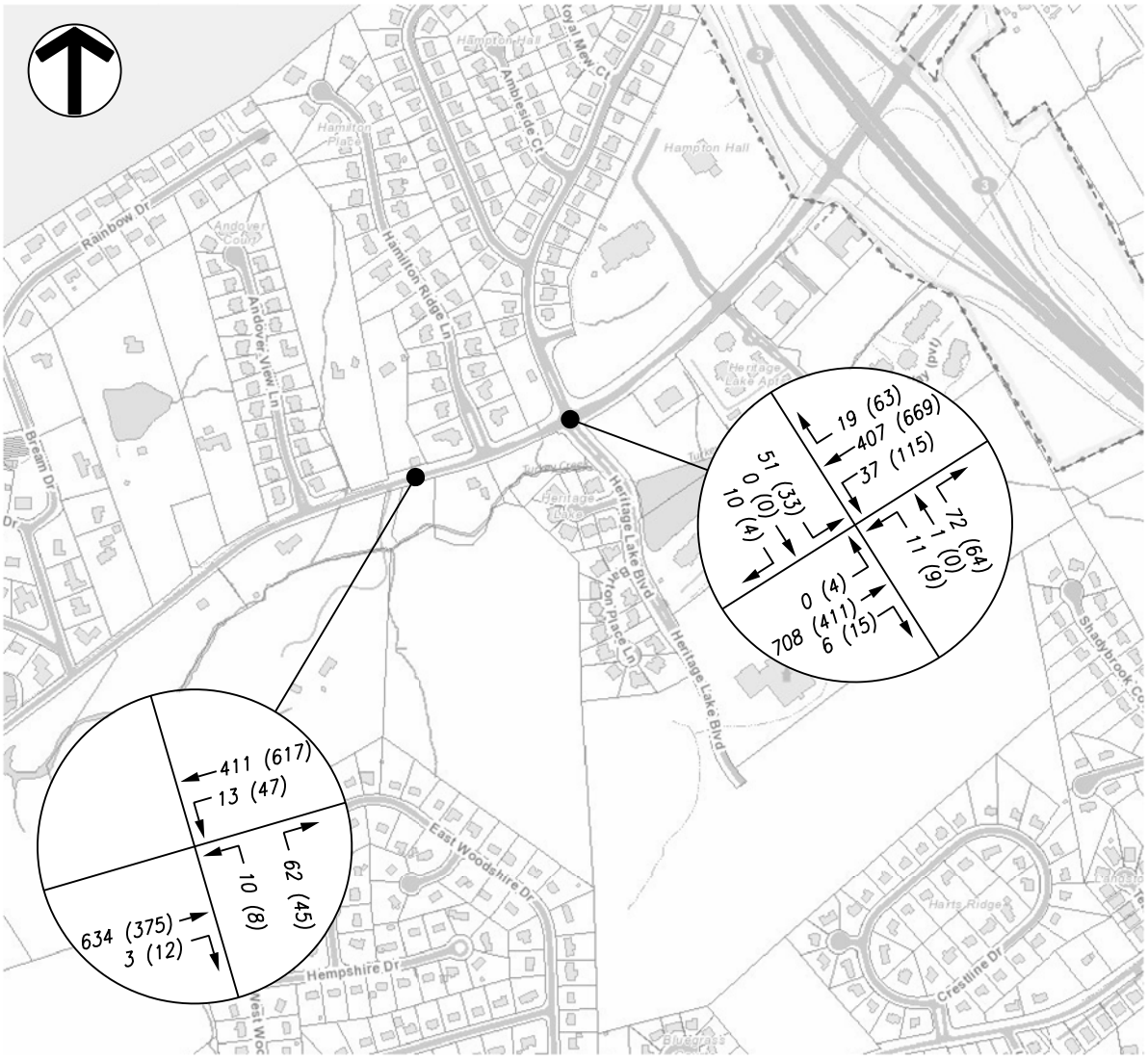


Figure 10: Peak Hour Full Buildout Traffic

5 Projected Capacity and Level of Service

Unsignalized intersection capacity analyses were performed using the Highway Capacity Software (HCS7) for the AM and PM peak hours to evaluate the traffic conditions at the intersections of Westland Drive at Heritage Lake Boulevard and Westland Drive at Ridge Climber Road.

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. The HCS7 worksheets are included in Attachments 6, 7 and 8.

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 @ Heritage Lake Boulevard (Existing 2018)		
AM Peak	EB Approach	8.2 / A
	WB Approach	8.9 / A
	NB Approach	13.8 / B
	SB Approach	27.3 / D
PM Peak	EB Approach	9.0 / A
	WB Approach	8.1 / A
	NB Approach	11.9 / B
	SB Approach	26.5 / D
Westland Drive @ Heritage Lake Boulevard (Background 2021)		
AM Peak	EB Approach	8.3 / A
	WB Approach	9.1 / A
	NB Approach	14.6 / B
	SB Approach	33.7 / D
PM Peak	EB Approach	9.3 / A
	WB Approach	8.2 / A
	NB Approach	12.3 / B
	SB Approach	32.2 / D
Westland Drive @ Heritage Lake Boulevard (Full Buildout 2021)		
AM Peak	EB Approach	8.3 / A
	WB Approach	9.5 / A
	NB Approach	21.9 / C
	SB Approach	70.9 / F
PM Peak	EB Approach	9.4 / A
	WB Approach	8.8 / A
	NB Approach	18.4 / C
	SB Approach	78.5 / F
Westland Drive @ Ridge Climber Road (Full Buildout 2021)		
AM Peak	WB Approach	9.1 / A
	NB Approach	16.7 / C
PM Peak	WB Approach	8.3 / A
	NB Approach	13.6 / B

6 Turn Lane Warrant Analysis

The intersection of Westland Drive at Heritage Lake Boulevard was evaluated to determine if a right turn lane is warranted and the intersection of Westland Drive at the Ridge Climber Road was evaluated to determine if a right turn lane or a left turn lane is warranted. The Knox County Department of Engineering and Public Works handbook, "Access Control and Driveway Design Policy," was used to analyze the information.

A right turn lane is not warranted at the intersection of Westland Drive at Heritage Lake Boulevard. At the intersection of Westland Drive at Ridge Climber Road a right turn lane is not warranted and a left turn lane is warranted during the PM peak hour. The turn lane warrant worksheets and analysis are included in Attachment 9.

7 Signal Warrant Analysis

The intersection of Westland Drive at Heritage Lake Boulevard was evaluated to determine if a traffic signal is warranted for the existing, background and full buildout conditions. The "Manual of Uniform Traffic Control Devices" (MUTCD) published by the Federal Highway Administration in 2009 was used to determine if the intersection met a warrant for a signal. The volume based warrants including Warrant 1, Eight-Hour Vehicular Volume, Warrant 2, Four-Hour Vehicular Volume and Warrant 3, Peak Hour were evaluated based on existing, background and full buildout conditions. The traffic signal warrant worksheet is included in Attachment 10.

The intersection of Westland Drive at Heritage Lake Boulevard does not meet any of the conditions for Warrant 1, Eight-Hour Vehicular Volume, Warrant 2, Four-Hour Vehicular Volume or Warrant 3, Peak Hour and therefore does not warrant a traffic signal for any of the existing, background or full buildout conditions.

8 Conclusions and Recommendations

8.1 Westland Drive @ Heritage Lake Boulevard

The existing traffic conditions at the usignalized intersection of Westland Drive at Heritage Lake Boulevard were analyzed using the Highway Capacity Software (HCS7). The eastbound and westbound approaches operate at a LOS A during both the AM and PM peak hours. The northbound approach operates at a LOS B during both the AM and PM peak hours. The southbound left turn lane operates at a LOS D during both the AM and PM peak hours and the southbound thru/right lane operates at a LOS B during both the AM and PM peak hours.

The background traffic conditions at the usignalized intersection of Westland Drive at Heritage Lake Boulevard were analyzed using the Highway Capacity Software (HCS7). The eastbound and westbound approaches operate at a LOS A during both the AM and PM peak hours. The northbound approach operates at a LOS B during both the AM and PM peak hours. The southbound left turn lane operates at a LOS E during the AM peak hour and LOS D during the PM peak hour and the southbound thru/right lane operates at a LOS B during both the AM and PM peak hours.

The full buildout traffic conditions at the usignalized intersection of Westland Drive at Heritage Lake Boulevard were analyzed using the Highway Capacity Software (HCS7). The eastbound and westbound approaches operate at a LOS A during both the AM and PM peak hours. The northbound approach operates at a LOS C during both the AM and PM peak hours. The southbound left turn lane operates at a LOS F during both the AM and PM peak hours and the southbound thru/right lane operates at a LOS B during both the AM and PM peak hours.

After the completion of both the Westland Oaks Subdivision Units 1-3 an eastbound right turn lane is not warranted at the intersection of Westland Drive at Heritage Lake Boulevard.

The existing left turn lane on Westland Drive at the intersection with Heritage Lake Boulevard has a storage length of 225 feet and a taper length of 135 feet. The unsignalized intersection capacity analyses shows a 95% queue length at the full buildout for the westbound approach of Westland Drive of less than one car length during both the AM and PM peak hours; therefore the existing storage at the intersection is adequate and no change is necessary.

The existing left turn lane on Garrison Ridge Boulevard at the intersection with Heritage Lake Boulevard has a storage length of 100 feet and a taper length of 35 feet. The unsignalized intersection capacity analyses shows a 95% queue length at the full buildout for the southbound left turn lane of three car lengths during the AM

peak hour and two car lengths during the PM peak hour; therefore the existing storage at the intersection is adequate and no change is necessary.

The intersection of Westland Drive at Heritage Lake Boulevard was evaluated to determine if a traffic signal is warranted for the existing, background and full buildout conditions. Based on the "Manual of Uniform Traffic Control Devices" (MUTCD) published by the Federal Highway Administration in 2009 there are no signal warrants met for either the existing, background and full buildout conditions and therefore a signal is not warranted at this intersection at this time.

The intersection of Westland Drive at Heritage Lake Boulevard does not meet any of the conditions for Warrant 1, Eight-Hour Vehicular Volume, Warrant 2, Four-Hour Vehicular Volume or Warrant 3, Peak Hour and therefore does not warrant a traffic signal for any of the existing, background or full buildout conditions.

8.2 Westland Drive @ Ridge Climber Road

The full buildout traffic conditions at the usignalized intersection of Westland Drive at Ridge Climber Road were analyzed using the Highway Capactiy Software (HCS7). The westbound approach operates at a LOS A during both the AM and PM peak hours. The northbound approach operates at a LOS C during the AM peak hour and a LOS B during the PM peak hour.

After the completion of the Westland Oaks Subdivision Units 1-3 an eastbound right turn lane is not warranted and a westbound left turn lane is warranted during the PM peak hour due to the high volume of westbound thru traffic on Westland Drive.

Per the "TDOT – Roadway Design Guidelines" an approach taper of 293 feet, a bay taper of 147 feet and a storage length of 100 feet for an 11 foot turn lane on a 40 mph road is recommended. Figure 2-9 Turning Lane Terminology from the "TDOT – Roadway Design Guidelines" is included in Attachment 9 and shows the recommended storage and taper lengths for the westbound turn lane. FMA recommends the turn lane be built prior to the start of Westland Oaks Subdivision – Unit 3 and that the detailed design be coordinated with Knox County Engineering and Public Works.

8.3 Westland Drive

Knox County provided crash data from the year 2015 to 2017 on Westland Drive within the vicinity of Andover View Lane to Heritage Lake Boulevard. There were 10 crashes reported for this stretch of Westland Drive during the time frame stated.

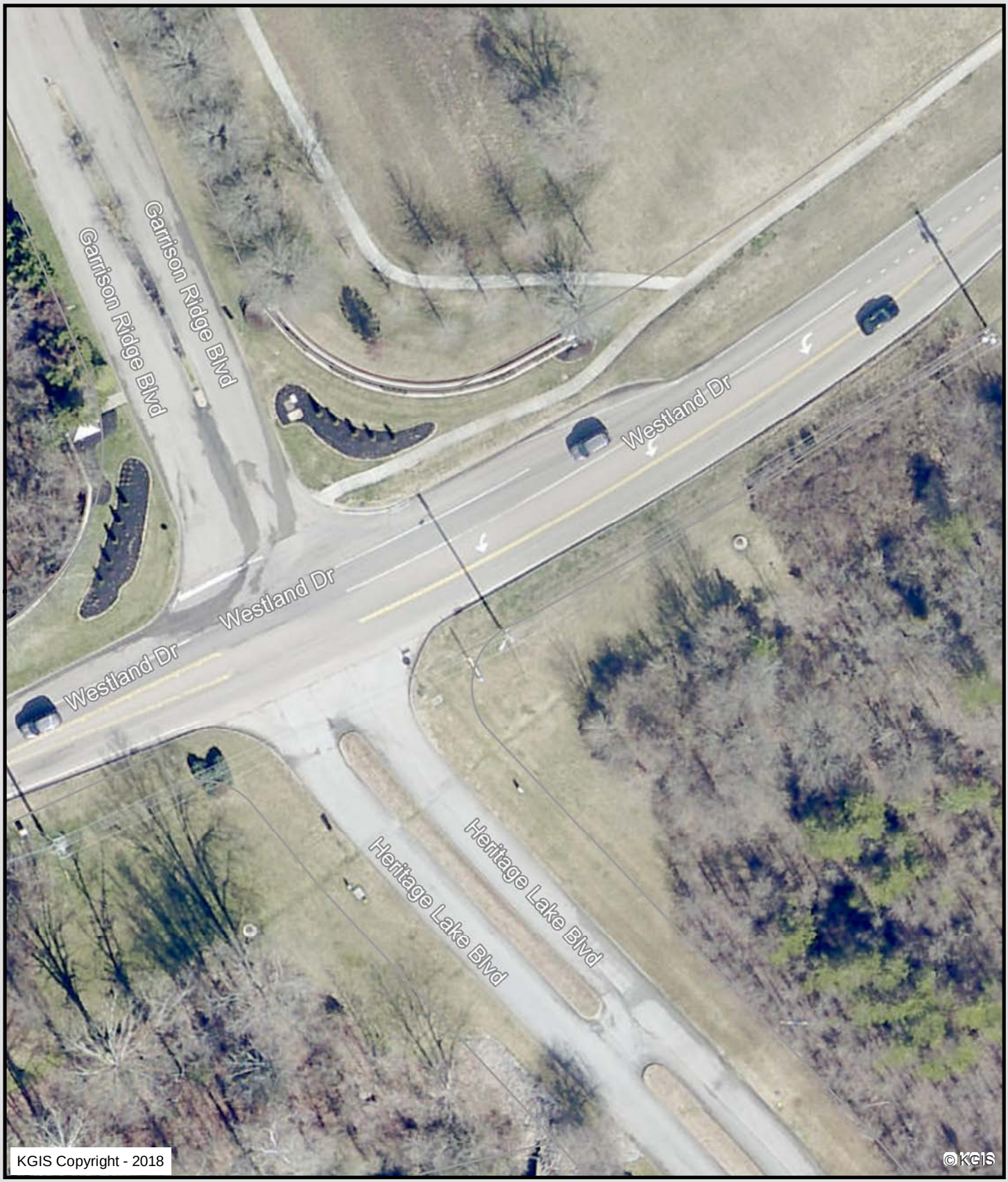
There are not any recommended improvements for Westland Drive at this time due to the relatively low number of crashes reported.

8.4 Heritage Woods Road "C"

The minimum required sight distance for a road with a posted speed limit of 25 mph is 250 feet in each direction in accordance with the "Subdivision Regulations" for Knoxville and Knox County. FMA measured the sight distance at the proposed intersection of Heritage Lake Boulevard at Heritage Woods Road "C". At 15 feet from the edge of pavement the sight distance at the proposed intersection is greater than 250 feet northbound and southbound; however, the northbound sight distance is partially blocked due to the existing overgrowth conditions.

FMA recommends that the sight distance be re-evaluated in the field after the completion of the proposed Heritage Woods Subdivision to ensure that the sight distance complies with the requirements for Knox County Engineering and Public Works. FMA also recommends any landscaping be installed so as to maintain the sight distance and continue to comply with Knox County Engineering and Public Works.

Attachment 1
Aerial Photo



Westland at Heritage Lake

Knoxville - Knox County - KUB Geographic Information System

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0 25 50 100

ft

Westland Oaks

Knoxville - Knox County - KUB Geographic Information System

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0 25 50 100

ft

Attachment 2
Heritage Lake Background Info

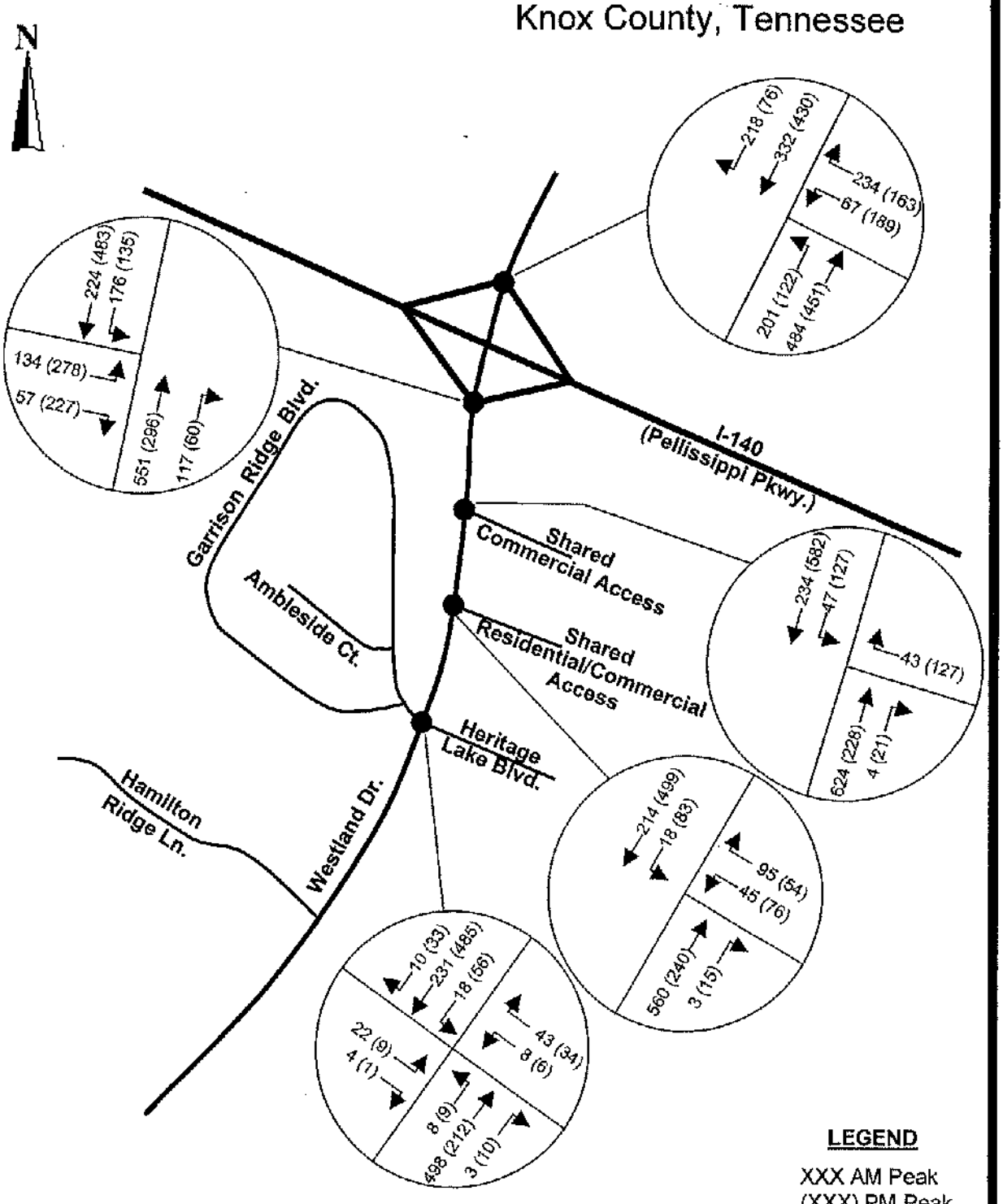
SITE PLAN
HERITAGE LAKE DEVELOPMENT
Knox County, Tennessee

N

WSA Wilbur Smith Associates

Figure 1

2005 PROJECTED TRAFFIC
HERITAGE LAKE DEVELOPMENT
Knox County, Tennessee



LEGEND

XXX AM Peak
(XXX) PM Peak

WSA **Wilbur Smith Associates**

Figure 10

was no significant changes in LOS for unsignalized and signalized intersections along Westland Drive. Tables 7 and 8 present the results of the analyses for signalized and unsignalized intersections, respectively.

TABLE 7

SIGNALIZED INTERSECTIONS
LEVEL OF SERVICE AND CAPACITY
SUMMARY

		2005 BACKGROUND			2005 PROJECT		
INTERSECTION	PERIOD	V/C	DELAY	LOS	V/C	DELAY	LOS
WESTLAND DRIVE	AM	0.580	10.5	B	0.683	13.7	B
I-140 S.B. RAMPS	PM	0.419	10.2	B	0.528	11.0	B
WESTLAND DRIVE	AM	0.661	10.6	B	0.713	11.7	B
I-140 N.B. RAMPS	PM	0.482	10.6	B	0.567	11.3	B

Average vehicle delay estimated in seconds

Sight Distance

The project access is along Westland Drive. Westland drive is a two-lane collector with fairly gentle vertical and horizontal geometry adjacent to the site. The posted speed limit is 40mph. A prevailing speed of 40mph requires a sight distance of 325 feet. A field review of the proposed site access points to Westland Drive determined sight distance is in excess of 400 feet, more than required for the posted speed of 40mph. Therefore, sight distance is more than acceptable and should be maintained with good driveway standards employed.

RECOMMENDATIONS

The analysis conducted and the review of the traffic volumes identified the following recommendations:

2005 Background Traffic Conditions:

- Signalize both the north and southbound ramps of Pellissippi Parkway and Westland Drive
- Provide a 250 foot eastbound left-turn storage on Westland Drive at the northbound Pellissippi on-ramp.
- Provide a 225 foot westbound left-turn storage on Westland Drive at the southbound Pellissippi

on-ramp.

- Provide a 375 foot minimum left-turn lane on the southbound Pellissippi off-ramp.
- Provide a 250 foot minimum left-turn lane on the northbound Pellissippi off-ramp.

Storage lengths for the left-turn lanes at signalized intersections were estimated using a nomograph developed by the Northwestern Traffic Institute, found in the ITE publication, **Transportation and Land Development**.

2005 Project Traffic Conditions:

- Provide a 50 foot westbound left-turn lane on Westland Drive at Garrison Ridge Boulevard.
- Provide a 125 foot westbound left-turn lane on Westland Drive at the proposed apartment access.
- Provide a 75 foot westbound left-turn lane on Westland Drive at the proposed shared access between the Weigels and office/commercial parcel.
- Minimize landscaping, using low growing vegetation, and signing at the driveways and public street intersections to insure that safe sight distance is maintained.
- Use a minimum of 15 foot driveway radius for the efficient and safe ingress and egress of the site.
- At public street intersections, use a minimum radius of 30 feet.
- Driveway and turn lane design should conform to the recommended standards and practices of the American Association of State Highway and Transportation Officials, the Institute of Transportation Engineers, and the Knox County Public Works Department.

The storage lengths for left-turn lanes at unsignalized intersections identified in the above recommendations were developed using Harmelink's criteria for left-turn lanes at unsignalized intersections. For the proposed intersection of Westland Drive and the access serving the multi-family units, the westbound left-turn lane was estimated assuming a traffic signal may be warranted in conjunction with commercial development proposed for the opposite side of Westland Drive.

CONCLUSION

The study of this Westland Drive project developed and evaluated existing, background, and project traffic conditions. Background traffic was determined using a 4.0 percent annual

Attachment 3
Traffic Counts

Project: Heritage Woods Subdivision
Intersection: Westland Dr at Heritage Lake Blvd / Garrison Ridge Blvd
Date Conducted: 11/7/2018 & 11/13/2018

	Westland Drive Eastbound				Westland Drive Westbound				Heritage Lake Blvd Northbound				Garrison Ridge Blvd Southbound				
Start	Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	Int. Total
7:00 AM	0	155	0	155	0	30	0	30	0	0	1	1	9	0	1	10	196
7:15 AM	0	195	0	195	1	50	0	51	0	0	3	3	16	0	2	18	267
7:30 AM	1	149	0	150	1	63	1	65	0	0	3	3	20	0	2	22	240
7:45 AM	0	138	0	138	0	75	8	83	0	0	1	1	16	0	1	17	239
Total	1	637	0	638	2	218	9	229	0	0	8	8	61	0	6	67	942
8:00 AM	0	151	1	152	0	77	3	80	0	0	4	4	15	0	1	16	252
8:15 AM	0	167	1	168	2	98	4	104	0	0	1	1	10	0	4	14	287
8:30 AM	0	136	0	136	4	97	7	108	0	1	2	3	10	0	1	11	258
8:45 AM	0	137	0	137	3	89	3	95	0	0	1	1	12	0	3	15	248
Total	0	591	2	593	9	361	17	387	0	1	8	9	47	0	9	56	1045
11:00 AM	1	77	0	78	5	63	0	68	0	0	2	2	3	0	0	3	151
11:15 AM	0	87	0	87	1	79	2	82	0	0	0	0	2	0	1	3	172
11:30 AM	0	81	0	81	2	96	2	100	0	0	2	2	5	0	0	5	188
11:45 AM	1	76	1	78	4	96	7	107	0	0	4	4	1	0	1	2	191
Total	2	321	1	324	12	334	11	357	0	0	8	8	11	0	2	13	702
12:00 PM	3	68	0	71	3	88	7	98	0	0	1	1	8	0	2	10	180
12:15 PM	0	80	0	80	2	90	0	92	1	0	1	2	4	0	0	4	178
12:30 PM	0	77	0	77	3	85	4	92	0	0	2	2	5	0	1	6	177
12:45 PM	2	92	0	94	1	84	4	89	0	0	6	6	5	0	1	6	195
Total	5	317	0	322	9	347	15	371	1	0	10	11	22	0	4	26	730
2:00 PM	2	78	0	80	3	71	4	78	0	0	6	6	4	0	0	4	168
2:15 PM	2	81	2	85	2	70	4	76	0	0	3	3	3	0	1	4	168
2:30 PM	0	68	0	68	4	82	7	93	0	0	3	3	3	0	2	5	169
2:45 PM	1	85	0	86	5	87	5	97	0	0	3	3	8	1	2	11	197
Total	5	312	2	319	14	310	20	344	0	0	15	15	18	1	5	24	702
3:00 PM	2	85	1	88	3	71	7	81	1	0	5	6	6	1	1	8	183
3:15 PM	1	67	0	68	3	94	4	101	2	0	10	12	5	0	0	5	186
3:30 PM	0	77	0	77	0	113	7	120	0	0	4	4	2	0	1	3	204
3:45 PM	3	78	0	81	2	142	14	158	1	0	2	3	7	0	1	8	250
Total	6	307	1	314	8	420	32	460	4	0	21	25	20	1	3	24	823
4:00 PM	0	84	0	84	4	122	9	135	0	0	2	2	14	0	1	15	236
4:15 PM	1	80	1	82	2	135	13	150	1	0	3	4	4	0	0	4	240
4:30 PM	2	83	0	85	7	119	11	137	1	0	7	8	3	0	1	4	234
4:45 PM	1	76	0	77	5	124	19	148	2	0	8	10	3	0	1	4	239
Total	4	323	1	328	18	500	52	570	4	0	20	24	24	0	3	27	949
5:00 PM	1	94	2	97	7	153	16	176	0	0	4	4	13	0	1	14	291
5:15 PM	0	86	0	86	6	142	10	158	0	0	5	5	9	0	1	10	259
5:30 PM	2	79	0	81	4	150	13	167	0	0	2	2	5	0	1	6	256
5:45 PM	1	71	2	74	6	132	12	150	1	0	4	5	8	0	1	9	238
Total	4	330	4	338	23	577	51	651	1	0	15	16	35	0	4	39	1044
Grand Total	15	2188	8	2211	60	2076	161	2297	9	1	72	82	187	1	25	213	4803
Approach %	0.7	99.0	0.4		2.6	90.4	7.0		11.0	1.2	87.8		87.8	0.5	11.7		
Total %	0.3	45.6	0.2	46.0	1.2	43.2	3.4	47.8	0.2	0.0	1.5	1.7	3.9	0.0	0.5	4.4	

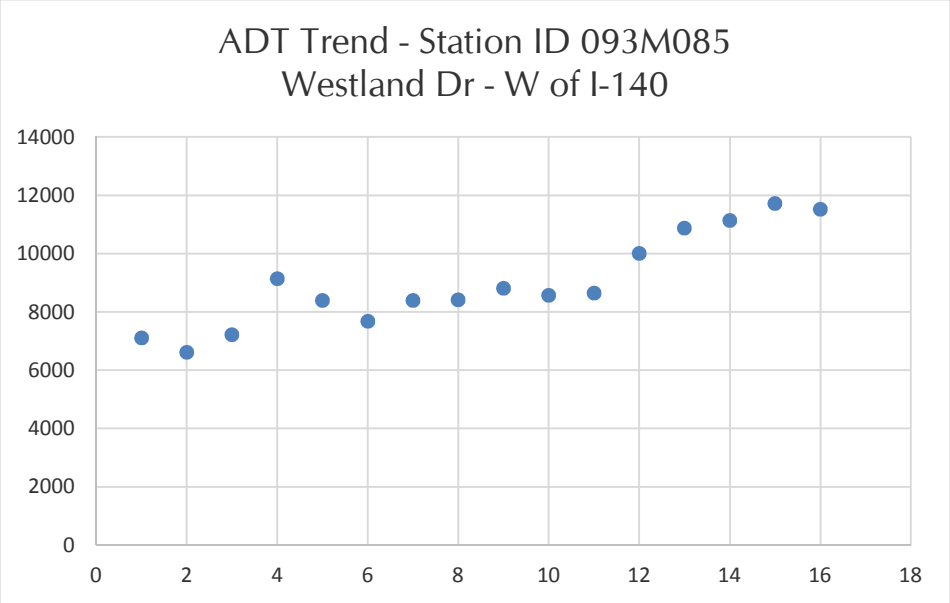
Project: Heritage Woods Subdivision
Date Conducted: 11/7/2018

AM Peak Hour	8:00 AM - 9:00 AM	1045
PM Peak Hour	4:45 PM - 5:45 PM	1045

	Westland Drive Eastbound				Westland Drive Westbound				Heritage Lake Blvd Northbound				Garrison Ridge Blvd Southbound				
Start	Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	Int. Total
Peak Hour Analysis from 7:00 AM to 9:00 AM																	
AM Peak Hour begins at 8:00 AM																	
8:00 AM	0	151	**1**	152	0	77	3	80	0	0	**4**	4	**15**	0	1	16	252
8:15 AM	0	**167**	1	168	2	**98**	4	104	0	0	1	1	10	0	**4**	14	**287**
8:30 AM	0	136	0	136	**4**	97	**7**	108	0	**1**	2	3	10	0	1	11	258
8:45 AM	0	137	0	137	3	89	3	95	0	0	1	1	12	0	3	15	248
Total Volume	0	591	2	593	9	361	17	387	0	1	8	9	47	0	9	56	1045
Future (3% over 3 yrs)	0	646	2		10	394	19		0	1	9		51	0	10		1142
PHF	-	0.88	0.50		0.56	0.92	0.61		-	0.25	0.50		0.78	-	0.56		0.91
Peak Hour Analysis from 3:00 PM to 6:00 PM																	
PM Peak Hour begins at 4:45 PM																	
4:45 PM	1	76	0	77	5	124	**19**	148	**2**	0	**8**	10	3	0	**1**	4	239
5:00 PM	1	**94**	**2**	97	**7**	**153**	16	176	0	0	4	4	**13**	0	1	14	**291**
5:15 PM	0	86	0	86	6	142	10	158	0	0	5	5	9	0	1	10	259
5:30 PM	**2**	79	0	81	4	150	13	167	0	0	2	2	5	0	1	6	256
Total Volume	4	335	2	341	22	569	58	649	2	0	19	21	30	0	4	34	1045
Future (3% over 3 yrs)	4	366	2		24	622	63		2	0	21		33	0	4		1142
PHF	0.50	0.89	0.25		0.79	0.93	0.76		0.25	-	0.59		0.58	-	1.00		0.90

Attachment 4
ADT Trends

Year	Adjusted Average Daily Traffic
2001	7110
2002	6610
2003	7210
2004	9140
2005	8391
2006	7680
2007	8390
2008	8410
2009	8810
2010	8570
2011	8640
2012	10000
2013	10870
2014	11130
2015	11710
2016	11520

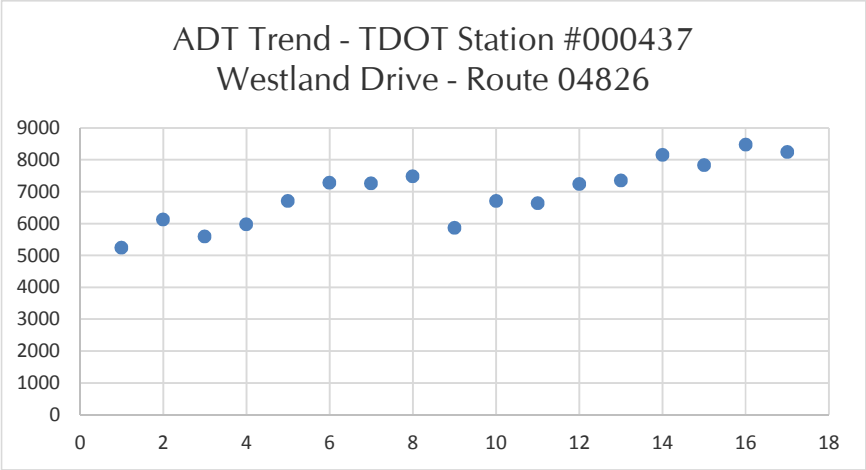


Most Recent Trend Line Growth

Year	ADT
2012	10000
2016	11520

Annual Percent Growth	**3.04%**

	Year	Adjusted Average Daily Traffic
1	2001	5238
2	2002	6119
3	2003	5589
4	2004	5969
5	2005	6706
6	2006	7278
7	2007	7257
8	2008	7475
9	2009	5865
10	2010	6706
11	2011	6634
12	2012	7243
13	2013	7353
14	2014	8156
15	2015	7834
16	2016	8475
17	2017	8246



Most Recent Trend Line Growth

Year	ADT
2013	7353
2017	8246

Annual Percent Growth	**2.43%**

Attachment 5
Trip Generation

Project: Heritage Woods
Date Conducted: 12/17/2018

Single-Family Detached Housing (LUC 210)
133 Single Family Lots

Average Daily Traffic
$Ln(T) = 0.92Ln(X) + 2.71$
$Ln(T) = 0.92Ln(133) + 2.71$
$T = 1352$

Peak Hour of Adjacent Street Traffic
One Hour Between 7 and 9 a.m.
$T = 0.71(X) + 4.80$
$T = 0.71(133) + 4.80$
$T = 99$

Peak Hour of Adjacent Street Traffic
One Hour Between 4 and 6 p.m.
$Ln(T) = 0.96Ln(X) + 0.20$
$Ln(T) = 0.96Ln(133) + 0.20$
$T = 134$

Time Period	Total Trips	Percent		Number	
		Enter	Exit	Enter	Exit
Weekday (24 hours)	1352	50%	50%	676	676
AM Peak Hour	99	25%	75%	25	74
PM Peak Hour	134	63%	37%	84	50

Project: Westland Oaks - Unit 3
Date Conducted: 8/24/2020

Local Apartment Trip Generation Study
68 Units

Average Daily Traffic
T = 15.193(X)^0.899
T = 15.193(68)^0.899
T = 675

Peak Hour of Adjacent Street Traffic
One Hour Between 7 and 9 a.m.
T = 0.758(X)^0.924
T = 0.758(68)^0.924
T = 37

Peak Hour of Adjacent Street Traffic
One Hour Between 4 and 6 p.m.
T = .669(X) + 10.069
T = .669(68) + 10.069
T = 56

		Percent		Number	
Time Period	Total Trips	Enter	Exit	Enter	Exit
Weekday (24 hours)	675	50%	50%	338	338
AM Peak Hour	37	22%	78%	8	29
PM Peak Hour	56	55%	45%	31	25

Project: Westland Oaks
Date Conducted: 11/7/2018

Single-Family Detached Housing (LUC 210)
74 Single Family Lots

Average Daily Traffic
$Ln(T) = 0.92Ln(X) + 2.71$
$Ln(T) = 0.92Ln(74) + 2.71$
$T = 788$

Peak Hour of Adjacent Street Traffic
One Hour Between 7 and 9 a.m.
$T = 0.71(X) + 4.80$
$T = 0.71(74) + 4.80$
$T = 57$

Peak Hour of Adjacent Street Traffic
One Hour Between 4 and 6 p.m.
$Ln(T) = 0.96Ln(X) + 0.20$
$Ln(T) = 0.96Ln(74) + 0.20$
$T = 76$

Time Period	Total Trips	Percent		Number	
		Enter	Exit	Enter	Exit
Weekday (24 hours)	788	50%	50%	394	394
AM Peak Hour	57	25%	75%	14	43
PM Peak Hour	76	63%	37%	48	28

Project: Existing Hamilton Ridge Subdivision
Date Conducted: 11/18/2018

Single-Family Detached Housing (LUC 210)
32 Single Family Lots

Average Daily Traffic

$Ln(T) = 0.92Ln(X) + 2.71$
$Ln(T) = 0.92Ln(32) + 2.71$
$T = 364$

Peak Hour of Adjacent Street Traffic
One Hour Between 7 and 9 a.m.

$T = 0.71(X) + 4.80$
$T = 0.71(32) + 4.80$
$T = 28$

Peak Hour of Adjacent Street Traffic
One Hour Between 4 and 6 p.m.

$Ln(T) = 0.96Ln(X) + 0.20$
$Ln(T) = 0.96Ln(32) + 0.20$
$T = 34$

Time Period	Total Trips	Percent		Number	
		Enter	Exit	Enter	Exit
Weekday (24 hours)	364	50%	50%	182	182
AM Peak Hour	28	25%	75%	7	21
PM Peak Hour	34	63%	37%	21	13

Single-Family Detached Housing
(210)

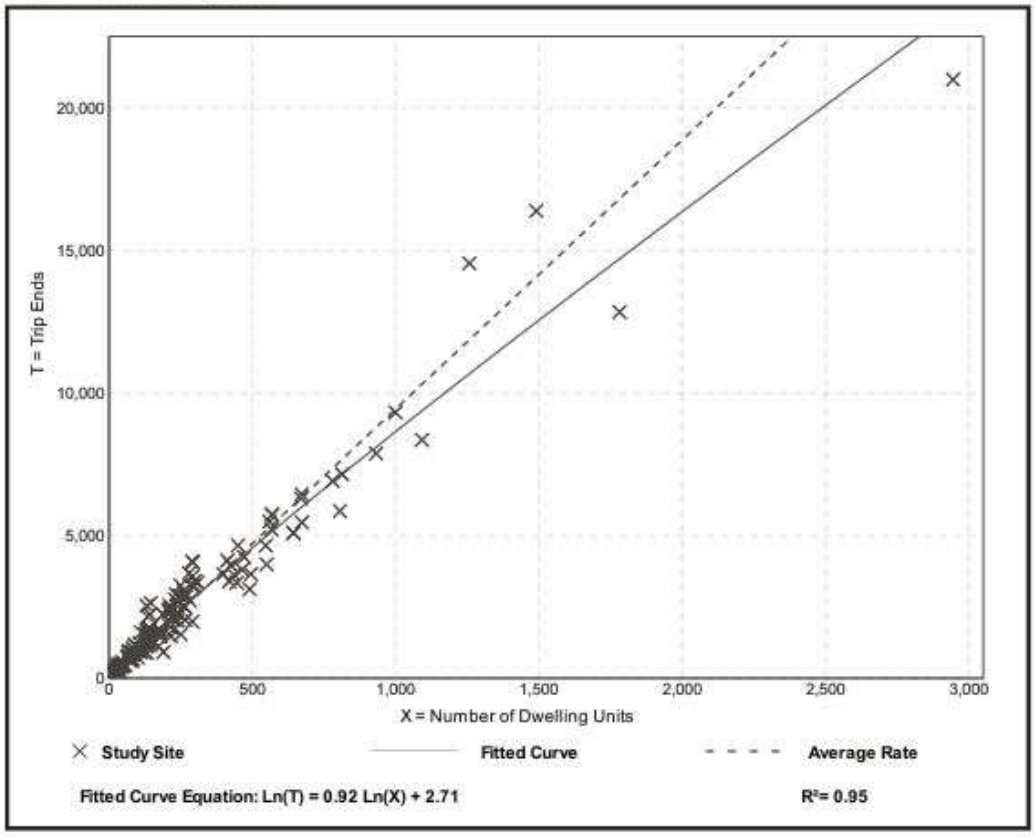
Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday**

Setting/Location: **General Urban/Suburban**
Number of Studies: 159
Avg. Num. of Dwelling Units: 264
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
9.44	4.81 - 19.39	2.10

Data Plot and Equation



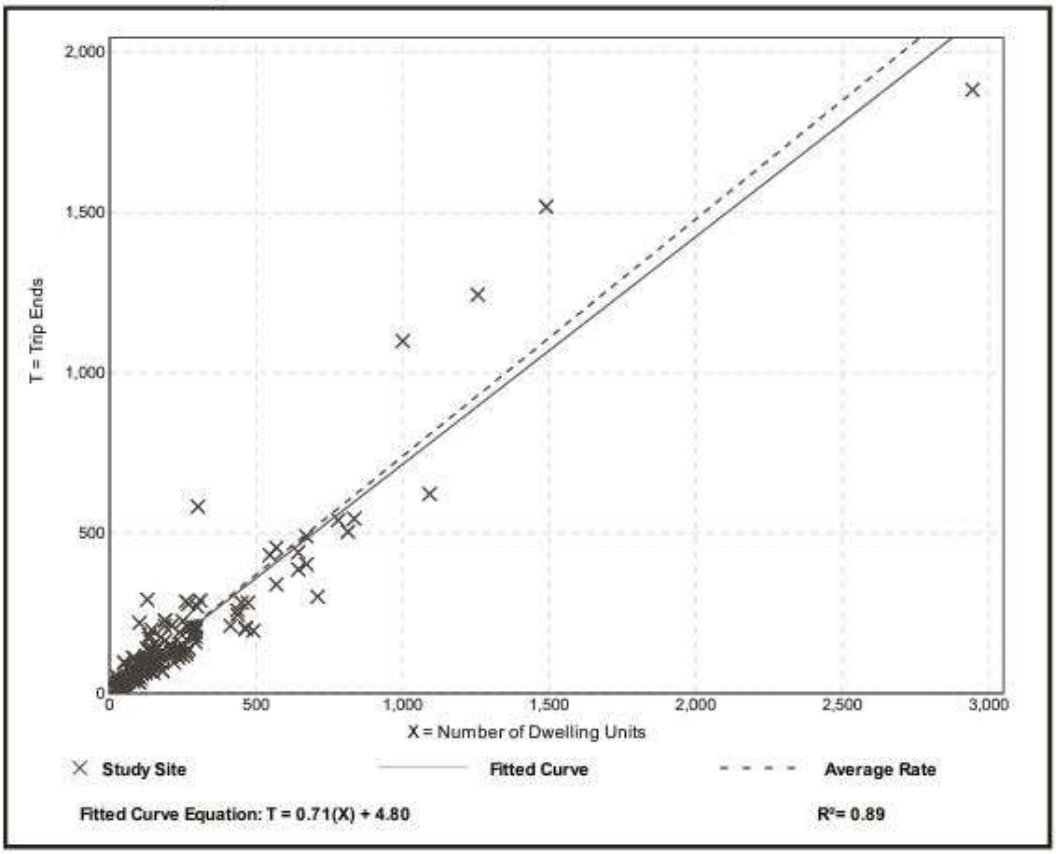
Single-Family Detached Housing
(210)

Vehicle Trip Ends vs:	**Dwelling Units**
On a:	**Weekday,** **Peak Hour of Adjacent Street Traffic,** **One Hour Between 7 and 9 a.m.**
Setting/Location:	**General Urban/Suburban**
Number of Studies:	173
Avg. Num. of Dwelling Units:	219
Directional Distribution:	25% entering, 75% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.74	0.33 - 2.27	0.27

Data Plot and Equation



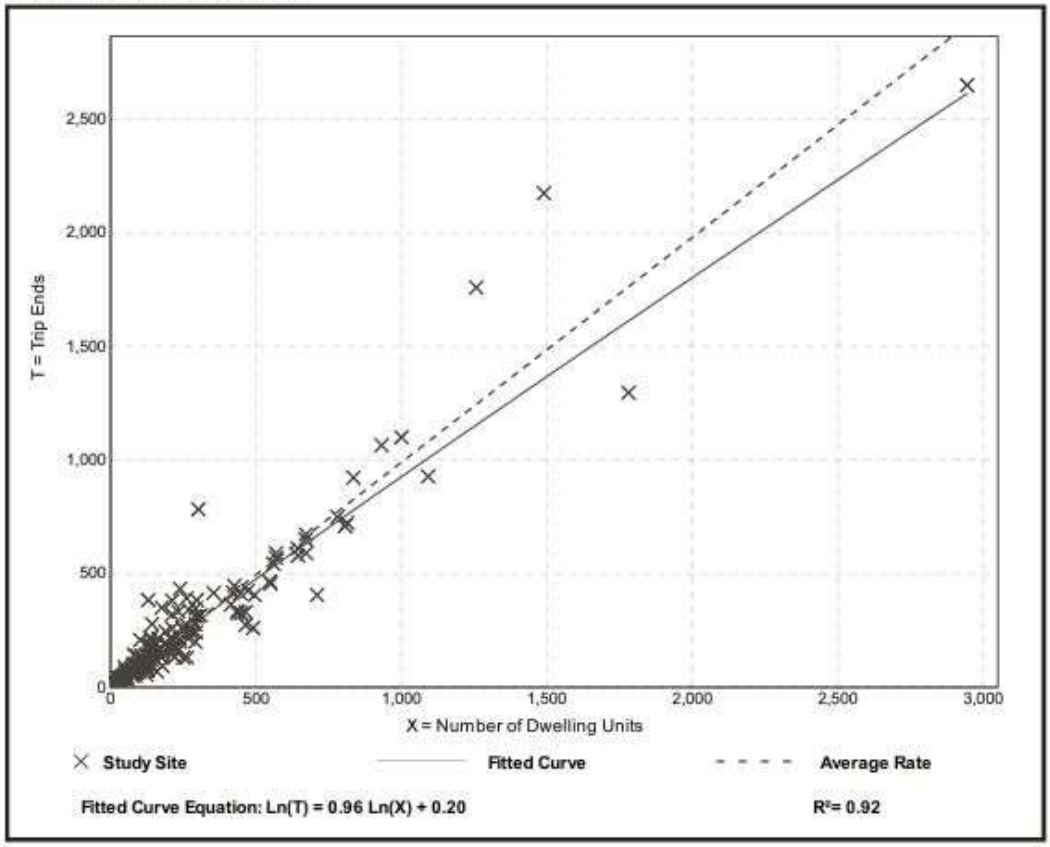
Single-Family Detached Housing
(210)

Vehicle Trip Ends vs:	**Dwelling Units**
On a:	**Weekday,**
	Peak Hour of Adjacent Street Traffic,
	One Hour Between 4 and 6 p.m.
Setting/Location:	**General Urban/Suburban**
Number of Studies:	190
Avg. Num. of Dwelling Units:	242
Directional Distribution:	63% entering, 37% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.99	0.44 - 2.98	0.31

Data Plot and Equation



KNOXVILLE·KNOX COUNTY
MPC
METROPOLITAN
PLANNING
COMMISSION
TENNESSEE

MEMORANDUM

To: Traffic Impact Study Reviewers and Preparers (see attached list)

From: Mike Conger MDC

Date: August 14, 2000

Subject: Local Trip Generation Rates for Multi-Family Residential Uses

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Attached please find a summary of the final report with data plots for the Knox County Local Apartment Trip Generation Study. As you will recall, this report was discussed when the traffic impact study group last convened this past February. A consensus was reached at that meeting that the trip generation rates developed in the local study should be used for new apartment complexes and any other "multi-family" residential uses that are being proposed.

The MPC voted at its July 2000 meeting to officially amend the Traffic Impact Study Guidelines with language which reads that "trip generation rates for proposed uses shall be calculated using the latest edition of the ITE Trip Generation Manual, or using local data when it is available". This amendment allows the full implementation of the new rates, and they should be used for future proposed multi-family developments unless it can be demonstrated otherwise.

Thanks for your assistance and cooperation in this matter, if there are any questions or comments, please let me know.

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KNOX COUNTY
LOCAL APARTMENT TRIP GENERATION STUDY

PURPOSE

A Traffic Impact Study (TIS) is currently required in Knox County when a proposed development is projected to generate in excess of 750 trips per day. The determinations of when the threshold is met as well as all subsequent analyses in the TIS are performed using the rates and equations given in the Institute of Transportation Engineers (ITE) Trip Generation Manual. Local governmental agencies rely heavily on the accuracy of these trip generation rates in order to correctly predict the impacts of a proposed development on the transportation system. Therefore, in certain instances, it is logical to verify whether the "national" rates and equations given in the ITE Trip Generation Manual are appropriate for use in a specific local area or region.

The decision was made to study the local trip-making characteristics of apartments because of the discrepancy between the trip generation rates for apartments and single family residential land uses as given in the ITE Trip Generation Manual. While these two land uses are similar in nature, the Trip Generation Manual predicts about three less trips per dwelling unit generated by apartments for the average weekday. Additionally the Trip Generation Manual points out that due to the age of their database, which dates back to the 1960's, "the rates for apartments probably had changed over time". It is also assumed that some of the ITE data had come from larger metropolitan areas with denser development and greater transit use than Knox County, which would contribute to lower trip generation rates. Therefore, this study will be used to either verify the rates given in the Trip Generation Manual or generate new ones that can be applied to locally proposed apartment developments.

PROCEDURE

The procedures recommended by ITE in conducting local trip generation studies were generally followed for this study, along with some important assumptions that have made. ITE has published a proposed recommended practice entitled "Trip Generation Handbook" which specifically outlines procedures for conducting local trip generation studies and establishing new rates and equations.

The first step in the study was to define the number and location of the sites to be studied, as well as the counting methodology. Initially 14 sites were selected, although one apartment complex – the College Park Apartments – was later omitted due to uncharacteristically high traffic generation numbers. The number of sites used in this study far exceeds the recommended minimum amount suggested by ITE, which is five sites. Traffic counts were taken for week-long periods at 15-minute intervals between July 22, 1996 and August 9, 1996 at the access points to the apartment complexes. A Technical Appendix to this report contains the traffic count data collected at each apartment complex.

RESULTS

The traffic count data was analyzed using spreadsheets in order to determine the weighted average rates and regression equations. In order to be considered valid, the local rates and equations for each time period of analysis that were generated must meet certain statistical criteria. First, the standard deviation of the independent variable (dwelling units) should be no more than 110 percent of the weighted average rate; and secondly, the regression equations require a computed coefficient of determination (R^2) value of at least 0.75 before good data fit is indicated. This statistical criteria is met by the local data results, and in fact it often exceeds the level of data fit given by their counterparts in the ITE Trip Generation Manual. Finally, in order to simplify the use of the local data, plots were generated that appear identical to the actual ones in the ITE Trip Generation Manual.

The resulting rates and equations calculated from the local data indicate that the average weekday trip generation of apartments in this area is well above the national rates reported in the ITE manual. For example, the locally computed average rate for number of trips generated during a weekday is 35% higher than the rate given by ITE (increase from 6.63 trips per dwelling unit to 9.03 trips per dwelling unit). The trip generation rates do not increase as much for the AM and PM peak hours however. The local rate is roughly 8% higher for the AM peak, and 16% higher for the PM peak. The plots from the ITE Trip Generation Manual are included in the Technical Appendix for comparison purposes.

ASSUMPTIONS MADE

Some important assumptions have been made which may affect the results of the local data that was collected:

- It is important to note that the local trip generation rates were computed for the *total* number of dwelling units in the apartment complex, and not necessarily for the number of *occupied* dwelling units. There are several reasons why this was done, chiefly because of the need for comparability with the rates given in ITE Trip Generation Manual, as it does not specify whether the dwelling units are occupied. According to ITE procedures the selected sites must only be of "reasonably full occupancy (i.e. at least 85%)". The Apartment Association of Greater Knoxville (AAGK) publishes quarterly reports on occupancy levels of apartment complexes, and the report covering the period of the data collection was reviewed to determine occupancy levels. According to the AAGK report from July 1, 1996 – September 30, 1996 all of the apartment complexes surveyed in this study met the minimum 85% occupancy level, with an average occupancy rate for all sites studied of 94%.

- The count data that was collected at each apartment complex was used "raw" meaning that it was not factored for possible daily or seasonal variations. Once again, according to an ITE representative it is not known whether the data used in the Trip Generation Manual was factored or not, so therefore in order to be able to compare

local rates to those in the manual you must assume that count data should not be factored. Additionally, it was felt that apartment complexes would generally not be as susceptible to major seasonal fluctuations as other land uses might be. The local rates were also developed using count data that was collected and averaged over an entire week, which should limit some of the daily variations. Finally, reliable local daily and seasonal variation factors do not truly exist.

CONCLUSION

The local apartment study methodology and results were distributed for comment to a group of local transportation professionals who are directly responsible for either preparing or reviewing traffic impact studies. A meeting was held between this group on February 16, 2000 in order to gather comments and discuss the study in greater detail. The following conclusions are based on the discussion and consensus reached at this meeting:

1. The trip generation rates and equations meet statistical requirements and resulted from a study that followed accepted procedures; therefore they should be adopted for future use. Furthermore, the rates and equations are recommended for use in reviewing the traffic impact of any development termed as "multi-family", such as townhouse and condominium developments due to their similarity to apartment complexes.

2. The Traffic Access and Impact Study Guidelines and Procedures adopted by MPC should be amended with the language that local data should be used when available, which will allow the implementation of these new multi-family trip generation rates.

3. The following suggestions were made for future consideration:
   - This study should be updated with data collected from local townhouse and condominium developments in order to further justify the use of the new trip generation rates.
   - A statistical comparison should be made between any newly developed rates and the ITE single family trip generation rates to determine if there is a significant difference. If there is no difference then perhaps ITE single-family rates could be used for any residential development proposed in Knox County.

Local Apartment
Trip Generation Study

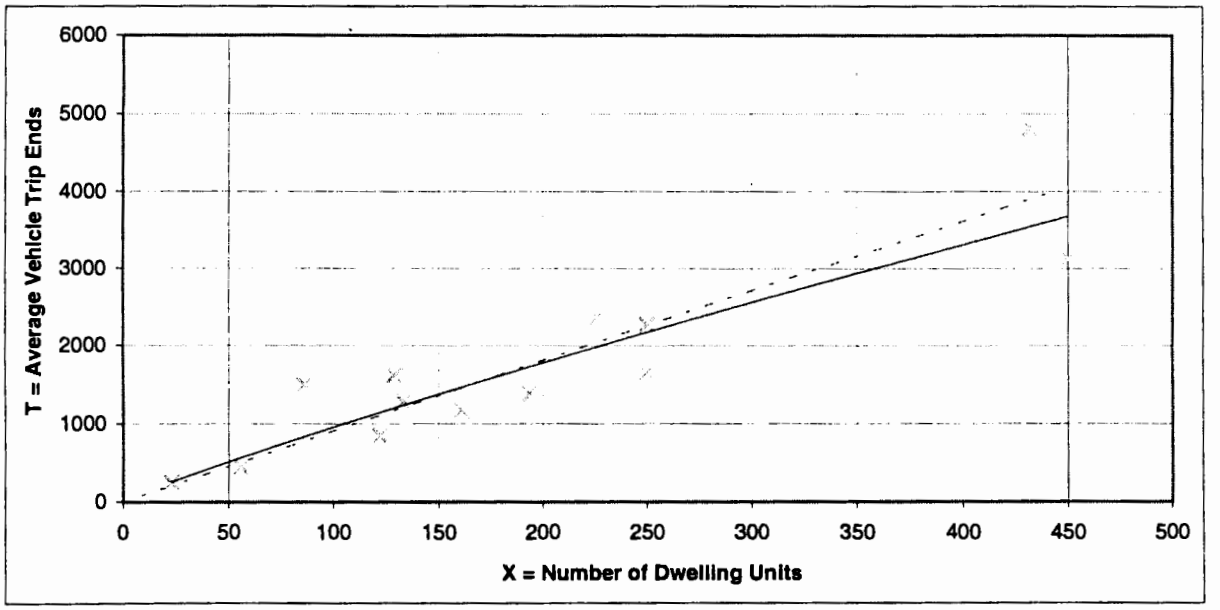
Average Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday**

Number of Studies: 13
Average Number of Dwelling Units: 193
Directional Distribution: 50% entering, 50% exiting

Trip Generation Per Dwelling Unit

Average Rate	Ranges of Rates	Standard Deviation
9.03	6.59 - 17.41	2.47

Data Plot and Equation



X Actual Data Points ——— Fitted Curve ····· Average Rate

Fitted Curve Equation: $T = 15.193(X)^{0.899}$ $R^2 = 0.88$

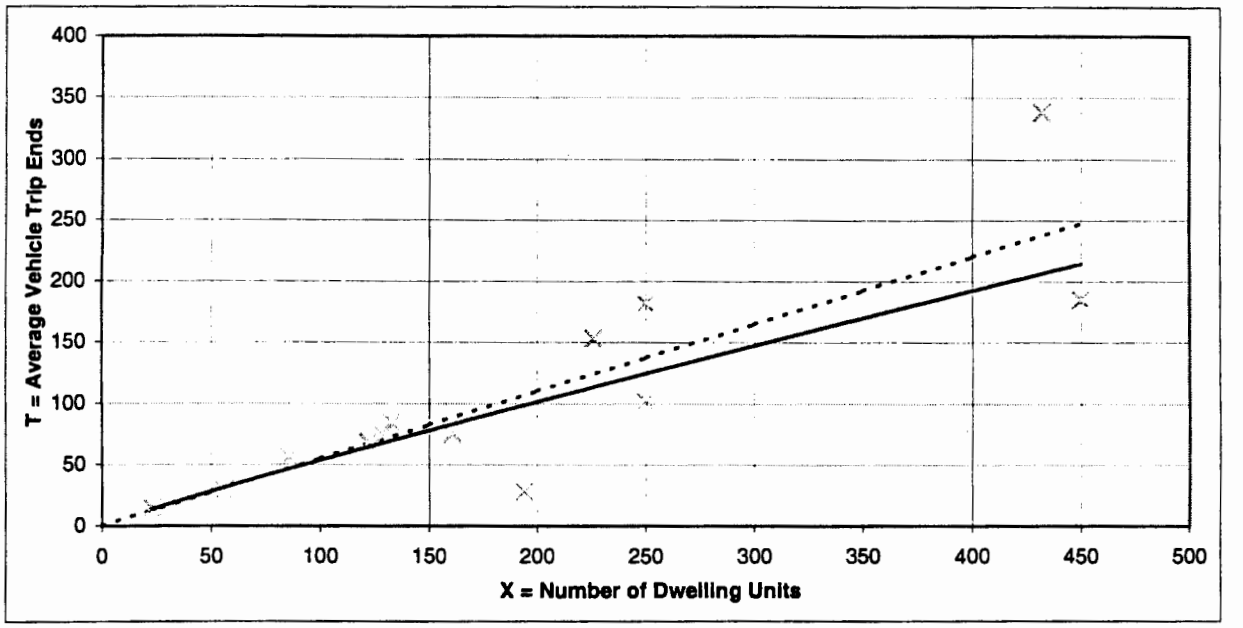
Local Apartment
Trip Generation Study

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:	13
Average Number of Dwelling Units:	193
Directional Distribution:	22% entering, 78% exiting

Trip Generation Per Dwelling Unit

Average Rate	Ranges of Rates	Standard Deviation
0.55	0.14 - 0.78	0.18

Data Plot and Equation



X Actual Data Points ——— Fitted Curve ····· Average Rate

Fitted Curve Equation: $T = 0.758(X)^{0.924}$ $R^2 = 0.75$

Local Apartment
Trip Generation Study

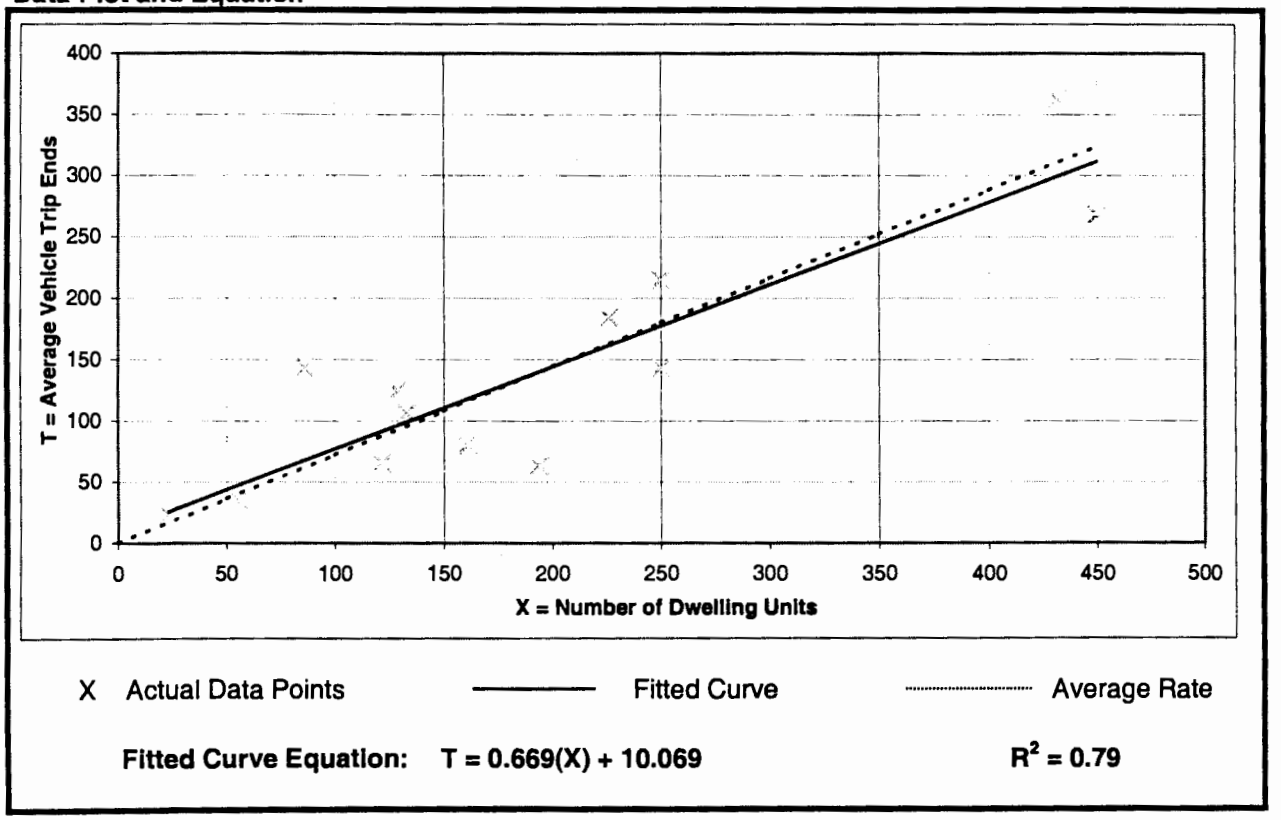
Average Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday,**
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.

Number of Studies: 13
Average Number of Dwelling Units: 193
Directional Distribution: 55% entering, 45% exiting

Trip Generation Per Dwelling Unit

Average Rate	Ranges of Rates	Standard Deviation
0.72	0.32 - 1.66	0.25

Data Plot and Equation



X Actual Data Points ——— Fitted Curve ····· Average Rate

Fitted Curve Equation: T = 0.669(X) + 10.069 **R^2 = 0.79**

Attachment 6
Intersection Worksheets – Existing AM/PM Peaks

HCS7 Two-Way Stop-Control Report

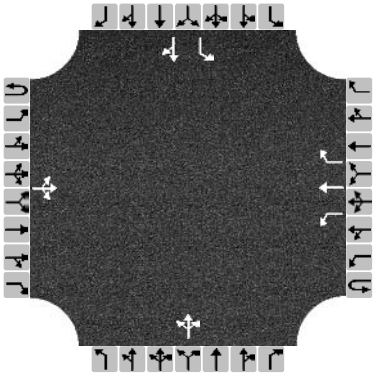
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	11/19/2018
Analysis Year	2018
Time Analyzed	Existing AM Peak
Intersection Orientation	East-West
Project Description	525.009 Heritage Woods Subdivision

Site Information

Intersection	Westland at Heritage Lake
Jurisdiction	Knox County
East/West Street	Westland Drive
North/South Street	Heritage Lake Boulevard
Peak Hour Factor	0.91
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	1		0	1	0		1	1	0
Configuration			LTR			L	T	R			LTR			L		TR
Volume, V (veh/h)		0	591	2		9	361	17		0	1	8		47	0	9
Percent Heavy Vehicles (%)		2				2				2	2	2		2	2	2
Proportion Time Blocked																
Percent Grade (%)										0				0		
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1				4.1				7.1	6.5	6.2		7.1	6.5	6.2
Critical Headway (sec)		4.12				4.12				7.12	6.52	6.22		7.12	6.52	6.22
Base Follow-Up Headway (sec)		2.2				2.2				3.5	4.0	3.3		3.5	4.0	3.3
Follow-Up Headway (sec)		2.22				2.22				3.52	4.02	3.32		3.52	4.02	3.32

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		0				10					10			52		10
Capacity, c (veh/h)		1142				935					419			192		652
v/c Ratio		0.00				0.01					0.02			0.27		0.02
95% Queue Length, Q_{95} (veh)		0.0				0.0					0.1			1.1		0.0
Control Delay (s/veh)		8.2				8.9					13.8			30.6		10.6
Level of Service, LOS		A				A					B			D		B
Approach Delay (s/veh)		0.0				0.2				13.8				27.3		
Approach LOS										B				D		

HCS7 Two-Way Stop-Control Report

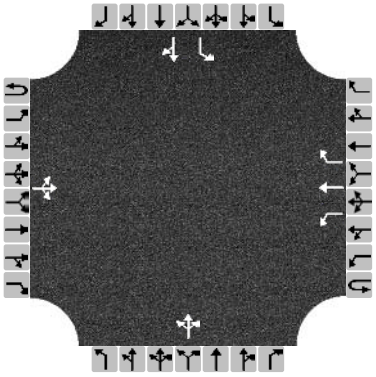
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	11/19/2018
Analysis Year	2018
Time Analyzed	Existing PM Peak
Intersection Orientation	East-West
Project Description	525.009 Heritage Woods Subdivision

Site Information

Intersection	Westland at Heritage Lake
Jurisdiction	Knox County
East/West Street	Westland Drive
North/South Street	Heritage Lake Boulevard
Peak Hour Factor	0.90
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	1		0	1	0		1	1	0
Configuration			LTR			L	T	R			LTR			L		TR
Volume, V (veh/h)		4	335	2		22	569	58		2	0	19		30	0	4
Percent Heavy Vehicles (%)		2				2				2	2	2		2	2	2
Proportion Time Blocked																
Percent Grade (%)										0				0		
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1				4.1				7.1	6.5	6.2		7.1	6.5	6.2
Critical Headway (sec)		4.12				4.12				7.12	6.52	6.22		7.12	6.52	6.22
Base Follow-Up Headway (sec)		2.2				2.2				3.5	4.0	3.3		3.5	4.0	3.3
Follow-Up Headway (sec)		2.22				2.22				3.52	4.02	3.32		3.52	4.02	3.32

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		4				24					23			33		4
Capacity, c (veh/h)		899				1184					548			188		480
v/c Ratio		0.00				0.02					0.04			0.18		0.01
95% Queue Length, Q_{95} (veh)		0.0				0.1					0.1			0.6		0.0
Control Delay (s/veh)		9.0				8.1					11.9			28.2		12.6
Level of Service, LOS		A				A					B			D		B
Approach Delay (s/veh)		0.1				0.3				11.9				26.5		
Approach LOS										B				D		

Attachment 7
Intersection Worksheets – Background AM/PM Peaks

HCS7 Two-Way Stop-Control Report

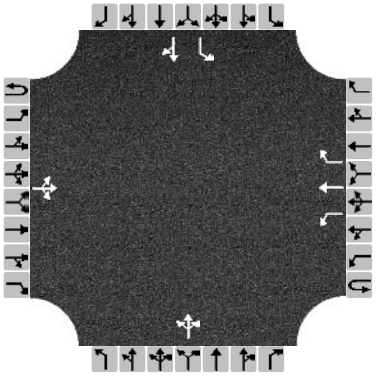
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	11/19/2018
Analysis Year	2021
Time Analyzed	Background AM Peak
Intersection Orientation	East-West
Project Description	525.009 Heritage Woods Subdivision

Site Information

Intersection	Westland at Heritage Lake
Jurisdiction	Knox County
East/West Street	Westland Drive
North/South Street	Heritage Lake Boulevard
Peak Hour Factor	0.91
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	1		0	1	0		1	1	0
Configuration			LTR			L	T	R			LTR			L		TR
Volume, V (veh/h)		0	646	2		10	394	19		0	1	9		51	0	10
Percent Heavy Vehicles (%)		2				2				2	2	2		2	2	2
Proportion Time Blocked																
Percent Grade (%)										0				0		
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1				4.1				7.1	6.5	6.2		7.1	6.5	6.2
Critical Headway (sec)		4.12				4.12				7.12	6.52	6.22		7.12	6.52	6.22
Base Follow-Up Headway (sec)		2.2				2.2				3.5	4.0	3.3		3.5	4.0	3.3
Follow-Up Headway (sec)		2.22				2.22				3.52	4.02	3.32		3.52	4.02	3.32

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		0				11					11			56		11
Capacity, c (veh/h)		1106				887					386			163		623
v/c Ratio		0.00				0.01					0.03			0.34		0.02
95% Queue Length, Q_{95} (veh)		0.0				0.0					0.1			1.4		0.1
Control Delay (s/veh)		8.3				9.1					14.6			38.2		10.9
Level of Service, LOS		A				A					B			E		B
Approach Delay (s/veh)		0.0				0.2				14.6				33.7		
Approach LOS										B				D		

HCS7 Two-Way Stop-Control Report

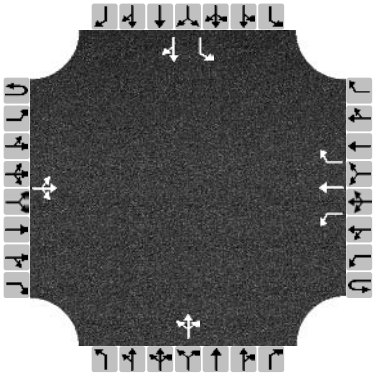
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	11/19/2018
Analysis Year	2021
Time Analyzed	Background PM Peak
Intersection Orientation	East-West
Project Description	525.009 Heritage Woods Subdivision

Site Information

Intersection	Westland at Heritage Lake
Jurisdiction	Knox County
East/West Street	Westland Drive
North/South Street	Heritage Lake Boulevard
Peak Hour Factor	0.90
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	1		0	1	0		1	1	0
Configuration			LTR			L	T	R			LTR			L		TR
Volume, V (veh/h)		4	366	2		24	622	63		2	0	21		33	0	4
Percent Heavy Vehicles (%)		2				2				2	2	2		2	2	2
Proportion Time Blocked																
Percent Grade (%)										0				0		
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1				4.1				7.1	6.5	6.2		7.1	6.5	6.2
Critical Headway (sec)		4.12				4.12				7.12	6.52	6.22		7.12	6.52	6.22
Base Follow-Up Headway (sec)		2.2				2.2				3.5	4.0	3.3		3.5	4.0	3.3
Follow-Up Headway (sec)		2.22				2.22				3.52	4.02	3.32		3.52	4.02	3.32

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		4				27					25			37		4
Capacity, c (veh/h)		851				1149					516			160		444
v/c Ratio		0.00				0.02					0.05			0.23		0.01
95% Queue Length, Q_{95} (veh)		0.0				0.1					0.2			0.9		0.0
Control Delay (s/veh)		9.3				8.2					12.3			34.3		13.2
Level of Service, LOS		A				A					B			D		B
Approach Delay (s/veh)		0.1				0.3				12.3				32.2		
Approach LOS										B				D		

Attachment 8
Intersection Worksheets – Full Buildout AM/PM Peaks

HCS7 Two-Way Stop-Control Report

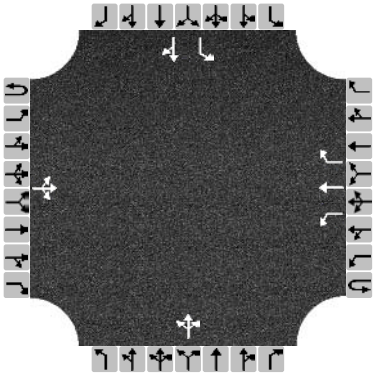
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	8/24/2020
Analysis Year	2021
Time Analyzed	Full Buildout AM Peak
Intersection Orientation	East-West
Project Description	525.0042 Westland Oaks Units 1-3

Site Information

Intersection	Westland at Heritage Lake
Jurisdiction	Knox County
East/West Street	Westland Drive
North/South Street	Heritage Lake Boulevard
Peak Hour Factor	0.91
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	1		0	1	0		1	1	0
Configuration			LTR			L	T	R			LTR			L		TR
Volume, V (veh/h)		0	708	6		37	407	19		11	1	72		51	0	10
Percent Heavy Vehicles (%)		2				2				2	2	2		2	2	2
Proportion Time Blocked																
Percent Grade (%)										0				0		
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1				4.1				7.1	6.5	6.2		7.1	6.5	6.2
Critical Headway (sec)		4.12				4.12				7.12	6.52	6.22		7.12	6.52	6.22
Base Follow-Up Headway (sec)		2.2				2.2				3.5	4.0	3.3		3.5	4.0	3.3
Follow-Up Headway (sec)		2.22				2.22				3.52	4.02	3.32		3.52	4.02	3.32

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		0				41					92			56		11
Capacity, c (veh/h)		1093				833					304			98		611
v/c Ratio		0.00				0.05					0.30			0.57		0.02
95% Queue Length, Q_{95} (veh)		0.0				0.2					1.2			2.7		0.1
Control Delay (s/veh)		8.3				9.5					21.9			82.7		11.0
Level of Service, LOS		A				A					C			F		B
Approach Delay (s/veh)		0.0				0.8				21.9				70.9		
Approach LOS										C				F		

HCS7 Two-Way Stop-Control Report

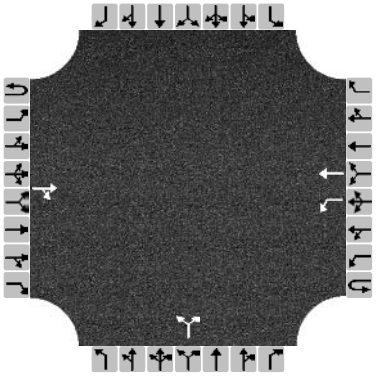
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	8/24/2020
Analysis Year	2021
Time Analyzed	Full Buildout AM Peak
Intersection Orientation	East-West
Project Description	525.0042 Westland Oaks Units 1-3

Site Information

Intersection	Westland at Ridge Climber
Jurisdiction	Knox County
East/West Street	Westland Drive
North/South Street	Ridge Climber Road
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	1	0		0	0	0
Configuration				TR		L	T				LR					
Volume, V (veh/h)			634	3		13	411			10		62				
Percent Heavy Vehicles (%)						2				2		2				
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)						4.12				6.42		6.22				
Base Follow-Up Headway (sec)						2.2				3.5		3.3				
Follow-Up Headway (sec)						2.22				3.52		3.32				

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						14					78					
Capacity, c (veh/h)						903					385					
v/c Ratio						0.02					0.20					
95% Queue Length, Q_{95} (veh)						0.0					0.7					
Control Delay (s/veh)						9.1					16.7					
Level of Service, LOS						A					C					
Approach Delay (s/veh)						0.3				16.7						
Approach LOS										C						

HCS7 Two-Way Stop-Control Report

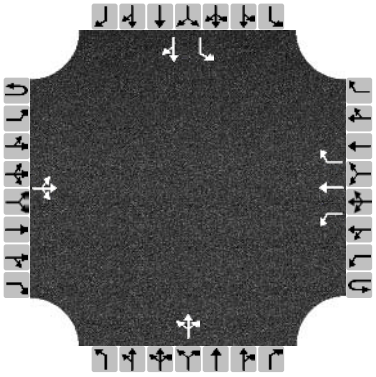
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	8/24/2020
Analysis Year	2021
Time Analyzed	Full Buildout PM Peak
Intersection Orientation	East-West
Project Description	525.042 Westland Oaks Units 1-3

Site Information

Intersection	Westland at Heritage Lake
Jurisdiction	Knox County
East/West Street	Westland Drive
North/South Street	Heritage Lake Boulevard
Peak Hour Factor	0.90
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	1		0	1	0		1	1	0
Configuration			LTR			L	T	R			LTR			L		TR
Volume, V (veh/h)		4	411	15		115	669	63		9	0	64		33	0	4
Percent Heavy Vehicles (%)		2				2				2	2	2		2	2	2
Proportion Time Blocked																
Percent Grade (%)										0				0		
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1				4.1				7.1	6.5	6.2		7.1	6.5	6.2
Critical Headway (sec)		4.12				4.12				7.12	6.52	6.22		7.12	6.52	6.22
Base Follow-Up Headway (sec)		2.2				2.2				3.5	4.0	3.3		3.5	4.0	3.3
Follow-Up Headway (sec)		2.22				2.22				3.52	4.02	3.32		3.52	4.02	3.32

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		4				128					81			37		4
Capacity, c (veh/h)		813				1087					349			79		415
v/c Ratio		0.00				0.12					0.23			0.47		0.01
95% Queue Length, Q_{95} (veh)		0.0				0.4					0.9			1.9		0.0
Control Delay (s/veh)		9.4				8.8					18.4			85.5		13.8
Level of Service, LOS		A				A					C			F		B
Approach Delay (s/veh)		0.1				1.2				18.4				78.5		
Approach LOS										C				F		

HCS7 Two-Way Stop-Control Report

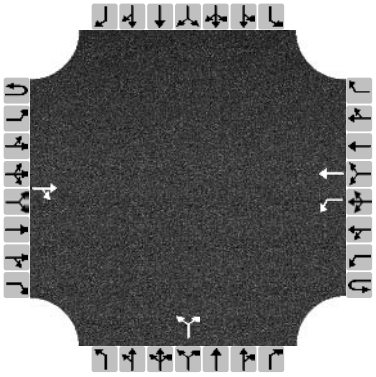
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	8/24/2020
Analysis Year	2021
Time Analyzed	Full Buildout PM Peak
Intersection Orientation	East-West
Project Description	525.0042 Westland Oaks Units 1-3

Site Information

Intersection	Westland at Ridge Climber
Jurisdiction	Knox County
East/West Street	Westland Drive
North/South Street	Ridge Climber Road
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	1	0		0	0	0
Configuration				TR		L	T				LR					
Volume, V (veh/h)			375	12		47	617			8		45				
Percent Heavy Vehicles (%)						2				2		2				
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)						4.12				6.42		6.22				
Base Follow-Up Headway (sec)						2.2				3.5		3.3				
Follow-Up Headway (sec)						2.22				3.52		3.32				

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						51					58					
Capacity, c (veh/h)						1137					475					
v/c Ratio						0.04					0.12					
95% Queue Length, Q_{95} (veh)						0.1					0.4					
Control Delay (s/veh)						8.3					13.6					
Level of Service, LOS						A					B					
Approach Delay (s/veh)						0.6					13.6					
Approach LOS											B					

Attachment 9
Turn Lane Warrant Analysis

Project: Westland Oaks Subdivision Units 1-3

Westland Drive at Heritage Lake Boulevard

Westland Drive VOLUMES
at Heritage Lake Boulevard

RIGHT TURN	Thru	RT	RT MAX	Warrant Met
AM	708	6	25	NO
PM	411	15	149	NO

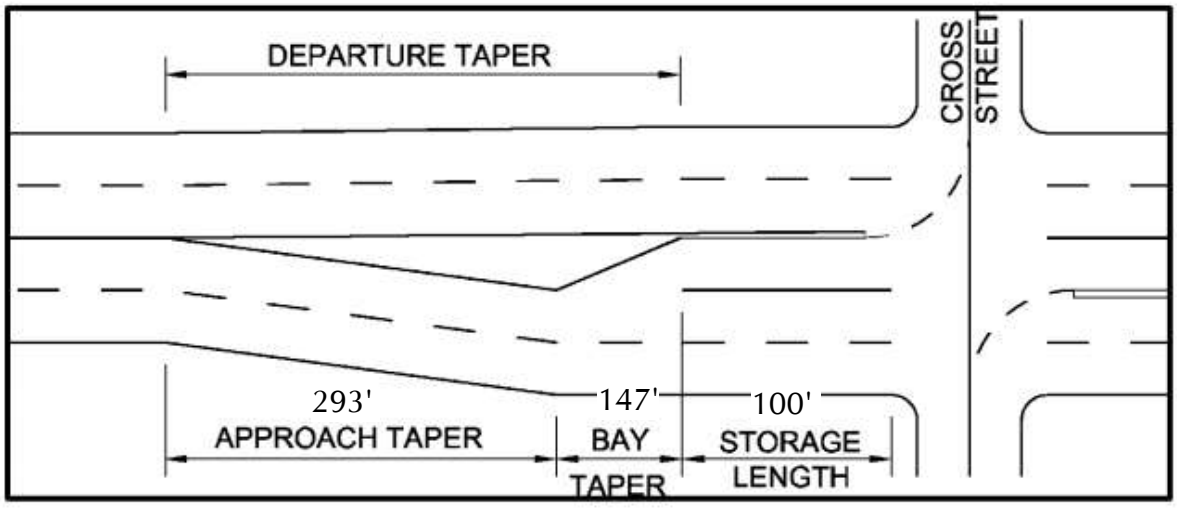
Westland Drive at Ridge Climber Road

Westland Drive VOLUMES
at Ridge Climber Road

LEFT TURN	Opposing	Thru	LT	LT MAX	Warrant Met
AM	637	411	13	20	NO
PM	387	617	47	20	YES

Westland Drive VOLUMES
at Ridge Climber Road

RIGHT TURN	Thru	RT	RT MAX	Warrant Met
AM	634	3	25	NO
PM	375	12	199	NO



Not to Scale

Figure 2-9
Turning Lane Terminology

Turn lane recommendations for an 11 foot turn lane on a 40 mph road.

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	15 RT PM Peak			Yes	Yes Yes	6 RT AM Peak 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.

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 47 LT PM Peak	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 20	15 15
600 - 649 650 - 699	13 LT AM Peak 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

* 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	12 RT PM Peak			3 RT AM Peak Yes	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.

Attachment 10
Signal Warrant Analysis

Project: Heritage Woods Subdivision
Intersection: Westland Dr at Heritage Lake Blvd / Garrison Ridge Blvd
Date Conducted: 12/17/2018

	Existing Conditions		**Warrant 1**			**Warrant 2**	**Warrant 3**
	Major Street	Minor Street	Condition A	Condition B	Condition A/B		
Start	veh/hr	veh/hr					
7:00 a.m.	867	67	NO	NO	NO	NO	NO
8:00 a.m.	980	56	NO	NO	NO	NO	NO
11:00 a.m.	681	13	NO	NO	NO	NO	NO
12:00 p.m.	693	26	NO	NO	NO	NO	NO
2:00 p.m.	663	24	NO	NO	NO	NO	NO
3:00 p.m.	774	24	NO	NO	NO	NO	NO
4:00 p.m.	898	27	NO	NO	NO	NO	NO
5:00 p.m.	989	39	NO	NO	NO	NO	NO

	Background Conditions		**Warrant 1**			**Warrant 2**	**Warrant 3**
	Major Street	Minor Street	Condition A	Condition B	Condition A/B		
Start	veh/hr	veh/hr					
7:00 a.m.	947	73	NO	NO	NO	NO	NO
8:00 a.m.	1071	61	NO	NO	NO	NO	NO
11:00 a.m.	744	14	NO	NO	NO	NO	NO
12:00 p.m.	757	28	NO	NO	NO	NO	NO
2:00 p.m.	724	26	NO	NO	NO	NO	NO
3:00 p.m.	846	26	NO	NO	NO	NO	NO
4:00 p.m.	981	30	NO	NO	NO	NO	NO
5:00 p.m.	1081	43	NO	NO	NO	NO	NO

	Full Buildout		**Warrant 1**			**Warrant 2**	**Warrant 3**
	Major Street	Minor Street	Condition A	Condition B	Condition A/B		
Start	veh/hr	veh/hr					
7:00 a.m.	1021	84	NO	YES	NO	NO	NO
8:00 a.m.	1145	84	NO	YES	NO	YES	NO
11:00 a.m.	818	14	NO	NO	NO	NO	NO
12:00 p.m.	831	28	NO	NO	NO	NO	NO
2:00 p.m.	873	26	NO	NO	NO	NO	NO
3:00 p.m.	995	26	NO	NO	NO	NO	NO
4:00 p.m.	1130	73	NO	NO	NO	NO	NO
5:00 p.m.	1230	73	NO	NO	NO	NO	NO