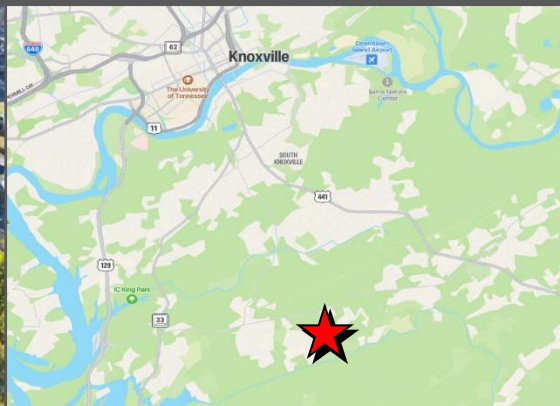


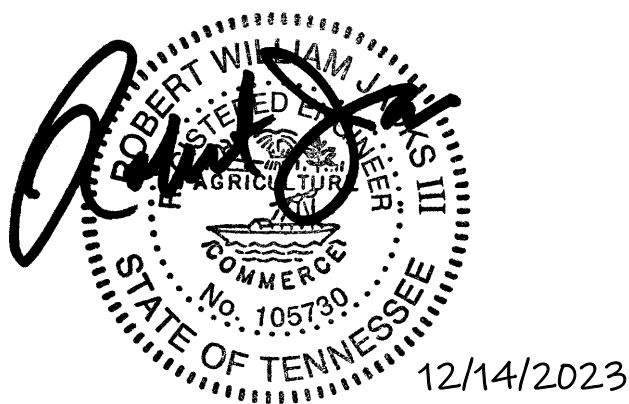


# Transportation Impact Letter CMH Homes Development Knox County, Tennessee



Revised December 2023

Prepared for:  
CMH Homes, Inc.  
5000 Clayton Road  
Maryville, TN 37804



1-SC-24-C / 1-B-24-DP  
TIL Version 2  
12/14/2023

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## EXECUTIVE SUMMARY

### **Preface:**

CMH Homes, Inc. proposes a residential development at 2116 Tipton Station Road in South Knox County, TN. The proposed development will include constructing 72 new single-family detached houses and retaining two existing detached houses on 20.21 +/- acres. The development is named and referenced in this report as “CMH Homes Development” since an official name has not been chosen yet. The development proposes a single entrance on the south side of Tipton Station Road, approximately 865 feet southwest of the existing intersection of Tipton Station Road at Coatney Road. It is anticipated that the development will be fully built and occupied by 2027.

This report’s primary purpose is to determine and evaluate the potential impacts of the development on the adjacent transportation system. The report briefly reviews the primary access road and entrance intersection. This report is a Transportation Impact Letter (TIL) and follows the requirements established by Knoxville/Knox County Planning. Knox County Engineering agreed to the scope of work for this TIL. Recommendations and mitigation measures are offered if transportation operations are projected to be below recognized engineering standards.

### **Results:**

The significant findings of this report include the following:

- The CMH Homes Development, with a total of 74 single-family detached houses, is estimated to generate 765 trips at full build-out and occupancy on an average weekday. Of these daily trips, 57 are estimated to occur during the AM peak hour and 75 in the PM peak hour in 2027.
- The Proposed Entrance for the subdivision at Tipton Station Road is expected to operate with reasonable vehicle delays in the projected AM and PM peak hours. The addition of the Proposed Entrance approach on Tipton Station Road will operate adequately in 2027 with respect to vehicle capacity.
- The projected 2027 traffic volumes do not warrant the construction of a separate left or right-turn lane on Tipton Station Road at the Proposed Entrance. A single exiting lane for the Proposed Entrance at Tipton Station Road will be sufficient.

**Recommendations:**

The following recommendations are offered based on the analyses to minimize the impacts of the proposed development on the adjacent transportation system while attempting to achieve an acceptable traffic flow and improved safety. More details regarding all the recommendations are discussed at the end of the report.

**Tipton Station Road at the Proposed Entrance:**

- The Proposed Entrance, Road "A", is recommended to be constructed with a 10-foot longitudinal white crosswalk for the existing sidewalk along Tipton Station Road. See TDOT Standard Drawing T-M-4 for crosswalk details.
- It is recommended that a Stop Sign (R1-1) be installed, and a 24" white stop bar be applied to the Proposed Entrance approach at Tipton Station Road. The stop bar should be applied a minimum of 4 feet away from the edge of the recommended white crosswalk, placed at the desired stopping point that maximizes the sight distance.
- Intersection sight distance at the Proposed Entrance at Tipton Station Road must not be impacted by future landscaping or signage. Based on a posted speed limit of 40-mph on Tipton Station Road, the required intersection sight distance is 400 feet for exiting left and right-turning vehicles. The available sight distances from the Proposed Entrance on Tipton Station Road will be adequate based on visual observations. The site engineer must verify that these distances will be available in the construction plans.
- At the Proposed Entrance, it is recommended that the existing double yellow centerline on Tipton Station Road be removed within the limits of the new intersection.
- The concept plan states that the two existing driveways for the houses at 2116 and 2120 Tipton Station Road will be removed, and access will be re-configured to tie these into the new internal roads for the subdivision. This modification will require the existing sidewalk along Tipton Station Road to be reconstructed where the existing driveways intersect. It is also recommended to reconstruct the sidewalk crossing at the existing gravel driveway just west of the concrete driveway at 2120 Tipton Station Road to facilitate pedestrian and bicycle traffic. The sidewalk along Tipton Station Road at the new Road "A" entrance road should have appropriate ADA-compliant ramps.

**CMH Homes Development Internal Roads:**

- A 25-mph Speed Limit Sign (R2-1) is recommended to be posted near the beginning of the development entrance off Tipton Station Road. It is recommended that a “No Outlet” Sign (W14-2a) be installed at the front of the development at Tipton Station Road. The “No Outlet” sign can be installed above or below the street name sign or separately posted on the Road “A” entrance road.
- Dual end-of-roadway object markers (OM4-1) should be installed at the end of Road “D” if a stub road is constructed. An additional sign should be posted at the stub road to follow Knoxville-Knox County Subdivision Regulations. This sign is for notification of a possible future street connection and is shown in the image below at the end of Road “D”. A “No Outlet” (W14-2) Sign supplemented with a “No Turnaround” Sign should be installed at the southern end of Road “B”. Stop Signs (R1-1) with 24” white stop bars are recommended to be installed at the internal intersections where shown.
- Sight distance at the new internal intersections must not be impacted by new signage, parked cars, or future landscaping in the subdivision. With a speed limit of 25-mph in the development, the internal intersection sight distance is 250 feet. The required stopping sight distance is 155 feet for a level road grade. The site designer should ensure that internal sight distance lengths are met.
- All drainage grates and covers for the residential development must be pedestrian and bicycle safe.
- If directed by the local post office, the site designer should include a parking area and a centralized mail delivery center within the development for the subdivision residents.
- All road grade and intersection elements should be designed to AASHTO, TDOT, and Knox County specifications and guidelines to ensure proper operation.



## DESCRIPTION OF EXISTING CONDITIONS

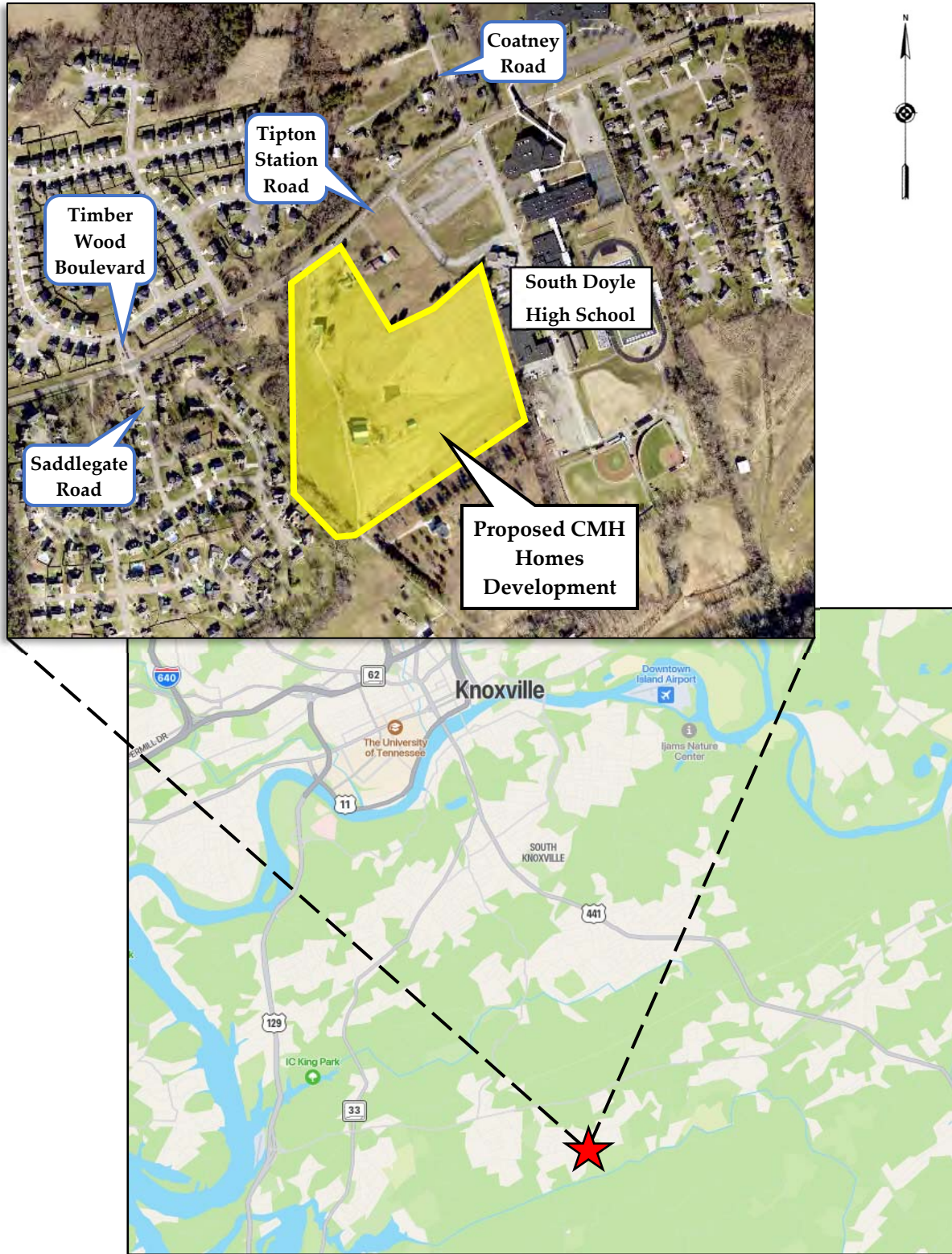
▪ STUDY AREA:

The proposed location of this new residential development is shown on a map in Figure 1. This proposed development will be located off Tipton Station Road in South Knox County, TN. The development will be constructed from a large existing single parcel. It will also include a smaller parcel already occupied by a single-family detached house adjacent to Tipton Station Road. The development will have a single entrance constructed on the south side between the existing houses at 2116 and 2120 Tipton Station Road.



The proposed development property is in a quasi-rural area of South Knox County, TN, being transformed to full suburban conditions. Near the development site, there are several established neighborhoods, standalone single-family homes, large undeveloped lots used for agricultural purposes, and South Doyle High School. This proposed residential development will be close to West Governor John Sevier Highway, providing the most accessible and convenient roadway for external destinations.

The existing development site has moderate topography, with the southwestern corner in a flood plain and the western edge lined by an unnamed tributary of Stock Creek. The large parent development parcel has a single-family detached house, barn structures, and a farm pond. The barn structures and the farm pond will be removed for construction. One other parcel along Tipton Station Road will be incorporated into the development, and it has an existing house that will remain. Most of the development property is open field currently used for farm activities.



**Figure 1**  
**Location Map**

▪ **EXISTING ROADWAYS:**

Table 1 lists the characteristics of the existing primary roadway adjacent to the development property and included in the report:

**TABLE 1  
 STUDY CORRIDOR CHARACTERISTICS**

NAME	CLASSIFICATION <sup>1</sup>	SPEED LIMIT	LANES	ROAD WIDTH <sup>2</sup>	TRANSIT <sup>3</sup>	PEDESTRIAN FACILITIES	BICYCLE FACILITIES
Tipton Station Road	Major Collector	40 mph	2	20 feet	None	None	No bike lanes

<sup>1</sup> 2018 Major Road Plan by Knoxville/Knox County Planning

<sup>2</sup> Edge of curb to edge of curb or edge of pavements near project site

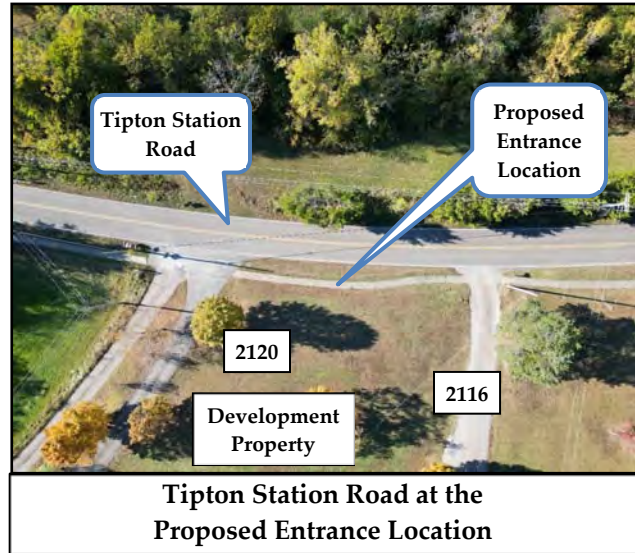
<sup>3</sup> According to Knoxville Area Transit System Map

**Tipton Station Road** is a 2-lane major collector and traverses in a generally northeast-southwest direction. The posted speed limit on Tipton Station Road is 40 mph at the project site. The speed limit within the nearby South Doyle High School zone is reduced to 20 mph. Flashing school beacons are located on Tipton Station Road, east and west of the campus. The beacon on the west side of the campus on Tipton Station Road is approximately 475 feet west of the intersection of Tipton Station Road and Coatney Road. The beacon on the east side of the campus on Tipton Station Road is approximately 1,300 feet east of the intersection of Tipton Station Road and Coatney Road. South Doyle High School is adjacent to the intersection of Tipton Station Road and Coatney Road and is situated on both the north and south sides of Tipton Station Road. The total enrollment of South Doyle High School is more than 1,000 students. Regular school hours at South Doyle High School are from 8:30 a.m. to 3:30 p.m.

Tipton Station Road is 7.4 miles long and runs between Chapman Highway (US Highway 411) on the east and Maryville Pike (SR 33) to the west. Tipton Station Road runs roughly parallel and south of West Governor John Sevier Highway (SR 168) along its length.

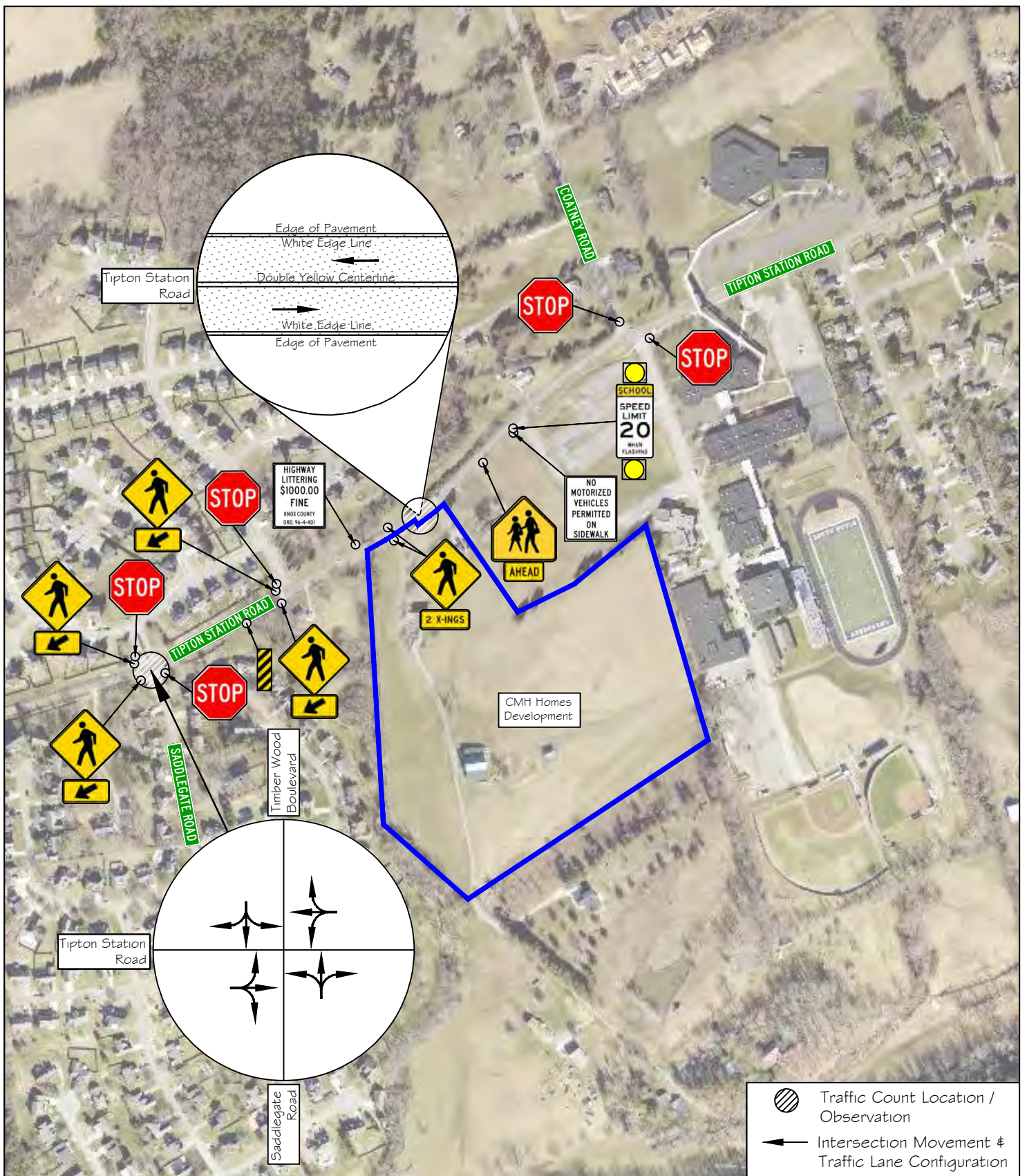
The pavement of Tipton Station Road is 20 feet wide, where the Proposed Entrance for the development will be constructed. Tipton Station Road is delineated with white edge lines. At the location of the Proposed Entrance for the development, the center of Tipton Station Road is delineated by a double yellow centerline. The pavement surface outside the white edge line is minimal, with a few inches of asphalt at most. Tipton Station Road has no curbing, and the adjacent study area has no utility lighting for roadway illumination. A 4-foot wide concrete



sidewalk is provided on the south side of Tipton Station Road and crosses the development property's road frontage. This sidewalk is approximately 0.8 miles long and has a variable distance offset from the roadway. It begins on the western end just before Bonnie Kate Elementary School and ends just past South Doyle High School to the east. To the west of the development site, a few white crosswalks with pedestrian warning signs are provided on Tipton Station Road for travel to the north side.



The Proposed Entrance for the development will be located on Tipton Station Road, between the existing driveways for 2116 and 2120 Tipton Station Road.

Figure 2 shows the existing lane configurations of the adjacent roadway and intersection where the traffic counts were conducted for the report and the current traffic road signage in the study area. The road signage shown in Figure 2 only includes warning and regulatory signage near the development site on the studied roadway corridor. The pages following Figure 2 give a further overview of the site study area with photographs.



 Traffic Count Location / Observation  
 Intersection Movement & Traffic Lane Configuration



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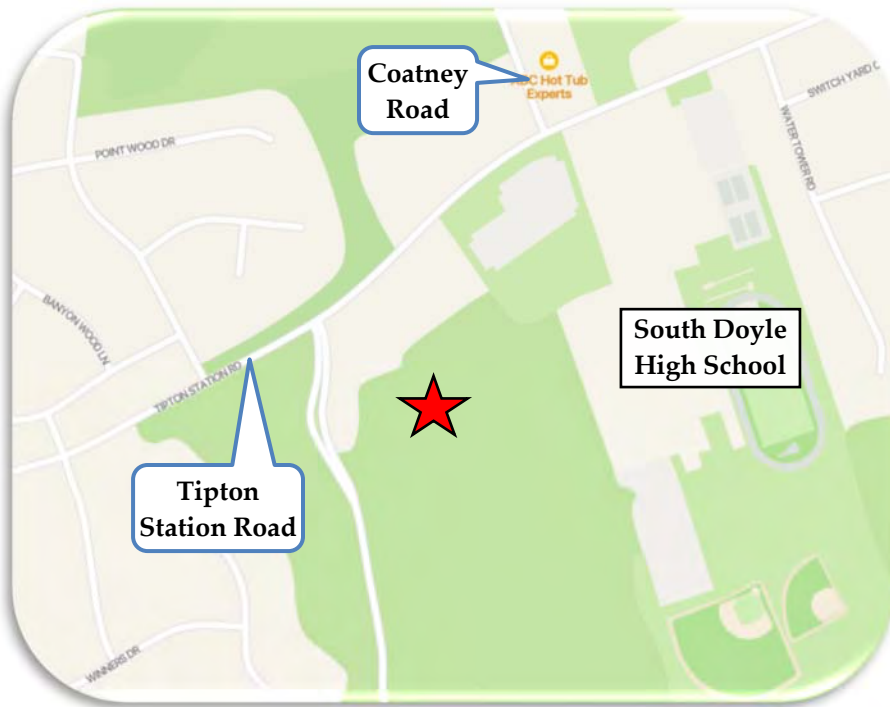


FIGURE 2

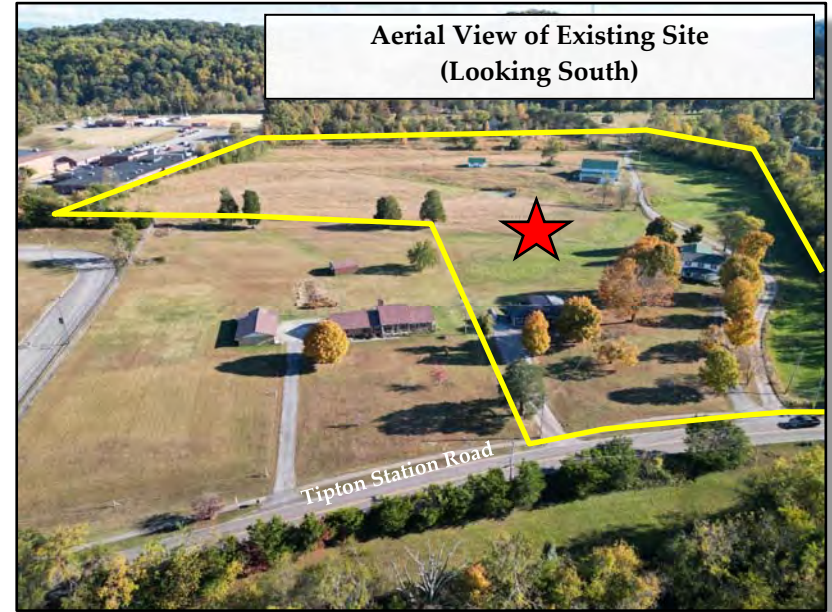
CMH Homes Development

Traffic Count Locations, Traffic Signage & Existing Lane Configurations

PHOTO EXHIBITS



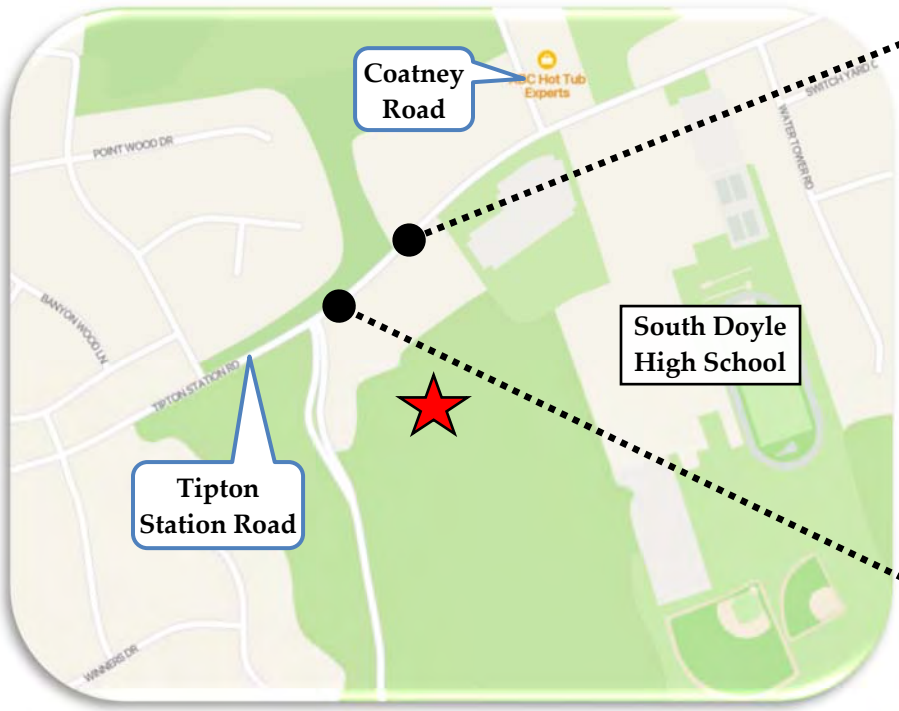
Tipton Station Road at the Proposed Development Site



Aerial View of Existing Site  
(Looking South)

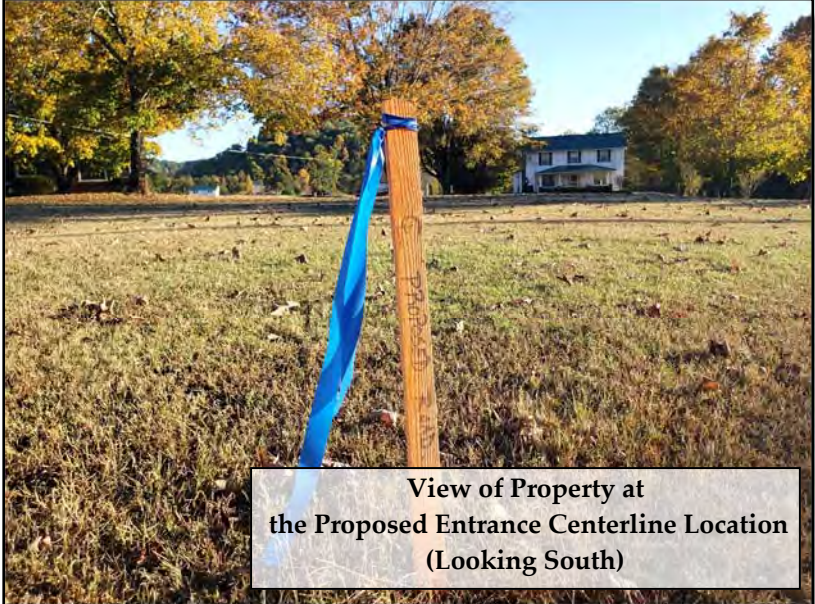
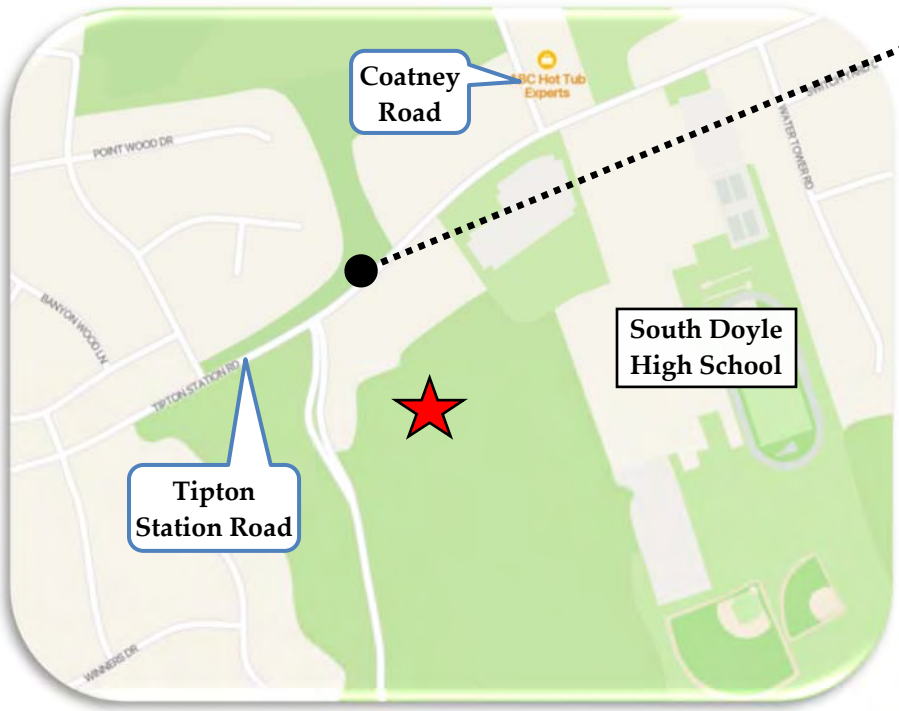


Aerial View of Existing Site  
(Looking North)



Tipton Station Road at the Proposed Development Site





Tipton Station Road at the Proposed Development Site



▪ **EXISTING TRANSPORTATION VOLUMES PER MODE:**

One annual vehicular traffic count location exists in the study area, and the Tennessee Department of Transportation (TDOT) conducts this count. The count location data is the following and can be viewed with further details in Appendix A:

- Existing vehicular roadway traffic:
  - TDOT reported an Average Daily Traffic (ADT) on Tipton Station Road, west of Saddlegate Road and Timber Wood Boulevard and the proposed development site, at 3,881 vehicles per day in 2022. From 2015 to 2022, this count station has indicated a +3.7% average annual traffic growth rate.

- Existing bicycle and pedestrian volumes:

An existing sidewalk on the south side of Tipton Station Road is provided for approximately 0.8 miles. During the 6-hour traffic count for this project, numerous walkers, joggers, and a few bicyclists were observed on the sidewalk. Four bicyclists and 72 pedestrians were observed during the traffic count, with the vast majority occurring during the late afternoon. The pedestrians comprised walkers, joggers, individuals walking their dogs, and many high-school-aged individuals jogging in groups.

Some trips could be completed by the future high school students in the subdivision to and from South Doyle High School. However, it is not expected that measurable bicycle or pedestrian trips will be generated that would significantly reduce vehicle trips to and from the proposed development on Tipton Station Road. Thus, these potential alternative transportation modes are not used for vehicle trip reductions.

- Public transportation:

The closest public transportation is provided by the Knoxville Area Transit (KAT) and is 3.5 miles away in front of the Lowe's Home Center in the South Grove Shopping Center adjacent to Chapman Highway. Since the distance to the nearest public bus service is so far away, the proposed development is not expected to have any reduced vehicle trips due to public transit usage.

## PROJECT DESCRIPTION

### ▪ LOCATION AND SITE PLAN:

The proposed plan layout with 74 single-family detached houses on 20.21 +/- acres is designed by Batson, Himes, Norvell, and Poe and is shown in Figure 3. Seventy-two single-family detached houses will be new, and the other two houses in the development will be existing that will be retained. These two existing houses are adjacent to the roadway at 2116 and 2120 Tipton Station Road. Four other houses south of the development property that utilize a shared gravel driveway to Tipton Station Road will also remain. They will be provided access to Tipton Station Road via the new internal roads and the Proposed Entrance for the development. While these four existing houses will be provided new access, the existing shared gravel driveway south of the development property that provides access to Tipton Station Road for these homes will remain.

The design shows five new streets constructed for the residential development. As shown in the figure, a single entrance will be constructed for the development at Tipton Station Road. The two houses along Tipton Station Road that will be retained will have their driveways re-configured and will be provided access to Tipton Station Road via the internal roads for the development. These two houses will lose direct access, and their existing driveways tying to the Tipton Station Road will be removed.

The entrance road, Road "A", will be nearly 600 feet long and constructed with 13-foot entering and exiting lanes. The southern end of Road "B" will transition to the existing gravel driveway that currently provides road access to the four existing single-family houses south of the development property. Road "D" will be constructed as a stub-out road for possible future expansion to the adjacent property to the south. However, no plans for future expansion have been made at this time.

The CMH Homes Development will be located on a large parcel of 19.16 acres and one small parcel adjacent to Tipton Station Road, just over 1 acre. The large parcel has one single-family detached house at 2120 Tipton Station Road with a barn, a small shed, and a farm pond. This existing house will be retained, and the other structures will be razed during construction. The development will incorporate one small parcel at 2116 Tipton Station Road. This parcel also has



**View of Northeastern Corner of Development Property at  
South Doyle High School**

an existing detached single-family house that will be retained.

The total common areas designated for the subdivision will be 1.83 acres spread over three lots. Two of these common areas will have detention ponds on the west side of the development designed to control stormwater for the development. An existing floodplain and a wetland will be avoided on the southwestern portion of the property.

Most of the single-family house lots in the development will be around 0.17 acres in size (~7,500 ft<sup>2</sup>), with many greater than 0.25 acres. The smallest lots will be 0.13 acres (5,875 ft<sup>2</sup>), and the largest, outside the existing house lots along Tipton Station Road, will be 0.54 acres in size (23,382 ft<sup>2</sup>). Each house will have a garage and driveway. A 5-foot walking path will be provided on the development's northeast corner and will allow non-motorized access to the South Doyle High School Campus. The developer is not proposing other on-site amenities for the future subdivision residents.

The schedule for the completion of this new residential development depends on economic factors and construction timelines. This project is also contingent on permitting, design, and other regulatory approvals. The area's real estate and rental market is still experiencing large amounts of activity and growth. This report assumed that the total construction build-out of the development and full occupancy would occur within the next four years (2027).



Figure 3  
Proposed Plan Layout  
CMH Homes Development

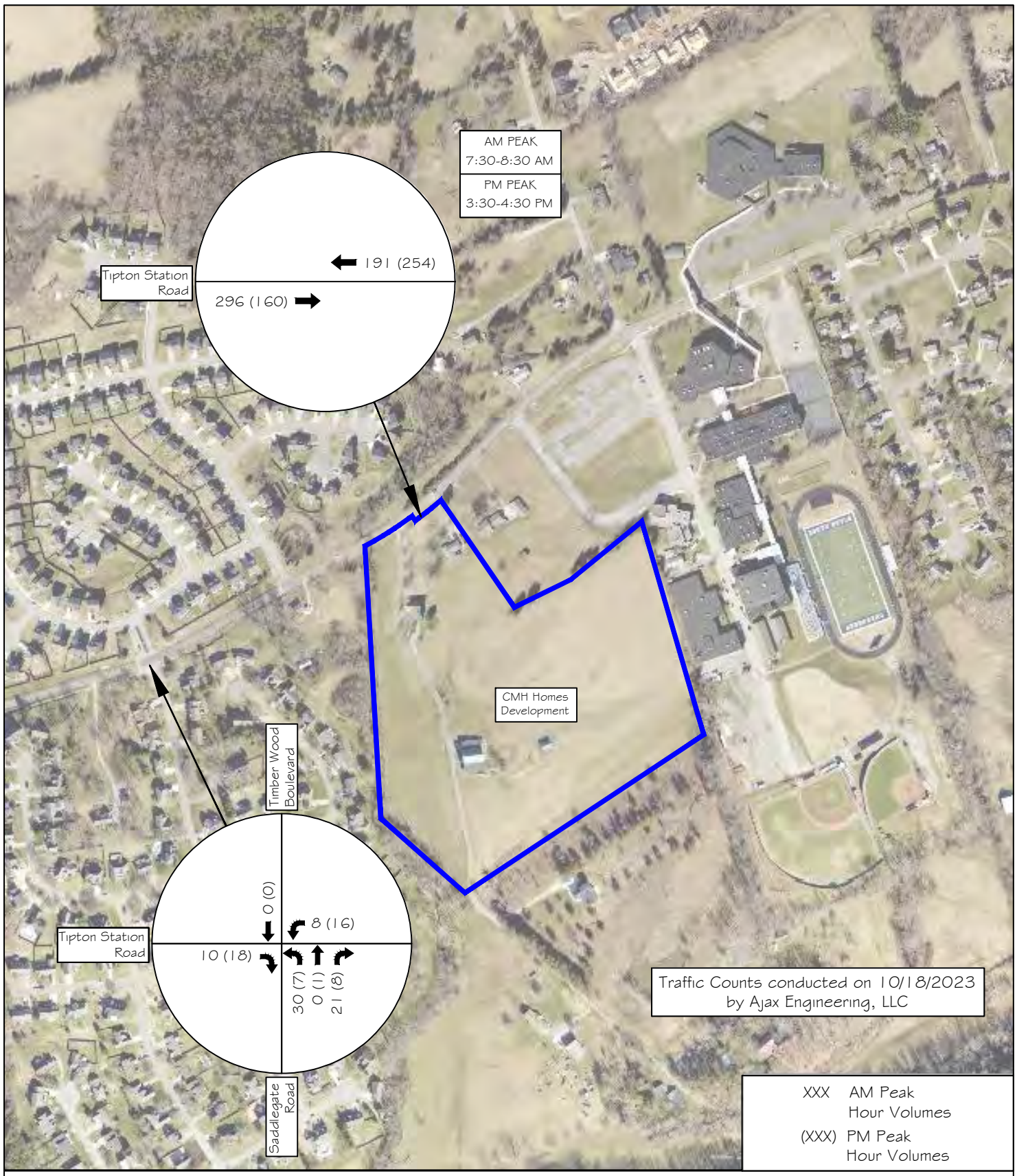
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## ANALYSIS OF EXISTING AND PROJECTED CONDITIONS

- **EXISTING TRAFFIC CONDITIONS:**

A 6-hour traffic count was conducted at the intersection of Tipton Station Road at Saddlegate Road and Timber Wood Boulevard, near the proposed development site, on Wednesday, October 18<sup>th</sup>, 2023. A 2-way traffic count was also conducted on Tipton Station Road, where the Proposed Entrance is proposed to be constructed. Manual traffic counts were conducted to identify and tabulate the morning and afternoon peak period volumes and the travel directions near the proposed development site. Local public schools were in session when the traffic counts were conducted. Based on the 2-way traffic volumes collected on Tipton Station Road, where the Proposed Entrance will tie into, the AM and PM peak hours were observed at 7:30 – 8:30 a.m. and 3:30 – 4:30 p.m.

The manual tabulated traffic counts can be reviewed in Figure 4 and Appendix B. The volumes shown in Figure 4 at the intersection are based on the observed AM and PM peak 2-way volumes. The peak hours for the entering and exiting movements to and from Saddlegate Road at the intersection occurred at 7:00 – 8:00 a.m. and 5:00 – 6:00 p.m.



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FIGURE 4

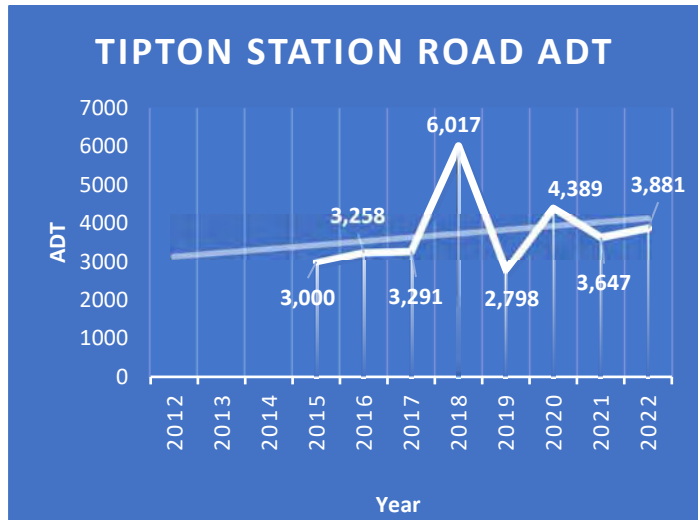
CMH Homes Development

2023 Peak Hour Traffic Volumes -  
EXISTING TRAFFIC CONDITIONS

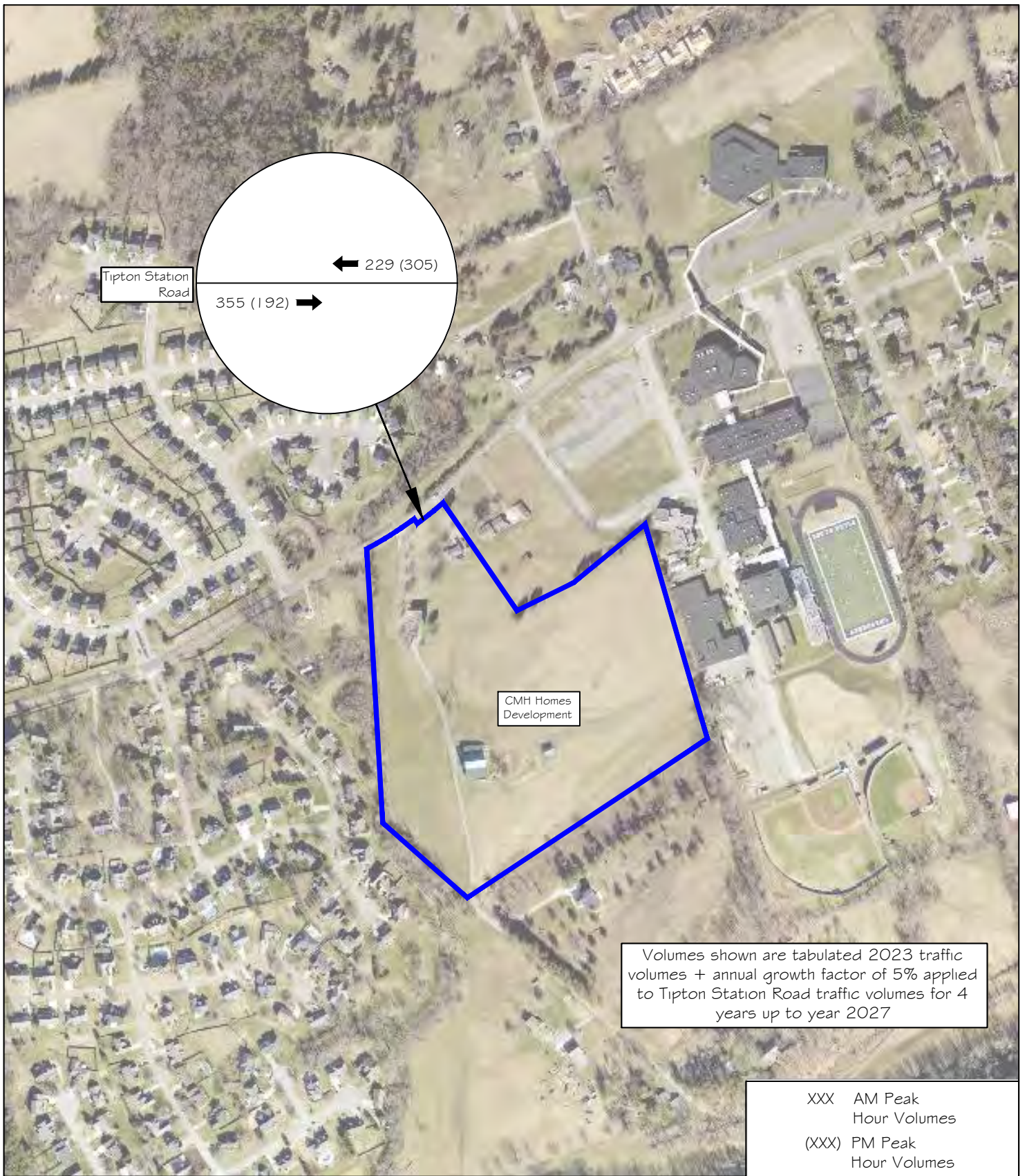
▪ **PROJECTED TRAFFIC CONDITIONS WITHOUT THE PROJECT:**

Horizon year traffic conditions represent the projected traffic volumes in the study area without the proposed project being developed (no-build option). The build-out and full occupancy of this proposed development are assumed to occur by 2027.

According to the nearby TDOT count station, vehicular traffic on Tipton Station Road has shown moderate growth over the past few years. Data in Appendix A shows that Tipton Station Road, west of Saddlegate Road and Timber Wood Boulevard, has experienced annual growth of +3.7% over the past eight years.



An annual growth rate was assumed and applied to the existing thru 2023 volumes tabulated on Tipton Station Road near the Proposed Entrance location to estimate the future volumes in the horizon year of 2027 without the potential development traffic. For this report, a higher annual growth rate of +5% was used to calculate future growth on Tipton Station Road up to 2027 to account for potential traffic growth in the study area and result in a conservative analysis. Figure 5 shows the projected 2027 horizon year traffic volumes on Tipton Station Road at the development site without the project during the AM and PM peak hours.



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FIGURE 5

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2027 Peak Hour Traffic Volumes -  
PROJECTED TRAFFIC CONDITIONS  
WITHOUT THE PROJECT



▪ **TRIP GENERATION:**

A generated trip is a single or one-direction vehicle movement entering or exiting the study site. The estimated amount of traffic the proposed 74 single-family detached houses will generate was calculated based on rates and equations provided by the Trip Generation Manual, 11th Edition, an Institute of Transportation Engineers (ITE) publication. The Trip Generation Manual is the traditional and most popular resource for determining trip generation rates when transportation impact studies are produced. The data and calculations from ITE for the proposed land use are shown in Appendix C. A summary of this information is presented in the following table:



**TABLE 2**  
**TRIP GENERATION FOR CMH HOMES DEVELOPMENT**  
 74 Single-Family Detached Houses

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	74 Houses	765	26%	74%		63%	37%	
				15	42	57	47	28	75
<b>Total New Volume Site Trips</b>			<b>765</b>	<b>15</b>	<b>42</b>	<b>57</b>	<b>47</b>	<b>28</b>	<b>75</b>

ITE Trip Generation Manual, 11th Edition  
 Trips calculated by using Fitted Curve Equation

For the proposed residential development, it is estimated that 15 vehicles will enter and 42 will exit, for a total of 57 generated trips during the AM peak hour in the year 2027. Similarly, it is estimated that 47 vehicles will enter and 28 will exit, for a total of 75 generated trips during the PM peak hour in the year 2027. The calculated trips generated for an average weekday are estimated to be 765 vehicles for the proposed development. No vehicle trip reductions were included in the calculations or analysis.

▪ **TRIP DISTRIBUTION AND ASSIGNMENT:**

The projected trip distribution and assignment for the CMH Homes Development is based on the existing observed traffic count data and engineering judgment.

During the traffic count, distinct directional splits were observed for the eastbound and westbound Tipton Station Road thru volumes during the morning and afternoon peak hours. In the AM peak hour, 39% of thru traffic on Tipton Station Road was observed traveling west and 61% east. In the PM peak hour, an exact opposite flow was observed, with 61% of the traffic on Tipton Station Road traveling westbound and 39% eastbound.

The observed entering and exiting splits on Saddlegate Road are projected to be a good analog for the future residents of the CMH Homes Development since this road serves a similar residential land use as proposed for the development site. Saddlegate Road provides the singular road access to the Woodhaven Subdivision. This subdivision is located south of Tipton Station Road and has 124 single-family detached houses. The entering and exiting percentages during the observed AM and PM peak hours at the 2-way traffic count location on Tipton Station Road to and from Saddlegate Road were the following:

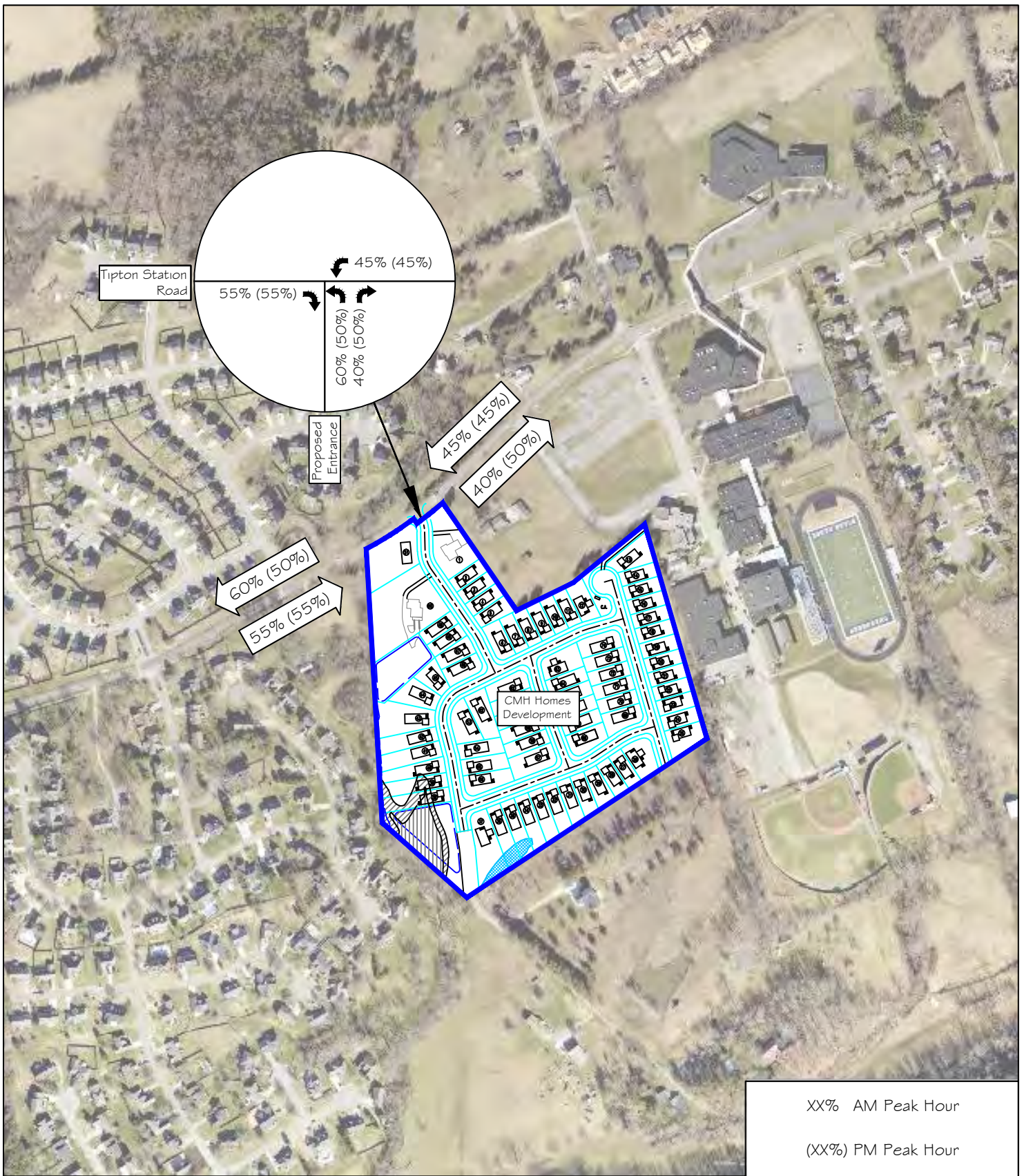
**Observed Entering and Exiting Vehicle Distribution  
 at Saddlegate Road on Tipton Station Road  
 (7:30 - 8:30 a.m. / 3:30 - 4:30 p.m.)**

AM PEAK HOUR	
ENTER FROM WEST	56%
ENTER FROM EAST	44%
EXIT TO EAST	41%
EXIT TO WEST	59%
PM PEAK HOUR	
ENTER FROM WEST	53%
ENTER FROM EAST	47%
EXIT TO EAST	53%
EXIT TO WEST	47%

During the traffic count, most vehicles entered and exited this subdivision to and from the west during the AM peak hour. During the PM peak hour, the splits were more evenly divided. The traffic count data for Timber Wood Boulevard was not used since this road is one of two entrances for the Woodcreek Reserve Subdivision to the north of Tipton Station Road and would not represent the overall entering and exiting splits.

Figure 6 shows the projected distribution of traffic entering and exiting the development at the Proposed Entrance at Tipton Station Road. Due to the development's proximity to the high school, these distributions are based on the observed peak hours at the 2-way traffic count location. The percentages shown in the figure only pertain to the trips generated by the proposed dwellings in the development calculated from the ITE trip rates.

Figure 7 shows the traffic assignment of the computed trips generated by the development and is based on the assumed distribution of trips shown in Figure 6. It should be noted that the entering and exiting traffic shown in Figure 7 at the Proposed Entrance includes trips generated by 78 single-family detached houses since four existing houses south of the proposed development will be provided access to Tipton Station Road via the new internal roads and the Proposed Entrance. The trip generation calculations for 78 houses are also included in Appendix C.



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NOT TO SCALE



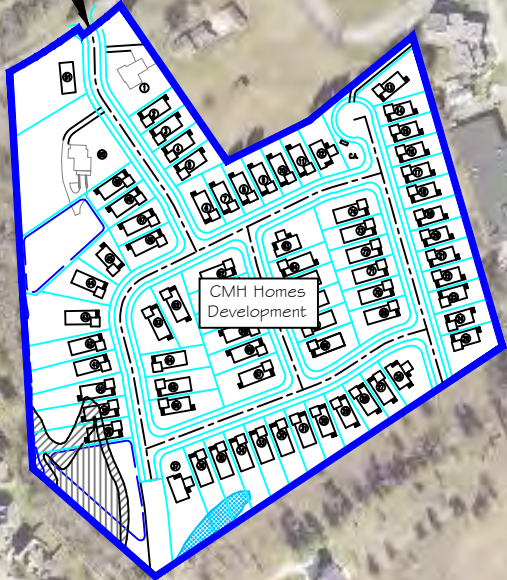
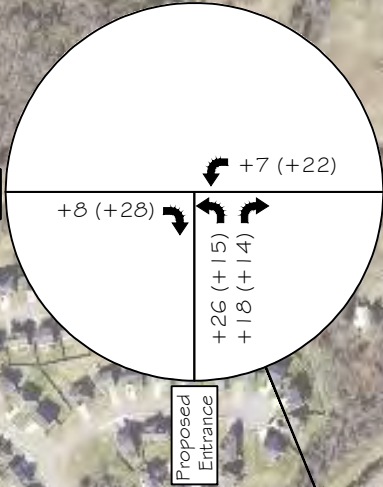
FIGURE 6

CMH Homes Development

Directional Distribution of Generated Traffic during AM and PM Peak Hour

TRIP GENERATION FOR CMH HOMES DEVELOPMENT 74 Single-Family Detached Houses		
	AM PEAK	PM PEAK
ENTER	15	47
EXIT	42	28

TRIP GENERATION FOR CMH HOMES DEVELOPMENT 74 Single-Family Detached Houses + 4 Existing Single-Family Detached Houses		
	AM PEAK	PM PEAK
ENTER	15	50
EXIT	44	29



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



11812 Black Road  
Knoxville, TN 37932  
Phone: (865) 556-0042  
Email: ajaxengineering@gmail.com

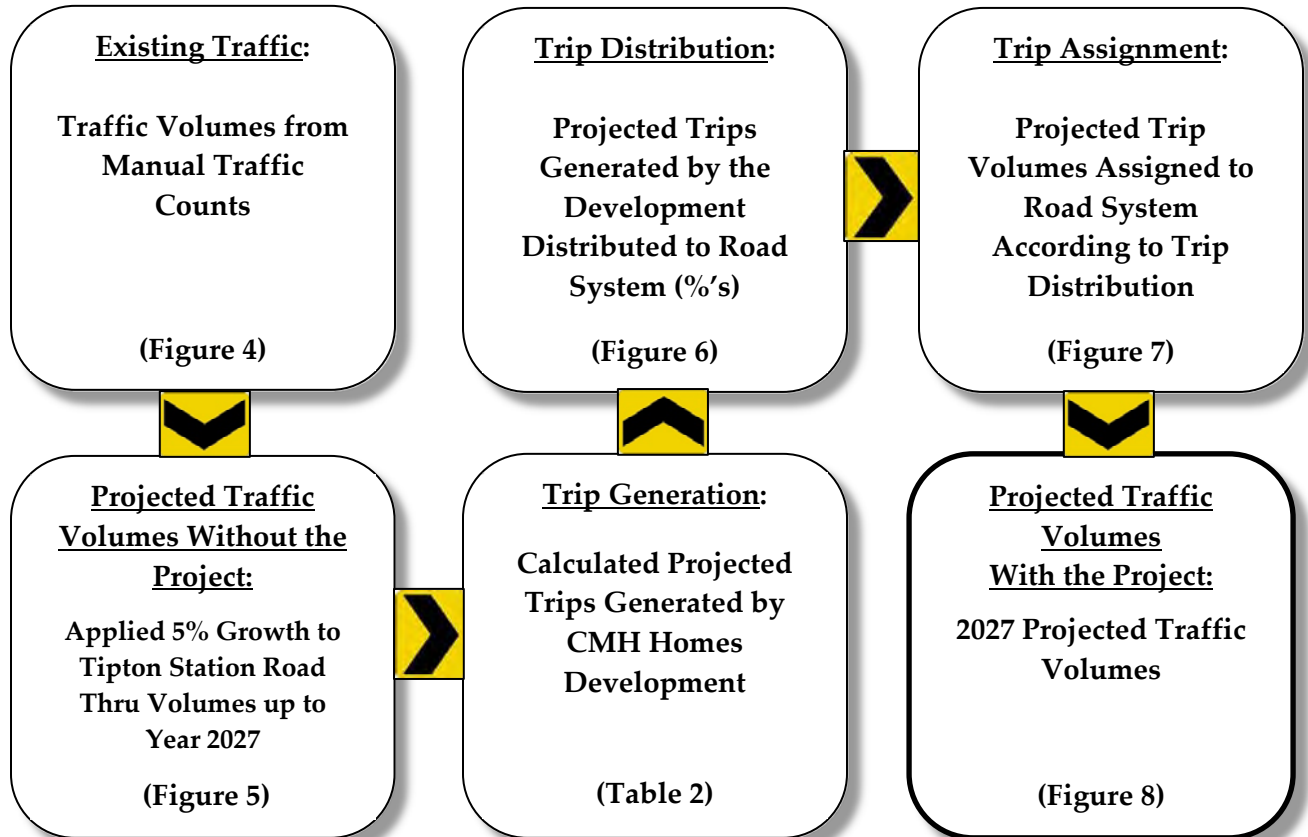
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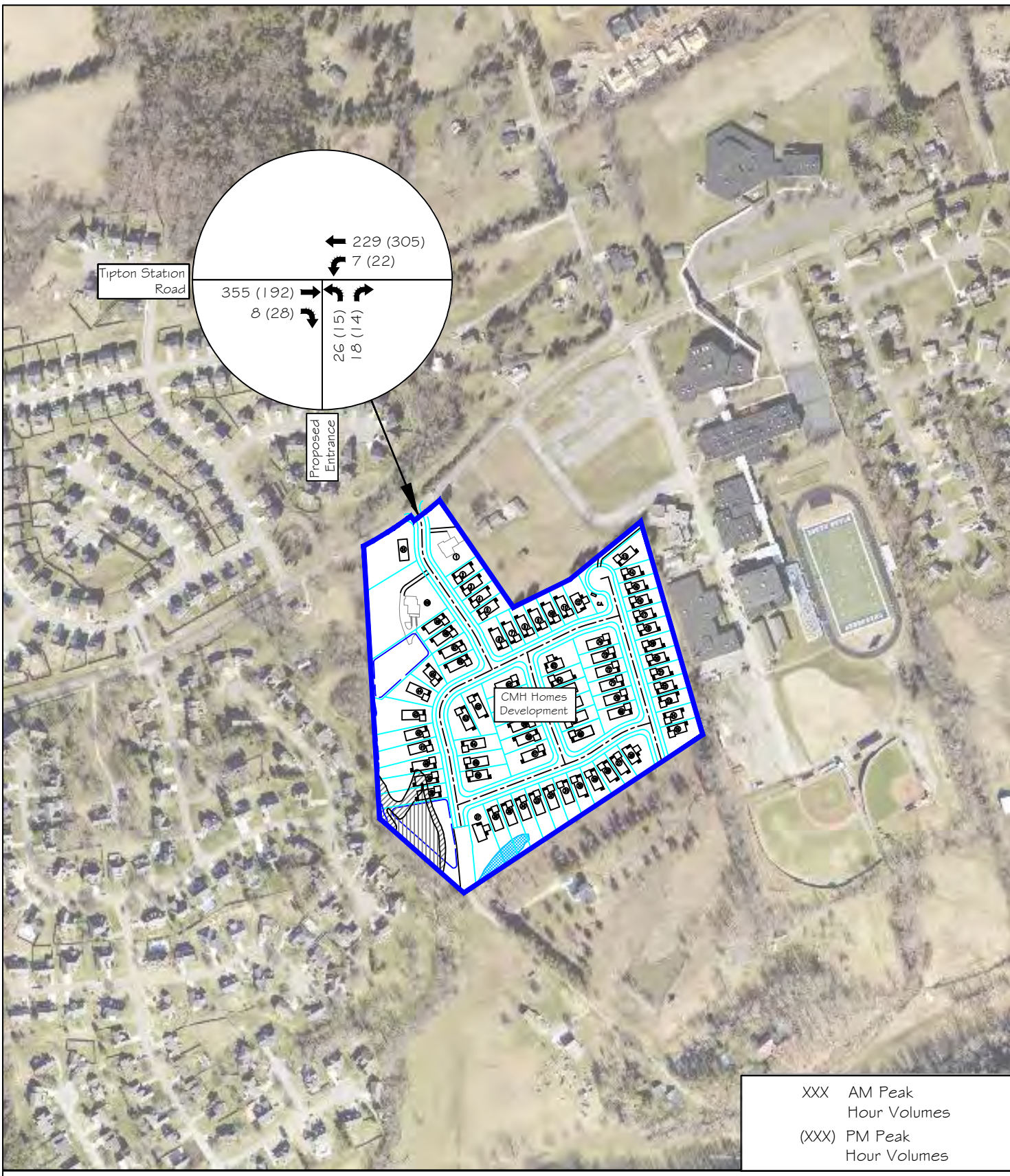
FIGURE 7  
CMH Homes Development  
Traffic Assignment of Generated Traffic  
during AM and PM Peak Hour

▪ **PROJECTED TRAFFIC CONDITIONS WITH THE PROJECT:**

Several additive steps were taken to estimate the total projected traffic volumes at the Proposed Entrance intersection on Tipton Station Road when the subdivision development is constructed and fully occupied in 2027. The steps are illustrated below for clarity and review:



The calculated peak hour traffic (Table 2) generated by the CMH Homes Development was added to the 2027 horizon year traffic (Figure 5) by following the predicted trip distributions and assignments (Figures 6 and 7). This procedure was completed to obtain the total projected traffic volumes at the Proposed Entrance intersection when the CMH Homes Development is fully built and occupied in 2027. Figure 8 shows the projected 2027 AM and PM peak hour traffic volumes, which include the generated development traffic entering and exiting the Proposed Entrance intersection and the projected thru volumes on Tipton Station Road.



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NOT TO SCALE



FIGURE 8

CMH Homes Development

2027 Peak Hour Traffic Volumes -  
 PROJECTED TRAFFIC CONDITIONS  
 WITH THE PROJECT

Capacity analyses were conducted to determine the projected LOS at the Proposed Entrance intersection with the development traffic in 2027, shown in Figure 8. The capacity analyses were calculated following the Highway Capacity Manual (HCM) methods and Synchro Traffic Software (Version 11).

Methodology:

LOS is a qualitative measurement developed by the transportation profession to express 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 worst. This grading system provides a reliable, straightforward means to communicate road operations to the public. The HCM lists level of service criteria for unsignalized intersections and signalized intersections.



LOS is defined by delay per vehicle (seconds), and roadway facilities are also characterized by the volume-to-capacity ratio (v/c). LOS designations, which are based on delay, are reported differently for unsignalized and signalized intersections. For example, a delay of 20 seconds at an unsignalized intersection would indicate LOS C, representing the additional delay a motorist would experience traveling through the intersection. Also, for example, a v/c ratio of 0.75 for an approach at an unsignalized intersection would indicate that it is operating at 75% of its available capacity. This difference is primarily due to motorists' different expectations between the two road facilities. Generally, for most instances, the LOS D / LOS E boundary is considered the upper limit of acceptable delay during peak periods in urban and suburban areas.

For unsignalized intersections, LOS is measured in terms of delay (in seconds). This measure is an attempt to quantify delay, including travel time, driver discomfort, and fuel consumption. For unsignalized intersections, the analysis assumes that the mainline thru and right-turn traffic does not stop and is not affected by the traffic on the minor side streets. Thus, the LOS for a two-way stop (or yield) controlled intersection is defined by



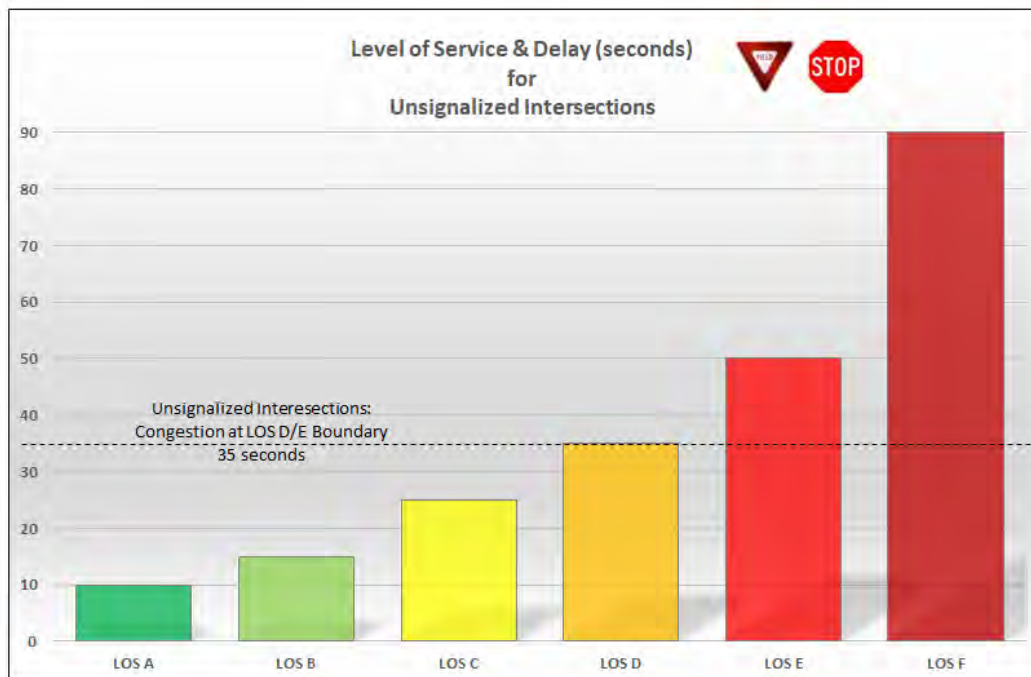
the delay for each minor approach and major street left-turn movements. Table 3 lists the level of service criteria for unsignalized intersections. The analysis results of unsignalized intersections using the HCM methodologies are conservative due to the more significant vehicle gap parameters used in the method. More often, in normal road conditions, drivers are more willing to accept smaller gaps in traffic than what is modeled using the HCM methodology. The unsignalized intersection methodology also does not account for more significant gaps sometimes produced by nearby upstream and downstream signalized intersections. For unsignalized intersections, in most instances, the upper limit of acceptable delay during peak hours is the LOS D/E boundary at 35 seconds.

**TABLE 3**  
**LEVEL OF SERVICE AND DELAY FOR UNSIGNALIZED INTERSECTIONS**



LEVEL OF SERVICE	DESCRIPTION	CONTROL DELAY (seconds/vehicle)
A	Little or no delay	0 - 10
B	Short Traffic Delays	>10 -15
C	Average Traffic Delays	>15 - 25
D	Long Traffic Delays	>25 - 35
E	Very Long Traffic Delays	>35 - 50
F	Extreme Traffic Delays	>50


Source: Highway Capacity Manual, 6th Edition



Intersection capacity results from the projected 2027 peak hour traffic are shown in Table 4. The intersection in the table is shown with a LOS designation, delay (in seconds), and v/c ratio (volume/capacity) for the AM and PM peak hours. Appendix D includes the worksheets for the projected 2027 peak hour capacity analyses.

As shown in Table 4, the intersection is calculated to operate with good LOS and reasonable vehicle delays in the projected 2027 conditions.

**TABLE 4**  
**2027 INTERSECTION CAPACITY ANALYSIS RESULTS -**  
**PROJECTED TRAFFIC CONDITIONS WITH THE PROJECT**

INTERSECTION	TRAFFIC CONTROL	APPROACH/MOVEMENT	AM PEAK			PM PEAK		
			LOS <sup>a</sup>	DELAY <sup>b</sup> (seconds)	v/c <sup>c</sup>	LOS <sup>a</sup>	DELAY <sup>b</sup> (seconds)	v/c <sup>c</sup>
Tipton Station Road (EB & WB) at Proposed Entrance (NB)	 Unsignalized	Northbound Left/Right	B	14.3	0.113	B	13.5	0.070
		Westbound Left	A	8.3	0.007	A	7.7	0.018

Note: All analyses were calculated in Synchro 11 software and reported using HCM 2010 intersection methodology

<sup>a</sup> Level of Service, <sup>b</sup> Average Delay (sec/vehicle), <sup>c</sup> Volume-to-Capacity Ratio

▪ **POTENTIAL TRANSPORTATION SAFETY ISSUES:**

The study area was investigated for potential existing and future safety issues when the development is constructed. These transportation features are discussed in the following pages.

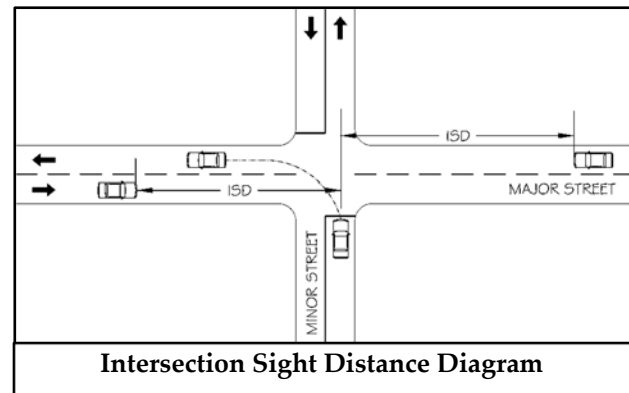
○ **EVALUATION OF SIGHT DISTANCE**

For intersections, sight distance evaluations have two categories: Stopping Sight Distance (SSD) and Intersection Sight Distance (ISD).

*Methodology:*

SSD is the distance required for a motorist on a major street to perceive and react and for the vehicle to come to a complete stop before colliding with an object on the road. For evaluating intersections, this object would be another vehicle entering the intersection from a minor street. SSD can be considered the minimum visibility distance standard for evaluating the safety of an intersection.

ISD is the required visibility distance standard for evaluating the safety of an intersection per section 3.04.J.5 in the Knoxville-Knox County Subdivision Regulations. ISD is based on the time required to perceive, react, and complete the desired traffic maneuver once a motorist on a minor street decides to perform a traffic maneuver.



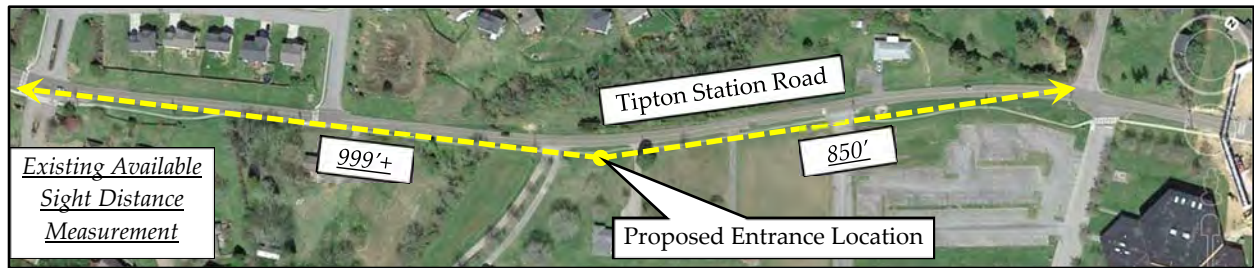
**Intersection Sight Distance Diagram**

Three traffic maneuvers are available for vehicles stopped on a minor street at a 4-way intersection: (1) left-turn, (2) right-turn, (3) or a crossing maneuver across the major street. For turns from the minor street, ISD is needed to allow a stopped motorist to turn onto a major street without being overtaken by an approaching vehicle. The most critical ISD is for left turns from the minor street. The ISD for this maneuver includes the time to turn left and clear half of the intersection without conflicting with the oncoming traffic from the left and accelerating to the road's operating speed without causing the approaching vehicles from the right to reduce their speed substantially.

With a speed limit of 40-mph on Tipton Station Road at the Proposed Entrance, the ISD is calculated to be 400 feet based on Knox County's requirement of providing 10 feet of sight distance per 1 mph of vehicle speed.

Visual observations of the sight distances at the Proposed Entrance location on Tipton Station Road were undertaken. Using a Nikon Laser Rangefinder at the Proposed Entrance location, the available sight distance was visually estimated to be 999 feet + (limit of rangefinder) to the southwest and 850 feet to the northeast.

Thus, the available sight distances from the Proposed Entrance on Tipton Station Road will be adequate based on visual observations. Images of the existing sight distances at the Proposed Entrance location are labeled below with the ISD and rangefinder-measured sight distances.



**View of Sight Distance on Tipton Station Road at the Proposed Entrance Location (Looking Southwest)**



**View of Sight Distance on Tipton Station Road at the Proposed Entrance Location (Looking Northeast)**

- **EVALUATION OF TURN LANE THRESHOLDS**

The need for separate entering turn lanes was evaluated in the projected 2027 conditions for the Proposed Entrance at Tipton Station Road.

The criteria used for these turn lane evaluations were based on Knox County's "Access Control and Driveway Design Policy". This design policy relates vehicle volume thresholds based on prevailing speeds for two-lane and four-lane roadways. The location of the Proposed Entrance on Tipton Station Road is within a 40-mph speed zone; thus, it was evaluated based on this speed.

According to Knox County's guidelines with a posted speed limit of 40-mph, separate left and right-turn lanes on Tipton Station Road at the Proposed Entrance are not warranted based on the projected AM and PM peak hour 2027 traffic volumes. The worksheets for these evaluations are provided in Appendix E.

- **PROJECTED VEHICLE QUEUES**

An additional software program was used to calculate the projected 2027 AM and PM peak hour vehicle queues at the studied intersection. The previously mentioned Synchro Traffic Software includes SimTraffic. The Synchro portion of the software performs the macroscopic calculations for intersections, and SimTraffic performs micro-simulation and animation of vehicular traffic. SimTraffic (Version 11) software was utilized to estimate the projected vehicle queues.

The 95<sup>th</sup> percentile vehicle queue is the recognized measurement in the traffic engineering profession as the design standard used when considering vehicle queue lengths. A 95<sup>th</sup> percentile vehicle queue length means 95% certainty that the vehicle queue will not extend beyond that point. The calculated vehicle queue results were based on averaging the outcome obtained during ten traffic simulations in the software. The 95<sup>th</sup> percentile vehicle queue lengths at the intersection are shown in Table 5 for the projected 2027 conditions with the project. The vehicle queue worksheet results from the SimTraffic software are in Appendix F.

**TABLE 5  
 VEHICLE QUEUE SUMMARY -  
 2027 PROJECTED PEAK HOUR TRAFFIC WITH THE PROJECT**

INTERSECTION	APPROACH/ MOVEMENT	SIMTRAFFIC 95 <sup>th</sup> PERCENTILE QUEUE LENGTH (ft)	
		AM PEAK HOUR	PM PEAK HOUR
Tipton Station Road (EB & WB) at Proposed Entrance (NB)	Westbound Left/Thru	11	17
	Northbound Left/Right	43	40

Note: 95<sup>th</sup> percentile queues were calculated in SimTraffic 11 software

Table 5 shows minimal projected queue lengths at the intersection in the 2027 peak hour conditions. The projected vehicle queues for the exiting traffic (northbound left/right) in the 2027 AM and PM peak hours at the Proposed Entrance are calculated to be reasonable. The longest queue on the westbound approach on Tipton Station Road at the Proposed Entrance was calculated to be less than one passenger car, assuming a length of 25 feet per vehicle. Results are not reported for the eastbound approach since the movements at this approach (right turns) will be free-flowing and not dependent on conflicting vehicles.

## CONCLUSIONS & RECOMMENDATIONS

The following is an overview of recommendations to minimize the transportation impacts of the CMH Homes Development on the adjacent transportation system while attempting to achieve an acceptable traffic flow and safety level.



**Tipton Station Road at the Proposed Entrance:** The 2027 projected level of service calculations for this intersection resulted in low vehicle delays and LOS.

- 1a) The construction of separate left or right-turn lanes on Tipton Station Road for entering vehicles at the Proposed Entrance is not warranted or recommended.
- 1b) A single exiting lane for the development entrance at Tipton Station Road will be sufficient. The northbound exiting lane of Road "A" at Tipton Station Road is proposed as a shared left/right turn lane. The longest vehicle queue in the projected 2027 conditions on this exiting approach is calculated to be 43 feet in the AM peak hour and 40 feet in the PM peak hour. These queue lengths are reasonable and translate to just under two passenger cars, assuming a length of 25 feet per vehicle.
- 1c) The Proposed Entrance, Road "A", is recommended to be constructed with a 10-foot longitudinal white crosswalk for the existing sidewalk along Tipton Station Road. See TDOT Standard Drawing T-M-4 for crosswalk details.
- 1d) It is recommended that a Stop Sign (R1-1) be installed, and a 24" white stop bar be applied to the Proposed Entrance approach at Tipton Station Road. The stop bar should be applied a minimum of 4 feet away from the edge of the recommended white crosswalk, placed at the desired stopping point that maximizes the sight distance.
- 1e) Intersection sight distance at the Proposed Entrance at Tipton Station Road must not be impacted by future landscaping or signage. Based on a posted speed limit of 40-mph on Tipton Station Road, the required intersection sight distance is 400 feet for exiting left and right-turning vehicles. The available sight distances from the Proposed Entrance on Tipton Station Road will be adequate based on visual observations. The site engineer must verify that these distances will be available in the construction plans.
- 1f) At the Proposed Entrance, it is recommended that the existing double yellow centerline

on Tipton Station Road be removed within the limits of the new intersection.

- 1g) The concept plan states that the two existing driveways for the houses at 2116 and 2120 Tipton Station Road will be removed, and access will be re-configured to tie these into the new internal roads for the subdivision. This modification will require the existing sidewalk along Tipton Station Road to be reconstructed where the existing driveways intersect. It is also recommended to reconstruct the sidewalk crossing at the existing gravel driveway just west of the concrete driveway at 2120 Tipton Station Road to facilitate pedestrian and bicycle traffic. The crossing at the existing gravel driveway is currently in poor condition. The sidewalk along Tipton Station Road at the new Road "A" entrance road should have appropriate ADA-compliant ramps.



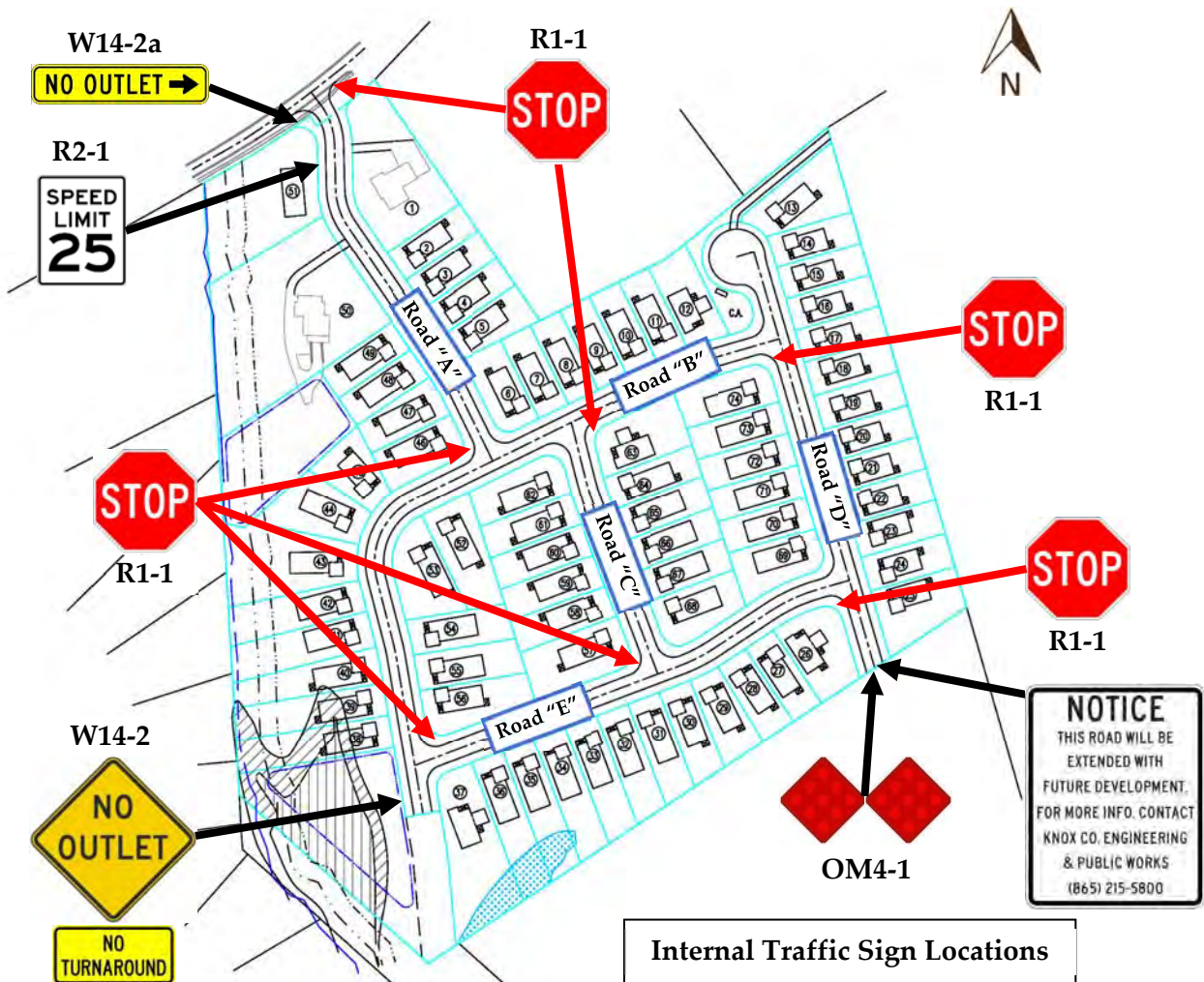
**View of Sidewalk Crossing at the Existing Gravel Driveway (Looking West)**





**CMH Homes Development Internal Roads:** The layout plan shows a single entrance at Tipton Station Road constructed for the development, as shown in Figure 3.

- 2a) A 25-mph Speed Limit Sign (R2-1) is recommended to be posted near the beginning of the development entrance off Tipton Station Road. It is recommended that a “No Outlet” Sign (W14-2a) be installed at the front of the development at Tipton Station Road. The “No Outlet” sign can be installed above or below the street name sign or separately posted on the Road “A” entrance road.
- 2b) Dual end-of-roadway object markers (OM4-1) should be installed at the end of Road “D” if a stub road is constructed. An additional sign should be posted at the stub road to follow Knoxville-Knox County Subdivision Regulations. This sign is for notification of a possible future street connection and is shown in the image below at the end of Road “D”. A “No Outlet” (W14-2) Sign supplemented with a “No Turnaround” Sign should be installed at the southern end of Road “B”. Stop Signs (R1-1) with 24” white stop bars are recommended to be installed at the internal intersections, as shown below:



- 2c) Sight distance at the new internal intersections must not be impacted by new signage, parked cars, or future landscaping in the subdivision. With a speed limit of 25-mph in the development, the internal intersection sight distance is 250 feet. The required stopping sight distance is 155 feet for a level road grade. The site designer should ensure that internal sight distance lengths are met.
  
- 2d) All drainage grates and covers for the residential development must be pedestrian and bicycle safe.
  
- 2e) If directed by the local post office, the site designer should include a parking area and a centralized mail delivery center within the development for the subdivision residents.
  
- 2f) All road grade and intersection elements should be designed to AASHTO, TDOT, and Knox County specifications and guidelines to ensure proper operation.

**APPENDIX A**

**HISTORICAL TRAFFIC COUNT DATA**

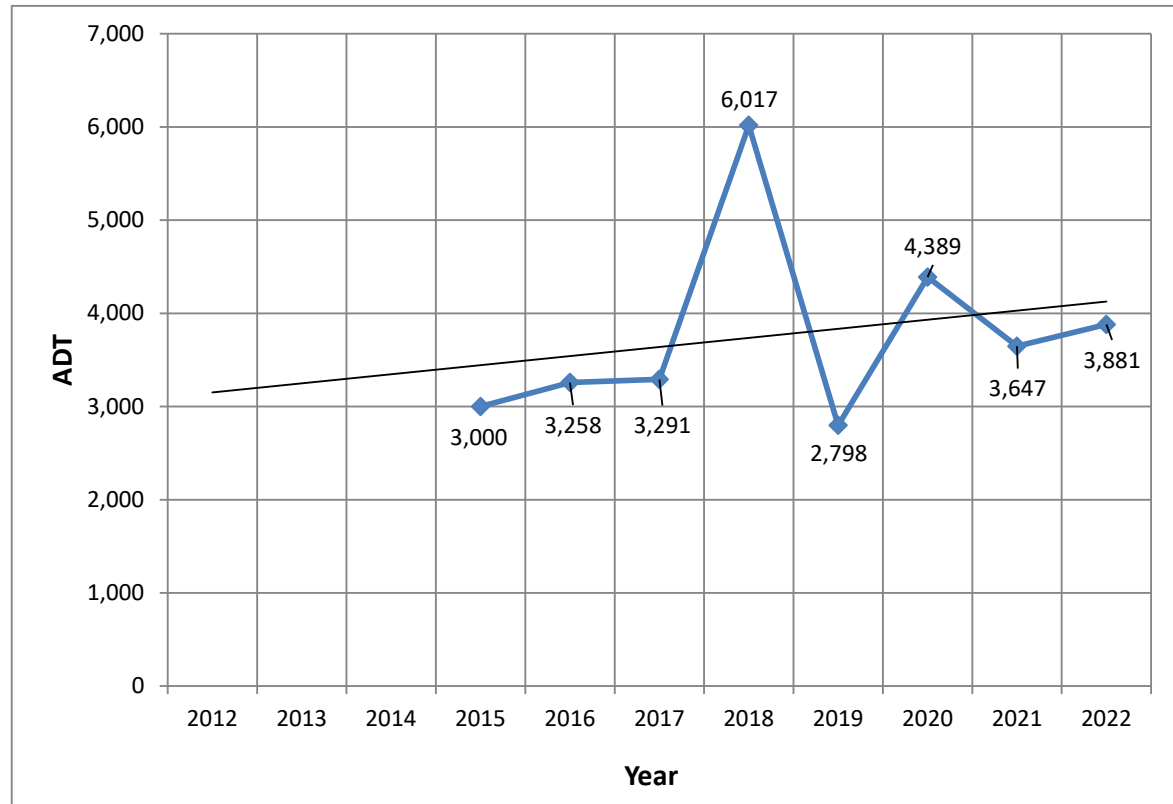
## Historical Traffic Counts

Organization: TDOT

Station ID #: 47000514

Location: Tipton Station Road, east of Martin Mill Pike


YEAR	ADT	
2012		
2013		
2014		
2015	3,000	Trendline ↓
2016	3,258	
2017	3,291	
2018	6,017	
2019	2,798	
2020	4,389	
2021	3,647	
2022	3,881	



2015 - 2022 Growth Rate = 29.4%

Average Annual Growth Rate = 3.7%

[List View](#) [All DIRs](#)

Record  7690 of 15697 Goto Record  go

Location ID	47000514	MPO ID	
Type	SPOT	HPMS ID	
On NHS		On HPMS	
LRS ID	4702436001	LRS Loc PL	0.448
SF Group	Urban	Route Type	
AF Group	Urban Minor Collector	Route	
GF Group	Knox	Active	Yes
Class Dist Grp	Urban Minor Collector	Category	CC
Seas Class Grp			
WIM Group			
QC Group	Default		
Frct'l Class	Minor Collector	Milepost	
Located On	02436		
Loc On Alias	TIPTON STATION RD.		
	TIPTON STATION RD-EAST OF MARTIN MILL PK.		

[More Detail](#)

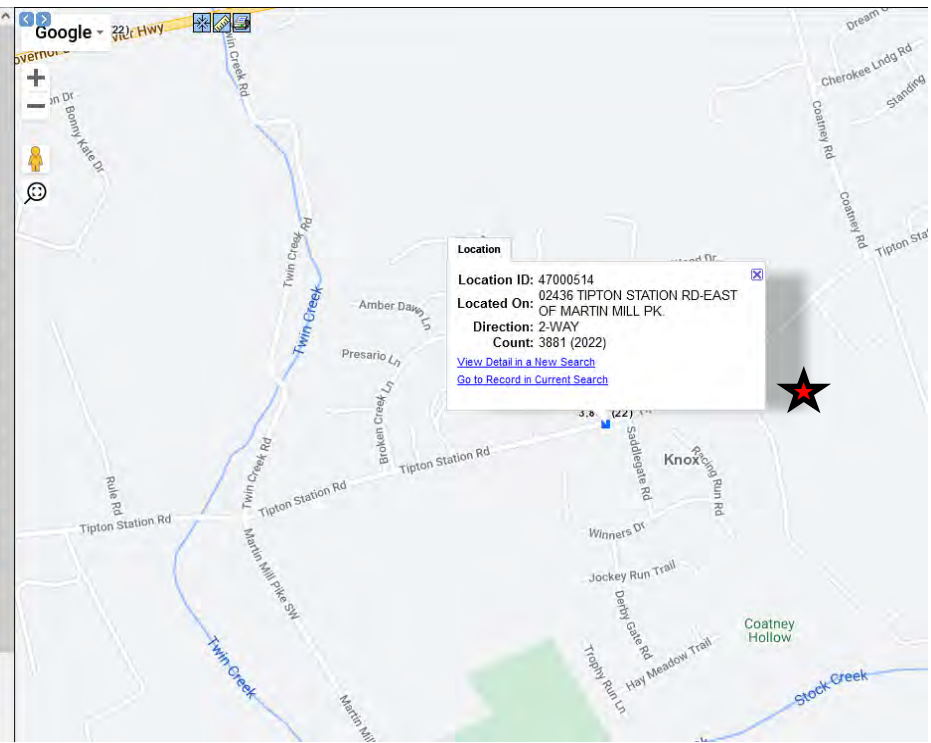
**STATION DATA**

Directions: **2-WAY**

**AADT**

Year	AADT	DHV-30	K %	D %	PA	BC	Src
2022	3,881	454	12	65	3,784 (98%)	97 (2%)	
2021	3,647	394	11	65	3,596 (99%)	51 (1%)	
2020	4,389	487	11	65	4,241 (97%)	148 (3%)	
2019	2,798		14	65			
2018	6,017		14	65			

1-5 of 8



**APPENDIX B**

**MANUAL TRAFFIC COUNT DATA**

### TRAFFIC COUNT DATA

Major Street: Tipton Station Road (WB-EB)  
 Minor Street: (at 2120 Tipton Station Road)  
 Traffic Control: n/a

10/18/2023 (Wednesday)  
 Morning: Fog / Afternoon: Sunny & Mild  
 Conducted by: Ajax Engineering

TIME BEGIN	Tipton Station Road	Tipton Station Road	VEHICLE TOTAL	PEAK HOUR
	WESTBOUND THRU	EASTBOUND THRU		
7:00 AM	31	17	48	
7:15 AM	55	38	93	
7:30 AM	43	91	134	<b>7:30 AM - 8:30 AM</b>
7:45 AM	50	50	100	
8:00 AM	33	61	94	
8:15 AM	65	94	159	
8:30 AM	18	9	27	
8:45 AM	17	14	31	
<b>TOTAL</b>	<b>312</b>	<b>374</b>	<b>686</b>	
2:00 PM	33	26	59	
2:15 PM	20	12	32	
2:30 PM	30	23	53	
2:45 PM	20	68	88	
3:00 PM	19	42	61	
3:15 PM	19	59	78	
3:30 PM	120	44	164	<b>3:30 PM - 4:30 PM</b>
3:45 PM	42	34	76	
4:00 PM	52	40	92	
4:15 PM	40	42	82	
4:30 PM	39	36	75	
4:45 PM	37	31	68	
5:00 PM	36	52	88	
5:15 PM	49	75	124	
5:30 PM	41	59	100	
5:45 PM	27	61	88	
<b>TOTAL</b>	<b>624</b>	<b>704</b>	<b>1328</b>	

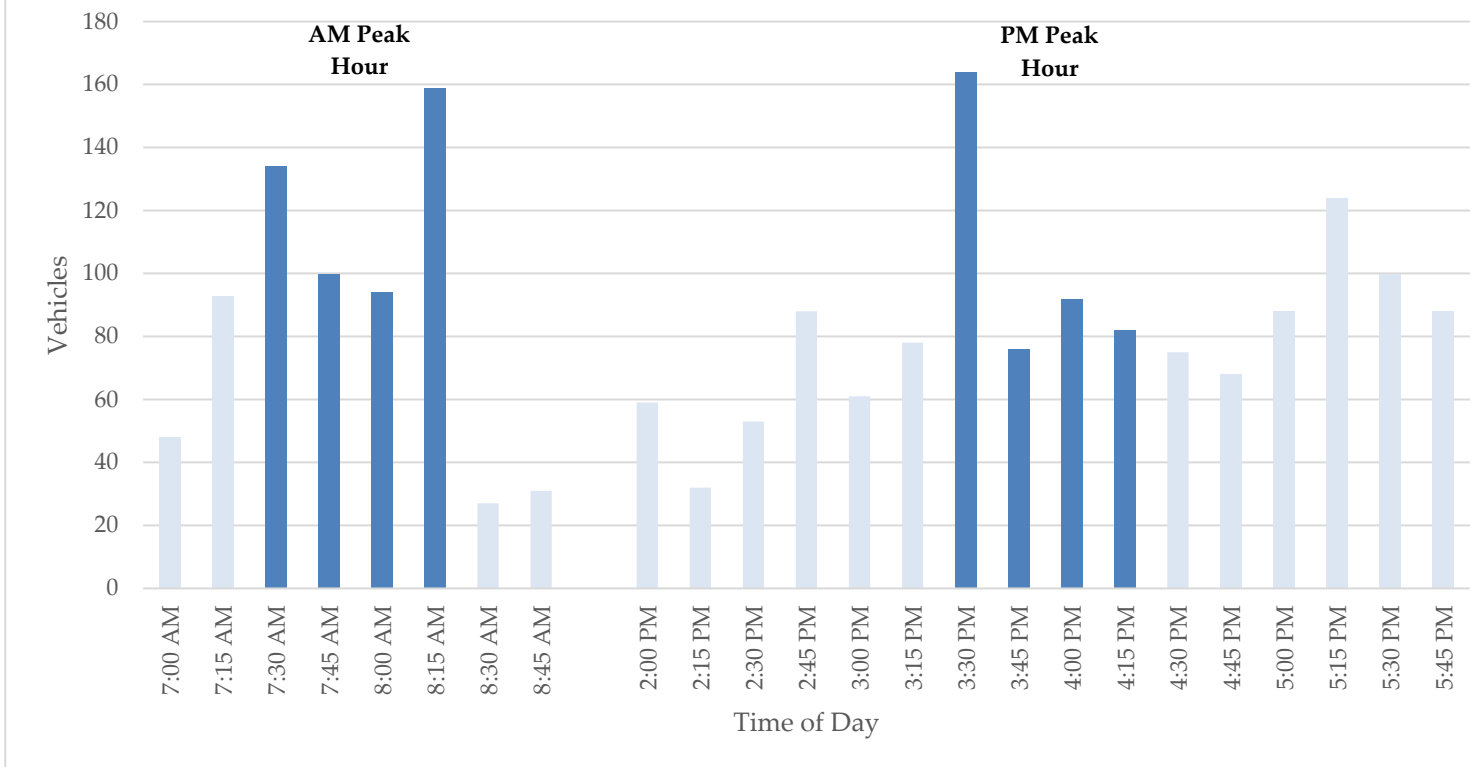
**2023 AM Peak Hour** **7:30 AM - 8:30 AM**

TIME BEGIN	Tipton Station Road	Tipton Station Road
	WESTBOUND THRU	EASTBOUND THRU
7:30 AM	43	91
7:45 AM	50	50
8:00 AM	33	61
8:15 AM	65	94
<b>TOTAL</b>	<b>191</b>	<b>296</b>
<b>PHF</b>	<b>0.73</b>	<b>0.79</b>
<b>Truck %</b>	<b>1.1%</b>	<b>1.4%</b>

**2023 PM Peak Hour** **3:30 PM - 4:30 PM**

TIME BEGIN	Tipton Station Road	Tipton Station Road
	WESTBOUND THRU	EASTBOUND THRU
3:30 PM	120	44
3:45 PM	42	34
4:00 PM	52	40
4:15 PM	40	42
<b>TOTAL</b>	<b>254</b>	<b>160</b>
<b>PHF</b>	<b>0.53</b>	<b>0.91</b>
<b>Truck %</b>	<b>2.8%</b>	<b>0.6%</b>

# Tipton Station Road (at 2120 Tipton Station Road ) Traffic Count Totals 10/18/2023





**TRAFFIC COUNT DATA**

Major Street: Tipton Station Road (EB and WB)  
 Minor Street: Saddlegate Road (NB) / Timber Wood Boulevard (SB)  
 Traffic Control: Stop Signs on Minor Streets

10/18/2023 (Wednesday)  
 Morning: Fog / Afternoon: Sunny & Mild  
 Conducted by: Ajax Engineering

TIME BEGIN	Timber Wood Boulevard			Tipton Station Road			Saddlegate Road			Tipton Station Road			VEHICLE TOTAL	PEAK HOUR
	SOUTHBOUND			WESTBOUND			NORTHBOUND			EASTBOUND				
	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT		
7:00 AM		0		1			11	0	4			1	17	7:00 AM - 8:00 AM
7:15 AM		0		1			12	0	4			4	21	
7:30 AM		0		1			10	0	10			1	22	
7:45 AM		0		3			7	0	2			3	15	
8:00 AM		0		1			7	0	4			3	15	
8:15 AM		0		3			6	0	5			3	17	
8:30 AM		0		0			4	0	2			3	9	
8:45 AM		0		3			2	0	4			1	10	
<b>TOTAL</b>		0		13			59	0	35			19	126	
2:00 PM		0		2			3	0	3			3	11	
2:15 PM		0		2			3	0	0			4	9	
2:30 PM		0		3			1	1	3			2	10	
2:45 PM		2		2			2	0	3			6	15	
3:00 PM		0		5			3	0	3			2	13	
3:15 PM		0		2			1	0	4			6	13	
3:30 PM		0		6			2	0	3			8	19	
3:45 PM		0		6			1	1	3			2	13	
4:00 PM		0		2			3	0	0			5	10	
4:15 PM		0		2			1	0	2			3	8	
4:30 PM		0		6			3	0	3			5	17	
4:45 PM		0		2			1	1	1			3	8	
5:00 PM		0		3			4	0	0			9	16	5:00 PM - 6:00 PM
5:15 PM		1		5			10	0	5			6	27	
5:30 PM		0		3			7	0	2			7	19	
5:45 PM		0		2			4	0	4			10	20	
<b>TOTAL</b>		3		53			49	3	39			81	228	

**2023 AM Peak Hour 7:00 AM - 8:00 AM**

TIME BEGIN	Timber Wood Boulevard			Tipton Station Road			Saddlegate Road			Tipton Station Road		
	SOUTHBOUND			WESTBOUND			NORTHBOUND			EASTBOUND		
	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT
7:00 AM		0		1			11	0	4			1
7:15 AM		0		1			12	0	4			4
7:30 AM		0		1			10	0	10			1
7:45 AM		0		3			7	0	2			3
<b>TOTAL</b>		0		6			40	0	20			9
<b>PHF</b>		-		0.50			0.83	-	0.50			0.56

**2023 PM Peak Hour 5:00 PM - 6:00 PM**

TIME BEGIN	Timber Wood Boulevard			Tipton Station Road			Saddlegate Road			Tipton Station Road		
	SOUTHBOUND			WESTBOUND			NORTHBOUND			EASTBOUND		
	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT
5:00 PM		0		3			4	0	0			9
5:15 PM		1		5			10	0	5			6
5:30 PM		0		3			7	0	2			7
5:45 PM		0		2			4	0	4			10
<b>TOTAL</b>		1		13			25	0	11			32
<b>PHF</b>		0.25		0.65			0.63	-	0.55			0.80

**APPENDIX C**

**ITE TRIP GENERATION RATES**

# Land Use: 210

## Single-Family Detached Housing

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### Description

A single-family detached housing site includes any single-family detached home on an individual lot. A typical site surveyed is a suburban subdivision.

### Specialized Land Use

Data have been submitted for several single-family detached housing developments with homes that are commonly referred to as patio homes. A patio home is a detached housing unit that is located on a small lot with little (or no) front or back yard. In some subdivisions, communal maintenance of outside grounds is provided for the patio homes. The three patio home sites total 299 dwelling units with overall weighted average trip generation rates of 5.35 vehicle trips per dwelling unit for weekday, 0.26 for the AM adjacent street peak hour, and 0.47 for the PM adjacent street peak hour. These patio home rates based on a small sample of sites are lower than those for single-family detached housing (Land Use 210), lower than those for single-family attached housing (Land Use 251), and higher than those for senior adult housing -- single-family (Land Use 251). Further analysis of this housing type will be conducted in a future edition of *Trip Generation Manual*.

### Additional Data

The technical appendices provide supporting information on time-of-day distributions for this land use. The appendices can be accessed through either the ITETripGen web app or the trip generation resource page on the ITE website (<https://www.ite.org/technical-resources/topics/trip-and-parking-generation/>).

For 30 of the study sites, data on the number of residents and number of household vehicles are available. The overall averages for the 30 sites are 3.6 residents per dwelling unit and 1.5 vehicles per dwelling unit.

The sites were surveyed in the 1980s, the 1990s, the 2000s, and the 2010s in Arizona, California, Connecticut, Delaware, Illinois, Indiana, Kentucky, Maryland, Massachusetts, Minnesota, Montana, New Jersey, North Carolina, Ohio, Ontario (CAN), Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Vermont, Virginia, and West Virginia.

### Source Numbers

100, 105, 114, 126, 157, 167, 177, 197, 207, 211, 217, 267, 275, 293, 300, 319, 320, 356, 357, 367, 384, 387, 407, 435, 522, 550, 552, 579, 598, 601, 603, 614, 637, 711, 716, 720, 728, 735, 868, 869, 903, 925, 936, 1005, 1007, 1008, 1010, 1033, 1066, 1077, 1078, 1079

# Single-Family Detached Housing (210)

Vehicle Trip Ends vs: Dwelling Units  
On a: Weekday

Setting/Location: General Urban/Suburban

Number of Studies: 174

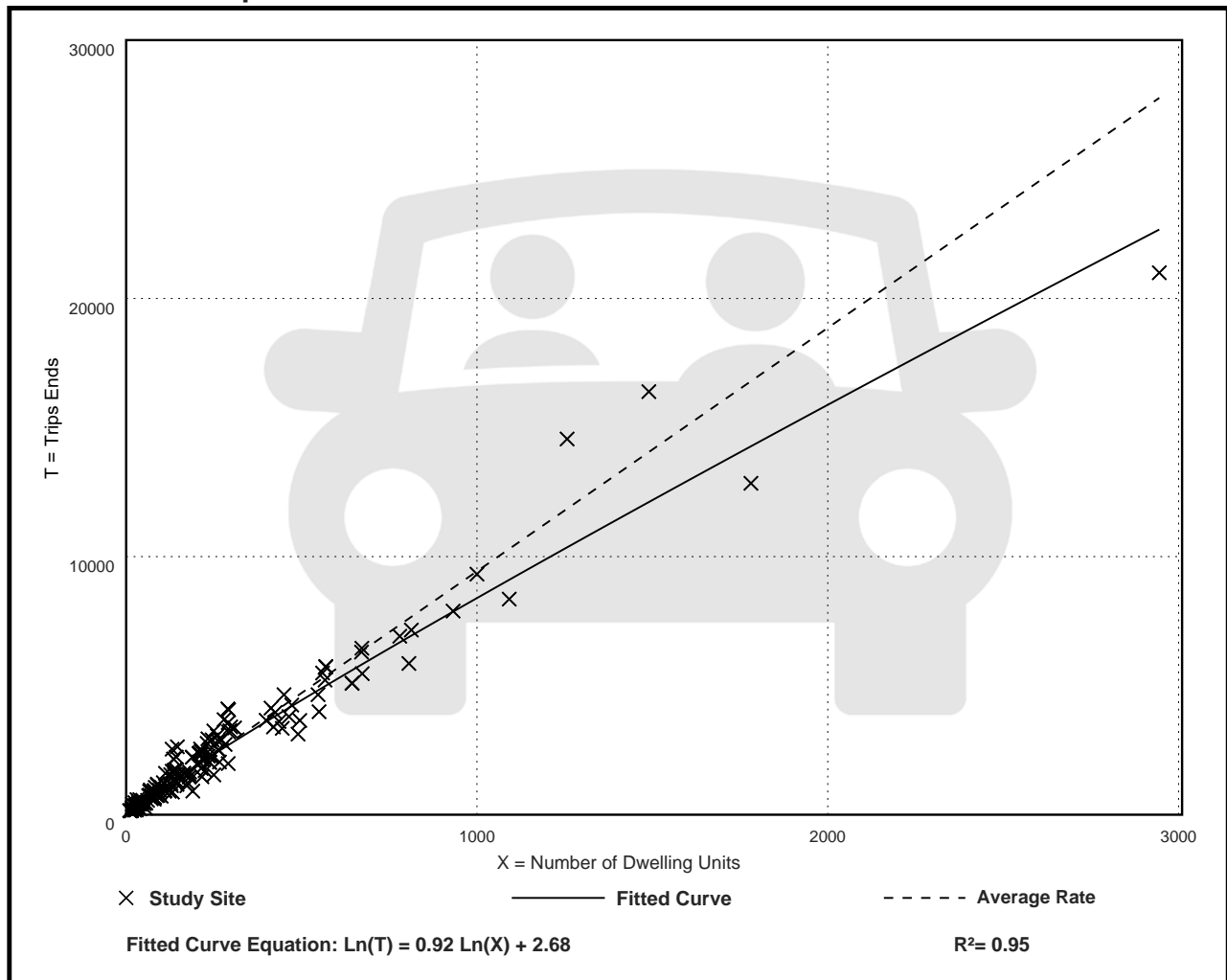
Avg. Num. of Dwelling Units: 246

Directional Distribution: 50% entering, 50% exiting

## Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
9.43	4.45 - 22.61	2.13

## 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: 192

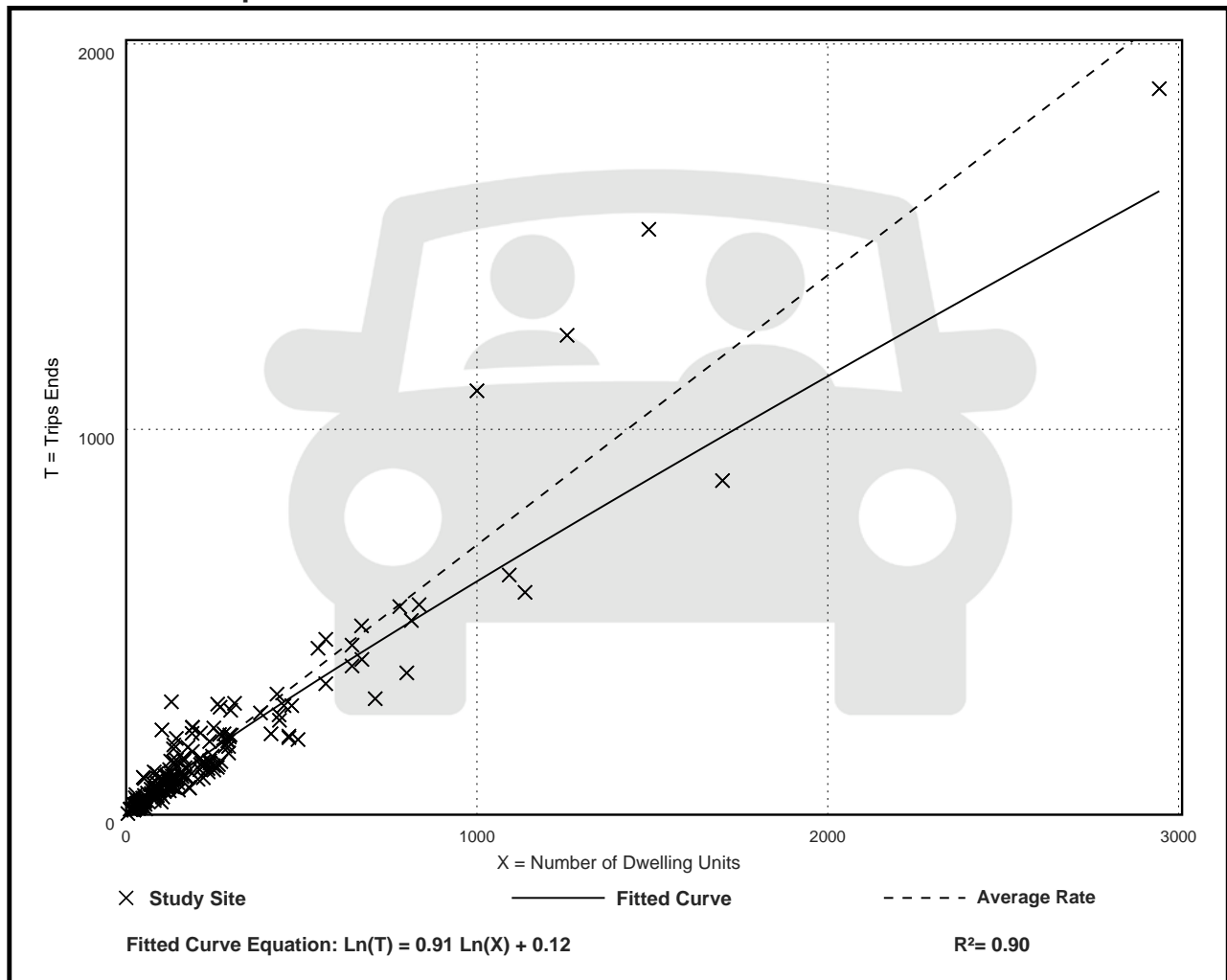
Avg. Num. of Dwelling Units: 226

Directional Distribution: 26% entering, 74% exiting

## Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.70	0.27 - 2.27	0.24

## 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: 208

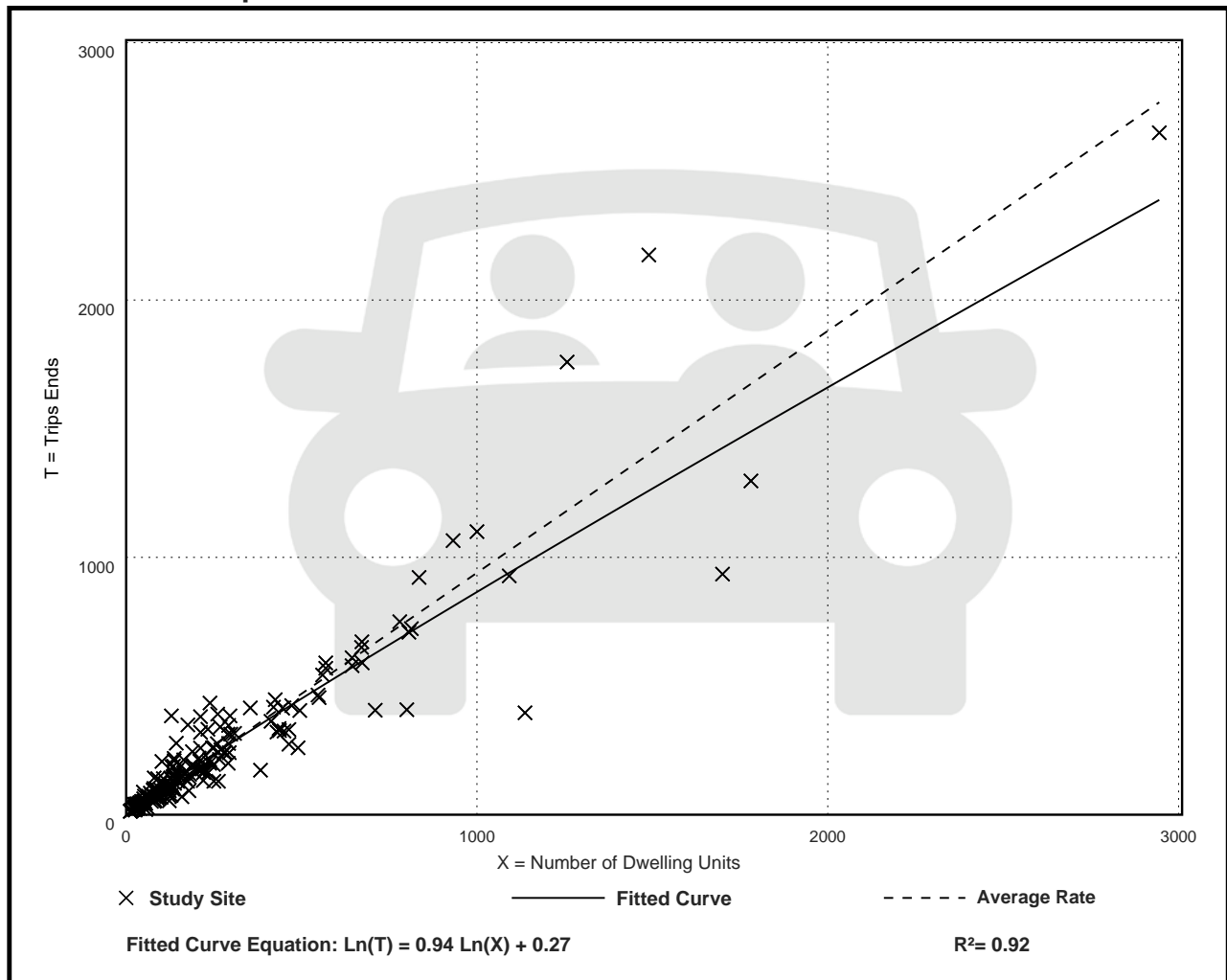
Avg. Num. of Dwelling Units: 248

Directional Distribution: 63% entering, 37% exiting

## Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.94	0.35 - 2.98	0.31

## Data Plot and Equation



**TRIP GENERATION FOR CMH HOMES DEVELOPMENT**

**74 Single-Family Detached Houses**

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	74 Houses	765	26%	74%		63%	37%	
				15	42	57	47	28	75
<b>Total New Volume Site Trips</b>			<b>765</b>	<b>15</b>	<b>42</b>	<b>57</b>	<b>47</b>	<b>28</b>	<b>75</b>

ITE Trip Generation Manual, 11th Edition

Trips calculated by using Fitted Curve Equation

# TRIP GENERATION FOR CMH HOMES DEVELOPMENT

## 74 Single-Family Detached Houses

74 Residential Houses = X

---

### Weekday:

Fitted Curve Equation:  $\text{Ln}(T) = 0.92 \text{Ln}(X) + 2.68$

$$\text{Ln}(T) = 0.92 * 4.30 + 2.68$$

$$\text{Ln}(T) = 6.64$$

$$\underline{\underline{T = 765 \text{ trips}}}$$

---

### Peak Hour of Adjacent Traffic between 7 and 9 am:

Fitted Curve Equation:  $\text{Ln}(T) = 0.91 \text{Ln}(X) + 0.12$

$$T = 0.91 * 4 + 0.12$$

$$\text{Ln}(T) = 4.04$$

$$\underline{\underline{T = 57 \text{ trips}}}$$

---

### Peak Hour of Adjacent Traffic between 4 and 6 pm:

Fitted Curve Equation:  $\text{Ln}(T) = 0.94 \text{Ln}(X) + 0.27$

$$\text{Ln}(T) = 0.94 * 4.30 + 0.27$$

$$\text{Ln}(T) = 4.32$$

$$\underline{\underline{T = 75 \text{ trips}}}$$



**TRIP GENERATION FOR CMH HOMES DEVELOPMENT**

**74 Single-Family Detached Houses + 4 Existing Single-Family Detached Houses**

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	78 Houses	803	26%	74%		63%	37%	
				15	44	59	50	29	79
<b>Total New Volume Site Trips</b>			<b>803</b>	<b>15</b>	<b>44</b>	<b>59</b>	<b>50</b>	<b>29</b>	<b>79</b>

ITE Trip Generation Manual, 11th Edition

Trips calculated by using Fitted Curve Equation

## TRIP GENERATION FOR CMH HOMES DEVELOPMENT

74 Single-Family Detached Houses + 4 Existing Single-Family Detached Ho

78 Residential Houses = X

---

### Weekday:

Fitted Curve Equation:  $\ln(T) = 0.92 \ln(X) + 2.68$

$$\ln(T) = 0.92 * 4.36 + 2.68$$

$$\ln(T) = 6.69$$

$$\underline{\underline{T = 803 \text{ trips}}}$$

---

### Peak Hour of Adjacent Traffic between 7 and 9 am:

Fitted Curve Equation:  $\ln(T) = 0.91 \ln(X) + 0.12$

$$T = 0.91 * 4 + 0.12$$

$$\ln(T) = 4.08$$

$$\underline{\underline{T = 59 \text{ trips}}}$$

---

### Peak Hour of Adjacent Traffic between 4 and 6 pm:

Fitted Curve Equation:  $\ln(T) = 0.94 \ln(X) + 0.27$

$$\ln(T) = 0.94 * 4.36 + 0.27$$

$$\ln(T) = 4.37$$

$$\underline{\underline{T = 79 \text{ trips}}}$$

**APPENDIX D**

**CAPACITY ANALYSES – HCM WORKSHEETS (SYNCHRO 11)**

**PROJECTED CONDITIONS (WITH THE PROJECT)**

HCM 2010 TWSC  
 4: Proposed Entrance & Tipton Station Road

11/27/2023

Intersection						
Int Delay, s/veh	0.9					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	355	8	7	229	26	18
Future Vol, veh/h	355	8	7	229	26	18
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	2	-	-	-2	0	-
Peak Hour Factor	79	90	90	73	90	90
Heavy Vehicles, %	1	0	0	1	0	0
Mvmt Flow	449	9	8	314	29	20

Major/Minor	Major1	Major2	Minor1		
Conflicting Flow All	0	0	458	0	784
Stage 1	-	-	-	-	454
Stage 2	-	-	-	-	330
Critical Hdwy	-	-	4.1	-	6.4
Critical Hdwy Stg 1	-	-	-	-	5.4
Critical Hdwy Stg 2	-	-	-	-	5.4
Follow-up Hdwy	-	-	2.2	-	3.5
Pot Cap-1 Maneuver	-	-	1114	-	365
Stage 1	-	-	-	-	644
Stage 2	-	-	-	-	733
Platoon blocked, %	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	1114	-	362
Mov Cap-2 Maneuver	-	-	-	-	362
Stage 1	-	-	-	-	644
Stage 2	-	-	-	-	726

Approach	EB	WB	NB
HCM Control Delay, s	0	0.2	14.3
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	434	-	-	1114	-
HCM Lane V/C Ratio	0.113	-	-	0.007	-
HCM Control Delay (s)	14.3	-	-	8.3	0
HCM Lane LOS	B	-	-	A	A
HCM 95th %tile Q(veh)	0.4	-	-	0	-

HCM 2010 TWSC  
 4: Proposed Entrance & Tipton Station Road

11/27/2023

Intersection						
Int Delay, s/veh	0.7					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	192	28	22	305	15	14
Future Vol, veh/h	192	28	22	305	15	14
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	2	-	-	-2	0	-
Peak Hour Factor	91	90	90	53	90	90
Heavy Vehicles, %	1	0	0	3	0	0
Mvmt Flow	211	31	24	575	17	16

Major/Minor	Major1	Major2	Minor1		
Conflicting Flow All	0	0	242	0	850 227
Stage 1	-	-	-	-	227 -
Stage 2	-	-	-	-	623 -
Critical Hdwy	-	-	4.1	-	6.4 6.2
Critical Hdwy Stg 1	-	-	-	-	5.4 -
Critical Hdwy Stg 2	-	-	-	-	5.4 -
Follow-up Hdwy	-	-	2.2	-	3.5 3.3
Pot Cap-1 Maneuver	-	-	1336	-	334 817
Stage 1	-	-	-	-	815 -
Stage 2	-	-	-	-	539 -
Platoon blocked, %	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	1336	-	325 817
Mov Cap-2 Maneuver	-	-	-	-	325 -
Stage 1	-	-	-	-	815 -
Stage 2	-	-	-	-	525 -

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	13.5
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	458	-	-	1336	-
HCM Lane V/C Ratio	0.07	-	-	0.018	-
HCM Control Delay (s)	13.5	-	-	7.7	0
HCM Lane LOS	B	-	-	A	A
HCM 95th %tile Q(veh)	0.2	-	-	0.1	-

**APPENDIX E**

**KNOX COUNTY TURN LANE VOLUME THRESHOLD WORKSHEETS**

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)

229

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			35
450 - 499	80	65	55			30
500 - 549	70	60	45			25
550 - 599	65	55	40			25
600 - 649	60	45	35			25
650 - 699	55	35	35			20
700 - 749	50	35	30			20
750 or More	45	35	25	25	20	20

Tipton Station Road at the Proposed Entrance

2027 Projected AM WB Left Turns = 7

Left Turn Lane NOT Warranted

355+8 =  
363

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		
8 Fewer Than 25 25 - 49 50 - 99						355		
100 - 149 150 - 199			Tipton Station Road at the Proposed Entrance  2027 Projected AM EB Right Turns = 8  Right Turn Lane NOT Warranted					
200 - 249 250 - 299							Yes	Yes
300 - 349 350 - 399						Yes	Yes	Yes
400 - 449 450 - 499		Yes				Yes	Yes	Yes
500 - 549 550 - 599	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
100 - 149 150 - 199		Yes	Yes	Yes	Yes	Yes
200 - 249 250 - 299	Yes	Yes	Yes	Yes	Yes	Yes
300 - 349 350 - 399	Yes	Yes	Yes	Yes	Yes	Yes
400 - 449 450 - 499	Yes	Yes	Yes	Yes	Yes	Yes
500 - 549 550 - 599	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		60	55	45
350 - 399	100	80		55	50	40
400 - 449	90	70		50	45	35
450 - 499	80	65		45	40	30
500 - 549	70	60		35	35	25
550 - 599	65	55		35	30	25
600 - 649	60	45		30	25	25
650 - 699	55	35		30	25	20
700 - 749	50	35	30	25	20	20
750 or More	45	35	25	25	20	20

192+28  
= 220

305

Tipton Station Road at  
the Proposed Entrance  
  
2027 Projected PM  
WB Left Turns = 22  
  
Left Turn Lane NOT  
Warranted

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

192

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						Yes
250 - 299					Yes	Yes
300 - 349				Yes	Yes	Yes
350 - 399				Yes	Yes	Yes
400 - 449				Yes	Yes	Yes
450 - 499				Yes	Yes	Yes
500 - 549		Yes	Yes	Yes	Yes	Yes
550 - 599	Yes	Yes	Yes	Yes	Yes	Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

Tipton Station Road at  
the Proposed Entrance

2027 Projected PM  
EB Right Turns = 28

Right Turn Lane NOT  
Warranted

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					Yes	Yes
50 - 99				Yes	Yes	Yes
100 - 149			Yes	Yes	Yes	Yes
150 - 199		Yes	Yes	Yes	Yes	Yes
200 - 249	Yes	Yes	Yes	Yes	Yes	Yes
250 - 299	Yes	Yes	Yes	Yes	Yes	Yes
300 - 349	Yes	Yes	Yes	Yes	Yes	Yes
350 - 399	Yes	Yes	Yes	Yes	Yes	Yes
400 - 449	Yes	Yes	Yes	Yes	Yes	Yes
450 - 499	Yes	Yes	Yes	Yes	Yes	Yes
500 - 549	Yes	Yes	Yes	Yes	Yes	Yes
550 - 599	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 F**

### **SIMTRAFFIC VEHICLE QUEUE WORKSHEETS**

---

Intersection: 4: Proposed Entrance & Tipton Station Road

---

Movement	WB	NB
Directions Served	LT	LR
Maximum Queue (ft)	19	48
Average Queue (ft)	1	23
95th Queue (ft)	11	43
Link Distance (ft)	143	206
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

---

Network Summary

---

Network wide Queuing Penalty: 0

---

Intersection: 4: Proposed Entrance & Tipton Station Road

---

Movement	WB	NB
Directions Served	LT	LR
Maximum Queue (ft)	32	42
Average Queue (ft)	2	17
95th Queue (ft)	17	40
Link Distance (ft)	143	206
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

---

Network Summary

---

Network wide Queuing Penalty: 0

**APPENDIX G**

**LETTER RESPONSE DOCUMENT**



CIVIL ENGINEERING / TRAFFIC ENGINEERING

11812 Black Road  
Knoxville, Tennessee 37932  
Phone (865) 556-0042  
[ajaxengineering@gmail.com](mailto:ajaxengineering@gmail.com)

December 14, 2023

**PROJECT NAME: CMH Homes Development (10-SB-23-C / 10-B-23-DP)**  
**TO: Knoxville-Knox County Planning**  
**SUBJECT: Response Document for CMH Homes Development TIL Review Comments**

Knoxville-Knox County Planning and Knox County Engineering:

The following response document addresses the comments in an email from Mike Conger, PE, dated December 8, 2023. This letter is added to the end of the revised report in Appendix G.

1. **Regarding the recommendations that were made for the signs within the neighborhood shown in the figure on Page 36 - it is preferred to change the "Pavement Ends" sign for Road "B" to instead be a "No Outlet" sign with a No Turn Around plaque in order to prevent drivers from continuing on the road and having to turn around in a private driveway/yard.**

Response: On Page 36, the "Pavement Ends" sign has been replaced with a "No Outlet" (W14-2) Sign and shown supplemented with a "No Turnaround" Sign at the end of Road "B" in the figure and updated in the discussion. This change has also been made on Page 3 in the Recommendations.

2. **Also on Page 36, please note that the red object marker (OM4-1) should be double posted at an appropriate width apart where shown for Road "D".**

Response: On Page 36, the red object marker (OM4-1) is shown with a dual configuration in the figure and updated in the discussion. This change has also been made on Page 3 in the Recommendations.

3. **Please reference the requirements in the Subdivision Regulations in Section 3.04.C.2.d "Notification of future street connection", which calls for a sign to be posted to make residents aware of a possible future extension. Also add a call-out to Figure 3 and on Page 36 for the Road "D" terminus indicating the stub-out purpose and coordinate with the site-civil engineer to ensure that it is clearly indicated on the site plans as well.**



Response: On Page 36, a notification of future street connection sign is shown in the figure and updated in the discussion. This change has also been made on Page 3 in the Recommendations. A call-out has also been placed in Figure 3.

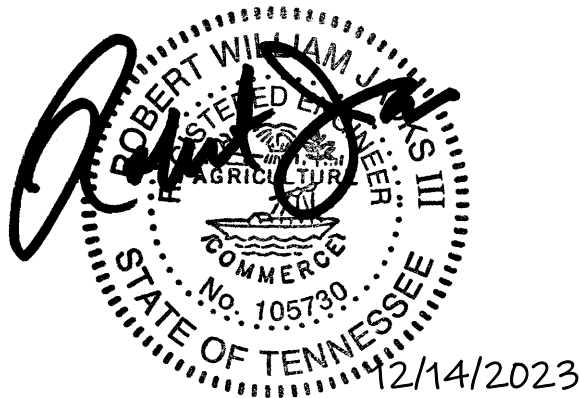
In addition to the revisions listed above, other changes in the report include the following:

- Updated Title Page
- Updated Table of Contents
- Updated Page Footers
- Added Appendix G to include this response letter

If you have any questions or further comments, please contact me. I look forward to your approval.

Sincerely,

Ajax Engineering, LLC  
Robert W. Jacks, P.E.



Ajax Engineering, LLC  
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Knoxville, TN 37932  
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