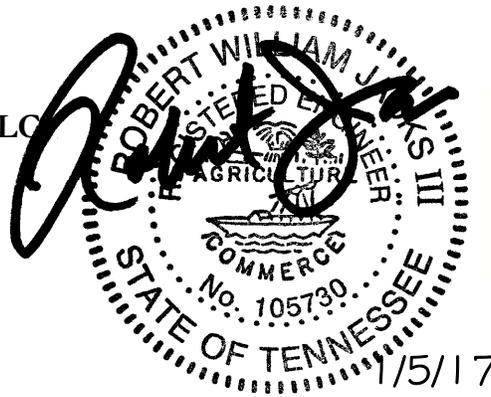


TRAFFIC IMPACT STUDY VINING MILL SUBDIVISION KNOX COUNTY, TENNESSEE

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INTRODUCTION

The purpose of this traffic study is to analyze the traffic impacts of a new proposed residential subdivision in Knox County, Tennessee. At this point in the concept stage, this development is named Vining Mill. This development is being proposed to the south of Hardin Valley Road and to the east of Marietta Church Road in west Knox County. This traffic impact study follows the procedures and standards as outlined for a Level 1 study in accordance with the standards set forth by the Knoxville/Knox County Metropolitan Planning Commission (MPC).

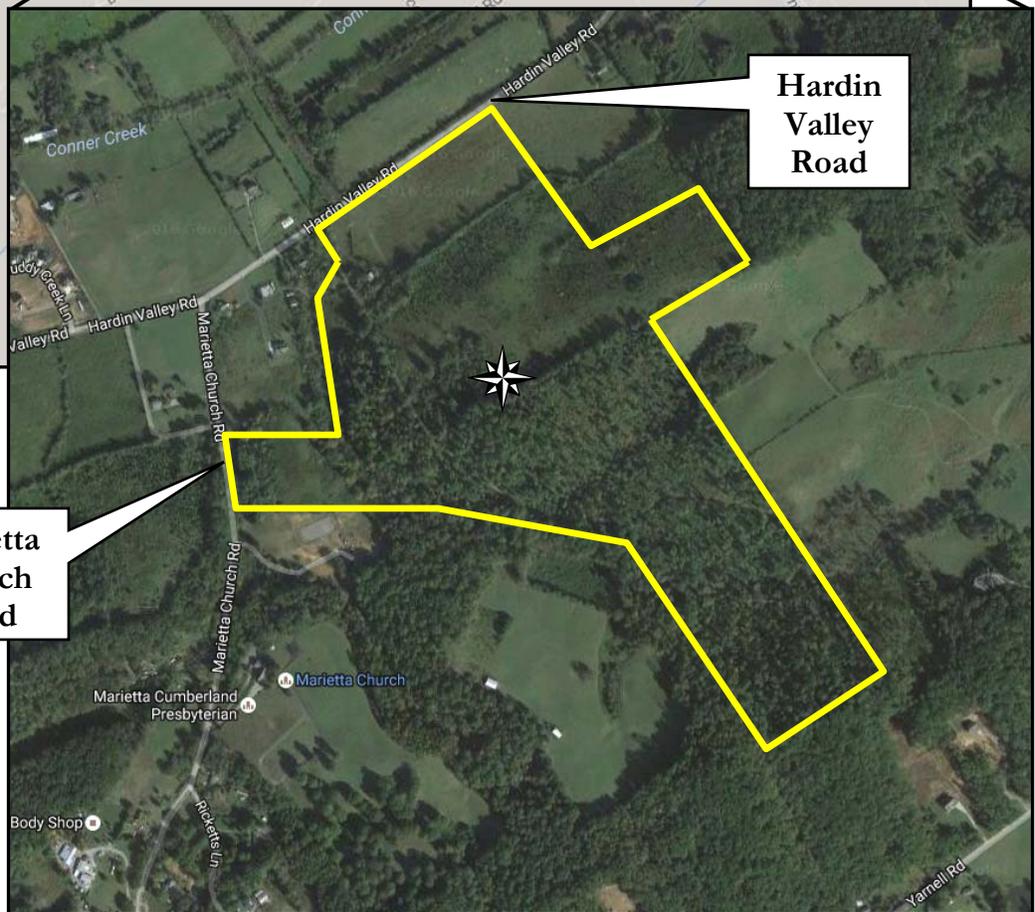
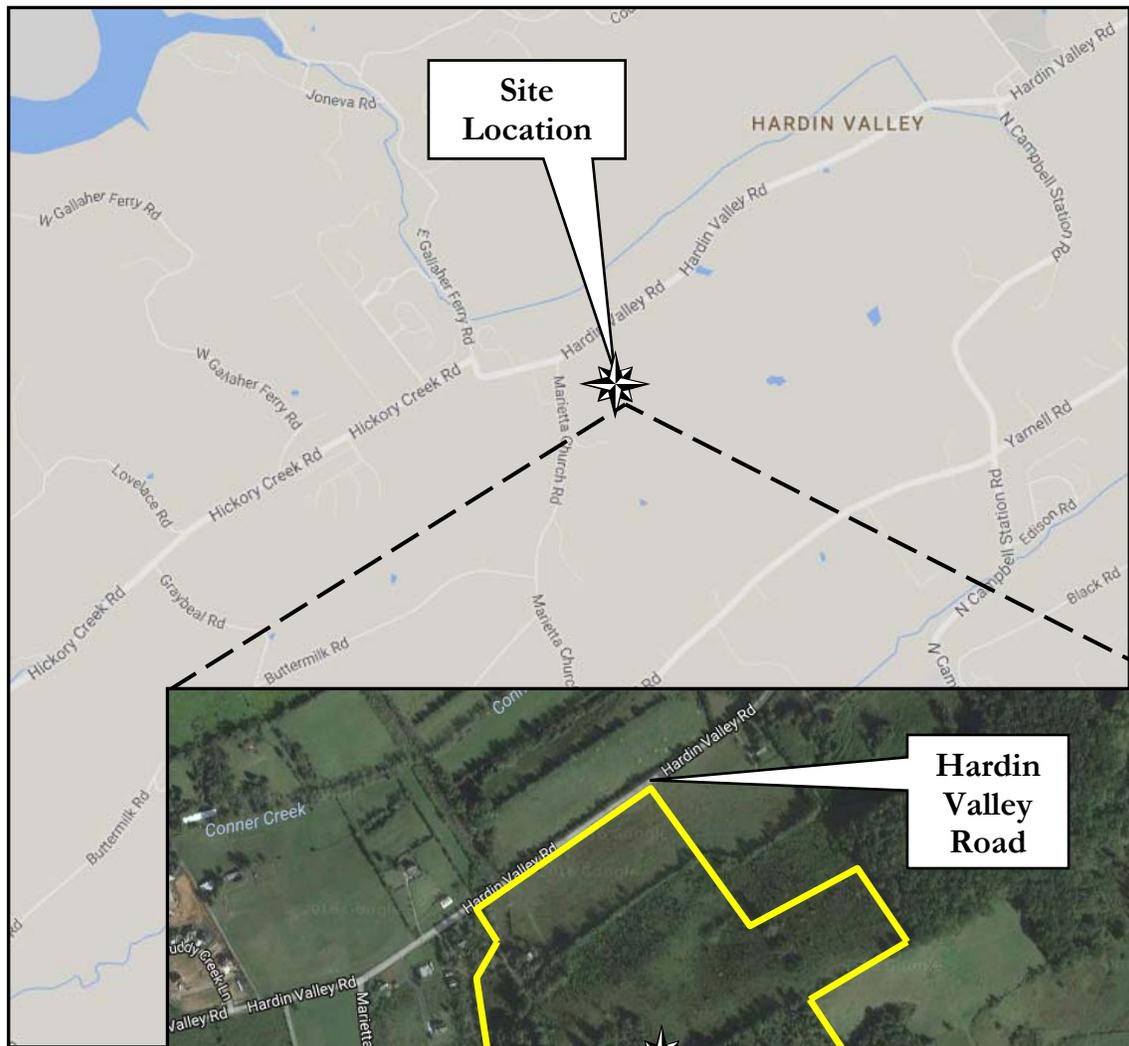
In this study the following analyses/methodologies were conducted:

- A review of the operating characteristics of the existing adjacent roadway system that will provide access to the proposed site
- Determination and application of the trips to the existing adjacent road system that are expected to be generated by the proposed development
- Evaluation of the road system locations to determine the potential traffic impacts of the proposed development
- Identification of recommendations for road improvements that would mitigate the expected increase in traffic volume from the projected future traffic volumes

PROJECT DESCRIPTION

The proposed location of this new development is shown on a map in Figure 1. The development is to be located adjacent to Hardin Valley Road just less than two miles to the west of the intersection of Hardin Valley Road and North Campbell Station Road. Immediate access to the development will be provided by Hardin Valley Road to the north and Marietta Church Road to the west. In the adjacent vicinity of this study area, there are several other relatively new residential subdivisions, individual residences, and undeveloped properties. The existing site primarily consists of undeveloped woods, pasture and scrubland. A branch of Conner Creek bisects the property and the topography has some fairly significant slopes.

The proposed subdivision is expected to be comprised of several new internal drives on approximately 111 acres. At this stage of design, the subdivision design contains 190 single family residential lots (1/4 acre to 2.5 acres in size) and approximately 30 acres of open space.



**Figure 1
Location Map**

The proposed plan layout given by Russell Rackley, PE is shown in Figure 2a. As can be seen in the figure, one main entrance will tie onto Hardin Valley Road and one will tie onto Marietta Church Road. Figure 2b shows the typical road cross section for the development. The internal roadways as shown in Figure 2b will have 5 foot wide sidewalks and a total road width of 26 feet. The total length of the new roadways within the development will be nearly 9,800 feet and are labeled on the layout plan in Figure 2a. The proposed entrance for the subdivision on Marietta Church Road is to be located approximately 1,050 feet to the south of the intersection at Hardin Valley Road. The proposed entrance for the subdivision on Hardin Valley Road is to be located approximately 1,685 feet to the east of the intersection at Marietta Church Road. The development, in addition to the individual home lots, will also have a subdivision swimming pool and gathering area at the front entrance near the intersection with Hardin Valley Road.

The actual schedule for completion of this new residential development is dependent on economic factors. However, the current market in this area of Knox County is experiencing rapid growth. This project is also contingent on permitting, design, and other issues. However, for the purposes of this study, it was assumed that the total construction build-out of the development and full occupancy will be by the year 2024 (8 years).

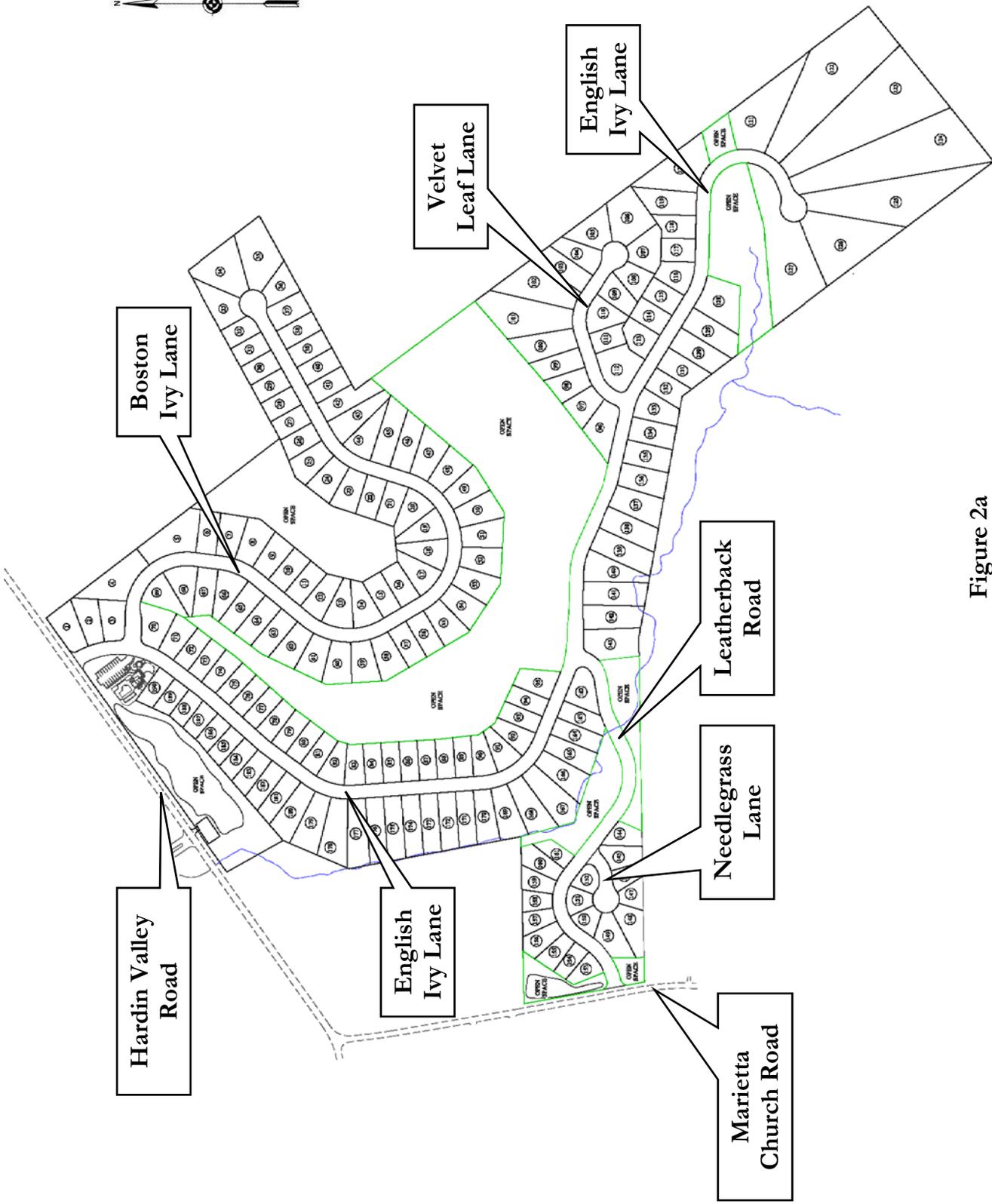
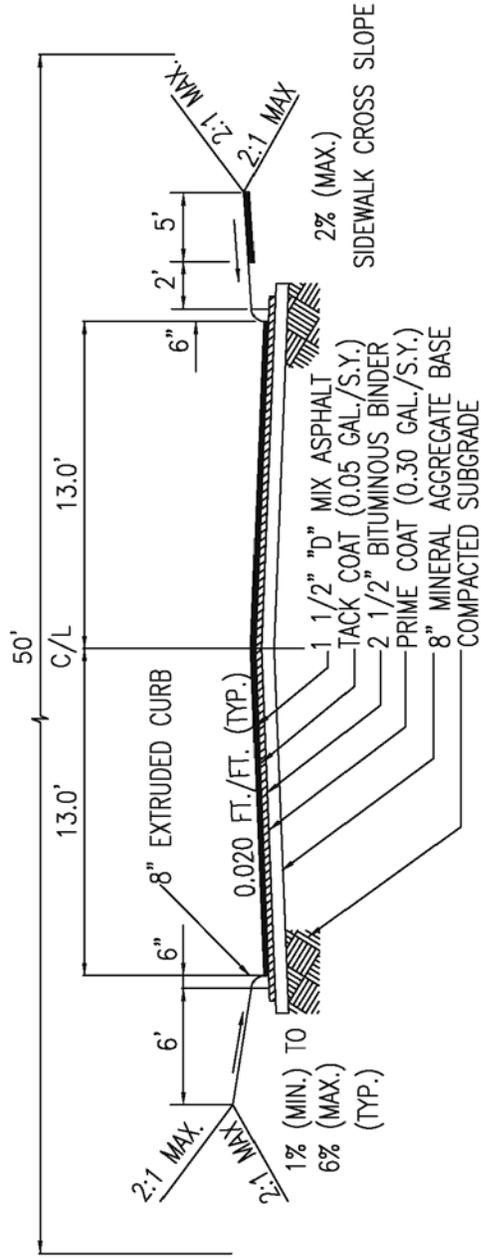


Figure 2a
Proposed Plan Layout
Vining Mill



TYPICAL ROAD SECTION

Figure 2b
Proposed Typical Road Cross Section
Vining Mill

EXISTING CONDITIONS IN STUDY AREA

Hardin Valley Road is classified as a Minor Arterial and traverses in a general northeast-southwest direction. Hardin Valley Road intersects Pellissippi Parkway at an underpass to the northeast of the site and terminates at the intersection of Hickory Creek Road and East Gallaher Ferry Road just to the west of the site. The speed limit on Hardin Valley Road is posted at 40 mph in the project area. Hardin Valley Road near the intersection of Marietta Church Road consists of a 2-lane section and has a total pavement width of 22 feet with approximately 10 foot travel lanes. Hardin Valley Road in the study area has a fairly level vertical alignment. In the Major Road Plan published by the MPC, Hardin Valley Road is listed as having 60 feet of right-of-way adjacent to the project location.

Hardin Valley Road provides road access to several schools in the surrounding area. Pellissippi State Community College, Hardin Valley Elementary, and Hardin Valley Academy (high school) are located several miles to the northeast of the site. In addition, Hardin Valley Middle School is currently being constructed adjacent to the elementary school. Average Daily Traffic (ADT) on Hardin Valley Road just slightly east of the project site was reported by the Knoxville Regional Transportation Planning Organization (TPO) at 4,380 vehicles per day in 2014. Historical traffic count data can be viewed in Appendix A.

Marietta Church Road is classified as Minor Collector that intersects and terminates at Hardin Valley Road at an unsignalized stop-controlled intersection (for the Marietta Church Road approach). Marietta Church Road terminates to the south at Yarnell Road. The speed limit on Marietta Church Road is posted at 30 mph in the project area. Marietta Church Road at the proposed road connection for the subdivision consists of a 2-lane section with a total pavement width of 21 feet with approximately 9.5 foot travel lanes. In the Major Road Plan published by the MPC, Marietta Church Road is listed as having 60 feet of right-of-way along this project location.

Average Daily Traffic (ADT) on Marietta Church Road adjacent to the project site was reported by the Knoxville Regional TPO at 1,440 vehicles per day in 2015. Historical traffic count data can be viewed in Appendix A.

PHOTO EXHIBITS



View of Hardin Valley Road at Marietta Church Road
(Looking East)



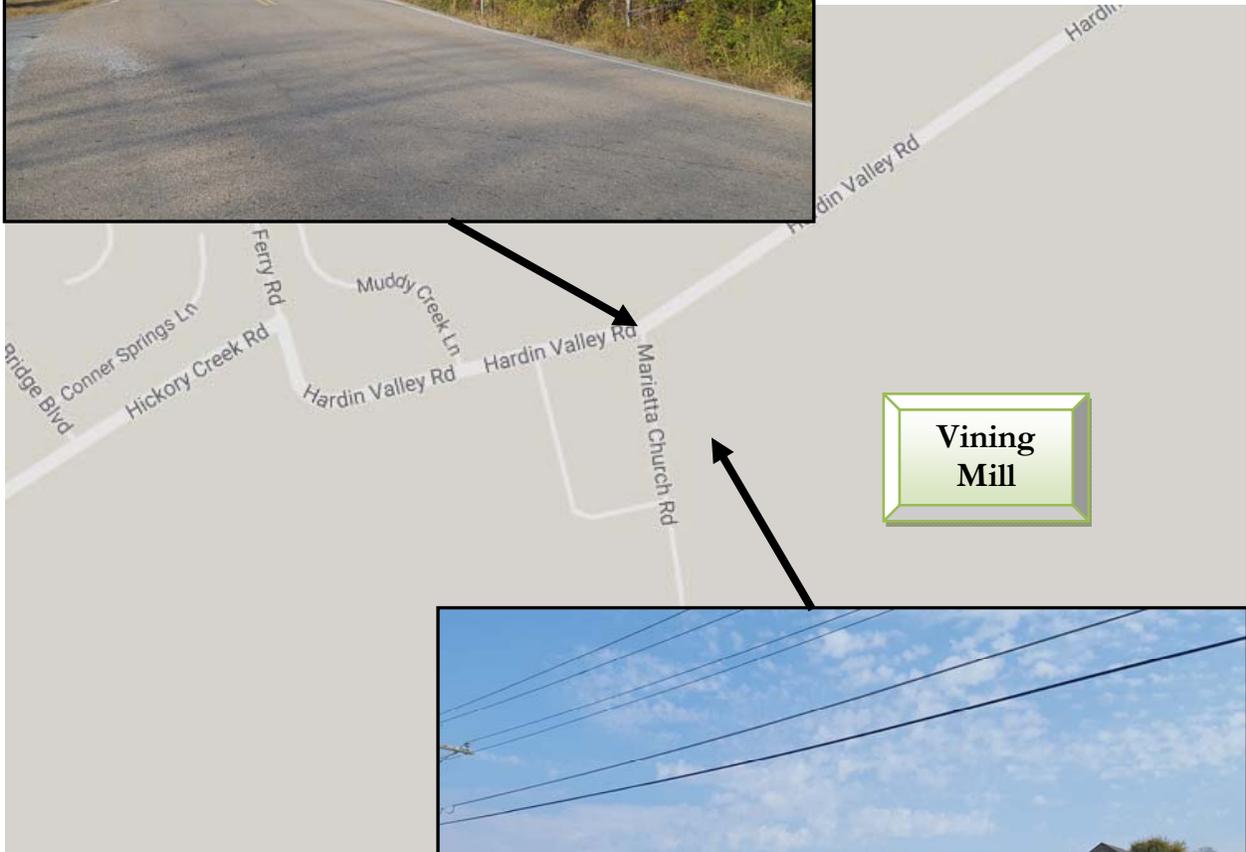
Vining Mill

View of Marietta Church Road at Hardin Valley Road
(Looking North)





**View of Hardin Valley
Road at Marietta
Church Road**
(Looking West)



**Vining
Mill**



**View of Site at
Marietta Church
Road**
(Looking East)

EXISTING TRAFFIC VOLUMES

In order to analyze the traffic impacts associated with the proposed future development, traffic counts were obtained on Hardin Valley Road at the intersection of Marietta Church Road. The traffic counts also included tabulating the turning movements at the intersection of Hardin Valley Road at Muddy Creek Lane which is located just west of the intersection of Hardin Valley Road and Marietta Church Road. Muddy Creek Lane is a relatively new local subdivision street with approximately 36 residences with a total of 41 lots. Muddy Creek Lane is a street within the Hunters Way subdivision. This subdivision has not been fully developed but is close to being completely built out. The turning movements at Muddy Creek Lane were counted and tabulated during the peak hours to help estimate future directional travel for the new studied subdivision.

The traffic counts on Hardin Valley Road at Marietta Church Road were obtained on Tuesday, November 1st, 2016 for a total of 6 hours. The counts were conducted during the morning and afternoon peak periods. The local schools were in session when the traffic counts were conducted. Based on the traffic volumes counted, the AM peak hour of traffic was observed at 7:15 - 8:15 at the intersection of Hardin Valley Road and Marietta Church Road. The PM peak hour was from 5:00 - 6:00 at the intersection. The manual tabulated traffic counts can be reviewed in Appendix B and the existing peak hour volumes are shown in Figure 3. The turning movements at Muddy Creek Lane during the AM and PM peak hour are also shown in Appendix B.

Capacity analyses were undertaken to determine the existing Level of Service (LOS) for the intersection of Hardin Valley Road at Marietta Church Road. The capacity analyses were calculated by following the methods outlined in the Highway Capacity Manual and using Synchro Traffic Software (Version 8). LOS is a qualitative measurement developed by the transportation profession of how well an intersection or roadway performs based on a driver's perception. LOS designations include LOS A through LOS F. The designation of LOS A signifies a roadway or intersection operating at best, while LOS F signifies road operations at the worst. The

A/B



C/D



E/F



(Source: FDOT)

Highway Capacity Manual (HCM) lists level of service criteria for unsignalized intersections and is presented in this report as Table 1. For unsignalized intersections, Level of Service is measured in terms of delay (in seconds). This measure is an attempt to quantify delay that includes travel time, driver discomfort, and fuel consumption. LOS for unsignalized intersections are only calculated for turning movements associated with stop or yield control and also for left turns on “un-controlled” major streets.

TABLE 1

LEVEL OF SERVICE AND DELAY FOR UNSIGNALIZED INTERSECTIONS



LEVEL OF SERVICE	DESCRIPTION	DELAY RANGE (seconds/vehicle)
A	Little or no delay	≤ 10
B	Short Traffic Delays	>10 and ≤15
C	Average Traffic Delays	>15 and ≤25
D	Long Traffic Delays	>25 and ≤35
E	Very Long Traffic Delays	>35 and ≤50
F	Extreme Traffic Delays	>50

Source: Highway Capacity Manual

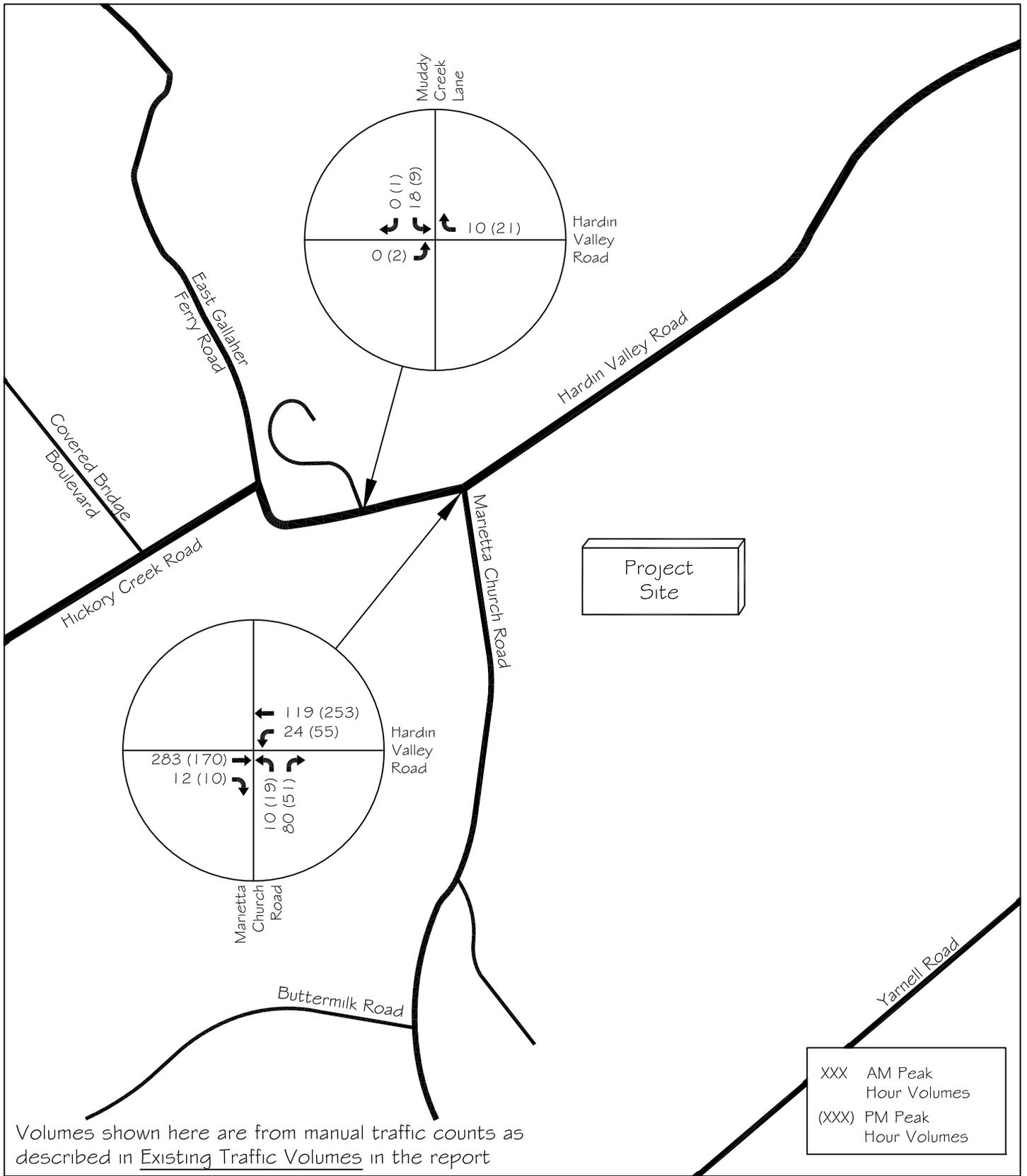
From the capacity calculations, the results from the existing peak hour traffic can be seen in Table 2 for the intersection. The intersection is shown with a LOS designation for the AM and PM peak hours in the table. Appendix C includes the worksheets from the capacity analyses for the existing peak hour traffic. For the intersection, the existing peak hour levels of service are shown to operate at a very good level during the AM and PM peak hours.

TABLE 2

2016 PEAK HOUR LEVEL OF SERVICE & DELAY - EXISTING

INTERSECTION	TRAFFIC CONTROL	APPROACH	LEVEL OF SERVICE		DELAY (seconds)	
			AM PEAK	PM PEAK	AM PEAK	PM PEAK
Hardin Valley Road at Marietta Church Road	Unsignalized	Westbound Left	A	A	1.8	1.8
		Northbound Left/Right	B	B	11.7	11.2

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2000 methodology



XXX AM Peak Hour Volumes
 (XXX) PM Peak Hour Volumes

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NORTH

FIGURE 3
 Vining Mill Subdivision
 2016 Peak Hour Traffic Volumes - EXISTING

BACKGROUND TRAFFIC VOLUMES

Background traffic volumes are estimates of non-development related traffic for a particular horizon or design year. Background traffic volume estimates represent the future condition the proposed study area is potentially subject to without the studied project being developed.

As previously stated, the build-out and full occupancy for this proposed new residential subdivision was assumed to occur in the year 2024. Traffic growth on Hardin Valley Road has exploded over the last 10 years due to the construction of the Hardin Valley schools and the expansion of residential development in the area. A background traffic growth rate was determined by obtaining and analyzing the nearby traffic counts in the area located on Hardin Valley Road and Marietta Church Road and as provided by the Knoxville Regional TPO. This historical data is located in Appendix A. The traffic data at these count stations indicate that the traffic has grown annually at 3% on Marietta Church Road and 5% on Hardin Valley Road.

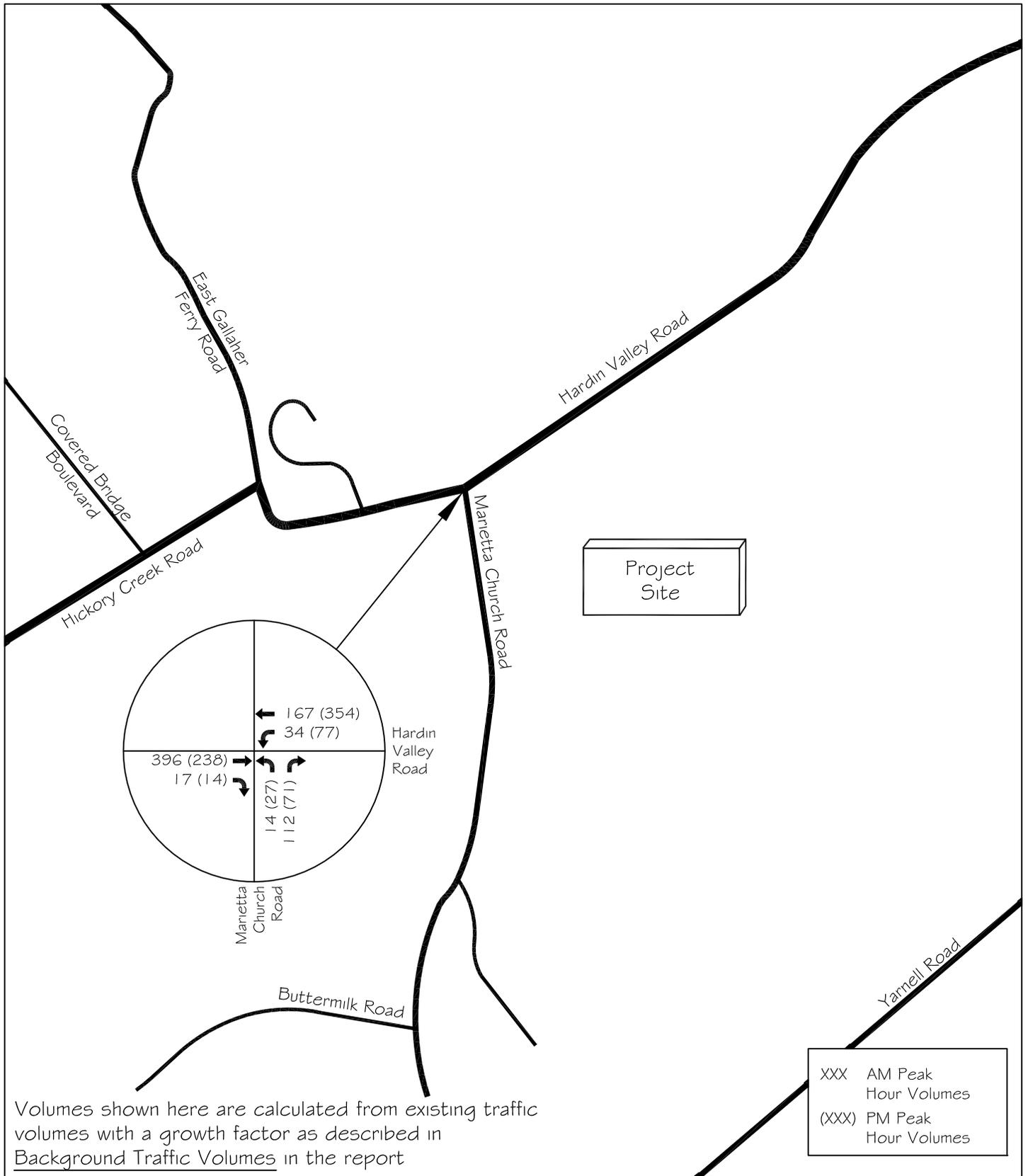
Therefore, to insure a reasonable estimate for this study, a 5% growth was used to take into account for the future development in the area and rising travel volumes. Background traffic volumes for this project were calculated by applying an annual growth rate to the existing traffic volumes shown in Figure 3. The results of this growth rate application to the existing traffic volumes can be seen in Figure 4 for the year 2024.

The application of background traffic to the existing intersection did not change the LOS designations from the existing traffic analysis for the AM and PM peak hours. Table 3 reports the LOS results and Appendix C contains the LOS worksheets for the background conditions. It is important to point out that these projected LOS designations for the intersection would potentially exist in the future even without the proposed residential subdivision being developed.

TABLE 3
2024 PEAK HOUR LEVEL OF SERVICE & DELAY - BACKGROUND

INTERSECTION	TRAFFIC CONTROL	APPROACH	LEVEL OF SERVICE		DELAY (seconds)	
			AM PEAK	PM PEAK	AM PEAK	PM PEAK
Hardin Valley Road at Marietta Church Road	 Unsignalized	Westbound Left	A	A	2.1	2.1
		Northbound Left/Right	B	B	14.7	13.9

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2000 methodology



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FIGURE 4
 Vining Mill Subdivision
 2024 Peak Hour Traffic Volumes - BACKGROUND

TRIP GENERATION

The estimated amount of traffic that will be generated by the proposed residential subdivision was calculated based upon rates and equations for peak hour trips provided by Trip Generation Manual, 9th Edition, a publication of the Institute of Transportation Engineers (ITE). A generated trip is a single or one-direction vehicle movement that is either entering or exiting the study site. The Trip Generation Manual is the traditional and most-sourced resource for determining trip generation rates when traffic impact studies are produced. The Manual lists and includes data for a variety of land uses. The data from ITE for the land use below is shown in Appendix D. A summary of this information is presented in the following table:

**TABLE 4
TRIP GENERATION FOR VINING MILL**

ITE LAND USE CODE	LAND USE DESCRIPTION	UNITS	GENERATED DAILY TRAFFIC	GENERATED TRAFFIC AM PEAK HOUR			GENERATED TRAFFIC PM PEAK HOUR		
				ENTER	EXIT	TOTAL	ENTER	EXIT	TOTAL
#210	Single-Family Detached Housing	190 Lots	1,896	25%	75%		63%	37%	
				36	107	143	118	70	188
Total New Volume Site Trips			1,896	36	107	143	118	70	188

ITE Trip Generation Manual, 9th Edition

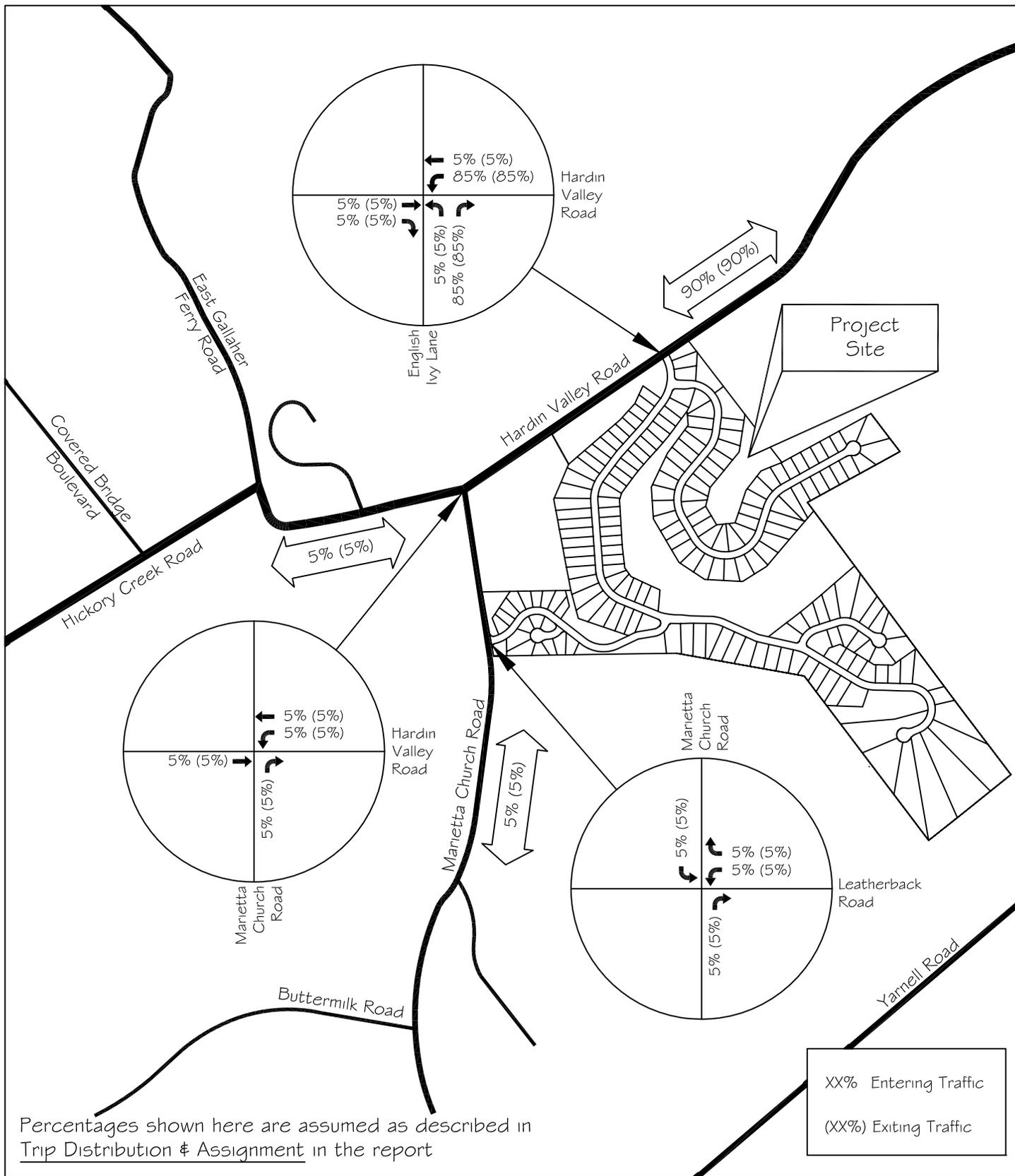
Based on these calculations, it is expected that 36 vehicles will enter the development, 107 will exit, for a total of 143 new generated trips during the AM Peak Hour (7:15 – 8:15 AM) in the year 2024. Similarly, it is expected that 118 vehicles will enter the development, 70 will exit, for a total of 188 new generated trips during the PM Peak Hour (5:00 – 6:00 PM) in the year 2024. The calculated trips generated for an average day are expected to be approximately 1,896 vehicles for the entire 190 lot development.

TRIP DISTRIBUTION & ASSIGNMENT

Figure 5 shows the projected distribution for traffic entering/exiting the new residential subdivision during the future peak hours at the new proposed road entrances/exits on Hardin Valley Road and Marietta Church Road. The percentages shown only pertain to the new trips generated by the new residential dwellings in the subdivision.

There are a variety of nearby developments that will potentially “attract” the projected generated traffic to and from the new subdivision; the largest being the Hardin Valley Academy (high school), Hardin Valley Elementary School, Pellissippi State Community College, and the soon to be built Hardin Valley Middle School. Pellissippi Parkway will be the major adjacent access for further destinations in the surrounding Knoxville area. As can be seen in Figure 5, the vast majority of trips generated by the development are assumed to utilize the new proposed intersection on Hardin Valley Road at English Ivy Lane.

The projected trip distributions are based on the existing traffic movements at the examined roadway and also surmised from the aforementioned surrounding concentrations of development and population. The turning movements that were counted at the intersection of Hardin Valley Road at Muddy Creek Lane were also used to help assume projected trip distributions. Figure 6 shows the Traffic Assignment of the computed trips that will be generated by the development (as shown in Table 4) that is applied to the various intersection movements based on the assumed distribution of trips shown in Figure 5.



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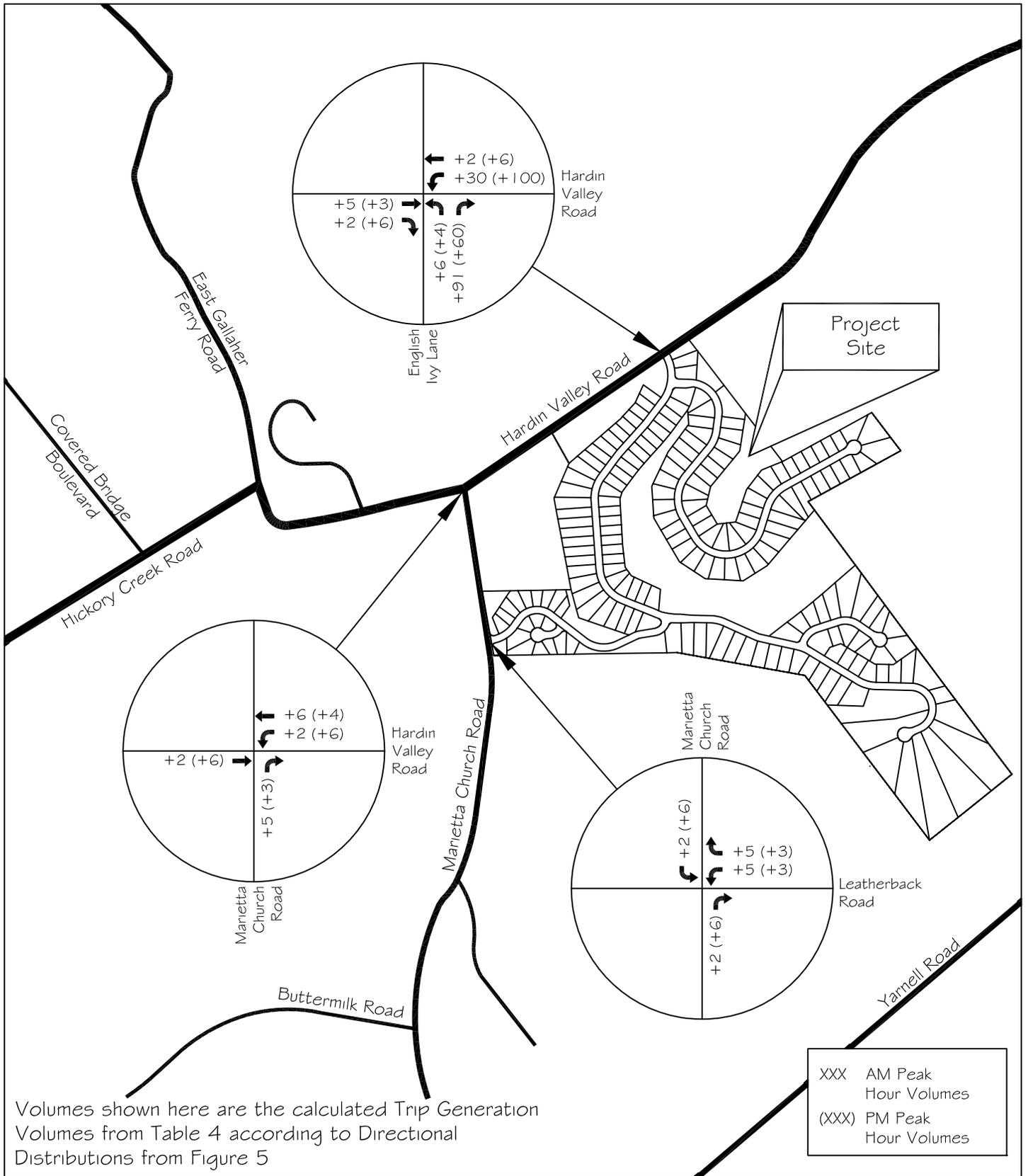
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FIGURE 5

Vining Mill Subdivision

Directional Distribution of
 Generated Traffic for Vining Hill



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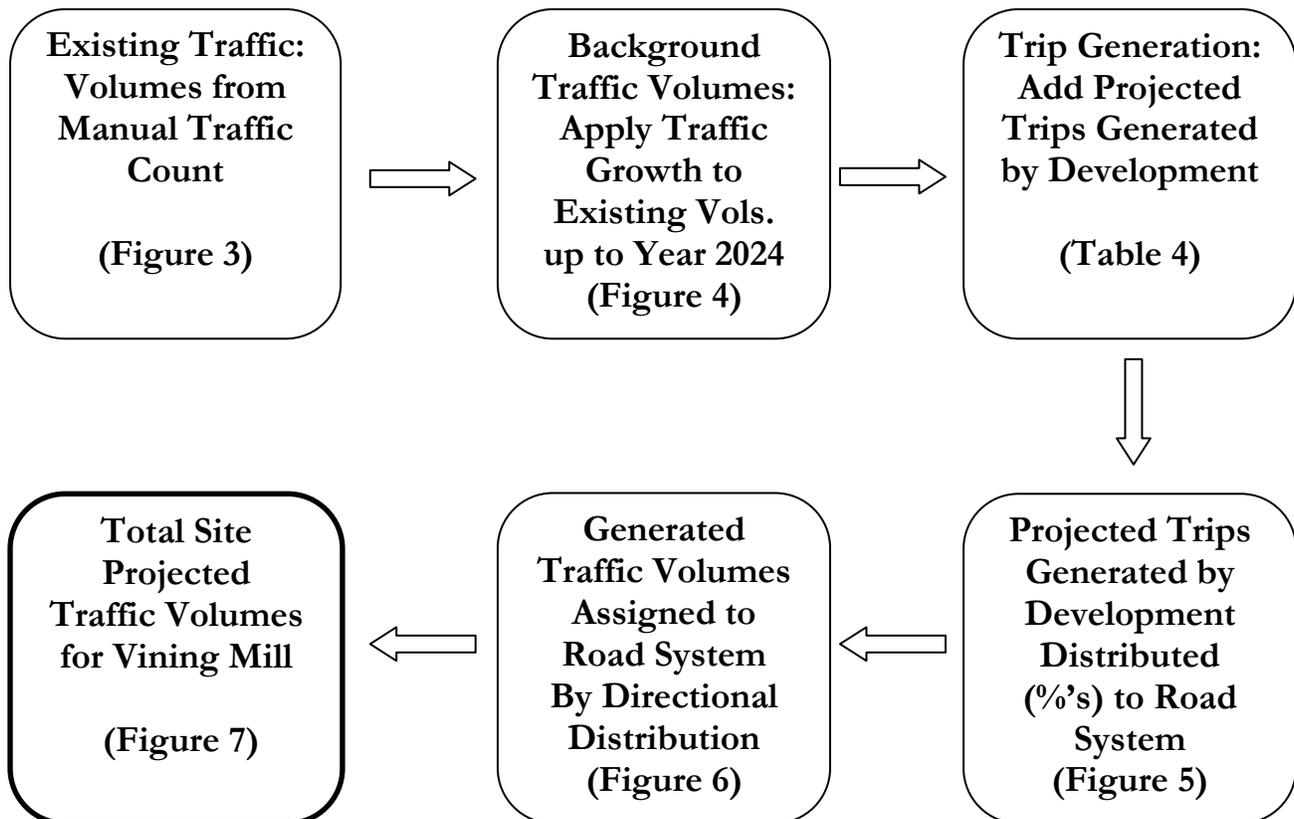
FIGURE 6

Vining Mill Subdivision

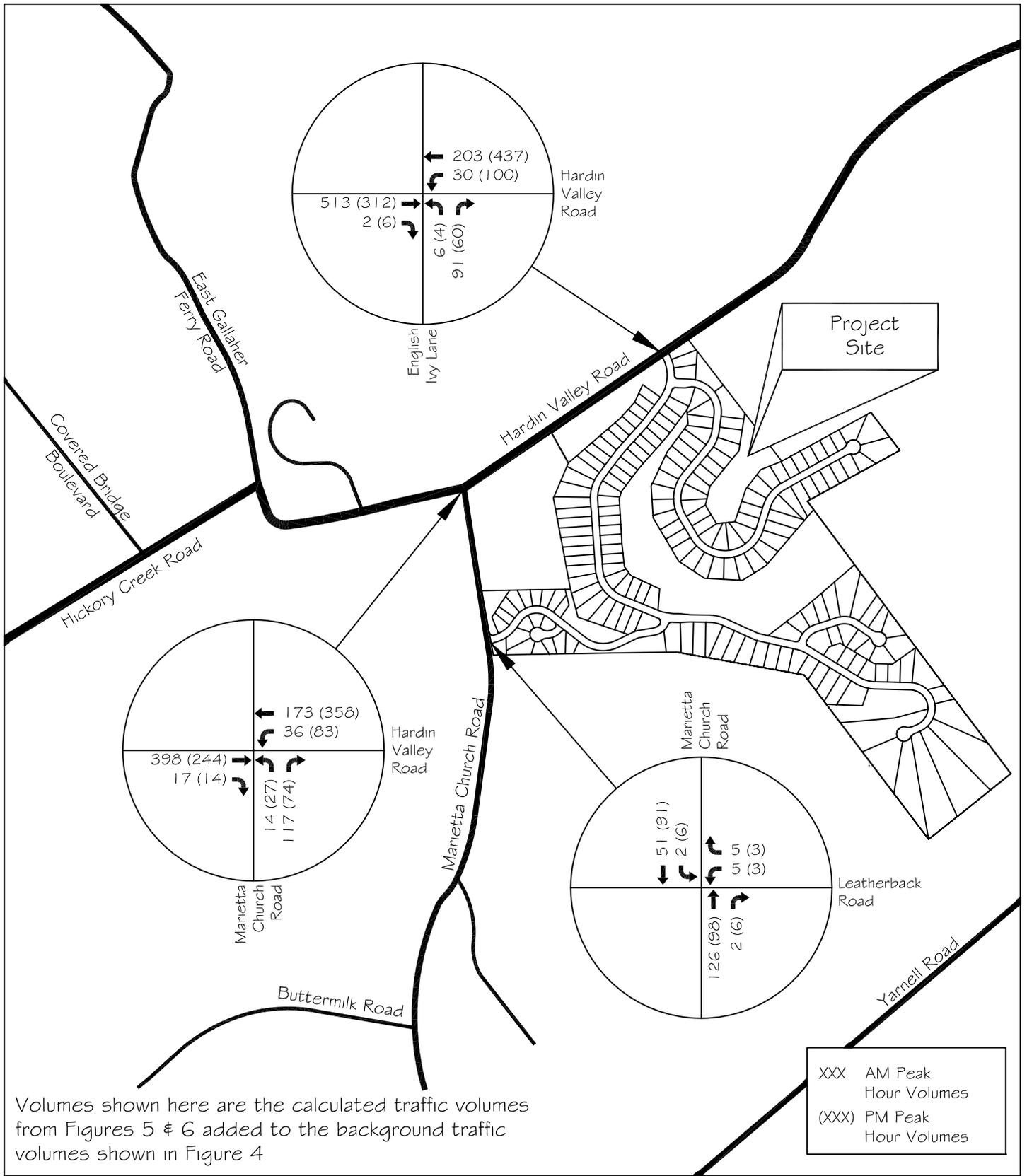
Traffic Assignment of
 Generated Traffic for Vining Hill

PROJECTED TRAFFIC VOLUMES

Overall, several additive steps were taken to calculate the total future projected traffic volumes at the studied unsignalized intersections when the residential subdivision is fully constructed and occupied (by 2024). The steps are illustrated below for clarity:



To calculate the total future projected traffic volumes at the proposed intersections on Hardin Valley Road and Marietta Church Road, application of the calculated peak hour traffic (from Table 4) generated by the new proposed subdivision were added to the 2024 background traffic volumes (shown in Figure 4) in accordance to the predicted directional distributions and assignments (shown in Figure 5 and 6). This procedure was necessary to obtain the total projected traffic volumes at the time the development is fully built-out and fully occupied by the year 2024. Figure 7 shows the projected AM and PM peak hour volumes at the studied intersections for the year 2024.



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FIGURE 7

Vining Mill Subdivision

2024 Peak Hour Traffic Volumes - PROJECTED

Capacity analyses were once again undertaken to determine the projected Level of Service (LOS) for the studied intersections. Appendix C includes the worksheets for these capacity analyses.

The results of the capacity calculations of the projected peak hour traffic can be seen in Table 5 for the intersections. For the intersections, the peak hour levels of service are shown to operate at very good levels during both the AM and PM peak hours. The calculated delay for the intersection of Hardin Valley Road and Marietta Church Road did not substantially degrade from the previous background capacity calculations.

**TABLE 5
2024 PEAK HOUR LEVEL OF SERVICE & DELAY - PROJECTED**

INTERSECTION	TRAFFIC CONTROL	APPROACH	LEVEL OF SERVICE		DELAY (seconds)	
			AM PEAK	PM PEAK	AM PEAK	PM PEAK
Hardin Valley Road at Marietta Church Road	 Unsignalized	Westbound Left	A	A	2.2	2.2
		Northbound Left/Right	B	B	15.0	14.2
Hardin Valley Road at English Ivy Road	 Unsignalized	Westbound Left	A	A	1.4	2.4
		Northbound Left/Right	B	B	13.9	11.5
Marietta Church Road at Leatherback Road	 Unsignalized	Westbound Left/Right	A	A	9.3	9.3
		Southbound Left	A	A	0.3	0.5

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2000 methodology

SPOT SPEED STUDY

As a further investigation of the study area, a spot speed study was also conducted. The spot speed study was conducted on Hardin Valley Road and on Marietta Church Road to sample and tabulate the existing vehicle speeds along the road in the vicinity of the proposed development. The equipment used for the speed study was a Bushnell Speedster III Radar Speed Gun. The results of the study indicate that the majority of the traffic along Hardin Valley Road travels at a greater speed than the posted speed limit. The posted speed limit for Hardin Valley Road is 40 mph. The results of the spot speed study indicate that the observed 85th percentile speed was just at 50 mph near the proposed intersection for the subdivision on Hardin Valley Road. The posted speed limit for Marietta Church Road is 30 mph. The results of the spot speed study indicate that the observed 85th percentile speed was just at 50 mph for southbound traffic near the proposed intersection for the subdivision on Marietta Church Road and 43 mph for northbound traffic. The differences between the northbound and southbound traffic speeds are due to the proximity to the intersection of Marietta Church Road and Hardin Valley Road. The spot speed field observations are provided in Appendix E.

EVALUATION OF TURN LANE THRESHOLDS

The proposed intersections to be located at Hardin Valley Road and on Marietta Church Road for the development were evaluated for the need for separate left or right turn lanes into the development. Based on the projected traffic volumes at the subdivision entrance on Hardin Valley Road at English Ivy Lane it does appear that a separate westbound left turn lane into the development will be warranted based on PM peak volumes. A separate right turn lane into the development at Hardin Valley Road at English Ivy Lane is not warranted. Separate turn lanes on Marietta Church Road at Leatherback Road are also not warranted. These determinations were made by using “Knox County’s Access Control and Driveway Design Policy” for turn lane requirements. The Knox County turn lane policy worksheet is located in Appendix F.

The design policy for turn lane warrants relate volume thresholds based on prevailing speeds for two-lane roadways. The speed classification that was chosen for this evaluation was based on the spot speed studies that showed the 85th percentile speed was 50 mph on both roads. Therefore, this study evaluation used the Knox County classification for speeds of 46 to 55 mph and the calculated projected volumes. It should be noted that the left turn lane on

Hardin Valley Road would also be warranted based on the projected volumes and the posted speed limit of 40 mph. The Knox County turn lane worksheet for speeds of 36 to 45 mph is also included in Appendix F.

CONCLUSIONS AND RECOMMENDATIONS

The following is an overview of recommendations to minimize the traffic impacts of the development with the surrounding road system while achieving an acceptable level of traffic flow and safety.

1) **Hardin Valley Road at English Ivy Lane:** From the capacity calculations, it has been shown (Table 5) that the traffic movements at this new intersection should operate very well during the AM and PM peak periods when the development is complete and fully occupied by the year 2024. This intersection is being projected to be the major entrance into the development with respect to traffic volumes due to it being located on Hardin Valley Road.

1a) **From the capacity calculations, a separate westbound left turn lane on Hardin Valley Road at English Ivy Lane into the development is required due to the projected volumes turning into the development with large opposing traffic volumes during the PM peak hour.** This was determined by using “Knox County’s Access Control and Driveway Design Policy” for turn lane requirements. **The left turn lane storage bay length should be a minimum of 100 feet.** This was estimated by using charts for left-turn storage at non-signalized intersections from TDOT. These charts are located in Appendix G. The design engineer should follow TDOT’s requirements for taper lengths on Hardin Valley Road while meeting this storage bay length. If the lane is not constructed at the beginning of construction, based on the calculations and traffic projections, it is estimated that this left turn storage lane on Hardin Valley Road would be warranted approximately prior to the 60th home being constructed in the subdivision. It may be necessary to be constructed prior to this forecasted milestone if the projected volumes rise quicker than anticipated.

During the projected PM peak hour when the proposed development warrants a 100 foot separate left turn lane, the traffic volumes generated by the new development should not result in queues that would extend past the proposed turn lane length on Hardin Valley Road. To estimate these projected lengths, SimTraffic (Version 8) software was utilized which performs micro-simulation

and animation of vehicular traffic and also calculates various vehicle parameters such as intersection queue lengths. The queue results from the SimTraffic software are located in Appendix H.

- 1b) From the results of the capacity calculations, separate northbound left and right turn lanes are not required at the intersection for exiting vehicles out of the development at Hardin Valley Road. Based on the calculations, a single exiting lane should be sufficient.

- 1c) **Based on a speed of 50 mph on Hardin Valley Road (85th percentile observed speed for the study was 50.5 mph); the recommended intersection sight distance requirement is 500 feet.** There was an attempt to approximately measure this distance at the site with the use of a rolling wheel. However, due to safety concerns at the time, this was not measured. The site designer should ensure that these sight distance lengths are met and they should be labeled on the plans. A land surveyor should measure the sight distance available and verify the required distances. The overall required sight distance should be measured at the intersection at a minimum of 15 feet off of the edge of the roadway per Knox County subdivision regulations (Section 62-88). There is a fairly significant horizontal curve and vertical curve on Hardin Valley Road just to the east of the proposed intersection of Hardin Valley Road and English Ivy Lane. There is some concern that these existing roadway curves could interfere with the required sight distance looking towards the east at the proposed intersection. Based on visual observation, sight distance looking to the west should be adequate at the proposed intersection but needs to be verified by a land surveyor.

- 1d) **It is recommended that the main entrance approach at the intersection with Hardin Valley Road be designed and constructed with a 24" white stop bar and with a Stop Sign (R1-1).**

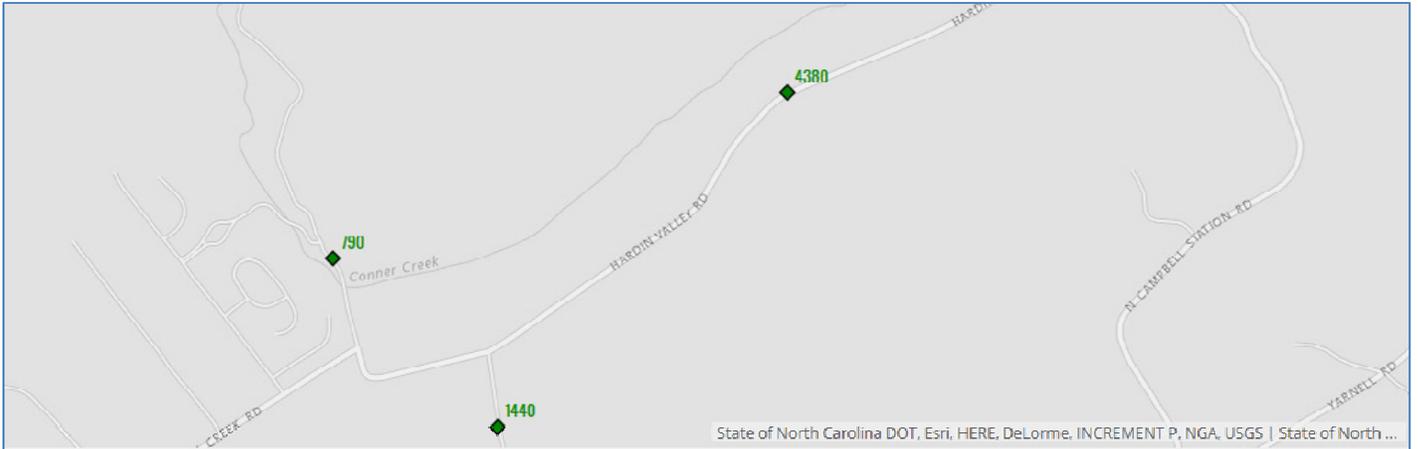
- 1e) Intersection sight distance at the new proposed main entrance at Hardin Valley Road must not be impacted by new signage, future landscaping or existing vegetation.

- 2) **Marietta Church Road at Leatherback Road:** From the capacity calculations, it has been shown (Table 5) that the traffic movements at this new intersection should operate very well during the AM and PM peak periods when the development is complete and fully occupied by the year 2024. This intersection is being projected to be the minor entrance into the development with respect to traffic volumes.
- 2a) From the capacity calculations, a separate left turn lane on Marietta Church Road at Leatherback Road into the development is not required due to the projected low volumes turning into the development and low opposing volumes. This was determined by using “Knox County’s Access Control and Driveway Design Policy” for turn lane requirements.
- 2b) From the results of the capacity calculations, separate westbound left and right turn lanes are not required at the intersection for exiting vehicles out of the development at Marietta Church Road.
- 2c) **Based on a speed of 50 mph on Hardin Valley Road (85th percentile observed speed was 50 mph heading southbound and 43 mph heading northbound), the recommended intersection sight distance requirement is 500 feet.** Using a rolling wheel, the measured sight distance at the proposed new intersection on Marietta Church Road looking north was observed to be in excess of 1,000 feet at the roadway edge. Sight distance at the proposed new intersection on Marietta Church Road looking south was measured to be at approximately 450 feet at the roadway edge. This sight distance measurement could be increased if it were measured 15 feet off of the edge of the roadway since the proposed entrance is located on the outside radius of the horizontal curve on Marietta Church Road (measurement 15 feet off of the roadway pavement was not possible during the field review due to vegetation). Some additional sight distance might also be gained by clearing some of the roadside within the right-of-way in the inside radius of this same horizontal curve just to the south on Marietta Church Road. The site designer should ensure that these sight distance lengths are met and they should be labeled on the plans. A land surveyor should measure the sight distance available and verify these estimates.

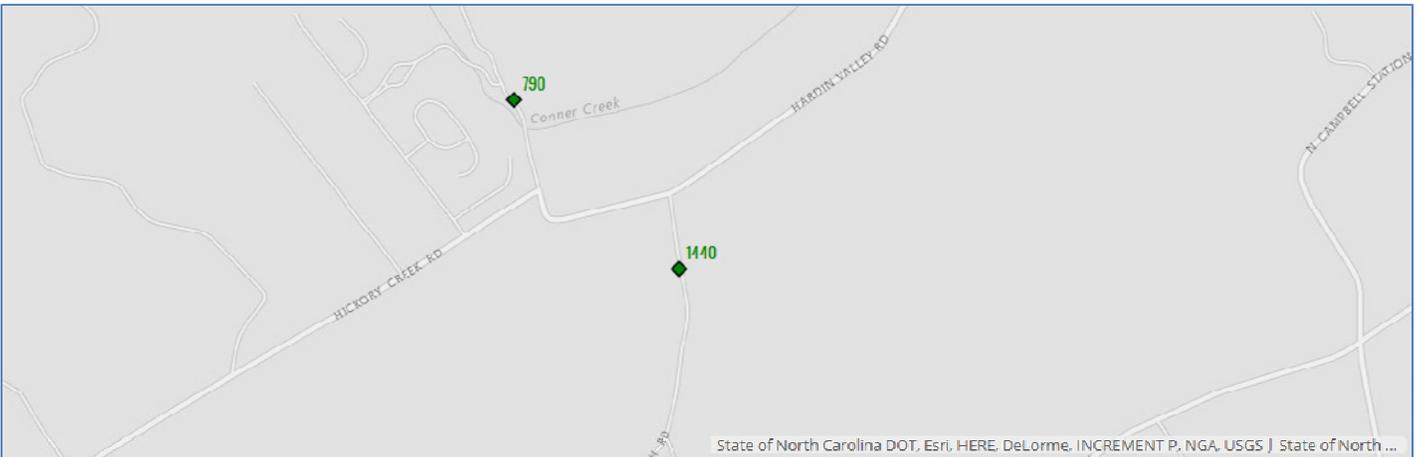
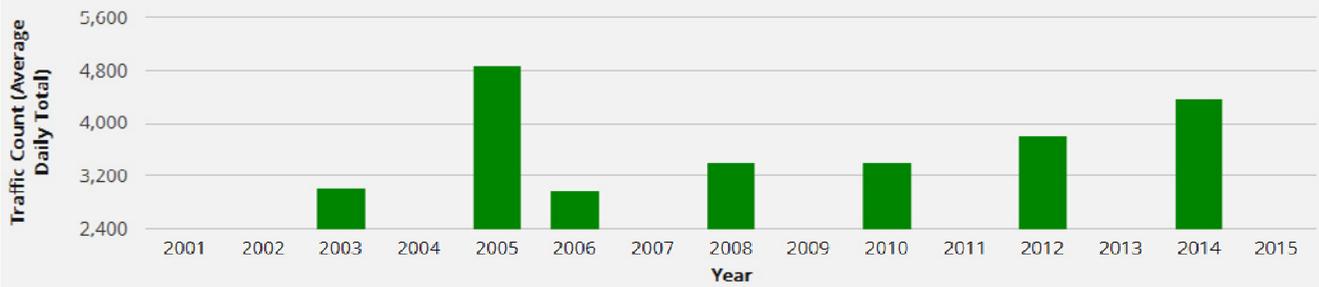
- 2d) **It is recommended that the main entrance approach at the intersection with Marietta Church Road be designed and constructed with a 24” white stop bar and with a Stop Sign (R1-1).**
- 2e) Intersection sight distance at the new proposed entrance at Marietta Church Road must not be impacted by new signage, future landscaping or existing vegetation.
- 3) **Vining Mill Internal Drives:** The current layout plans show 5 new roadways being constructed within the development as shown on Figure 2a. English Ivy Lane will be the connecting road to Hardin Valley Road and Leatherback Road will be the connecting road to Marietta Church Road.
- 3a) **Stop Signs (R1-1) should be installed at internal road intersections.** A Stop Sign should be installed at the Boston Ivy Lane approach at the intersection with English Ivy Lane. A Stop Sign should also be installed at the Leatherback Road approach at the intersection of English Ivy Lane and the approach of Velvet Leaf Lane intersection at English Ivy Lane. Finally, a Stop Sign should be installed at the Needlegrass Lane approach at Leatherback Road.
- 3b) **It is recommended that the internal speed limit for Vining Mill Subdivision be 25 mph and this speed limit be posted on signage at the front of the residential subdivision and also as required.**
- 3c) **Sight distance at all of the new internal “T” intersections must not be impacted by new signage or future landscaping.** For an assumed posted 25 mph speed for the internal development streets, the intersection sight distance requirement is 250 feet. The road layout designer should insure that these sight distance lengths are met, maximized, and they should be labeled on the plans.
- 3d) Sidewalks installed within the development should have appropriate ADA compliant ramps at all of the internal intersections corners.

- 3e) All road grade and intersection elements internally and externally should be designed to AASHTO, TDOT, and Knox County Engineering specifications and guidelines to ensure proper operation.
- 3f) **Traffic calming measures might be needed for this development.** The proposed English Ivy Lane horizontal alignment within the development has some stretches of straight sections and has some curvature. It is expected due to the existing topography that there could also be some fairly significant vertical curves. The possible need for traffic calming measures inside the project for English Ivy Lane will need to be coordinated with Knox County Engineering and Public Works during the detailed design phase. Speed humps could be considered to lower speeds through the subdivision.
- 4) **Hardin Valley Road at Marietta Church Road:** No specific changes or mitigations are recommended for this existing intersection at this time based on the projected calculations.

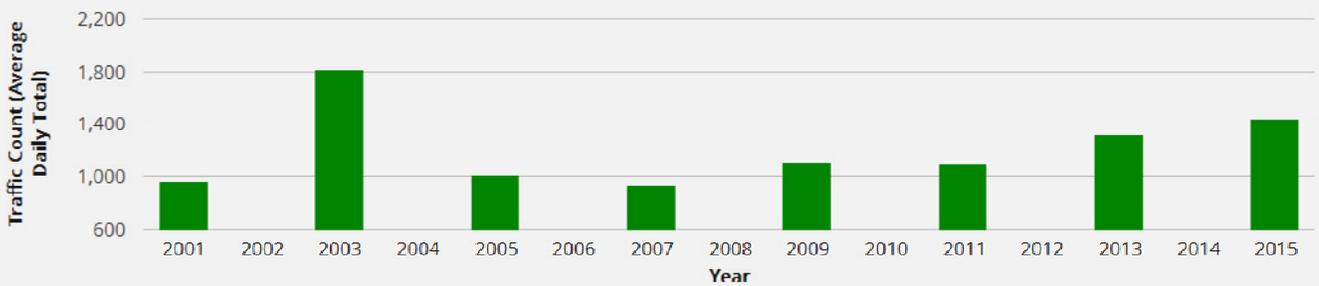
APPENDIX A
HISTORICAL TRAFFIC COUNT DATA



Hardin Valley Rd - E of Marietta Church Rd



Marietta Church Rd - S of Hardin Valley Rd

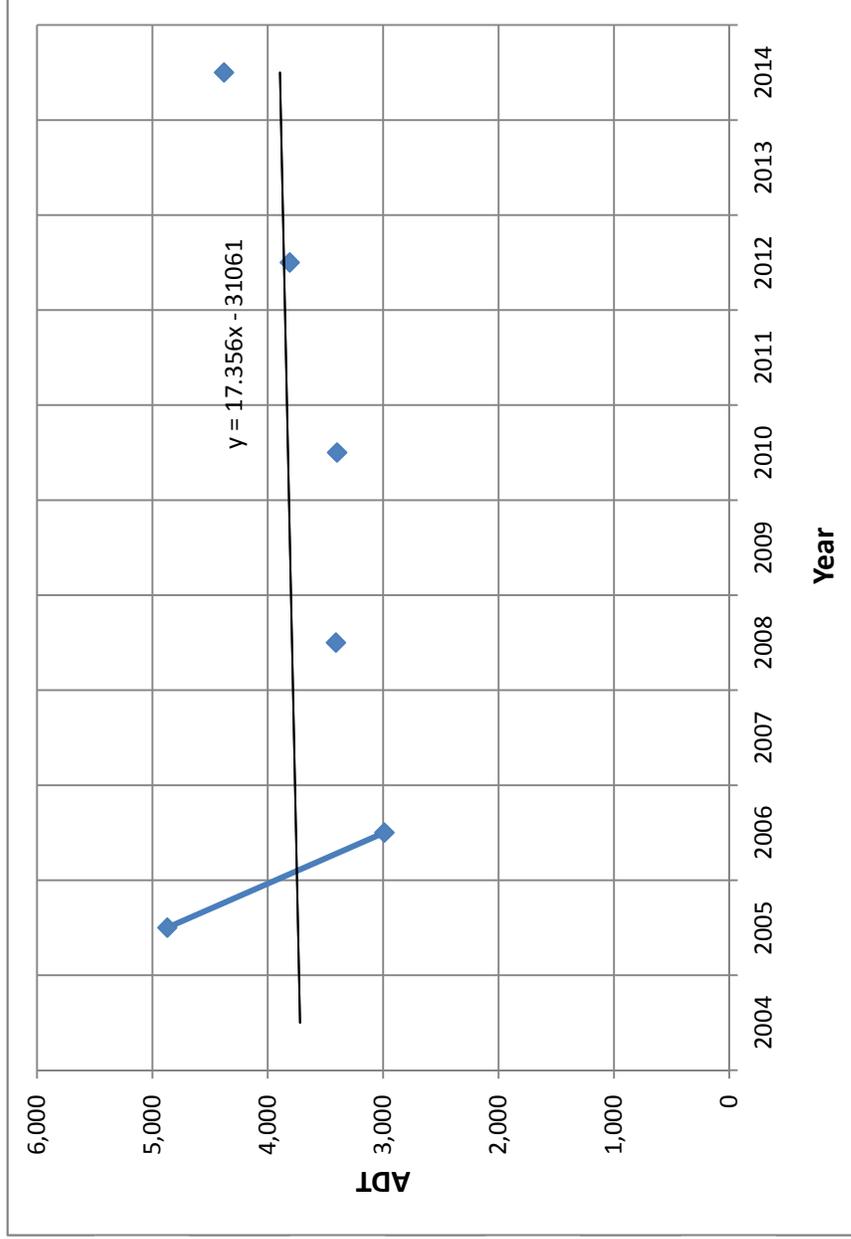


Historical Traffic Counts

Organization: Knoxville Regional TPO

Station ID #:

Location: Hardin Valley Road - East of Marietta Church Road



YEAR	ADT	Trendline
2004	4,871	
2005	2,990	
2006	3,410	
2007	3,400	
2008	3,810	
2009	4,380	
2010	4,380	
2011	4,380	
2012	4,380	
2013	4,380	
2014	4,380	

2006 - 2014 Growth Rate = 46.5%

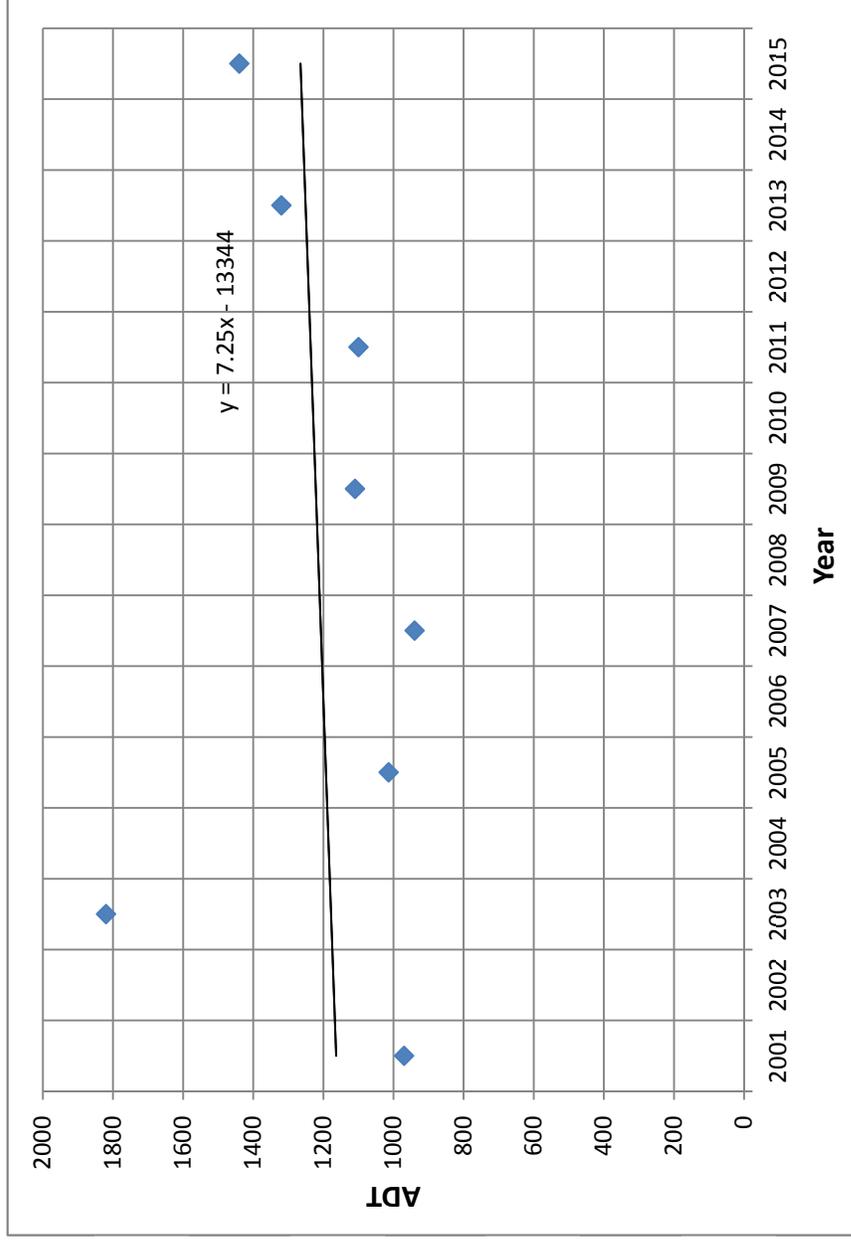
Annual Growth Rate = 4.9%

Historical Traffic Counts

Organization: Knoxville Regional TPO

Station ID #:

Location: Marietta Church Road - South of Hardin Valley Road



YEAR	ADT
2001	970
2002	1820
2003	1014
2004	940
2005	1110
2006	1100
2007	1320
2008	1440
2009	1440
2010	1440
2011	1440
2012	1440
2013	1440
2014	1440
2015	1440

2001 - 2015 % Growth = 48.5%

Annual Growth Rate = 2.9%

APPENDIX B
MANUAL TRAFFIC COUNT DATA

TRAFFIC COUNT DATA

Major Street: Hardin Valley Road (EB-WB)
 Minor Street: Marietta Church Road (NB)
 Traffic Control: Stop Control on Minor Street

11/1/2016 (Tuesday)
 Warm/Sunny
 Conducted by: Ajax Engineering

Primary Movement: Vehicles

TIME BEGIN	WESTBOUND		NORTHBOUND		EASTBOUND		VEHICLE TOTAL	PEAK HOUR
	LT	THRU	LT	RT	THRU	RT		
7:00 AM	4	13	2	17	56	1	93	
7:15 AM	3	26	3	15	85	2	134	7:15 AM - 8:15 AM
7:30 AM	9	31	4	17	78	5	144	
7:45 AM	7	26	3	23	54	3	116	
8:00 AM	5	36	0	25	66	2	134	
8:15 AM	6	35	2	19	50	1	113	
8:30 AM	4	44	2	18	45	2	115	
8:45 AM	3	20	1	10	52	1	87	
TOTAL	41	231	17	144	486	17	936	
2:00 PM	11	41	5	5	32	1	95	
2:15 PM	4	40	2	5	25	2	78	
2:30 PM	5	27	5	5	38	2	82	
2:45 PM	13	45	3	2	45	0	108	
3:00 PM	13	40	4	10	28	3	98	
3:15 PM	6	39	2	6	40	0	93	
3:30 PM	16	38	7	8	25	2	96	
3:45 PM	24	55	4	4	31	2	120	
4:00 PM	14	42	3	3	28	6	96	
4:15 PM	9	54	2	6	31	2	104	
4:30 PM	9	48	3	6	37	7	110	
4:45 PM	7	61	6	6	35	2	117	
5:00 PM	13	60	2	19	37	3	134	5:00 PM - 6:00 PM
5:15 PM	16	66	5	17	46	0	150	
5:30 PM	14	55	7	6	44	5	131	
5:45 PM	12	72	5	9	43	2	143	
TOTAL	186	783	65	117	565	39	1755	

AM Peak Hour 7:15 AM - 8:15 AM

TIME BEGIN	WESTBOUND		NORTHBOUND		EASTBOUND	
	LT	THRU	LT	RT	THRU	RT
7:15 AM	3	26	3	15	85	2
7:30 AM	9	31	4	17	78	5
7:45 AM	7	26	3	23	54	3
8:00 AM	5	36	0	25	66	2
TOTAL	24	119	10	80	283	12
PHF	0.67	0.83	0.63	0.80	0.83	0.60

PM Peak Hour 5:00 PM - 6:00 PM

TIME BEGIN	WESTBOUND		NORTHBOUND		EASTBOUND	
	LT	THRU	LT	RT	THRU	RT
5:00 PM	13	60	2	19	37	3
5:15 PM	16	66	5	17	46	0
5:30 PM	14	55	7	6	44	5
5:45 PM	12	72	5	9	43	2
TOTAL	55	253	19	51	170	10
PHF	0.86	0.88	0.68	0.67	0.92	0.50

TRAFFIC COUNT DATA

Major Street: Hardin Valley Road (EB-WB)
 Minor Street: Muddy Creek Lane (SB)
 Traffic Control: Stop Control on Minor Street

11/1/2016 (Tuesday)
 Warm/Sunny
 Conducted by: Ajax Engineering

Primary Movement: Vehicles

TIME BEGIN	WESTBOUND		SOUTHBOUND		EASTBOUND		VEHICLE TOTAL	PEAK HOUR
	THRU	RT	LT	RT	LEFT	THRU		
7:00 AM								
7:15 AM		<i>2</i>	<i>6</i>	<i>0</i>	<i>0</i>		<i>8</i>	
7:30 AM		<i>1</i>	<i>4</i>	<i>0</i>	<i>0</i>		<i>5</i>	
7:45 AM		<i>2</i>	<i>5</i>	<i>0</i>	<i>0</i>		<i>7</i>	
8:00 AM		<i>5</i>	<i>3</i>	<i>0</i>	<i>0</i>		<i>8</i>	
8:15 AM								
8:30 AM								
8:45 AM								
TOTAL		10	18	0	0		28	
2:00 PM								
2:15 PM								
2:30 PM								
2:45 PM								
3:00 PM								
3:15 PM								
3:30 PM								
3:45 PM								
4:00 PM								
4:15 PM								
4:30 PM								
4:45 PM								
5:00 PM		<i>2</i>	<i>1</i>	<i>0</i>	<i>1</i>		<i>4</i>	
5:15 PM		<i>5</i>	<i>1</i>	<i>0</i>	<i>0</i>		<i>6</i>	
5:30 PM		<i>7</i>	<i>4</i>	<i>0</i>	<i>1</i>		<i>12</i>	
5:45 PM		<i>7</i>	<i>3</i>	<i>1</i>	<i>0</i>		<i>11</i>	
TOTAL		21	9	1	2		33	

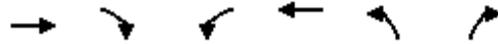
APPENDIX C
CAPACITY ANALYSES -
HCM WORKSHEETS
(SYNCHRO 8)

HCM Unsignalized Intersection Capacity Analysis 2: Marietta Church Road & Hardin Valley Road



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	→			←	↔	↔
Volume (veh/h)	283	12	24	119	10	80
Sign Control	Free			Free	Stop	
Grade	2%			-2%	-2%	
Peak Hour Factor	0.83	0.60	0.67	0.83	0.63	0.80
Hourly flow rate (vph)	341	20	36	143	16	100
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			361		566	351
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			361		566	351
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		97	86
cM capacity (veh/h)			1198		475	697
Direction, Lane #	EB 1	WB 1	NB 1			
Volume Total	361	179	116			
Volume Left	0	36	16			
Volume Right	20	0	100			
cSH	1700	1198	655			
Volume to Capacity	0.21	0.03	0.18			
Queue Length 95th (ft)	0	2	16			
Control Delay (s)	0.0	1.8	11.7			
Lane LOS		A	B			
Approach Delay (s)	0.0	1.8	11.7			
Approach LOS			B			
Intersection Summary						
Average Delay			2.6			
Intersection Capacity Utilization			38.7%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis 2: Marietta Church Road & Hardin Valley Road



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	→			←	↘	↙
Volume (veh/h)	170	10	55	253	19	51
Sign Control	Free			Free	Stop	
Grade	2%			-2%	-2%	
Peak Hour Factor	0.92	0.50	0.86	0.88	0.68	0.67
Hourly flow rate (vph)	185	20	64	288	28	76
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			205		610	195
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			205		610	195
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			95		94	91
cM capacity (veh/h)			1367		440	852
Direction, Lane #	EB 1	WB 1	NB 1			
Volume Total	205	351	104			
Volume Left	0	64	28			
Volume Right	20	0	76			
cSH	1700	1367	680			
Volume to Capacity	0.12	0.05	0.15			
Queue Length 95th (ft)	0	4	13			
Control Delay (s)	0.0	1.8	11.2			
Lane LOS		A	B			
Approach Delay (s)	0.0	1.8	11.2			
Approach LOS			B			
Intersection Summary						
Average Delay			2.7			
Intersection Capacity Utilization			40.1%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis 2: Marietta Church Road & Hardin Valley Road



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	→			←	↘	↙
Volume (veh/h)	396	17	34	167	14	112
Sign Control	Free			Free	Stop	
Grade	2%			-2%	-2%	
Peak Hour Factor	0.83	0.60	0.67	0.83	0.63	0.80
Hourly flow rate (vph)	477	28	51	201	22	140
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			505		794	491
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			505		794	491
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			95		94	76
cM capacity (veh/h)			1059		343	582

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	505	252	162
Volume Left	0	51	22
Volume Right	28	0	140
cSH	1700	1059	531
Volume to Capacity	0.30	0.05	0.31
Queue Length 95th (ft)	0	4	32
Control Delay (s)	0.0	2.1	14.7
Lane LOS		A	B
Approach Delay (s)	0.0	2.1	14.7
Approach LOS			B

Intersection Summary			
Average Delay		3.2	
Intersection Capacity Utilization	50.2%		ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis

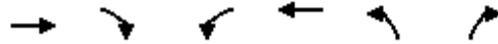
2: Marietta Church Road & Hardin Valley Road



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	→			←	↔	↔
Volume (veh/h)	238	14	77	354	27	71
Sign Control	Free			Free	Stop	
Grade	2%			-2%	-2%	
Peak Hour Factor	0.92	0.50	0.86	0.88	0.68	0.67
Hourly flow rate (vph)	259	28	90	402	40	106
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			287		854	273
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			287		854	273
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			93		87	86
cM capacity (veh/h)			1275		309	771
Direction, Lane #	EB 1	WB 1	NB 1			
Volume Total	287	492	146			
Volume Left	0	90	40			
Volume Right	28	0	106			
cSH	1700	1275	548			
Volume to Capacity	0.17	0.07	0.27			
Queue Length 95th (ft)	0	6	27			
Control Delay (s)	0.0	2.1	13.9			
Lane LOS		A	B			
Approach Delay (s)	0.0	2.1	13.9			
Approach LOS			B			
Intersection Summary						
Average Delay			3.3			
Intersection Capacity Utilization			52.1%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

5: English Ivy Road & Hardin Valley Road



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	→			←	↘	↙
Volume (veh/h)	513	2	30	203	6	91
Sign Control	Free			Free	Stop	
Grade	2%			-2%	-2%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	558	2	33	221	7	99
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			560		845	559
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			560		845	559
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		98	81
cM capacity (veh/h)			1011		323	529

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	560	253	105
Volume Left	0	33	7
Volume Right	2	0	99
cSH	1700	1011	509
Volume to Capacity	0.33	0.03	0.21
Queue Length 95th (ft)	0	2	19
Control Delay (s)	0.0	1.4	13.9
Lane LOS		A	B
Approach Delay (s)	0.0	1.4	13.9
Approach LOS			B

Intersection Summary			
Average Delay		2.0	
Intersection Capacity Utilization		48.6%	ICU Level of Service
Analysis Period (min)		15	A

HCM Unsignalized Intersection Capacity Analysis 2: Marietta Church Road & Hardin Valley Road



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	398	17	36	173	14	117
Sign Control	Free			Free	Stop	
Grade	2%			-2%	-2%	
Peak Hour Factor	0.83	0.60	0.67	0.83	0.63	0.80
Hourly flow rate (vph)	480	28	54	208	22	146
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			508		810	494
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			508		810	494
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			95		93	75
cM capacity (veh/h)			1057		335	580
Direction, Lane #	EB 1	WB 1	NB 1			
Volume Total	508	262	168			
Volume Left	0	54	22			
Volume Right	28	0	146			
cSH	1700	1057	529			
Volume to Capacity	0.30	0.05	0.32			
Queue Length 95th (ft)	0	4	34			
Control Delay (s)	0.0	2.2	15.0			
Lane LOS		A	B			
Approach Delay (s)	0.0	2.2	15.0			
Approach LOS			B			
Intersection Summary						
Average Delay			3.3			
Intersection Capacity Utilization			51.1%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

7: Marietta Church Road & Leatherback Road



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	5	5	126	2	2	51
Sign Control	Stop		Free			Free
Grade	-2%		2%			-2%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	5	137	2	2	55
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	198	138			139	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	198	138			139	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	99			100	
cM capacity (veh/h)	790	910			1444	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	11	139	58
Volume Left	5	0	2
Volume Right	5	2	0
cSH	846	1700	1444
Volume to Capacity	0.01	0.08	0.00
Queue Length 95th (ft)	1	0	0
Control Delay (s)	9.3	0.0	0.3
Lane LOS	A		A
Approach Delay (s)	9.3	0.0	0.3
Approach LOS	A		

Intersection Summary			
Average Delay		0.6	
Intersection Capacity Utilization		16.8%	ICU Level of Service A
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis

5: English Ivy Road & Hardin Valley Road



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	→			←	←	↘
Volume (veh/h)	312	6	100	437	4	60
Sign Control	Free			Free	Stop	
Grade	2%			-2%	-2%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	339	7	109	475	4	65
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			346		1035	342
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			346		1035	342
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			91		98	91
cM capacity (veh/h)			1213		234	700

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	346	584	70
Volume Left	0	109	4
Volume Right	7	0	65
cSH	1700	1213	623
Volume to Capacity	0.20	0.09	0.11
Queue Length 95th (ft)	0	7	9
Control Delay (s)	0.0	2.4	11.5
Lane LOS		A	B
Approach Delay (s)	0.0	2.4	11.5
Approach LOS			B

Intersection Summary			
Average Delay		2.2	
Intersection Capacity Utilization		59.2%	ICU Level of Service
Analysis Period (min)		15	B

HCM Unsignalized Intersection Capacity Analysis 2: Marietta Church Road & Hardin Valley Road



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	→			←	↔	↔
Volume (veh/h)	244	14	83	358	27	74
Sign Control	Free			Free	Stop	
Grade	2%			-2%	-2%	
Peak Hour Factor	0.92	0.50	0.86	0.88	0.68	0.67
Hourly flow rate (vph)	265	28	97	407	40	110
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None		None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			293		879	279
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			293		879	279
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			92		87	86
cM capacity (veh/h)			1268		297	765
Direction, Lane #	EB 1	WB 1	NB 1			
Volume Total	293	503	150			
Volume Left	0	97	40			
Volume Right	28	0	110			
cSH	1700	1268	539			
Volume to Capacity	0.17	0.08	0.28			
Queue Length 95th (ft)	0	6	28			
Control Delay (s)	0.0	2.2	14.2			
Lane LOS		A	B			
Approach Delay (s)	0.0	2.2	14.2			
Approach LOS			B			
Intersection Summary						
Average Delay			3.4			
Intersection Capacity Utilization			53.2%	ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

7: Marietta Church Road & Leatherback Road



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	3	3	98	6	6	91
Sign Control	Stop		Free			Free
Grade	-2%		2%			-2%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	3	107	7	7	99
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	222	110			113	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	222	110			113	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	763	944			1476	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	7	113	105
Volume Left	3	0	7
Volume Right	3	7	0
cSH	844	1700	1476
Volume to Capacity	0.01	0.07	0.00
Queue Length 95th (ft)	1	0	0
Control Delay (s)	9.3	0.0	0.5
Lane LOS	A		A
Approach Delay (s)	9.3	0.0	0.5
Approach LOS	A		

Intersection Summary			
Average Delay		0.5	
Intersection Capacity Utilization		19.7%	ICU Level of Service
Analysis Period (min)		15	A

APPENDIX D
ITE TRIP GENERATION

Land Use: 210

Single-Family Detached Housing

Description

Single-family detached housing includes all single-family detached homes on individual lots. A typical site surveyed is a suburban subdivision.

Additional Data

The number of vehicles and residents had a high correlation with average weekday vehicle trip ends. The use of these variables was limited, however, because the number of vehicles and residents was often difficult to obtain or predict. The number of dwelling units was generally used as the independent variable of choice because it was usually readily available, easy to project and had a high correlation with average weekday vehicle trip ends.

This land use included data from a wide variety of units with different sizes, price ranges, locations and ages. Consequently, there was a wide variation in trips generated within this category. Other factors, such as geographic location and type of adjacent and nearby development, may also have had an effect on the site trip generation.

Single-family detached units had the highest trip generation rate per dwelling unit of all residential uses because they were the largest units in size and had more residents and more vehicles per unit than other residential land uses; they were generally located farther away from shopping centers, employment areas and other trip attractors than other residential land uses; and they generally had fewer alternative modes of transportation available because they were typically not as concentrated as other residential land uses.

The peak hour of the generator typically coincided with the peak hour of the adjacent street traffic.

The sites were surveyed between the late 1960s and the 2000s throughout the United States and Canada.

Source Numbers

1, 4, 5, 6, 7, 8, 11, 12, 13, 14, 16, 19, 20, 21, 26, 34, 35, 36, 38, 40, 71, 72, 84, 91, 98, 100, 105, 108, 110, 114, 117, 119, 157, 167, 177, 187, 192, 207, 211, 246, 275, 283, 293, 300, 319, 320, 357, 384, 435, 550, 552, 579, 598, 601, 603, 611, 614, 637, 711, 735

Single-Family Detached Housing (210)

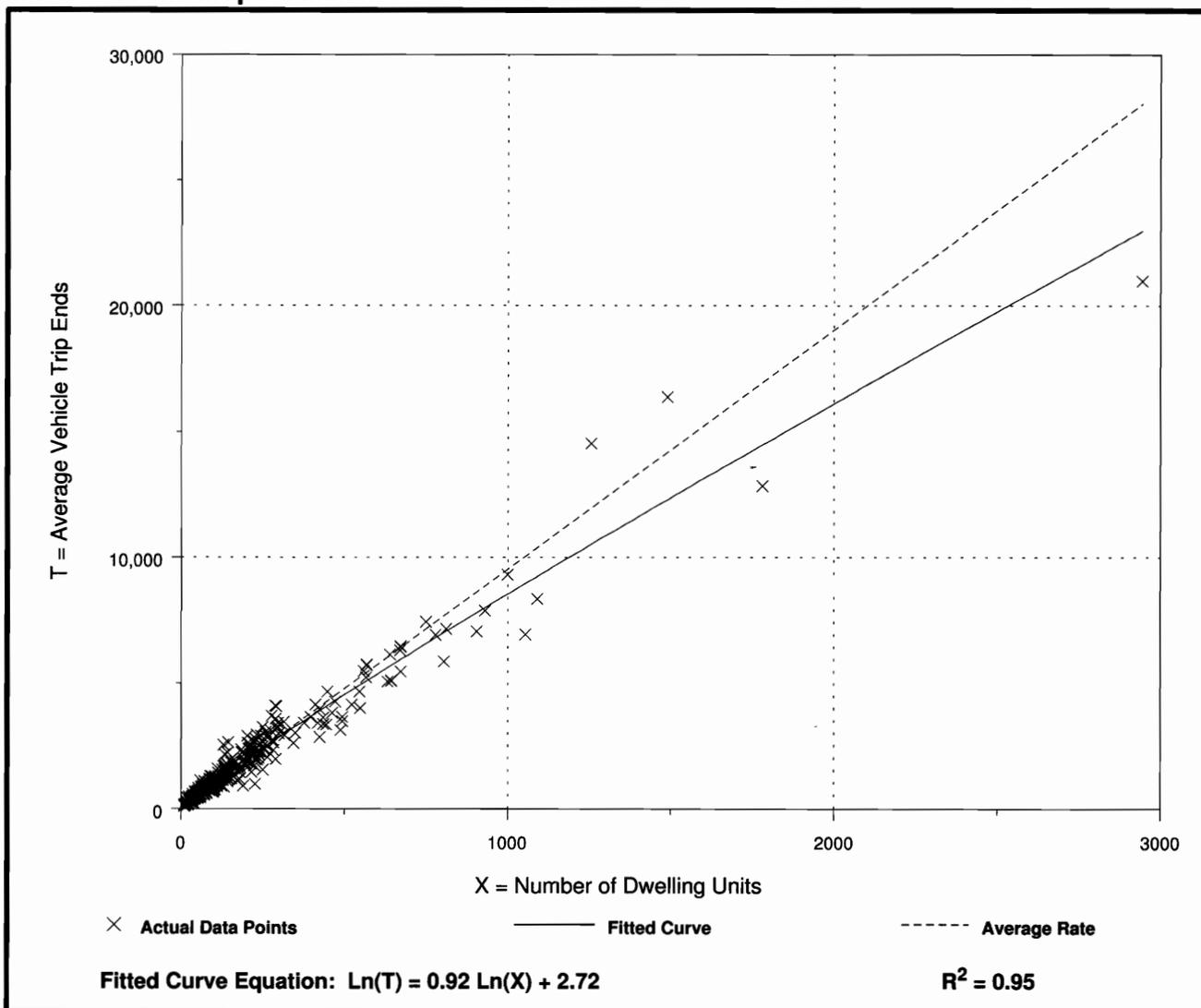
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

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



Single-Family Detached Housing (210)

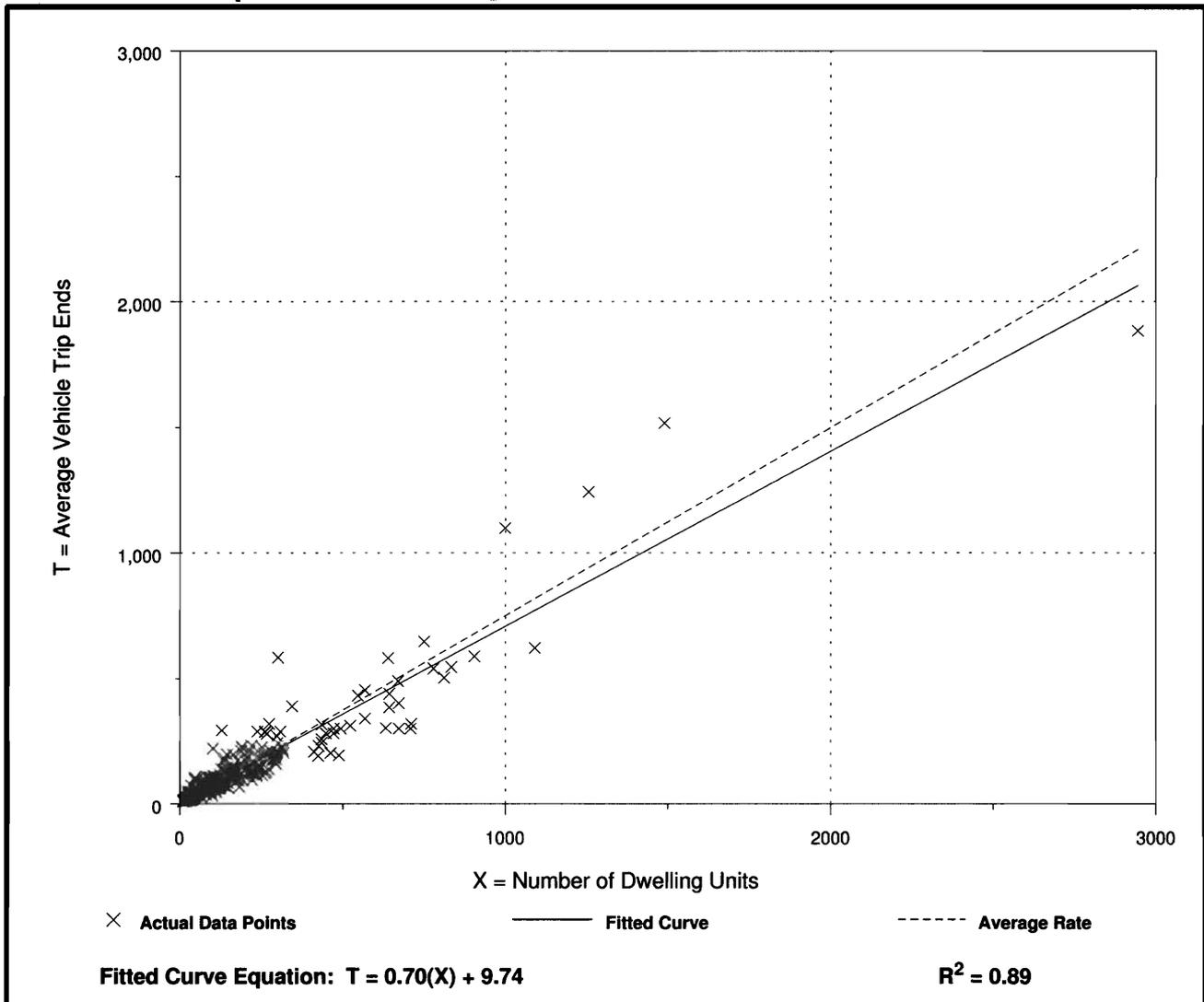
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.

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



Single-Family Detached Housing (210)

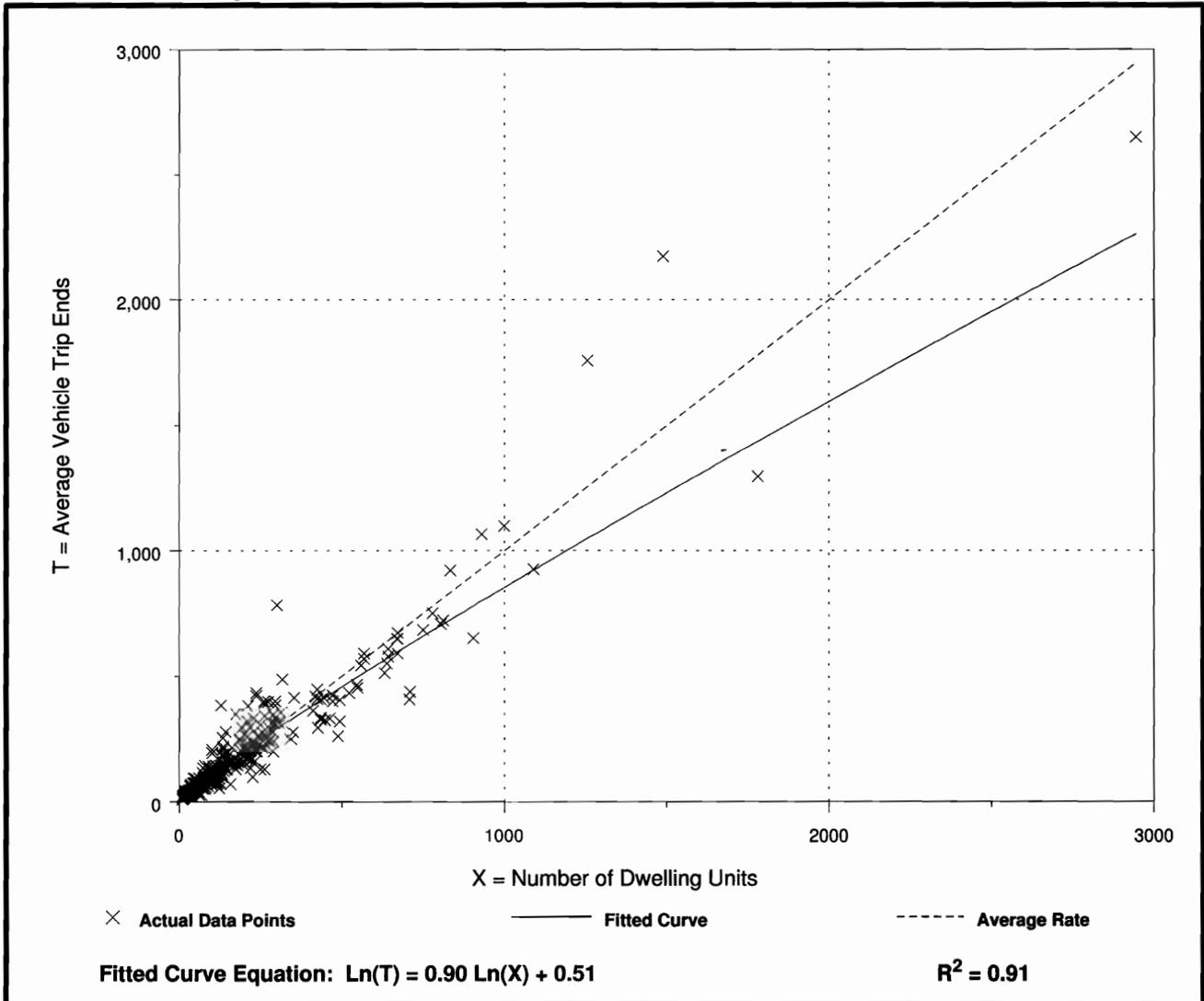
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.

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



APPENDIX E
SPOT SPEED STUDY

SPOT SPEED STUDY

Location: Hardin Valley Road (adjacent to proposed property) Date: 11/3/2016
 Posted Speed Limit: 40 mph Weather: Sunny
 Equipment: Bushnell Speedster III Radar Speed Gun Time: 11:00 AM

Vehicle	Speed (mph)
1	49
2	47
3	56
4	43
5	46
6	46
7	44
8	51
9	43
10	46
11	49
12	42
13	40
14	41
15	47
16	45
17	47
18	40
19	40
20	45
21	44
22	41
23	49
24	45
25	40
26	39
27	41

Sample Size Requirements (from *ITE Manual of Transportation Engineering Studies*)

$$N = (S * K / E)^2$$

- where:
- N = minimum number of measured speeds
 - S = estimated sample standard deviation (mph)
 - K = constant corresponding to the desired confidence level
 - E = permitted error in the average speed estimate (mph)
- S = 5 mph (Table 3-2, page 38)
 K = 2.58 (Confidence level of 99% - Table 3-3, page 38)
 E = 2 mph assumed error range

Therefore, N = 42

SPOT SPEED STUDY

Location: Hardin Valley Road (adjacent to proposed property) Date: 11/3/2016
 Posted Speed Limit: 40 mph Weather: Sunny
 Equipment: Bushnell Speedster III Radar Speed Gun Time: 11:00 AM

28	45
29	48
30	51
31	33
32	43
33	60
34	37
35	45
36	53
37	43
38	42
39	42
40	44
41	51
42	41
43	48
44	46
45	52
46	41
47	51
48	44
49	43
50	38
51	50

85th percentile speed = 50.5 mph

SPOT SPEED STUDY

Location: Marietta Church Road
 Posted Speed Limit: 30 mph
 Equipment: Bushnell Speedster III Radar Speed Gun

(adjacent to proposed property)

Date: 11/8/2016
 Weather: Hazy/Cloudy
 Time: 12:00 PM

Vehicle	Speed (mph)
Vehicles Heading SB	
1	45
2	50
3	37
4	50
5	40
6	43
7	42
8	45
9	43
10	48
11	46
12	49
13	43
14	66
15	50
16	49
17	38
18	45
19	52
20	38
21	36
22	47
23	54
24	45
25	48
26	43
27	35
28	49
29	40
30	34
85th percentile speed =	
50.0	
mph	

Vehicle	Speed (mph)
Vehicles Heading NB	
1	38
2	36
3	43
4	34
5	42
6	37
7	36
8	38
9	34
10	46
11	33
12	43
13	40
14	37
15	43
16	50
17	38
18	43
19	32
20	43
21	40
22	35
23	35
24	32
25	46
26	42
27	35
28	39
29	36
30	40
85th percentile speed =	
43.0	
mph	

APPENDIX F

KNOX COUNTY TURN LANE THRESHOLD WORKSHEET

TABLE 6A

LEFT-TURN LANE VOLUME THRESHOLDS
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 46 TO 55 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	200	140	100	75	60	50
150 - 199	175	120	85	65	55	45
200 - 249	150	100	75	60	50	40
250 - 299	130	85	65	55	45	35
300 - 349	110	75	60	50	40	30
350 - 399	95	65	55	45	35	25
400 - 449	80	60	50	40	30	25
450 - 499	70	55	45	35	25	20
500 - 549	60	50	40	30	25	20
550 - 599	50	45	35	25	20	20
600 - 649	45	40	30	25	20	20
650 - 699	40	35	30	20	20	20
700 - 749	35	35	25	20	20	15
750 or More	35	35	25	20	15	15

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

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

TABLE 6B

RIGHT-TURN LANE VOLUME THRESHOLDS
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 46 TO 55 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						Yes
200 - 249 250 - 299				Yes	Yes Yes	Yes Yes
300 - 349 350 - 399			Yes Yes	Yes Yes	Yes Yes	Yes Yes
400 - 449 450 - 499		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

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

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

APPENDIX G

**TDOT WARRANT FOR LEFT-TURN
STORAGE LANES**

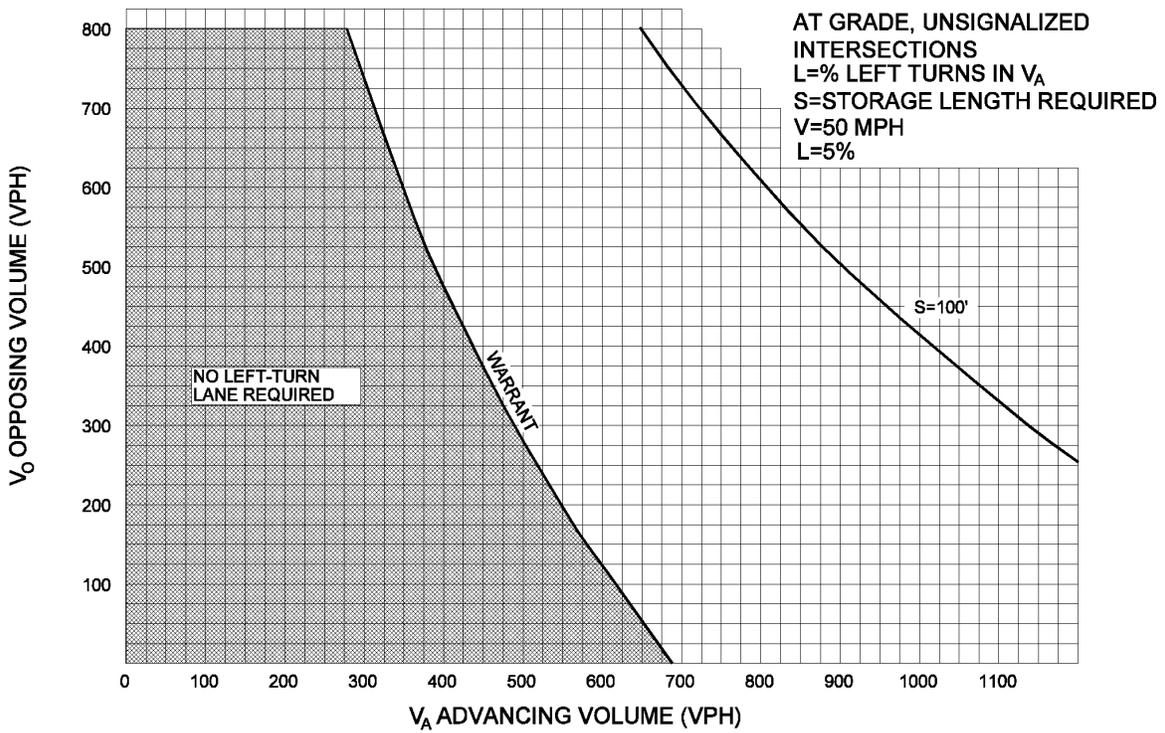


Figure 2-19A

Warrant for Left-Turn Storage Lanes on Two-Lane Highways (V = 50 mph and L = 5%)

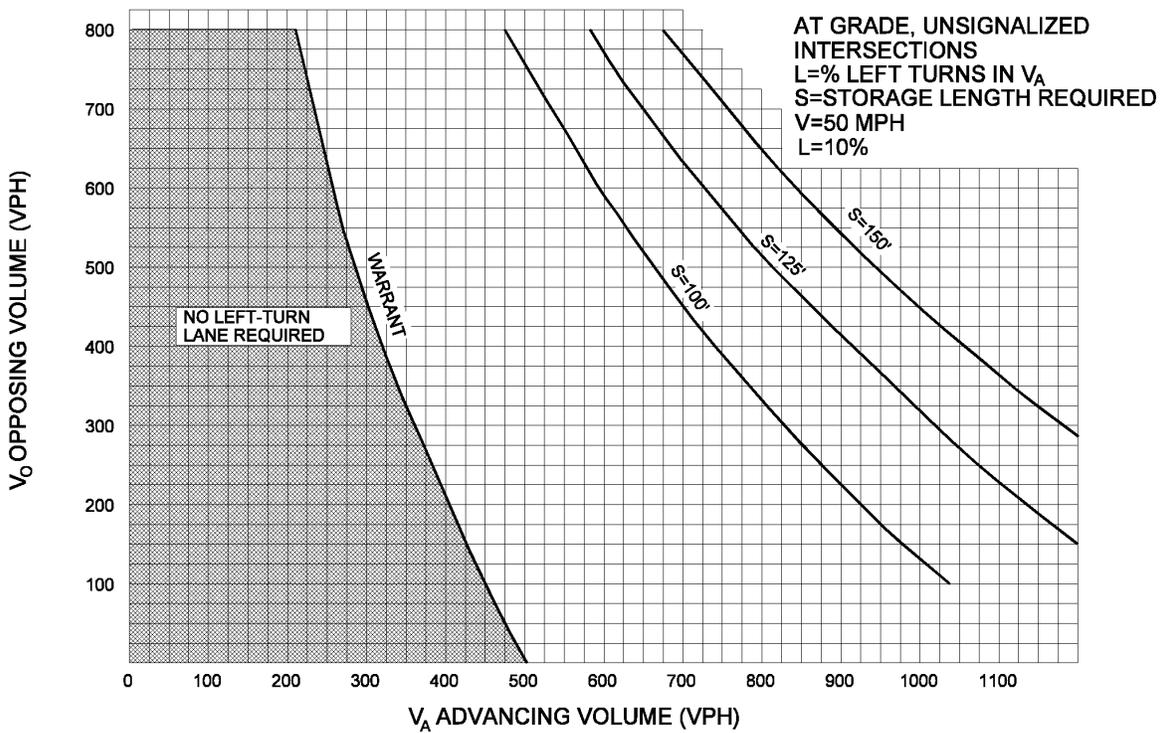


Figure 2-19B

Warrant for Left-Turn Storage Lanes on Two-Lane Highways (V = 50 mph and L = 10%)

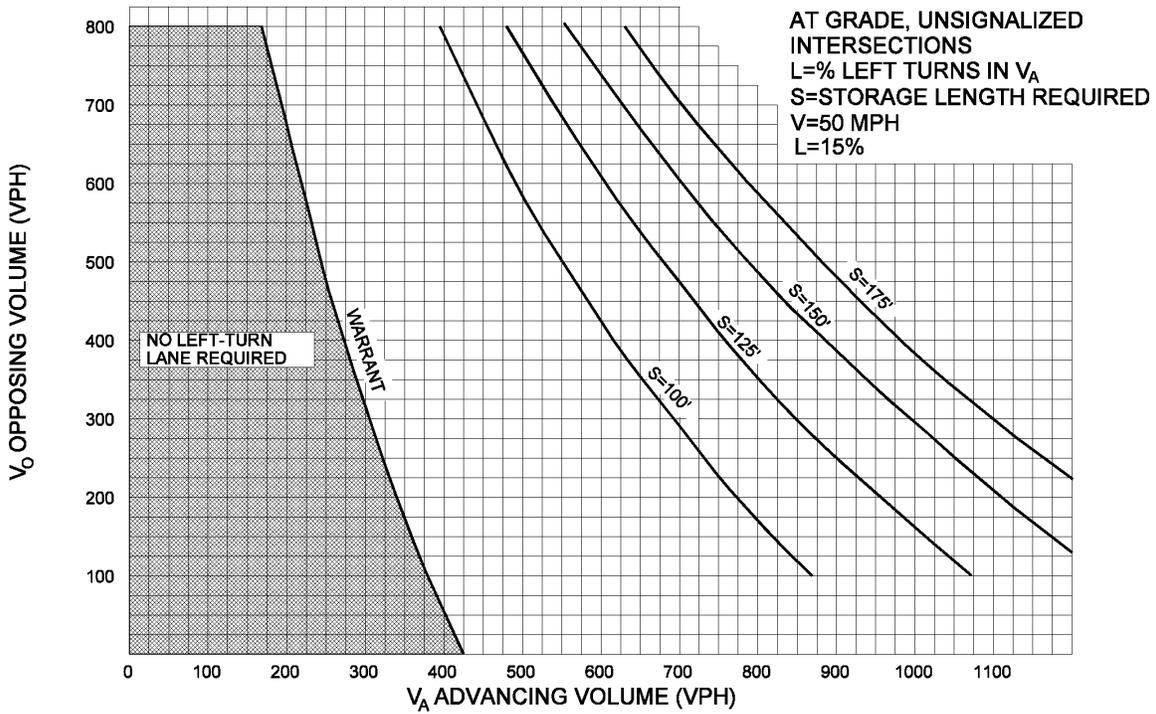


Figure 2-19C

Warrant for Left-Turn Storage Lanes on Two-Lane Highways (V = 50 mph and L = 15%)

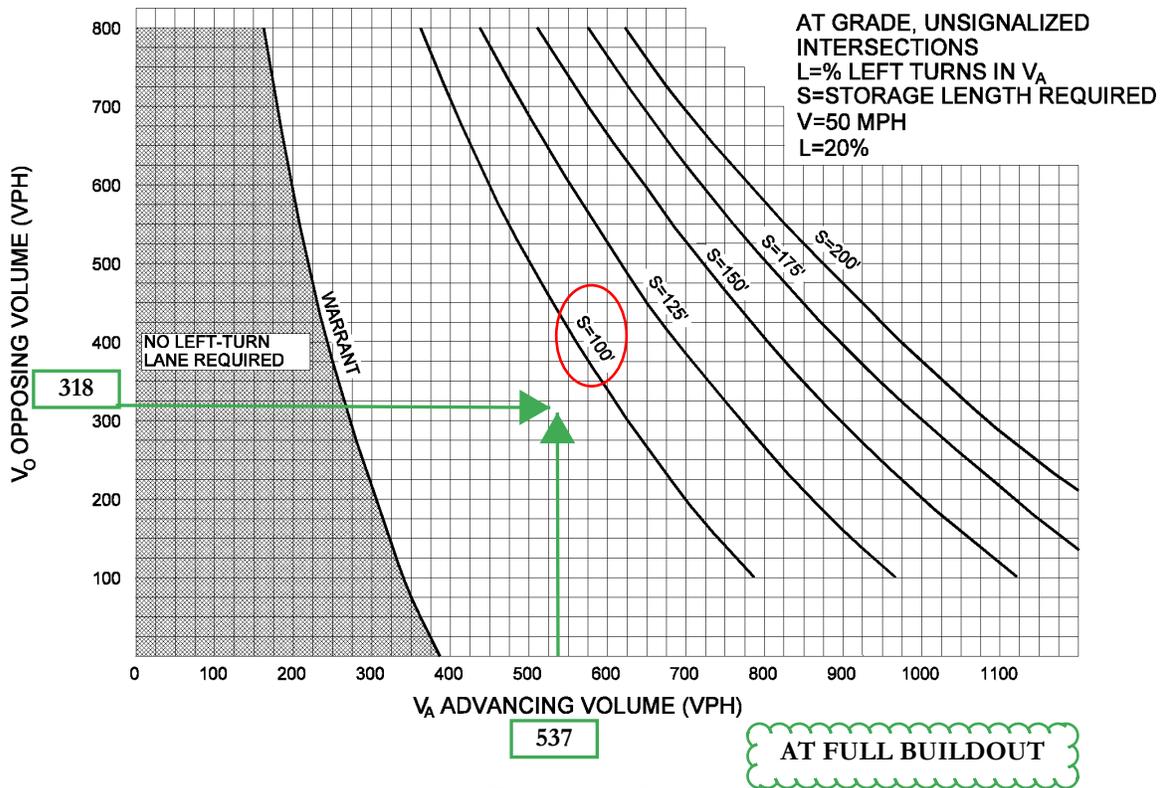


Figure 2-19D

Warrant for Left-Turn Storage Lanes on Two-Lane Highways (V = 50 mph and L = 20%)

APPENDIX H
SIMTRAFFIC QUEUE REPORTS

Intersection: 2: Marietta Church Road & Hardin Valley Road

Movement	EB	WB	NB
Directions Served	TR	LT	LR
Maximum Queue (ft)	2	73	71
Average Queue (ft)	0	20	36
95th Queue (ft)	3	58	58
Link Distance (ft)	288	1823	1004
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 5: English Ivy Road & Hardin Valley Road

Movement	WB	NB
Directions Served	L	LR
Maximum Queue (ft)	53	69
Average Queue (ft)	18	31
95th Queue (ft)	45	57
Link Distance (ft)		200
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)	100	
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 7: Marietta Church Road & Leatherback Road

Movement	WB	NB	SB
Directions Served	LR	TR	LT
Maximum Queue (ft)	31	2	11
Average Queue (ft)	5	0	0
95th Queue (ft)	23	2	7
Link Distance (ft)	196	96	1004
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Network Summary

Network wide Queuing Penalty: 0