

# TRANSPORTATION IMPACT STUDY

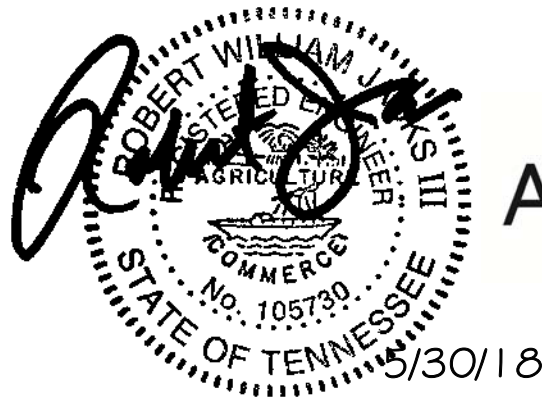
## BRAKEBILL ROAD DEVELOPMENT

### KNOX COUNTY, TENNESSEE

-Prepared For-

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Revised May 2018

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## **EXECUTIVE SUMMARY**

### **Preface:**

Vertex Development, LLC is proposing a residential and commercial development consisting of single-family homes, an apartment complex and a mini-warehouse facility adjacent to Brakebill Road and Hammer Road in east Knox County, TN. Currently, the name of the proposed development is “Brakebill Road Development”. The purpose of this study is to determine and evaluate the potential impacts of the proposed development on the adjacent transportation system. The study includes a review of the operating characteristics of the transportation system that will provide access to the proposed site. This study will analyze and recommend potential mitigation measures if traffic operations are estimated to be below traffic engineering standards.

### **Study Results:**

The findings of this study include the following:

- With the 94.9-acre site being constructed with 247 single-family detached home sites, 78 single-family attached home sites (for a total of 325 single-family home sites), a 250-unit apartment complex and a 4.1-acre mini-warehouse facility; the development is expected to generate approximately 5,254 new trips on an average weekday. Approximately 362 of these new trips are estimated to occur during the AM peak hour of traffic and 481 trips in the PM peak hour of traffic at full build-out and occupancy. For this study, it was assumed that this development will reach full build-out and occupancy in the year 2025.
- A total of four new unsignalized intersections will be created by this new development. These intersections are projected to operate with minimal delays. Of the four existing intersections examined in the study, two of them were projected to need modifications.
- Based on the review of the vehicle crash history and the study observations on Brakebill Road, it was determined that the narrowness of Brakebill Road could be a contributing factor to vehicle crashes and could possibly be prevented with remediation strategies.

## **Recommendations:**

An overview of the recommendations for the external roadways and intersections is provided in Figure 10 on page 72. The following recommendations are listed here and offered based on the study analyses:

- A Stop Sign (R1-1) with a 24” white stop bar needs to be installed on the eastbound approach of Hammer Road at Brakebill Road.
- The new Road “A” at Brakebill Road intersection will require a separate northbound left turn lane on Brakebill Road with a storage length of 75 feet. This lane should be constructed prior to the 325-lot residential subdivision being opened to residents.
- The existing Strawberry Plains Pike at Brakebill Road intersection currently meets warrants for traffic signalization based on the existing traffic counts. This intersection currently is operating with a poor level of service and has high vehicle delays for eastbound left turns. It is recommended that this intersection have a traffic signal installed and coordinated with the existing traffic signal to the south at the Strawberry Plains Pike and Interstate 40 On/Off Ramps (north side) intersection. Based on the projected volumes in 2025 and a preliminary traffic signal design, the existing northbound left turn lane at the Strawberry Plains Pike at Brakebill Road will need to be increased in length to a minimum of 205 feet. This traffic signal should be constructed prior to the 325-lot residential subdivision being opened to residents.
- Based on the projected traffic volumes in 2025, the existing turn lanes at the Strawberry Plains Pike and Interstate 40 On/Off Ramps (north side) intersection will need to be modified. The projected results in the study show that an additional northbound left turn lane will be required due to this traffic movement exceeding 300 vehicles per hour in the PM peak hour. Adding an additional northbound left turn lane will require constructing a second lane on the westbound Interstate 40 On Ramp and merging these lanes prior to or on westbound Interstate 40. The existing northbound left turn lane has approximately 190 feet of storage. Based on the projected volumes, in addition to

adding a second turn lane, these dual lanes will also need each to be increased to a length of 225 feet.

- Based on the narrowness of Brakebill Road and the recent past crash history, it is recommended that remediation strategies be employed to attempt to reduce future vehicle crashes. While this road was evaluated to not meet the benchmark for TDOT safety funding, Brakebill Road crash history indicates that a substantial amount of crashes involved head-on, opposite direction sideswipe, and road departure crashes. The recommended strategies include identifying and removing/re-locating road side hazards, installing advanced warning signage on two existing horizontal curves, and installing rumble strips on the centerline and the edge line of Brakebill Road. Eventually, Brakebill Road will need to be widened and upgraded since it is a major collector and is an important link in between Asheville Highway (US 25E/Hwy 11E) and Strawberry Plains Pike at Interstate 40. The current width of Brakebill Road adjacent to the development site is approximately 18.5 feet and it would be beneficial to widen and upgrade the road to facilitate travel in between Strawberry Plains Pike and Asheville Highway (US 25E/Hwy 11E).

## DESCRIPTION OF EXISTING CONDITIONS

### ■ **STUDY AREA:**

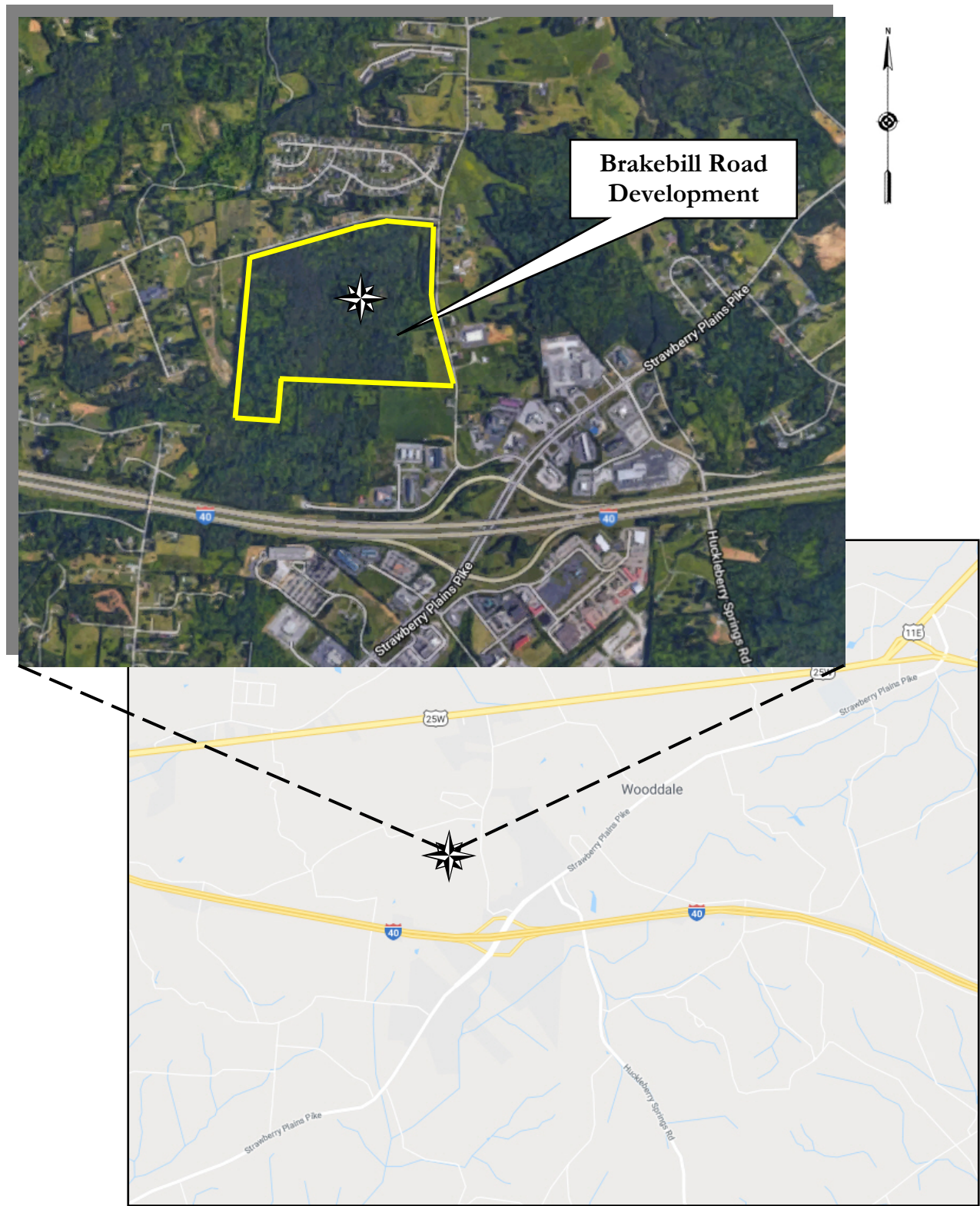
The proposed location of this new development is shown on a map in Figure 1. The proposed development is to be located adjacent to Brakebill Road and Hammer Road in east Knox County, TN. The development site is located to the south of Asheville Highway (US 25E/Hwy 11E), west of Strawberry Plains Pike and north of Interstate 40. The proposed development is to be comprised of several internal paved roads and will contain 247 single-family detached home sites, 78 single-family attached home sites, 250 apartment units, and a 4.1 acre mini-warehouse facility encompassing approximately 94.9 acres. To analyze the transportation impacts associated with the proposed development, the following roadways and intersections were reviewed where the greatest impact is expected and as requested by the Knoxville/Knox County Metropolitan Planning Commission (MPC):

- Asheville Highway (US 25E/Hwy 11E) at Brakebill Road
- Hammer Road at Brakebill Road
- Strawberry Plains Pike at Brakebill Road
- Strawberry Plains Pike at Interstate 40 On/Off Ramps (north side)

The proposed development property is located within Knox County. However, all the study intersections, except for the Hammer Road at Brakebill Road intersection, are located within the City of Knoxville limits.

In the immediate vicinity of this development, there are several residential areas, unused/woodland properties, farm properties, and a temple. The proposed development site property currently consists almost entirely of undeveloped woodlands.

The development property is bounded by Hammer Road to the north, Brakebill Road to the east, undeveloped property and a handful of individual residences to the west, and undeveloped property to the south.



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



■ **EXISTING ROADWAYS:**

Table 1 shows the characteristics of the primary existing roadways included in the study:

**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
Asheville Highway (US 25W / Hwy 11E)	Major Arterial	55 mph	4 divided	100 feet	None	No sidewalks along roadway	No bike lanes
Brakebill Road	Major Collector	30 mph	2 undivided	18.5 feet	None	No sidewalks along roadway	No bike lanes
Hammer Road	Minor Collector	30 mph	2 undivided	16.5 feet	None	No sidewalks along roadway	No bike lanes
Strawberry Plains Pike	Minor Arterial	40 mph	4 divided	120 feet	None	No sidewalks along roadway	No bike lanes

<sup>1</sup> Major Road Plan - May 2011 by Knoxville/Knox County Metropolitan Planning Commission

<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

**Asheville Highway (US 25W/Hwy 11E)** is a major arterial that traverses in a general northeast-southwest direction. According to Wikipedia, US 25W is 145.7 miles in length and runs in between Newport, Tennessee to Corbin, Kentucky. Highway 11E is 120.9 miles in length and runs in between Knoxville, TN and Bristol, Virginia. Closer to the study area, Asheville Highway provides convenient access to Knoxville to the southwest, Jefferson City to the northeast (via Hwy 11E), and Dandridge to the east (via US 25W). At the intersection of Brakebill Road, Asheville Highway is a divided highway with a grass median. Traffic movements at the 4-way intersection of Brakebill Road at Asheville Highway are controlled by a traffic signal and the signal heads are supported on span wires. There are some street lights at the intersection of Asheville Highway (US 25E/Hwy 11E) at Brakebill Road.

**Brakebill Road** provides immediate access to the proposed Brakebill Road Development and traverses in a north-south direction. Brakebill Road is 1.3 miles in length and exists in between Asheville Highway (US 25E/Hwy 11E) to the north and Strawberry Plains Pike to the south. Commercial development is located on each end of Brakebill Road with residential, farm properties, a temple, and undeveloped land in between.

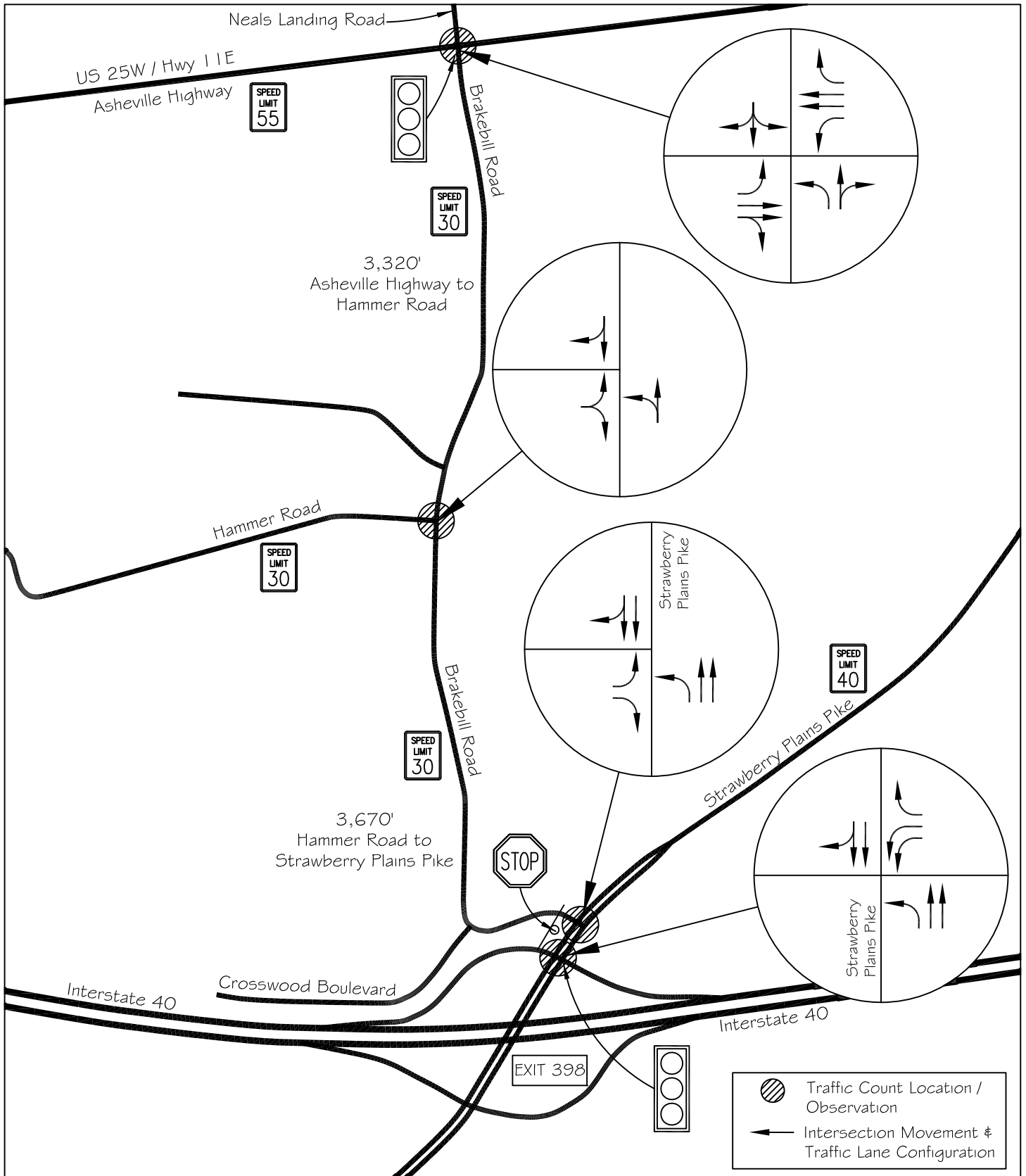
Brakebill Road has a fairly straight horizontal alignment for much of its length but does have some significant horizontal curvature. On the southern end of Brakebill Road, at the intersection with Crosswood Boulevard (prior to the terminus at Strawberry Plains Pike), there is an extreme horizontal road curve with a significant vertical change in grade. The cross slope at this horizontal curve is over 10% with a vertical grade of nearly 8%. While Brakebill Road is classified as a major collector, the road is relatively narrow in width. Evidence of wheel tracking off the pavement is present along Brakebill Road. Brakebill Road intersects Strawberry Plains Pike at a divided highway section with a grass median. At this intersection, the minor roadway, Brakebill Road, is controlled by a Stop Sign (R1-1) for eastbound traffic and Strawberry Plains Pike northbound and southbound traffic operates freely.

**Hammer Road** traverses in a general northeast-southwest direction between Brakebill Road on the east side and Manis Road on the west side (adjacent to Interstate 40). Hammer Road is classified as a minor collector in the study area. Hammer Road was once a continuous road from Brakebill Road to what is now known as Governor John Sevier Highway (SR 168) prior to the construction of Interstate 40. Hammer Road now officially ends on the north side of Interstate 40 at Manis Road but begins again on the south side of Interstate 40 and eventually terminates at Governor John Sevier Highway (SR 168). Hammer Road is a relatively narrow road near the project site and consists entirely of individual residences and farm properties adjacent to the proposed development. The horizontal and vertical alignment on Hammer Road is relatively calm near the proposed development. However, several hundred feet to the west, Hammer Road has two sharp horizontal 90-degree curves. Hammer Road intersects Brakebill Road at a t-intersection. Northbound and southbound traffic on Brakebill Road operates freely at this intersection while the eastbound approach at Hammer Road operates at a stop condition. However, currently, a Stop Sign (R1-1) is not provided on the Hammer Road approach.

**Strawberry Plains Pike** traverses in between Andrew Johnson Highway (Hwy 11E) to the northeast of the project site, past Governor John Sevier Highway (SR 168), and then ends at Thorngrove Pike to the southwest. In the study area, Strawberry Plains Pike is a divided highway with a grass median and has a significant amount of commercial businesses. Gas stations, restaurants, and hotels populate Strawberry Plains Pike adjacent to Interstate 40. Exit 398 of Interstate 40 at Strawberry Plains Pike attracts large amounts of truck traffic and motorists associated with the surrounding development. The intersection of Strawberry Plains Pike at the northern (and southern) Interstate 40 On/Off Ramps is controlled by a traffic signal and the

signal heads are supported on span wires. Roadway lighting is provided at the intersection of Strawberry Plains Pike with Brakebill Road and the Interstate 40 On/Off Ramps (north and south side).

Figure 2 shows the lane configurations of the study area roadways and intersections and shows the study traffic count locations. It also shows the posted speed limits in the area along with distances on Brakebill Road in between Asheville Highway (US 25E/Hwy 11E) and Strawberry Plains Pike. The pages following Figure 2 give an overview of the site study area with photographs.



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NOT TO SCALE



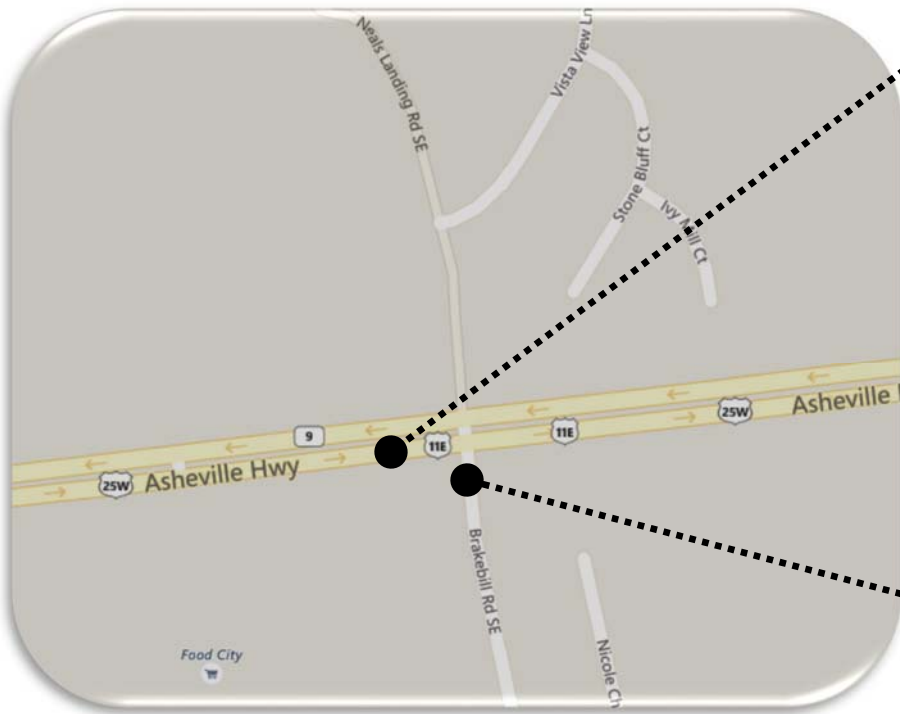
FIGURE 2

Brakebill Road Development

Traffic Count Locations & Existing Lane Configurations

**PHOTO EXHIBITS**

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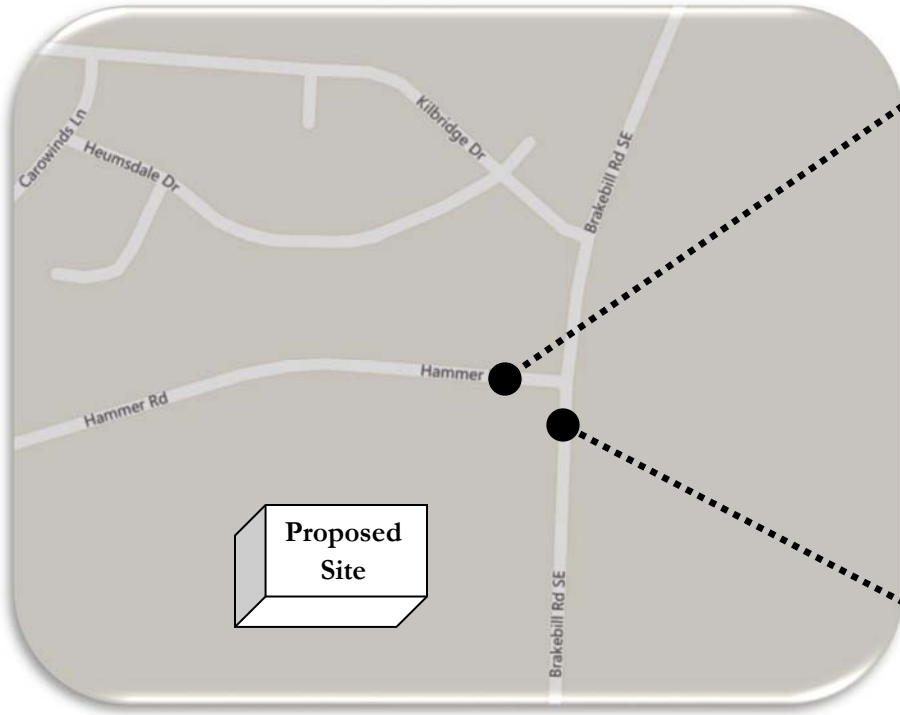
**Asheville Highway (US 25E/Hwy 11E) at Brakebill Road**



**View of Asheville Highway (US 25W/Hwy 11E) at Brakebill Road (Looking East)**



**View of Brakebill Road at Asheville Highway (US 25W/Hwy 11E) (Looking North)**



**Brakebill Road at Hammer Road**

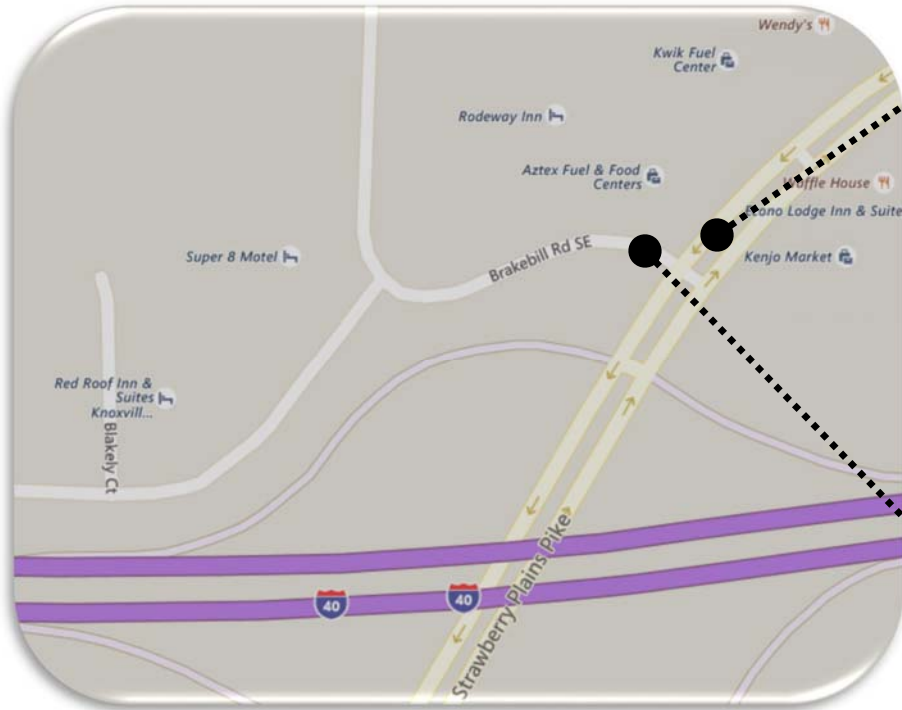


**View of Hammer Road at Brakebill Road  
(Looking East)**



**View of Brakebill Road at Hammer Road  
(Looking North)**





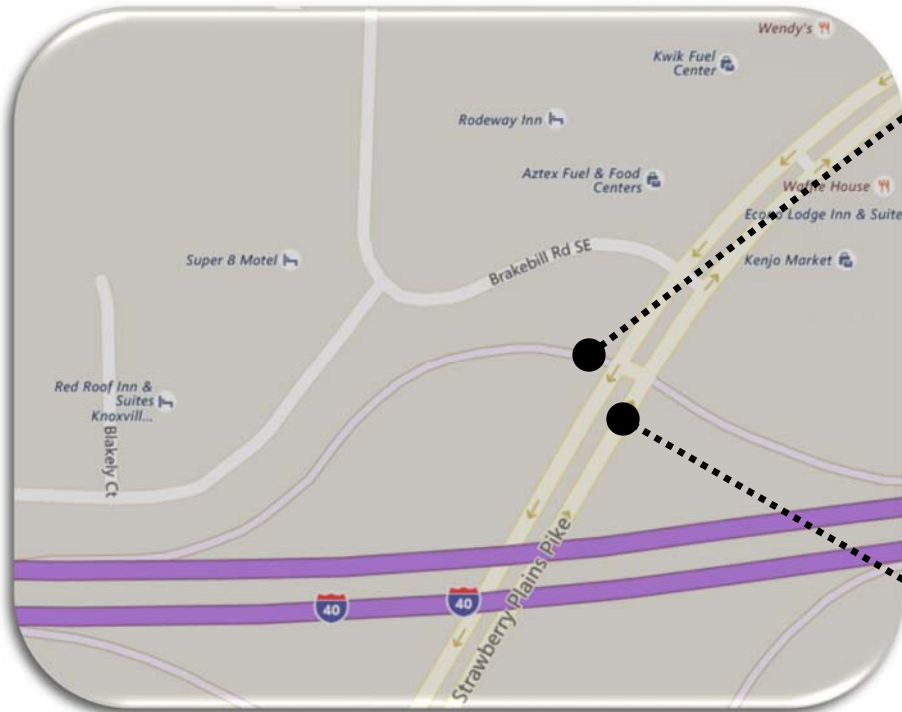
**Brakebill Road at Strawberry Plains Pike**



**View of Strawberry Plains Pike at Brakebill Road  
(Looking Southwest)**



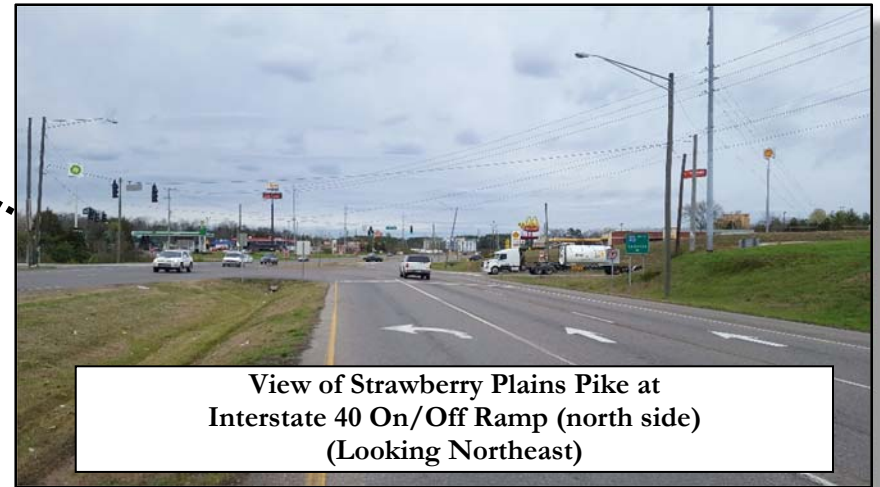
**View of Brakebill Road at Strawberry Plains Pike  
(Looking East)**



Interstate 40 On/Off Ramps (north side) at Strawberry Plains Pike



View of Interstate 40 Off Ramp (north side) at Strawberry Plains Pike (Looking Southeast)



View of Strawberry Plains Pike at Interstate 40 On/Off Ramp (north side) (Looking Northeast)

■ **EXISTING TRANSPORTATION VOLUMES PER MODE:**

There are two annual vehicular traffic count locations adjacent to this project site.

- Existing vehicular roadway traffic:
  - Average Daily Traffic (ADT) on Brakebill Road near the project site was reported by the Tennessee Department of Transportation (TDOT) at 3,278 vehicles per day in 2016. From 2010 – 2016, this count station has indicated a -0.5% average annual growth rate.
  - ADT on Strawberry Plains Pike to the south of Interstate 40 and the project site was reported by the MPC at 17,650 vehicles per day in 2016. Traffic data at this location on Strawberry Plains Pike has been collected sporadically throughout the past 10 years. Due to this lack of regular data collection, a reliable average annual growth rate for Strawberry Plains Pike is difficult to gauge. However, based on data only from 2006, 2008, 2012, and 2016; the average annual growth rate was calculated to be -1.4%. All the researched historical traffic count data for this report can be viewed in Appendix A.
  
- Existing bicycle and pedestrian volumes: The average daily pedestrian and bicycle traffic along the study corridor is not known. A couple of pedestrians were observed at the intersections during the manual traffic counts. A single bicyclist was also observed on Brakebill Road. It is reasonably assumed that these volumes are minimal to non-existent in the study area.

■ **ON-STREET PARKING:**

Currently, on-street parking is not allowed on any of the studied roadways adjacent to the project site.

■ **PEDESTRIAN AND BICYCLE FACILITIES:**

Bicycle facilities (lanes) and pedestrian sidewalks are not currently available within the project site study area on any of the studied roadways.

- **WALK SCORE:**

A private company offers an online website that grades and gives scores to locations within the United States based on “walkability”. According to the website, the numerical value assigned (the Walk Score) is based on the distance to the closest amenity in various relevant categories (businesses, schools, parks, etc.).

Appendix B shows a map and gives information for the proposed site development Walk Score at Brakebill Road. Based on the project location, the site is given a Walk Score of 15 at 499 Brakebill Road (close to the intersection of Brakebill Road at Hammer Road). This Walk Score indicates that the site is almost completely dependent on vehicles for errands and travel. This low walkability score is due to the complete absence of sidewalks on Brakebill Road to outside destinations/amenities even though there are several potential destinations/amenities on each end of Brakebill Road.

- **TRANSIT SERVICES:**

The City of Knoxville has a network of public transit opportunities offered by Knoxville Area Transit (KAT). Bus service is not available in this area of Knox County. The overall KAT bus system map is in Appendix C. The closest public transit bus service is located approximately 5 miles away via Asheville Highway (US 25E/Hwy 11E) at Chilhowee Drive adjacent to Holston Hills. This KAT service is Route 31 “Magnolia Avenue”. It operates on weekdays and weekends and this route map is also included in Appendix C.

Other transit services include the East Tennessee Human Resource Agency (ETHRA) and Knoxville-Knox County Community Action Committee (CAC) which provides transportation services in Knox County when requested. Other services include private taxis and ride-sharing opportunities (Uber, etc.). Knox County school busses were observed traveling on the studied roadways during the traffic counts.

## **PROJECT DESCRIPTION**

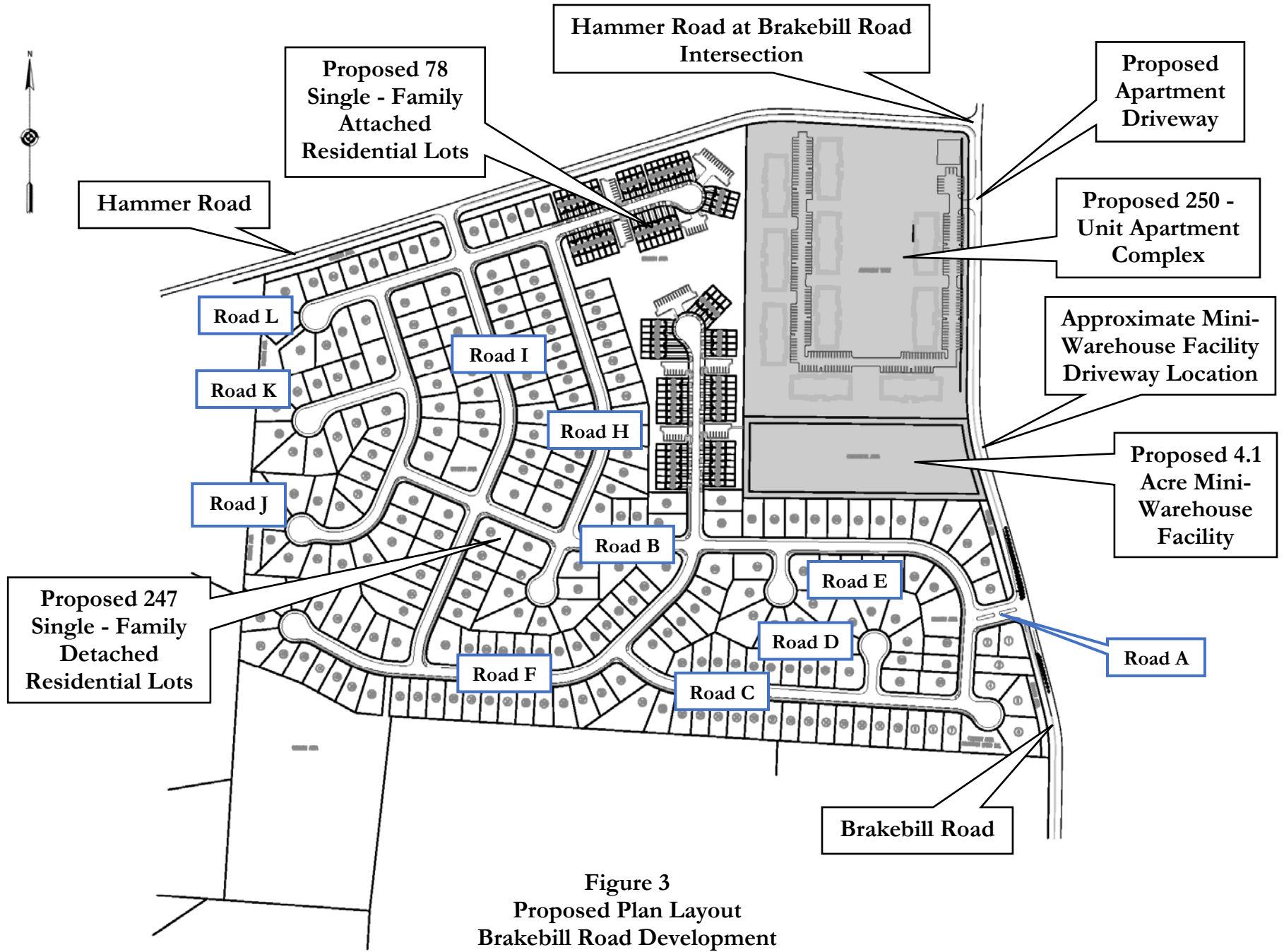
### **■ LOCATION AND SITE PLAN:**

The proposed plan layout designed by Batson, Himes, Norvell, and Poe is shown in Figure 3. As can be seen in the figure, a trio of new entrances are proposed to tie into Brakebill Road and one will tie into Hammer Road. (Note: The layout for the proposed mini-warehouse is not complete and the driveway location is shown only with a call-out in Figure 3.) The proposed development is expected to be comprised of several new internal drives and parking lot areas on 94.9 acres. At this stage of design, it is proposed that the development will include the following:

- 247 single-family detached home sites and 78 single-family attached home sites on approximately 76.8 acres to the south of Hammer Road and to the west of Brakebill Road.
- 250 apartment units on 14 acres at the southwest corner of the intersection of Hammer Road at Brakebill Road.
- 4.1 acres for a mini-warehouse facility to the south of the apartment complex and to the west of Brakebill Road.

The actual schedule for completion of these new residential developments and the mini-warehouse facility is dependent on economic factors and construction timelines. This project is also contingent on permitting, design, and other issues. Due to the physical location of this development within the Knox County market, the developer has estimated that the full build-out and occupancy will take a bit more than 5 years. Thus, for the purposes of this study, it was assumed that the total construction build-out and full occupancy of the entire development will occur by the year 2025.

At this point, the development is expected to start construction initially for the residential subdivision, followed by the apartment complex, and the mini-warehouse facility last.



**Figure 3**  
**Proposed Plan Layout**  
**Brakebill Road Development**



■ **PROPOSED USES AND ZONING REQUIREMENTS:**

The proposed single-family detached and attached residential development is expected to be comprised of 11 new internal roadways with 325 lots on approximately 76.8 acres. The single-family residential development will also incorporate 10 lots/areas dedicated to open/common space in which some will incorporate the storm water controls for the development. The attached residential homes will have several parking lot areas for the residences.

The proposed apartment development design is in its initial stage and potentially subject to design layout revisions. Currently, the initial design plans for the apartment complex shows 11 buildings containing 250 units. Parking lot areas are shown for the complex and a single entrance/exit is shown located approximately 250 feet to the south of the existing intersection of Hammer Road at Brakebill Road.

The plans for the mini-warehouse facility have not been formalized. It is, however, proposed to be located within 4.1 acres of the development property and will have direct access to Brakebill Road. The mini-warehouse facility property is shown on the plan layout approximately 900 feet away from the intersection of Hammer Road at Brakebill Road. Knox County Zoning Regulations (Article 4.93) state that mini-warehouse facilities must be more than 2 acres in size and must connect to either a major collector or arterial. The proposed plan for this facility meets both of these standards.

The site property was zoned as Agricultural (A). The property was recently requested to be rezoned to Planned Residential (PR). The rezoning was approved internally by the MPC on February 8th, 2018 for a density up to 9 dwelling units per acre. The official determination for rezoning was approved by the Knox County Commission on March 26th, 2018. Note: In order for the mini-warehouse facility to be allowed, this portion of the property will have to be rezoned for Planned Residential (PR) at some point in the future. The existing adjacent surrounding land uses are the following:

- Ten properties to the north on the opposite side of Hammer Road are zoned as Agricultural (A) and two properties are zoned as Low Density Residential (RA). One property is zoned as Planned Residential (PR) with a density of 1 - 3

dwelling units per acre. Most all these properties are currently occupied with single-family homes.

- Two properties are located to the west and are currently zoned Agricultural (A) and Planned Residential (PR) with a density of 1 – 8 dwelling units per acre. The one property that is zoned Agricultural (A) has a single-family residence. The other property zoned Planned Residential (PR) is vacant land which appears to have been partially graded in the past in anticipation of a residential development.
- To the south, 2 properties are zoned Agricultural (A). These two properties consist of vacant land and a single-family residence/farm property.
- The properties to the east on the opposite side of Brakebill Road are also zoned Agricultural (A). They consist of single-family residences and farm property. In addition to these residential properties, there is also a Hindu temple named BAPS Shri Swaminarayan Mandir.

The Planned Residential (PR) zone allows for a variety of land uses primarily within the residential realm. Uses permitted in this zone include single-family dwellings, duplexes, and multi-dwelling structures and developments. The current zoning map prior to the requested rezoning for the project site is provided in Appendix D.

■ **DEVELOPMENT DENSITY:**

The allowable density by Knox County for the development is 9 dwelling units per acre based on the recent rezoning. Combining 325 single-family detached and attached residential lots on 76.8 acres with the 250-unit apartment complex located on 14 acres results in a density of approximately 6.33 units per acre. This density is far below the maximum density of 9 dwelling units per acre allowed based on the rezoning.

■ **ON-SITE CIRCULATION AND VEHICLE PARKING:**

The proposed single-family detached and attached residential portion of the development is expected to be comprised of 11 new internal paved roadways. The eleven new internal roads will include ten cul-de-sacs and are labeled on the layout plan (Figure 3) as Road “A” thru Road “L” (Road “G” has been removed as of 5/29/18). The total length of the internal roadways in the residential subdivision will be just over 11,165 feet (2.1 miles). The internal roadways for the

single-family detached and attached residential development will be paved, include 8” extruded concrete curbing, and the lane widths will be 13 feet for a total of 26-foot pavement width within a 50-foot right-of-way. The internal roadways in the layout plan are shown flanked with 5-foot concrete sidewalks on one side of the road for most of the development.

The internal parking areas for the attached residential units is currently designed to be constructed in 9 main areas providing 75 parking spaces. The internal parking areas shown in Figure 3 include 18-foot deep parking spaces on both sides of a 26-foot wide aisle-way. The parking spaces are shown in the plan to be 9 feet in width. The required amount of parking spaces based on the Knoxville/Knox County regulations is 1 space per dwelling unit for one-bedroom units and 1.5 spaces per dwelling unit with two or more bedrooms. The number of bedrooms for each unit is not known at this point to determine the amount of required parking spaces.

The internal parking areas for the apartment complex is currently designed to be constructed with a ringed parking area aisle-way and is approximately 1,800 feet in length. The internal parking areas shown in Figure 3 include 18-foot deep parking spaces on both sides of a 26-foot wide aisle-way. The parking spaces are shown in the plan to be 9 feet in width. The required amount of parking spaces based on the Knoxville/Knox County regulations is 1 space per dwelling unit for one-bedroom units and 1.5 spaces per dwelling unit with two or more bedrooms. The number of bedrooms for each unit is not known at this point to determine the amount of required parking spaces.

Currently, there is not enough design information to provide details about the layout and configuration of the proposed mini-warehouse facility.

■ **SERVICE AND DELIVERY VEHICLE ACCESS AND CIRCULATION:**

In addition to passenger vehicles, the proposed internal roadways and parking aisle-ways will also provide access to service, delivery, maintenance, and fire protection vehicles. It is not expected that any of these vehicles will impact off-site adjacent roadway operations other than when these vehicle-types will occasionally enter and exit the development. The internal roadways in all portions of the development are expected to be able to accommodate these types of vehicles along with passenger vehicles.

## TRAFFIC ANALYSIS OF EXISTING AND PROJECTED CONDITIONS

### ■ EXISTING TRAFFIC CONDITIONS

Traffic counts were conducted at the following existing unsignalized and signalized intersections as directed by the MPC:

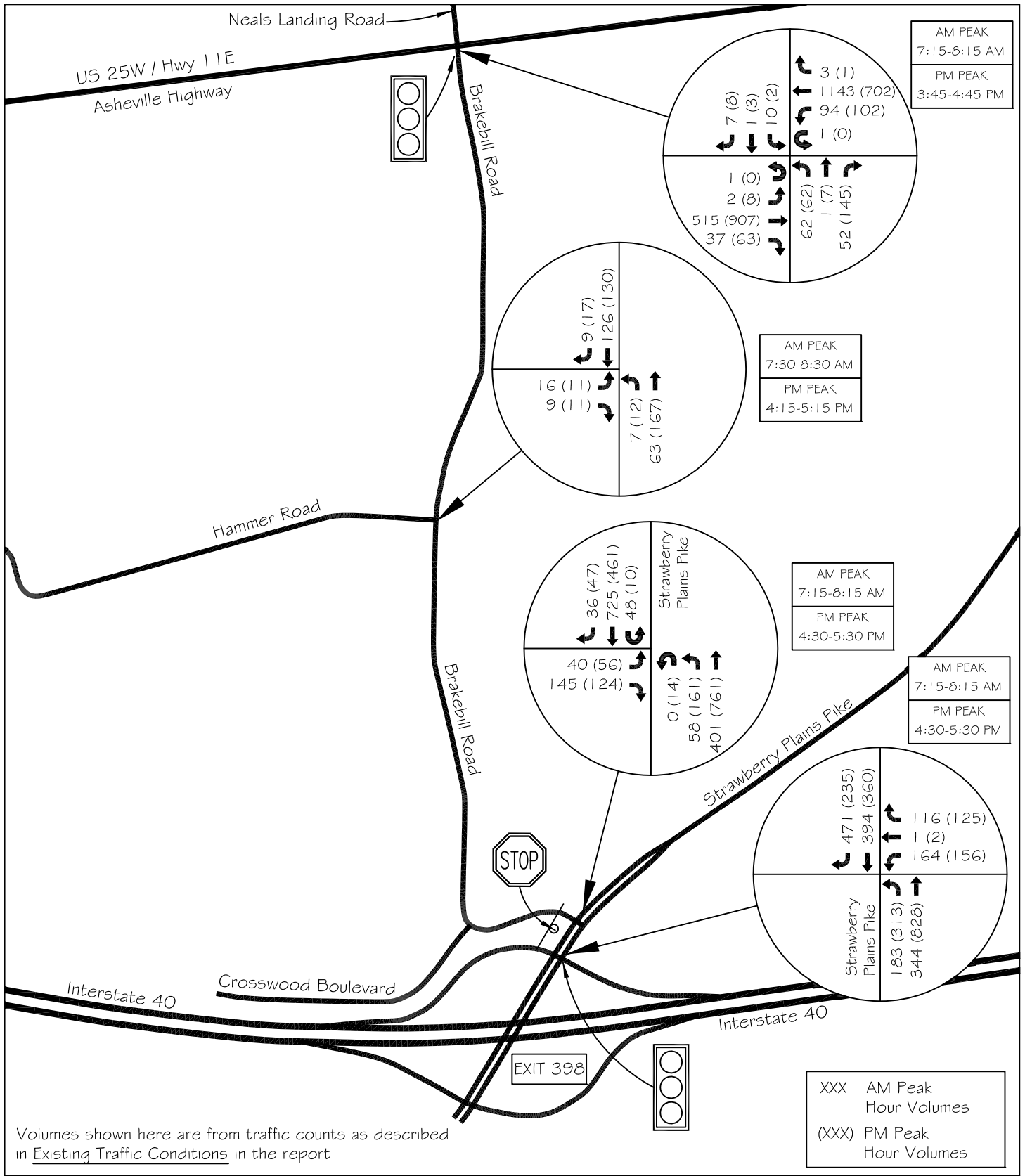
- Asheville Highway (US 25E/Hwy 11E) at Brakebill Road
- Hammer Road at Brakebill Road
- Strawberry Plains Pike at Brakebill Road
- Strawberry Plains Pike at Interstate 40 On/Off Ramps (north side)

Traffic counts were conducted by Quality Counts, LLC on Tuesday, March 20th, 2018. The counts were conducted during the peak periods and the local schools were in session when the traffic counts were conducted. The intersections of Asheville Highway (US 25E/Hwy 11E) at Brakebill Road and Hammer Road at Brakebill Road were counted from 7 – 9 am and 2 – 6 pm. The intersections of Strawberry Plains Pike at Brakebill Road and Strawberry Plains Pike at the Interstate 40 On/Off Ramps (north side) were counted from 7 – 9 am, 11 am – 1 pm, and 2 – 6 pm. Based on the traffic volumes counted at the intersections, the AM and PM peak hour of traffic were observed at the following times:

- Asheville Highway (US 25E/Hwy 11E) at Brakebill Road  
7:15 – 8:15 AM / 3:45 – 4:45 PM
- Hammer Road at Brakebill Road  
7:30 – 8:30 AM / 4:15 – 5:15 PM
- Strawberry Plains Pike at Brakebill Road  
7:15 – 8:15 AM / 4:30 – 5:30 PM
- Strawberry Plains Pike at Interstate 40 On/Off Ramps (north side)  
7:15 – 8:15 AM / 4:30 – 5:30 PM

The manual tabulated traffic counts can be reviewed in Appendix E. In Figure 4, the volumes are shown from the existing traffic counts during the AM and PM peak hours observed at each intersection. (Note: For the intersection of Strawberry Plains Pike at Brakebill Road, Quality Counts, LLC data in the appendix shows the traffic count with Brakebill Road as the

southbound approach and Strawberry Plains Pike as the westbound and eastbound approach. This report shows Brakebill Road as the eastbound approach and Strawberry Plains Pike as the northbound and southbound approaches.)



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FIGURE 4

Brakebill Road Development

2018 Peak Hour Traffic Volumes -  
EXISTING TRAFFIC CONDITIONS

Capacity analyses were undertaken to determine the existing Level of Service (LOS) for the studied intersections with respect to vehicular traffic. 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. This grading system provides a reliable straightforward means to communicate road operations to the public. The Highway Capacity Manual (HCM) lists level of service criteria for unsignalized intersections and signalized intersections.

A/B



C/D



E/F



*(Source: FDOT)*

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. 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 movement. Table 2 lists the level of service criteria for unsignalized intersections.

For signalized intersections, level of service is based upon control delay (in seconds) for various movements within the intersection. This delay is a measurement of driver discomfort, frustration, fuel consumption, lost travel time and is dependent on traffic signal cycle lengths, lengths of green phases, and the quality of traffic progression. This control delay includes deceleration/acceleration delay, queue move-up time, and stopped delay time. Table 3 lists the level of service criteria for signalized intersections.

The signal timing information that was used for this study for studying the signalized intersections was given by the City of Knoxville and is shown in Appendix F. The intersections of Asheville Highway (US 25E/Hwy 11E) at Brakebill Road and Strawberry Plains Pike at Interstate 40 On/Off Ramps (north side) operate with actuated traffic signals and they currently



are not in coordination with any other traffic signals.

From the capacity calculations, the results from the existing peak hour vehicular traffic can be seen in Table 4 for the intersections. The intersections in the table are shown with a LOS designation, delay (in seconds), and v/c ratio (volume/capacity) for the AM and PM peak hours. A v/c ratio of 1 would indicate that the traffic volumes are at the roadway capacity. Appendix G includes the worksheets from the capacity analyses for the existing peak hour vehicular traffic.

Most of the intersection approaches and intersections are shown to operate at an adequate level during the existing AM and PM peak hours for vehicular traffic. However, for the intersection of Strawberry Plains Pike at Brakebill Road, the existing peak hour level of service is calculated as extremely poor during the AM and PM peak hours for eastbound left turning traffic. Large delays for this movement are experienced by motorists attempting to turn left from Brakebill Road onto northbound Strawberry Plains Pike due to the large conflicting traffic volumes.

**TABLE 2**



**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

**TABLE 3**





**LEVEL OF SERVICE AND DELAY FOR  
SIGNALIZED INTERSECTIONS**



LEVEL OF SERVICE	DESCRIPTION	CONTROL DELAY PER VEHICLE (seconds)
A	Operation with very low control delay. Progression is extremely favorable and most vehicles do not stop at all.	≤10.0
B	Generally good level of progression. More vehicles stop than with LOS A, causing higher levels of average delay.	10.1 - 20.0
C	Higher delays with individual cycle failures may begin at this level. Many vehicles may still pass through without stopping.	20.1 - 35.0
D	Approaching unstable flow. The influence of congestion becomes more noticeable. Many vehicles stop.	35.1 - 55.0
E	Considered the limit of acceptable delay. High delays indicated by poor progression, long cycle lengths, and high v/c ratios.	55.1 - 80.0
F	Unacceptable delay occurs. Progression is extremely poor with long cycle lengths and high v/c ratios.	>80.0

Source: Highway Capacity Manual

**TABLE 4**  
**2018 PEAK HOUR LEVEL OF SERVICE & DELAY - EXISTING TRAFFIC CONDITIONS**

INTERSECTION	TRAFFIC CONTROL	APPROACH	AM PEAK			PM PEAK		
			LOS	DELAY (seconds)	V/C	LOS	DELAY (seconds)	V/C
Asheville Highway (US 25E/Hwy 11E) at Brakebill Road	 Signalized	Eastbound	B	14.9		C	20.1	
		Westbound	B	14.0		B	12.2	
		Northbound	D	35.2		C	32.6	
		Southbound	D	38.7		D	40.6	
		Intersection Summary	B	16.2	0.630	B	18.3	0.600
Hammer Road at Brakebill Road	 Unsignalized	Northbound Left	A	7.5	0.008	A	7.7	0.012
		Eastbound Left/Right	B	10.3	0.061	B	10.8	0.061
Strawberry Plains Pike at Brakebill Road	 Unsignalized	Northbound Left	B	11.2	0.132	B	10.3	0.238
		Eastbound Left	F	56.2	0.518	E	40.5	0.420
		Eastbound Right	B	14.4	0.289	B	11.1	0.191
Strawberry Plains Pike at Interstate 40 On/Off Ramps (north side)	 Signalized	Westbound	C	29.6		C	30.2	
		Northbound	A	6.5		A	9.5	
		Southbound	B	11.3		B	10.3	
		Intersection Summary	B	13.1	0.550	B	12.9	0.780

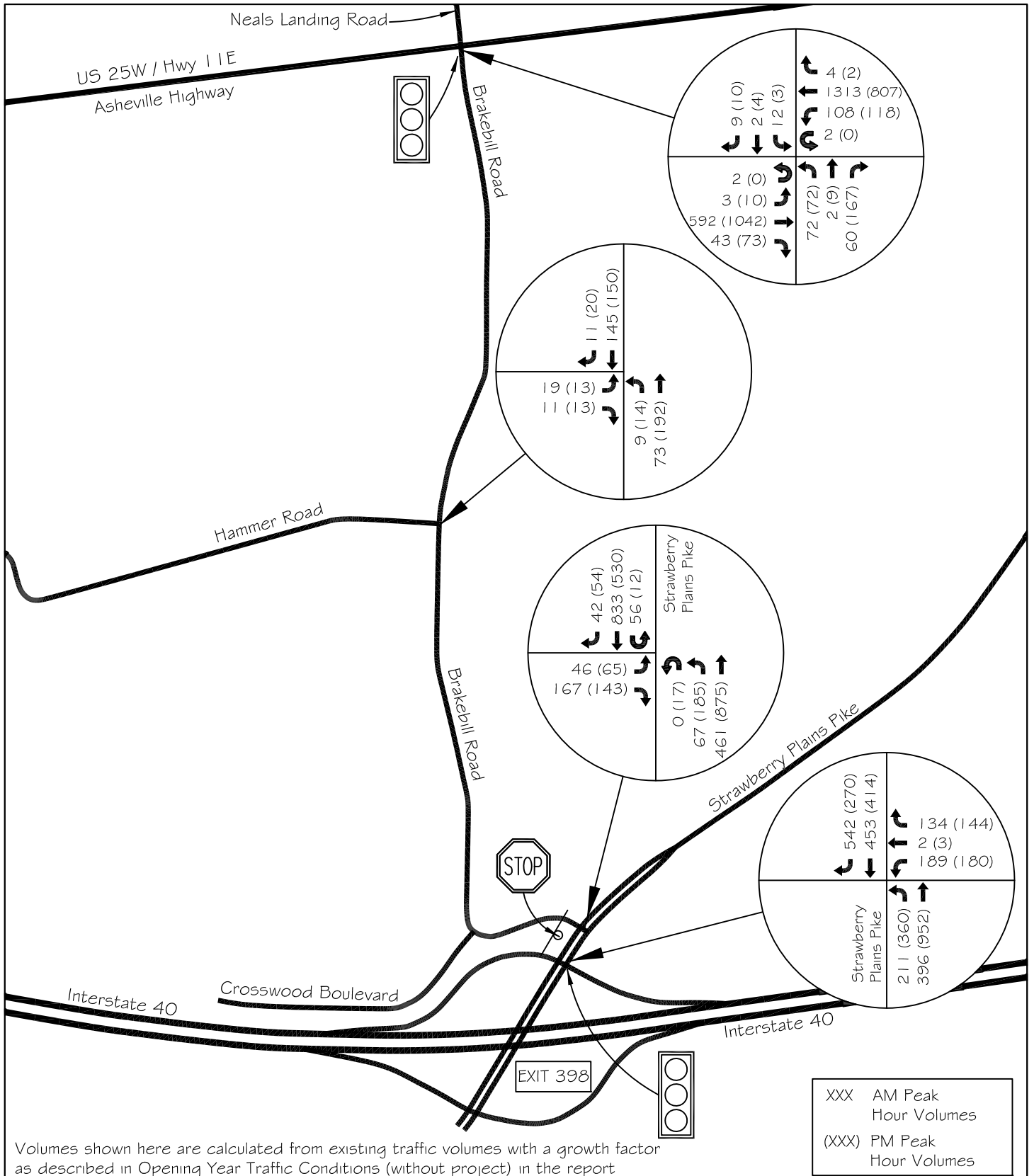
Note: All analyses were calculated in Synchro 8 software and reported with HCM 2010 methodology for unsignalized intersections and HCM 2000 methodology for signalized intersections

■ **OPENING YEAR TRAFFIC CONDITIONS (WITHOUT PROJECT):**

Opening year traffic volume estimates represent the future condition the proposed study area is potentially subject to without the proposed project being developed (no-build option). As previously stated, the build-out and full occupancy for this proposed new development was assumed to occur in the year 2025. This corresponds with almost seven years for the entire development to be constructed and reach full occupancy.

Vehicular traffic on nearby roadways has shown overall negative growth over the past few years according to the TDOE and MPC count stations (historical traffic data is shown in Appendix A). Currently, there are no known significant upcoming developments adjacent to the proposed site that would indicate future increased traffic volumes in the study area. To insure a reasonable traffic growth estimate for this study, several factors were used to consider future growth in the area and potential rising travel volumes. To account for any potential traffic growth in the study area, an average annual growth rate of 2% was used to calculate future growth up to the year 2025 for the studied intersections. The results of this growth rate to the existing traffic volumes can be seen in Figure 5. Figure 5 shows the projected opening year traffic volumes in 2025 during the AM and PM peak hours without the project being developed.

The capacity analysis for the intersection of Strawberry Plains Pike at Brakebill Road was calculated to operate extremely poorly during the AM and PM peak hours for eastbound left turning traffic in the year 2025. The other intersections and intersection approaches are shown to operate at an adequate level during the AM and PM peak hours for vehicular traffic in the year 2025. It should be noted that the signalized intersection of Strawberry Plains Pike at the Interstate 40 On/Off Ramps (north side) is calculated to have an overall v/c ratio of 0.970 in the PM peak hour in the year 2025. This indicates that the projected volumes at this intersection will be nearly at capacity based on the existing number of traffic lanes. Table 5 reports the results for the projected opening year traffic conditions (without project) in 2025. Appendix G contains the LOS capacity worksheets for the opening year conditions (without project) in the year 2025. It is important to point out that these projected calculated LOS designations for the intersections could potentially exist in the future even without the proposed residential project being constructed and developed.



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





FIGURE 5

Brakebill Road Development

2025 Peak Hour Traffic Volumes -  
OPENING YEAR TRAFFIC (WITHOUT  
PROJECT)

**TABLE 5  
2025 PEAK HOUR LEVEL OF SERVICE & DELAY - OPENING YEAR (WITHOUT PROJECT)**

INTERSECTION	TRAFFIC CONTROL	APPROACH	AM PEAK			PM PEAK		
			LOS	DELAY (seconds)	V/C	LOS	DELAY (seconds)	V/C
Asheville Highway (US 25E/Hwy 11E) at Brakebill Road	 Signalized	Eastbound	B	17.1		C	21.2	
		Westbound	B	18.3		B	13.4	
		Northbound	C	35.0		D	36.9	
		Southbound	D	41.2		D	46.2	
		Intersection Summary	B	19.6	0.720	B	19.9	0.660
Hammer Road at Brakebill Road	 Unsignalized	Northbound Left	A	7.6	0.011	A	7.8	0.014
		Eastbound Left/Right	B	10.7	0.077	B	11.4	0.077
Strawberry Plains Pike at Brakebill Road	 Unsignalized	Northbound Left	B	12.5	0.174	B	11.4	0.303
		Eastbound Left	F	131.5	0.847	F	73.5	0.646
		Eastbound Right	C	16.7	0.370	B	11.8	0.234
Strawberry Plains Pike at Interstate 40 On/Off Ramps (north side)	 Signalized	Westbound	C	30.0		C	31.0	
		Northbound	B	10.4		C	24.4	
		Southbound	B	12.4		B	11.1	
		Intersection Summary	B	14.9	0.710	C	21.4	0.970

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2010 methodology for unsignalized intersections and HCM 2000 methodology for signalized intersections

■ **TRIP GENERATION**

A generated trip is a single or one-direction vehicle movement that is either entering or exiting the development site. The Trip Generation Manual, a publication of the Institute of Transportation Engineers, 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 estimated amount of traffic that will be generated by the proposed single-family detached and attached residential lots and the mini-warehouse facility for this development was calculated based upon rates and equations for peak hour trips provided by Trip Generation Manual, 9<sup>th</sup> Edition. The estimated amount of traffic that will be generated by the proposed apartment development was calculated based upon equations for peak hour trips provided by the MPC. These equations were developed by the MPC from local studies to estimate apartment trip generation in the local area and were published in December 1999. The trip generation data and calculations for the proposed land uses are shown in Appendix H. A summary of this information is presented in the following tables. Table 6a shows the overall total potential generated traffic for the entire development. Tables 6b thru 6e shows the potential generated traffic broken down into the 4-individual land uses in the development.

**TABLE 6A**  
**TRIP GENERATION FOR BRAKEBILL ROAD DEVELOPMENT**  
 Entire Development

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
Total New Volume Site Trips			5,254	85	277	362	290	191	481

With a total of 247 single-family detached residential lots, 78 single-family attached residential lots, 250 apartment units, and 4.1 acres of mini-warehouse facilities; based on the calculations, it is estimated that 85 vehicles will enter the development, 277 will exit, for a total of 362 new generated trips during the AM Peak Hour in the year 2025. Similarly, it is estimated that 290 vehicles will enter the development, 191 will exit, for a total of 481 new generated trips during the PM Peak Hour in the year 2025. The calculated trips generated for an average weekday could be expected to be 5,254 vehicles for the entire development. For this study, no trip reductions were included for pass-by or internal trips.



**TABLE 6B  
TRIP GENERATION FOR BRAKEBILL ROAD DEVELOPMENT  
247 Single-Family Detached Homes**

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	247 Lots	2,414	25%	75%		63%	37%	
				46	137	183	150	88	238
Total New Volume Site Trips			2,414	46	137	183	150	88	238

ITE Trip Generation Manual, 9th Edition

**TABLE 6C  
TRIP GENERATION FOR BRAKEBILL ROAD DEVELOPMENT  
78 Single-Family Attached Homes**

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
#230	Residential Condominium / Townhouse	78 Dwellings	519	17%	83%		67%	33%	
				7	36	43	34	16	50
Total New Volume Site Trips			519	7	36	43	34	16	50

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**TABLE 6D  
TRIP GENERATION FOR BRAKEBILL ROAD DEVELOPMENT  
Apartments**

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
MPC Local Rate	Dwelling Units	250 Units	2,175	22%	78%		55%	45%	
				27	98	125	98	80	178
Total New Volume Site Trips			2,175	27	98	125	98	80	178

MPC Local Rate

**TABLE 6E  
TRIP GENERATION FOR BRAKEBILL ROAD DEVELOPMENT  
Mini-Warehouse Facility**

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
#151	Mini-Warehouse	4.1 acres	146	45%	55%		50%	50%	
				5	6	11	8	7	15
Total New Volume Site Trips			146	5	6	11	8	7	15

ITE Trip Generation Manual, 9th Edition

## ■ TRIP DISTRIBUTION AND ASSIGNMENT

Figures 6a and 6b show the projected distribution for traffic entering and for traffic exiting, respectively, for the proposed development during the future AM and PM peak hour at the existing studied intersections and at the new proposed intersections on Hammer Road and Brakebill Road. The percentages shown in the figures only pertain to the new trips generated by the proposed single-family detached and attached residential lots, the apartment units, and the mini-warehouse facility that were calculated from the ITE and MPC trip generation rates.

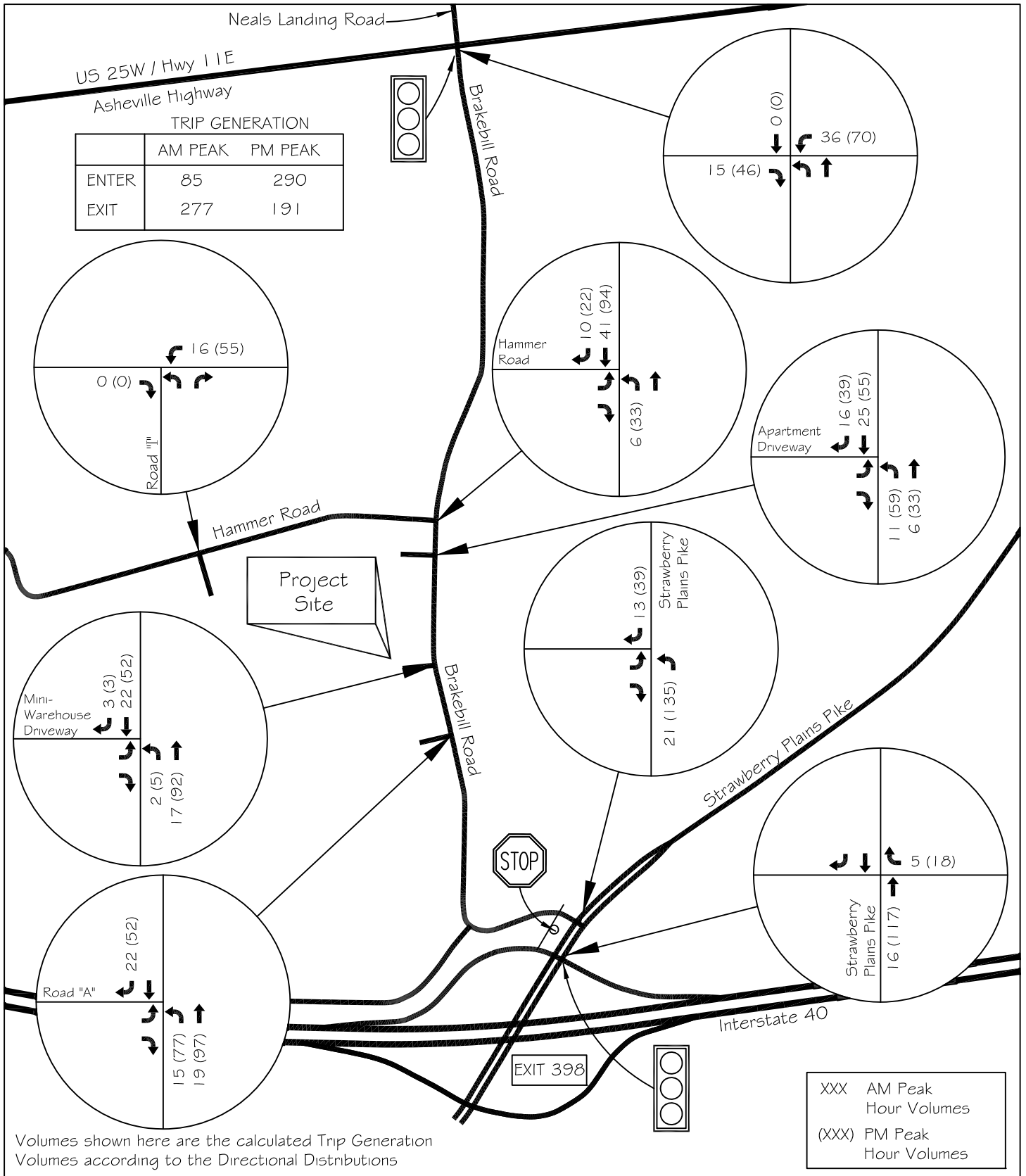
There are a variety of destinations that will potentially “attract” the projected traffic to and from the new development. These destinations will be accessed by utilizing Asheville Highway (US 25E/Hwy 11E) to the north and Strawberry Plains Pike to the south and east via Brakebill Road. In addition to employment centers and commercial development, traffic will travel to and from a variety of public and private elementary, middle, and high schools. This proposed development will be zoned for Sunnyview Primary School, Carter Middle School, and Carter High School.

To help estimate the projected trip distribution, an additional traffic count was conducted (by Ajax Engineering, LLC) just to the north of the project site at the intersection of Kilbridge Drive and Brakebill Road during the AM and PM peak hours. This intersection serves as an access point on Brakebill Road to an existing residential subdivision named Stonehaven. Stonehaven has several dozen single-family detached residential homes and has been filled out and is an established neighborhood. The results of this count are shown in Appendix E. This count was conducted to gain a better understanding of the existing traffic patterns of a nearby residential development during the peak hours of traffic. This data was then correlated to the proposed traffic for the Brakebill Road Development. Since this was an existing similar land use near this study development, the turning movement counts from Kilbridge Drive were assumed to be a reasonable estimate for the Brakebill Road Development travel patterns and were used to help allocate the future traffic distribution.

The traffic distributions shown and portioned at the new proposed intersections on Hammer Road and Brakebill Road for the single-family residential portion of the development were based on assumed internal travel times/distances and the layout within the development. Specifically, with 2 entrances, it was assumed that 70% of generated traffic will enter and exit the

intersection of Brakebill Road at Road “A”. A smaller portion, 30%, of the single-family detached and attached residences generated traffic was assumed to enter and exit at the intersection of Hammer Road at Road “I”. Also, it was assumed that none of the development traffic will enter or exit from and to the western side of Hammer Road. It is expected that only a minimal amount of traffic will enter from or travel to this direction. To facilitate these trip distribution calculations, a spreadsheet was developed, and the results of it are shown in Appendix I.

Figures 7a and 7b shows the Traffic Assignment of the computed trips for traffic entering and for traffic exiting, respectively, at the new development during the future AM and PM peak hour that will be generated by the development and applied to the various intersection movements. This is based on the assumed distribution of trips shown in Figures 6a and 6b and the total trips generated shown in Table 6a.



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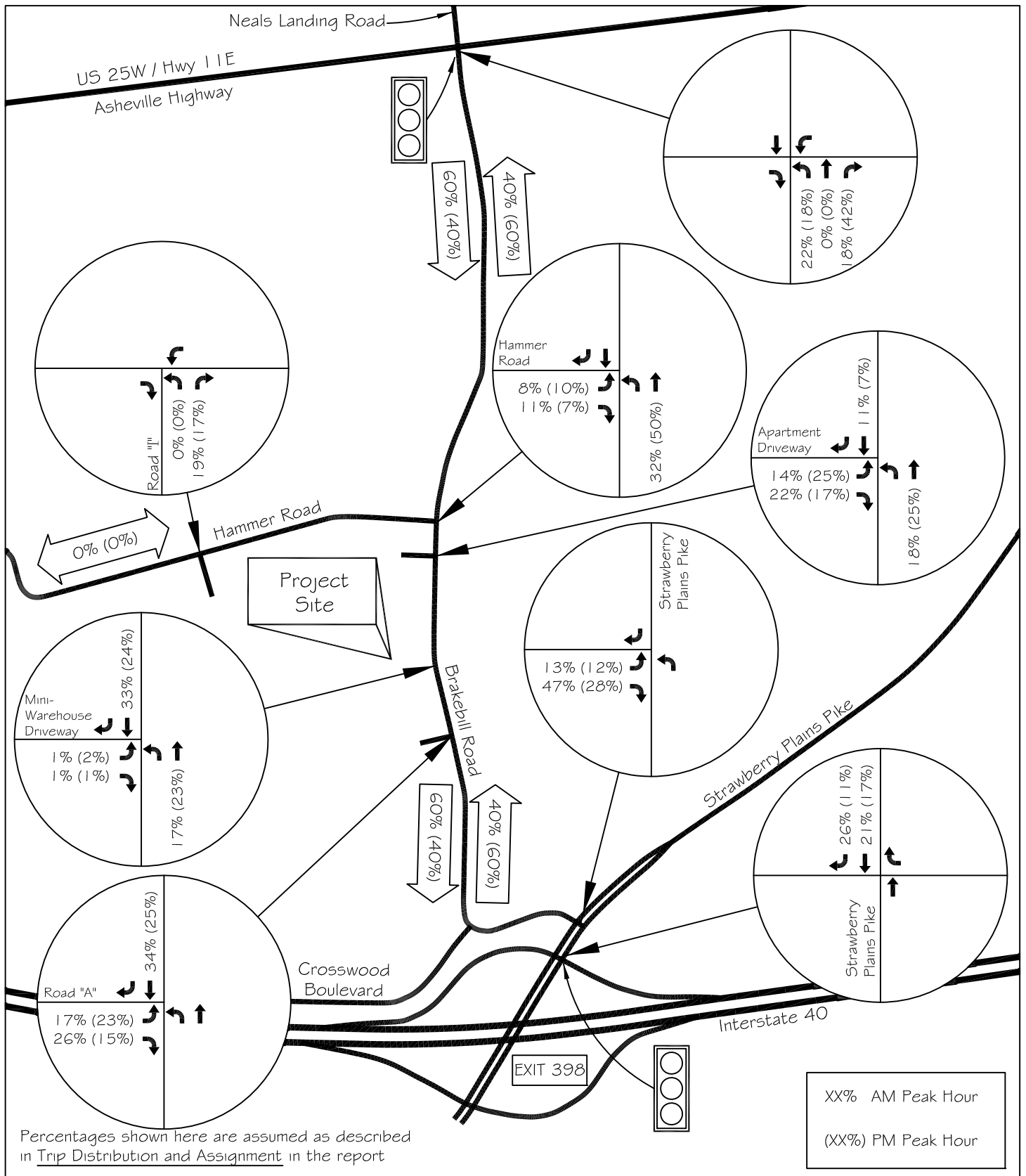
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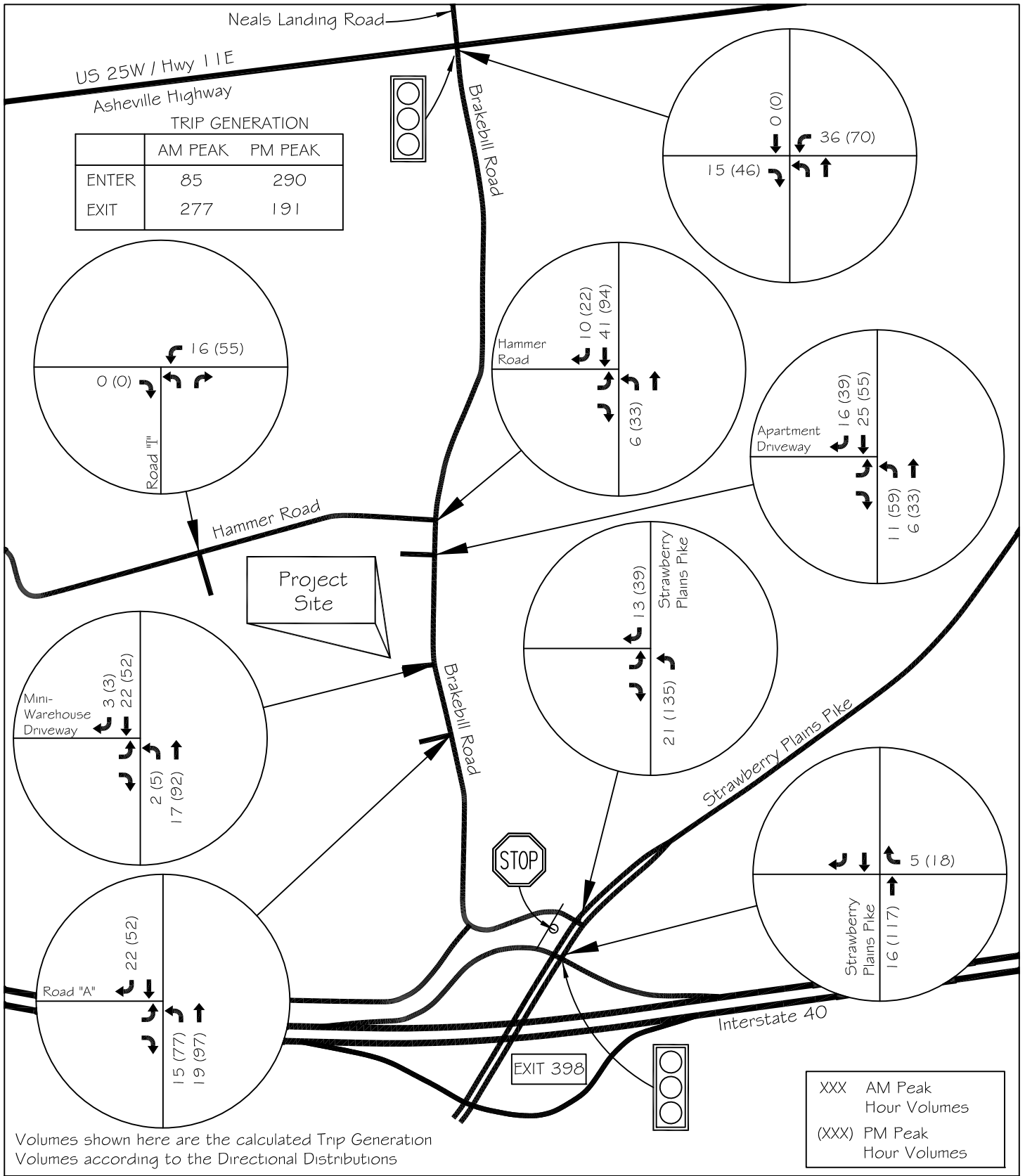
FIGURE 7A

Brakebill Road Development

ENTERING  
 Traffic Assignment of Generated Traffic  
 during AM and PM Peak Hour



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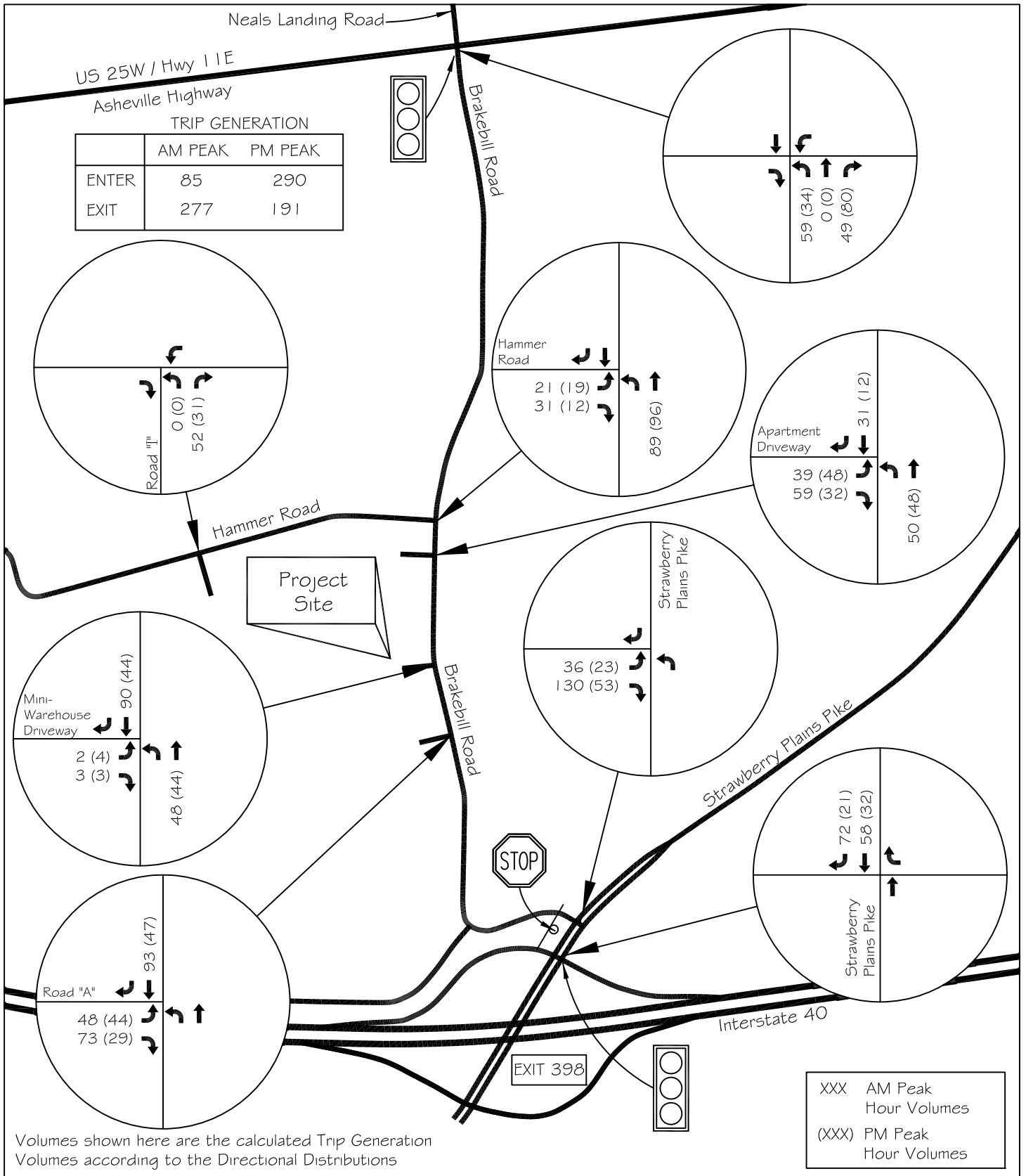
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**FIGURE 7A**  
 Brakebill Road Development  
 ENTERING  
 Traffic Assignment of Generated Traffic during AM and PM Peak Hour



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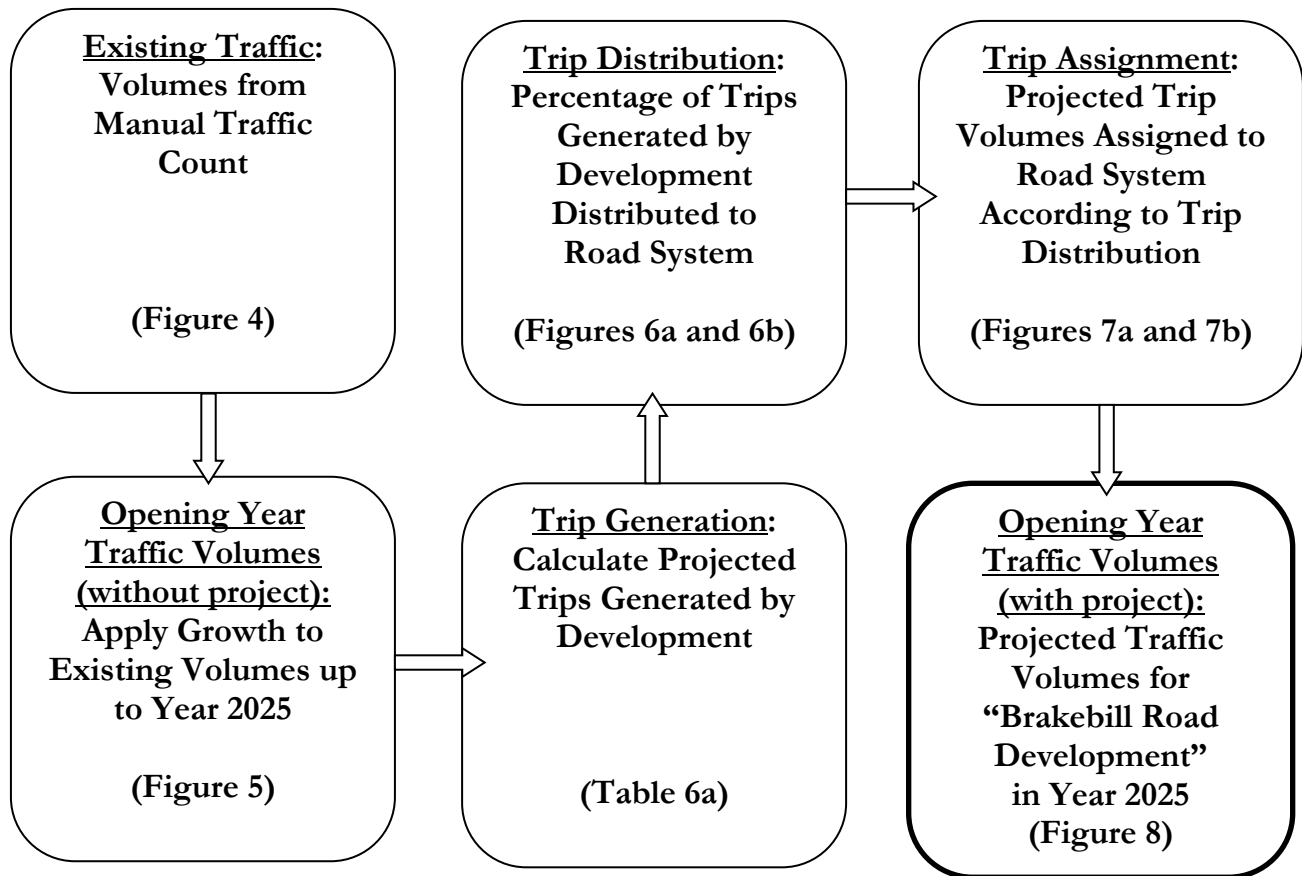
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FIGURE 7B  
 Brakebill Road Development  
 EXITING  
 Traffic Assignment of Generated Traffic  
 during AM and PM Peak Hour

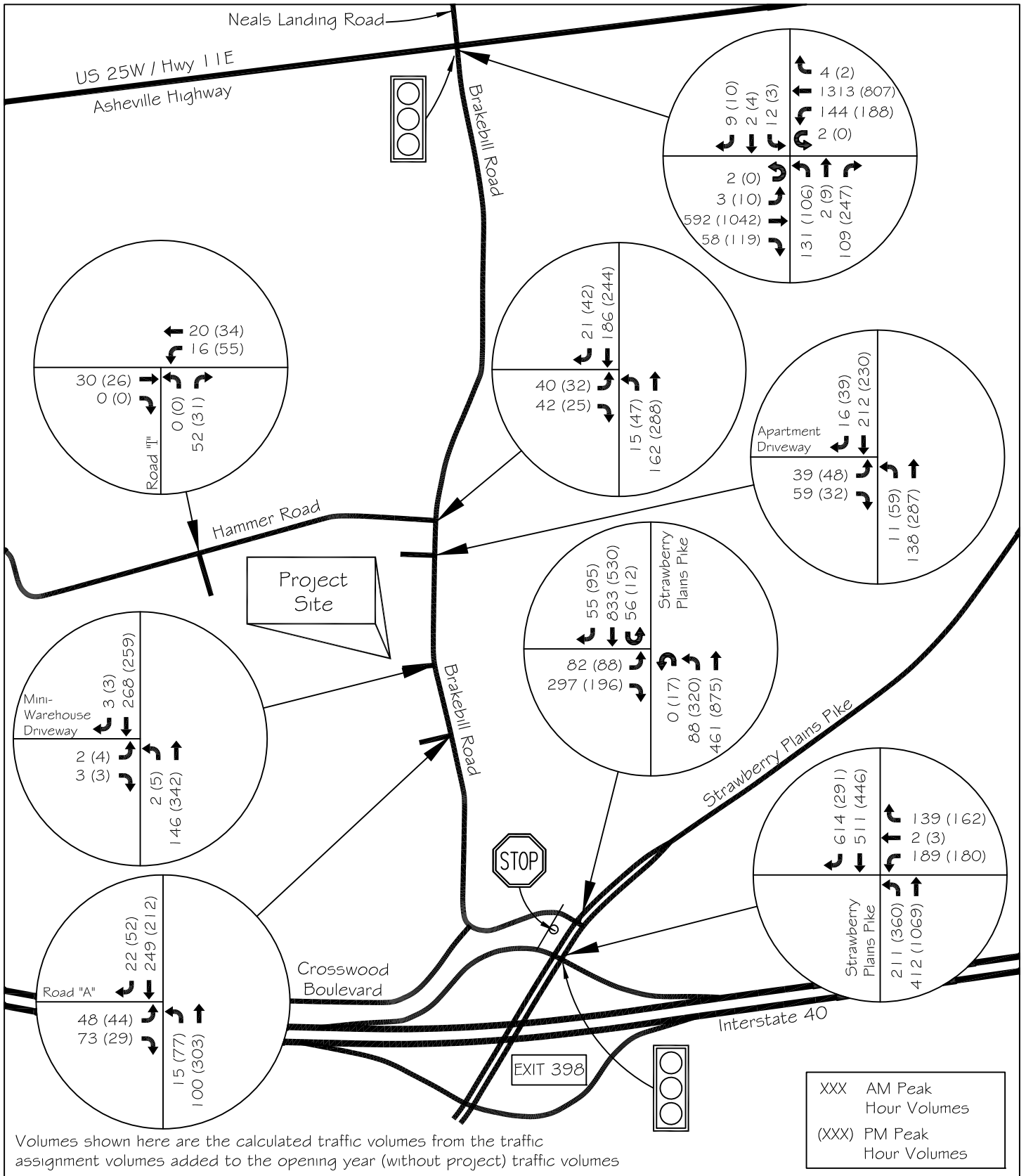
■ **OPENING YEAR TRAFFIC CONDITIONS (WITH PROJECT)**

Overall, several additive steps were taken to estimate the total opening year projected traffic volumes at the studied intersections when the Brakebill Road Development is fully constructed and occupied in the year 2025. The steps are illustrated below for clarity:



To calculate the total future projected traffic volumes at the studied intersections, the trips generated (from the ITE and MPC trip rates) by the new proposed development were added to the 2025 opening year traffic volumes (shown in Figure 5) in accordance with the predicted directional distributions and assignments (shown in Figures 6a/6b and 7a/7b). This procedure was necessary to obtain the total projected traffic volumes at the time the development is fully built-out and occupied in the year 2025. Figure 8 shows the projected AM and PM peak hour volumes at the studied intersections for the year 2025 with the development traffic.





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**FIGURE 8**  
 Brakebill Road Development  
 2025 Peak Hour Traffic Volumes -  
 OPENING YEAR TRAFFIC (WITH  
 PROJECT)

Capacity analyses were conducted to determine the projected Level of Service for vehicles at the existing and proposed intersections for the year 2025 with the development traffic. Appendix G includes the worksheets for these capacity analyses.

The results of the capacity calculations of the projected 2025 peak hour vehicular traffic at the studied intersections can be seen in Table 7 for the AM and PM peak hour. As can be seen in the table, the eastbound left turn movements at the intersection of Strawberry Plains Pike at Brakebill Road (previously calculated to operate poorly) will suffer intolerable delays in the projected conditions. This movement was shown to have a v/c ratio of 1.786 in the AM peak and 1.612 in the PM peak.

All the new proposed intersections on Hammer Road and Brakebill Road are shown to operate very well with respect to level of service under unsignalized conditions in the future projected conditions. The existing intersection of Strawberry Plains Pike at the Interstate 40 On/Off Ramps (north side) is projected to operate with an overall v/c ratio of 1.02 during the PM peak hour which means the projected vehicle volumes are just over capacity. This greater volume than capacity ratio could result in unstable traffic conditions and excessive vehicle queues.

**TABLE 7  
2025 PEAK HOUR LEVEL OF SERVICE & DELAY - OPENING YEAR (WITH PROJECT)**

INTERSECTION	TRAFFIC CONTROL	APPROACH	AM PEAK			PM PEAK		
			LOS	DELAY (seconds)	V/C	LOS	DELAY (seconds)	V/C
Asheville Highway (US 25E/Hwy 11E) at Brakebill Road	 Signalized	Eastbound	C	20.3		C	26.8	
		Westbound	C	21.1		B	18.8	
		Northbound	D	36.0		D	42.4	
		Southbound	D	43.1		D	52.0	
		Intersection Summary	C	23.1	0.770	C	26.1	0.790
Hammer Road at Brakebill Road	 Unsignalized	Northbound Left	A	7.8	0.020	A	8.3	0.054
		Eastbound Left/Right	B	13.6	0.245	C	17.9	0.271
Strawberry Plains Pike at Brakebill Road	 Unsignalized	Northbound Left	B	13.2	0.233	C	20.6	0.668
		Eastbound Left	F	483.6	1.786	F	431.2	1.612
		Eastbound Right	D	26.3	0.667	B	13.3	0.337
Strawberry Plains Pike at Interstate 40 On/Off Ramps (north side)	 Signalized	Westbound	C	30.0		C	31.7	
		Northbound	B	16.0		C	29.0	
		Southbound	B	13.7		B	11.3	
		Intersection Summary	B	17.1	0.790	C	24.1	1.020
Hammer Road at Road "I"	 Unsignalized	Northbound Left/Right	A	8.6	0.053	A	8.5	0.033
		Westbound Left	A	7.3	0.012	A	7.3	0.038
Brakebill Road at Apartment Driveway	 Unsignalized	Northbound Left	A	7.7	0.009	A	8.0	0.051
		Eastbound Left/Right	B	11.1	0.156	B	14.5	0.191
Brakebill Road at Mini-Warehouse Driveway	 Unsignalized	Northbound Left	A	7.8	0.002	A	7.8	0.004
		Eastbound Left/Right	B	11.0	0.009	B	12.7	0.016
Brakebill Road at Road "A"	 Unsignalized	Northbound Left	A	7.9	0.013	A	8.0	0.067
		Eastbound Left/Right	B	11.7	0.200	B	14.9	0.183

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2010 methodology for unsignalized intersections and HCM 2000 methodology for signalized intersections

## **DISCUSSION OF VEHICLE SPEEDS AND CRASHES ON BRAKEBILL ROAD**

There are several issues related to the safety and efficiency of vehicle traffic within the study area. These issues include high vehicle delays/high vehicle volumes, sight distances, vehicle crashes, and vehicle speeds. As part of the study process, the primary access road for this proposed development, Brakebill Road, was investigated further regarding existing vehicle speeds and vehicle crash history.

- A spot speed study was conducted on the northbound and southbound approaches of Brakebill Road at two locations to determine free-flow speeds. The equipment used for the speed study was a Bushnell Speedster III Radar Speed Gun. The results of the study indicate that most of the traffic along Brakebill Road adjacent to the proposed development travels at a greater speed than the posted speed limit of 30 mph. The results of the spot speed study indicated that the observed 85<sup>th</sup> percentile speed was 40 mph for traffic on Brakebill Road near the proposed Road “A” intersection. The results of the spot speed study also indicated that the observed 85<sup>th</sup> percentile speed was 45 mph for traffic on Brakebill Road near the Hammer Road intersection. The spot speed field observations are provided in Appendix J.
- The MPC provided traffic crash data for Brakebill Road. This data was obtained from the TDOT E-TRIMS (Enhanced Tennessee Roadway Information Management System) database. According to the MPC, the crash data in the E-TRIMS system is from the statewide TITAN (Tennessee Integrated Traffic Analysis Network) database. The TITAN database includes all reportable vehicle crash data from Tennessee law enforcement agencies.

The crash data included the master record number, date and time, crash type, log mile location, number of injuries, weather conditions, light conditions, and number of vehicles involved. The data showed a total of 45 vehicle crashes from 2009 to the present (4/3/18) occurring along Brakebill Road. During the past 3 years (4/3/15 to 4/3/18), the data showed 19 vehicle crashes occurring along Brakebill Road. The total number of traffic crashes during the past 3 years is summarized in the following and further detailed in Figure 9:

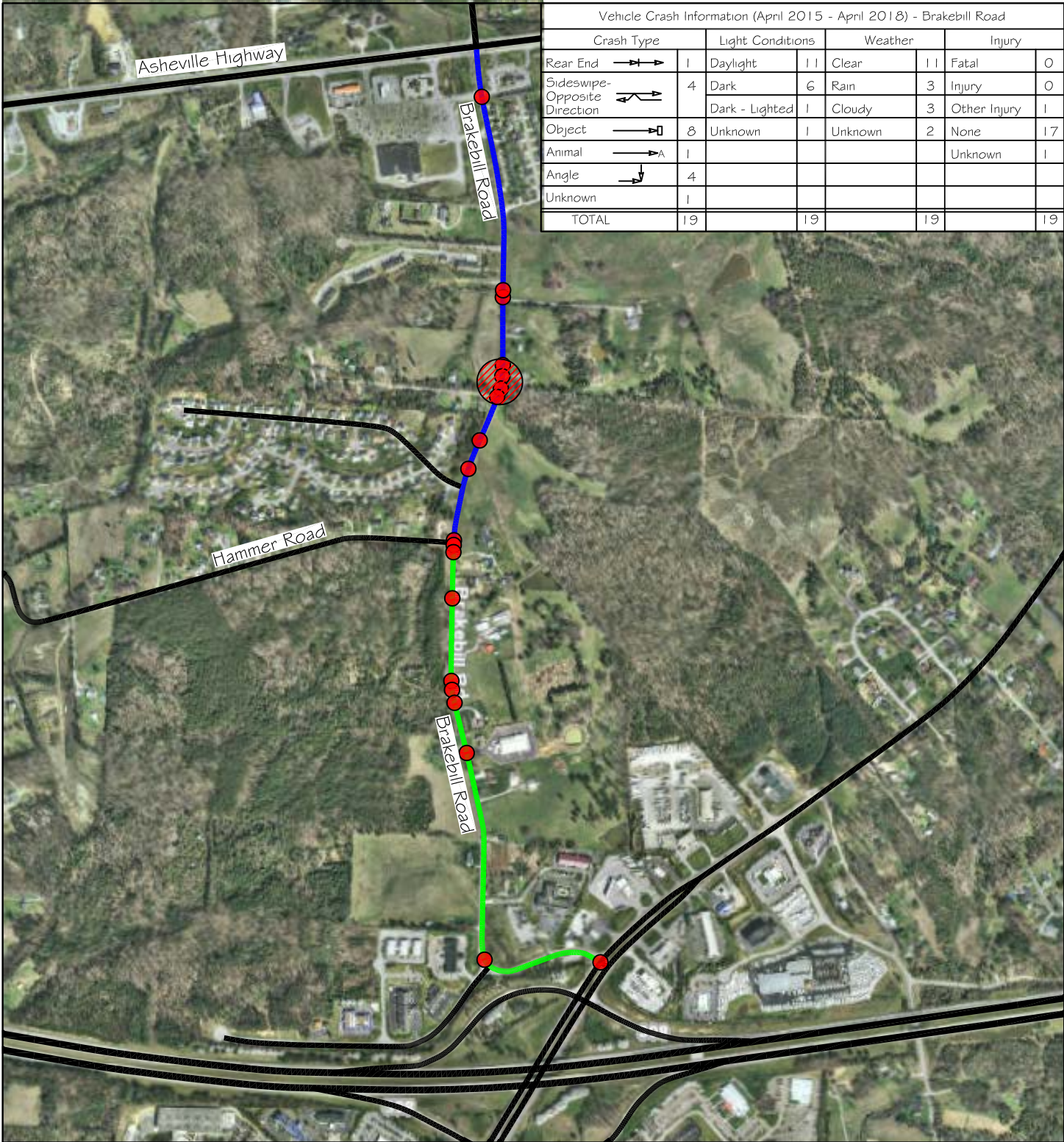
#### Crash Data from 4/3/15 to 4/3/18:

- Brakebill Road – 19 Total Vehicle Crashes
  - 18 Vehicle Crashes with no injuries (property damage only)
  - 1 Vehicle Crash with one suspected non-incapacitating injury

The individual traffic crash reports were obtained for the majority of these 19 crashes from the Knox County Sheriff's Department. These individual crash reports provided more details into the specifics of each crash. Based on evaluating the obtained individual traffic crash reports from Brakebill Road, 5 of the 19 crashes indicated that the narrowness of Brakebill Road could have been a contributable factor. Of those 5 crashes, 3 were opposite direction sideswipe crashes in which vehicles suffered damage due to the vehicles swiping each other in the center of the road. The other 2 crashes involved striking off-road objects because the drivers perceived that an opposing vehicle was in their lane of traffic. These vehicles departed the roadway when their wheels left the pavement and the driver lost control of their vehicles. Based on a review of the 19 crashes; wet pavement, weather, and time of day did not appear to be a causative factor.

Based on statewide vehicle crash data, TDOT has compiled and calculated statewide crash rates for various types of intersections, road sections, and road spots in Tennessee based on rolling data from the past 3 years of current data. (TDOT defines a spot location as a section of roadway less than or equal to 0.10 mile.) This data is categorized by urban and rural locations, route type (major collector, local, etc.), type of roadway facility (number of lanes, etc.), and location type (intersection, section, or spot). The statewide crash rate tables for intersections, sections, and spots from TDOT was obtained for this study and is provided in Appendix K. As shown in Figure 9, the Brakebill Road crash rates were investigated at an intersection, 2 sections, and a spot location. To calculate the section crash rates, Brakebill Road was broken into 2 sections: Asheville Highway (US 25E/Hwy 11E) to Hammer Road and Hammer Road to Strawberry Plains Pike. The intersection of Hammer Road at Brakebill Road was calculated for an intersection crash rate. Additionally, a spot location was examined on Brakebill Road just to the north of Palmer Lane (north of Kilbridge Drive and Hammer Road) where 3 crashes have occurred in the past 3 years within 0.023 mile. Other intersections on Brakebill Road (Crosswood Boulevard, Kilbridge Drive) did not experience enough crashes to consider analyzing.





Vehicle Crash Information (April 2015 - April 2018) - Brakebill Road							
Crash Type		Light Conditions		Weather		Injury	
Rear End	1	Daylight	11	Clear	11	Fatal	0
Sideswipe-Opposite Direction	4	Dark	6	Rain	3	Injury	0
		Dark - Lighted	1	Cloudy	3	Other Injury	1
Object	8	Unknown	1	Unknown	2	None	17
Animal	1					Unknown	1
Angle	4						
Unknown	1						
TOTAL	19		19		19		19

— Segment 1     ● Crash Location  
— Segment 2     ◉ Spot Location



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NOT TO SCALE



FIGURE 9  
 Brakebill Road Development  
 Vehicle Crash Data on  
 Brakebill Road

TDOT has developed a crash analysis file that compares the actual crash rates at roadway intersections, sections, and spots versus the state average. Based on the number of crashes reported at the intersection of Hammer Road at Brakebill Road, the 2 road sections, and the spot location for the past 3 years; it does not appear that the calculated crash rates are considered high enough to obtain TDOT safety funding. To obtain TDOT safety funding, the ratio of the actual crash rate to the critical crash rate (A/C ratio) would need to be 3.5 or higher. Appendix K includes the crash rate calculations for the intersection, 2 road sections, and spot location. The calculations show the actual crash rate vs. the statewide average crash rate (A/S) and the ratio of the actual crash rate vs. the critical crash rate (A/C). The critical crash rate (A/C) gives more weight to specific crash severities while the statewide average comparison (A/S) only considers total numbers. The calculated ratios are shown in the following tables for the intersection, 2 road sections, and spot location respectively:

**Table 8  
Crash Rates on Brakebill Road**

<b>Brakebill Road,</b>		<b>Knox County</b>				<b>LM 0.629</b>	
<b>Intersection (Hammer Road at Brakebill Road)</b>							
2 Crashes	-	2015 - 2018	Actual	-	0.503	Acc/MMM	
State Average	-	0.121	Acc/MMM	Critical	-	0.653	Acc/MMM
A/S Ratio	=	4.16		A/C Ratio	=	0.77	
0 Fatal Crash		0 Incap. Injury Crash		1 Other Injury Crash			
<b>Brakebill Road,</b>		<b>Knox County</b>				<b>LM 0.000</b>	
<b>Section 1 (Asheville Highway - Hammer Road)</b>							
11 Crashes	-	2015 - 2018	Actual	-	4.725	Acc/MMM	
State Average	-	2.183	Acc/MMM	Critical	-	4.651	Acc/MMM
A/S Ratio	=	2.16		A/C Ratio	=	1.02	
0 Fatal Crash		0 Incap. Injury Crash		1 Other Injury Crash			
<b>Brakebill Road,</b>		<b>Knox County</b>				<b>LM 0.000</b>	
<b>Section 2 (Hammer Road - Strawberry Plains Pike)</b>							
8 Crashes	-	2015 - 2018	Actual	-	3.110	Acc/MMM	
State Average	-	2.183	Acc/MMM	Critical	-	4.521	Acc/MMM
A/S Ratio	=	1.42		A/C Ratio	=	0.69	
0 Fatal Crash		0 Incap. Injury Crash		0 Other Injury Crash			
<b>Brakebill Road,</b>		<b>Knox County</b>				<b>LM 0.000</b>	
<b>Spot Location (just north of Palmer Lane)</b>							
4 Crashes	-	2015 - 2018	Actual	-	1.081	Acc/MMM	
State Average	-	0.767	Acc/MMM	Critical	-	1.961	Acc/MMM
A/S Ratio	=	1.41		A/C Ratio	=	0.55	
0 Fatal Crash		0 Incap. Injury Crash		0 Other Injury Crash			

## **CONCLUSIONS AND RECOMMENDATIONS**

The following discussion is an overview of recommendations to minimize the traffic impacts of the proposed development on the surrounding road system while attempting to achieve an acceptable level of traffic flow and safety. An overview of the recommendations for the external roads and intersections is shown in Figure 10 on page 72.

### **1) ASHEVILLE HIGHWAY (US 25E/HWY 11E) AT BRAKEBILL ROAD:**

This intersection was calculated to operate adequately with respect to the level of service during the existing conditions and during the projected conditions when the Brakebill Road Development is completed and fully occupied in the year 2025. Some minor signal timing changes might be required in the future at the intersection to optimize the level of service and reduce queue lengths.

### **2) HAMMER ROAD AT BRAKEBILL ROAD**

2a) The 85<sup>th</sup> percentile spot speed that was conducted near this intersection was calculated to be 45 mph. Based on Knox County Engineering Policy, the recommended sight distance is ten times the 85<sup>th</sup> percentile speed. This would indicate a required sight distance of 450 feet looking north and south for eastbound left and right turn movements at Hammer Road. The sight distance at this intersection is more than 450 feet looking north and south from Hammer Road based on visual observation.

2b) The intersection at Hammer Road and Brakebill Road was calculated to operate very well with respect to level of service under unsignalized conditions in the year 2025. Separate left turn lanes or right turn lanes on Brakebill Road onto Hammer Road is not required based on the projected volumes. The Hammer Road at Brakebill Road intersection turn lane evaluation was evaluated based on the projected traffic volumes at the intersection and according to “Knox County’s Access Control and Driveway Design Policy”. The Knox County turn lane policy worksheets are in Appendix L and the results shown in the Appendix are based on the projected volumes during the PM peak hour since this time period is estimated to have the



highest volumes at the intersection.

The design policy for turn lane warrants relates volume thresholds based on prevailing speeds for two-lane roadways. The speed classification that was chosen for this intersection evaluation was based on the measured 85<sup>th</sup> percentile speed of 45 mph near this existing intersection. Therefore, this intersection evaluation used the Knox County classification for speeds of 36 to 45 mph with the calculated projected volumes from the PM peak hour.

- 2c) The intersection of Hammer Road at Brakebill Road currently operates as a two-way stop-controlled t-intersection. At this intersection, Hammer Road operates under a stop condition but does not currently have a Stop Sign (R1-1) installed. A Stop Sign (R1-1) should be installed on the Hammer Road approach at Brakebill Road. A 24” white stop bar should also be installed.

### **3) HAMMER ROAD AT ROAD “I”**

- 3a) Based on a posted speed of 30 mph on Hammer Road, the recommended sight distance is 300 feet at the proposed intersection with Road “I”. The sight distance at this proposed intersection has been measured by a land surveyor and is more than 400 feet looking east and west from the proposed Road “I”.

- 3b) The intersection of Hammer Road at Road “I” was calculated to operate very well with respect to level of service under unsignalized conditions in the year 2025. The capacity analysis shows that only a single exiting lane for left and right exiting vehicles is required at the Road “I” entrance. Also, separate left turn lanes or right turn lanes on Hammer Road into the subdivision entrance are not required due to the low projected volumes. This was confirmed by an evaluation of the Knox County turn lane threshold policy.

The speed classification that was chosen for this intersection turn lane evaluation was based on the posted speed limit of 30 mph on Hammer Road. Therefore, this intersection evaluation used the Knox County classification for speeds of 35 mph or less with the calculated projected volumes.

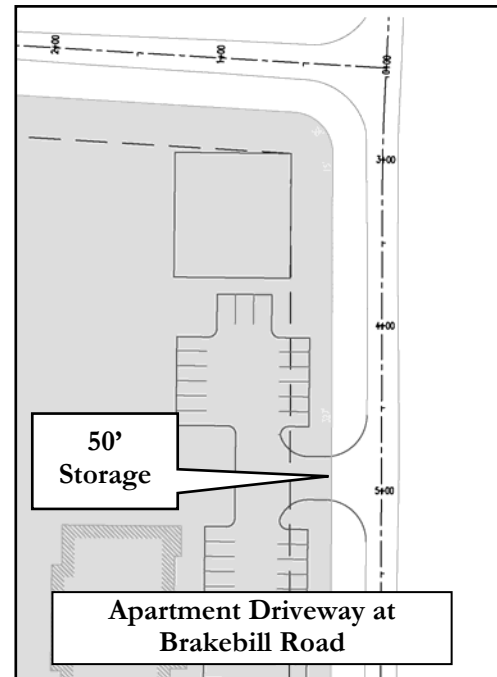
- 3c) It is recommended that a Stop Sign (R1-1) and a 24" white stop bar be applied to the pavement of the Road "I" approach at Hammer Road. The stop bar should be applied at a minimum of 4 feet away from the edge of Hammer Road and should be placed at the desired stopping point that provides the maximum sight distance.
- 3d) Intersection sight distance at Road "I" must not be impacted by future landscaping or signage.
- 3e) Due to the narrowness of Hammer Road, it is recommended that a large curb radius (a minimum of 40 feet) be designed and constructed that would facilitate right turns off and on to Hammer Road at the Road "I" intersection. This would allow school busses, and larger maintenance and delivery vehicles the opportunity to turn freely without overlapping into opposite traffic lanes.

#### 4) **BRAKEBILL ROAD AT APARTMENT DRIVEWAY**

- 4a) The 85<sup>th</sup> percentile spot speed that was conducted on Brakebill Road near this proposed intersection was calculated to be 45 mph. This would indicate a required sight distance of 450 feet looking north and south for eastbound left and right turn movements at the apartment driveway. While not measured in the field, these distances appear to be available from visual observation where the proposed driveway will tie into Brakebill Road. However, a land surveyor has not verified the sight distance at this proposed intersection since a design and location of the driveway for the apartment complex has not been finalized. Once the design is finalized, the sight distance will be confirmed based on the Knox County policy and standards.
- 4b) The intersection of Brakebill Road and the Apartment Driveway was calculated to operate very well with respect to level of service under unsignalized conditions in the year 2025. The capacity analysis shows that only a single exiting lane for left and right exiting vehicles is required at the Apartment Driveway entrance. Also, separate left turn lanes or right turn lanes on Brakebill Road into the apartment complex is not required based on the projected volumes. This was confirmed by an evaluation of the Knox County turn lane threshold policy based on the measured 85<sup>th</sup> percentile speed of 45 mph near this proposed intersection. Therefore, this intersection

evaluation used the Knox County classification for speeds of 36 to 45 mph with the calculated projected volumes from the PM peak hour. The Knox County turn lane policy worksheets are in Appendix L.

- 4c) The current initial design plans for the Apartment Driveway shows an entrance/exit driveway throat length of approximately 50 feet in between the edge of Brakebill Road and the edge of the interior parking area aisle-way. The final design of this driveway needs to maintain no less than 50 feet of driveway throat (storage) length. This length should be maximized if possible to keep stopped vehicles from blocking the path of entering vehicles or vehicles traveling along the internal circulation parking area aisle-ways. This length will also assist in avoiding stopped vehicles from queuing and blocking the parking area spaces near the driveway.



The proposed intersection of the Apartment Driveway at Brakebill Road is currently shown on the preliminary plans as being located approximately 250 feet to the south of the intersection of Hammer Road at Brakebill Road. It is recommended that the final design not allow the proposed intersection to be located any closer than this distance. Ideally, it should be designed further away to minimize the possibility of conflicts between the 2 intersections.

- 4d) It is recommended that a Stop Sign (R1-1) and a 24" white stop bar be applied to the pavement of the Apartment Driveway approach at Brakebill Road. The stop bar should be applied at a minimum of 4 feet away from the edge of Brakebill Road and should be placed at the desired stopping point that provides the maximum sight distance.

- 4e) Intersection sight distance at the Apartment Driveway must not be impacted by future landscaping or signage.
- 4f) Due to the narrowness of Brakebill Road, it is recommended that a large curb radius (a minimum of 40 feet) be designed and constructed that would facilitate right turns off and on to Brakebill Road at the Apartment Driveway intersection. This would allow school busses, and larger maintenance and delivery vehicles the opportunity to turn freely without overlapping into opposite traffic lanes.

**5) BRAKEBILL ROAD AT MINI-WAREHOUSE FACILITY DRIVEWAY**

- 5a) The 85<sup>th</sup> percentile spot speed that was conducted on Brakebill Road close to this proposed intersection was calculated to be 45 mph. This would indicate a required sight distance of 450 feet looking north and south for eastbound left and right turn movements at the Mini-Warehouse Facility Driveway. A land surveyor has not verified the sight distance at this proposed intersection since a design and location of the driveway for the mini-warehouse has not been finalized. Once the design is finalized, the sight distance will be confirmed based on the Knox County policy and standards.
- 5b) The intersection of Brakebill Road at the Mini-Warehouse Facility Driveway was calculated to operate very well with respect to level of service under unsignalized conditions in the year 2025. The capacity analysis shows that only a single exiting lane for left and right exiting vehicles is required at the Mini-Warehouse Facility Driveway entrance. Also, separate left turn lanes or right turn lanes on Brakebill Road into the Mini-Warehouse Facility is not required based on the projected volumes from the PM peak hour. This was confirmed by an evaluation of the Knox County turn lane threshold policy based on the measured 85<sup>th</sup> percentile speed of 45 mph near this proposed intersection. Therefore, this intersection evaluation used the Knox County classification for speeds of 36 to 45 mph with the calculated projected volumes. The Knox County turn lane policy worksheets are in Appendix L.
- 5c) The design plans for the Mini-Warehouse Facility Driveway have not been completed. The entrance/exit driveway for this facility should be designed with

sufficient throat length to accommodate larger vehicles that are expected to enter and exit the facility.

5d) The proposed intersection of the Mini-Warehouse Facility Driveway at Brakebill Road is expected to be designed and constructed at the center of the 4.1-acre property. If this is the location of the proposed driveway, this new driveway intersection will be approximately 780 feet to the south of the Apartment Driveway and approximately 500 feet to the north of Road “A”. Based on these distances, the spacing of this driveway with the other driveway and road are appropriate.

5e) It is recommended that a Stop Sign (R1-1) and a 24” white stop bar be applied to the pavement of the Mini-Warehouse Facility Driveway approach at Brakebill Road. The stop bar should be applied at a minimum of 4 feet away from the edge of Brakebill Road and should be placed at the desired stopping point that provides the maximum sight distance.

5f) Intersection sight distance at the Mini-Warehouse Facility Driveway must not be impacted by future landscaping or signage.

5g) Due to the narrowness of Brakebill Road, it is recommended that a large curb radius (a minimum of 50 feet) be designed and constructed that would facilitate right turns off and on to Brakebill Road at the Mini-Warehouse Facility Driveway intersection. This would allow larger vehicles that will access this type of facility the opportunity to turn freely without overlapping into opposite traffic lanes.

## **6) BRAKEBILL ROAD AT ROAD “A”**

6a) With a posted speed limit of 30 mph, this would indicate a required sight distance of 300 feet looking north and south for eastbound left and right turn movements at Road “A”. The sight distance at this proposed intersection has been measured by a land surveyor and is more than 450 feet looking north and is 325 feet looking south from the proposed Road “A”.

6b) The intersection of Brakebill Road at Road “A” was calculated to operate very

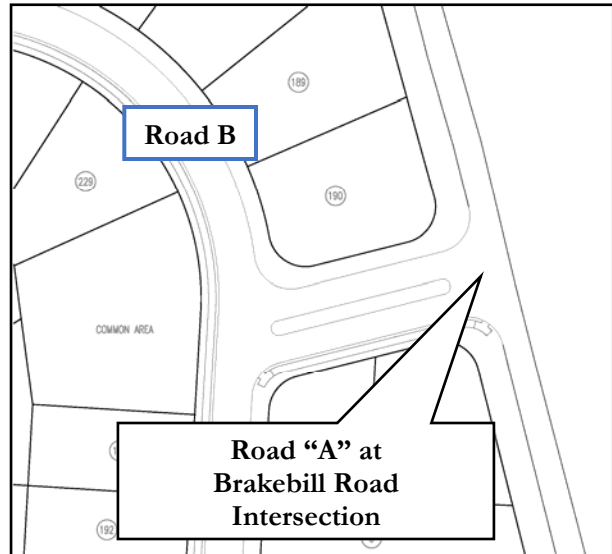
well with respect to level of service under unsignalized conditions in the year 2025. The capacity analysis shows that only a single exiting lane for left and right exiting vehicles is required at the Road “A” entrance.

The Brakebill Road at Road “A” intersection was evaluated for the need for separate turn lanes on Brakebill Road for entering vehicles into the development. Based on the projected traffic volumes at the intersection on Brakebill Road and according to “Knox County’s Access Control and Driveway Design Policy”, a separate northbound left turn lane is warranted on Brakebill Road for entering vehicles. A separate southbound right turn lane on Brakebill Road for entering vehicles is not warranted. The Knox County turn lane policy worksheets are in Appendix L and the results shown in the Appendix are based on the projected volumes during the PM peak hour since this time period is estimated to have the highest volumes at the intersection. The speed classification that was chosen for this evaluation was based on the calculated and observed 85<sup>th</sup> percentile speed of 40 mph near this proposed intersection. Therefore, this intersection evaluation used the Knox County classification for speeds of 36 - 45 mph or less with the calculated projected volumes.

To estimate the required northbound left turn storage length, SimTraffic (Version 8) software was utilized which performs micro-simulation and animation of vehicular traffic and calculates various vehicle parameters such as intersection queue lengths. Based on the software results according to the projected volumes, the 95<sup>th</sup> percentile queue distance was calculated. The 95<sup>th</sup> percentile queue is the recognized measurement in the traffic engineering profession as the design standard used when considering queue distances. A 95<sup>th</sup> percentile queue means that there is a 95% certainty the queue will not extend beyond that point. (The calculated queue results were based on averaging the outcome obtained during 10 traffic simulations.) The queue results from the SimTraffic software are in Appendix M. The results shown in the Appendix indicate that the 95<sup>th</sup> percentile queue for northbound left turns on Brakebill Road at Road “A” was calculated to be 20 feet during the projected AM peak hour and 43 feet during the projected PM peak hour. Based on these results, the proposed storage length should be a minimum distance of 75 feet which is the Knox County standard minimum length for left turn storage. (Note: the results

shown for the Level of Service in Table 7 included a separate northbound left turn lane at this intersection).

The current design for Road “A” at Brakebill Road shows a throat length (storage) of approximately 165 feet in between the edge of Brakebill Road and the edge of the internal road “B”. The 95<sup>th</sup> percentile queue length for the eastbound approach at Brakebill Road was calculated to have a length of 62 feet for the AM peak and 57 feet for the PM peak. Thus, the current design length of Road “A” should be sufficient for exiting eastbound left and right turns at Brakebill Road. These queue results for Road “A” at Brakebill Road are in Appendix M.



- 6c) It is recommended that a Stop Sign (R1-1) and a 24” white stop bar be applied to the pavement of the Road “A” eastbound approach at Brakebill Road. The stop bar should be applied at a minimum of 4 feet away from the edge of Brakebill Road and should be placed at the desired stopping point that provides the maximum sight distance.
- 6d) Intersection sight distance at Road “A” must not be impacted by future landscaping or signage.
- 6e) Due to the narrowness of Brakebill Road, it is recommended that a large curb radius (a minimum of 40 feet) be designed and constructed that would facilitate right turns off and on to Brakebill Road at the Road “A” intersection. This would allow school busses, and larger maintenance and delivery vehicles the opportunity to turn freely without overlapping into opposite traffic lanes.

## 7) STRAWBERRY PLAINS PIKE AT INTERSTATE 40 ON/OFF RAMPS (NORTH SIDE)

This intersection was calculated to operate adequately with respect to the level of service during the existing conditions and during the projected conditions when the Brakebill Road Development is completed and fully occupied in the year 2025. However, the v/c ratio of the intersection in the year 2025 even without the project generated trips included in the analysis was calculated to be 0.970 during the PM peak hour. A v/c ratio of 1 would indicate that the traffic volumes are at the roadway capacity. This high v/c ratio at this intersection is primarily due to the projected amount of northbound left turns.

The projected northbound left turn lane volume in the PM peak hour was calculated to be 360 vehicles in 2025. Single left turn lanes that are experiencing more than 300 vehicles/hour are many times recommended to be increased to dual left turn lanes. In the future, if dual left turn lanes for the northbound approach are constructed, the physical space for adding an additional northbound left turn should be available by constructing a second lane in the existing 30-foot-wide grass median. To construct an additional lane in the grass median, the storm water drainage system will need to be re-configured and an additional lane would also need to be constructed for the westbound Interstate 40 On Ramp. Options for constructing an additional lane on the westbound Interstate 40 On Ramp could include merging the lanes downstream of the intersection and prior to the entrance to Interstate 40 or continuing the On Ramp dual lanes to the entrance of Interstate 40 and merging the lanes downstream on Interstate 40. Merging further downstream might be a better alternative due to the large amount of truck traffic.

Nonetheless, adding a second northbound left turn lane would significantly reduce the v/c ratio at this intersection and increase the level of service. This additional lane could be expected to be needed in the near future based on the projected growth.



**8) STRAWBERRY PLAINS PIKE AT BRAKEBILL ROAD**

8a) This intersection was calculated operating poorly with respect to the level of service for eastbound left turns during the existing conditions and operate extremely poor in the year 2025 without the



**View of Median of Strawberry Plains Pike at Brakebill Road (Looking South)**

project and with the project. While there are not excessive volumes attempting this turning movement, the amount of conflicting volumes causes extreme delays for the eastbound left turns attempting to turn towards northbound Strawberry Plains Pike. Many times, eastbound left turn drivers require the median space on Strawberry Plains Pike to provide a haven prior to completing the left turn entering the flow of northbound traffic. Drivers using the median as a haven potentially obstruct and conflict with the northbound left turn vehicles. Competition for sight distance and physical space within the median occurs between northbound left turns and eastbound left turns when the eastbound left turn movement uses the median as a mid-way haven.

In 2010, the intersection of Strawberry Plains Pike at Brakebill Road was selected by TDOT to undergo a Road Safety Audit Review (RSAR). This intersection was identified by the TDOT safety needs planning process and was evaluated since the crash ratio at the time of the study in 2010 met the threshold for safety improvements. As part of the review, traffic counts were obtained, and the intersection was determined as meeting MUTCD (Manual on Uniform Traffic Control Devices) Warrants for traffic signalization. However, due to the short distance (approximately 270 feet) between this intersection and the signalized intersection of Strawberry Plains Pike at the Interstate 40 On/Off Ramps (north side) to the south, traffic signalization was deemed “undesirable”. The TDOT RSAR report for this intersection in 2010 is in Appendix N. An overview of the 2010 TDOT recommended upgrades and changes at the intersection were the following:

- i. Re-striping and installation of pavement markings
- ii. Replacement and installation of new traffic signage
- iii. Vegetation removal
- iv. Relocation of an existing storm water culvert
- v. Construction of a new northbound left turn lane at the intersection of Strawberry Plains Pike at Brakebill Road
- vi. Construction of separate eastbound left and right turn lanes at the intersection of Strawberry Plains Pike at Brakebill Road

From the field review for this current traffic study, it appears that these recommendations were installed and/or constructed. Most importantly, the construction of the recommended turn lanes at the intersection of Strawberry Plains Pike at Brakebill Road were completed as recommended.

- 8b) As an investigation into a potential remediation for this intersection, and as a follow up to the TDOT review that indicated this intersection met warrants for traffic signalization in 2010; this intersection was re-examined with the 2018 traffic volumes with respect to traffic signal warrants. The traffic counts at this intersection were conducted from 7-9 am, 11 am–1 pm and 2-6 pm for a total of 8 hours.

The Manual on Uniform Traffic Control Devices – 2009 Edition (MUTCD) presents 9 different warrants that have been developed by the traffic engineering profession to determine whether a traffic signal is warranted. These warrants cover a broad range of minimum elements required to indicate whether a traffic signal is justified for any particular location. These elements consist of traffic volumes, pedestrian volumes, crash history, and other factors. The MUTCD explicitly states that a traffic control signal should not be installed unless one or more of the signal warrants in the manual are met. However, the satisfaction of a warrant does not entirely in itself justify the need for a traffic signal. Sometimes further engineering studies and judgments also need to be applied before justifying the need for a traffic signal to be installed. These further studies are a very important step in insuring that an installation of a traffic signal will not actually bring about degradations in safety and efficiencies.

The MUTCD defines 9 different warrants, two of which are potentially applicable for this intersection at this time and are explained below:

➤ Warrant 1, Eight-Hour Vehicular Volume:

Warrant 1 is comprised of 2 conditions – A and B. The Minimum Vehicular Volume, Condition A, is intended for application where the volume of intersecting traffic is the principal reason for consideration of signal installation. The Interruption of Continuous Traffic, Condition B, is intended for application at locations where Condition A is not satisfied and where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street.

➤ Warrant 2, Four-Hour Vehicular Volume:

The Four-Hour Vehicular Volume signal warrant conditions are intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

The intersection of Strawberry Plains Pike at Brakebill Road was evaluated for possible justification for a traffic signal based on the MUTCD Warrants listed above and the 2018 traffic count volumes. Brakebill Road was used as the minor side street for the warrant analysis and Strawberry Plains Pike was the major street. According to the Federal Highway Administration (FHWA), the traffic signal warrants are intentionally written in a manner that provides a large amount of flexibility to engineers in terms of how they determine the number of moving lanes and the volume of approaching traffic used in the analysis. The decisions as to which approach lanes on the major and minor streets and the corresponding traffic volumes are determined by the engineering judgment of the engineer conducting the study or by the methods established by local and state agencies. Ultimately, it the decision of the reviewing agency to determine whether right turn volumes from the minor street should be included.

For the intersection of Strawberry Plains Pike at Brakebill Road, when the analysis includes right turn volumes from Brakebill Road (the minor street approach), it

appears that this intersection currently meets traffic signal warrants. The intersection meets Warrant #1, Condition B and Warrant 2 based on the 2018 existing volumes collected for this study. However, if the right turn volumes from Brakebill Road are not included, the intersection does not meet signal warrants. Nonetheless, justification could be made for a traffic signal at this location currently since it does meet a traffic signal warrant when including right turns from the minor street approach. The results of the traffic signal warrant assessment at this intersection for the existing volumes of 2018 are in Appendix O and Table 9 presents the results.



**TABLE 9  
TRAFFIC SIGNAL WARRANT SUMMARY**

INTERSECTION	Volume Warrant (Required Number of Hours Satisfied)			
	Warrant 1			Warrant 2
	Condition #1A (8 hours)	Condition #1B (8 hours)	Condition 1A and 1B Combination (8 hours)	(4 hours)
<b>2018 - Existing Volumes</b> Strawberry Plains Pike at Brakebill Road (100% of Right Turns Included on Brakebill Road)	<b>Not Satisfied</b>	<b>Satisfied</b>	<b>Not Satisfied</b>	<b>Satisfied</b>
<b>2018 - Existing Volumes</b> Strawberry Plains Pike at Brakebill Road (0% of Right Turns Included on Brakebill Road)	<b>Not Satisfied</b>	<b>Not Satisfied</b>	<b>Not Satisfied</b>	<b>Not Satisfied</b>

8c) With the results of the traffic signal warrant analysis indicating that this intersection could be justified to have a traffic signal installed, Synchro Traffic Software (Version 8) was used to design a preliminary plan for traffic signalization. This preliminary design included coordinating the existing traffic signal at Strawberry Plains Pike at the Interstate 40 On/Off Ramps (north side) with the proposed traffic signal at Strawberry Plains Pike at Brakebill Road. Based on an 80 second coordinated cycle, the preliminary design resulted in a much-improved level of service for eastbound left turns at Brakebill Road. The level of service results of this preliminary design for the two intersections are shown in Table 10 and Appendix G includes the worksheets for these capacity analyses. The results shown in Table 10 includes the recommended addition of a northbound left turn lane at the intersection of Strawberry Plains Pike at the Interstate 40 On/Off Ramps. Also, the results of the

calculated queue lengths based on the preliminary traffic signal design are shown in Table 11.

**TABLE 10**  
**2025 PEAK HOUR LEVEL OF SERVICE & DELAY - OPENING YEAR (WITH PROJECT)**  
**WITH PRELIMINARY NEW TRAFFIC SIGNAL DESIGN**

INTERSECTION	TRAFFIC CONTROL	APPROACH	AM PEAK			PM PEAK		
			LOS	DELAY (seconds)	V/C	LOS	DELAY (seconds)	V/C
Strawberry Plains Pike at Brakebill Road	 Signalized	Eastbound	D	39.5	0.600	C	32.2	0.840
		Northbound	A	5.1		A	9.7	
		Southbound	A	7.0		A	3.7	
		Intersection Summary	B	13.1	B	11.0	0.840	
Strawberry Plains Pike at Interstate 40 On/Off Ramps (north side)	 Signalized	Westbound	C	32.6	0.570	C	34.2	0.540
		Northbound	A	5.7		A	5.8	
		Southbound	A	7.3		B	11.5	
		Intersection Summary	B	11.1	B	11.8	0.540	

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

**TABLE 11**  
**TURN LANE STORAGE & QUEUE SUMMARY**  
**2025 PM Projected Peak Hour Traffic Volumes**  
**with Preliminary New Traffic Signal Design**

Intersection Name/Turn Lane	Volume (vph) *	Existing Storage Length (ft)	Sim Traffic 95% Queue (ft)
<b>Strawberry Plains Pike at Brakebill Road</b>			
Eastbound Left	88	120	91
Northbound Left/U-Turn	337	150	204
<b>Strawberry Plains Pike at I-40 On/Off Ramps</b>			
Westbound Left	189	200	164
Westbound Left		200	220
Northbound Left	360	190	158
Northbound Left **		190	269

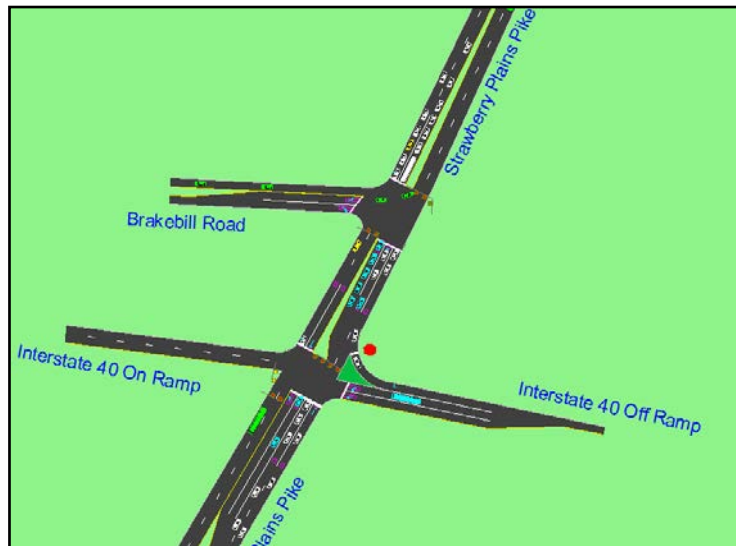
\* Volumes are from largest volume for each individual movement during the AM or PM peak hour

\*\* Lane assumed to be constructed

The results of the queue analysis shown in Table 11 indicate that some of the turn lane lengths may need to be increased based on the projected volumes and the preliminary signal timing design. The northbound left lane at Strawberry Plains Pike at Brakebill Road was calculated to have a 95<sup>th</sup> percentile queue length of 204 feet

with an existing storage length of 150 feet. This would require this turn lane be lengthened to its maximum length available in between the two intersections. This additional 64 feet is potentially available but will require careful consideration since this additional length will encroach on the intersection of Strawberry Plains Pike at Interstate 40 On/Off Ramps (north side).

Based on the 2025 projected volumes, other turn lane lengths that may need to be increased include the turn lanes at the intersection of Strawberry Plains Pike at the Interstate 40 On/Off Ramps. The results indicated that the existing Interstate 40 Off Ramp westbound dual left turn lane storage lengths could be exceeded by what is currently available by



**Image from SimTraffic Software:  
New Proposed Traffic Signal at Strawberry Plains Pike at Brakebill Road and Existing Traffic Signal at Strawberry Plains Pike at Interstate 40 On/Off Ramps (north side)**

approximately 20 feet. In actuality, the expected queue lengths would be more evenly distributed between the two lanes which would result in a required length of 192 feet in both lanes ( $164 \text{ feet} + 220 \text{ feet} / 2 \text{ lanes} = 192 \text{ feet}$ ) which is below the currently provided storage of 200 feet.

In addition to needing dual northbound left turn lanes at the intersection of Strawberry Plains Pike at the Interstate 40 On/Off Ramps (as discussed earlier on page 55), these dual left turn lanes will need to be extended further than the current 190 feet of storage length currently offered by the existing single left turn lane. The software modeled that the northbound left turn lanes would have a 95<sup>th</sup> percentile queue of 158 feet and 269 feet. In actuality, the expected queue lengths would be more evenly distributed between the two lanes which would result in a required length of 213 feet in both lanes ( $158 \text{ feet} + 269 \text{ feet} / 2 \text{ lanes} = 214 \text{ feet}$ ). This could be

easily rectified by extending the dual northbound left turn lanes to 215 feet by adding 25 feet to the existing 190 feet of storage length (currently provided by the existing single turn lane) for a total of 215 feet.

Further analysis of the coordinated signal system at these 2 intersections should be optimized based on the actual future volumes instead of the projected volumes. Using the actual future volumes versus the projected volumes from this study could reduce the projected peak queue lengths and the potential turn lane storage extensions required.

Even though TDOT in 2010 recognized that the intersection of Strawberry Plains Pike at Brakebill Road met signal warrants but deemed the intersection as “undesirable” to be signalized, it is recommended that this intersection be signalized. This intersection currently meets warrants for signalization and is projected to continue to meet warrants for signalization in the future. If a traffic signal is not installed in the short term; at a minimum, it is recommended that this intersection be signalized prior to the Brakebill Road 325-lot residential subdivision being opened to residents. If this intersection is not signalized and experiences the potential increased traffic volumes, intolerable vehicle delays will occur. This could result in increased vehicle crashes due to impatient drivers. Potential issues to consider related to installing a traffic signal at the intersection of Strawberry Plains Pike at Brakebill Road include the following:

- a. Shorter traffic signal cycles lengths are recommended since queue lengths tend to be shorter for short cycle lengths and will be necessary due to the short distance between the 2 intersections.
- b. The traffic signals on Strawberry Plains Pike at both intersections in the northbound and southbound approaches need to be carefully designed with respect to placement and visibility. The signal heads on these approaches will need to be installed with louvers or optically programmed signals to restrict signal visibility to these traffic lanes. This will be required to eliminate drivers from driving thru or not recognizing the first set of signal heads in the progression thru the two sets of signalized intersections.



9) BRAKEBILL ROAD

From the results earlier in this report it was shown that the calculated crash rates on Brakebill Road were not high enough to receive consideration for TDOT safety funding. Nonetheless, the narrowness of the roadway, the shoulder drop-offs, and the lack of a clear zone outside the roadway could be considered as a potential factor in the road crashes. As stated earlier, based on evaluating the obtained individual traffic crash reports from Brakebill Road over the past 3 years, 5 of the 19 crashes indicated that the narrowness of Brakebill Road could have been a contributable factor. These 5 crashes were either opposite direction sideswipes or road departures. Examining the crash data several more years back to September 2009, an additional 15 crashes on Brakebill Road occurred that either involved head-on collisions, opposite direction sideswipes, or collisions with objects off the roadway. As one can easily conclude, research has indicated that narrow roads have a significant influence on these types of crashes. Pictures showing the various pavement drop-offs and roadside hazards on Brakebill Road are shown below:





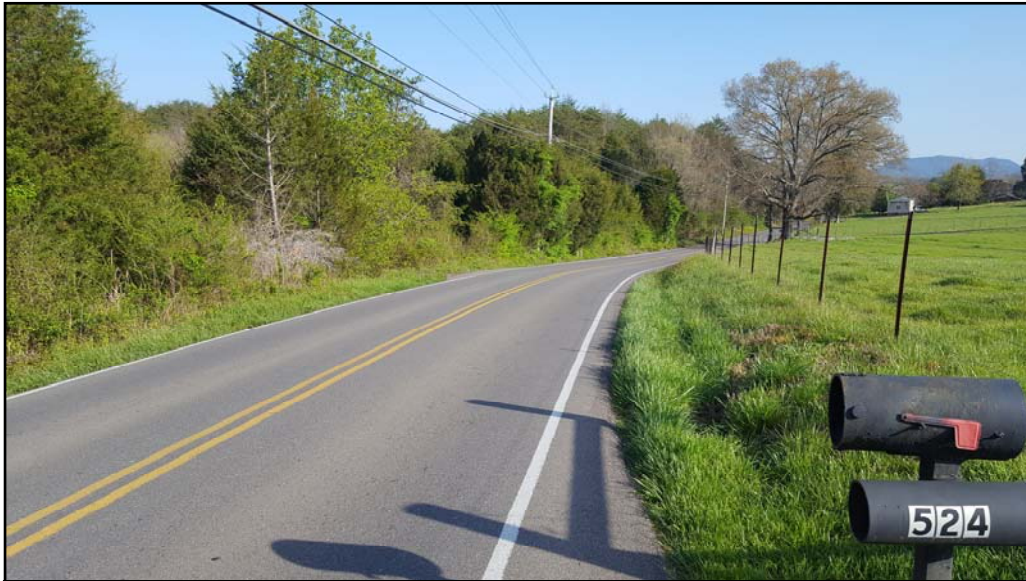
The most logical recommendation would include widening Brakebill Road. Brakebill Road is a major collector and an important link in between Asheville Highway (US 25E/Hwy 11E) and Strawberry Plains Pike at Interstate 40. Improving Brakebill Road with appropriate horizontal and vertical alignments, lane widths, shoulders, and clear zones would potentially greatly decrease the amount of vehicle crashes. It is expected that this road at some point in the future will need to be widened and improved. In the interim, and to accommodate traffic growth and development in the area, several strategies should be employed to reduce the number of opposite direction sideswipes, head-on, and roadway departure crashes.

To determine appropriate strategies to potentially reduce traffic crashes on Brakebill Road, resources from the FHWA were reviewed. The following measures are recommended to be implemented on Brakebill Road:

- i. Identify and remove or re-locate roadside hazards (ditches, utility poles, and trees): Research has indicated that increasing the clear zone prevents crashes. Most of the road departure crashes since 2009 on Brakebill Road involved striking trees. The next most common object struck was utility poles followed by roadside ditch crashes. According to research, 80% of all fatal crashes at curves are roadway departure crashes. (Source: Fatality Analysis Reporting System). Roadside hazards that have been identified and documented along Brakebill Road are shown in a summary located at the end of this section.
  
- ii. Advanced warning signs: Warning signs call attention to unexpected conditions on or next to the roadway. It is recommended that advance warning signs be installed on Brakebill Road in advance of two of the horizontal curves where evidence of crash clusters have occurred. Advance warning Curve Signs (W1-2) should be placed before the horizontal curve in both directions just to the north of 524 Brakebill Road. The other location where an advance warning Curve Sign (W1-2) should be installed is before the horizontal curve on Brakebill Road heading southbound near the intersection of Brakebill Road at Palmer



Lane. An advance warning curve sign is already posted for the northbound direction on Brakebill Road.



**Horizontal Curve on Brakebill Road near 524 Brakebill Road  
(Looking North)**



**Horizontal Curve on Brakebill Road near Palmer Lane  
(Looking South)**

- iii. Installation of Rumble Strips (along the edgeway and the center of the road): According to the FHWA, edgeway and center line rumble strips are an effective countermeasure to reduce vehicle departure crashes, head-on collisions, and opposite direction sideswipe crashes. A table from NCHRP Report 641, Guidance for the Design and Application of Shoulder and Centerline Rumble Strips, is shown below which shows the reduction in crash history based on before and after research studies on urban and rural two-lane roads.

<b>Center line Rumble Strip – Reduction in crash frequency from before to after rumble strip implementation for head-on and opposite direction sideswipe fatal and injury collisions</b>		
	Percent reduction in crash frequency from before to after rumble strip implementation	Standard Error
Rural two-lane roads	45%	6%
Urban two-lane roads	64%	27%

*Excerpt from Table 67 of NCHRP Report 641.*

<b>Shoulder Rumble Strip – Reduction in crash frequency from before to after rumble strip implementation for single-vehicle run-off-road fatal and injury crashes</b>		
	Percent reduction in crash frequency from before to after rumble strip implementation	Standard Error
Rural two-lane roads	36%	10%
Rural freeways	17%	7%

*Excerpt from Table 28 of NCHRP Report 641.*

The results from the NCHRP (National Cooperative Highway Research Program) report show significant reductions in head-on, opposite direction sideswipes, and roadway departure crashes after installation of rumble strips on two lane roadways. It is recommended rumble strips should be installed on Brakebill Road at a minimum at the 2 horizontal curves identified above where advance curve signs are recommended. Over the past 3 years, clusters of crashes at these horizontal curves have occurred and could be reduced in the future with the installation of rumble strips. Other horizontal curves on Brakebill Road should be

considered as well. TDOT provides a standard (T-M-16) for asphalt shoulder rumble stripe installation details for non-access controlled routes.

Some potential issues to consider related to installing rumble strips involve the following:

- a. Pavement: The asphalt pavement of the roadway needs to be of sufficient thickness and quality to install rumble strips.
- b. Bicyclists: Rumble strips can be detrimental to bicycle travel and hazardous to bicyclists. However, currently, there is very little evidence of regular bicycle travel on Brakebill Road.
- c. Noise: Rumble strips can be a nuisance with respect to the noise generated from vehicles traveling over the strips. The noise is beneficial to the driver inside the vehicle to give a warning but can be a nuisance to those who live nearby. Brakebill Road is not a heavily populated area, but there are residences adjacent to the two horizontal curves where rumble strips are recommended. There are options to reduce noise by reducing rumble strip widths, installing sinusoidal-shaped rumble strips which do not produce as much noise, and by discontinuing rumble strips near intersections and major driveways.

These potential issues are not expected to be a serious impediment for installing rumble strips on Brakebill Road. These measures should be beneficial to reducing the amount of head-on, sideswipe, and departure crashes on Brakebill Road.

A summary of the identified roadside hazards along Brakebill Road are listed in the following section. These identified roadside hazards are comprised of vegetation obstructions, drainage ditches, utility poles, trees, and road shoulder drop-offs.





**Intersection of  
Brakebill Road  
at Crosswood  
Boulevard**

**Roadside vegetation obscures sight distance for turning vehicles at Crosswood Boulevard (Looking Northwest)**



**Near 701  
Brakebill Road  
Driveway**

**Steep road/shoulder drop-off and deteriorated pavement  
(Looking North)**



**Near 512  
Brakebill Road  
Driveway**

**Large trees and utility poles adjacent to roadway with shoulder drop-off into drainage ditch (Looking North)**



Near 508  
Brakebill Road  
Driveway

Large trees and utility poles adjacent to roadway with shoulder drop-off into drainage ditch (Looking North)



Near 428  
Brakebill Road  
Driveway

Large trees and utility poles adjacent to roadway with shoulder drop-off into drainage ditch (Looking South)



Just South of  
Kilbridge Drive

Large trees adjacent to roadway with shoulder drop-off into drainage ditch (Looking North)





Near 420  
Brakebill Road  
Property

Large trees and large tree stump adjacent to roadway with shoulder drop-off into drainage ditch (Looking North)



Near 322  
Brakebill Road  
Property

Utility poles adjacent to roadway with shoulder drop-off (Looking South)



Near 320  
Brakebill Road  
Property

Large trees adjacent to roadway (Looking North)



**Just South of  
Suncrest Lane**

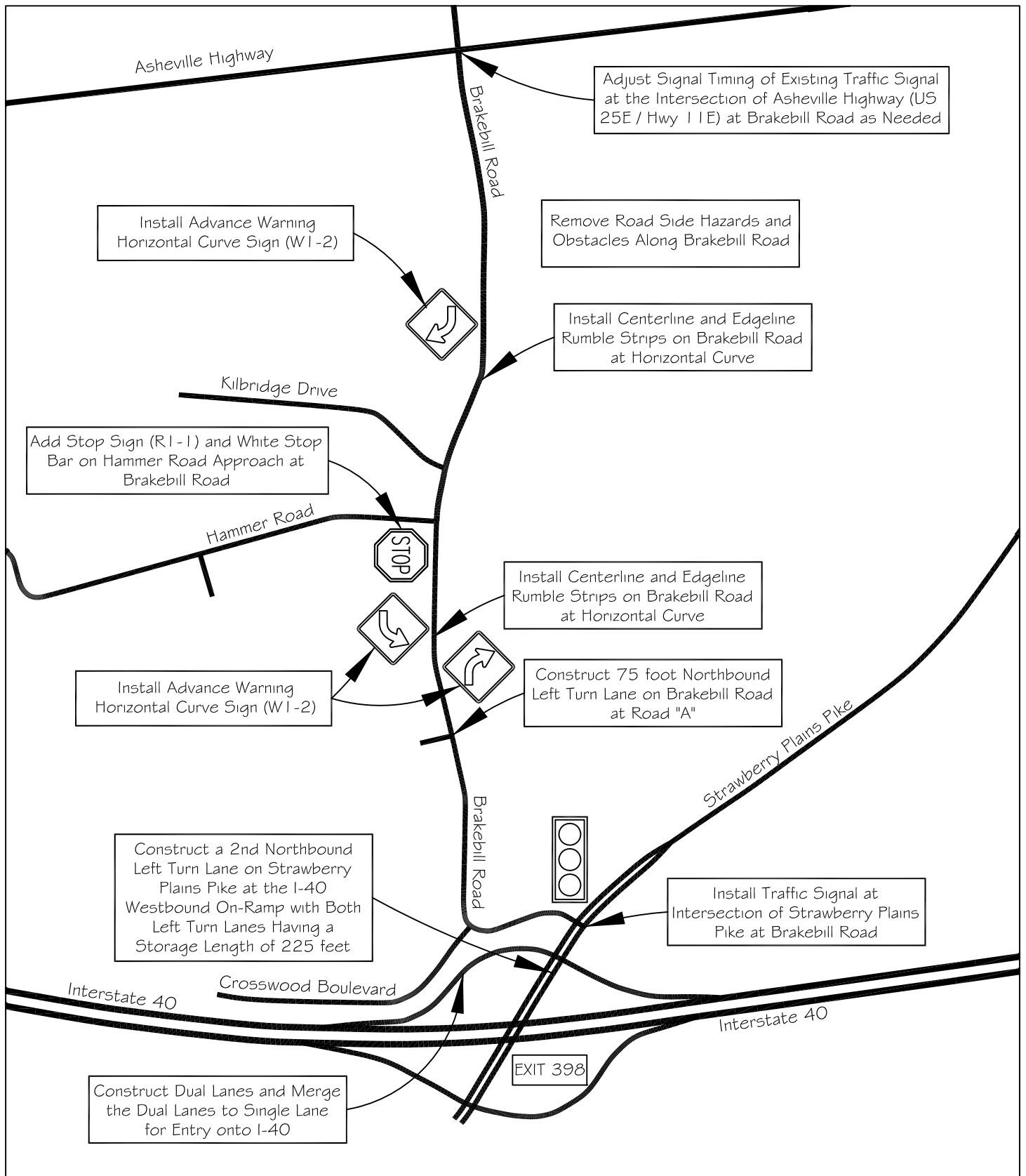
**Deep shoulder drop-off into drainage ditch  
with evidence of vehicle scraping asphalt  
(Looking North)**



**Just North of  
Suncrest Lane**

**Shoulder drop-off with evidence of vehicle scraping asphalt  
(Looking South)**





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

NOT TO SCALE



FIGURE 10

Brakebill Road Development

Summary of Recommended External Road Improvements

**10) BRAKEBILL ROAD DEVELOPMENT ROADS AND PARKING AREA AISLE-WAYS**

The current concept plan shows several new roads and parking area aisle-ways being constructed within the Brakebill Road Development as shown on Figure 3.

10a) It is recommended that a “No Outlet” (W14-2) sign is posted near the front of the apartment complex entrance and the mini-warehouse facility.

10b) It is recommended that a 25-mph speed limit be posted at the entrances on Road “A” and Road “T” into the new residential subdivision. It is recommended that a 15-mph speed limit be posted at the entrance at the Apartment Driveway.

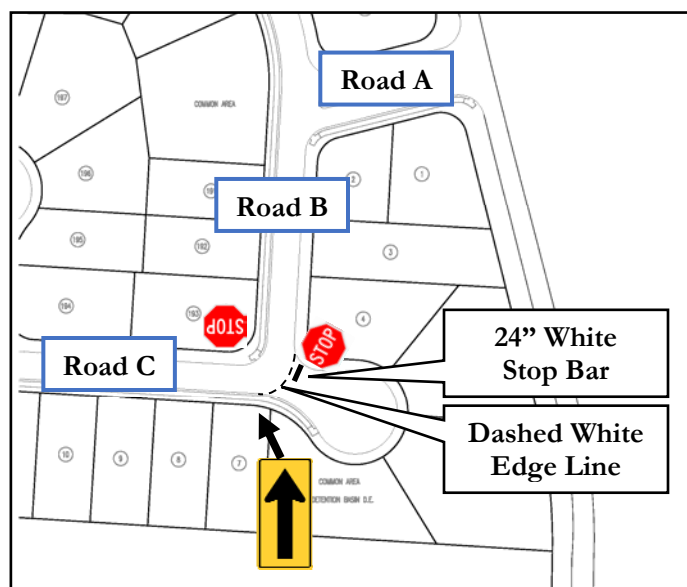
10c) All drainage grates and covers for both residential developments need to be pedestrian and bicycle safe.

10d) Sight distance at the new internal intersections must not be impacted by new signage, future landscaping, or parked vehicles.

10e) The internal sidewalks that are proposed for the development should have appropriate ADA compliant curbed ramps at intersection corners and the sidewalks are recommended to be 5 feet minimum in width.

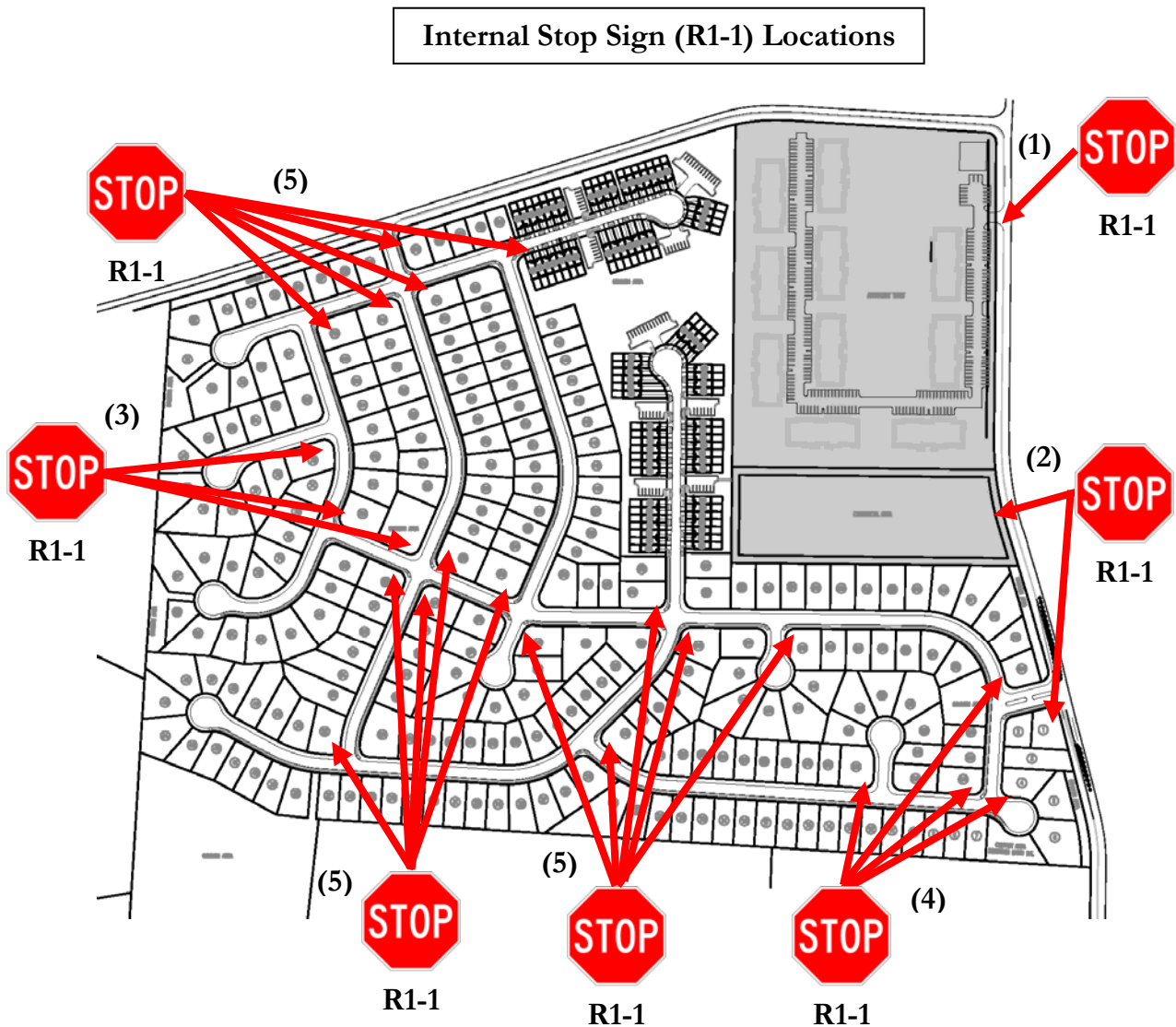
10f) All road grade and intersection elements internally and externally should be designed to AASHTO, TDOT, and Knox County Engineering specifications and guidelines to ensure proper operation.

10g) The intersection of Road “B” and Road “C” in the single-family residential subdivision has been designed



with a cul-de-sac on the southeast corner. This non-traditional intersection layout will require additional pavement markings and signage to reduce the possibility of vehicle conflicts. It is recommended that a white dashed line be installed in the outside path of Road “C” transitioning to Road “B”. A Stop Sign (R1-1) should be installed at the Road “B” approach and at the cul-de-sac approach at the intersection of Road “B” and Road “C”. A Left Direction Arrow Sign (W1-6) should be installed facing the eastbound approach of Road “C” at the curved path to Road “B”. A 24” white stop bar at the cul-de-sac intersection should also be installed in front of the dashed white edge line.

10h) A total of 25 Stop Signs (R1-1) should be installed at the internal road intersections as shown below:



**APPENDIX A**

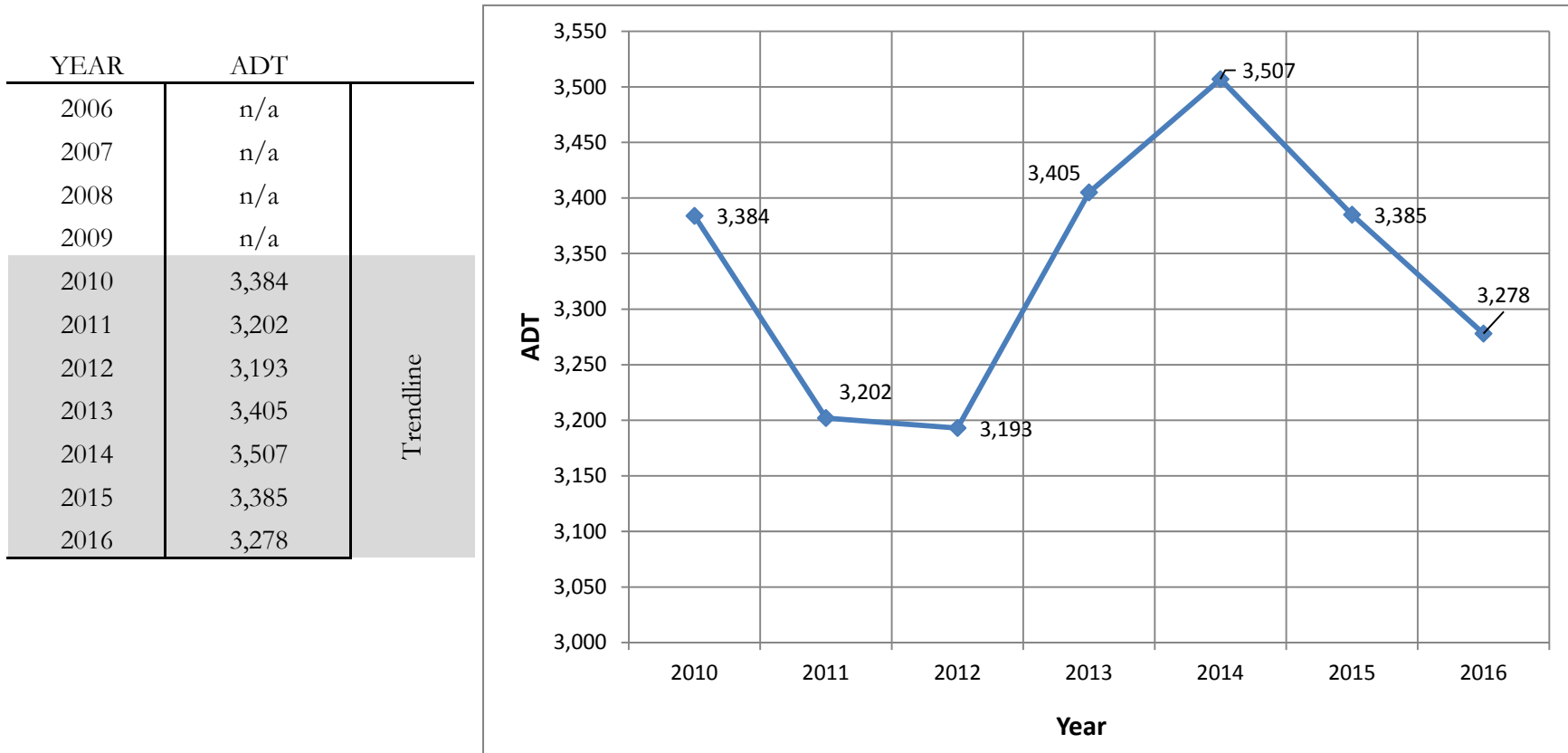
**HISTORICAL TRAFFIC COUNT DATA**

## Historical Traffic Counts

Organization: TDOT

Station ID #: 000472

Location: Brakebill Road (North of Strawberry Plains Pike)



2010 - 2016 Growth Rate = -3.1%

Average Annual Growth Rate = -0.5%



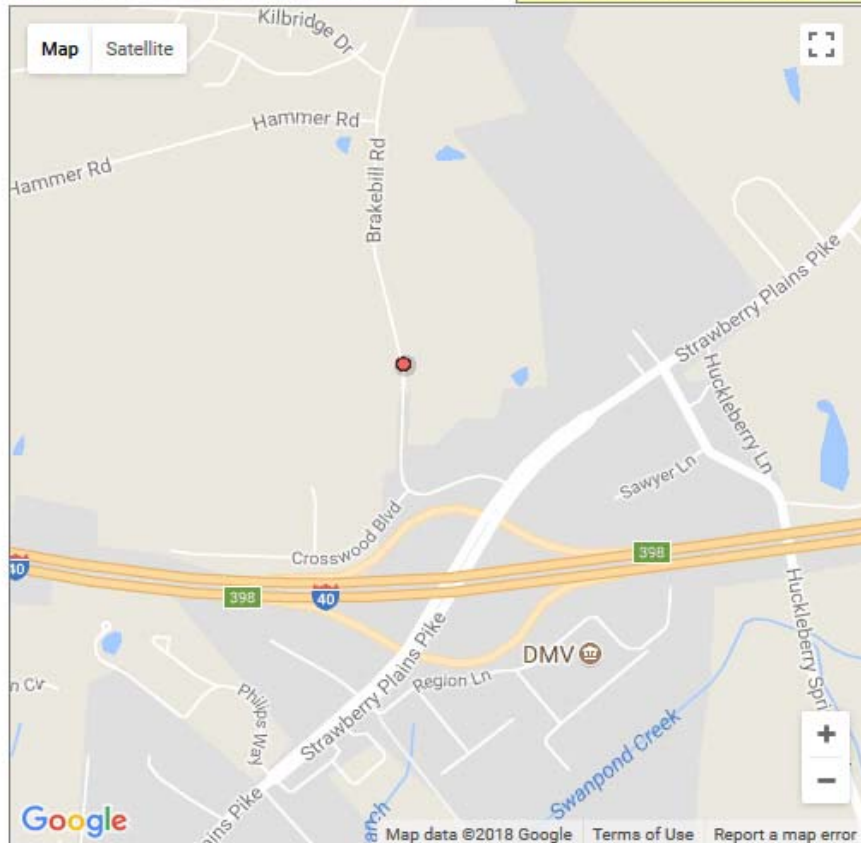
## Traffic History

Traffic History reflects the Annual Average Daily Traffic (AADT) count along specific locations on Tennessee's road network

View stations on map:

Non-Map Record Search:

Station Number:



Station Information	
Station	000472
Route	05630
Location	BRAKERBILL RD. - N. OF STRAWBERRY PLAINS PK
County	Knox
2016	3278
2015	3385
2014	3507
2013	3405
2012	3193
2011	3202
2010	3384
2009	NA
2008	NA
2007	NA
2006	NA
2005	NA
2004	NA
2003	NA
2002	NA
2001	NA
2000	NA
1999	NA

Download File: [KML](#) | [ESRI Geodatabase](#) | [ESRI Shapefile](#) | [Database Table](#)  
Open With: [Google Earth](#) | [ArcGIS Explorer](#) | [MS Access or Excel](#)

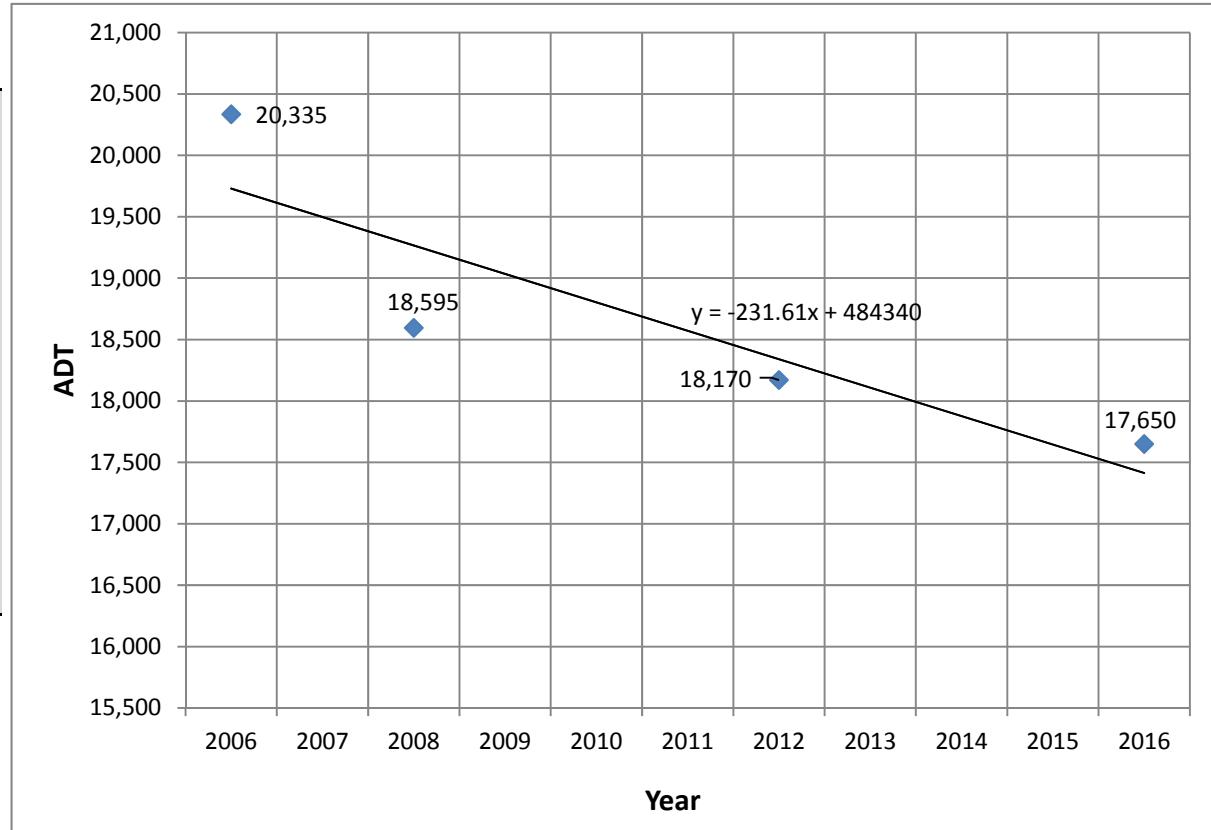
# Historical Traffic Counts

Organization: MPC

Station ID #: 093C327

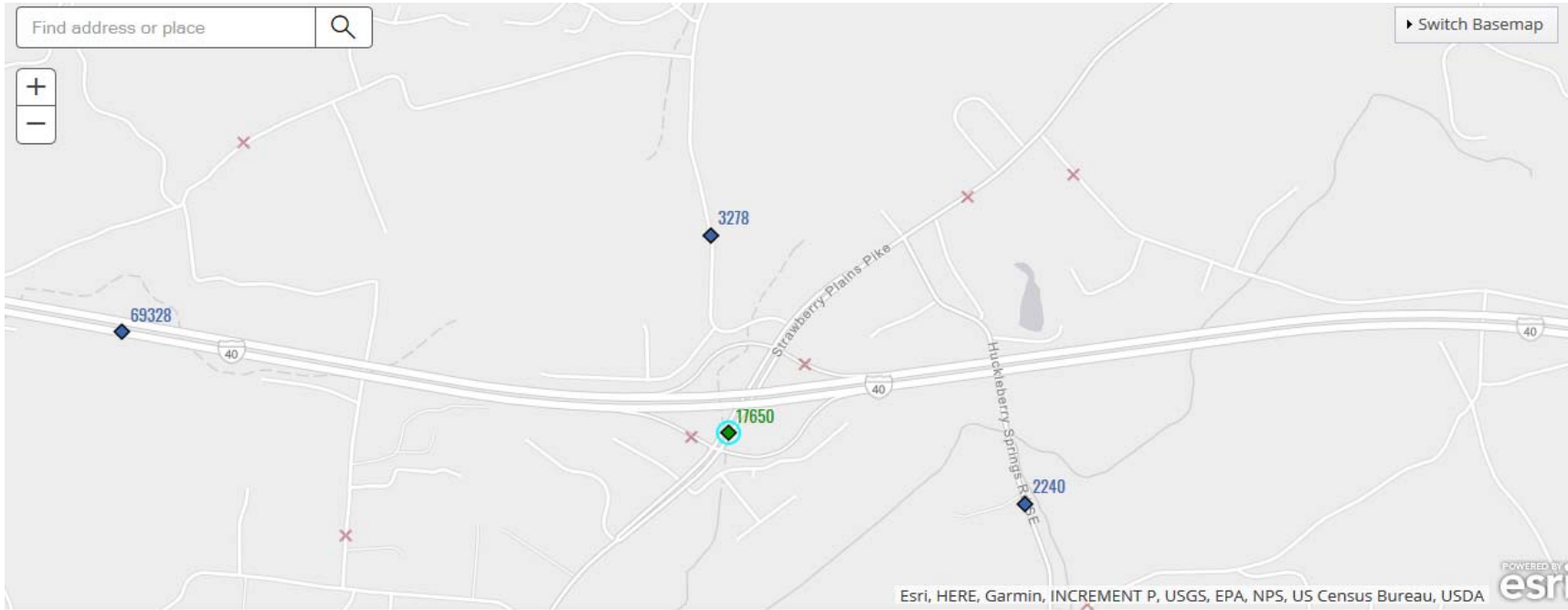
Location: Strawberry Plains Pike (South of I-40)

YEAR	ADT	Trendline
2006	20,335	
2007		
2008	18,595	
2009		
2010		
2011		
2012	18,170	
2013		
2014		
2015		
2016	17,650	

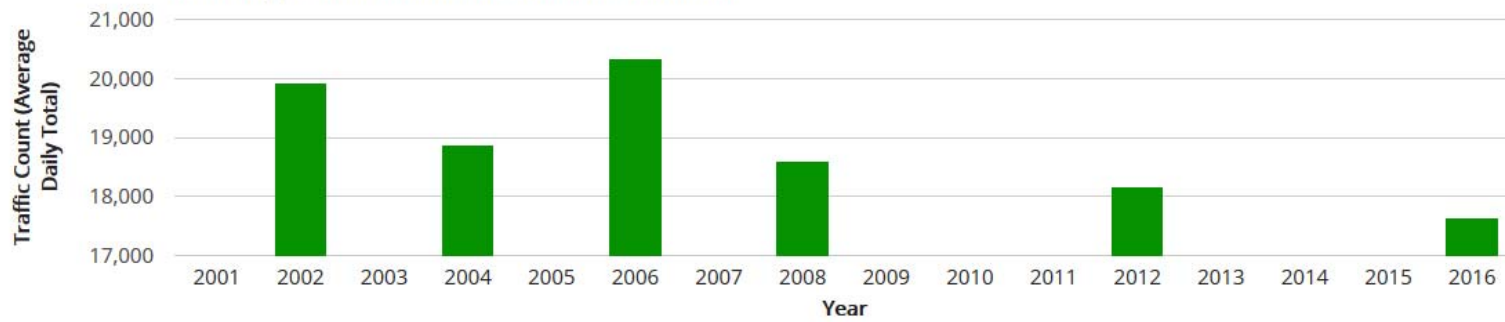


2006 - 2016 Growth Rate = -13.2%

Average Annual Growth Rate = -1.4%



**Strawberry Plains Pk - N of I-40E Ex (Station ID: 093C327)**






**APPENDIX B**

**WALK SCORE**


**WALK SCORE**  
(from walkscore.com)




**Walk Score**  [Get Scores](#) [Find Apartments](#) [My Favorites](#) [Add to Your Site](#)


Type an address, neighborhood or city

### 499 Brakebill Road

Knoxville, Tennessee, 37924

Commute to **Downtown Knoxville** 

 20 min  60+ min  60+ min [View Routes](#)

[Looking for a home for sale in Knoxville?](#) 

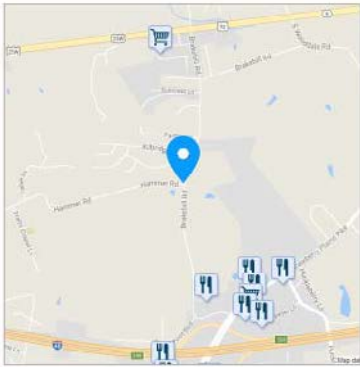
**Walk Score**  
**15**

**Car-Dependent**  
Almost all errands require a car.

**Transit Score**  
**0**

**Minimal Transit**  
It is possible to get on a bus.

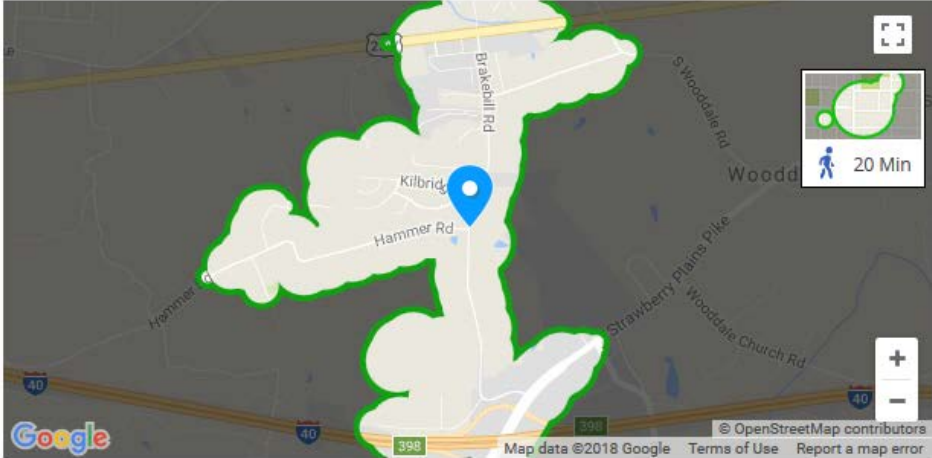
[About your score](#)  
[Add scores to your site](#)



## Travel Time Map

[Add to your site](#)

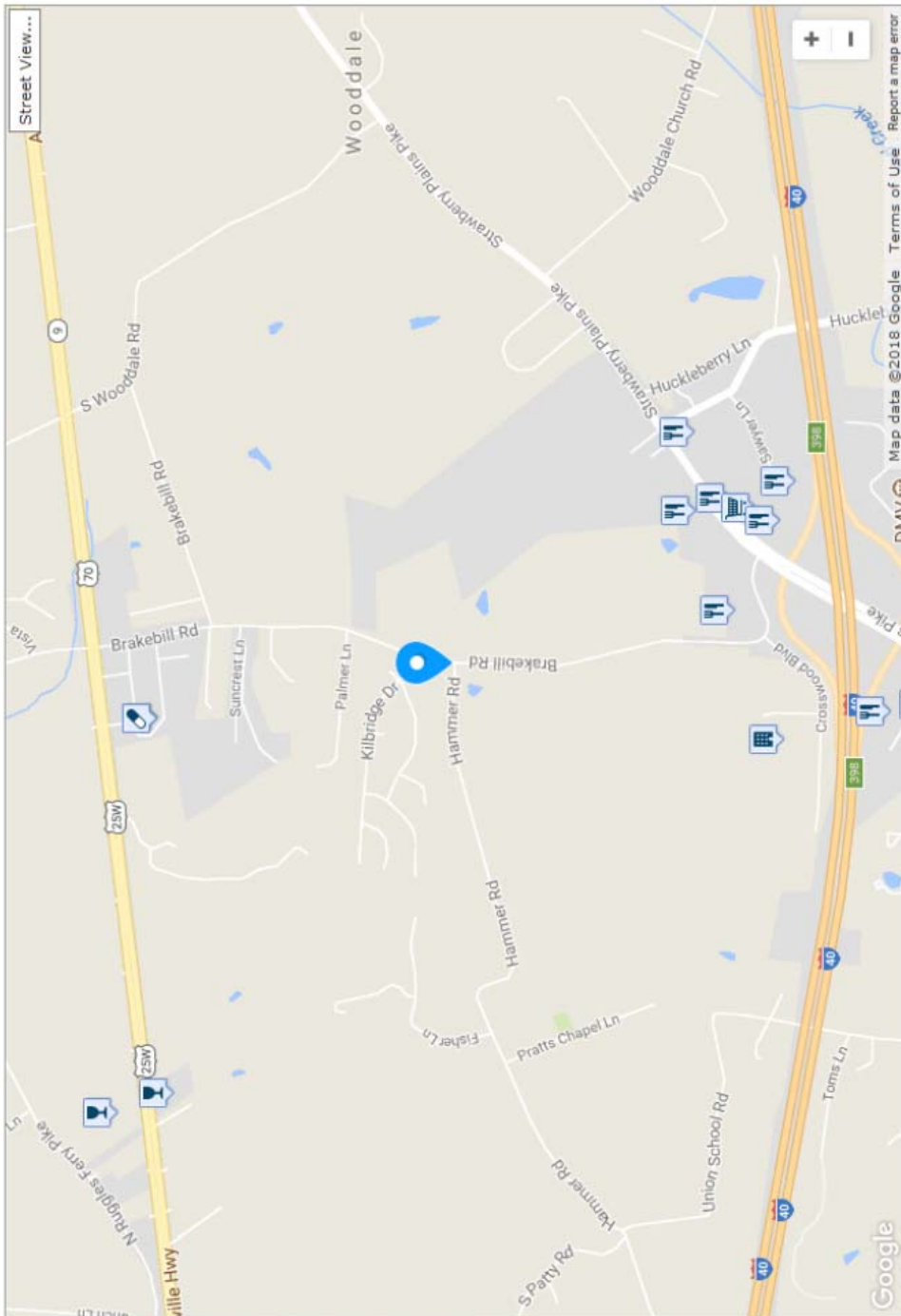
Explore how far you can travel by car, bus, bike and foot from 499 Brakebill Road.



Map data ©2018 Google [Terms of Use](#) [Report a map error](#)

## What's Nearby

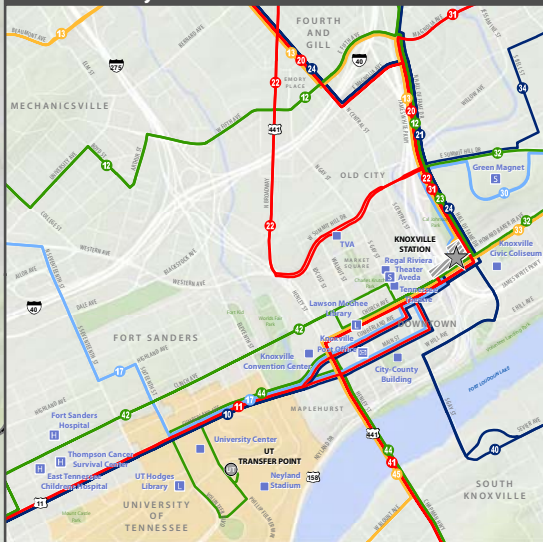
- Restaurants:** Wendy's .4mi
- Coffee:** Clark Brothers Coffee 4mi
- Bars:** Six Pockets Sports Grill .9mi
- Groceries:** KenJo Markets .5mi
- Parks:** Volunteer Park 3mi
- Schools:** Sunnyview Primary School 1.7mi
- Shopping:** Jean's Wear 1.7mi
- Entertainment:** Tennessee Firefighters Museum .5mi
- Errands:** Food City Pharmacy .6mi
- Search Nearby:**



**APPENDIX C**

**KNOXVILLE AREA TRANSIT MAP AND INFORMATION**

### Knoxville City Center



**Legend**

- Transfer Point
- Lift Service Area Boundary

**Points of Interest**

- Hospital
- School
- Library
- Point of Interest
- Post Office

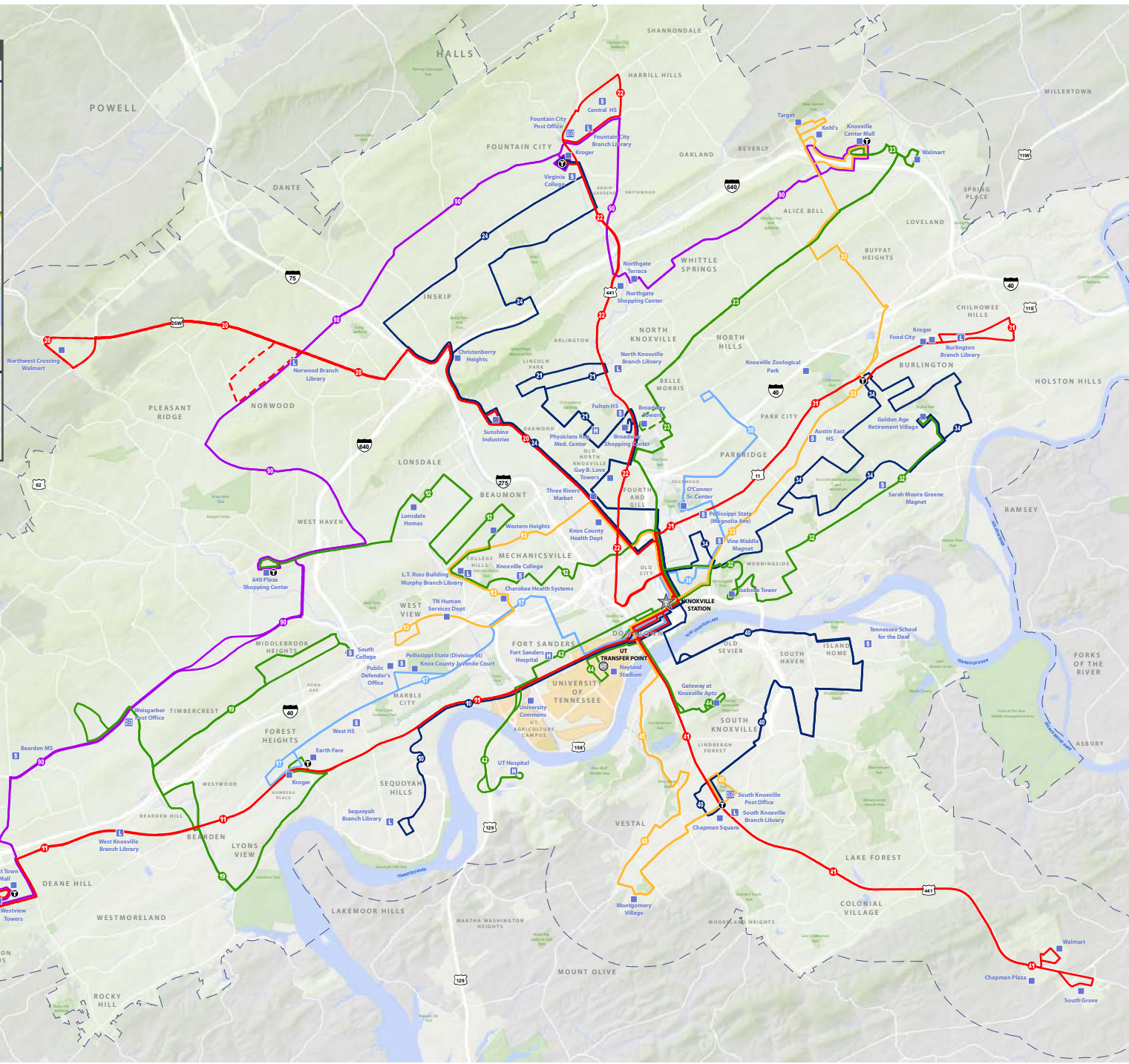
**Distances**

0 5 10 Minutes Walking

0 5 10 Minutes Biking

0 0.5 1 Map Scale in Miles

North





# 31 MAGNOLIA AVENUE

(Weekdays and Weekends)



### Legend

- # Route Timepoint
- T Transfer Point
- Bus Stop

### Points of Interest

<span style="border: 1px solid black; padding: 2px;">H</span> Hospital	<span style="border: 1px solid black; padding: 2px;">✉</span> Post Office
<span style="border: 1px solid black; padding: 2px;">L</span> Library	<span style="border: 1px solid black; padding: 2px;">S</span> School
<span style="border: 1px solid black; padding: 2px;">■</span> Point of Interest	<span style="border: 1px solid black; padding: 2px;">P</span> Park & Ride



# MAGNOLIA AVENUE

(Weekdays and Weekends)

## SERVES:

- ★ Chilhowee Park
- ★ Holston Drive
- ★ Knoxville Station/Downtown
- ★ Kroger
- ★ Pellissippi State, Magnolia Ave. Campus



Information Updated: August 24, 2015

## Weekday Schedule Route 31: Magnolia

Going away from Downtown						Going toward Downtown					
Transfer to:			Rts. 33 & 34			Rts. 33 & 34					
Knoxville Station—Platform F	Magnolia at Jessamine	Magnolia at Chestnut	Kirkwood St. Superstop (Arrives)	Kirkwood St. Superstop (Leaves)	Burns Rd at Asheville Hwy	Chilhowee at Holston	Kirkwood St. Superstop (Arrives)	Kirkwood St. Superstop (Leaves)	Magnolia at Chestnut	Magnolia at Jessamine	Knoxville Station
<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>		

WEEKDAY SCHEDULE												
A.M.	—	—	—	—	—	5:38	5:43	5:51	5:53	5:59	6:04	6:10
						5:53	5:58	6:06	6:08	6:14	6:19	6:25
	—	—	—	—	—	6:08	6:13	6:21	6:23	6:29	6:34	6:40
						6:23	6:28	6:36	6:38	6:44	6:49	6:55
	6:15	6:19	6:25	6:30	6:33	6:38	6:43	6:51	6:53	6:59	7:04	7:10
	6:30	6:34	6:40	6:45	6:48	6:53	6:58	7:06	7:08	7:14	7:19	7:25
	6:45	6:49	6:55	7:00	7:03	7:08	7:13	7:21	7:23	7:29	7:34	7:40
	7:00	7:04	7:10	7:15	7:18	7:23	7:28	7:36	7:38	7:44	7:49	7:55
	7:15	7:19	7:25	7:30	7:33	7:38	7:43	7:51	7:53	7:59	8:04	8:10
	7:30	7:34	7:40	7:45	7:48	7:53	7:58	8:06	8:08	8:14	8:19	8:25
	7:45	7:49	7:55	8:00	8:03	8:08	8:13	8:21	8:23	8:29	8:34	8:40
	8:00	8:04	8:10	8:15	8:18	8:23	8:28	8:36	8:38	8:44	8:49	8:55
	8:15	8:19	8:25	8:30	8:33	8:38	8:43	8:51	8:53	8:59	9:04	9:10
	8:30	8:34	8:40	8:45	8:48	8:53	8:58	9:06	9:08	9:14	9:19	9:25
	8:45	8:49	8:55	9:00	9:03	9:08	9:13	9:21	9:23	9:29	9:34	9:40
	9:00	9:04	9:10	9:15	9:18	9:23	9:28	9:36	9:38	9:44	9:49	9:55
	9:15	9:19	9:25	9:30	9:33	9:38	9:43	9:51	9:53	9:59	10:04	10:10
	9:45	9:49	9:55	10:00	10:03	10:08	10:13	10:21	10:23	10:29	10:34	10:40
	10:15	10:19	10:25	10:30	10:33	10:38	10:43	10:51	10:53	10:59	11:04	11:10
	10:45	10:49	10:55	11:00	11:03	11:08	11:13	11:21	11:23	11:29	11:34	11:40
	11:15	11:19	11:25	11:30	11:33	11:38	11:43	11:51	11:53	11:59	12:04	12:10
	11:45	11:49	11:55	12:00	12:03	12:08	12:13	12:21	12:23	12:29	12:34	12:40
<b>P.M.</b>	12:15	12:19	12:25	12:30	12:33	12:38	12:43	12:51	12:53	12:59	1:04	1:10
	12:45	12:49	12:55	1:00	1:03	1:08	1:13	1:21	1:23	1:29	1:34	1:40
	1:15	1:19	1:25	1:30	1:33	1:38	1:43	1:51	1:53	1:59	2:04	2:10
	1:45	1:49	1:55	2:00	2:03	2:08	2:13	2:21	2:23	2:29	2:34	2:40
	2:15	2:19	2:25	2:30	2:33	2:38	2:43	2:51	2:53	2:59	3:04	3:10
	2:45	2:49	2:55	3:00	3:03	3:08	3:13	3:21	3:23	3:29	3:34	3:40
	3:15	3:19	3:25	3:30	3:33	3:38	3:43	3:51	3:53	3:59	4:04	4:10
	—	—	—	—	—	3:53	3:58	4:06	4:08	4:14	4:19	4:25
	3:45	3:49	3:55	4:00	4:03	4:08	4:13	4:21	4:23	4:29	4:34	4:40
	4:00	4:04	4:10	4:15	4:18	4:23	4:28	4:36	4:38	4:44	4:49	4:55
	4:15	4:19	4:25	4:30	4:33	4:38	4:43	4:51	4:53	4:59	5:04	5:10
	4:30	4:34	4:40	4:45	4:48	4:53	4:58	5:06	5:08	5:14	5:19	5:25
	4:45	4:49	4:55	5:00	5:03	5:08	5:13	5:21	5:23	5:29	5:34	5:40
	5:00	5:04	5:10	5:15	5:18	5:23	5:28	5:36	5:38	5:44	5:49	5:55
	5:15	5:19	5:25	5:30	5:33	5:38	5:43	5:51	5:53	5:59	6:04	6:10
	5:30	5:34	5:40	5:45	5:48	5:53	5:58	6:06	6:08	6:14	6:19	6:25
	5:45	5:49	5:55	6:00	6:03	6:08	6:13	6:21	6:23	6:29	6:34	6:40
	6:00	6:04	6:10	6:15	6:18	6:23	6:28	6:36	6:38	6:44	6:49	6:55
	6:15	6:19	6:25	6:30	6:33	6:38	6:43	6:51	6:53	6:59	7:04	7:10
	6:45	6:49	6:55	7:00	7:03	7:08	7:13	7:21	7:23	7:29	7:34	7:40
	7:15	7:19	7:25	7:30	7:33	7:38	7:43	7:51	7:53	7:59	8:04	8:10
	7:45	7:49	7:55	8:00	8:03	8:08	8:13	8:21	8:23	8:29	8:34	8:40
	8:15	8:19	8:25	8:30	8:33	8:38	8:43	8:51	8:53	8:59	9:04	9:10
	8:45	8:49	8:55	9:00	9:03	9:08	9:13	9:21	9:23	9:29	9:34	9:40
	9:15	9:19	9:25	9:30	9:33	9:38	9:43	9:51	9:53	9:59	10:04	10:10
	9:45	9:49	9:55	10:00	10:03	10:08	10:13	10:21	10:23	10:29	10:34	To Garage
	10:15	10:19	10:25	10:30	10:33	10:38	10:43	10:51	10:53	10:59	11:04	11:10
	11:15	11:19	11:25	11:30	11:33	11:38	11:43	11:51	11:53	11:59	12:04	To Garage





# MAGNOLIA AVENUE

(Weekdays and Weekends)

## SERVES:

- ★ Chilhowee Park
- ★ Kroger
- ★ Holston Drive
- ★ Pellissippi State, Magnolia Ave. Campus
- ★ Knoxville Station/Downtown



Information Updated: August 24, 2015

## Saturday-Sunday Schedule Route 31: Magnolia

Going away from Downtown						Going toward Downtown					
Transfer to:		Rts. 33 & 34				Rts. 33 & 34					
Knoxville Station—Platform F <b>1</b>	Magnolia at Jessamine <b>2</b>	Magnolia at Chestnut <b>3</b>	Kirkwood St. Superstop (Arrives) <b>4</b> (Leaves)	Burns Rd at Asheville Hwy <b>5</b>	Chilhowee at Holston <b>6</b>	Kirkwood St. Superstop (Arrives) <b>7</b> (Leaves)	Magnolia at Chestnut <b>8</b>	Magnolia at Jessamine <b>9</b>	Knoxville Station <b>10</b>		

SATURDAY SCHEDULE												
A.M.	—	—	—	—	—	6:38	6:43	6:51	6:53	6:59	7:04	7:10
	—	—	—	—	—	7:08	7:13	7:21	7:23	7:29	7:34	7:40
	7:15	7:19	7:25	7:30	7:33	7:38	7:43	7:51	7:53	7:59	8:04	8:10
	7:45	7:49	7:55	8:00	8:03	8:08	8:13	8:21	8:23	8:29	8:34	8:40
	8:15	8:19	8:25	8:30	8:33	8:38	8:43	8:51	8:53	8:59	9:04	9:10
	8:45	8:49	8:55	9:00	9:03	9:08	9:13	9:21	9:23	9:29	9:34	9:40
	9:15	9:19	9:25	9:30	9:33	9:38	9:43	9:51	9:53	9:59	10:04	10:10
	9:45	9:49	9:55	10:00	10:03	10:08	10:13	10:21	10:23	10:29	10:34	10:40
	10:15	10:19	10:25	10:30	10:33	10:38	10:43	10:51	10:53	10:59	11:04	11:10
	10:45	10:49	10:55	11:00	11:03	11:08	11:13	11:21	11:23	11:29	11:34	11:40
	11:15	11:19	11:25	11:30	11:33	11:38	11:43	11:51	11:53	11:59	12:04	12:10
	11:45	11:49	11:55	12:00	12:03	12:08	12:13	12:21	12:23	12:29	12:34	12:40
P.M.	12:15	12:19	12:25	12:30	12:33	12:38	12:43	12:51	12:53	12:59	1:04	1:10
	12:45	12:49	12:55	1:00	1:03	1:08	1:13	1:21	1:23	1:29	1:34	1:40
	1:15	1:19	1:25	1:30	1:33	1:38	1:43	1:51	1:53	1:59	2:04	2:10
	1:45	1:49	1:55	2:00	2:03	2:08	2:13	2:21	2:23	2:29	2:34	2:40
	2:15	2:19	2:25	2:30	2:33	2:38	2:43	2:51	2:53	2:59	3:04	3:10
	2:45	2:49	2:55	3:00	3:03	3:08	3:13	3:21	3:23	3:29	3:34	3:40
	3:15	3:19	3:25	3:30	3:33	3:38	3:43	3:51	3:53	3:59	4:04	4:10
	3:45	3:49	3:55	4:00	4:03	4:08	4:13	4:21	4:23	4:29	4:34	4:40
	4:15	4:19	4:25	4:30	4:33	4:38	4:43	4:51	4:53	4:59	5:04	5:10
	4:45	4:49	4:55	5:00	5:03	5:08	5:13	5:21	5:23	5:29	5:34	5:40
	5:15	5:19	5:25	5:30	5:33	5:38	5:43	5:51	5:53	5:59	6:04	6:10
	5:45	5:49	5:55	6:00	6:03	6:08	6:13	6:21	6:23	6:29	6:34	6:40
	6:15	6:19	6:25	6:30	6:33	6:38	6:43	6:51	6:53	6:59	7:04	7:10
	6:45	6:49	6:55	7:00	7:03	7:08	7:13	7:21	7:23	7:29	7:34	7:40
	7:15	7:19	7:25	7:30	7:33	7:38	7:43	7:51	7:53	7:59	8:04	8:10
	7:45	7:49	7:55	8:00	8:03	8:08	8:13	8:21	8:23	8:29	8:34	8:40
	8:15	8:19	8:25	8:30	8:33	8:38	8:43	8:51	8:53	8:59	9:04	9:10
	8:45	8:49	8:55	9:00	9:03	9:08	9:13	9:21	9:23	9:29	9:34	9:40
	9:15	9:19	9:25	9:30	9:33	9:38	9:43	9:51	9:53	9:59	10:04	10:10
	9:45	9:49	9:55	10:00	10:03	10:08	10:13	10:21	10:23	10:29	10:34	To Garage
	10:15	10:19	10:25	10:30	10:33	10:38	10:43	10:51	10:53	10:59	11:04	11:10
	11:15	11:19	11:25	11:30	11:33	11:38	11:43	11:51	11:53	11:59	12:04	To Garage
SUNDAY SCHEDULE												
A.M.	8:15	8:19	8:25	8:30	8:33	8:38	8:43	8:51	8:53	8:59	9:04	9:10
	9:15	9:19	9:25	9:30	9:33	9:38	9:43	9:51	9:53	9:59	10:04	10:10
	10:15	10:19	10:25	10:30	10:33	10:38	10:43	10:51	10:53	10:59	11:04	11:10
	11:15	11:19	11:25	11:30	11:33	11:38	11:43	11:51	11:53	11:59	12:04	12:10
P.M.	12:15	12:19	12:25	12:30	12:33	12:38	12:43	12:51	12:53	12:59	1:04	1:10
	1:15	1:19	1:25	1:30	1:33	1:38	1:43	1:51	1:53	1:59	2:04	2:10
	2:15	2:19	2:25	2:30	2:33	2:38	2:43	2:51	2:53	2:59	3:04	3:10
	3:15	3:19	3:25	3:30	3:33	3:38	3:43	3:51	3:53	3:59	4:04	4:10
	4:15	4:19	4:25	4:30	4:33	4:38	4:43	4:51	4:53	4:59	5:04	5:10
	5:15	5:19	5:25	5:30	5:33	5:38	5:43	5:51	5:53	5:59	6:04	6:10
	6:15	6:19	6:25	6:30	6:33	6:38	6:43	6:51	6:53	6:59	7:04	7:10
	7:15	7:19	7:25	7:30	7:33	7:38	7:43	7:51	7:53	7:59	8:04	8:10
	8:15	8:19	8:25	8:30	8:33	8:38	8:43	8:51	8:53	8:59	9:05	To Garage

Need help reading this schedule?

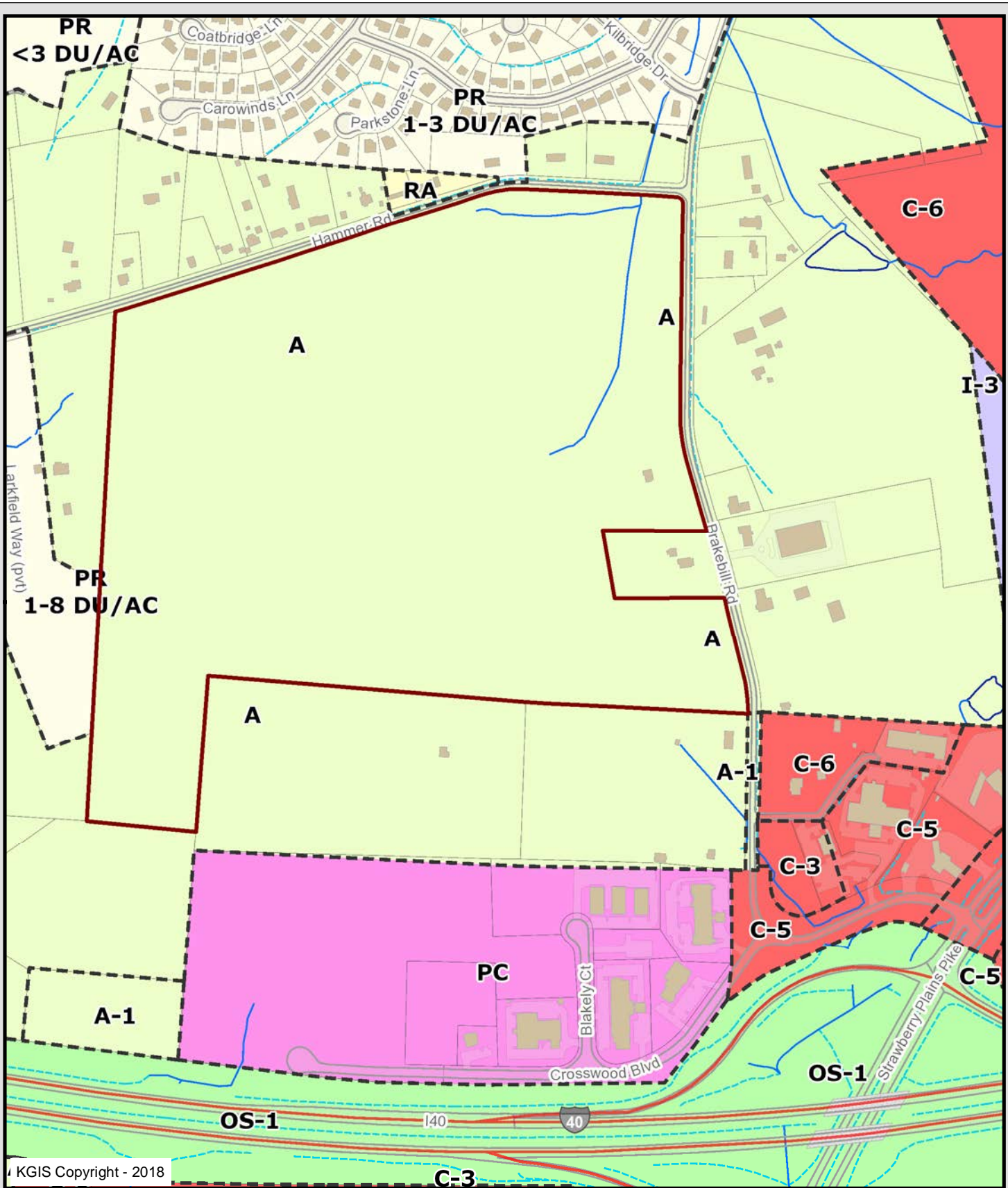
Need other general information on how to ride?

[Click here to Download the General Schedule Information pdf](#) available from [katbus.com](http://katbus.com)



**APPENDIX D**

**ZONING MAP**

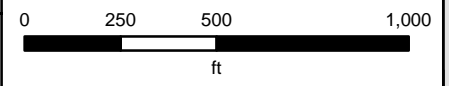


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### Brakebill Road Development Zoning Map

Printed: 3/22/2018 at 6:18:53 PM

**Knoxville - Knox County - KUB Geographic Information System**



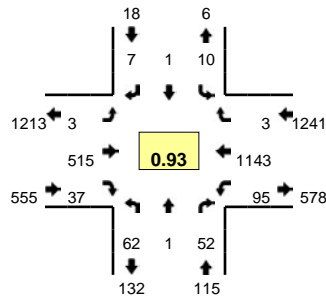
KGIS makes no representation or warranty as to the accuracy of his map and its information nor to its fitness for use. Any user of this map product accepts the same AS IS, WITH ALL FAULTS, and assumes all responsibility for the use thereof, and further covenants and agrees to hold KGIS harmless from any and all damage, loss, or liability arising from any use of this map product.

**APPENDIX E**

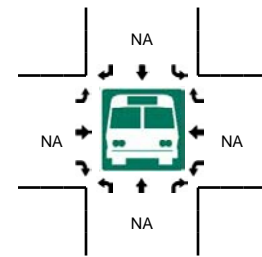
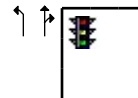
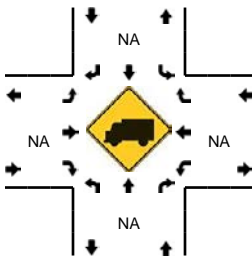
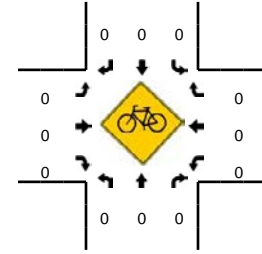
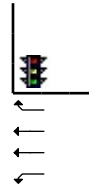
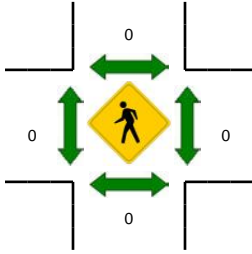
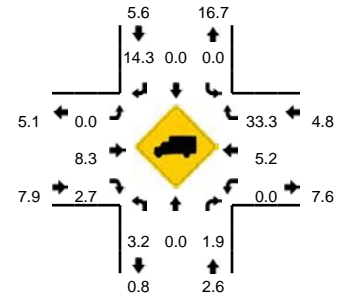
**MANUAL TRAFFIC COUNT DATA**

**LOCATION:** Brakebill Rd -- Asheville Hwy  
**CITY/STATE:** Knoxville, TN

**QC JOB #:** 14618701  
**DATE:** Tue, Mar 20 2018



**Peak-Hour: 7:15 AM -- 8:15 AM**  
**Peak 15-Min: 7:30 AM -- 7:45 AM**

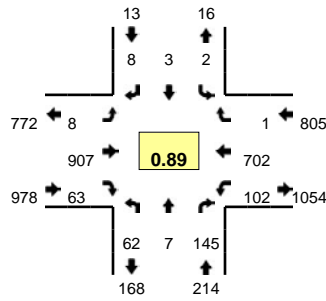


15-Min Count Period Beginning At	Brakebill Rd (Northbound)				Brakebill Rd (Southbound)				Asheville Hwy (Eastbound)				Asheville Hwy (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	11	0	4	0	1	4	7	0	2	78	6	0	12	243	0	0	368	
7:15 AM	14	0	9	0	4	0	2	0	1	132	4	0	21	309	0	0	496	
7:30 AM	20	1	11	0	5	0	0	0	0	129	12	0	20	318	0	0	516	
7:45 AM	16	0	13	0	1	1	2	0	1	134	11	1	24	288	1	0	493	1873
8:00 AM	12	0	19	0	0	0	3	0	0	120	10	0	29	228	2	1	424	1929
8:15 AM	15	1	17	0	1	0	2	0	1	98	5	0	31	235	0	0	406	1839
8:30 AM	10	0	7	0	0	0	0	0	1	103	6	0	19	198	0	0	344	1667
8:45 AM	6	0	9	0	0	0	0	0	2	101	8	0	15	159	0	0	300	1474
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
All Vehicles	80	4	44	0	20	0	0	0	0	516	48	0	80	1272	0	0	2064	
Heavy Trucks	4	0	0		0	0	0		0	44	4		0	28	0		80	
Pedestrians	0				0				0	0			0	0			0	
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0	
Railroad																		
Stopped Buses																		

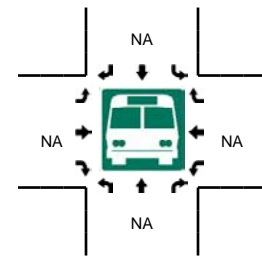
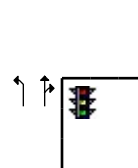
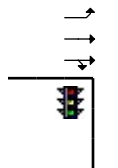
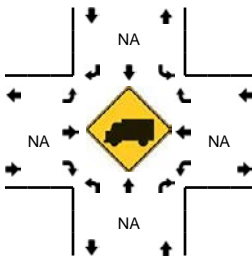
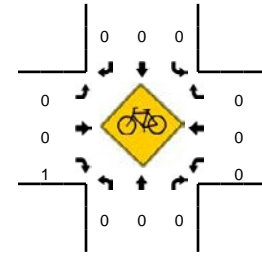
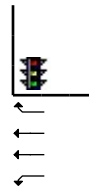
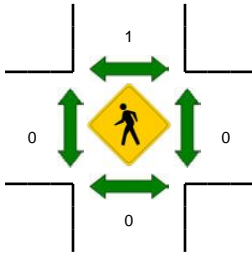
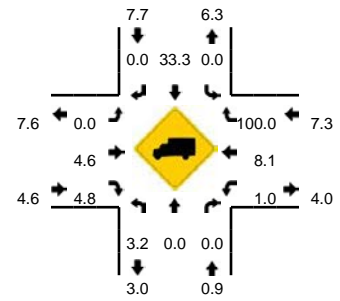
Comments:

**LOCATION:** Brakebill Rd -- Asheville Hwy  
**CITY/STATE:** Knoxville, TN

**QC JOB #:** 14618702  
**DATE:** Tue, Mar 20 2018



**Peak-Hour: 3:45 PM -- 4:45 PM**  
**Peak 15-Min: 3:45 PM -- 4:00 PM**

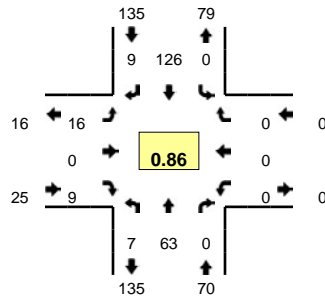


15-Min Count Period Beginning At	Brakebill Rd (Northbound)				Brakebill Rd (Southbound)				Asheville Hwy (Eastbound)				Asheville Hwy (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
2:00 PM	13	1	23	0	1	0	1	0	1	140	10	1	23	139	0	1	354	
2:15 PM	11	0	15	0	1	2	1	0	0	142	7	1	20	143	0	0	343	
2:30 PM	13	1	19	0	1	0	0	0	0	163	11	0	23	157	1	0	389	
2:45 PM	15	0	21	0	0	0	0	0	5	162	18	1	17	143	0	0	382	1468
3:00 PM	15	0	33	0	0	0	0	0	1	190	16	0	24	128	2	0	409	1523
3:15 PM	10	0	26	0	1	1	3	0	1	220	18	0	21	149	3	0	453	1633
3:30 PM	12	0	36	0	0	1	2	0	2	195	14	0	24	179	2	0	467	1711
3:45 PM	11	2	34	0	1	1	2	0	3	232	15	0	35	225	1	0	562	1891
4:00 PM	23	2	36	0	0	1	2	0	1	193	11	0	24	159	0	0	452	1934
4:15 PM	10	1	28	0	1	0	2	0	1	242	23	0	20	150	0	0	478	1959
4:30 PM	18	2	47	0	0	1	2	0	3	240	14	0	23	168	0	0	518	2010
4:45 PM	16	2	36	0	0	0	2	0	2	237	15	0	19	131	0	0	460	1908
5:00 PM	11	1	38	0	0	1	2	0	2	246	17	0	21	153	0	0	492	1948
5:15 PM	8	1	42	0	0	0	3	0	3	255	13	0	27	158	1	0	511	1981
5:30 PM	14	0	29	0	1	2	3	0	3	229	10	0	20	143	1	0	455	1918
5:45 PM	8	2	34	0	2	0	0	0	1	247	23	1	13	129	0	0	460	1918
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	44	8	136	0	4	4	8	0	12	928	60	0	140	900	4	0	2248	
Heavy Trucks	0	0	0		0	4	0		0	56	4		4	100	4		172	
Pedestrians	0	0	0		0	0	0		0	0	0		0	0	0		0	
Bicycles	0	0	0		0	0	0		0	0	1		0	0	0		1	
Railroad																		
Stopped Buses																		

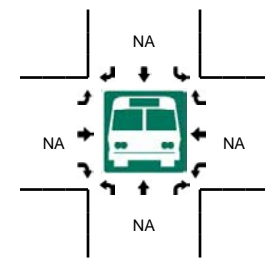
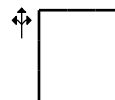
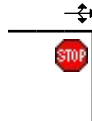
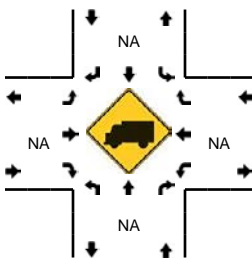
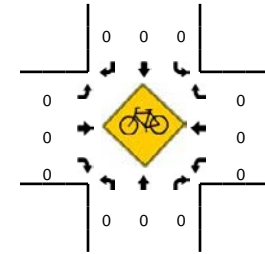
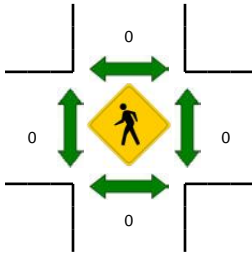
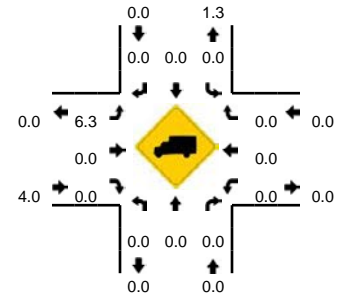
Comments:

**LOCATION:** Brakebill Rd -- Hammer Rd  
**CITY/STATE:** Knoxville, TN

**QC JOB #:** 14618703  
**DATE:** Tue, Mar 20 2018



**Peak-Hour: 7:30 AM -- 8:30 AM**  
**Peak 15-Min: 7:45 AM -- 8:00 AM**

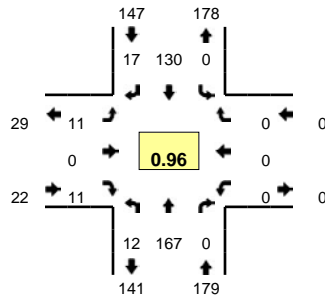


15-Min Count Period Beginning At	Brakebill Rd (Northbound)				Brakebill Rd (Southbound)				Hammer Rd (Eastbound)				Hammer Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	2	11	0	0	0	25	0	0	1	0	0	0	0	0	0	0	39	
7:15 AM	0	8	0	0	0	31	0	0	1	0	1	0	0	0	0	0	41	
7:30 AM	1	16	0	0	0	31	1	0	1	0	2	0	0	0	0	0	52	
7:45 AM	3	22	0	0	0	37	0	0	3	0	2	0	0	0	0	0	67	199
8:00 AM	0	10	0	0	0	31	4	0	8	0	2	0	0	0	0	0	55	215
8:15 AM	3	15	0	0	0	27	4	0	4	0	3	0	0	0	0	0	56	230
8:30 AM	1	12	0	0	0	23	0	0	1	0	0	0	0	0	0	0	37	215
8:45 AM	0	12	0	0	0	18	0	0	2	0	3	0	0	0	0	0	35	183
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
All Vehicles	12	88	0	0	0	148	0	0	12	0	8	0	0	0	0	0	268	
Heavy Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad																		
Stopped Buses																		

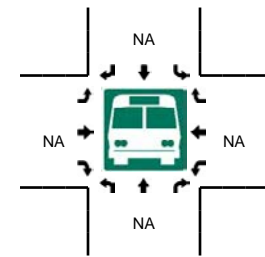
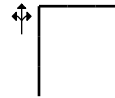
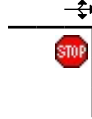
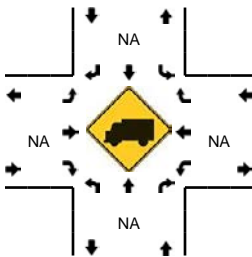
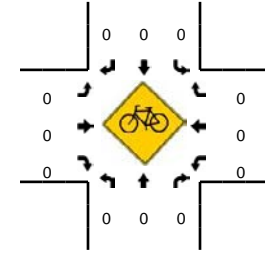
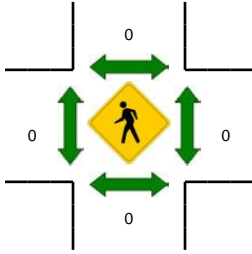
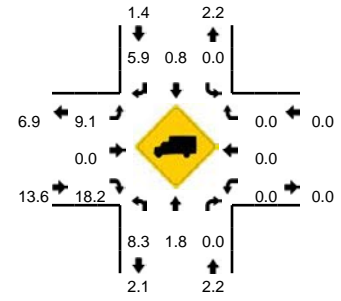
Comments:

**LOCATION:** Brakebill Rd -- Hammer Rd  
**CITY/STATE:** Knoxville, TN

**QC JOB #:** 14618704  
**DATE:** Tue, Mar 20 2018



**Peak-Hour: 4:15 PM -- 5:15 PM**  
**Peak 15-Min: 4:15 PM -- 4:30 PM**



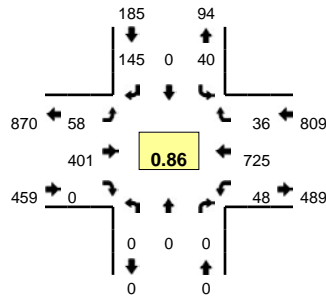
15-Min Count Period Beginning At	Brakebill Rd (Northbound)				Brakebill Rd (Southbound)				Hammer Rd (Eastbound)				Hammer Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
2:00 PM	0	23	0	0	0	30	3	0	2	0	0	0	0	0	0	0	58	
2:15 PM	0	23	0	0	0	28	2	0	1	0	2	0	0	0	0	0	56	
2:30 PM	2	17	0	0	0	27	1	0	3	0	1	0	0	0	0	0	51	
2:45 PM	6	25	0	0	0	35	1	0	6	0	2	0	0	0	0	0	75	240
3:00 PM	5	23	0	0	0	30	7	0	3	0	2	0	0	0	0	0	70	252
3:15 PM	2	22	0	0	0	30	3	0	3	0	4	0	0	0	0	0	64	260
3:30 PM	4	29	0	0	0	37	7	0	5	0	2	0	0	0	0	0	84	293
3:45 PM	8	38	0	0	0	30	9	0	6	0	3	0	0	0	0	0	94	312
4:00 PM	4	26	0	0	0	35	6	0	2	0	1	0	0	0	0	0	74	316
4:15 PM	4	36	0	0	0	42	2	0	5	0	2	0	0	0	0	0	91	343
4:30 PM	2	46	0	0	0	30	5	0	2	0	2	0	0	0	0	0	87	346
4:45 PM	3	40	0	0	0	25	5	0	2	0	5	0	0	0	0	0	80	332
5:00 PM	3	45	0	0	0	33	5	0	2	0	2	0	0	0	0	0	90	348
5:15 PM	1	33	0	0	0	34	4	0	1	0	3	0	0	0	0	0	76	333
5:30 PM	6	33	0	0	0	33	5	0	6	0	2	0	0	0	0	0	85	331
5:45 PM	2	34	0	0	0	45	1	0	0	0	2	0	0	0	0	0	84	335
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
All Vehicles	16	144	0	0	0	168	8	0	20	0	8	0	0	0	0	0	364	
Heavy Trucks	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	4	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad																		
Stopped Buses																		

Comments:

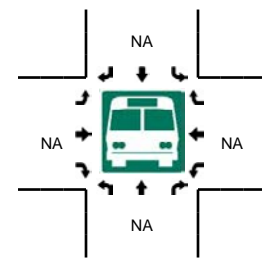
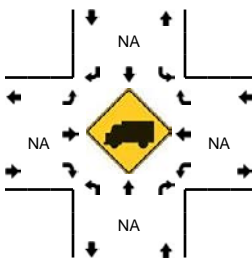
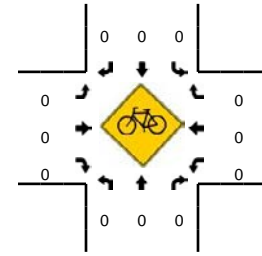
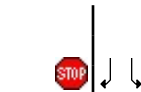
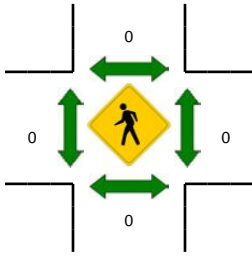
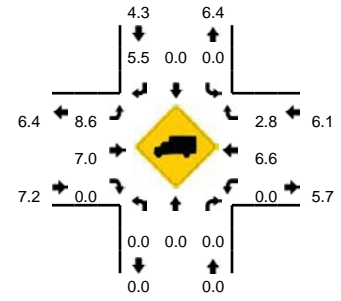


**LOCATION:** Brakebill Rd -- Strawberry Plains Pike  
**CITY/STATE:** Knoxville, TN

**QC JOB #:** 14618707  
**DATE:** Tue, Mar 20 2018



**Peak-Hour: 7:15 AM -- 8:15 AM**  
**Peak 15-Min: 7:30 AM -- 7:45 AM**

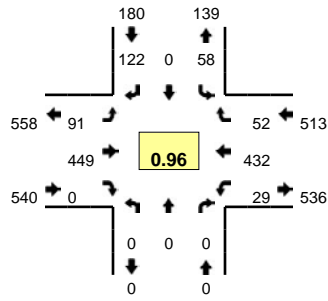


15-Min Count Period Beginning At	Brakebill Rd (Northbound)				Brakebill Rd (Southbound)				Strawberry Plains Pike (Eastbound)				Strawberry Plains Pike (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	0	0	0	0	3	0	32	0	10	67	0	0	0	132	6	3	253	
7:15 AM	0	0	0	0	5	0	34	0	11	92	0	0	0	182	6	13	343	
7:30 AM	0	0	0	0	18	0	39	0	13	100	0	0	0	230	11	11	422	
7:45 AM	0	0	0	0	11	0	35	0	22	110	0	0	0	173	13	11	375	1393
8:00 AM	0	0	0	0	6	0	37	0	12	99	0	0	0	140	6	13	313	1453
8:15 AM	0	0	0	0	8	0	34	0	17	69	0	0	0	150	12	11	301	1411
8:30 AM	0	0	0	0	5	0	19	0	14	76	0	1	0	111	4	4	234	1223
8:45 AM	0	0	0	0	6	0	22	0	12	80	0	0	0	115	7	6	248	1096
<b>Peak 15-Min Flowrates</b>	<b>Northbound</b>				<b>Southbound</b>				<b>Eastbound</b>				<b>Westbound</b>				<b>Total</b>	
All Vehicles	0	0	0	0	72	0	156	0	52	400	0	0	0	920	44	44	1688	
Heavy Trucks	0	0	0	0	0	0	12	0	0	20	0	0	0	48	0	0	80	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad																		
Stopped Buses																		

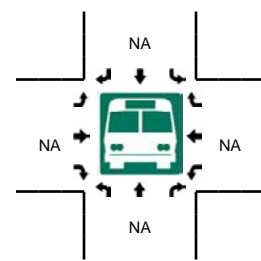
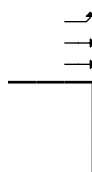
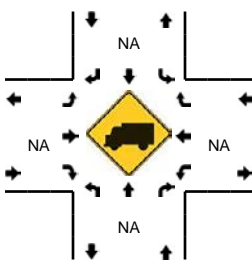
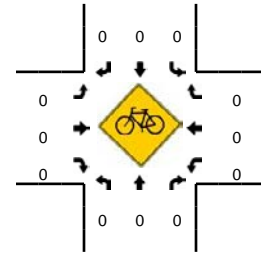
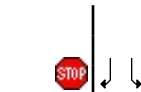
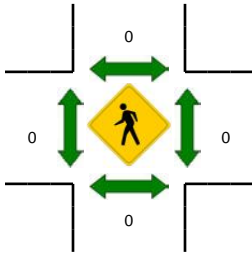
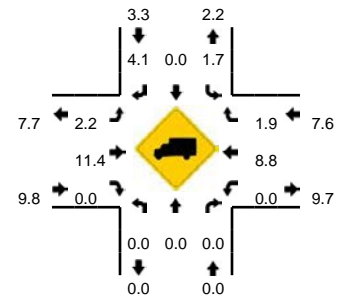
Comments:

**LOCATION:** Brakebill Rd -- Strawberry Plains Pike  
**CITY/STATE:** Knoxville, TN

**QC JOB #:** 14618708  
**DATE:** Tue, Mar 20 2018



**Peak-Hour: 12:00 PM -- 1:00 PM**  
**Peak 15-Min: 12:15 PM -- 12:30 PM**

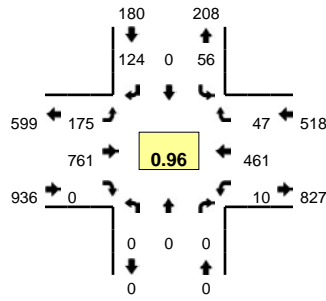


15-Min Count Period Beginning At	Brakebill Rd (Northbound)				Brakebill Rd (Southbound)				Strawberry Plains Pike (Eastbound)				Strawberry Plains Pike (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
11:00 AM	0	0	0	0	8	0	20	0	9	94	0	0	0	110	5	6	252	
11:15 AM	0	0	0	0	13	0	25	0	19	99	0	1	0	87	9	5	258	
11:30 AM	0	0	0	0	12	0	32	0	26	101	0	0	0	100	18	3	292	
11:45 AM	0	0	0	0	10	0	27	0	16	113	0	0	0	104	6	2	278	1080
12:00 PM	0	0	0	0	17	0	25	0	16	128	0	0	0	96	8	4	294	1122
12:15 PM	0	0	0	0	13	0	35	0	25	105	0	2	0	115	18	7	320	1184
12:30 PM	0	0	0	0	8	0	33	0	25	116	0	2	0	106	12	10	312	1204
12:45 PM	0	0	0	0	20	0	29	0	21	100	0	0	0	115	14	8	307	1233
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
All Vehicles	0	0	0	0	52	0	140	0	100	420	0	8	0	460	72	28	1280	
Heavy Trucks	0	0	0	0	0	0	4	0	4	40	0	0	0	52	4	0	104	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Stopped Buses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

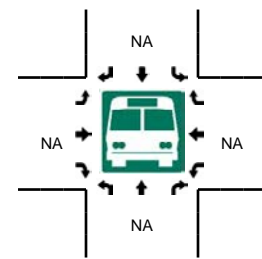
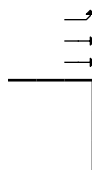
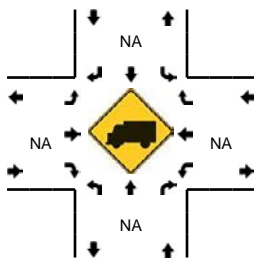
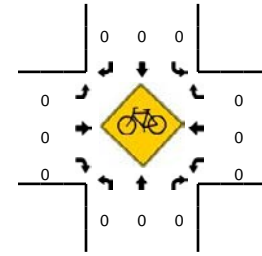
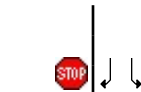
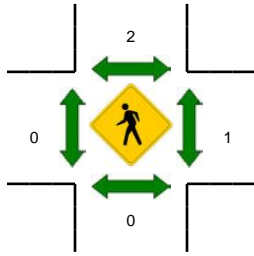
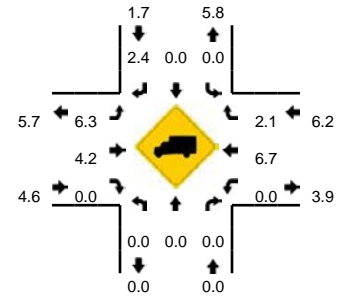
Comments:

**LOCATION:** Brakebill Rd -- Strawberry Plains Pike  
**CITY/STATE:** Knoxville, TN

**QC JOB #:** 14618709  
**DATE:** Tue, Mar 20 2018



**Peak-Hour: 4:30 PM -- 5:30 PM**  
**Peak 15-Min: 5:15 PM -- 5:30 PM**

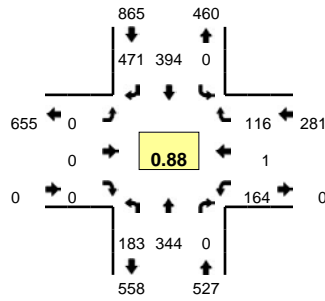


15-Min Count Period Beginning At	Brakebill Rd (Northbound)				Brakebill Rd (Southbound)				Strawberry Plains Pike (Eastbound)				Strawberry Plains Pike (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
2:00 PM	0	0	0	0	15	0	25	0	18	104	0	0	0	86	10	1	259	
2:15 PM	0	0	0	0	19	0	19	0	14	133	0	1	0	90	13	4	293	
2:30 PM	0	0	0	0	8	0	27	0	22	123	0	5	0	94	12	3	294	
2:45 PM	0	0	0	0	19	0	30	0	23	105	0	0	0	101	13	2	293	1139
3:00 PM	0	0	0	0	15	0	27	0	23	134	0	0	0	105	14	3	321	1201
3:15 PM	0	0	0	0	14	0	27	0	20	131	0	0	0	100	9	5	306	1214
3:30 PM	0	0	0	0	23	0	25	0	29	139	0	2	0	117	13	8	356	1276
3:45 PM	0	0	0	0	15	0	29	0	29	175	0	0	0	122	18	10	398	1381
4:00 PM	0	0	0	0	15	0	23	0	19	139	0	0	0	115	19	5	335	1395
4:15 PM	0	0	0	0	20	0	29	0	32	186	0	0	0	99	11	4	381	1470
4:30 PM	0	0	0	0	13	0	30	0	32	185	0	11	0	118	20	4	413	1527
4:45 PM	0	0	0	0	10	0	27	0	44	195	0	2	0	107	7	3	395	1524
5:00 PM	0	0	0	0	15	0	32	0	49	174	0	1	0	114	12	2	399	1588
5:15 PM	0	0	0	0	18	0	35	0	36	207	0	0	0	122	8	1	427	1634
5:30 PM	0	0	0	0	16	0	25	0	33	175	0	0	0	96	11	2	358	1579
5:45 PM	0	0	0	0	18	0	32	0	32	164	0	1	0	108	13	6	374	1558
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	0	0	0	0	72	0	140	0	144	828	0	0	0	488	32	4	1708	
Heavy Trucks	0	0	0	0	0	0	0	0	8	20	0	0	0	20	0	0	48	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad																		
Stopped Buses																		

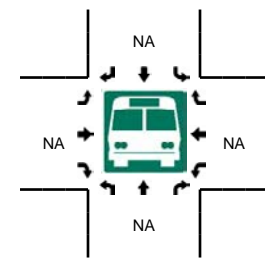
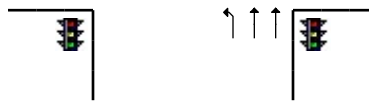
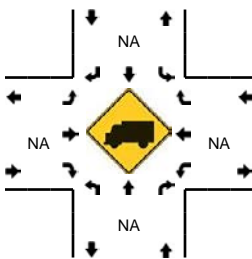
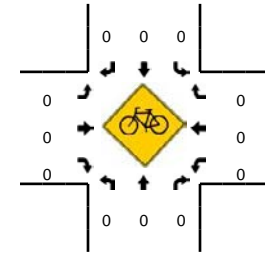
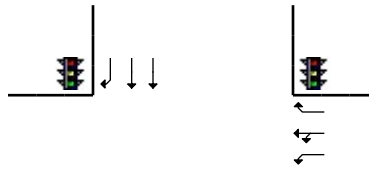
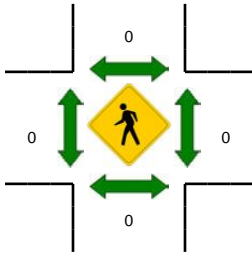
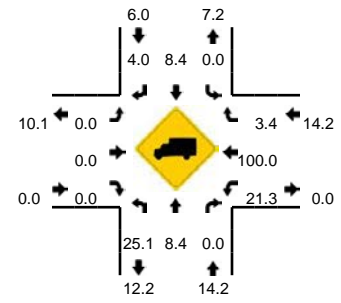
Comments:

**LOCATION:** Strawberry Plains Pike -- I-40 WB Ramps  
**CITY/STATE:** Knoxville, TN

**QC JOB #:** 14618710  
**DATE:** Tue, Mar 20 2018



**Peak-Hour: 7:15 AM -- 8:15 AM**  
**Peak 15-Min: 7:30 AM -- 7:45 AM**

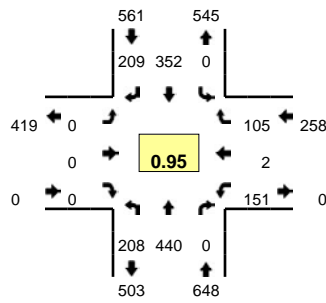


15-Min Count Period Beginning At	Strawberry Plains Pike (Northbound)				Strawberry Plains Pike (Southbound)				I-40 WB Ramps (Eastbound)				I-40 WB Ramps (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	47	43	0	0	0	77	92	0	0	0	0	0	44	0	21	0	324	
7:15 AM	48	74	0	0	0	91	119	0	0	0	0	0	36	0	28	0	396	
7:30 AM	48	94	0	0	0	105	153	0	0	0	0	0	39	0	34	0	473	
7:45 AM	46	97	0	0	0	106	113	0	0	0	0	0	52	1	35	0	450	1643
8:00 AM	41	79	0	0	0	92	86	0	0	0	0	0	37	0	19	0	354	1673
8:15 AM	47	66	0	0	0	89	99	0	0	0	0	0	46	0	27	0	374	1651
8:30 AM	46	67	0	0	0	72	60	0	0	0	0	0	39	0	28	0	312	1490
8:45 AM	39	69	0	0	0	79	62	0	0	0	0	0	35	0	29	0	313	1353
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	192	376	0	0	0	420	612	0	0	0	0	0	156	0	136	0	1892	
Heavy Trucks	44	24	0	0	0	32	16	0	0	0	0	0	32	0	4	0	152	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Stopped Buses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

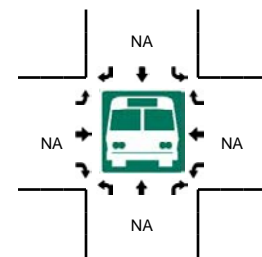
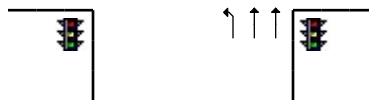
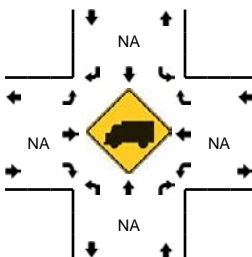
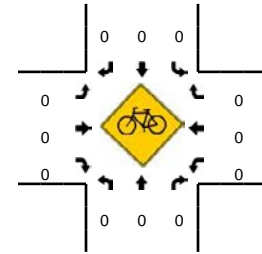
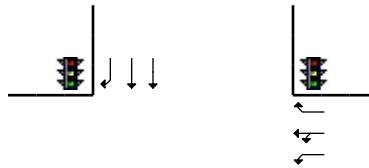
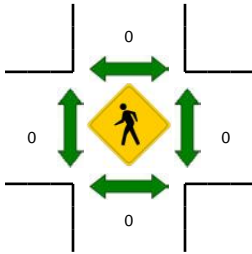
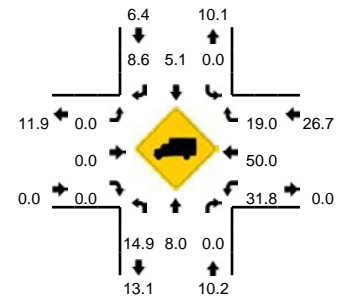
Comments:

**LOCATION:** Strawberry Plains Pike -- I-40 WB Ramps  
**CITY/STATE:** Knoxville, TN

**QC JOB #:** 14618711  
**DATE:** Tue, Mar 20 2018



**Peak-Hour: 12:00 PM -- 1:00 PM**  
**Peak 15-Min: 12:15 PM -- 12:30 PM**

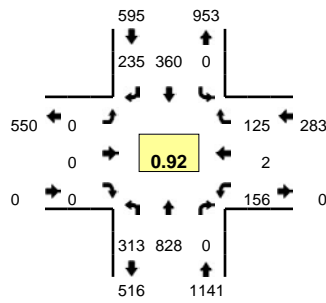


15-Min Count Period Beginning At	Strawberry Plains Pike (Northbound)				Strawberry Plains Pike (Southbound)				I-40 WB Ramps (Eastbound)				I-40 WB Ramps (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
11:00 AM	39	69	0	0	0	69	64	0	0	0	0	0	23	2	30	0	296	
11:15 AM	44	93	0	0	0	63	48	0	0	0	0	0	41	0	25	0	314	
11:30 AM	47	110	0	0	0	82	53	0	0	0	0	0	38	0	24	0	354	
11:45 AM	56	114	0	0	0	88	43	0	0	0	0	0	27	0	19	0	347	1311
12:00 PM	40	120	0	0	0	86	37	0	0	0	0	0	19	1	28	0	331	1346
12:15 PM	64	107	0	0	0	96	59	0	0	0	0	0	36	1	25	0	388	1420
12:30 PM	59	115	0	0	0	88	50	0	0	0	0	0	46	0	29	0	387	1453
12:45 PM	45	98	0	0	0	82	63	0	0	0	0	0	50	0	23	0	361	1467
<b>Peak 15-Min Flowrates</b>	<b>Northbound</b>				<b>Southbound</b>				<b>Eastbound</b>				<b>Westbound</b>				<b>Total</b>	
All Vehicles	256	428	0	0	0	384	236	0	0	0	0	0	144	4	100	0	1552	
Heavy Trucks	40	44	0	0	0	28	16	0	0	0	0	0	48	0	12	0	188	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Stopped Buses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

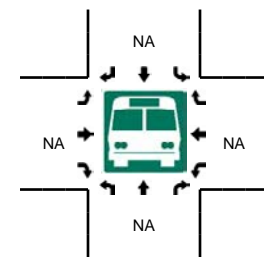
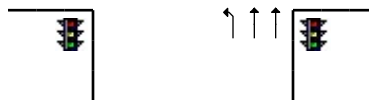
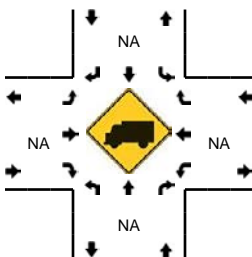
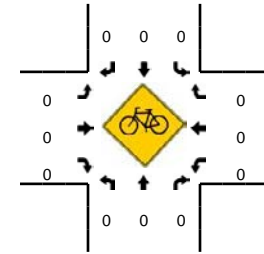
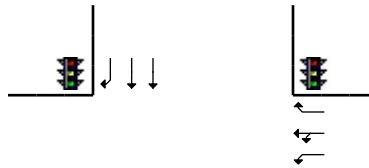
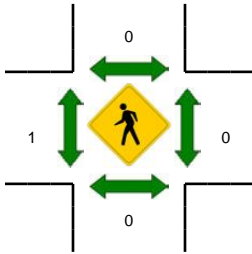
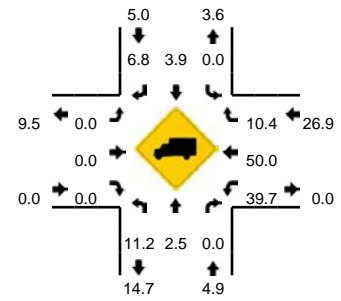
Comments:

**LOCATION:** Strawberry Plains Pike -- I-40 WB Ramps  
**CITY/STATE:** Knoxville, TN

**QC JOB #:** 14618712  
**DATE:** Tue, Mar 20 2018



**Peak-Hour: 4:30 PM -- 5:30 PM**  
**Peak 15-Min: 4:30 PM -- 4:45 PM**



15-Min Count Period Beginning At	Strawberry Plains Pike (Northbound)				Strawberry Plains Pike (Southbound)				I-40 WB Ramps (Eastbound)				I-40 WB Ramps (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
2:00 PM	57	94	0	0	0	52	55	0	0	0	0	0	32	2	31	0	323	
2:15 PM	48	114	0	0	0	72	41	0	0	0	0	0	37	1	23	0	336	
2:30 PM	54	127	0	0	0	64	56	0	0	0	0	0	41	0	21	0	363	
2:45 PM	72	104	0	0	0	77	49	0	0	0	0	0	30	0	31	0	363	1385
3:00 PM	57	131	0	0	0	91	52	0	0	0	0	0	45	0	22	0	398	1460
3:15 PM	53	127	0	0	0	67	59	0	0	0	0	0	42	0	20	0	368	1492
3:30 PM	83	143	0	0	0	99	52	0	0	0	0	0	30	0	34	0	441	1570
3:45 PM	44	161	0	0	0	109	60	0	0	0	0	0	31	0	36	0	441	1648
4:00 PM	43	124	0	0	0	81	65	0	0	0	0	0	21	0	26	0	360	1610
4:15 PM	67	189	0	0	0	85	50	0	0	0	0	0	41	0	29	0	461	1703
4:30 PM	105	202	0	0	0	98	68	0	0	0	0	0	35	1	38	0	547	1809
4:45 PM	82	216	0	0	0	71	57	0	0	0	0	0	52	0	27	0	505	1873
5:00 PM	75	196	0	0	0	83	61	0	0	0	0	0	36	0	32	0	483	1996
5:15 PM	51	214	0	0	0	108	49	0	0	0	0	0	33	1	28	0	484	2019
5:30 PM	49	170	0	0	0	85	42	0	0	0	0	0	42	0	38	0	426	1898
5:45 PM	40	166	0	0	0	100	45	0	0	0	0	0	43	0	30	0	424	1817
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
All Vehicles	420	808	0	0	0	392	272	0	0	0	0	0	140	4	152	0	2188	
Heavy Trucks	24	52	0	0	0	16	12	0	0	0	0	0	72	4	24	0	204	
Pedestrians	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Stopped Buses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Comments:

**TRAFFIC COUNT DATA**

Major Street: Brakebill Road (NB - SB)  
 Minor Street: Kilbridge Drive (EB)  
 Traffic Control: Stop Control on Kilbridge Drive

3/20/2018 (Tuesday)  
 Cloudy/Windy  
 Conducted by: Ajax Engineering

TIME BEGIN	Brakebill Road		Brakebill Road		Kilbridge Drive		VEHICLE TOTAL	PEAK HOUR
	SOUTHBOUND		NORTHBOUND		EASTBOUND			
	THRU	RIGHT	LT	THRU	LT	RT		
7:00 AM	20	0	2	10	1	4	37	
7:15 AM	21	0	0	9	9	8	47	
7:30 AM	<b>20</b>	<b>1</b>	<b>1</b>	<b>17</b>	<b>8</b>	<b>12</b>	<b>59</b>	<b>7:30 AM - 8:30 AM</b>
7:45 AM	<b>28</b>	<b>4</b>	<b>2</b>	<b>21</b>	<b>5</b>	<b>10</b>	<b>70</b>	
8:00 AM	<b>26</b>	<b>4</b>	<b>1</b>	<b>19</b>	<b>12</b>	<b>10</b>	<b>72</b>	
8:15 AM	<b>24</b>	<b>5</b>	<b>0</b>	<b>18</b>	<b>7</b>	<b>5</b>	<b>59</b>	
8:30 AM	20	3	4	10	0	5	42	
8:45 AM	16	1	0	14	3	2	36	
TOTAL	175	18	10	118	45	56	422	
Peak % Exit	-	-	-	-	46%	54%		
Peak % Enter	-	78%	22%	-	-	-		
2:00 PM	28	2	4	20	1	4	59	
2:15 PM	29	3	2	24	3	2	63	
2:30 PM	27	3	0	19	4	1	54	
2:45 PM	32	5	2	30	2	1	72	
3:00 PM	39	3	1	23	4	0	70	
3:15 PM	30	5	3	22	3	2	65	
3:30 PM	35	4	3	32	2	5	81	
3:45 PM	39	4	10	34	2	5	94	
4:00 PM	36	6	3	27	4	2	78	
4:15 PM	<b>44</b>	<b>7</b>	<b>4</b>	<b>36</b>	<b>7</b>	<b>2</b>	<b>100</b>	<b>4:15 PM - 5:15 PM</b>
4:30 PM	<b>26</b>	<b>9</b>	<b>5</b>	<b>46</b>	<b>2</b>	<b>6</b>	<b>94</b>	
4:45 PM	<b>28</b>	<b>1</b>	<b>8</b>	<b>34</b>	<b>3</b>	<b>2</b>	<b>76</b>	
5:00 PM	<b>38</b>	<b>8</b>	<b>9</b>	<b>40</b>	<b>4</b>	<b>1</b>	<b>100</b>	
5:15 PM	35	6	5	29	4	4	83	
5:30 PM	35	7	7	31	4	1	85	
5:45 PM	43	9	5	30	1	4	92	
TOTAL	285	53	46	273	29	22	708	
Peak % Exit	-	-	-	-	59%	41%		
Peak % Enter	-	49%	51%	-	-	-		

**2018 AM Peak Hour** **7:30 AM - 8:30 AM**

TIME BEGIN	Brakebill Road		Brakebill Road		Kilbridge Drive	
	SOUTHBOUND		NORTHBOUND		EASTBOUND	
	THRU	RIGHT	LT	THRU	LT	RT
7:30 AM	20	1	1	17	8	12
7:45 AM	28	4	2	21	5	10
8:00 AM	26	4	1	19	12	10
8:15 AM	24	5	0	18	7	5
TOTAL	98	14	4	75	32	37
PHF	0.88	0.70	0.50	0.89	0.67	0.77

**2018 PM Peak Hour** **4:15 PM - 5:15 PM**

TIME BEGIN	Brakebill Road		Brakebill Road		Kilbridge Drive	
	SOUTHBOUND		NORTHBOUND		EASTBOUND	
	THRU	RIGHT	LT	THRU	LT	RT
4:15 PM	44	7	4	36	7	2
4:30 PM	26	9	5	46	2	6
4:45 PM	28	1	8	34	3	2
5:00 PM	38	8	9	40	4	1
TOTAL	136	25	26	156	16	11
PHF	0.77	0.69	0.72	0.85	0.57	0.46



**APPENDIX F**

**EXISTING TRAFFIC SIGNAL TIMING INFORMATION**

Filename: DATA\INT#4807.EL

Intersection: BRAKEBILL Thu Mar 29 14:57:19 2018

Startup Data:

Ring 1 - 2  
 Start Phases 2 6  
 UCF Entry Phases 4 8  
 UCF Exit Phases 2 6

Start Overlaps Yellow at Power-up? NO  
 Start in All Red at Power-up? NO  
 Zone ID: 0  
 Controller ID: 0  
 Hold 2 sec. Minimum Red Revert? YES Red Revert Time: 4.0 sec.  
 Override Holds if  
 Uniform Code Flash Active? YES  
 Dual Entry 1256? YES  
 Dual Entry 3478? YES  
 Passage Interval Sequential? YES  
 Simultaneous Gap? NO  
 Conditional Service set by Input? NO  
 Conditional Service 1256? NO  
 Conditional Service 3478? NO

Timing Data:

Interval	Time by Phase (sec.)							
	1	2	3	4	5	6	7	8
Initial	5	15	0	5	5	15	0	5
Passage	3.0	3.0	0.0	3.0	3.0	3.0	0.0	3.0
Yellow	4.0	5.0	0.0	4.0	4.0	5.0	0.0	4.0
Red Clear	1.0	2.0	0.0	2.5	1.0	2.0	0.0	2.5
Max 1	20	50	0	25	20	50	0	25
Max 2	20	50	0	25	20	50	0	25
Walk	0	15	0	0	0	0	0	0
Ped Clear	0	0	0	0	0	0	0	0

Max 3 Parameters

	1	2	3	4	5	6	7	8
Adjust (sec.)	0	0	0	0	0	0	0	0
Limit (sec.)	0	0	0	0	0	0	0	0
Set (max outs)	0	0	0	0	0	0	0	0
Clr (gap outs)	0	0	0	0	0	0	0	0

Functions:

	1	2	3	4	5	6	7	8
Min. Recall	N	Y	N	N	N	Y	N	N
Max. Recall	N	Y	N	N	N	Y	N	N
Ped. Recall	N	Y	N	N	N	N	N	N
Det. Non-lock	Y	N	N	Y	Y	N	N	Y
CNA I Active	N	Y	N	N	N	Y	N	N

Database Printout of 1880EL Local

Filename: DATA\INT#4807.EL

Intersection: BRAKEBILL Thu Mar 29 14:57:19 2018

Startup Data:

CNA II Active N N N N N N N N  
 Flashing Walks N N N N N N N N  
 Phase Omitted N N Y N N N Y N  
 Ped Omitted Y N Y Y Y Y Y Y  
 Soft Recall N N N N N N N N

Asheville Hwy and BRAKE.TXT

Ped Cl thru Yel N N N N N N N N N  
 Ped Cl thru Red N N N N N N N N N

Begin Daylight Savings in week: 15  
 End Daylight Savings in week: 45

Time of Day Changepoints:

Week Plan:

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
Plan: 0	0	0	0	0	0	0	0
Plan: 1	0	0	0	0	0	0	0
Plan: 2	0	0	0	0	0	0	0
Plan: 3	0	0	0	0	0	0	0
Plan: 4	0	0	0	0	0	0	0
Plan: 5	0	0	0	0	0	0	0
Plan: 6	0	0	0	0	0	0	0
Plan: 7	0	0	0	0	0	0	0
Plan: 8	0	0	0	0	0	0	0
Plan: 9	0	0	0	0	0	0	0

Week Plan Implementation:

Week 1: 0	Week 14: 0	Week 27: 0	Week 40: 0
Week 2: 0	Week 15: 0	Week 28: 0	Week 41: 0
Week 3: 0	Week 16: 0	Week 29: 0	Week 42: 0
Week 4: 0	Week 17: 0	Week 30: 0	Week 43: 0
Week 5: 0	Week 18: 0	Week 31: 0	Week 44: 0
Week 6: 0	Week 19: 0	Week 32: 0	Week 45: 0
Week 7: 0	Week 20: 0	Week 33: 0	Week 46: 0
Week 8: 0	Week 21: 0	Week 34: 0	Week 47: 0
Week 9: 0	Week 22: 0	Week 35: 0	Week 48: 0
Week 10: 0	Week 23: 0	Week 36: 0	Week 49: 0
Week 11: 0	Week 24: 0	Week 37: 0	Week 50: 0
Week 12: 0	Week 25: 0	Week 38: 0	Week 51: 0
Week 13: 0	Week 26: 0	Week 39: 0	Week 52: 0

Special Day Plan Implementation (Plan-Week-Day):

Slot 1 0 - 0 - 0	Slot 18 0 - 0 - 0	Slot 35 0 - 0 - 0
Slot 2 0 - 0 - 0	Slot 19 0 - 0 - 0	Slot 36 0 - 0 - 0
Slot 3 0 - 0 - 0	Slot 20 0 - 0 - 0	Slot 37 0 - 0 - 0
Slot 4 0 - 0 - 0	Slot 21 0 - 0 - 0	Slot 38 0 - 0 - 0
Slot 5 0 - 0 - 0	Slot 22 0 - 0 - 0	Slot 39 0 - 0 - 0

♀

Database Printout of 1880EL Local

Page: 3

Filename: DATA\INT#4807.EL

Intersection: BRAKEBILL Thu Mar 29 14:57:19 2018

Slot 6 0 - 0 - 0	Slot 23 0 - 0 - 0	Slot 40 0 - 0 - 0
Slot 7 0 - 0 - 0	Slot 24 0 - 0 - 0	Slot 41 0 - 0 - 0
Slot 8 0 - 0 - 0	Slot 25 0 - 0 - 0	Slot 42 0 - 0 - 0
Slot 9 0 - 0 - 0	Slot 26 0 - 0 - 0	Slot 43 0 - 0 - 0
Slot 10 0 - 0 - 0	Slot 27 0 - 0 - 0	Slot 44 0 - 0 - 0
Slot 11 0 - 0 - 0	Slot 28 0 - 0 - 0	Slot 45 0 - 0 - 0
Slot 12 0 - 0 - 0	Slot 29 0 - 0 - 0	Slot 46 0 - 0 - 0
Slot 13 0 - 0 - 0	Slot 30 0 - 0 - 0	Slot 47 0 - 0 - 0
Slot 14 0 - 0 - 0	Slot 31 0 - 0 - 0	Slot 48 0 - 0 - 0
Slot 15 0 - 0 - 0	Slot 32 0 - 0 - 0	Slot 49 0 - 0 - 0
Slot 16 0 - 0 - 0	Slot 33 0 - 0 - 0	Slot 50 0 - 0 - 0
Slot 17 0 - 0 - 0	Slot 34 0 - 0 - 0	

Coordination Operating Modes:

Asheville Hwy and BRAKE.TXT

4 Splits / 4 Cycles? NO  
 Unused Cycle Time to Side St.? NO  
 Ckt 4 enables Aux TOD? NO  
 Offset Interruption? NO  
 Cycle 4 = 2 A.M. Sync? NO  
 Split 2 = 2 A.M. Sync? NO  
 Flash with Ckt 1? NO  
 Invert Free Output? NO  
 Auto Permissive? NO  
 Cycle 4 = Flash? NO  
 Enable Max 2 with Ckt 9? NO  
 Conditional Service with Ckt 9? NO  
 Invert Free Input? NO  
 Activate CNA 1? YES  
 Activate Walk Rest Modifier? YES  
 Inhibit Max Termination? YES  
 Enhanced Permissive? NO  
 Use Split Matrix? YES  
 Use Yellow Offset Timer? NO  
 Interconnect? NO  
 Maximum Dwell Time: 25 sec.  
 Full Dwell? NO  
 Short Route? YES

Phase Relationships:

Ring 1 - 2  
 Hold 1 Phases 2 - 0  
 Hold 1 Omit Phases 0 - 0  
 Hold 2 Omit Phases 0 - 0  
 Hold 3 Omit Phases 0 - 0  
 Hold 3 Omit Phases 0 - 0  
 Hold 3 Omit Phases 0 - 0  
 Hold 3 Ped Omit 0 - 0

♀

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Filename: DATA\INT#4807.EL

Intersection: BRAKEBILL

Thu Mar 29 14:57:19 2018

```

|||||
Non Early Release Phases 0 - 0
Non Early Release Phases 0 - 0
Non Early Release Phases 0 - 0
Phases Omitted w/ Ckt 9 0 - 0
Phases Omitted w/ Ckt 9 0 - 0
Peds Omitted w/ Ckt 9 0 - 0
  
```

Phase Reverse by Cyc - Ofst  
 1 - 2 0 - 0  
 1 - 2 0 - 0  
 5 - 6 0 - 0  
 5 - 6 0 - 0  
 3 - 4 0 - 0  
 3 - 4 0 - 0  
 7 - 8 0 - 0  
 7 - 8 0 - 0

Split Plans:

	1	2	Percent per Phase							Permissives					
			3	4	5	6	7	8	Begin	End	Begin	End	Begin	End	
Split 1	40	40	0	20	0	0	0	0	0	10	0	20	0	30	
Split 2	40	40	0	20	0	0	0	0	0	10	0	20	0	30	

Asheville Hwy and BRAKE.TXT

Split 3	40	40	0	20	0	0	0	0	0	10	0	20	0	30
Split 4	40	40	0	20	0	0	0	0	0	10	0	20	0	30
Split 5	40	40	0	20	0	0	0	0	0	10	0	20	0	30
Split 6	50	36	0	14	0	0	0	0	0	10	0	20	0	30
Split 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 16	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Split Matrix:

Cycle	Offset				
	1	2	3	4	5
1	1	1	1	5	5
2	3	3	3	3	3
3	6	2	4	4	4
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6

Database Printout of 1880EL Local  
 Filename: DATA\INT#4807.EL  
 Intersection: BRAKEBILL

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Offset Times:

Cycle	Offset				
	1	2	3	4	5
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0

Cycle Times:

Cycle	Time
1	80 sec.
2	95 sec.
3	120 sec.
4	0 sec.
5	0 sec.
6	0 sec.

Closed Loop Options:

TOD Flash/Aux? NO  
 Free w/ Ckt 0? YES

Report Channel Failures to Central

Conflict Flash (3) Occurrence and Resume Normal  
 Manual /Auto Flash (3) Occurrence and Resume Normal  
 MCE (3) Occurrence and Resume Normal  
 Preempt (0) Auto-log only  
 Channel # 5 (0) Auto-log only

Asheville Hwy and BRAKE.TXT

Channel # 6 (0) Auto-log only  
Channel # 7 (0) Auto-log only  
Channel # 8 (0) Auto-log only  
Door Open (3) Occurence and Resume Normal

Main Street Phs for Out of Step Test

Ring 1 - 2  
2 - 0

Speed Trap Sensor Pairs

1-2 3-4 5-6 7-8  
NO NO NO NO

Standard Overlaps:

♀  
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Intersection: BRAKEBILL Thu Mar 29 14:57:19 2018

Internal Overlap Program? YES

	Phase							
Program	1	2	3	4	5	6	7	8
Ovl A	.	.	.	.	.	.	.	.
Ovl B	.	.	.	.	.	.	.	.
Ovl C	.	.	.	.	.	.	.	.
Ovl D	.	.	.	.	.	.	.	.

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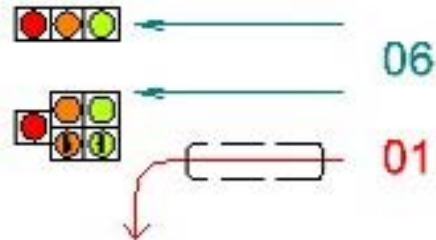
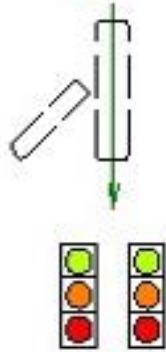
# Asheville Hwy & Brakebill

LED Conversion completed  
August 14, 2006



Neals Landing

04



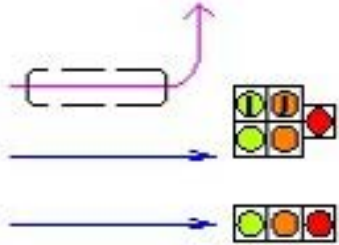
06

01

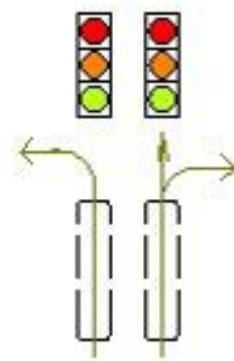
Asheville Hwy

05

02



Asheville Hwy



08

Brakebill



Filename: DATA\INT#9103.EL

Intersection: I-40 WB RAMP

Thu Mar 29 14:59:41 2018

|||||

Startup Data:

Ring 1 - 2  
 Start Phases 2 0  
 UCF Entry Phases 4 0  
 UCF Exit Phases 2 0

Start Overlaps Yellow at Power-up? NO  
 Start in All Red at Power-up? NO  
 Zone ID: 9  
 Controller ID: 1  
 Hold 2 sec. Minimum Red Revert? NO Red Revert Time: 0.0 sec.  
 Override Holds if  
 Uniform Code Flash Active? YES  
 Dual Entry 1256? NO  
 Dual Entry 3478? NO  
 Passage Interval Sequential? NO  
 Simultaneous Gap? NO  
 Conditional Service set by Input? NO  
 Conditional Service 1256? NO  
 Conditional Service 3478? NO

Timing Data:

Interval	Time by Phase (sec.)							
	1	2	3	4	5	6	7	8
Initial	6	20	0	7	0	0	0	0
Passage	3.0	3.0	0.0	3.0	0.0	0.0	0.0	0.0
Yellow	4.0	4.0	0.0	4.0	0.0	0.0	0.0	0.0
Red Clear	1.0	1.0	0.0	1.0	0.0	0.0	0.0	0.0
Max 1	14	45	0	18	0	0	0	0
Max 2	14	45	0	18	0	0	0	0
Walk	0	20	0	0	0	0	0	0
Ped Clear	0	0	0	0	0	0	0	0

Max 3 Parameters

	1	2	3	4	5	6	7	8
Adjust (sec.)	0	0	0	0	0	0	0	0
Limit (sec.)	0	0	0	0	0	0	0	0
Set (max outs)	0	0	0	0	0	0	0	0
Clr (gap outs)	0	0	0	0	0	0	0	0

Functions:

	1	2	3	4	5	6	7	8
Min. Recall	N	Y	N	N	N	N	N	N
Max. Recall	N	Y	N	N	N	N	N	N
Ped. Recall	N	N	N	N	N	N	N	N
Det. Non-lock	Y	N	N	Y	N	N	N	N
CNA I Active	N	Y	N	N	N	Y	N	N

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Intersection: I-40 WB RAMP

Thu Mar 29 14:59:41 2018

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CNA II Active N N N N N N N N  
 Flashing Walks N N N N N N N N  
 Phase Omitted N N Y N Y Y Y Y  
 Ped Omitted Y N Y Y Y Y Y Y  
 Soft Recall N N N N N N N N

Straw Plains Pike and 40WB.TXT

Ped Cl thru Yel N N N N N N N N  
 Ped Cl thru Red N N N N N N N N

Begin Daylight Savings in week: 15  
 End Daylight Savings in week: 45

Time of Day Changepoints:

Base Day Plan 0

Time	Cycle	Offset	Ckt 1 (Flash)	Ckt 0 (Free)	Ckt 9
05:00	3	1	.	.	.
06:30	5	1	.	.	.
09:00	3	1	.	.	.
10:30	5	1	.	.	.
14:00	3	1	.	.	.
15:30	6	1	.	.	.
18:30	3	1	.	.	.
23:00	1	1	.	.	.

Base Day Plan 1

Time	Cycle	Offset	Ckt 1 (Flash)	Ckt 0 (Free)	Ckt 9
06:30	3	1	.	.	.
10:00	5	1	.	.	.
18:30	3	1	.	.	.
23:00	1	1	.	.	.

Week Plan:

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
Plan: 0	1	0	0	0	0	0	1
Plan: 1	0	0	0	0	0	0	0
Plan: 2	0	0	0	0	0	0	0
Plan: 3	0	0	0	0	0	0	0
Plan: 4	0	0	0	0	0	0	0
Plan: 5	0	0	0	0	0	0	0
Plan: 6	0	0	0	0	0	0	0
Plan: 7	0	0	0	0	0	0	0
Plan: 8	0	0	0	0	0	0	0
Plan: 9	0	0	0	0	0	0	0

Week Plan Implementation:

Week 1: 0      Week 14: 0      Week 27: 0      Week 40: 0

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Intersection: I-40 WB RAMP      Thu Mar 29 14:59:41 2018

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Week 2: 0	Week 15: 0	Week 28: 0	Week 41: 0
Week 3: 0	Week 16: 0	Week 29: 0	Week 42: 0
Week 4: 0	Week 17: 0	Week 30: 0	Week 43: 0
Week 5: 0	Week 18: 0	Week 31: 0	Week 44: 0
Week 6: 0	Week 19: 0	Week 32: 0	Week 45: 0
Week 7: 0	Week 20: 0	Week 33: 0	Week 46: 0
Week 8: 0	Week 21: 0	Week 34: 0	Week 47: 0
Week 9: 0	Week 22: 0	Week 35: 0	Week 48: 0
Week 10: 0	Week 23: 0	Week 36: 0	Week 49: 0
Week 11: 0	Week 24: 0	Week 37: 0	Week 50: 0
Week 12: 0	Week 25: 0	Week 38: 0	Week 51: 0
Week 13: 0	Week 26: 0	Week 39: 0	Week 52: 0

Special Day Plan Implementation (Plan-Week-Day):

Straw Plains Pike and 40WB.TXT

Slot 1	0 - 0 - 0	Slot 18	0 - 0 - 0	Slot 35	0 - 0 - 0
Slot 2	0 - 0 - 0	Slot 19	0 - 0 - 0	Slot 36	0 - 0 - 0
Slot 3	0 - 0 - 0	Slot 20	0 - 0 - 0	Slot 37	0 - 0 - 0
Slot 4	0 - 0 - 0	Slot 21	0 - 0 - 0	Slot 38	0 - 0 - 0
Slot 5	0 - 0 - 0	Slot 22	0 - 0 - 0	Slot 39	0 - 0 - 0
Slot 6	0 - 0 - 0	Slot 23	0 - 0 - 0	Slot 40	0 - 0 - 0
Slot 7	0 - 0 - 0	Slot 24	0 - 0 - 0	Slot 41	0 - 0 - 0
Slot 8	0 - 0 - 0	Slot 25	0 - 0 - 0	Slot 42	0 - 0 - 0
Slot 9	0 - 0 - 0	Slot 26	0 - 0 - 0	Slot 43	0 - 0 - 0
Slot 10	0 - 0 - 0	Slot 27	0 - 0 - 0	Slot 44	0 - 0 - 0
Slot 11	0 - 0 - 0	Slot 28	0 - 0 - 0	Slot 45	0 - 0 - 0
Slot 12	0 - 0 - 0	Slot 29	0 - 0 - 0	Slot 46	0 - 0 - 0
Slot 13	0 - 0 - 0	Slot 30	0 - 0 - 0	Slot 47	0 - 0 - 0
Slot 14	0 - 0 - 0	Slot 31	0 - 0 - 0	Slot 48	0 - 0 - 0
Slot 15	0 - 0 - 0	Slot 32	0 - 0 - 0	Slot 49	0 - 0 - 0
Slot 16	0 - 0 - 0	Slot 33	0 - 0 - 0	Slot 50	0 - 0 - 0
Slot 17	0 - 0 - 0	Slot 34	0 - 0 - 0		

Coordination Operating Modes:

4 Splits / 4 Cycles? NO  
 Unused Cycle Time to Side St. ? NO  
 Ckt 4 enables Aux TOD? NO  
 Offset Interruption? NO  
 Cycle 4 = 2 A.M. Sync? NO  
 Split 2 = 2 A.M. Sync? NO  
 Flash with Ckt 1? NO  
 Invert Free Output? NO  
 Auto Permissive? YES  
 Cycle 4 = Flash? NO  
 Enable Max 2 with Ckt 9? NO  
 Conditional Service with Ckt 9? NO  
 Invert Free Input? NO  
 Activate CNA 1? YES

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Filename: DATA\INT#9103.EL

Intersection: I-40 WB RAMP

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|||||
Activate Walk Rest Modifier? YES
Inhibit Max Termination? YES
Enhanced Permissive? NO
Use Split Matrix? YES
Use Yellow Offset Timer? NO
Interconnect? NO
Maximum Dwell Time: 0 sec.
Full Dwell? NO
Short Route? YES
    
```

Phase Relationships:

Ring 1 - 2

Hold 1 Phases	2 - 0
Hold 1 Omit Phases	0 - 0
Hold 2 Omit Phases	0 - 0
Hold 3 Omit Phases	0 - 0
Hold 3 Omit Phases	0 - 0
Hold 3 Omit Phases	0 - 0
Hold 3 Ped Omit	0 - 0
Non Early Release Phases	0 - 0
Non Early Release Phases	0 - 0
Non Early Release Phases	0 - 0
Phases Omitted w/ Ckt 9	0 - 0



Straw Plains Pike and 40WB.TXT

Cycle  
1 70 sec.  
2 75 sec.  
3 80 sec.  
4 90 sec.  
5 100 sec.  
6 100 sec.

Closed Loop Options:

TOD Flash/Aux? YES  
Free w/ Ckt 0? YES

Report Channel Failures to Central  
Conflict Flash (3) Occurrence and Resume Normal

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Database Printout of 1880EL Local

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Intersection: I-40 WB RAMP Thu Mar 29 14:59:41 2018

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|||||
Manual /Auto Flash (3) Occurrence and Resume Normal
MCE (3) Occurrence and Resume Normal
Preempt (3) Occurrence and Resume Normal
Channel # 5 (3) Occurrence and Resume Normal
Channel # 6 (3) Occurrence and Resume Normal
Channel # 7 (3) Occurrence and Resume Normal
Channel # 8 (3) Occurrence and Resume Normal
Door Open (3) Occurrence and Resume Normal

```

Main Street Phs for Out of Step Test

Ring 1 - 2  
2 - 6

Speed Trap Sensor Pairs

1-2 3-4 5-6 7-8  
NO NO NO NO

Standard Overlaps:

Internal Overlap Program? YES

Program	Phase							
	1	2	3	4	5	6	7	8
Ovl A	X	X	.	.	.	.	.	.
Ovl B	.	.	.	.	.	.	.	.
Ovl C	.	.	.	.	.	.	.	.
Ovl D	.	.	.	.	.	.	.	.

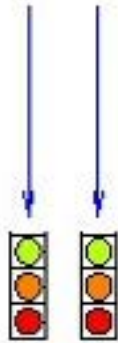
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# Strawberry Plains Pk & I-40 WB Ramps



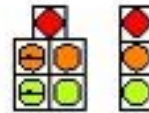
Strawberry Plains Pk

02

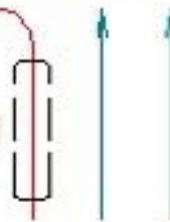


04

I-40 WB Exit



01



OLA 01+02

Strawberry Plains Pk

**APPENDIX G**

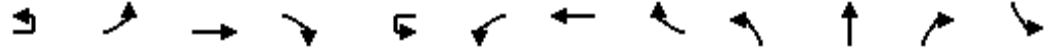
**CAPACITY ANALYSES – HCM WORKSHEETS (SYNCHRO 8)**



## **EXISTING TRAFFIC CONDITIONS**

HCM Signalized Intersection Capacity Analysis  
 5: Brakebill Road/Neals Landing Road & Asheville Highway

4/3/2018



Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Volume (vph)	1	2	515	37	1	94	1143	3	62	1	52	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)			-2%				-1%			-7%		
Total Lost time (s)		5.0	7.0			5.0	7.0	7.0	6.5	6.5		
Lane Util. Factor		1.00	0.95			1.00	0.95	1.00	1.00	1.00		
Frt		1.00	0.99			1.00	1.00	0.85	1.00	0.86		
Flt Protected		0.95	1.00			0.95	1.00	1.00	0.95	1.00		
Satd. Flow (prot)		1823	3347			1814	3455	1220	1814	1655		
Flt Permitted		0.17	1.00			0.36	1.00	1.00	0.95	1.00		
Satd. Flow (perm)		328	3347			681	3455	1220	1814	1655		
Peak-hour factor, PHF	0.25	0.50	0.96	0.77	0.25	0.81	0.90	0.38	0.78	0.25	0.68	0.50
Adj. Flow (vph)	4	4	536	48	4	116	1270	8	79	4	76	20
RTOR Reduction (vph)	0	0	5	0	0	0	0	4	0	69	0	0
Lane Group Flow (vph)	0	8	579	0	0	120	1270	4	79	11	0	0
Heavy Vehicles (%)	0%	0%	8%	3%	0%	0%	5%	33%	3%	0%	2%	0%
Turn Type	Prot	pm+pt	NA		Prot	pm+pt	NA	Prot	Split	NA		Split
Protected Phases	5	5	2		1	1	6	6	8	8		4
Permitted Phases		2				6						
Actuated Green, G (s)		36.8	35.9			48.9	43.0	43.0	7.3	7.3		
Effective Green, g (s)		36.8	35.9			48.9	43.0	43.0	7.3	7.3		
Actuated g/C Ratio		0.46	0.45			0.61	0.54	0.54	0.09	0.09		
Clearance Time (s)		5.0	7.0			5.0	7.0	7.0	6.5	6.5		
Vehicle Extension (s)		3.0	3.0			3.0	3.0	3.0	3.0	3.0		
Lane Grp Cap (vph)		167	1498			528	1852	654	165	150		
v/s Ratio Prot		0.00	0.17			c0.02	c0.37	0.00	c0.04	0.01		
v/s Ratio Perm		0.02				0.12						
v/c Ratio		0.05	0.39			0.23	0.69	0.01	0.48	0.07		
Uniform Delay, d1		12.2	14.8			6.9	13.6	8.7	34.6	33.4		
Progression Factor		1.00	1.00			1.00	1.00	1.00	1.00	1.00		
Incremental Delay, d2		0.1	0.2			0.2	1.1	0.0	2.2	0.2		
Delay (s)		12.3	15.0			7.1	14.7	8.7	36.8	33.6		
Level of Service		B	B			A	B	A	D	C		
Approach Delay (s)			14.9				14.0			35.2		
Approach LOS			B				B			D		
<b>Intersection Summary</b>												
HCM 2000 Control Delay			16.2				HCM 2000 Level of Service		B			
HCM 2000 Volume to Capacity ratio			0.63									
Actuated Cycle Length (s)			80.2				Sum of lost time (s)		25.0			
Intersection Capacity Utilization			58.9%				ICU Level of Service		B			
Analysis Period (min)			15									
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis  
 5: Brakebill Road/Neals Landing Road & Asheville Highway

4/3/2018



Movement	SBT	SBR
Lane Configurations	↕	
Volume (vph)	1	7
Ideal Flow (vphpl)	1900	1900
Grade (%)	1%	
Total Lost time (s)	6.5	
Lane Util. Factor	1.00	
Frt	0.95	
Flt Protected	0.97	
Satd. Flow (prot)	1678	
Flt Permitted	0.97	
Satd. Flow (perm)	1678	
Peak-hour factor, PHF	0.25	0.58
Adj. Flow (vph)	4	12
RTOR Reduction (vph)	11	0
Lane Group Flow (vph)	25	0
Heavy Vehicles (%)	0%	14%
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	4.0	
Effective Green, g (s)	4.0	
Actuated g/C Ratio	0.05	
Clearance Time (s)	6.5	
Vehicle Extension (s)	3.0	
Lane Grp Cap (vph)	83	
v/s Ratio Prot	c0.01	
v/s Ratio Perm		
v/c Ratio	0.30	
Uniform Delay, d1	36.7	
Progression Factor	1.00	
Incremental Delay, d2	2.0	
Delay (s)	38.7	
Level of Service	D	
Approach Delay (s)	38.7	
Approach LOS	D	

Intersection Summary

**Intersection**

Int Delay, s/veh 1.8

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	16	9	7	63	126	9
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	3	-	-	3	-2	-
Peak Hour Factor	50	75	58	72	85	56
Heavy Vehicles, %	6	0	0	0	0	0
Mvmt Flow	32	12	12	88	148	16

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	268	156	164 0
Stage 1	156	-	- -
Stage 2	112	-	- -
Critical Hdwy	7.06	6.5	4.1 -
Critical Hdwy Stg 1	6.06	-	- -
Critical Hdwy Stg 2	6.06	-	- -
Follow-up Hdwy	3.554	3.3	2.2 -
Pot Cap-1 Maneuver	682	883	1427 -
Stage 1	841	-	- -
Stage 2	886	-	- -
Platoon blocked, %			- -
Mov Cap-1 Maneuver	676	883	1427 -
Mov Cap-2 Maneuver	676	-	- -
Stage 1	841	-	- -
Stage 2	878	-	- -

Approach	EB	NB	SB
HCM Control Delay, s	10.3	0.9	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1427	-	722	-	-
HCM Lane V/C Ratio	0.008	-	0.061	-	-
HCM Control Delay (s)	7.5	0	10.3	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0	-	0.2	-	-

HCM 2010 TWSC  
 10: Strawberry Plains Pike & Brakebill Road

4/3/2018

**Intersection**

Int Delay, s/veh 4.4

Movement	EBL	EBR	NBL	NBT	SBU	SBT	SBR
Vol, veh/h	40	145	58	401	48	725	36
Conflicting Peds, #/hr	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	-	None
Storage Length	120	0	150	-	-	-	-
Veh in Median Storage, #	0	-	-	0	-	0	-
Grade, %	-3	-	-	1	-	-2	-
Peak Hour Factor	56	93	66	91	92	79	69
Heavy Vehicles, %	0	6	9	7	0	7	3
Mvmt Flow	71	156	88	441	52	918	52

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	1444	485	970
Stage 1	1048	-	-
Stage 2	396	-	-
Critical Hdwy	6.2	6.72	4.28
Critical Hdwy Stg 1	5.2	-	-
Critical Hdwy Stg 2	5.2	-	-
Follow-up Hdwy	3.5	3.36	2.29
Pot Cap-1 Maneuver	159	539	665
Stage 1	361	-	-
Stage 2	699	-	-
Platoon blocked, %			-
Mov Cap-1 Maneuver	138	539	665
Mov Cap-2 Maneuver	138	-	-
Stage 1	361	-	-
Stage 2	607	-	-

Approach	EB	NB	SB
HCM Control Delay, s	27.5	1.9	0.5
HCM LOS	D		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	665	-	138	539	-	-
HCM Lane V/C Ratio	0.132	-	0.518	0.289	-	-
HCM Control Delay (s)	11.2	-	56.2	14.4	-	-
HCM Lane LOS	B	-	F	B	-	-
HCM 95th %tile Q(veh)	0.5	-	2.5	1.2	-	-

# HCM Signalized Intersection Capacity Analysis

## 14: Strawberry Plains Pike & Interstate 40 On Ramp/Interstate 40 Off Ramp

4/3/2018



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↔↔		↗	↖	↑↑			↑↑	
Volume (vph)	0	0	0	164	0	116	183	344	0	0	394	471
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-3%			1%				-1%
Total Lost time (s)				5.0		5.0	5.0	5.0			5.0	
Lane Util. Factor				0.97		1.00	1.00	0.95			0.95	
Frt				1.00		0.85	1.00	1.00			0.91	
Flt Protected				0.95		1.00	0.95	1.00			1.00	
Satd. Flow (prot)				2937		1591	1437	3326			3130	
Flt Permitted				0.95		1.00	0.21	1.00			1.00	
Satd. Flow (perm)				2937		1591	314	3326			3130	
Peak-hour factor, PHF	0.92	0.92	0.92	0.79	0.25	0.83	0.95	0.89	0.92	0.92	0.93	0.77
Adj. Flow (vph)	0	0	0	208	0	140	193	387	0	0	424	612
RTOR Reduction (vph)	0	0	0	0	0	120	0	0	0	0	283	0
Lane Group Flow (vph)	0	0	0	208	0	20	193	387	0	0	753	0
Heavy Vehicles (%)	0%	0%	0%	21%	100%	3%	25%	8%	0%	0%	8%	4%
Turn Type				Prot		Prot	pm+pt	NA			NA	
Protected Phases				4		4	1	1 2			2	
Permitted Phases							1 2					
Actuated Green, G (s)				10.4		10.4	49.0	54.0			40.0	
Effective Green, g (s)				10.4		10.4	49.0	54.0			40.0	
Actuated g/C Ratio				0.14		0.14	0.66	0.73			0.54	
Clearance Time (s)				5.0		5.0	5.0				5.0	
Vehicle Extension (s)				3.0		3.0	3.0				3.0	
Lane Grp Cap (vph)				410		222	342	2414			1682	
v/s Ratio Prot				c0.07		0.01	c0.07	0.12			0.24	
v/s Ratio Perm							c0.30					
v/c Ratio				0.51		0.09	0.56	0.16			0.45	
Uniform Delay, d1				29.6		27.9	6.2	3.2			10.5	
Progression Factor				1.00		1.00	1.00	1.00			1.00	
Incremental Delay, d2				1.0		0.2	6.6	0.1			0.9	
Delay (s)				30.6		28.0	12.8	3.3			11.3	
Level of Service				C		C	B	A			B	
Approach Delay (s)		0.0			29.6			6.5			11.3	
Approach LOS		A			C			A			B	

### Intersection Summary

HCM 2000 Control Delay	13.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	74.4	Sum of lost time (s)	15.0
Intersection Capacity Utilization	52.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 5: Brakebill Road/Neals Landing Road & Asheville Highway

4/3/2018



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↔	↑↔		↔	↑↑	↔	↔	↔			↔	
Volume (vph)	8	907	63	102	702	1	62	7	145	2	3	8
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-1%			-7%				1%
Total Lost time (s)	5.0	7.0		5.0	7.0	7.0	6.5	6.5			6.5	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	1.00			1.00	
Frt	1.00	0.99		1.00	1.00	0.85	1.00	0.86			0.93	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00			0.99	
Satd. Flow (prot)	1823	3427		1796	3359	812	1814	1684			1608	
Flt Permitted	0.32	1.00		0.15	1.00	1.00	0.95	1.00			0.99	
Satd. Flow (perm)	607	3427		276	3359	812	1814	1684			1608	
Peak-hour factor, PHF	0.67	0.94	0.68	0.73	0.78	0.25	0.67	0.88	0.77	0.50	0.75	1.00
Adj. Flow (vph)	12	965	93	140	900	4	93	8	188	4	4	8
RTOR Reduction (vph)	0	5	0	0	0	2	0	165	0	0	8	0
Lane Group Flow (vph)	12	1053	0	140	900	2	93	31	0	0	8	0
Heavy Vehicles (%)	0%	5%	5%	1%	8%	100%	3%	0%	0%	0%	33%	0%
Turn Type	pm+pt	NA		pm+pt	NA	Prot	Split	NA		Split	NA	
Protected Phases	5	2		1	6	6	8	8		4	4	
Permitted Phases	2			6								
Actuated Green, G (s)	36.1	35.2		48.7	42.8	42.8	10.0	10.0			2.2	
Effective Green, g (s)	36.1	35.2		48.7	42.8	42.8	10.0	10.0			2.2	
Actuated g/C Ratio	0.45	0.44		0.60	0.53	0.53	0.12	0.12			0.03	
Clearance Time (s)	5.0	7.0		5.0	7.0	7.0	6.5	6.5			6.5	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)	284	1491		325	1777	429	224	208			43	
v/s Ratio Prot	0.00	c0.31		c0.05	c0.27	0.00	c0.05	0.02			c0.01	
v/s Ratio Perm	0.02			0.21								
v/c Ratio	0.04	0.71		0.43	0.51	0.00	0.42	0.15			0.19	
Uniform Delay, d1	12.5	18.6		9.9	12.3	9.0	32.7	31.7			38.5	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00			1.00	
Incremental Delay, d2	0.1	1.5		0.9	0.2	0.0	1.2	0.3			2.2	
Delay (s)	12.5	20.2		10.8	12.5	9.0	34.0	32.0			40.6	
Level of Service	B	C		B	B	A	C	C			D	
Approach Delay (s)		20.1			12.2			32.6			40.6	
Approach LOS		C			B			C			D	

### Intersection Summary

HCM 2000 Control Delay	18.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	80.9	Sum of lost time (s)	25.0
Intersection Capacity Utilization	58.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			



**Intersection**

Int Delay, s/veh 1.3

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	11	11	12	167	130	17
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	3	-	-	3	-2	-
Peak Hour Factor	55	55	75	91	77	85
Heavy Vehicles, %	9	18	8	2	1	6
Mvmt Flow	20	20	16	184	169	20

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	395	179	189 0
Stage 1	179	-	- -
Stage 2	216	-	- -
Critical Hdwy	7.09	6.68	4.18 -
Critical Hdwy Stg 1	6.09	-	- -
Critical Hdwy Stg 2	6.09	-	- -
Follow-up Hdwy	3.581	3.462	2.272 -
Pot Cap-1 Maneuver	558	812	1350 -
Stage 1	811	-	- -
Stage 2	775	-	- -
Platoon blocked, %			- -
Mov Cap-1 Maneuver	551	812	1350 -
Mov Cap-2 Maneuver	551	-	- -
Stage 1	811	-	- -
Stage 2	765	-	- -

Approach	EB	NB	SB
HCM Control Delay, s	10.8	0.6	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1350	-	657	-	-
HCM Lane V/C Ratio	0.012	-	0.061	-	-
HCM Control Delay (s)	7.7	0	10.8	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0	-	0.2	-	-

HCM 2010 TWSC  
 10: Strawberry Plains Pike & Brakebill Road

4/3/2018

**Intersection**

Int Delay, s/veh 3.7

Movement	EBL	EBR	NBU	NBL	NBT	SBU	SBT	SBR
Vol, veh/h	56	124	14	161	761	10	461	47
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	None	-	-	None	-	-	None
Storage Length	120	0	-	150	-	-	-	-
Veh in Median Storage, #	0	-	-	-	0	-	0	-
Grade, %	-3	-	-	-	1	-	-2	-
Peak Hour Factor	78	89	92	82	92	92	94	59
Heavy Vehicles, %	0	2	0	6	4	0	7	2
Mvmt Flow	72	139	15	196	827	11	490	80

Major/Minor	Minor2	Major1				Major2		
Conflicting Flow All	1389	285	709	570	0	604	-	0
Stage 1	552	-	-	-	-	-	-	-
Stage 2	837	-	-	-	-	-	-	-
Critical Hdwy	6.2	6.64	6.4	4.22	-	6.4	-	-
Critical Hdwy Stg 1	5.2	-	-	-	-	-	-	-
Critical Hdwy Stg 2	5.2	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	3.32	2.5	2.26	-	2.5	-	-
Pot Cap-1 Maneuver	171	729	517	971	-	602	-	-
Stage 1	599	-	-	-	-	-	-	-
Stage 2	449	-	-	-	-	-	-	-
Platoon blocked, %					-		-	-
Mov Cap-1 Maneuver	171	729	890	890	-	602	-	-
Mov Cap-2 Maneuver	171	-	-	-	-	-	-	-
Stage 1	599	-	-	-	-	-	-	-
Stage 2	449	-	-	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	21.1	2.1	0.2
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	890	-	171	729	-	-
HCM Lane V/C Ratio	0.238	-	0.42	0.191	-	-
HCM Control Delay (s)	10.3	-	40.5	11.1	-	-
HCM Lane LOS	B	-	E	B	-	-
HCM 95th %tile Q(veh)	0.9	-	1.9	0.7	-	-

# HCM Signalized Intersection Capacity Analysis

## 14: Strawberry Plains Pike & Interstate 40 On Ramp/Interstate 40 Off Ramp

4/3/2018



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↔↔		↗	↖	↕			↕↕	
Volume (vph)	0	0	0	156	0	125	313	828	0	0	360	235
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-3%			1%				-1%
Total Lost time (s)				5.0		5.0	5.0	5.0			5.0	
Lane Util. Factor				0.97		1.00	1.00	0.95			0.95	
Frt				1.00		0.85	1.00	1.00			0.94	
Flt Protected				0.95		1.00	0.95	1.00			1.00	
Satd. Flow (prot)				2539		1490	1618	3522			3250	
Flt Permitted				0.95		1.00	0.34	1.00			1.00	
Satd. Flow (perm)				2539		1490	585	3522			3250	
Peak-hour factor, PHF	0.92	0.92	0.92	0.75	0.50	0.82	0.75	0.96	0.92	0.92	0.83	0.86
Adj. Flow (vph)	0	0	0	208	0	152	417	862	0	0	434	273
RTOR Reduction (vph)	0	0	0	0	0	130	0	0	0	0	125	0
Lane Group Flow (vph)	0	0	0	208	0	22	417	862	0	0	582	0
Heavy Vehicles (%)	0%	0%	0%	40%	50%	10%	11%	2%	0%	0%	4%	7%
Turn Type				Prot		Prot	pm+pt	NA			NA	
Protected Phases				4		4	1	1 2			2	
Permitted Phases							1 2					
Actuated Green, G (s)				10.9		10.9	49.0	54.0			40.0	
Effective Green, g (s)				10.9		10.9	49.0	54.0			40.0	
Actuated g/C Ratio				0.15		0.15	0.65	0.72			0.53	
Clearance Time (s)				5.0		5.0	5.0				5.0	
Vehicle Extension (s)				3.0		3.0	3.0				3.0	
Lane Grp Cap (vph)				369		216	506	2539			1735	
v/s Ratio Prot				c0.08		0.01	c0.10	0.24			0.18	
v/s Ratio Perm							c0.44					
v/c Ratio				0.56		0.10	0.82	0.34			0.34	
Uniform Delay, d1				29.8		27.8	6.3	3.9			9.9	
Progression Factor				1.00		1.00	1.00	1.00			0.99	
Incremental Delay, d2				2.0		0.2	14.1	0.4			0.5	
Delay (s)				31.8		28.0	20.5	4.2			10.3	
Level of Service				C		C	C	A			B	
Approach Delay (s)		0.0			30.2			9.5			10.3	
Approach LOS		A			C			A			B	

### Intersection Summary

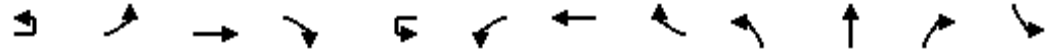
HCM 2000 Control Delay	12.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	74.9	Sum of lost time (s)	15.0
Intersection Capacity Utilization	50.9%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

**OPENING YEAR TRAFFIC CONDITIONS (WITHOUT PROJECT)**

# HCM Signalized Intersection Capacity Analysis

## 5: Brakebill Road/Neals Landing Road & Asheville Highway

4/4/2018



Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations		↔	↕			↔	↕	↕	↕	↕		
Volume (vph)	2	3	592	43	2	108	1313	4	72	2	60	12
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)			-2%				-1%			-7%		
Total Lost time (s)		5.0	7.0			5.0	7.0	7.0	6.5	6.5		
Lane Util. Factor		1.00	0.95			1.00	0.95	1.00	1.00	1.00		
Frt		1.00	0.99			1.00	1.00	0.85	1.00	0.86		
Flt Protected		0.95	1.00			0.95	1.00	1.00	0.95	1.00		
Satd. Flow (prot)		1823	3347			1814	3455	1220	1814	1666		
Flt Permitted		0.11	1.00			0.30	1.00	1.00	0.95	1.00		
Satd. Flow (perm)		210	3347			579	3455	1220	1814	1666		
Peak-hour factor, PHF	0.25	0.50	0.96	0.77	0.25	0.81	0.90	0.38	0.78	0.25	0.68	0.50
Adj. Flow (vph)	8	6	617	56	8	133	1459	11	92	8	88	24
RTOR Reduction (vph)	0	0	5	0	0	0	0	5	0	78	0	0
Lane Group Flow (vph)	0	14	668	0	0	141	1459	6	92	18	0	0
Heavy Vehicles (%)	0%	0%	8%	3%	0%	0%	5%	33%	3%	0%	2%	0%
Turn Type	Prot	pm+pt	NA		Prot	pm+pt	NA	Prot	Split	NA		Split
Protected Phases	5	5	2		1	1	6	6	8	8		4
Permitted Phases		2				6						
Actuated Green, G (s)		37.6	36.6			50.2	44.2	44.2	9.7	9.7		
Effective Green, g (s)		37.6	36.6			50.2	44.2	44.2	9.7	9.7		
Actuated g/C Ratio		0.45	0.43			0.59	0.52	0.52	0.11	0.11		
Clearance Time (s)		5.0	7.0			5.0	7.0	7.0	6.5	6.5		
Vehicle Extension (s)		3.0	3.0			3.0	3.0	3.0	3.0	3.0		
Lane Grp Cap (vph)		112	1451			470	1809	638	208	191		
v/s Ratio Prot		0.00	0.20			c0.03	c0.42	0.00	c0.05	0.01		
v/s Ratio Perm		0.05				0.15						
v/c Ratio		0.12	0.46			0.30	0.81	0.01	0.44	0.09		
Uniform Delay, d1		14.5	16.9			8.2	16.6	9.6	34.8	33.4		
Progression Factor		1.00	1.00			1.00	1.00	1.00	1.00	1.00		
Incremental Delay, d2		0.5	0.2			0.4	2.7	0.0	1.5	0.2		
Delay (s)		15.0	17.1			8.6	19.3	9.6	36.3	33.6		
Level of Service		B	B			A	B	A	D	C		
Approach Delay (s)			17.1				18.3			35.0		
Approach LOS			B				B			C		

Intersection Summary		
HCM 2000 Control Delay	19.6	HCM 2000 Level of Service
HCM 2000 Volume to Capacity ratio	0.72	B
Actuated Cycle Length (s)	84.4	Sum of lost time (s)
Intersection Capacity Utilization	63.9%	25.0
Analysis Period (min)	15	ICU Level of Service
c Critical Lane Group		B

HCM Signalized Intersection Capacity Analysis  
 5: Brakebill Road/Neals Landing Road & Asheville Highway

4/4/2018



Movement	SBT	SBR
Lane Configurations	↕	
Volume (vph)	2	9
Ideal Flow (vphpl)	1900	1900
Grade (%)	1%	
Total Lost time (s)	6.5	
Lane Util. Factor	1.00	
Frt	0.95	
Flt Protected	0.98	
Satd. Flow (prot)	1683	
Flt Permitted	0.98	
Satd. Flow (perm)	1683	
Peak-hour factor, PHF	0.25	0.58
Adj. Flow (vph)	8	16
RTOR Reduction (vph)	15	0
Lane Group Flow (vph)	33	0
Heavy Vehicles (%)	0%	14%
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	4.5	
Effective Green, g (s)	4.5	
Actuated g/C Ratio	0.05	
Clearance Time (s)	6.5	
Vehicle Extension (s)	3.0	
Lane Grp Cap (vph)	89	
v/s Ratio Prot	c0.02	
v/s Ratio Perm		
v/c Ratio	0.37	
Uniform Delay, d1	38.6	
Progression Factor	1.00	
Incremental Delay, d2	2.6	
Delay (s)	41.2	
Level of Service	D	
Approach Delay (s)	41.2	
Approach LOS	D	

Intersection Summary

**Intersection**

Int Delay, s/veh 1.9

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	19	11	9	73	145	11
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	3	-	-	3	-2	-
Peak Hour Factor	50	75	58	72	85	56
Heavy Vehicles, %	6	0	0	0	0	0
Mvmt Flow	38	15	16	101	171	20

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	312	180	190 0
Stage 1	180	-	- -
Stage 2	132	-	- -
Critical Hdwy	7.06	6.5	4.1 -
Critical Hdwy Stg 1	6.06	-	- -
Critical Hdwy Stg 2	6.06	-	- -
Follow-up Hdwy	3.554	3.3	2.2 -
Pot Cap-1 Maneuver	638	855	1396 -
Stage 1	817	-	- -
Stage 2	865	-	- -
Platoon blocked, %			- -
Mov Cap-1 Maneuver	630	855	1396 -
Mov Cap-2 Maneuver	630	-	- -
Stage 1	817	-	- -
Stage 2	855	-	- -

Approach	EB	NB	SB
HCM Control Delay, s	10.7	1	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1396	-	680	-	-
HCM Lane V/C Ratio	0.011	-	0.077	-	-
HCM Control Delay (s)	7.6	0	10.7	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0	-	0.3	-	-

**Intersection**

Int Delay, s/veh 7.7

Movement	EBL	EBR	NBL	NBT	SBU	SBT	SBR
Vol, veh/h	46	167	67	461	56	833	42
Conflicting Peds, #/hr	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	-	None
Storage Length	120	0	150	-	-	-	-
Veh in Median Storage, #	0	-	-	0	-	0	-
Grade, %	-3	-	-	1	-	-2	-
Peak Hour Factor	56	93	66	91	92	79	69
Heavy Vehicles, %	0	6	9	7	0	7	3
Mvmt Flow	82	180	102	507	61	1054	61

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	1663	558	1115 0 370
Stage 1	1207	-	- - -
Stage 2	456	-	- - -
Critical Hdwy	6.2	6.72	4.28 - 6.4
Critical Hdwy Stg 1	5.2	-	- - -
Critical Hdwy Stg 2	5.2	-	- - -
Follow-up Hdwy	3.5	3.36	2.29 - 2.5
Pot Cap-1 Maneuver	118	485	583 - 846
Stage 1	306	-	- - -
Stage 2	659	-	- - -
Platoon blocked, %			- - -
Mov Cap-1 Maneuver	97	485	583 - 846
Mov Cap-2 Maneuver	97	-	- - -
Stage 1	306	-	- - -
Stage 2	544	-	- - -

Approach	EB	NB	SB
HCM Control Delay, s	52.7	2.1	0.5
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	583	-	97	485	-	-
HCM Lane V/C Ratio	0.174	-	0.847	0.37	-	-
HCM Control Delay (s)	12.5	-	131.5	16.7	-	-
HCM Lane LOS	B	-	F	C	-	-
HCM 95th %tile Q(veh)	0.6	-	4.7	1.7	-	-



# HCM Signalized Intersection Capacity Analysis

## 14: Strawberry Plains Pike & Interstate 40 On Ramp/Interstate 40 Off Ramp

4/4/2018



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↔↔		↗	↖	↕			↕↕	
Volume (vph)	0	0	0	189	0	134	211	396	0	0	453	542
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-3%			1%				-1%
Total Lost time (s)				5.0		5.0	5.0	5.0			5.0	
Lane Util. Factor				0.97		1.00	1.00	0.95			0.95	
Frt				1.00		0.85	1.00	1.00			0.91	
Flt Protected				0.95		1.00	0.95	1.00			1.00	
Satd. Flow (prot)				2937		1591	1437	3326			3130	
Flt Permitted				0.95		1.00	0.16	1.00			1.00	
Satd. Flow (perm)				2937		1591	236	3326			3130	
Peak-hour factor, PHF	0.92	0.92	0.92	0.79	0.25	0.83	0.95	0.89	0.92	0.92	0.93	0.77
Adj. Flow (vph)	0	0	0	239	0	161	222	445	0	0	487	704
RTOR Reduction (vph)	0	0	0	0	0	138	0	0	0	0	328	0
Lane Group Flow (vph)	0	0	0	239	0	23	222	445	0	0	863	0
Heavy Vehicles (%)	0%	0%	0%	21%	100%	3%	25%	8%	0%	0%	8%	4%
Turn Type				Prot		Prot	pm+pt	NA			NA	
Protected Phases				4		4	1	1 2			2	
Permitted Phases							1 2					
Actuated Green, G (s)				10.9		10.9	49.0	54.0			40.0	
Effective Green, g (s)				10.9		10.9	49.0	54.0			40.0	
Actuated g/C Ratio				0.15		0.15	0.65	0.72			0.53	
Clearance Time (s)				5.0		5.0	5.0				5.0	
Vehicle Extension (s)				3.0		3.0	3.0				3.0	
Lane Grp Cap (vph)				427		231	298	2397			1671	
v/s Ratio Prot				c0.08		0.01	c0.09	0.13			0.28	
v/s Ratio Perm							c0.40					
v/c Ratio				0.56		0.10	0.74	0.19			0.52	
Uniform Delay, d1				29.8		27.8	8.6	3.4			11.2	
Progression Factor				1.00		1.00	1.00	1.00			1.00	
Incremental Delay, d2				1.6		0.2	15.5	0.2			1.1	
Delay (s)				31.4		27.9	24.1	3.5			12.4	
Level of Service				C		C	C	A			B	
Approach Delay (s)		0.0			30.0			10.4			12.4	
Approach LOS		A			C			B			B	

### Intersection Summary

HCM 2000 Control Delay	14.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	74.9	Sum of lost time (s)	15.0
Intersection Capacity Utilization	58.7%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 5: Brakebill Road/Neals Landing Road & Asheville Highway

4/4/2018



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	1042	73	118	807	2	72	9	167	3	4	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-1%			-7%				1%
Total Lost time (s)	5.0	7.0		5.0	7.0	7.0	6.5	6.5			6.5	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	1.00			1.00	
Frt	1.00	0.99		1.00	1.00	0.85	1.00	0.86			0.94	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00			0.99	
Satd. Flow (prot)	1823	3427		1796	3359	812	1814	1685			1617	
Flt Permitted	0.26	1.00		0.11	1.00	1.00	0.95	1.00			0.99	
Satd. Flow (perm)	490	3427		215	3359	812	1814	1685			1617	
Peak-hour factor, PHF	0.67	0.94	0.68	0.73	0.78	0.25	0.67	0.88	0.77	0.50	0.75	1.00
Adj. Flow (vph)	15	1109	107	162	1035	8	107	10	217	6	5	10
RTOR Reduction (vph)	0	5	0	0	0	4	0	191	0	0	10	0
Lane Group Flow (vph)	15	1211	0	162	1035	4	107	36	0	0	11	0
Heavy Vehicles (%)	0%	5%	5%	1%	8%	100%	3%	0%	0%	0%	33%	0%
Turn Type	pm+pt	NA		pm+pt	NA	Prot	Split	NA		Split	NA	
Protected Phases	5	2		1	6	6	8	8		4	4	
Permitted Phases	2			6								
Actuated Green, G (s)	44.6	42.6		56.8	49.8	49.8	10.9	10.9			2.4	
Effective Green, g (s)	44.6	42.6		56.8	49.8	49.8	10.9	10.9			2.4	
Actuated g/C Ratio	0.50	0.47		0.63	0.55	0.55	0.12	0.12			0.03	
Clearance Time (s)	5.0	7.0		5.0	7.0	7.0	6.5	6.5			6.5	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)	272	1620		296	1856	448	219	203			43	
v/s Ratio Prot	0.00	c0.35		c0.06	0.31	0.01	c0.06	0.02			c0.01	
v/s Ratio Perm	0.03			0.29								
v/c Ratio	0.06	0.75		0.55	0.56	0.01	0.49	0.18			0.26	
Uniform Delay, d1	11.6	19.4		11.9	13.0	9.1	37.0	35.6			43.0	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00			1.00	
Incremental Delay, d2	0.1	1.9		2.1	0.4	0.0	1.7	0.4			3.2	
Delay (s)	11.7	21.3		14.0	13.4	9.1	38.7	36.0			46.2	
Level of Service	B	C		B	B	A	D	D			D	
Approach Delay (s)		21.2			13.4			36.9			46.2	
Approach LOS		C			B			D			D	

Intersection Summary			
HCM 2000 Control Delay	19.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	90.1	Sum of lost time (s)	25.0
Intersection Capacity Utilization	63.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

**Intersection**

Int Delay, s/veh 1.4

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	13	13	14	192	150	20
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	3	-	-	3	-2	-
Peak Hour Factor	55	55	75	91	77	85
Heavy Vehicles, %	9	18	8	2	1	6
Mvmt Flow	24	24	19	211	195	24

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	455	207	218 0
Stage 1	207	-	- -
Stage 2	248	-	- -
Critical Hdwy	7.09	6.68	4.18 -
Critical Hdwy Stg 1	6.09	-	- -
Critical Hdwy Stg 2	6.09	-	- -
Follow-up Hdwy	3.581	3.462	2.272 -
Pot Cap-1 Maneuver	510	781	1317 -
Stage 1	784	-	- -
Stage 2	746	-	- -
Platoon blocked, %			- -
Mov Cap-1 Maneuver	502	781	1317 -
Mov Cap-2 Maneuver	502	-	- -
Stage 1	784	-	- -
Stage 2	734	-	- -

Approach	EB	NB	SB
HCM Control Delay, s	11.4	0.6	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1317	-	611	-	-
HCM Lane V/C Ratio	0.014	-	0.077	-	-
HCM Control Delay (s)	7.8	0	11.4	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0	-	0.3	-	-

HCM 2010 TWSC  
 10: Strawberry Plains Pike & Brakebill Road

4/4/2018

**Intersection**

Int Delay, s/veh 5.2

Movement	EBL	EBR	NBU	NBL	NBT	SBU	SBT	SBR
Vol, veh/h	65	143	17	185	875	12	530	54
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	None	-	-	None	-	-	None
Storage Length	120	0	-	150	-	-	-	-
Veh in Median Storage, #	0	-	-	-	0	-	0	-
Grade, %	-3	-	-	-	1	-	-2	-
Peak Hour Factor	78	89	92	82	92	92	94	59
Heavy Vehicles, %	0	2	0	6	4	0	7	2
Mvmt Flow	83	161	18	226	951	13	564	92

Major/Minor	Minor2	Major1				Major2		
Conflicting Flow All	1600	328	816	655	0	694	-	0
Stage 1	636	-	-	-	-	-	-	-
Stage 2	964	-	-	-	-	-	-	-
Critical Hdwy	6.2	6.64	6.4	4.22	-	6.4	-	-
Critical Hdwy Stg 1	5.2	-	-	-	-	-	-	-
Critical Hdwy Stg 2	5.2	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	3.32	2.5	2.26	-	2.5	-	-
Pot Cap-1 Maneuver	129	686	442	902	-	528	-	-
Stage 1	550	-	-	-	-	-	-	-
Stage 2	394	-	-	-	-	-	-	-
Platoon blocked, %					-		-	-
Mov Cap-1 Maneuver	129	686	806	806	-	528	-	-
Mov Cap-2 Maneuver	129	-	-	-	-	-	-	-
Stage 1	550	-	-	-	-	-	-	-
Stage 2	394	-	-	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	32.9	2.3	0.2
HCM LOS	D		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	806	-	129	686	-	-
HCM Lane V/C Ratio	0.303	-	0.646	0.234	-	-
HCM Control Delay (s)	11.4	-	73.5	11.8	-	-
HCM Lane LOS	B	-	F	B	-	-
HCM 95th %tile Q(veh)	1.3	-	3.4	0.9	-	-

# HCM Signalized Intersection Capacity Analysis

## 14: Strawberry Plains Pike & Interstate 40 On Ramp/Interstate 40 Off Ramp

4/4/2018



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↖↗		↖	↖	↕			↕↗	
Volume (vph)	0	0	0	180	0	144	360	952	0	0	414	270
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-3%			1%				-1%
Total Lost time (s)				5.0		5.0	5.0	5.0			5.0	
Lane Util. Factor				0.97		1.00	1.00	0.95			0.95	
Frt				1.00		0.85	1.00	1.00			0.94	
Flt Protected				0.95		1.00	0.95	1.00			1.00	
Satd. Flow (prot)				2539		1490	1618	3522			3250	
Flt Permitted				0.95		1.00	0.29	1.00			1.00	
Satd. Flow (perm)				2539		1490	499	3522			3250	
Peak-hour factor, PHF	0.92	0.92	0.92	0.75	0.50	0.82	0.75	0.96	0.92	0.92	0.83	0.86
Adj. Flow (vph)	0	0	0	240	0	176	480	992	0	0	499	314
RTOR Reduction (vph)	0	0	0	0	0	144	0	0	0	0	126	0
Lane Group Flow (vph)	0	0	0	240	0	32	480	992	0	0	687	0
Heavy Vehicles (%)	0%	0%	0%	40%	50%	10%	11%	2%	0%	0%	4%	7%
Turn Type				Prot		Prot	pm+pt	NA			NA	
Protected Phases				4		4	1	1 2			2	
Permitted Phases							1 2					
Actuated Green, G (s)				11.4		11.4	49.0	54.0			40.0	
Effective Green, g (s)				11.4		11.4	49.0	54.0			40.0	
Actuated g/C Ratio				0.15		0.15	0.65	0.72			0.53	
Clearance Time (s)				5.0		5.0	5.0				5.0	
Vehicle Extension (s)				3.0		3.0	3.0				3.0	
Lane Grp Cap (vph)				383		225	457	2522			1724	
v/s Ratio Prot				c0.09		0.02	c0.13	0.28			0.21	
v/s Ratio Perm							c0.56					
v/c Ratio				0.63		0.14	1.05	0.39			0.40	
Uniform Delay, d1				30.0		27.8	9.1	4.2			10.5	
Progression Factor				1.00		1.00	1.00	1.00			0.99	
Incremental Delay, d2				3.2		0.3	55.9	0.5			0.7	
Delay (s)				33.2		28.0	65.0	4.7			11.1	
Level of Service				C		C	E	A			B	
Approach Delay (s)		0.0			31.0			24.4			11.1	
Approach LOS		A			C			C			B	

### Intersection Summary

HCM 2000 Control Delay	21.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	75.4	Sum of lost time (s)	15.0
Intersection Capacity Utilization	56.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

**OPENING YEAR TRAFFIC CONDITIONS (WITH PROJECT)**

# HCM Signalized Intersection Capacity Analysis

## 5: Brakebill Road/Neals Landing Road & Asheville Highway

5/30/2018



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	1042	119	188	807	2	106	9	247	3	4	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-1%			-7%				1%
Total Lost time (s)	5.0	7.0		5.0	7.0	7.0	6.5	6.5			6.5	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	1.00			1.00	
Frt	1.00	0.98		1.00	1.00	0.85	1.00	0.85			0.94	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00			0.99	
Satd. Flow (prot)	1823	3401		1796	3359	812	1814	1680			1617	
Flt Permitted	0.27	1.00		0.09	1.00	1.00	0.95	1.00			0.99	
Satd. Flow (perm)	523	3401		165	3359	812	1814	1680			1617	
Peak-hour factor, PHF	0.67	0.94	0.68	0.73	0.78	0.25	0.67	0.88	0.77	0.50	0.75	1.00
Adj. Flow (vph)	15	1109	175	258	1035	8	158	10	321	6	5	10
RTOR Reduction (vph)	0	9	0	0	0	3	0	278	0	0	10	0
Lane Group Flow (vph)	15	1275	0	258	1035	5	158	53	0	0	11	0
Heavy Vehicles (%)	0%	5%	5%	1%	8%	100%	3%	0%	0%	0%	33%	0%
Turn Type	pm+pt	NA		pm+pt	NA	Prot	Split	NA		Split	NA	
Protected Phases	5	2		1	6	6	8	8		4	4	
Permitted Phases	2			6								
Actuated Green, G (s)	49.2	47.0		65.4	58.2	58.2	13.7	13.7			2.7	
Effective Green, g (s)	49.2	47.0		65.4	58.2	58.2	13.7	13.7			2.7	
Actuated g/C Ratio	0.48	0.46		0.64	0.57	0.57	0.13	0.13			0.03	
Clearance Time (s)	5.0	7.0		5.0	7.0	7.0	6.5	6.5			6.5	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)	280	1570		320	1920	464	244	226			42	
v/s Ratio Prot	0.00	0.37		c0.11	0.31	0.01	c0.09	0.03			c0.01	
v/s Ratio Perm	0.02			c0.41								
v/c Ratio	0.05	0.81		0.81	0.54	0.01	0.65	0.24			0.27	
Uniform Delay, d1	13.7	23.6		25.5	13.5	9.4	41.8	39.4			48.6	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00			1.00	
Incremental Delay, d2	0.1	3.3		13.7	0.3	0.0	5.8	0.5			3.4	
Delay (s)	13.8	26.9		39.3	13.8	9.4	47.6	39.9			52.0	
Level of Service	B	C		D	B	A	D	D			D	
Approach Delay (s)		26.8			18.8			42.4			52.0	
Approach LOS		C			B			D			D	

Intersection Summary			
HCM 2000 Control Delay	26.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	101.8	Sum of lost time (s)	25.0
Intersection Capacity Utilization	74.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

**Intersection**

Int Delay, s/veh 2.4

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	48	32	59	287	230	39
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	53	36	66	319	256	43

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	727	277	299 0
Stage 1	277	-	- -
Stage 2	450	-	- -
Critical Hdwy	6.4	6.2	4.1 -
Critical Hdwy Stg 1	5.4	-	- -
Critical Hdwy Stg 2	5.4	-	- -
Follow-up Hdwy	3.5	3.3	2.2 -
Pot Cap-1 Maneuver	394	767	1274 -
Stage 1	774	-	- -
Stage 2	647	-	- -
Platoon blocked, %			- -
Mov Cap-1 Maneuver	369	767	1274 -
Mov Cap-2 Maneuver	369	-	- -
Stage 1	774	-	- -
Stage 2	606	-	- -

Approach	EB	NB	SB
HCM Control Delay, s	14.5	1.4	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1274	-	466	-	-
HCM Lane V/C Ratio	0.051	-	0.191	-	-
HCM Control Delay (s)	8	0	14.5	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0.2	-	0.7	-	-



# HCM Signalized Intersection Capacity Analysis

## 14: Strawberry Plains Pike & Interstate 40 On Ramp/Interstate 40 Off Ramp

5/30/2018



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↔↔		↗	↖	↕			↕↕	
Volume (vph)	0	0	0	189	0	139	211	412	0	0	511	614
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-3%			1%				-1%
Total Lost time (s)				5.0		5.0	5.0	5.0			5.0	
Lane Util. Factor				0.97		1.00	1.00	0.95			0.95	
Frt				1.00		0.85	1.00	1.00			0.91	
Flt Protected				0.95		1.00	0.95	1.00			1.00	
Satd. Flow (prot)				2937		1591	1437	3326			3130	
Flt Permitted				0.95		1.00	0.11	1.00			1.00	
Satd. Flow (perm)				2937		1591	171	3326			3130	
Peak-hour factor, PHF	0.92	0.92	0.92	0.79	0.25	0.83	0.95	0.89	0.92	0.92	0.93	0.77
Adj. Flow (vph)	0	0	0	239	0	167	222	463	0	0	549	797
RTOR Reduction (vph)	0	0	0	0	0	143	0	0	0	0	331	0
Lane Group Flow (vph)	0	0	0	239	0	24	222	463	0	0	1015	0
Heavy Vehicles (%)	0%	0%	0%	21%	100%	3%	25%	8%	0%	0%	8%	4%
Turn Type				Prot		Prot	pm+pt	NA			NA	
Protected Phases				4		4	1	1 2			2	
Permitted Phases							1 2					
Actuated Green, G (s)				10.9		10.9	49.0	54.0			40.0	
Effective Green, g (s)				10.9		10.9	49.0	54.0			40.0	
Actuated g/C Ratio				0.15		0.15	0.65	0.72			0.53	
Clearance Time (s)				5.0		5.0	5.0				5.0	
Vehicle Extension (s)				3.0		3.0	3.0				3.0	
Lane Grp Cap (vph)				427		231	263	2397			1671	
v/s Ratio Prot				c0.08		0.02	c0.10	0.14			0.32	
v/s Ratio Perm							c0.45					
v/c Ratio				0.56		0.11	0.84	0.19			0.61	
Uniform Delay, d1				29.8		27.8	15.2	3.4			12.0	
Progression Factor				1.00		1.00	1.00	1.00			1.00	
Incremental Delay, d2				1.6		0.2	26.8	0.2			1.7	
Delay (s)				31.4		28.0	42.0	3.6			13.7	
Level of Service				C		C	D	A			B	
Approach Delay (s)		0.0			30.0			16.0			13.7	
Approach LOS		A			C			B			B	

### Intersection Summary

HCM 2000 Control Delay	17.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	74.9	Sum of lost time (s)	15.0
Intersection Capacity Utilization	62.6%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

**Intersection**

Int Delay, s/veh 4.7

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	30	0	17	20	0	50
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, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	6	0	0	0	0	0
Mvmt Flow	33	0	19	22	0	56

Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	33
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	-	4.1
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	-	2.2
Pot Cap-1 Maneuver	-	-	1592
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	-	1592
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	0	3.3	8.6
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	1046	-	-	1592	-
HCM Lane V/C Ratio	0.053	-	-	0.012	-
HCM Control Delay (s)	8.6	-	-	7.3	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0.2	-	-	0	-

HCM 2010 TWSC  
 10: Strawberry Plains Pike & Brakebill Road

5/30/2018

**Intersection**

Int Delay, s/veh 35.4

Movement	EBL	EBR	NBL	NBT	SBU	SBT	SBR
Vol, veh/h	82	297	88	461	56	833	55
Conflicting Peds, #/hr	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	-	None
Storage Length	120	0	150	-	-	-	-
Veh in Median Storage, #	0	-	-	0	-	0	-
Grade, %	-3	-	-	1	-	-2	-
Peak Hour Factor	56	93	66	91	92	79	69
Heavy Vehicles, %	0	6	9	7	0	7	3
Mvmt Flow	146	319	133	507	61	1054	80

**Major/Minor**

	Minor2		Major1		Major2		
Conflicting Flow All	1736	567	1134	0	370	-	0
Stage 1	1216	-	-	-	-	-	-
Stage 2	520	-	-	-	-	-	-
Critical Hdwy	6.2	6.72	4.28	-	6.4	-	-
Critical Hdwy Stg 1	5.2	-	-	-	-	-	-
Critical Hdwy Stg 2	5.2	-	-	-	-	-	-
Follow-up Hdwy	3.5	3.36	2.29	-	2.5	-	-
Pot Cap-1 Maneuver	~ 107	479	573	-	846	-	-
Stage 1	303	-	-	-	-	-	-
Stage 2	618	-	-	-	-	-	-
Platoon blocked, %				-		-	-
Mov Cap-1 Maneuver	~ 82	479	573	-	846	-	-
Mov Cap-2 Maneuver	~ 82	-	-	-	-	-	-
Stage 1	303	-	-	-	-	-	-
Stage 2	475	-	-	-	-	-	-

**Approach**

	EB	NB	SB
HCM Control Delay, s	170.1	2.7	0.5
HCM LOS	F		

**Minor Lane/Major Mvmt**

	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	573	-	82	479	-	-
HCM Lane V/C Ratio	0.233	-	1.786	0.667	-	-
HCM Control Delay (s)	13.2	-	\$ 483.6	26.3	-	-
HCM Lane LOS	B	-	F	D	-	-
HCM 95th %tile Q(veh)	0.9	-	12.5	4.8	-	-

**Notes**

~: Volume exceeds capacity    \$: Delay exceeds 300s    +: Computation Not Defined    \*: All major volume in platoon

**Intersection**

Int Delay, s/veh 3

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	48	73	15	100	249	22
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	75	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	53	81	17	111	277	24

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	433	289	301 0
Stage 1	289	-	- -
Stage 2	144	-	- -
Critical Hdwy	6.4	6.2	4.1 -
Critical Hdwy Stg 1	5.4	-	- -
Critical Hdwy Stg 2	5.4	-	- -
Follow-up Hdwy	3.5	3.3	2.2 -
Pot Cap-1 Maneuver	584	755	1272 -
Stage 1	765	-	- -
Stage 2	888	-	- -
Platoon blocked, %			- -
Mov Cap-1 Maneuver	576	755	1272 -
Mov Cap-2 Maneuver	576	-	- -
Stage 1	765	-	- -
Stage 2	876	-	- -

Approach	EB	NB	SB
HCM Control Delay, s	11.7	1	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1272	-	672	-	-
HCM Lane V/C Ratio	0.013	-	0.2	-	-
HCM Control Delay (s)	7.9	-	11.7	-	-
HCM Lane LOS	A	-	B	-	-
HCM 95th %tile Q(veh)	0	-	0.7	-	-

**Intersection**

Int Delay, s/veh 0.2

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	2	3	2	146	268	3
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	25	25	0	0	0	0
Mvmt Flow	2	3	2	162	298	3

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	466	299	301 0
Stage 1	299	-	- -
Stage 2	167	-	- -
Critical Hdwy	6.65	6.45	4.1 -
Critical Hdwy Stg 1	5.65	-	- -
Critical Hdwy Stg 2	5.65	-	- -
Follow-up Hdwy	3.725	3.525	2.2 -
Pot Cap-1 Maneuver	515	689	1272 -
Stage 1	703	-	- -
Stage 2	810	-	- -
Platoon blocked, %			- -
Mov Cap-1 Maneuver	514	689	1272 -
Mov Cap-2 Maneuver	514	-	- -
Stage 1	703	-	- -
Stage 2	808	-	- -

Approach	EB	NB	SB
HCM Control Delay, s	11	0.1	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1272	-	606	-	-
HCM Lane V/C Ratio	0.002	-	0.009	-	-
HCM Control Delay (s)	7.8	0	11	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0	-	0	-	-

**Intersection**

Int Delay, s/veh 3.2

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	40	42	15	162	186	21
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	3	-	-	3	-2	-
Peak Hour Factor	50	75	58	72	85	56
Heavy Vehicles, %	6	0	0	0	0	0
Mvmt Flow	80	56	26	225	219	38

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	515	238	256 0
Stage 1	238	-	- -
Stage 2	277	-	- -
Critical Hdwy	7.06	6.5	4.1 -
Critical Hdwy Stg 1	6.06	-	- -
Critical Hdwy Stg 2	6.06	-	- -
Follow-up Hdwy	3.554	3.3	2.2 -
Pot Cap-1 Maneuver	471	790	1321 -
Stage 1	761	-	- -
Stage 2	726	-	- -
Platoon blocked, %			- -
Mov Cap-1 Maneuver	461	790	1321 -
Mov Cap-2 Maneuver	461	-	- -
Stage 1	761	-	- -
Stage 2	710	-	- -

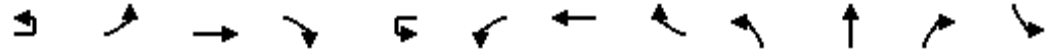
Approach	EB	NB	SB
HCM Control Delay, s	13.6	0.8	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1321	-	556	-	-
HCM Lane V/C Ratio	0.02	-	0.245	-	-
HCM Control Delay (s)	7.8	0	13.6	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0.1	-	1	-	-

# HCM Signalized Intersection Capacity Analysis

## 5: Brakebill Road/Neals Landing Road & Asheville Highway

5/30/2018



Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations		↔	↕			↔	↕	↗	↖	↕		
Volume (vph)	2	3	592	58	2	144	1313	4	131	2	109	12
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)			-2%				-1%			-7%		
Total Lost time (s)		5.0	7.0			5.0	7.0	7.0	6.5	6.5		
Lane Util. Factor		1.00	0.95			1.00	0.95	1.00	1.00	1.00		
Frt		1.00	0.98			1.00	1.00	0.85	1.00	0.86		
Flt Protected		0.95	1.00			0.95	1.00	1.00	0.95	1.00		
Satd. Flow (prot)		1823	3338			1814	3455	1220	1814	1654		
Flt Permitted		0.11	1.00			0.28	1.00	1.00	0.95	1.00		
Satd. Flow (perm)		218	3338			531	3455	1220	1814	1654		
Peak-hour factor, PHF	0.25	0.50	0.96	0.77	0.25	0.81	0.90	0.38	0.78	0.25	0.68	0.50
Adj. Flow (vph)	8	6	617	75	8	178	1459	11	168	8	160	24
RTOR Reduction (vph)	0	0	7	0	0	0	0	5	0	136	0	0
Lane Group Flow (vph)	0	14	685	0	0	186	1459	6	168	32	0	0
Heavy Vehicles (%)	0%	0%	8%	3%	0%	0%	5%	33%	3%	0%	2%	0%
Turn Type	Prot	pm+pt	NA		Prot	pm+pt	NA	Prot	Split	NA		Split
Protected Phases	5	5	2		1	1	6	6	8	8		4
Permitted Phases		2				6						
Actuated Green, G (s)		36.2	35.2			50.4	44.4	44.4	13.2	13.2		
Effective Green, g (s)		36.2	35.2			50.4	44.4	44.4	13.2	13.2		
Actuated g/C Ratio		0.41	0.40			0.57	0.50	0.50	0.15	0.15		
Clearance Time (s)		5.0	7.0			5.0	7.0	7.0	6.5	6.5		
Vehicle Extension (s)		3.0	3.0			3.0	3.0	3.0	3.0	3.0		
Lane Grp Cap (vph)		107	1332			451	1739	614	271	247		
v/s Ratio Prot		0.00	0.21			c0.05	c0.42	0.00	c0.09	0.02		
v/s Ratio Perm		0.05				0.19						
v/c Ratio		0.13	0.51			0.41	0.84	0.01	0.62	0.13		
Uniform Delay, d1		17.0	20.0			10.0	18.8	10.9	35.1	32.5		
Progression Factor		1.00	1.00			1.00	1.00	1.00	1.00	1.00		
Incremental Delay, d2		0.6	0.3			0.6	3.7	0.0	4.2	0.2		
Delay (s)		17.6	20.4			10.6	22.6	10.9	39.3	32.8		
Level of Service		B	C			B	C	B	D	C		
Approach Delay (s)			20.3				21.1			36.0		
Approach LOS			C				C			D		

### Intersection Summary

HCM 2000 Control Delay	23.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	88.2	Sum of lost time (s)	25.0
Intersection Capacity Utilization	68.2%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis  
 5: Brakebill Road/Neals Landing Road & Asheville Highway

5/30/2018



Movement	SBT	SBR
Lane Configurations	↕	
Volume (vph)	2	9
Ideal Flow (vphpl)	1900	1900
Grade (%)	1%	
Total Lost time (s)	6.5	
Lane Util. Factor	1.00	
Frt	0.95	
Flt Protected	0.98	
Satd. Flow (prot)	1683	
Flt Permitted	0.98	
Satd. Flow (perm)	1683	
Peak-hour factor, PHF	0.25	0.58
Adj. Flow (vph)	8	16
RTOR Reduction (vph)	15	0
Lane Group Flow (vph)	33	0
Heavy Vehicles (%)	0%	14%
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	4.6	
Effective Green, g (s)	4.6	
Actuated g/C Ratio	0.05	
Clearance Time (s)	6.5	
Vehicle Extension (s)	3.0	
Lane Grp Cap (vph)	87	
v/s Ratio Prot	c0.02	
v/s Ratio Perm		
v/c Ratio	0.38	
Uniform Delay, d1	40.4	
Progression Factor	1.00	
Incremental Delay, d2	2.7	
Delay (s)	43.1	
Level of Service	D	
Approach Delay (s)	43.1	
Approach LOS	D	

Intersection Summary



**Intersection**

Int Delay, s/veh 2.5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	39	59	11	138	212	16
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	43	66	12	153	236	18

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	422	244	253 0
Stage 1	244	-	- -
Stage 2	178	-	- -
Critical Hdwy	6.4	6.2	4.1 -
Critical Hdwy Stg 1	5.4	-	- -
Critical Hdwy Stg 2	5.4	-	- -
Follow-up Hdwy	3.5	3.3	2.2 -
Pot Cap-1 Maneuver	592	800	1324 -
Stage 1	801	-	- -
Stage 2	858	-	- -
Platoon blocked, %			- -
Mov Cap-1 Maneuver	586	800	1324 -
Mov Cap-2 Maneuver	586	-	- -
Stage 1	801	-	- -
Stage 2	849	-	- -

Approach	EB	NB	SB
HCM Control Delay, s	11.1	0.6	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1324	-	698	-	-
HCM Lane V/C Ratio	0.009	-	0.156	-	-
HCM Control Delay (s)	7.7	0	11.1	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0	-	0.6	-	-

# HCM Signalized Intersection Capacity Analysis

## 14: Strawberry Plains Pike & Interstate 40 On Ramp/Interstate 40 Off Ramp

5/30/2018



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↔↔		↗	↖	↑↑			↑↔	
Volume (vph)	0	0	0	180	0	162	360	1069	0	0	446	291
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-3%			1%				-1%
Total Lost time (s)				5.0		5.0	5.0	5.0			5.0	
Lane Util. Factor				0.97		1.00	1.00	0.95			0.95	
Frt				1.00		0.85	1.00	1.00			0.94	
Flt Protected				0.95		1.00	0.95	1.00			1.00	
Satd. Flow (prot)				2539		1490	1618	3522			3250	
Flt Permitted				0.95		1.00	0.27	1.00			1.00	
Satd. Flow (perm)				2539		1490	453	3522			3250	
Peak-hour factor, PHF	0.92	0.92	0.92	0.75	0.50	0.82	0.75	0.96	0.92	0.92	0.83	0.86
Adj. Flow (vph)	0	0	0	240	0	198	480	1114	0	0	537	338
RTOR Reduction (vph)	0	0	0	0	0	114	0	0	0	0	125	0
Lane Group Flow (vph)	0	0	0	240	0	84	480	1114	0	0	750	0
Heavy Vehicles (%)	0%	0%	0%	40%	50%	10%	11%	2%	0%	0%	4%	7%
Turn Type				Prot		Prot	pm+pt	NA			NA	
Protected Phases				4		4	1	1 2			2	
Permitted Phases							1 2					
Actuated Green, G (s)				11.4		11.4	49.0	54.0			40.0	
Effective Green, g (s)				11.4		11.4	49.0	54.0			40.0	
Actuated g/C Ratio				0.15		0.15	0.65	0.72			0.53	
Clearance Time (s)				5.0		5.0	5.0				5.0	
Vehicle Extension (s)				3.0		3.0	3.0				3.0	
Lane Grp Cap (vph)				383		225	433	2522			1724	
v/s Ratio Prot				c0.09		0.06	c0.13	0.32			0.23	
v/s Ratio Perm							c0.59					
v/c Ratio				0.63		0.37	1.11	0.44			0.43	
Uniform Delay, d1				30.0		28.8	8.7	4.4			10.8	
Progression Factor				1.00		1.00	1.00	1.00			0.97	
Incremental Delay, d2				3.2		1.0	76.1	0.6			0.8	
Delay (s)				33.2		29.8	84.8	5.0			11.3	
Level of Service				C		C	F	A			B	
Approach Delay (s)		0.0			31.7			29.0			11.3	
Approach LOS		A			C			C			B	
<b>Intersection Summary</b>												
HCM 2000 Control Delay			24.1									C
HCM 2000 Volume to Capacity ratio			1.02									
Actuated Cycle Length (s)			75.4						15.0			
Intersection Capacity Utilization			58.4%									B
Analysis Period (min)			15									
c Critical Lane Group												

**Intersection**

Int Delay, s/veh 4.5

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	26	0	55	34	0	31
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, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	27	0	0	14	0	0
Mvmt Flow	29	0	61	38	0	34

Major/Minor	Major1	Major2	Minor1
Conflicting Flow All	0	0	29
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	-	-	4.1
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	-	-	2.2
Pot Cap-1 Maneuver	-	-	1597
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	-	-	1597
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	0	4.5	8.5
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	1052	-	-	1597	-
HCM Lane V/C Ratio	0.033	-	-	0.038	-
HCM Control Delay (s)	8.5	-	-	7.3	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0.1	-	-	0.1	-

HCM 2010 TWSC  
 10: Strawberry Plains Pike & Brakebill Road

5/30/2018

**Intersection**

Int Delay, s/veh 24.7

Movement	EBL	EBR	NBU	NBL	NBT	SBU	SBT	SBR
Vol, veh/h	88	196	17	320	875	12	530	95
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	None	-	-	None	-	-	None
Storage Length	120	0	-	150	-	-	-	-
Veh in Median Storage, #	0	-	-	-	0	-	0	-
Grade, %	-3	-	-	-	1	-	-2	-
Peak Hour Factor	78	89	32	82	92	63	94	59
Heavy Vehicles, %	0	2	0	6	4	0	7	2
Mvmt Flow	113	220	53	390	951	19	564	161

Major/Minor	Minor2	Major1				Major2		
Conflicting Flow All	2044	362	945	725	0	694	-	0
Stage 1	682	-	-	-	-	-	-	-
Stage 2	1362	-	-	-	-	-	-	-
Critical Hdwy	6.2	6.64	6.4	4.22	-	6.4	-	-
Critical Hdwy Stg 1	5.2	-	-	-	-	-	-	-
Critical Hdwy Stg 2	5.2	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	3.32	2.5	2.26	-	2.5	-	-
Pot Cap-1 Maneuver	~ 70	654	366	848	-	528	-	-
Stage 1	525	-	-	-	-	-	-	-
Stage 2	259	-	-	-	-	-	-	-
Platoon blocked, %					-		-	-
Mov Cap-1 Maneuver	~ 70	654	664	664	-	528	-	-
Mov Cap-2 Maneuver	~ 70	-	-	-	-	-	-	-
Stage 1	525	-	-	-	-	-	-	-
Stage 2	259	-	-	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	154.9	6.6	0.3
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	664	-	70	654	-	-
HCM Lane V/C Ratio	0.668	-	1.612	0.337	-	-
HCM Control Delay (s)	20.6	-	431.2	13.3	-	-
HCM Lane LOS	C	-	F	B	-	-
HCM 95th %tile Q(veh)	5.1	-	9.7	1.5	-	-

**Notes**

-: Volume exceeds capacity    \$: Delay exceeds 300s    +: Computation Not Defined    \*: All major volume in platoon

**Intersection**

Int Delay, s/veh 2.4

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	44	29	77	303	212	52
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	75	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	49	32	86	337	236	58

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	772	264	293 0
Stage 1	264	-	- -
Stage 2	508	-	- -
Critical Hdwy	6.4	6.2	4.1 -
Critical Hdwy Stg 1	5.4	-	- -
Critical Hdwy Stg 2	5.4	-	- -
Follow-up Hdwy	3.5	3.3	2.2 -
Pot Cap-1 Maneuver	371	780	1280 -
Stage 1	785	-	- -
Stage 2	608	-	- -
Platoon blocked, %			- -
Mov Cap-1 Maneuver	346	780	1280 -
Mov Cap-2 Maneuver	346	-	- -
Stage 1	785	-	- -
Stage 2	567	-	- -

Approach	EB	NB	SB
HCM Control Delay, s	14.9	1.6	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1280	-	444	-	-
HCM Lane V/C Ratio	0.067	-	0.183	-	-
HCM Control Delay (s)	8	-	14.9	-	-
HCM Lane LOS	A	-	B	-	-
HCM 95th %tile Q(veh)	0.2	-	0.7	-	-

**Intersection**

Int Delay, s/veh 0.2

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	4	3	5	342	259	3
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	25	25	0	0	0	0
Mvmt Flow	4	3	6	380	288	3

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	680	289	291 0
Stage 1	289	-	- -
Stage 2	391	-	- -
Critical Hdwy	6.65	6.45	4.1 -
Critical Hdwy Stg 1	5.65	-	- -
Critical Hdwy Stg 2	5.65	-	- -
Follow-up Hdwy	3.725	3.525	2.2 -
Pot Cap-1 Maneuver	383	699	1282 -
Stage 1	710	-	- -
Stage 2	636	-	- -
Platoon blocked, %			- -
Mov Cap-1 Maneuver	381	699	1282 -
Mov Cap-2 Maneuver	381	-	- -
Stage 1	710	-	- -
Stage 2	632	-	- -

Approach	EB	NB	SB
HCM Control Delay, s	12.7	0.1	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1282	-	473	-	-
HCM Lane V/C Ratio	0.004	-	0.016	-	-
HCM Control Delay (s)	7.8	0	12.7	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0	-	0.1	-	-

**Intersection**

Int Delay, s/veh 2.8

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	32	25	47	288	244	42
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	3	-	-	3	-2	-
Peak Hour Factor	55	55	75	91	77	85
Heavy Vehicles, %	9	18	8	2	1	6
Mvmt Flow	58	45	63	316	317	49

Major/Minor	Minor2	Major1	Major2
Conflicting Flow All	784	342	366 0
Stage 1	342	-	- -
Stage 2	442	-	- -
Critical Hdwy	7.09	6.68	4.18 -
Critical Hdwy Stg 1	6.09	-	- -
Critical Hdwy Stg 2	6.09	-	- -
Follow-up Hdwy	3.581	3.462	2.272 -
Pot Cap-1 Maneuver	309	647	1160 -
Stage 1	665	-	- -
Stage 2	588	-	- -
Platoon blocked, %			- -
Mov Cap-1 Maneuver	289	647	1160 -
Mov Cap-2 Maneuver	289	-	- -
Stage 1	665	-	- -
Stage 2	549	-	- -

Approach	EB	NB	SB
HCM Control Delay, s	17.9	1.4	0
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1160	-	382	-	-
HCM Lane V/C Ratio	0.054	-	0.271	-	-
HCM Control Delay (s)	8.3	0	17.9	-	-
HCM Lane LOS	A	A	C	-	-
HCM 95th %tile Q(veh)	0.2	-	1.1	-	-

**OPENING YEAR TRAFFIC CONDITIONS (WITH PROJECT)  
WITH REVISED TRAFFIC SIGNALS**



# HCM Signalized Intersection Capacity Analysis

## 10: Strawberry Plains Pike & Brakebill Road

5/30/2018



Movement	EBL	EBR	NBL	NBT	SBU	SBT	SBR
Lane Configurations							
Volume (vph)	82	297	88	461	56	833	55
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900
Grade (%)	-3%			1%		-2%	
Total Lost time (s)	5.0	5.0	5.0	5.0		5.0	
Lane Util. Factor	1.00	1.00	1.00	0.95		0.95	
Frt	1.00	0.85	1.00	1.00		0.99	
Flt Protected	0.95	1.00	0.95	1.00		1.00	
Satd. Flow (prot)	1832	1546	1648	3357		3385	
Flt Permitted	0.95	1.00	0.20	1.00		0.90	
Satd. Flow (perm)	1832	1546	351	3357		3045	
Peak-hour factor, PHF	0.56	0.93	0.66	0.91	0.92	0.79	0.69
Adj. Flow (vph)	146	319	133	507	61	1054	80
RTOR Reduction (vph)	0	110	0	0	0	6	0
Lane Group Flow (vph)	146	209	133	507	0	1189	0
Heavy Vehicles (%)	0%	6%	9%	7%	0%	7%	3%
Turn Type	Prot	Perm	Perm	NA	Perm	NA	
Protected Phases	4			2		6	
Permitted Phases		4	2		6		
Actuated Green, G (s)	14.1	14.1	55.9	55.9		55.9	
Effective Green, g (s)	14.1	14.1	55.9	55.9		55.9	
Actuated g/C Ratio	0.18	0.18	0.70	0.70		0.70	
Clearance Time (s)	5.0	5.0	5.0	5.0		5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	322	272	245	2345		2127	
v/s Ratio Prot	0.08			0.15			
v/s Ratio Perm		c0.13	0.38			c0.39	
v/c Ratio	0.45	0.77	0.54	0.22		0.56	
Uniform Delay, d1	29.5	31.4	5.8	4.3		6.0	
Progression Factor	1.00	1.00	0.90	0.64		1.00	
Incremental Delay, d2	1.0	12.2	8.2	0.2		1.1	
Delay (s)	30.5	43.6	13.5	3.0		7.0	
Level of Service	C	D	B	A		A	
Approach Delay (s)	39.5			5.1		7.0	
Approach LOS	D			A		A	

### Intersection Summary

HCM 2000 Control Delay	13.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	70.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 14: Strawberry Plains Pike & Interstate 40 On Ramp/Interstate 40 Off Ramp

5/30/2018



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↔↔		↗	↔↔	↕↕			↕↕	
Volume (vph)	0	0	0	189	0	139	211	412	0	0	511	614
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-3%			1%				-1%
Total Lost time (s)				5.0		5.0	5.0	5.0			5.0	
Lane Util. Factor				0.97		1.00	0.97	0.95			0.95	
Frt				1.00		0.85	1.00	1.00			0.91	
Flt Protected				0.95		1.00	0.95	1.00			1.00	
Satd. Flow (prot)				2937		1591	2787	3326			3130	
Flt Permitted				0.95		1.00	0.11	1.00			1.00	
Satd. Flow (perm)				2937		1591	332	3326			3130	
Peak-hour factor, PHF	0.92	0.92	0.92	0.79	0.25	0.83	0.95	0.89	0.92	0.92	0.93	0.77
Adj. Flow (vph)	0	0	0	239	0	167	222	463	0	0	549	797
RTOR Reduction (vph)	0	0	0	0	0	144	0	0	0	0	329	0
Lane Group Flow (vph)	0	0	0	239	0	23	222	463	0	0	1017	0
Heavy Vehicles (%)	0%	0%	0%	21%	100%	3%	25%	8%	0%	0%	8%	4%
Turn Type				Prot		Prot	pm+pt	NA			NA	
Protected Phases				4		4	1	1 2			2	
Permitted Phases							1 2					
Actuated Green, G (s)				11.2		11.2	53.8	58.8			43.0	
Effective Green, g (s)				11.2		11.2	53.8	58.8			43.0	
Actuated g/C Ratio				0.14		0.14	0.67	0.73			0.54	
Clearance Time (s)				5.0		5.0	5.0				5.0	
Vehicle Extension (s)				3.0		3.0	3.0				3.0	
Lane Grp Cap (vph)				411		222	554	2444			1682	
v/s Ratio Prot				c0.08		0.01	c0.05	0.14			c0.33	
v/s Ratio Perm							0.22					
v/c Ratio				0.58		0.11	0.40	0.19			0.60	
Uniform Delay, d1				32.2		30.0	8.3	3.3			12.7	
Progression Factor				1.00		1.00	1.00	1.00			0.47	
Incremental Delay, d2				2.1		0.2	2.2	0.2			1.3	
Delay (s)				34.3		30.2	10.4	3.4			7.3	
Level of Service				C		C	B	A			A	
Approach Delay (s)		0.0			32.6			5.7			7.3	
Approach LOS		A			C			A			A	

### Intersection Summary

HCM 2000 Control Delay	11.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	56.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 10: Strawberry Plains Pike & Brakebill Road

5/30/2018



Movement	EBL	EBR	NBU	NBL	NBT	SBU	SBT	SBR
Lane Configurations								
Volume (vph)	88	196	17	320	875	12	530	95
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)	-3%				1%		-2%	
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	
Lane Util. Factor	1.00	1.00		1.00	0.95		0.95	
Frt	1.00	0.85		1.00	1.00		0.97	
Flt Protected	0.95	1.00		0.95	1.00		1.00	
Satd. Flow (prot)	1832	1607		1706	3454		3332	
Flt Permitted	0.95	1.00		0.37	1.00		0.92	
Satd. Flow (perm)	1832	1607		656	3454		3077	
Peak-hour factor, PHF	0.78	0.89	0.32	0.82	0.92	0.63	0.94	0.59
Adj. Flow (vph)	113	220	53	390	951	19	564	161
RTOR Reduction (vph)	0	192	0	0	0	0	24	0
Lane Group Flow (vph)	113	28	0	443	951	0	720	0
Heavy Vehicles (%)	0%	2%	0%	6%	4%	0%	7%	2%
Turn Type	Prot	Perm	Perm	Perm	NA	Perm	NA	
Protected Phases	4				2		6	
Permitted Phases		4	2	2		6		
Actuated Green, G (s)	10.2	10.2		59.8	59.8		59.8	
Effective Green, g (s)	10.2	10.2		59.8	59.8		59.8	
Actuated g/C Ratio	0.13	0.13		0.75	0.75		0.75	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	
Lane Grp Cap (vph)	233	204		490	2581		2300	
v/s Ratio Prot	c0.06				0.28			
v/s Ratio Perm		0.02		c0.68			0.23	
v/c Ratio	0.48	0.14		0.90	0.37		0.31	
Uniform Delay, d1	32.5	31.0		7.9	3.5		3.3	
Progression Factor	1.00	1.00		0.73	0.37		1.00	
Incremental Delay, d2	1.6	0.3		21.3	0.4		0.4	
Delay (s)	34.0	31.3		27.1	1.7		3.7	
Level of Service	C	C		C	A		A	
Approach Delay (s)	32.2				9.7		3.7	
Approach LOS	C				A		A	

### Intersection Summary

HCM 2000 Control Delay	11.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	66.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 14: Strawberry Plains Pike & Interstate 40 On Ramp/Interstate 40 Off Ramp

5/30/2018



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↔↔		↗	↔↔	↕↕			↕↕	
Volume (vph)	0	0	0	180	0	162	360	1069	0	0	446	291
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			-3%			1%				-1%
Total Lost time (s)				5.0		5.0	5.0	5.0			5.0	
Lane Util. Factor				0.97		1.00	0.97	0.95			0.95	
Frt				1.00		0.85	1.00	1.00			0.94	
Flt Protected				0.95		1.00	0.95	1.00			1.00	
Satd. Flow (prot)				2539		1490	3139	3522			3250	
Flt Permitted				0.95		1.00	0.25	1.00			1.00	
Satd. Flow (perm)				2539		1490	837	3522			3250	
Peak-hour factor, PHF	0.92	0.92	0.92	0.75	0.50	0.82	0.75	0.96	0.92	0.92	0.83	0.86
Adj. Flow (vph)	0	0	0	240	0	198	480	1114	0	0	537	338
RTOR Reduction (vph)	0	0	0	0	0	119	0	0	0	0	124	0
Lane Group Flow (vph)	0	0	0	240	0	79	480	1114	0	0	752	0
Heavy Vehicles (%)	0%	0%	0%	40%	50%	10%	11%	2%	0%	0%	4%	7%
Turn Type				Prot		Prot	pm+pt	NA			NA	
Protected Phases				4		4	1	1 2			2	
Permitted Phases							1 2					
Actuated Green, G (s)				11.7		11.7	53.3	58.3			40.0	
Effective Green, g (s)				11.7		11.7	53.3	58.3			40.0	
Actuated g/C Ratio				0.15		0.15	0.67	0.73			0.50	
Clearance Time (s)				5.0		5.0	5.0				5.0	
Vehicle Extension (s)				3.0		3.0	3.0				3.0	
Lane Grp Cap (vph)				371		217	940	2566			1625	
v/s Ratio Prot				c0.09		0.05	0.08	c0.32			0.23	
v/s Ratio Perm							c0.26					
v/c Ratio				0.65		0.37	0.51	0.43			0.46	
Uniform Delay, d1				32.2		30.8	6.1	4.3			13.0	
Progression Factor				1.00		1.00	1.00	1.00			0.81	
Incremental Delay, d2				3.9		1.0	2.0	0.5			0.9	
Delay (s)				36.1		31.9	8.1	4.8			11.5	
Level of Service				D		C	A	A			B	
Approach Delay (s)		0.0			34.2			5.8			11.5	
Approach LOS		A			C			A			B	

### Intersection Summary

HCM 2000 Control Delay	11.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	48.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

**APPENDIX H**

**ITE AND MPC LOCAL TRIP GENERATION RATES**

# 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)

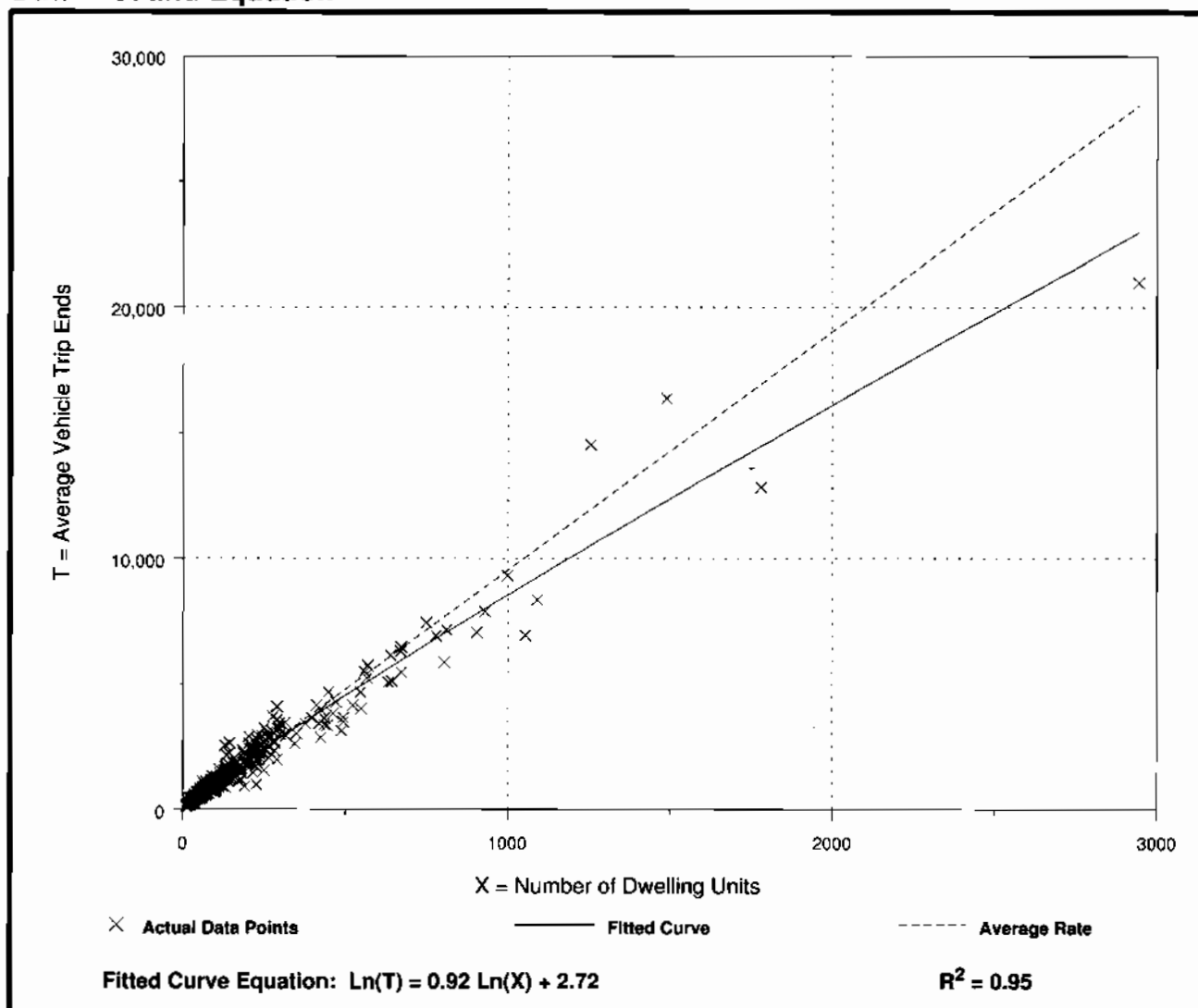
Average Vehicle Trip Ends vs: Dwelling Units  
On a: Weekday

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)

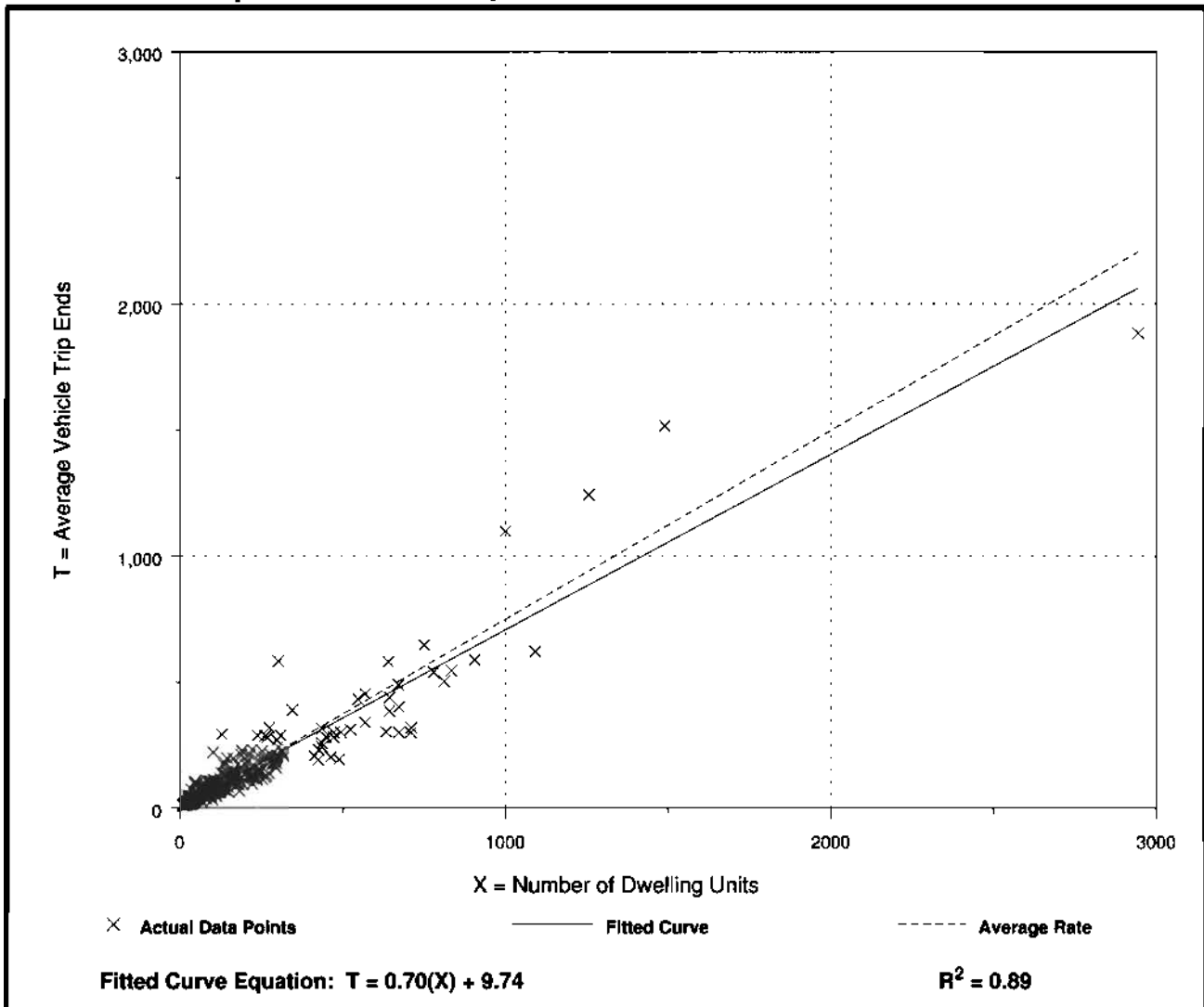
**Average Vehicle Trip Ends vs: Dwelling Units**  
**On a: Weekday,**  
**Peak Hour of Adjacent Street Traffic,**  
**One Hour Between 7 and 9 a.m.**

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)

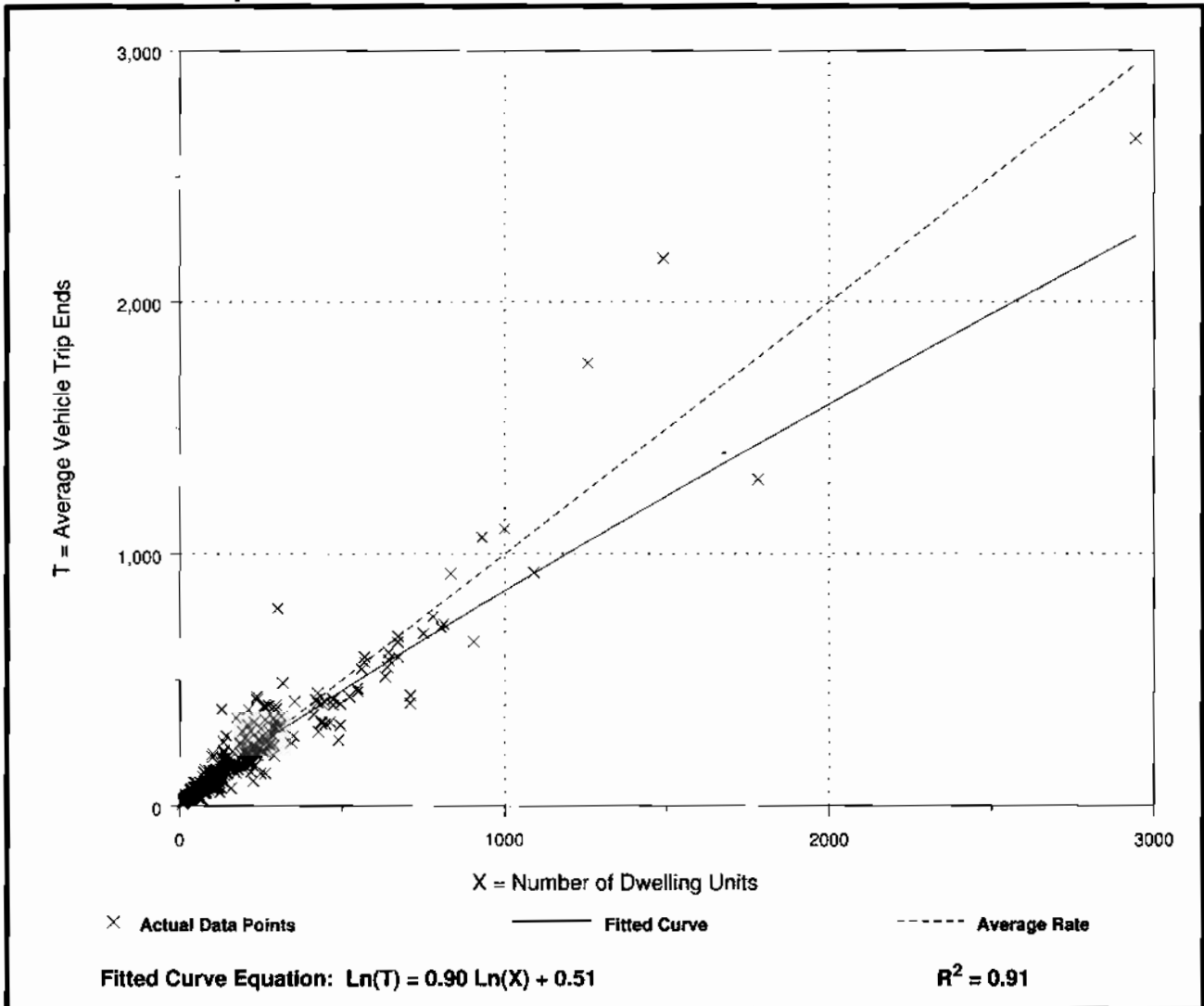
**Average Vehicle Trip Ends vs: Dwelling Units**  
**On a: Weekday,**  
**Peak Hour of Adjacent Street Traffic,**  
**One Hour Between 4 and 6 p.m.**

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



# Land Use: 230

## Residential Condominium/Townhouse

### Description

Residential condominiums/townhouses are defined as ownership units that have at least one other owned unit within the same building structure. **Both condominiums and townhouses are included in this land use.** The studies in this land use did not identify whether the condominiums/townhouses were low-rise or high-rise. Low-rise residential condominium/townhouse (Land Use 231), high-rise residential condominium/townhouse (Land Use 232) and luxury condominium/townhouse (Land Use 233) are related uses.

### Additional Data

The number of vehicles and the number of 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 is usually readily available, easy to project and had a high correlation with average weekday vehicle trip ends.

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

The sites were surveyed between the mid-1970s and the 2000s throughout the United States and Canada.

### Source Numbers

4, 92, 94, 95, 97, 100, 105, 106, 114, 168, 186, 204, 237, 253, 293, 319, 320, 321, 390, 412, 418, 561, 562, 583, 638

# Residential Condominium/Townhouse (230)

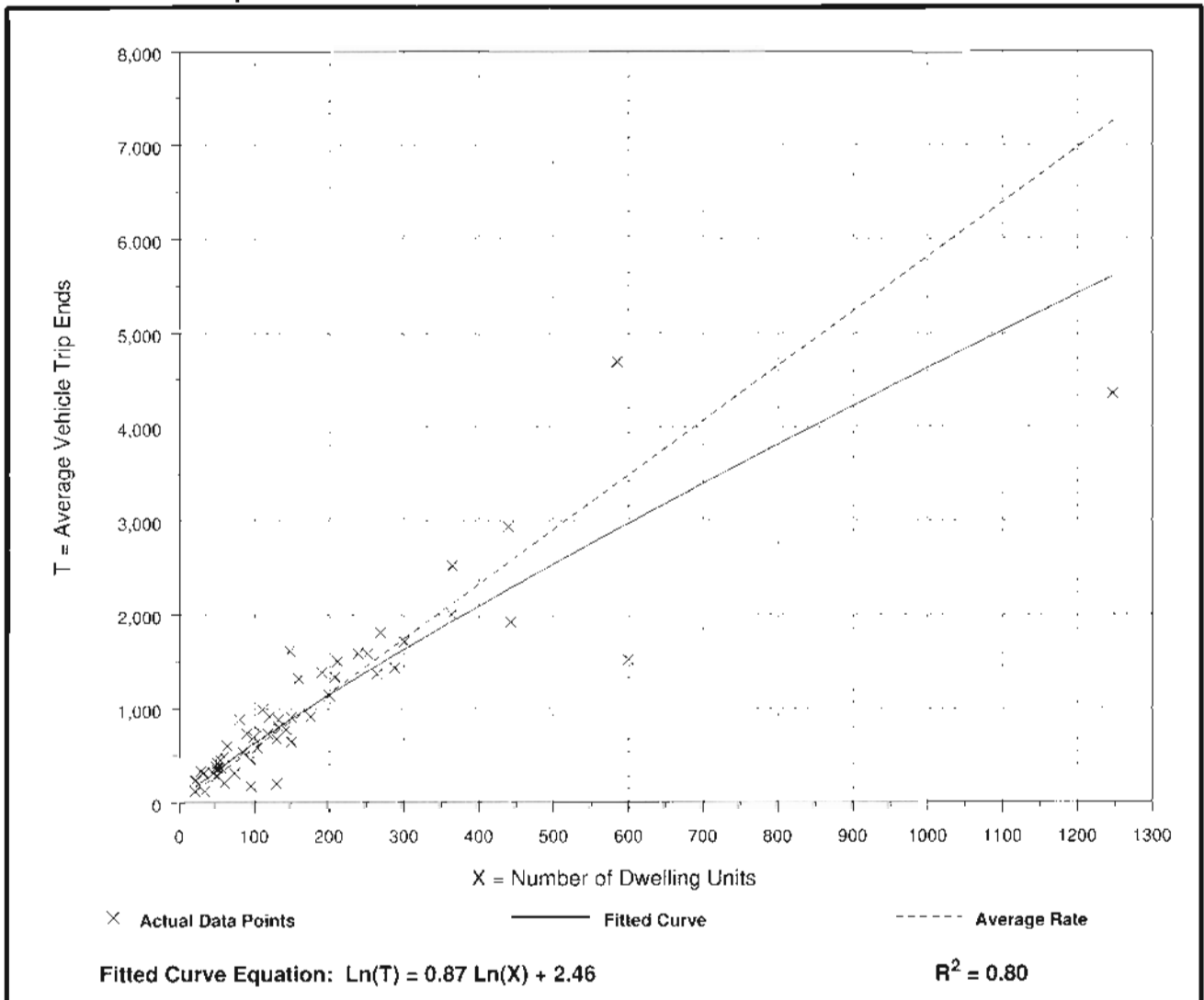
**Average Vehicle Trip Ends vs: Dwelling Units  
On a: Weekday**

Number of Studies: 56  
Avg. Number of Dwelling Units: 179  
Directional Distribution: 50% entering, 50% exiting

## Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
5.81	1.53 - 11.79	3.11

## Data Plot and Equation



# Residential Condominium/Townhouse (230)

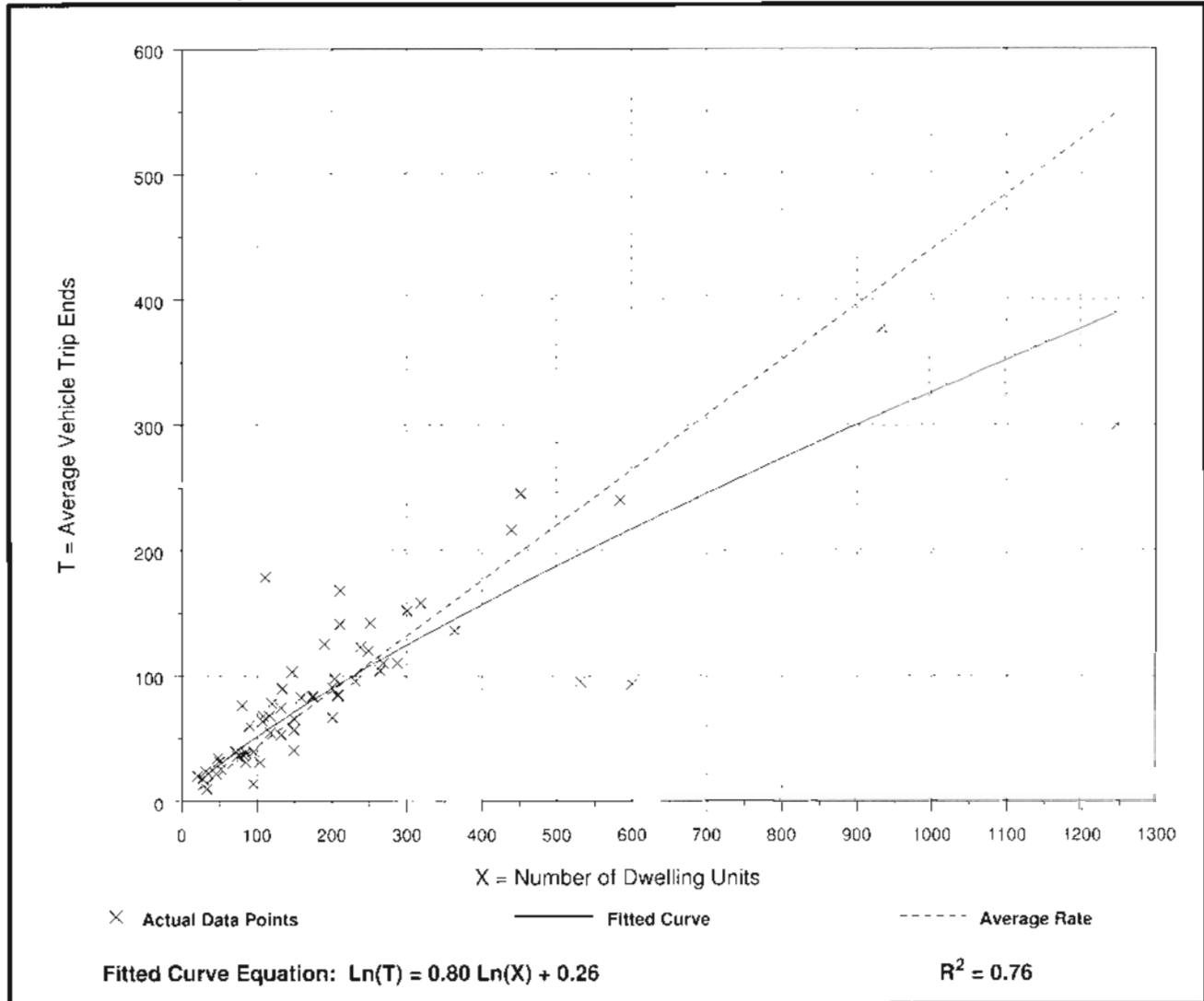
**Average Vehicle Trip Ends vs: Dwelling Units**  
**On a: Weekday,**  
**Peak Hour of Adjacent Street Traffic,**  
**One Hour Between 7 and 9 a.m.**

Number of Studies: 59  
 Avg. Number of Dwelling Units: 213  
 Directional Distribution: 17% entering, 83% exiting

## Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.44	0.15 - 1.61	0.69

## Data Plot and Equation



# Residential Condominium/Townhouse (230)

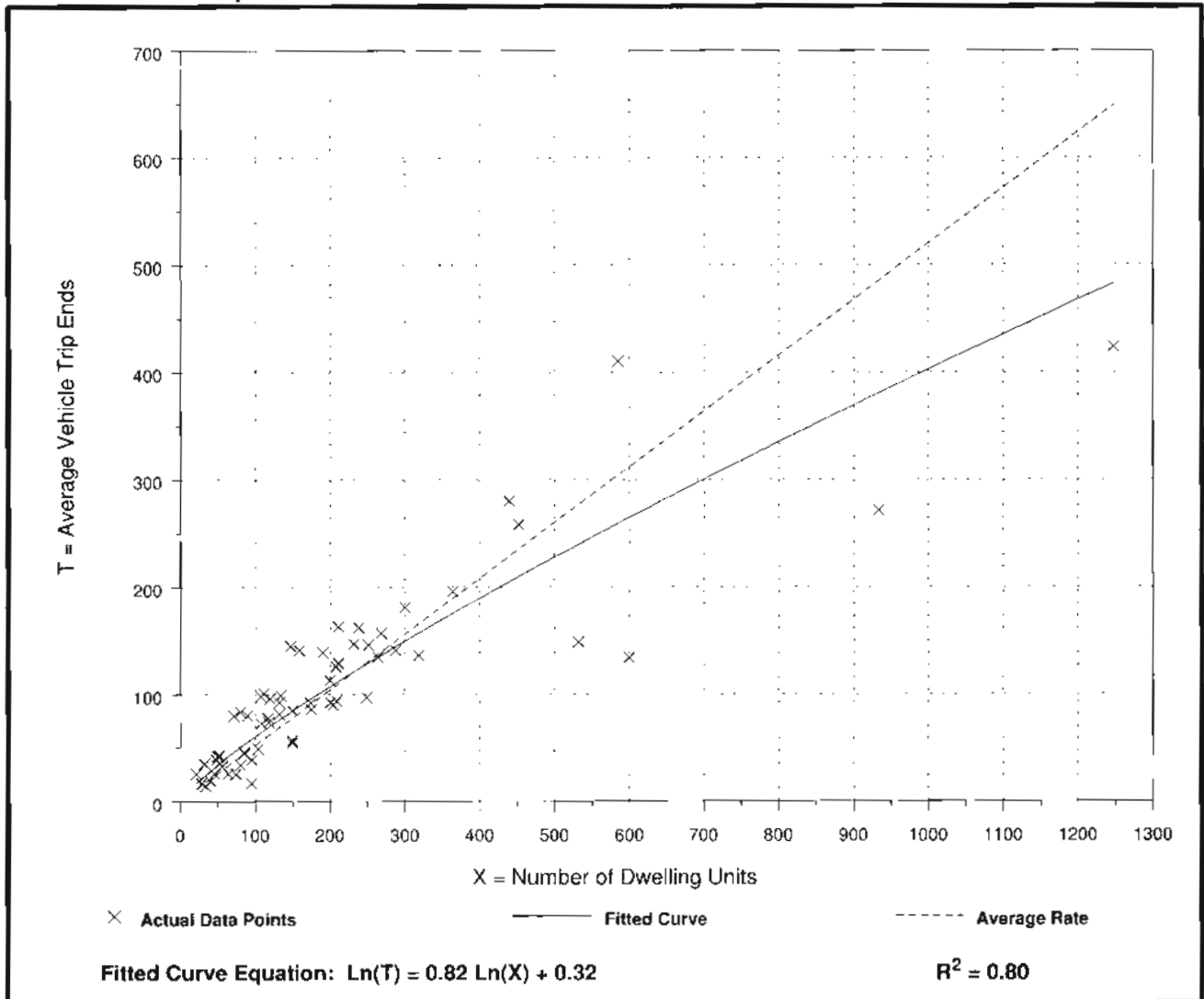
**Average Vehicle Trip Ends vs: Dwelling Units**  
**On a: Weekday,**  
**Peak Hour of Adjacent Street Traffic,**  
**One Hour Between 4 and 6 p.m.**

Number of Studies: 62  
 Avg. Number of Dwelling Units: 205  
 Directional Distribution: 67% entering, 33% exiting

## Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.52	0.18 - 1.24	0.75

## Data Plot and Equation



# Local Apartment Trip Generation Study

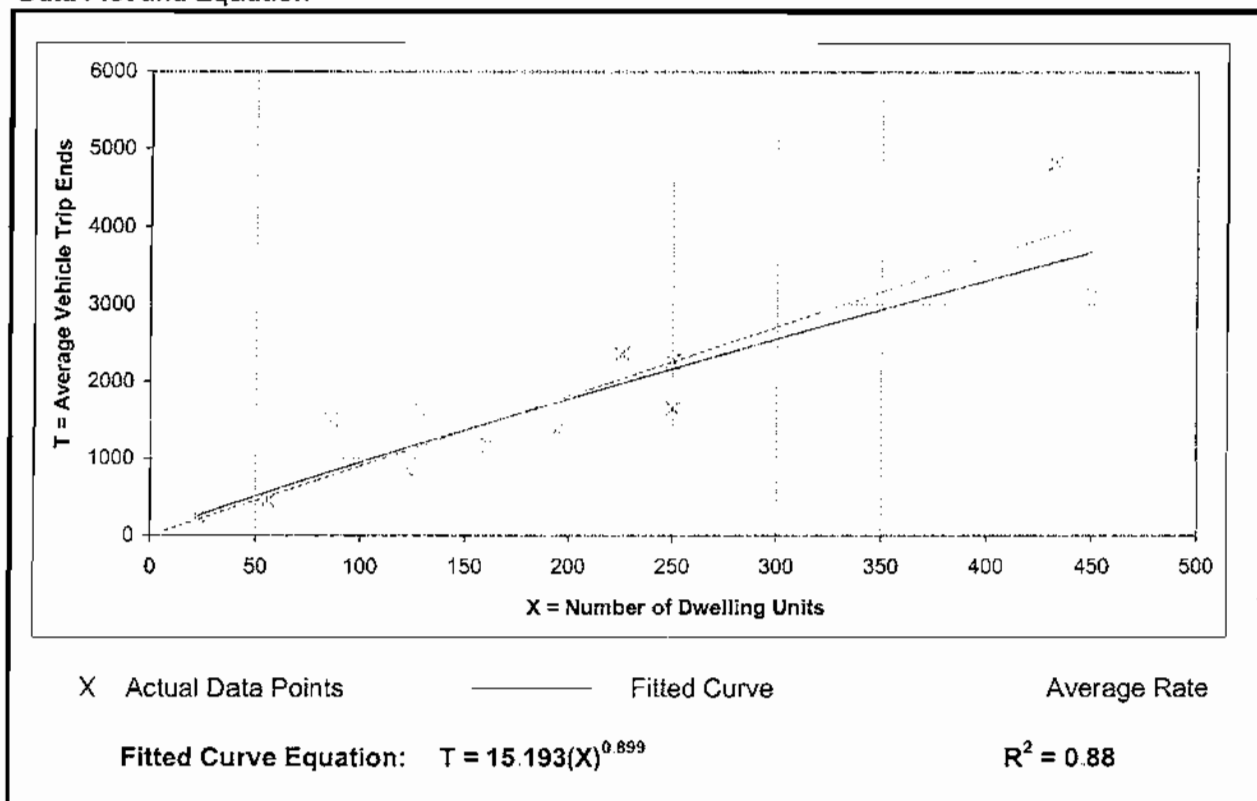
Average Vehicle Trip Ends vs: Dwelling Units  
On a: Weekday

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

## Trip Generation Per Dwelling Unit

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

## Data Plot and Equation



# Local Apartment Trip Generation Study

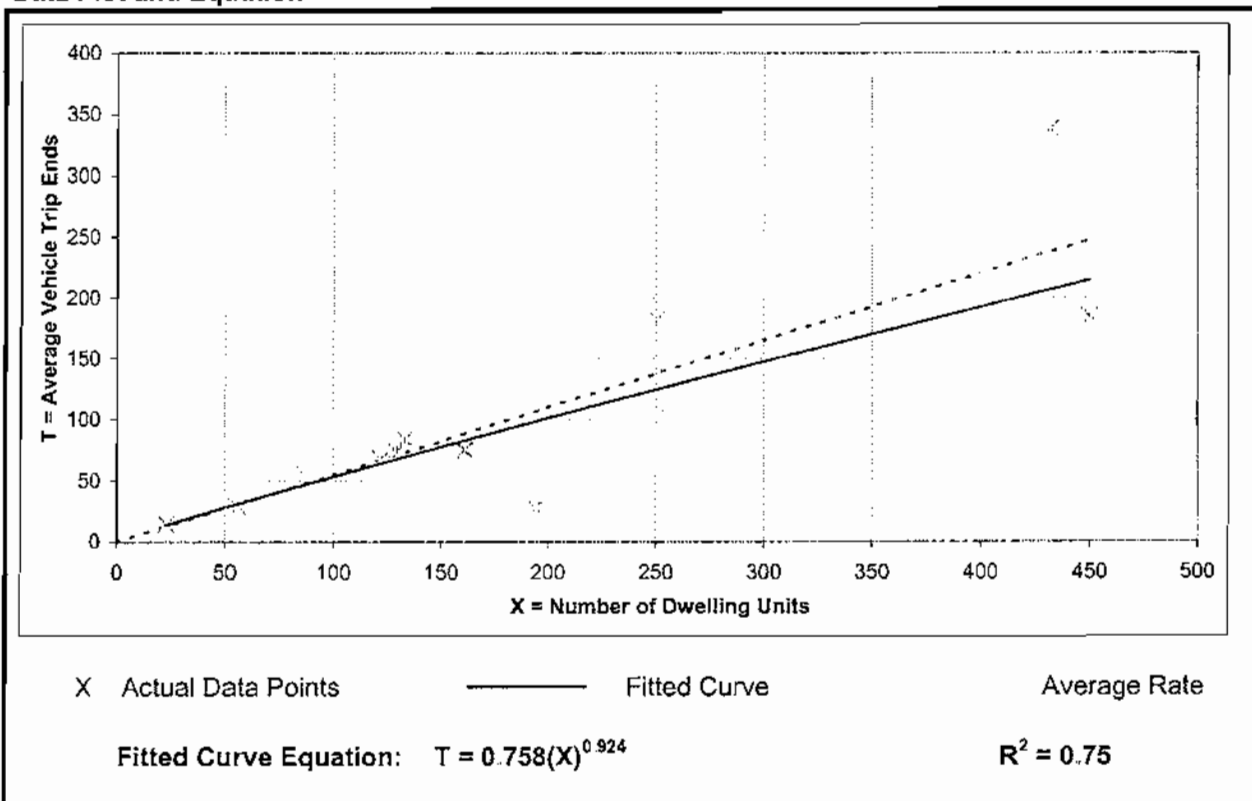
Average Vehicle Trip Ends vs: Dwelling Units  
 On a: Weekday,  
 Peak Hour of Adjacent Street Traffic,  
 One Hour Between 7 and 9 a.m.

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

## Trip Generation Per Dwelling Unit

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

## Data Plot and Equation



# Local Apartment Trip Generation Study

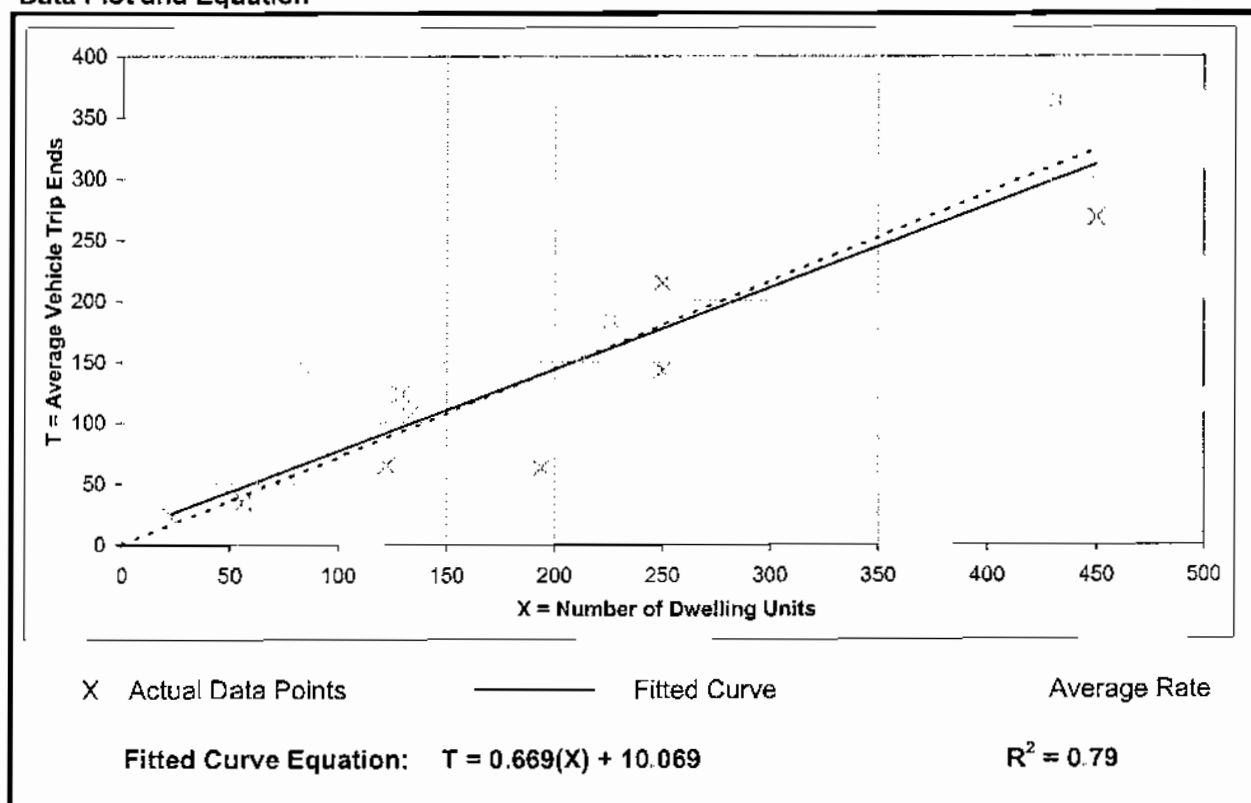
Average Vehicle Trip Ends vs: Dwelling Units  
 On a: Weekday,  
 Peak Hour of Adjacent Street Traffic,  
 One Hour Between 4 and 6 p.m.

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

## Trip Generation Per Dwelling Unit

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

## Data Plot and Equation





# Land Use: 151

## Mini-Warehouse

### Description

Mini-warehouses are buildings in which a number of storage units or vaults are rented for the storage of goods. They are typically referred to as "self-storage" facilities. Each unit is physically separated from other units, and access is usually provided through an overhead door or other common access point.

### Additional Data

Truck trips accounted for 2 to 15 percent of the weekday traffic at the sites where data were available.

Vehicle occupancy ranged from 1.2 to 1.9 persons per automobile on an average weekday.

Peak hours of the generator—

The weekday P.M. peak hour was between 12:00 p.m. and 7:00 p.m. The Saturday peak hour was between 10:00 a.m. and 1:00 p.m. The Sunday peak hour was between 1:00 p.m. and 6:00 p.m.

For the purpose of this land use, the independent variable "occupied storage units" is defined as the number of units that have been rented.

The sites were surveyed between 1979 and 2008 in California, Colorado, Massachusetts, New Jersey and Texas.

### Source Numbers

113, 212, 403, 551, 568, 642, 708, 724

# Mini-Warehouse (151)

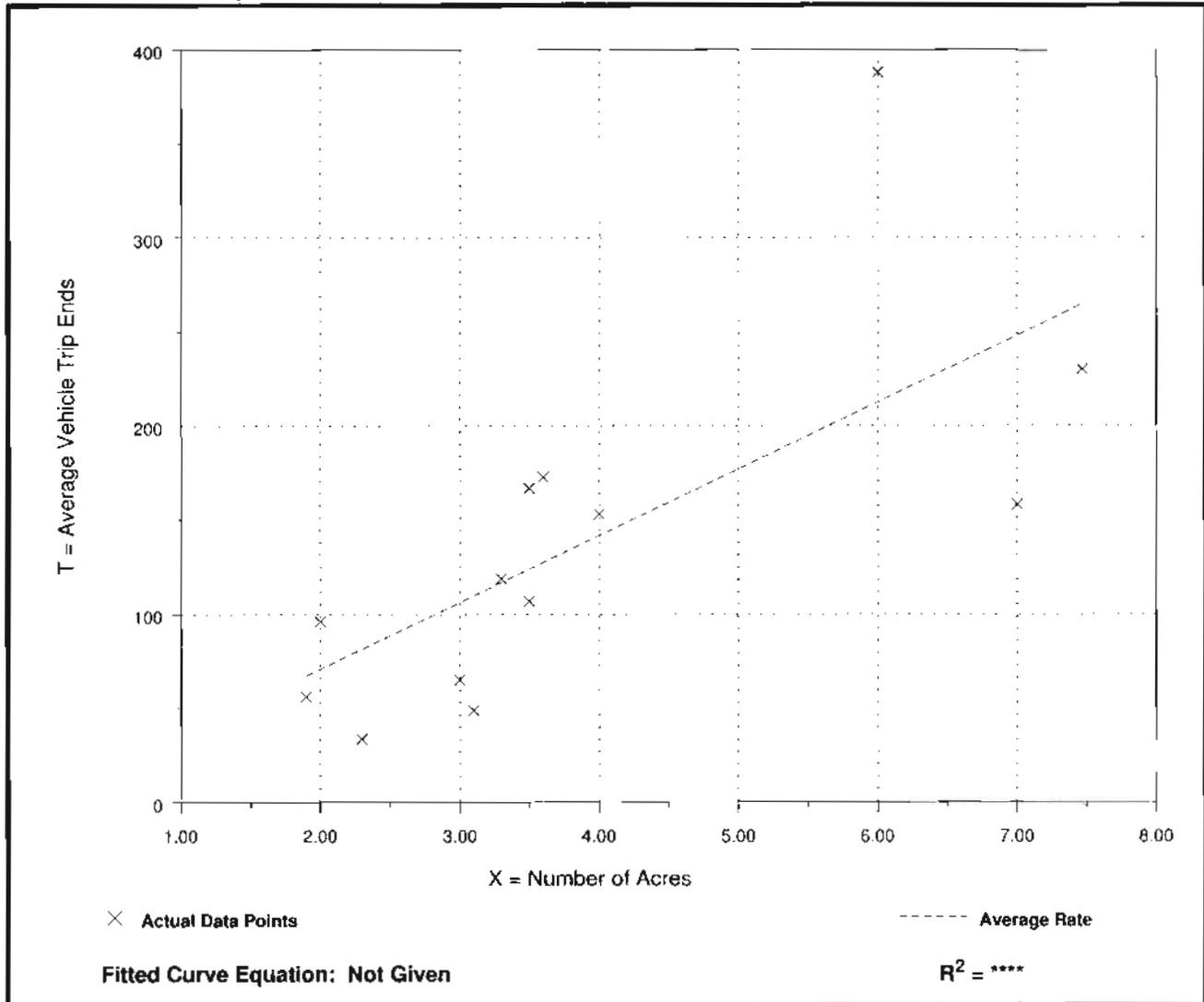
**Average Vehicle Trip Ends vs: Acres**  
**On a: Weekday**

Number of Studies: 13  
Average Number of Acres: 4  
Directional Distribution: 50% entering, 50% exiting

## Trip Generation per Acre

Average Rate	Range of Rates	Standard Deviation
35.43	14.78 - 64.67	15.63

## Data Plot and Equation



# Mini-Warehouse (151)

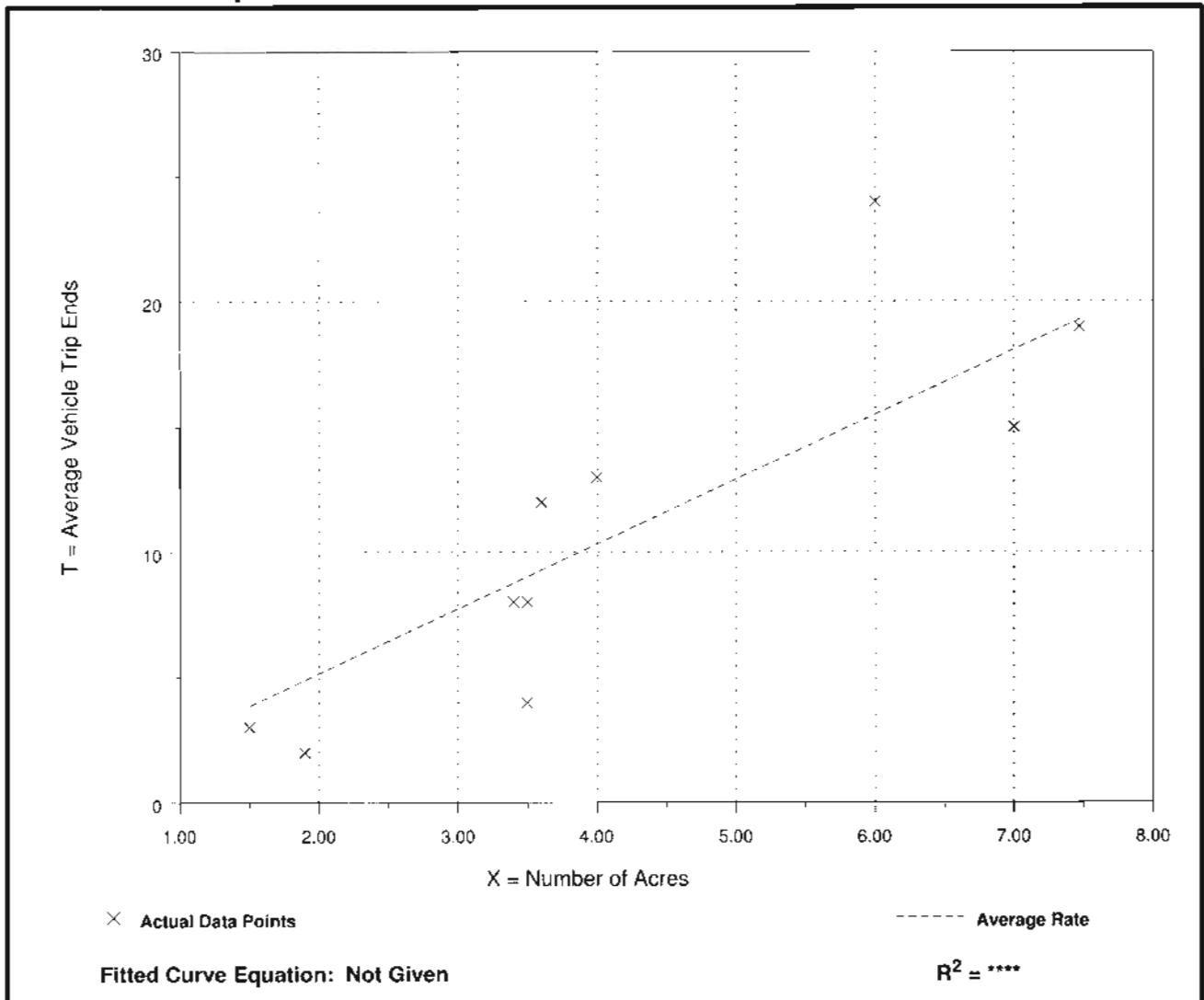
**Average Vehicle Trip Ends vs: Acres**  
**On a: Weekday,**  
**Peak Hour of Adjacent Street Traffic,**  
**One Hour Between 7 and 9 a.m.**

Number of Studies: 10  
 Average Number of Acres: 4  
 Directional Distribution: 45% entering, 55% exiting

### Trip Generation per Acre

Average Rate	Range of Rates	Standard Deviation
2.58	1.05 - 4.00	1.67

### Data Plot and Equation



# Mini-Warehouse (151)

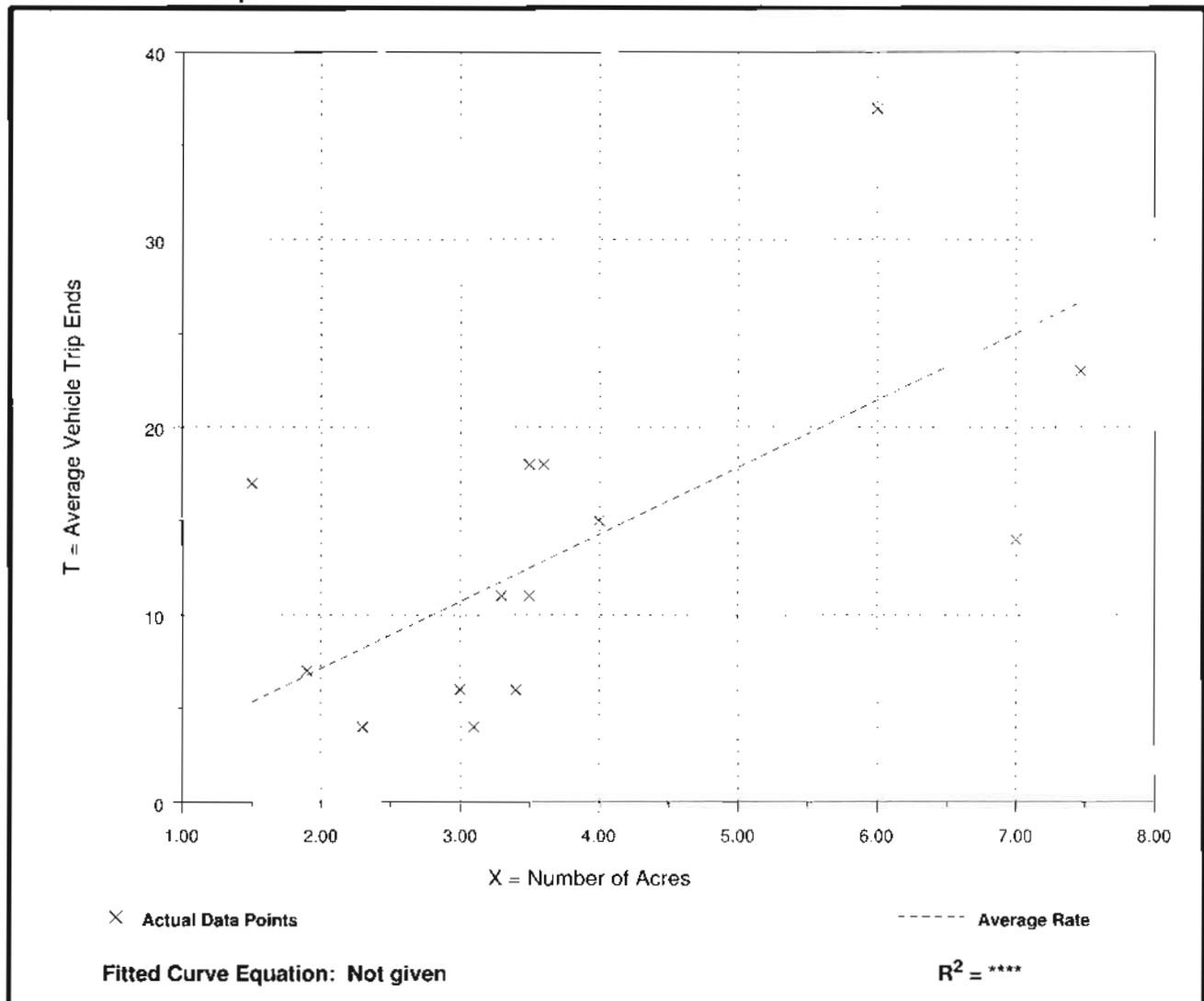
**Average Vehicle Trip Ends vs: Acres**  
**On a: Weekday,**  
**Peak Hour of Adjacent Street Traffic,**  
**One Hour Between 4 and 6 p.m.**

Number of Studies: 14  
 Average Number of Acres: 4  
 Directional Distribution: 50% entering, 50% exiting

## Trip Generation per Acre

Average Rate	Range of Rates	Standard Deviation
3.57	1.29 - 11.33	2.57

## Data Plot and Equation



**TABLE 6A**  
**TRIP GENERATION FOR BRAKEBILL ROAD DEVELOPMENT**  
 Entire Development

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
Total New Volume Site Trips			5,254	85	277	362	290	191	481

**TABLE 6B**  
**TRIP GENERATION FOR BRAKEBILL ROAD DEVELOPMENT**  
 247 Single-Family Detached Homes

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	247 Lots	2,414	25%	75%		63%	37%	
				46	137	183	150	88	238
Total New Volume Site Trips			2,414	46	137	183	150	88	238

**TRIP GENERATION FOR BRAKEBILL ROAD DEVELOPMENT**  
247 single family detached homes

247 Residential Units = X

---

**Weekday:**

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

$$\ln(T) = 0.92 * 5.51 + 2.72$$

$$\ln(T) = 7.79$$

$$\underline{\underline{T = 2,414 \text{ trips}}}$$

---

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

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

$$T = 0.70 * 247 + 9.74$$

$$\underline{\underline{T = 183 \text{ trips}}}$$

---

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

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

$$\ln(T) = 0.90 * 5.51 + 0.51$$

$$\ln(T) = 5.47$$

$$\underline{\underline{T = 238 \text{ trips}}}$$

**TABLE 6C**  
**TRIP GENERATION FOR BRAKEBILL ROAD DEVELOPMENT**  
**78 Single-Family Attached Homes**

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
#230	Residential Condominium / Townhouse	78 Dwellings	519	17%	83%		67%	33%	
				7	36	43	34	16	50
Total New Volume Site Trips			519	7	36	43	34	16	50



## TRIP GENERATION FOR BRAKEBILL ROAD DEVELOPMENT

78 attached homes

$$78 \text{ Dwelling Units} = X$$

---

### Weekday:

Fitted Curve Equation:  $\ln(T) = 0.87 \ln(X) + 2.46$

$$\ln(T) = 0.87 * 4.36 + 2.46$$

$$\ln(T) = 6.25$$

$$\underline{\underline{T = 519 \text{ trips}}}$$

---

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

Fitted Curve Equation:  $\ln(T) = 0.80 \ln(X) + 0.26$

$$\ln(T) = 0.80 * 4.36 + 0.26$$

$$\ln(T) = 3.75$$

$$\underline{\underline{T = 43 \text{ trips}}}$$

---

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

Fitted Curve Equation:  $\ln(T) = 0.82 \ln(X) + 0.32$

$$\ln(T) = 0.82 * 4.36 + 0.32$$

$$\ln(T) = 3.89$$

$$\underline{\underline{T = 50 \text{ trips}}}$$

**TABLE 6D**  
**TRIP GENERATION FOR BRAKEBILL ROAD DEVELOPMENT**  
 Apartments

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
MPC Local Rate	Dwelling Units	250 Units	2,175	22%	78%		55%	45%	
				27	98	125	98	80	178
Total New Volume Site Trips			2,175	27	98	125	98	80	178

**TRIP GENERATION FOR BRAKEBILL ROAD DEVELOPMENT**  
**250 Apartments**

**250 Residential Units = X**

---

**Weekday:**

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

$$T = 15.193 * 143.136$$
$$\underline{\underline{T = 2,175 \text{ trips}}}$$

---

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

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

$$T = 0.758 * 164.322$$
$$\underline{\underline{T = 125 \text{ trips}}}$$

---

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

Fitted Curve Equation:  $T = 0.669(X)+10.069$

$$T = 0.669 * 250 + 10.069$$
$$\underline{\underline{T = 178 \text{ trips}}}$$

**TABLE 6E**  
**TRIP GENERATION FOR BRAKEBILL ROAD DEVELOPMENT**  
**Mini-Warehouse Facility**

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
#151	Mini-Warehouse	4.1 acres	146	45%	55%		50%	50%	
				5	6	11	8	7	15
Total New Volume Site Trips			146	5	6	11	8	7	15

**TRIP GENERATION FOR BRAKEBILL ROAD DEVELOPMENT**  
**4.1 acres of Mini-Warehouse Facility**

$$4.1 \text{ acres} = X$$

---

**Weekday:**

Average Rate:  $T = 35.43(X)$

$$T = 35.43 * 4.10$$

$$\underline{\underline{T = 146 \text{ trips}}}$$

---

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

Average Rate:  $T = 2.58(X)$

$$T = 2.58 * 4.10$$

$$\underline{\underline{T = 11 \text{ trips}}}$$

---

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

Average Rate:  $T = 3.57(X)$

$$T = 3.57 * 4.10$$

$$\underline{\underline{T = 15 \text{ trips}}}$$

**APPENDIX I**

**TRIP DISTRIBUTION SPREADSHEET CALCULATIONS**



Brakebill Road Development - Trip Distribution Calculations - PM Peak

Inputted Value

Calculated Value for Trip Distribution and Trip Assignment Figures

# OF TOTAL TRIPS	TOTAL DEVELOPMENT AM		TOTAL DEVELOPMENT PM	
	ENTER	EXIT	ENTER	EXIT
	85	277	290	191

ENTER % BY DIRECTION		EXIT % BY DIRECTION	
60% NB	40% SB	60%	40% SB

# TOTAL ALL TRIPS	RESIDENTIAL LOTS AM		RESIDENTIAL LOTS PM	
	ENTER	EXIT	ENTER	EXIT
	53	173	184	104
	62%	62%	63%	54%

% SPLIT BY ENTRANCE (BASED ON LOT DISTRIBUTION)					% SPLIT BY ENTRANCE (BASED ON LOT DISTRIBUTION)															
70% at Road "A"					30% at Road "I"					70% at Road "A"					30% at Road "I"					
	NB	SB	WB	EB	TOTAL		NB	SB	WB	EB	TOTAL		NB	SB	WB	EB	TOTAL			
	42%	28%	30%	0%	100%		42%	28%	30%	0%	100%		42%	28%	30%	0%	100%			
	Brakebill Rd/Road A		ENTER			Brakebill Rd/Road A		EXIT			Brakebill Rd/Road A		ENTER							
	NB LEFT		WB LEFT			NB LEFT		WB LEFT			NB LEFT		WB LEFT							
	SB RIGHT		EB RIGHT			SB RIGHT		EB RIGHT			SB RIGHT		EB RIGHT							
	77	52	55	0	184	44	29	0	31	104	77	52	55	0	184	44	29	0	31	104
	27%	18%	19%	0%	63%	23%	15%	0%	16%	54%	27%	18%	19%	0%	63%	23%	15%	0%	16%	54%

# TOTAL ALL TRIPS	APARTMENTS AM		APARTMENTS PM	
	ENTER	EXIT	ENTER	EXIT
	27	98	98	80
	32%	35%	34%	42%

ENTER % BY DIRECTION		EXIT % BY DIRECTION		
60% NB	40% SB	60% NB	40% SB	
% SPLIT BY ENTRANCE (SINGLE ENTRANCES)				
60%	40%	0%	0%	
100%	0%	100%	0%	
	ENTER		EXIT	
	NB LEFT		NB LEFT	
	SB RIGHT		SB RIGHT	
	59	39	0	98
	20%	13%	0%	34%

# TOTAL ALL TRIPS	MINI-WAREHOUSE AM		MINI-WAREHOUSE PM	
	ENTER	EXIT	ENTER	EXIT
	5	6	8	7
	6%	2%	3%	4%

ENTER		EXIT	
Brakebill Rd/Mini NB LEFT		Brakebill Rd/Apt EB LEFT	
SB RIGHT		SB RIGHT	
WB LEFT		WB LEFT	
EB RIGHT		EB RIGHT	
5		3	
2%		2%	
0%		0%	
0%		0%	
8		7	
3%		4%	
100%		100%	

THRU MOVEMENTS AT "INTERIOR" INTERSECTIONS

VOL'S	ENTER			EXIT		
	AT ROAD "A"	AT MINI-WAREHOUSE	AT APARTMENT	AT ROAD "A"	AT MINI-WAREHOUSE	AT APARTMENT
97	92	33	47	44	12	
33%	32%	11%	25%	23%	6%	
VOL'S	ENTER			EXIT		
	AT ROAD "A"	AT MINI-WAREHOUSE	AT APARTMENT	AT ROAD "A"	AT MINI-WAREHOUSE	AT APARTMENT
0	52	55	0	44	48	
0%	18%	19%	32%	23%	25%	

TURNING MOVEMENTS AT "EXTERIOR" INTERSECTIONS

PM	PROJECTED %'s		PROJECTED TRIPS		PROJECTED MOVEMENT %'s	PM	EXISTING TURNING %'s		PROJECTED TRIPS	PROJECTED MOVEMENT %'s
	ENTER	EXIT	ENTER	EXIT			ENTER	EXIT		
TOTAL TRIPS			290	191						
TO/FROM ASHEVILLE HIGHWAY	40%	60%	116	115						
TO/FROM STRAWBERRY PLAINS	60%	40%	174	76						
	100%	100%	290	191						
ASHEVILLE/BRAKEBILL INTERSECTION:	EXISTING TURNING %'s				HAMMER/BRAKEBILL INTERSECTION:		EXISTING TURNING %'s			
ENTER FROM ASHEVILLE HWY WB LT	60.0%		70	24%	ENTER FROM BRAKEBILL NB LT	40.0%		33	11%	
ENTER FROM ASHEVILLE HWY EB RT	40.0%		46	16%	ENTER FROM BRAKEBILL SB RT	60.0%		22	8%	
EXIT TO ASHEVILLE HWY NB LT		30.0%	34	18%	EXIT TO BRAKEBILL EB LT		50.0%	19	10%	
EXIT TO ASHEVILLE HWY NB RT		70.0%	80	42%	EXIT TO BRAKEBILL EB RT		50.0%	12	6%	
	100%	100%	116	115	100%		100%	55	31	
STRAW_PLAINS/BRAKEBILL INTERSECTION:	EXISTING TURNING %'s				STRAW_PLAINS/-40 RAMPS INTERSECTION:		EXISTING TURNING %'s			
ENTER FROM STRAW_PLAINS NB LT	77.5%		135	47%	ENTER FROM I-40 WB RT	13.0%		18	6%	
ENTER FROM STRAW_PLAINS SB RT	22.5%		39	14%	ENTER FROM STRAW_PLAINS NB THRU	87.0%		117	41%	
EXIT TO STRAW_PLAINS EB LT		31.0%	23	12%	EXIT TO I-40 SB RT		39.5%	21	11%	
EXIT TO STRAW_PLAINS EB RT		69.0%	52	28%	EXIT TO STRAW_PLAINS SB THRU		60.5%	32	17%	
	100%	100%	174	76	100%		100%	135	53	
			290	190						



**APPENDIX J**  
**SPOT SPEED STUDY**

## SPOT SPEED STUDY

Location: Brakebill Road at Hammer Road  
 Posted Speed Limit: 30 mph  
 Equipment: Bushnell Speedster III Radar Speed Gun  
 Direction: Northbound and Southbound

Date: 3/20/18  
 Weather: Overcast/Windy  
 Time: 4:00 PM  
 Pavement Conditions: Dry

Vehicle #	Speed (mph)
1	39
2	44
3	43
4	46
5	46
6	45
7	51
8	45
9	39
10	40
11	42
12	42
13	38
14	42
15	34
16	44
17	39
18	42
19	41
20	43
21	39
22	40
23	37
24	41
25	38

Vehicle #	Speed (mph)
26	40
27	44
28	40
29	49
30	37
31	46
32	46
33	40
34	41
35	37
36	42
37	44
38	38
39	45
40	40
41	42
42	41
43	36
44	42
45	42
46	44
47	39
48	42
49	46
50	41

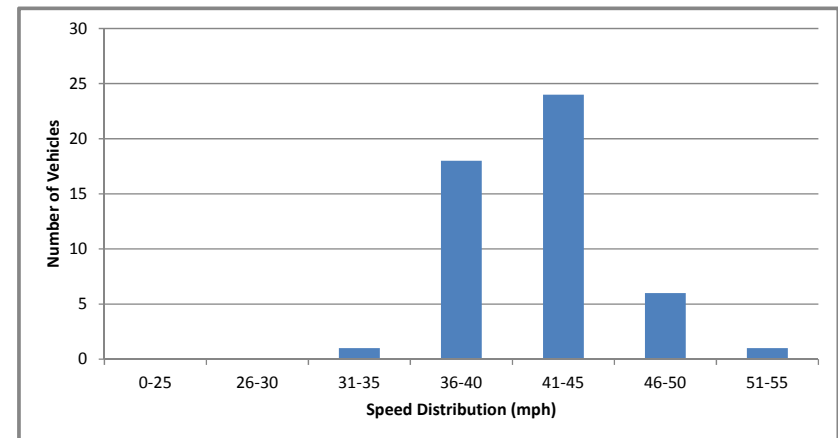
Sample Size Requirements (*ITE Manual of Transportation Engineering Studies*)

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

where: N = minimum number of measured speeds  
 S = estimated sample standard deviation (mph)  
 K = constant corresponding to 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 observations needed



Average speed = 41.7 mph  
 50th percentile speed = 42.0 mph  
 85th percentile speed = 45.0 mph

## SPOT SPEED STUDY

Location: Brakebill Road at Proposed Entrance (adjacent to Hindu temple)  
 Posted Speed Limit: 30 mph  
 Equipment: Bushnell Speedster III Radar Speed Gun  
 Direction: Northbound and Southbound

Date: 3/20/18  
 Weather: Overcast/Windy  
 Time: 4:30 PM  
 Pavement Conditions: Dry

Vehicle #	Speed (mph)
1	43
2	35
3	35
4	38
5	38
6	39
7	31
8	29
9	32
10	33
11	31
12	33
13	31
14	43
15	38
16	36
17	44
18	37
19	36
20	35
21	36
22	34
23	37
24	43
25	36

Vehicle #	Speed (mph)
26	39
27	36
28	40
29	44
30	43
31	40
32	30
33	34
34	34
35	37
36	35
37	35
38	37
39	39
40	32
41	26
42	31
43	37
44	29
45	36
46	35
47	44
48	38
49	39
50	39

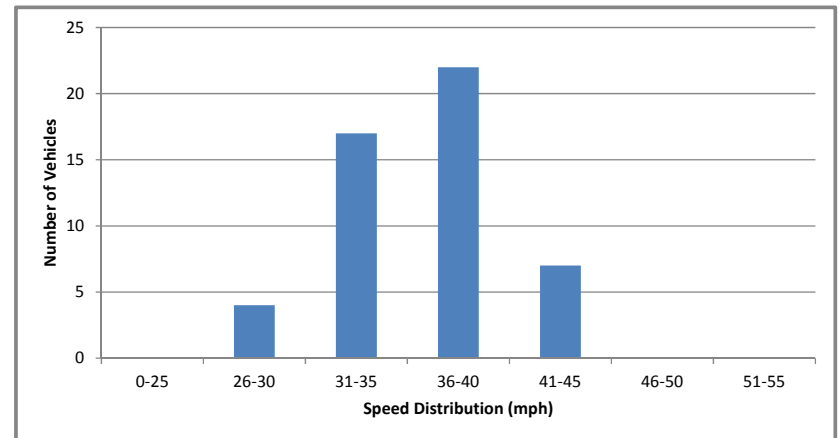
Sample Size Requirements (*ITE Manual of Transportation Engineering Studies*)

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

where: N = minimum number of measured speeds  
 S = estimated sample standard deviation (mph)  
 K = constant corresponding to 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 observations needed



Average speed = 36.2 mph  
 50th percentile speed = 36.0 mph  
 85th percentile speed = 40.0 mph

**APPENDIX K**

**TDOT STATEWIDE CRASH RATES &  
SPREADSHEET CALCULATIONS**

**Tennessee Department of Transportation  
Statewide Average Crash Rates for Sections and Spots**

Study: OFFICIAL HSIP STUDY 2014 - 2016

Begin Date: 1/1/2014 End Date: 12/31/2016

Route Type	Rural / Urban	Location Type	Highway Type	Fatal Rate	Incap. Rate	Other Inj. Rate	Pd. Rate	Total Rate	Severe Crash Rate	Total Veh. Miles (in millions)
<b>Interstates and State Routes</b>										
IS & SR	Rural	Section	2 OR 3 LN	0.024	0.116	0.403	1.106	<b>1.647</b>	0.139	22,121
IS & SR	Rural	Section	2 OR 3 LN W/TL	0.011	0.078	0.358	1.583	<b>2.030</b>	0.089	628
IS & SR	Rural	Section	4 OR MORE UNDIV	0.011	0.064	0.379	1.225	<b>1.679</b>	0.075	359
IS & SR	Rural	Section	4 OR MORE DIV	0.009	0.047	0.156	0.484	<b>0.696</b>	0.056	7,213
IS & SR	Rural	Section	4 OR MORE W TL	0.018	0.042	0.194	0.641	<b>0.896</b>	0.061	2,673
IS & SR	Rural	Section	FREEWAY	0.006	0.027	0.103	0.392	<b>0.528</b>	0.033	25,129
IS & SR	Rural	Spot	2 OR 3 LN	0.007	0.033	0.117	0.323	<b>0.480</b>	0.040	77,767
IS & SR	Rural	Spot	2 OR 3 LN W/TL	0.002	0.013	0.066	0.297	<b>0.378</b>	0.015	3,560
IS & SR	Rural	Spot	4 OR MORE UNDIV	0.003	0.012	0.065	0.210	<b>0.290</b>	0.015	2,268
IS & SR	Rural	Spot	4 OR MORE DIV	0.003	0.013	0.044	0.138	<b>0.196</b>	0.016	26,451
IS & SR	Rural	Spot	4 OR MORE W TL	0.004	0.010	0.048	0.158	<b>0.221</b>	0.015	11,151
IS & SR	Rural	Spot	FREEWAY	0.001	0.004	0.017	0.064	<b>0.086</b>	0.005	154,522
IS & SR	Urban	Section	2 OR 3 LN	0.015	0.085	0.559	1.915	<b>2.574</b>	0.100	10,470
IS & SR	Urban	Section	2 OR 3 LN W/TL	0.009	0.071	0.583	2.315	<b>2.978</b>	0.080	1,877
IS & SR	Urban	Section	4 OR MORE UNDIV	0.013	0.086	0.813	3.042	<b>3.954</b>	0.098	2,910
IS & SR	Urban	Section	4 OR MORE DIV	0.009	0.051	0.397	1.537	<b>1.994</b>	0.059	17,187
IS & SR	Urban	Section	4 OR MORE W TL	0.011	0.078	0.680	2.525	<b>3.294</b>	0.089	14,184
IS & SR	Urban	Section	FREEWAY	0.005	0.025	0.225	0.857	<b>1.112</b>	0.030	50,490
IS & SR	Urban	Spot	2 OR 3 LN	0.002	0.013	0.087	0.311	<b>0.414</b>	0.015	74,483
IS & SR	Urban	Spot	2 OR 3 LN W/TL	0.001	0.010	0.075	0.308	<b>0.394</b>	0.011	15,299
IS & SR	Urban	Spot	4 OR MORE UNDIV	0.001	0.009	0.092	0.363	<b>0.465</b>	0.010	37,084
IS & SR	Urban	Spot	4 OR MORE DIV	0.001	0.007	0.057	0.224	<b>0.289</b>	0.008	132,270
IS & SR	Urban	Spot	4 OR MORE W TL	0.001	0.009	0.080	0.301	<b>0.392</b>	0.011	126,015
IS & SR	Urban	Spot	FREEWAY	0.001	0.003	0.027	0.103	<b>0.133</b>	0.004	423,396
Note: Section rates are crashes per million vehicle miles.										
Note: Spot rates are crashes per million vehicles. Spots are sections of roadway less than or equal to .10 mile.										
Note: Severe crash rates are the sum of rates for fatal and incapacitating injury crashes.										

**Tennessee Department of Transportation**  
**Statewide Average Crash Rates for Sections and Spots**

Study: OFFICIAL HSIP STUDY 2014 - 2016

Begin Date: 1/1/2014 End Date: 12/31/2016

Route Type	Rural / Urban	Location Type	Highway Type	Fatal Rate	Incap. Rate	Other Inj. Rate	Pd. Rate	Total Rate	Severe Crash Rate	Total Veh. Miles (in millions)
<b>Functionally Classified Local Roads</b>										
FUNCT.	Rural	Section	2 OR 3 LN	0.034	0.179	0.676	1.943	<b>2.832</b>	0.213	7,033
FUNCT.	Rural	Section	2 OR 3 LN W/TL	0.024	0.096	0.358	1.194	<b>1.671</b>	0.119	42
FUNCT.	Rural	Section	4 OR MORE UNDIV	0.001	0.001	1.814	4.405	<b>6.219</b>	0.001	4
FUNCT.	Rural	Section	4 OR MORE DIV	0.001	0.001	0.001	0.001	<b>0.001</b>	0.001	0
FUNCT.	Rural	Section	4 OR MORE W TL	0.001	0.001	0.001	0.001	<b>0.001</b>	0.001	0
FUNCT.	Rural	Section	FREEWAY	0.001	1.323	2.646	6.615	<b>10.583</b>	1.323	1
FUNCT.	Rural	Spot	2 OR 3 LN	0.016	0.083	0.313	0.901	<b>1.312</b>	0.098	15,243
FUNCT.	Rural	Spot	2 OR 3 LN W/TL	0.001	0.022	0.076	0.305	<b>0.403</b>	0.022	183
FUNCT.	Rural	Spot	4 OR MORE UNDIV	0.001	0.041	0.326	0.856	<b>1.223</b>	0.041	25
FUNCT.	Rural	Spot	FREEWAY	0.001	0.151	0.302	0.905	<b>1.357</b>	0.151	7
FUNCT.	Urban	Section	2 OR 3 LN	0.011	0.098	0.734	2.776	<b>3.618</b>	0.109	15,443
FUNCT.	Urban	Section	2 OR 3 LN W/TL	0.004	0.068	0.692	3.053	<b>3.817</b>	0.072	1,639
FUNCT.	Urban	Section	4 OR MORE UNDIV	0.011	0.076	0.924	3.518	<b>4.529</b>	0.087	2,736
FUNCT.	Urban	Section	4 OR MORE DIV	0.007	0.044	0.552	2.445	<b>3.047</b>	0.050	3,750
FUNCT.	Urban	Section	4 OR MORE W TL	0.016	0.064	0.737	2.713	<b>3.530</b>	0.079	4,650
FUNCT.	Urban	Section	FREEWAY	0.004	0.025	0.470	1.958	<b>2.457</b>	0.030	475
FUNCT.	Urban	Spot	2 OR 3 LN	0.002	0.017	0.128	0.497	<b>0.643</b>	0.018	94,012
FUNCT.	Urban	Spot	2 OR 3 LN W/TL	0.001	0.009	0.094	0.428	<b>0.532</b>	0.010	12,328
FUNCT.	Urban	Spot	4 OR MORE UNDIV	0.001	0.009	0.110	0.456	<b>0.576</b>	0.010	27,060
FUNCT.	Urban	Spot	4 OR MORE DIV	0.001	0.006	0.074	0.330	<b>0.410</b>	0.006	32,186
FUNCT.	Urban	Spot	4 OR MORE W TL	0.002	0.008	0.091	0.342	<b>0.443</b>	0.010	39,317
FUNCT.	Urban	Spot	FREEWAY	0.001	0.003	0.064	0.277	<b>0.344</b>	0.004	4,234

**Tennessee Department of Transportation**  
**Statewide Average Crash Rates for Sections and Spots**

Study: OFFICIAL HSIP STUDY 2014 - 2016

Begin Date: 1/1/2014 End Date: 12/31/2016

Route Type	Rural / Urban	Location Type	Highway Type	Fatal Rate	Incap. Rate	Other Inj. Rate	Pd. Rate	Total Rate	Severe Crash Rate	Total Veh. Miles (in millions)
<b>High Risk Rural Roads</b>										
MAJOR COL.	Rural	Section	2 OR 3 LN	0.029	0.151	0.533	1.470	<b>2.183</b>	0.181	7,712
MAJOR COL.	Rural	Section	2 OR 3 LN W/TL	0.016	0.087	0.309	1.774	<b>2.186</b>	0.103	126
MAJOR COL.	Rural	Section	4 OR MORE UNDIV	0.001	0.214	0.357	1.928	<b>2.500</b>	0.214	14
MAJOR COL.	Rural	Section	4 OR MORE DIV	0.001	0.001	0.687	1.899	<b>2.585</b>	0.001	25
MAJOR COL.	Rural	Section	4 OR MORE W TL	0.018	0.071	0.285	1.017	<b>1.391</b>	0.089	56
MAJOR COL.	Rural	Section	FREEWAY	0.001	0.001	0.535	2.407	<b>2.942</b>	0.001	4
MAJOR COL.	Rural	Spot	2 OR 3 LN	0.010	0.053	0.187	0.517	<b>0.767</b>	0.063	22,204
MAJOR COL.	Rural	Spot	2 OR 3 LN W/TL	0.002	0.016	0.062	0.357	<b>0.437</b>	0.018	675
MAJOR COL.	Rural	Spot	4 OR MORE UNDIV	0.001	0.036	0.072	0.346	<b>0.453</b>	0.036	84
MAJOR COL.	Rural	Spot	4 OR MORE DIV	0.001	0.001	0.159	0.484	<b>0.642</b>	0.001	126
MAJOR COL.	Rural	Spot	4 OR MORE W TL	0.003	0.012	0.047	0.186	<b>0.249</b>	0.015	338
MAJOR COL.	Rural	Spot	FREEWAY	0.001	0.001	0.071	0.318	<b>0.388</b>	0.001	28
MIN COL.	Rural	Section	2 OR 3 LN	0.034	0.180	0.663	1.891	<b>2.768</b>	0.214	6,421
MIN COL.	Rural	Section	2 OR 3 LN W/TL	0.001	0.081	0.269	1.022	<b>1.372</b>	0.081	37
MIN COL.	Rural	Section	4 OR MORE UNDIV	0.001	0.001	1.814	4.405	<b>6.219</b>	0.001	4
MIN COL.	Rural	Section	4 OR MORE DIV	0.001	0.001	0.001	0.001	<b>0.001</b>	0.001	0
MIN COL.	Rural	Section	4 OR MORE W TL	0.001	0.001	0.001	0.001	<b>0.001</b>	0.001	0
MIN COL.	Rural	Section	FREEWAY	0.001	2.484	2.484	4.968	<b>9.936</b>	2.484	0
MIN COL.	Rural	Spot	2 OR 3 LN	0.017	0.089	0.327	0.934	<b>1.366</b>	0.105	13,065
MIN COL.	Rural	Spot	2 OR 3 LN W/TL	0.001	0.018	0.053	0.260	<b>0.331</b>	0.018	169
MIN COL.	Rural	Spot	4 OR MORE UNDIV	0.001	0.041	0.326	0.856	<b>1.223</b>	0.041	25
MIN COL.	Rural	Spot	FREEWAY	0.001	0.483	0.483	1.448	<b>2.414</b>	0.483	2

**Tennessee Department of Transportation**

**Statewide Intersection Crash Rates**

Study: OFFICIAL HSIP STUDY 2014 - 2016

Begin Date: 1/1/2014 End Date: 12/31/2016

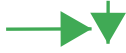
		Rural					Urban				
		Multi-Lane					Multi-Lane				
		2 Lane	2 Ln w/Turn	Univided	Divided	Turn Lane	2 Lane	2 Ln w/Turn	Univided	Divided	Turn Lane
<b>Signalized Intersections</b>											
	<b>Non-injury</b>	0.456	0.525	0.699	0.401	0.392	0.595	0.452	0.633	0.545	0.507
	<b>Injury</b>	0.109	0.109	0.134	0.141	0.129	0.167	0.130	0.180	0.157	0.160
	<b>Incap Inj</b>	0.020	0.027	0.017	0.032	0.027	0.012	0.010	0.016	0.018	0.013
	<b>Fatal</b>	0.001	0.001	0.001	0.004	0.001	0.001	0.001	0.001	0.001	0.001
	<b>Total</b>	<b>0.586</b>	<b>0.661</b>	<b>0.850</b>	<b>0.577</b>	<b>0.549</b>	<b>0.774</b>	<b>0.592</b>	<b>0.830</b>	<b>0.721</b>	<b>0.682</b>
<b>Full Stop Intersections</b>											
	<b>Non-injury</b>	0.425	0.898	0.564	0.443	0.900	0.379	0.653	0.110	0.550	0.001
	<b>Injury</b>	0.088	0.225	0.564	0.194	0.053	0.100	0.087	0.110	0.167	0.001
	<b>Incap Inj</b>	0.006	0.001	0.001	0.001	0.001	0.010	0.001	0.001	0.015	0.001
	<b>Fatal</b>	0.001	0.001	0.001	0.001	0.001	0.002	0.044	0.001	0.001	0.001
	<b>Total</b>	<b>0.519</b>	<b>1.122</b>	<b>1.128</b>	<b>0.637</b>	<b>0.953</b>	<b>0.490</b>	<b>0.783</b>	<b>0.219</b>	<b>0.731</b>	<b>0.001</b>
<b>Other Intersections</b>											
	<b>Non-injury</b>	0.079	0.073	0.075	0.048	0.042	0.127	0.117	0.165	0.120	0.105
	<b>Injury</b>	0.033	0.020	0.026	0.025	0.016	0.040	0.033	0.049	0.039	0.033
	<b>Incap Inj</b>	0.008	0.007	0.003	0.008	0.003	0.005	0.004	0.005	0.006	0.004
	<b>Fatal</b>	0.001	0.000	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001
	<b>Total</b>	<b>0.121</b>	<b>0.099</b>	<b>0.104</b>	<b>0.083</b>	<b>0.062</b>	<b>0.173</b>	<b>0.154</b>	<b>0.220</b>	<b>0.166</b>	<b>0.143</b>

Intersection Rates: Crashes / Million Entering Vehicles





<b>Brakebill Road, Knox County</b>		<b>LM 0.629</b>	
<b>Intersection (Hammer Road at Brakebill Road)</b>			
2 Crashes	- 2015 - 2018	Actual	- 0.503 Acc/MVM
State Average	- 0.121 Acc/MVM	Critical	- 0.653 Acc/MVM
A/S Ratio	= 4.16	A/C Ratio	= 0.77



# TENNESSEE DEPARTMENT OF TRANSPORTATION

COUNTY = **Knox** Date: **4/10/2018**  
 Route = **Brakebill Road**  
 Location = **Section 1 (Asheville Highway - Hammer Road)**  
 Highway Type = **2-lane undivided**  
 FUNCTIONAL CLASS **Major Collector**  
 DATA YEARS = **2015 - 2018 TITAN Data**  
 ADT YEARS USED = **2017**  
 COMMENTS =  
 ANALYZED BY = **RWJ**

SECTION = MORE THAN 0.10 MILE / SPOT = LESS THAN 0.10 MILE

BLM	ELM	Length	Average AADT	VMT
0.00	0.63	0.63	3,380	2,126
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0

0.63                      3,380                      2,126

INTERSECTION Leg      Traffic AADT  
 Log Mile =  North =   
East =   
South =   
West =   
Entering AADT =   
2017

2-Lane Undivided  
 2015 - 2018      Titan Data

		Total	Fatal	Incap. Injury	*Severe Crashes	Other	Injury
No. of Crashes	=	11	0	0	0		1
No. of Years	=	3.0					
SW avg. rate	=	2.183	0.029	0.151	0.180		0.533
<b>2014 - 2016 HSIP</b>							
Exposure (E)	=	2.3280					
Crash Rate (A)	=	4.725	0.000	0.000	0.000		0.430
Critical Rate (C)	=	4.651					
Severity Index (SI)	=	0.0909					
Actual Rate/SW Average	=	2.16	0.00	0.00	0.00		0.81
Ratio of A/C	=	1.02					

\* Severe Crashes are the sum of fatal and incapacitating injury crashes

Revised 5/12/2010

<b>Brakebill Road, Knox County</b>		<b>LM 0.000</b>	
<b>Section 1 (Asheville Highway - Hammer Road)</b>			
11 Crashes	- 2015 - 2018	Actual	- 4.725 Acc/MVM
State Average	- 2.183 Acc/MVM	Critical	- 4.651 Acc/MVM
A/S Ratio	= 2.16	A/C Ratio	= 1.02

# TENNESSEE DEPARTMENT OF TRANSPORTATION

COUNTY = **Knox** Date: **4/10/2018**  
 Route = **Brakebill Road**  
 Location = **Section 2 (Hammer Road - Strawberry Plains Pike)**  
 Highway Type = **2-lane undivided**  
 FUNCTIONAL CLASS **Major Collector**  
 DATA YEARS = **2015 - 2018 TITAN Data**  
 ADT YEARS USED = **2017**  
 COMMENTS =  
 ANALYZED BY = **RWJ**

SECTION = MORE THAN 0.10 MILE / SPOT = LESS THAN 0.10 MILE

BLM	ELM	Length	Average AADT	VMT
0.63	1.32	0.70	3,380	2,349
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0

0.70                      3,380                      2,349

INTERSECTION Leg      Traffic AADT  
 Log Mile =  North =   
East =   
South =   
West =   
Entering AADT =   
2017

2-Lane Undivided  
 2015 - 2018      Titan Data

		Total	Fatal	Incap. Injury	*Severe Crashes	Other	Injury
No. of Crashes	=	8	0	0	0		0
No. of Years	=	3.0					
SW avg. rate	=	2.183	0.029	0.151	0.180		0.533
<b>2014 - 2016 HSIP</b>							
Exposure (E)	=	2.5723					
Crash Rate (A)	=	3.110	0.000	0.000	0.000		0.000
Critical Rate (C)	=	4.521					
Severity Index (SI)	=	0.0000					
Actual Rate/SW Average	=	1.42	0.00	0.00	0.00		0.00
Ratio of A/C	=	0.69					

\* Severe Crashes are the sum of fatal and incapacitating injury crashes

Revised 5/12/2010

<b>Brakebill Road, Knox County</b>		<b>LM 0.000</b>	
<b>Section 2 (Hammer Road - Strawberry Plains Pike)</b>			
8 Crashes	- 2015 - 2018	Actual	- 3.110 Acc/MVM
State Average	- 2.183 Acc/MVM	Critical	- 4.521 Acc/MVM
A/S Ratio	= 1.42	A/C Ratio	= 0.69

# TENNESSEE DEPARTMENT OF TRANSPORTATION

COUNTY = **Knox** Date: **4/10/2018**  
 Route = **Brakebill Road**  
 Location = **Spot Location (just north of Palmer Lane)**  
 Highway Type = **2-lane undivided**  
 FUNCTIONAL CLASS **Major Collector**  
 DATA YEARS = **2015 - 2018 TITAN Data**  
 ADT YEARS USED = **2017**  
 COMMENTS =  
 ANALYZED BY = **RWJ**

SECTION = **MORE THAN 0.10 MILE / SPOT = LESS THAN 0.10 MILE**

BLM	ELM	Length	Average AADT	VMT
0.40	0.44	0.04	3,380	122
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0
0.00	0.00	0.00	0	0

0.04                      3,380                      122

INTERSECTION Leg      Traffic AADT  
 Log Mile =  North =   
East =   
South =   
West =   
Entering AADT =   
2017

2-Lane Undivided  
 2015 - 2018      Titan Data

		Total	Fatal	Incap. Injury	*Severe Crashes	Other	Injury
No. of Crashes	=	4	0	0	0		0
No. of Years	=	3.0					
SW avg. rate	=	0.767	0.010	0.053	0.063		0.187

2014 - 2016 HSIP

Exposure (E)	=	3.7011					
Crash Rate (A)	=	1.081	0.000	0.000	0.000		0.000
Critical Rate (C)	=	1.961					
Severity Index (SI)	=	0.0000					
Actual Rate/SW Average	=	1.41	0.00	0.00	0.00		0.00
Ratio of A/C	=	0.55					

\* Severe Crashes are the sum of fatal and incapacitating injury crashes

Revised 5/12/2010

<b>Brakebill Road, Knox County</b>		<b>LM 0.000</b>	
<b>Spot Location (just north of Palmer Lane)</b>			
4 Crashes	- 2015 - 2018	Actual	- 1.081 Acc/MVM
State Average	- 0.767 Acc/MVM	Critical	- 1.961 Acc/MVM
A/S Ratio	= 1.41	A/C Ratio	= 0.55



**APPENDIX L**

**KNOX COUNTY TURN LANE VOLUME THRESHOLD WORKSHEET**

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		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

Hammer Road at  
Brakebill Road  
Projected PM  
Left Turns = 46  
  
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

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
400 - 449 450 - 499		Yes	Yes	Yes	Yes	Yes
500 - 549 550 - 599	Yes	Yes	Yes	Yes	Yes	Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

Hammer Road at Brakebill Road  
Projected PM Right Turns = 42  
  
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 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 4A

LEFT-TURN LANE VOLUME THRESHOLDS  
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 35 MPH OR LESS

(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	300	235	185	145	120	100
150 - 199	245	200	160	130	110	90
200 - 249	205	Hammer Road at Road "I" Projected PM Left Turns = 54  Left Turn Lane NOT Warranted	140	115	100	80
250 - 299	175		125	105	90	70
300 - 349	155		110	95	80	65
350 - 399	135		100	85	70	60
400 - 449	120		90	75	65	55
450 - 499	105		80	70	60	50
500 - 549	95	80	70	65	55	50
550 - 599	85	70	65	60	50	45
600 - 649	75	65	60	55	45	40
650 - 699	70	60	55	50	40	35
700 - 749	65	55	50	45	35	30
750 or More	60	50	45	40	35	30

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 599	= / > 600
100 - 149	100	80	70	60	55	50
150 - 199	90	75	65	55	50	45
200 - 249	80	72	60	55	50	45
250 - 299	70	65	55	50	45	40
300 - 349	65	60	50	50	45	40
350 - 399	60	55	50	45	40	40
400 - 449	55	50	45	45	40	35
450 - 499	50	45	45	40	35	35
500 - 549	50	45	40	40	35	35
550 - 599	45	40	40	35	35	35
600 - 649	40	35	35	35	35	30
650 - 699	35	35	35	30	30	30
700 - 749	30	30	30	30	30	30
750 or More	30	30	30	30	30	30

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

**TABLE 4B  
RIGHT-TURN LANE VOLUME THRESHOLDS  
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 35 MPH OR LESS**

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

Hammer Road at  
 Road "I"  
 Projected PM  
 Right Turns = 0  
  
 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 50 - 99					Yes	Yes Yes
100 - 149 150 - 199			Yes	Yes Yes	Yes Yes	Yes Yes
200 - 249 250 - 299	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		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

Brakebill Road at  
Apartment Driveway  
Projected PM  
Left Turns = 59  
  
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

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
400 - 449 450 - 499		Yes	Yes	Yes	Yes	Yes
500 - 549 550 - 599	Yes	Yes	Yes	Yes	Yes	Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

Brakebill Road at  
Apartment Driveway  
Projected PM  
Right Turns = 39  
  
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 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	70	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

Brakebill Road at  
Mini-Warehouse  
Projected PM  
Left Turns = 5  
  
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

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
400 - 449 450 - 499		Yes	Yes	Yes	Yes	Yes
500 - 549 550 - 599	Yes	Yes	Yes	Yes	Yes	Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

Fewer Than 25 → 250 - 299

Brakebill Road at Mini-Warehouse Driveway  
Projected PM Right Turns = 3  
  
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 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	70	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

Brakebill Road at  
Road "A"  
Projected PM  
Left Turns = 75  
  
Left Turn Lane  
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

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
400 - 449 450 - 499		Yes	Yes	Yes	Yes	Yes
500 - 549 550 - 599	Yes	Yes	Yes	Yes	Yes	Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

Brakebill Road at Road "A"  
Projected PM Right Turns = 50  
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 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.

## **APPENDIX M**

### **SIMTRAFFIC QUEUE LENGTHS**

# Queuing and Blocking Report

5/30/2018

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## Intersection: 21: Brakebill Road & Road "A"

---

Movement	EB	NB
Directions Served	LR	L
Maximum Queue (ft)	75	31
Average Queue (ft)	39	3
95th Queue (ft)	62	20
Link Distance (ft)	212	
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		75
Storage Blk Time (%)		
Queuing Penalty (veh)		

# Queuing and Blocking Report

5/30/2018

---

## Intersection: 21: Brakebill Road & Road "A"

---

Movement	EB	NB
Directions Served	LR	L
Maximum Queue (ft)	66	40
Average Queue (ft)	33	16
95th Queue (ft)	57	43
Link Distance (ft)	212	
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		75
Storage Blk Time (%)		
Queuing Penalty (veh)		



**Intersection: 10: Strawberry Plains Pike & Brakebill Road**

Movement	EB	EB	NB	NB	NB	SB	SB
Directions Served	L	R	UL	T	T	UT	TR
Maximum Queue (ft)	194	269	122	124	113	292	353
Average Queue (ft)	54	142	54	19	31	96	137
95th Queue (ft)	153	254	102	80	84	210	277
Link Distance (ft)		248		180	180	461	461
Upstream Blk Time (%)		5		0	0	0	0
Queuing Penalty (veh)		0		0	0	0	0
Storage Bay Dist (ft)	120		150				
Storage Blk Time (%)	0	20	0	0			
Queuing Penalty (veh)	0	17	0	0			

**Intersection: 14: Strawberry Plains Pike & Interstate 40 On Ramp/Interstate 40 Off Ramp**

Movement	WB	WB	WB	NB	NB	NB	NB	SB	SB
Directions Served	L	L	R	L	L	T	T	T	TR
Maximum Queue (ft)	189	257	68	190	228	147	67	196	197
Average Queue (ft)	48	133	2	28	113	45	19	108	161
95th Queue (ft)	164	220	48	119	190	104	53	187	219
Link Distance (ft)			358			451	451	180	180
Upstream Blk Time (%)			0					0	5
Queuing Penalty (veh)			0					2	28
Storage Bay Dist (ft)	200	200		190	190				
Storage Blk Time (%)	0	2		0	1				
Queuing Penalty (veh)	0	3		0	2				

**Network Summary**

Network wide Queuing Penalty: 52
----------------------------------

**Intersection: 10: Strawberry Plains Pike & Brakebill Road**

Movement	EB	EB	NB	NB	NB	SB	SB
Directions Served	L	R	UL	T	T	UT	TR
Maximum Queue (ft)	115	163	180	246	242	174	193
Average Queue (ft)	46	62	134	118	79	54	61
95th Queue (ft)	91	118	204	273	211	129	145
Link Distance (ft)		248		180	180	461	461
Upstream Blk Time (%)		0	11	13	5		
Queuing Penalty (veh)		0	0	79	31		
Storage Bay Dist (ft)	120		150				
Storage Blk Time (%)	0	1	22	6			
Queuing Penalty (veh)	0	1	97	20			

**Intersection: 14: Strawberry Plains Pike & Interstate 40 On Ramp/Interstate 40 Off Ramp**

Movement	WB	WB	WB	NB	NB	NB	NB	SB	SB
Directions Served	L	L	R	L	L	T	T	T	TR
Maximum Queue (ft)	219	273	195	219	289	455	334	180	186
Average Queue (ft)	61	154	18	46	147	151	90	91	123
95th Queue (ft)	191	251	131	158	269	351	227	154	190
Link Distance (ft)			358			451	451	180	180
Upstream Blk Time (%)			1			3	0	0	1
Queuing Penalty (veh)			0			0	0	0	3
Storage Bay Dist (ft)	200	200		190	190				
Storage Blk Time (%)	0	4	1	0	2	9			
Queuing Penalty (veh)	0	6	3	0	12	34			

**Network Summary**

Network wide Queuing Penalty: 286
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**APPENDIX N**

**TDOT ROAD SAFETY AUDIT REVIEW**



STATE OF TENNESSEE  
DEPARTMENT OF TRANSPORTATION  
PROJECT PLANNING DIVISION  
SUITE 1000, JAMES K. POLK BUILDING  
505 DEADERICK STREET  
NASHVILLE, TENNESSEE 37243-0334

Gerald F. Nicely  
COMMISSIONER

Phil Bredesen  
GOVERNOR

MEMORANDUM

To: Mr. Paul Degges, Chief Engineer

From:  Steve Allen, Director  
Project Planning Division

Date: March 16, 2010

**Subject: RSAR INTERSECTION OF STRAWBERRY PLAINS PIKE AND  
BRAKEBILL ROAD, KNOX COUNTY**

The Road Safety Audit Review for the intersection of Strawberry Plains Pike and Brakebill Road, Knox County, has been completed and the report is attached. This project was identified through the TDOT safety needs planning process. Strawberry Plains Pike is a divided four lane urban collector roadway. The intersection of Strawberry Plains Pike and Brakebill Road appears on the Highway Safety Improvement Program (HSIP) and qualifies for Hazard Elimination Safety Program (HESP) funds because the crash ratio (actual crash rate divided by the critical crash rate) was 4.10, which is greater than 3.5 (the minimum threshold).

The following guidance was provided:

- **Figure 1**
  1. Restripe all edgelines along the I-40 entrance and exit ramps extending approximately 500 feet from the intersection of Strawberry Plains Pike and the I-40 ramps.
  2. Install a (36"x36") Stop Ahead (W3-1) warning sign approximately but not less than 400 feet in advance of the intersection on Brakebill Road. A "400 FEET" (30"x18") supplemental plate (W16-2a) should be mounted underneath this sign.
  3. Construct separate left and right turn lanes (within the existing right-of-way) on the Brakebill Road approach. The left turn lane should have at least 100 feet of storage.
  4. Install a 24" thermoplastic stop bar and left and right turn lane arrows on the Brakebill Road approach.
  5. Replace existing Stop signs with (36"x36") Stop (R1-1) signs on the Brakebill approach.
  6. Install a "Brakebill Rd." Street Name (D3-1) sign above the Stop sign in the southwest corner of the intersection of Strawberry Plains Pike and Brakebill Road.
  7. Remove the vegetation (within the existing right-of-way) in the southwest corner of the intersection of Strawberry Plains Pike and Brakebill Road.
  8. Relocate the culvert on the north side of Brakebill Road and install a standard end treatment and backfill (see inset on Figure 1).

9. Install yellow-red retroreflective bi-directional raised pavement markings spaced at 20 feet center-to-center on the inside edge lines outside the median opening area so that the red lens is only visible to wrong-way traffic.
10. Restripe all edge and centerlines along Strawberry Plains Pike extending 100 feet north and 200 feet south of Brakebill Road.
11. Place 12" diagonal chevron channelization pavement markings spaced at 10 feet apart between the northbound left turn lane and northbound through lanes along Strawberry Plains Pike.
12. Install a thermoplastic left turn lane arrow in the northbound left turn lane.
13. Construct a 12 foot wide northbound left turn lane having 75 feet of storage in the median of Strawberry Plains Pike.
14. Install yellow-yellow retroreflective bi-directional raised pavement markings spaced at 10 feet center-to-center on the edge lines inside the median opening area.
15. Relocate "WRONG WAY" sign approximately 45 feet north of existing location within median.
16. Install (30"x30") "DO NOT ENTER" (R5-1) signs north of Brakebill Road on both sides of southbound Strawberry Plains Pike.
17. Install a (30"x30") Intersection Ahead (W2-2) warning sign approximately but not less than 400 feet in advance of the intersection on Strawberry Plains Pike. A (24"x12") "400 FEET" supplemental plate (W16-2a) should be mounted underneath this sign.
18. Install "Rear Access to McDonalds" (30"x54") sign facing south-westbound traffic on the northeast side of the median opening located approximately 475 feet northeast of the intersection of Strawberry Plains Pike and Brakebill Road.

The estimated cost of improvements listed in this report is \$181,200. This includes \$13,600 of 100% federally funded items, \$150,800 of 90% federally funded items, and \$16,800 of 10% locally funded items. The local match to be provided by the City of Knoxville is \$16,800. These proposed improvements will be let to contract.

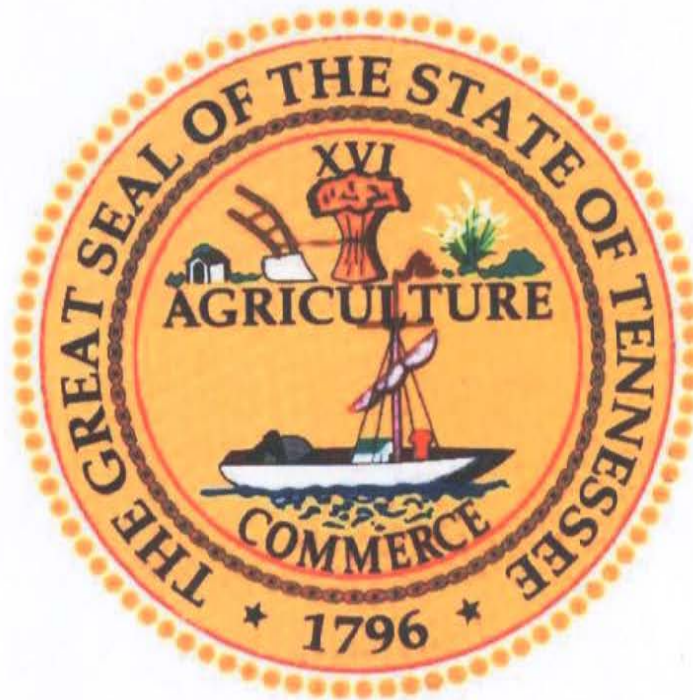
If you should need any further information, please contact me at (615) 741-2208.

Attachment

CC: Ed Cole, Gary Ogletree, Mike Tugwell, Steve Borden, Amanda Snowden, Jim Moore,  
FILE



**ROAD SAFETY AUDIT REPORT**  
**INTERSECTION OF STRAWBERRY PLAINS PIKE AND BRAKEBILL**  
**ROAD**  
**L.M. 8.80**  
**KNOX COUNTY**  
**PIN 113344.00**



**PREPARED BY**  
**RPM TRANSPORTATION CONSULTANTS, LLC**  
**FOR THE**  
**TENNESSEE DEPARTMENT OF TRANSPORTATION**  
**PROJECT PLANNING DIVISION**

Approved by:	Signature	DATE
<b>DIRECTOR</b> Project Planning Division		3-16-10

*This document is covered by 23 USC § 409 and its production pursuant to fulfilling public planning requirements does not waive the provisions of § 409.*

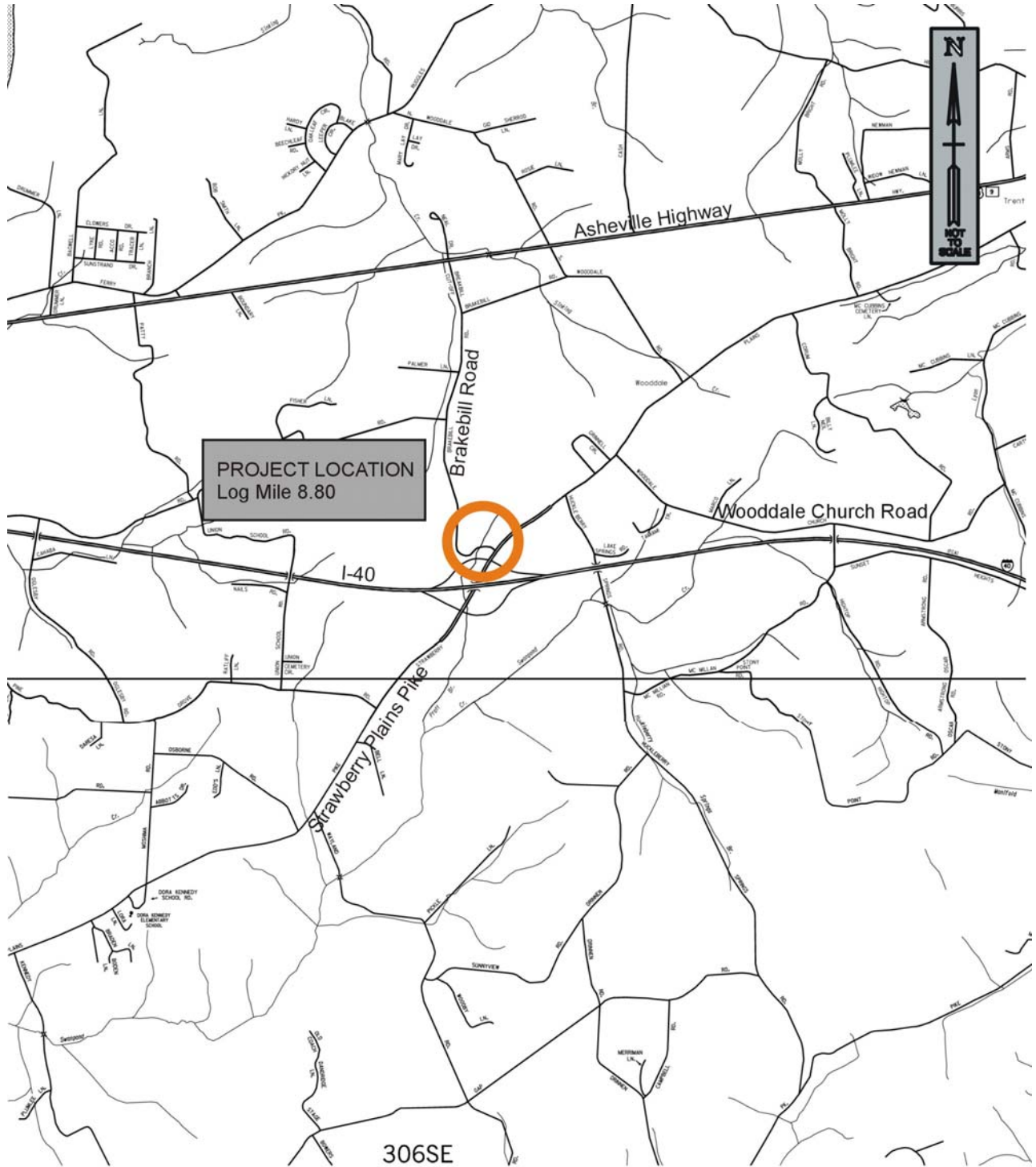
Strawberry Plains Pike (Local Route 1124) at Brakebill Road – L.M. 8.80  
Knoxville, Knox County Road Safety Audit Review



Project Location Map  
(Not to Scale)



Strawberry Plains Pike (Local Route 1124) at Brakebill Road – L.M. 8.80  
Knoxville, Knox County Road Safety Audit Review



Project Area Map  
(Not to Scale)

## Road Safety Audit Review

### Description of Project and Background

This project was identified through the TDOT safety needs planning process. The intersection of Strawberry Plains Pike and Brakebill Road appears on the Highway Safety Improvement Program (HSIP) and qualifies for Hazard Elimination Safety Program (HESP) funds because the crash ratio (actual crash rate divided by the critical crash rate) was 4.10, which is greater than 3.5 (the minimum threshold).

### RSAR Team Members

A RSAR team was assembled to evaluate the intersection of Strawberry Plains Pike and Brakebill Road in Knoxville, Knox County to determine appropriate safety measures.

### Team Members

<u>Name</u>	<u>Organization</u>	<u>Phone</u>	<u>Email</u>
Paul Lane	TDOT – Project Planning	615-253-2432	<a href="mailto:paul.lane@tn.gov">paul.lane@tn.gov</a>
Glenda Tyus	TDOT – Project Planning	615-741-1816	<a href="mailto:glenda.tyus@tn.gov">glenda.tyus@tn.gov</a>
Randy Plummer	TDOT- Region 1 Design	865-594-2400	<a href="mailto:randy.plummer@tn.gov">randy.plummer@tn.gov</a>
Jay Morgan	TDOT- Region 1 Design	865-594-2400	<a href="mailto:jay.morgan@tn.gov">jay.morgan@tn.gov</a>
Henry Reid	TDOT- Region 1 Design	865-594-2400	<a href="mailto:henry.reid@tn.gov">henry.reid@tn.gov</a>
Stephen Millsaps	City of Knoxville	865-215-6100	<a href="mailto:smillsaps@cityofknoxville.org">smillsaps@cityofknoxville.org</a>
Bill Cole	City of Knoxville	865-215-6100	<a href="mailto:bcole@cityofknoxville.org">bcole@cityofknoxville.org</a>
Jim Pointer	TDOT- District 15 Highway Maintenance	865-594-2718	N/A
John Sexton	Knox County Department of Engineering and Public Works	865-215-5860	<a href="mailto:john.sexton@knoxcounty.org">john.sexton@knoxcounty.org</a>
Amanda Snowden	TDOT- Region 1 Traffic	865-594-2400	<a href="mailto:amanda.snowden@tn.gov">amanda.snowden@tn.gov</a>
Andy Padgett	TDOT- Region 1 Traffic	865-594-2456	<a href="mailto:andrew.padgett@tn.gov">andrew.padgett@tn.gov</a>
Nathan Benditz	Knoxville TPO	865-215-2826	<a href="mailto:nathan.benditz@knoxtrans.org">nathan.benditz@knoxtrans.org</a>
Eric Jackson	TDOT- Traffic	615-741-0802	<a href="mailto:eric.jackson@tn.gov">eric.jackson@tn.gov</a>
Jeff Hammond	RPM Transportation	615-370-8410	<a href="mailto:jeffhammond@rpmtraffic.net">jeffhammond@rpmtraffic.net</a>
Blake Turner	RPM Transportation	615-370-8410	<a href="mailto:blaketurner@rpmtraffic.net">blaketurner@rpmtraffic.net</a>

## Information used in the Review

- City of Knoxville street map
- TRIMS Route Feature Description Listing
- TRIMS Highway Log Report
- TRIMS Geometric Report
- TRIMS Traffic Report
- TRIMS Road Segment Report
- ADAM historical traffic report
- TDOT Signal Warrant Study
- Hourly turning movements counts (included in appendix)
- Aerial photography
- Crash rate summary (included in appendix)
- Crash reports: 50090192, 50064350, 50064365, 50131679, 50075792, 50113006, 9858299, 50053558, 9275906, 9856871, 8115074, 9228217, 9229551, 8112521, 8551111, 9741760, 9737013

## Pre-Briefing Summary

This project was identified through the TDOT safety needs planning process. The intersection of Strawberry Plains Pike and Brakebill Road appears on the Highway Safety Improvement Program (HSIP) and qualifies for Hazard Elimination Safety Program (HESP) funds because the crash ratio (actual crash rate divided by the critical crash rate) was 4.10, which is greater than 3.5 (the minimum threshold).

A pre-brief meeting was held at 1:00 PM on Monday, October 12 at TDOT headquarters in Nashville. The following aspects of the intersection were discussed:

- The I-40 interchange location results in significant volumes of truck and tourism traffic.
- No turn lanes exist on Strawberry Plains Pike at this intersection.
- A study performed by TDOT Region I showed that MUTCD warrants for signalization are met.
- The intersection of Strawberry Plains Pike and Brakebill Road is located approximately 280 feet north of the signalized intersection of Strawberry Plains Pike and westbound I-40 ramps. This spacing would be undesirable for two signalized intersections.
- The intersection of Region Lane and Strawberry Plains Pike is approximately 480 feet south of the intersection of Strawberry Plains Pike and the eastbound I-40 ramps. These intersections are both signalized and operate acceptably.
- A slight downgrade exists on southbound Strawberry Plains Pike approaching the Brakebill Road intersection.

This intersection has experienced seventeen (17) crashes over the past three (3) years. The seventeen (17) crashes included fifteen (15) property damage, one (1) incapacitating injury crash, and one (1) non-incapacitating injury crash. Ten (10) (59%) of these were right angle crashes, and six (6) (35%) were rear end crashes, involving both northbound and southbound traffic along Strawberry Plains Pike. It was discussed that a northbound left turn lane and signalization would likely mitigate the rear end and right angle crashes, but that the signal spacing was undesirable.



## Observations

An onsite field review was held at 2:00 PM ET on Monday, October 19, 2009. The following observations are provided concerning the location:

- Due to the lack of a northbound turn lane on Strawberry Plains Pike, vehicles queue inside the median opening in order to make a left turn onto Brakebill Road.
- A single eastbound lane on Brakebill Road serves both left and right turning traffic.
- The culvert opening north of Brakebill Road does not have a standard end treatment.
- A previous study called the Huckleberry Springs Loop Study had identified a possible connection from Huckleberry Springs Road to Brakebill Road.
- The unsignalized intersection of Strawberry Plains Pike and Brakebill Road is located 280 feet north of the signalized intersection of Strawberry Plains Pike and the westbound I-40 ramps.
- The “Brakebill Road” street name signs appeared to be undersized.
- Stop signs are located on both sides of Brakebill Road at its approach to Strawberry Plains Pike; both Brakebill Road stop signs appeared to be undersized.
- The edgelines and centerlines along Brakebill Road had limited visibility.
- No advance intersection warning sign was present north of Brakebill Road for southbound Strawberry Plains Pike traffic.
- A “Stop Ahead” sign was not present west of Strawberry Plains Pike on Brakebill Road.
- A high number of southbound to northbound U-turns on Strawberry Plains Pike were noted at the Brakebill Road median opening, particularly during the AM peak period. It is likely that these vehicles are accessing the McDonald’s restaurant.

## Guidance

The following recommendations were developed by the RSAR team during the field review:

- Figure 1
  1. Restripe all edgelines along the I-40 entrance and exit ramps extending approximately 500 feet from the intersection of Strawberry Plains Pike and the I-40 ramps.
  2. Install a (36”x36”) Stop Ahead (W3-1) warning sign approximately but not less than 400 feet in advance of the intersection on Brakebill Road. A “400 FEET” (30”x18”) supplemental plate (W16-2a) should be mounted underneath this sign.
  3. Construct separate left and right turn lanes (within the existing right-of-way) on the Brakebill Road approach. The left turn lane should have at least 100 feet of storage.
  4. Install a 24” thermoplastic stop bar and left and right turn lane arrows on the Brakebill Road approach.
  5. Replace existing Stop signs with (36”x36”) Stop (R1-1) signs on the Brakebill approach.

6. Install a “Brakebill Rd.” Street Name (D3-1) sign above the Stop sign in the southwest corner of the intersection of Strawberry Plains Pike and Brakebill Road.
7. Remove the vegetation (within the existing right-of-way) in the southwest corner of the intersection of Strawberry Plains Pike and Brakebill Road.
8. Relocate the culvert on the north side of Brakebill Road and install a standard end treatment and backfill (see inset on Figure 1).
9. Install yellow-red retroreflective bi-directional raised pavement markings spaced at 20 feet center-to-center on the inside edge lines outside the median opening area so that the red lens is only visible to wrong-way traffic.
10. Restripe all edge and centerlines along Strawberry Plains Pike extending 100 feet north and 200 feet south of Brakebill Road.
11. Place 12” diagonal chevron channelization pavement markings spaced at 10 feet apart between the northbound left turn lane and northbound through lanes along Strawberry Plains Pike.
12. Install a thermoplastic left turn lane arrow in the northbound left turn lane.
13. Construct a 12 foot wide northbound left turn lane having 75 feet of storage in the median of Strawberry Plains Pike.
14. Install yellow-yellow retroreflective bi-directional raised pavement markings spaced at 10 feet center-to-center on the edge lines inside the median opening area.
15. Relocate “WRONG WAY” sign approximately 45 feet north of existing location within median.
16. Install (30”x30”) “DO NOT ENTER” (R5-1) signs north of Brakebill Road on both sides of southbound Strawberry Plains Pike.
17. Install a (30”x30”) Intersection Ahead (W2-2) warning sign approximately but not less than 400 feet in advance of the intersection on Strawberry Plains Pike. A (24”x12”) “400 FEET” supplemental plate (W16-2a) should be mounted underneath this sign.
18. Install “Rear Access to McDonalds” (30”x54”) sign facing south-westbound traffic on the northeast side of the median opening located approximately 475 feet northeast of the intersection of Strawberry Plains Pike and Brakebill Road.

The estimated cost of improvements listed in this report is \$181,200. This includes \$13,600 of 100% federally funded items, \$150,800 of 90% federally funded items, and \$16,800 of 10% locally funded items. The local match to be provided by the City of Knoxville is \$16,800. These proposed improvements will be let to contract. All items removed as part of this project shall be returned to the City of Knoxville.

**COST DATA SHEET  
 TOTAL PROJECT COST**

Route:	<b>LOCAL ROUTE 1124</b>
Description:	<b>INTERSECTION OF STRAWBERRY PLAINS PIKE AND BRAKEBILL ROAD</b>
County:	<b>KNOX</b>
Length:	<b>INTERSECTION</b>
Date:	<b>1/25/2010</b>

RIGHT-OF-WAY	\$	10,000
UTILITY RELOCATION	\$	24,000
CLEAR AND GRUBBING	\$	1,000
EARTHWORK	\$	17,000
PAVEMENT REMOVAL	\$	1,000
DRAINAGE	\$	15,000
STRUCTURES	\$	0
RAILROAD CROSSING OR SEPARATION	\$	0
PAVING	\$	51,000
RETAINING WALLS	\$	0
MAINTENANCE OF TRAFFIC	\$	4,000
TOPSOIL	\$	1,000
SEEDING	\$	0
SODDING	\$	3,000
SIGNING AND STRIPING	\$	8,400
LIGHTING	\$	0
SIGNALIZATION	\$	0
FENCE	\$	0
GUARDRAIL	\$	0
RIP RAP OR SLOPE PROTECTION	\$	0
OTHER CONST. ITEMS (15%)	\$	15,200
MOBILIZATION	\$	6,000
CONSTRUCTION COST	\$	122,600
10% ENG. & CONT.	\$	12,300
TOTAL CONSTRUCTION COST	\$	134,900
10% PRELIMINARY ENGINEERING	\$	12,300
TOTAL COST *	\$	181,200

\* For estimating future project costs, a compounded inflation rate of 10% per year will be applied from the date of this estimate.

**COST DATA SHEET**  
**100% Federally Funded Items**

Route:	<b>LOCAL ROUTE 1124</b>
Description:	<b>INTERSECTION OF STRAWBERRY PLAINS PIKE AND BRAKEBILL ROAD</b>
County:	<b>KNOX</b>
Length:	<b>INTERSECTION</b>
Date:	<b>1/25/2010</b>

RIGHT-OF-WAY	\$	0
UTILITY RELOCATION	\$	0
CLEAR AND GRUBBING	\$	0
EARTHWORK	\$	0
PAVEMENT REMOVAL	\$	0
DRAINAGE	\$	0
STRUCTURES	\$	0
RAILROAD CROSSING OR SEPARATION	\$	0
PAVING	\$	0
RETAINING WALLS	\$	0
MAINTENANCE OF TRAFFIC	\$	1,000
TOPSOIL	\$	0
SEEDING	\$	0
SODDING	\$	0
SIGNING AND STRIPING	\$	8,400
LIGHTING	\$	0
SIGNALIZATION	\$	0
FENCE	\$	0
GUARDRAIL	\$	0
RIP RAP OR SLOPE PROTECTION	\$	0
OTHER CONST. ITEMS (15%)	\$	1,400
MOBILIZATION	\$	600
<b>CONSTRUCTION COST</b>	<b>\$</b>	<b>11,400</b>
<b>10% ENG. &amp; CONT.</b>	<b>\$</b>	<b>1,100</b>
<b>TOTAL CONSTRUCTION COST</b>	<b>\$</b>	<b>12,500</b>
<b>10% PRELIMINARY ENGINEERING</b>	<b>\$</b>	<b>1,100</b>
<b>TOTAL COST *</b>	<b>\$</b>	<b>13,600</b>

\* For estimating future project costs, a compounded inflation rate of 10% per year will be applied from the date of this estimate.

**COST DATA SHEET**  
**90% Federally Funded**

<b>Route:</b>	<b>LOCAL ROUTE 1124</b>
<b>Description:</b>	<b>INTERSECTION OF STRAWBERRY PLAINS PIKE AND BRAKEBILL ROAD</b>
<b>County:</b>	<b>KNOX</b>
<b>Length:</b>	<b>INTERSECTION</b>
<b>Date:</b>	<b>1/25/2010</b>

RIGHT-OF-WAY	\$	9000
UTILITY RELOCATION	\$	21600
CLEAR AND GRUBBING	\$	900
EARTHWORK	\$	15,300
PAVEMENT REMOVAL	\$	900
DRAINAGE	\$	13,500
STRUCTURES	\$	0
RAILROAD CROSSING OR SEPARATION	\$	0
PAVING	\$	45,900
RETAINING WALLS	\$	0
MAINTENANCE OF TRAFFIC	\$	2,700
TOPSOIL	\$	900
SEEDING	\$	0
SODDING	\$	2,700
SIGNING AND STRIPING	\$	0
LIGHTING	\$	0
SIGNALIZATION	\$	0
FENCE	\$	0
GUARDRAIL	\$	0
RIP RAP OR SLOPE PROTECTION	\$	0
OTHER CONST. ITEMS (15%)	\$	12,420
MOBILIZATION	\$	4,860
<b>CONSTRUCTION COST</b>	<b>\$</b>	<b>100,080</b>
<b>10% ENG. &amp; CONT.</b>	<b>\$</b>	<b>10,080</b>
<b>TOTAL CONSTRUCTION COST</b>	<b>\$</b>	<b>110,160</b>
<b>10% PRELIMINARY ENGINEERING</b>	<b>\$</b>	<b>10,080</b>
<b>TOTAL COST *</b>	<b>\$</b>	<b>150,800</b>

*\* For estimating future project costs, a compounded inflation rate of 10% per year will be applied from the date of this estimate.*

**COST DATA SHEET**  
 10% Locally Funded

<b>Route:</b>	<b>LOCAL ROUTE 1124</b>
<b>Description:</b>	<b>INTERSECTION OF STRAWBERRY PLAINS PIKE AND BRAKEBILL ROAD</b>
<b>County:</b>	<b>KNOX</b>
<b>Length:</b>	<b>INTERSECTION</b>
<b>Date:</b>	<b>1/25/2010</b>

RIGHT-OF-WAY	\$	1000
UTILITY RELOCATION	\$	2400
CLEAR AND GRUBBING	\$	100
EARTHWORK	\$	1,700
PAVEMENT REMOVAL	\$	100
DRAINAGE	\$	1,500
STRUCTURES	\$	0
RAILROAD CROSSING OR SEPARATION	\$	0
PAVING	\$	5,100
RETAINING WALLS	\$	0
MAINTENANCE OF TRAFFIC	\$	300
TOPSOIL	\$	100
SEEDING	\$	0
SODDING	\$	300
SIGNING AND STRIPING	\$	0
LIGHTING	\$	0
SIGNALIZATION	\$	0
FENCE	\$	0
GUARDRAIL	\$	0
RIP RAP OR SLOPE PROTECTION	\$	0
OTHER CONST. ITEMS (15%)	\$	1,380
MOBILIZATION	\$	540
<b>CONSTRUCTION COST</b>	<b>\$</b>	<b>11,120</b>
<b>10% ENG. &amp; CONT.</b>	<b>\$</b>	<b>1,120</b>
<b>TOTAL CONSTRUCTION COST</b>	<b>\$</b>	<b>12,240</b>
<b>10% PRELIMINARY ENGINEERING</b>	<b>\$</b>	<b>1,120</b>
<b>TOTAL COST *</b>	<b>\$</b>	<b>16,800</b>

\* For estimating future project costs, a compounded inflation rate of 10% per year will be applied from the date of this estimate.

Strawberry Plains Pike (Local Route 1124) at Brakebill Road – L.M. 8.80  
Knoxville, Knox County Road Safety Audit Review

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10/19/09: Looking west on Brakebill Rd. from Strawberry Plains Pk.



10/19/09: Looking south on Strawberry Plains Pk. from median



Strawberry Plains Pike (Local Route 1124) at Brakebill Road – L.M. 8.80  
Knoxville, Knox County Road Safety Audit Review



10/19/09: Looking north on Strawberry Plains Pk. from Brakebill Rd.



10/19/09: Looking north onto Strawberry Plains Pk. from median



Strawberry Plains Pike (Local Route 1124) at Brakebill Road – L.M. 8.80  
Knoxville, Knox County Road Safety Audit Review

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*10/19/09: Looking east onto Strawberry Plains Pk. from Brakebill Rd.*

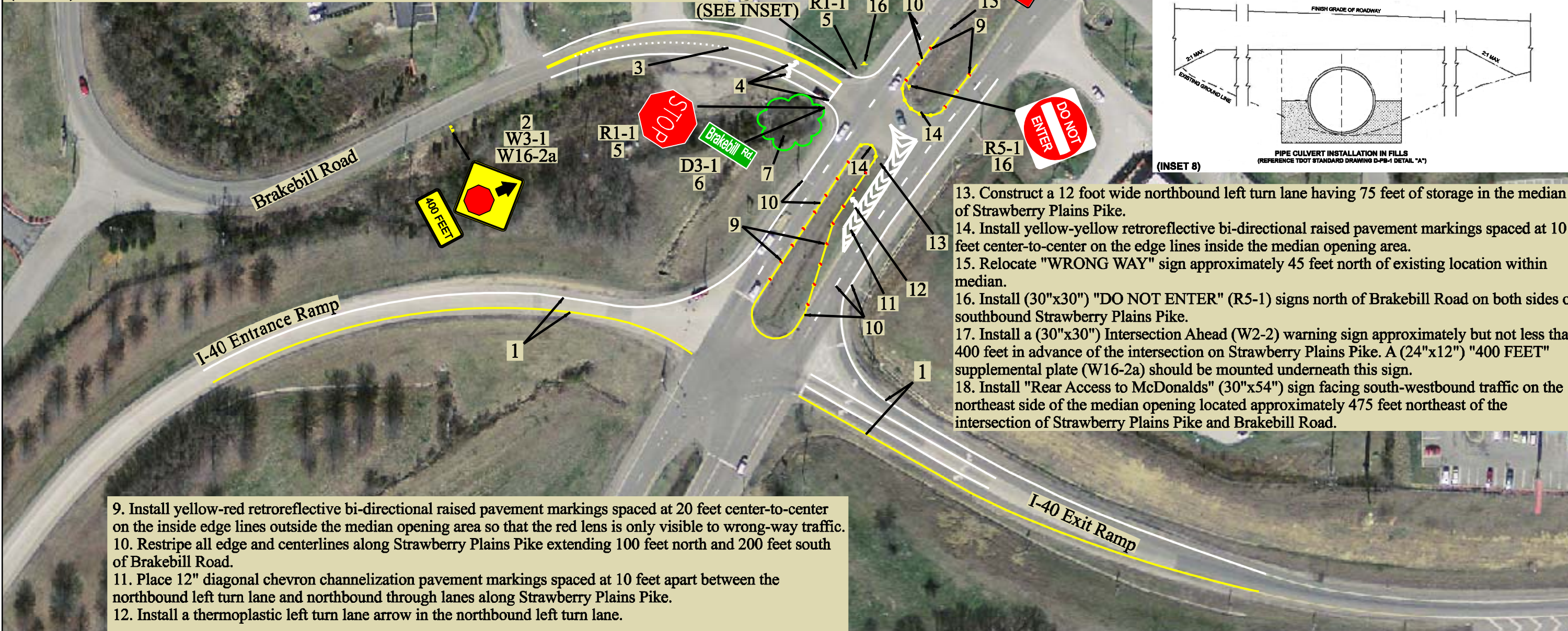


*10/19/09: Looking at the northern culvert opening at Brakebill Rd.*



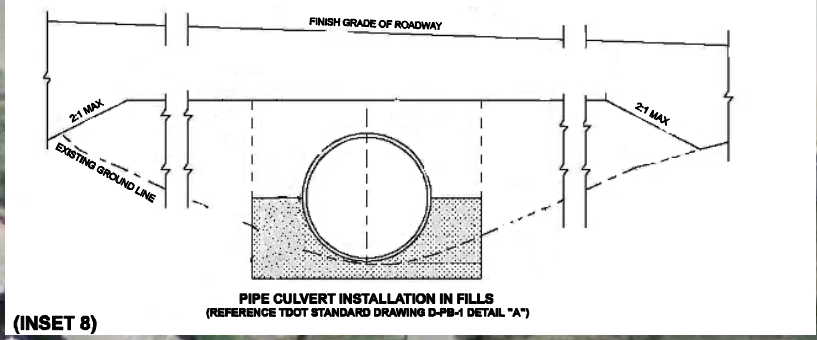
### GUIDANCE

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2. Install a (36"x36") Stop Ahead (W3-1) warning sign approximately but not less than 400 feet in advance of the intersection on Brakebill Road. A "400 FEET" (30"x18") supplemental plate (W16-2a) should be mounted underneath this sign.
3. Construct separate left and right turn lanes (within the existing right-of-way) on the Brakebill Road approach. The left turn lane should have at least 100 feet of storage.
4. Install a 24" thermoplastic stop bar and left and right turn lane arrows on the Brakebill Road approach.
5. Replace existing Stop signs with (36"x36") Stop (R1-1) signs on the Brakebill approach.
6. Install a "Brakebill Rd." Street Name (D3-1) sign above the Stop sign in the southwest corner of the intersection of Strawberry Plains Pike and Brakebill Road.
7. Remove the vegetation (within the existing right-of-way) in the southwest corner of the intersection of Strawberry Plains Pike and Brakebill Road.
8. Relocate the culvert on the north side of Brakebill Road and install a standard end treatment and backfill (see inset).



9. Install yellow-red retroreflective bi-directional raised pavement markings spaced at 20 feet center-to-center on the inside edge lines outside the median opening area so that the red lens is only visible to wrong-way traffic.
10. Restripe all edge and centerlines along Strawberry Plains Pike extending 100 feet north and 200 feet south of Brakebill Road.
11. Place 12" diagonal chevron channelization pavement markings spaced at 10 feet apart between the northbound left turn lane and northbound through lanes along Strawberry Plains Pike.
12. Install a thermoplastic left turn lane arrow in the northbound left turn lane.

13. Construct a 12 foot wide northbound left turn lane having 75 feet of storage in the median of Strawberry Plains Pike.
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15. Relocate "WRONG WAY" sign approximately 45 feet north of existing location within median.
16. Install (30"x30") "DO NOT ENTER" (R5-1) signs north of Brakebill Road on both sides of southbound Strawberry Plains Pike.
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ROAD SAFETY AUDIT REVIEW  
STRAWBERRY PLAINS PIKE AND BRAKEBILL ROAD  
L.M. 8.80  
KNOX COUNTY

SYTIME  
DGN/PC



## **APPENDIX**



Tennessee Department of Transportation  
Region 1 Traffic Office

Counted By: RH & RN  
Weather:  
Major: 4L div  
Minor: 2L

File Name : Strawberry Plains@Brakebill  
Site Code : 00000047  
Start Date : 2/10/2009  
Page No : 1

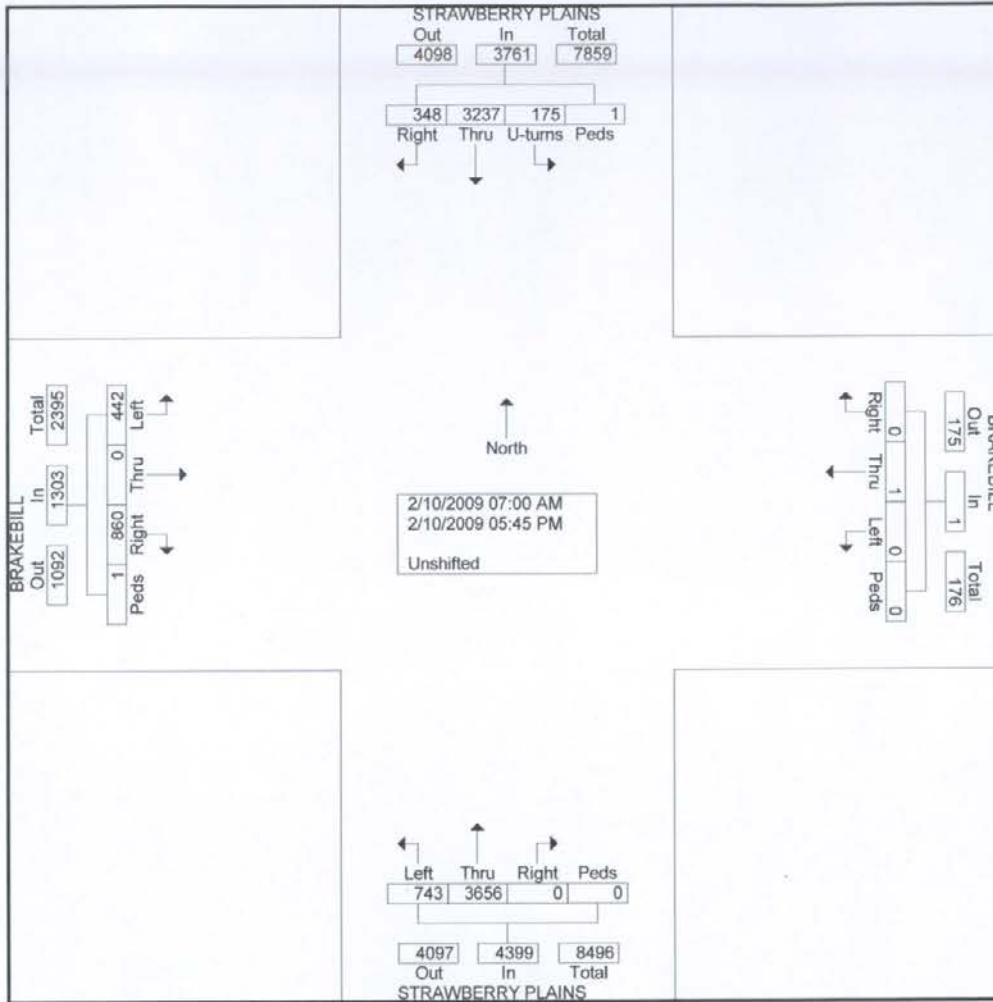
Groups Printed- Unshifted

Start Time	STRAWBERRY PLAINS Southbound					BRAKEBILL Westbound					STRAWBERRY PLAINS Northbound					BRAKEBILL Eastbound					Int. Total
	U-turns	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
07:00 AM	7	133	8	0	148	0	0	0	0	0	8	60	0	0	68	8	0	24	0	32	248
07:15 AM	4	144	19	0	167	0	0	0	0	0	19	47	0	0	66	7	0	28	0	35	268
07:30 AM	15	187	5	0	207	0	0	0	0	0	19	66	0	0	85	12	0	38	0	50	342
07:45 AM	14	156	5	0	175	0	0	0	0	0	17	79	0	0	96	12	0	39	0	51	322
Total	40	620	37	0	697	0	0	0	0	0	63	252	0	0	315	39	0	129	0	168	1180
08:00 AM	15	136	8	0	159	0	0	0	0	0	11	104	0	0	115	12	0	20	0	32	306
08:15 AM	8	123	4	0	135	0	0	0	0	0	13	70	0	0	83	8	0	20	0	28	246
08:30 AM	9	98	8	0	115	0	0	0	0	0	18	80	0	0	98	9	0	50	0	59	272
08:45 AM	5	101	9	0	115	0	0	0	0	0	11	64	0	0	75	11	0	31	0	42	232
Total	37	458	29	0	524	0	0	0	0	0	53	318	0	0	371	40	0	121	0	161	1056
11:00 AM	2	83	17	0	102	0	1	0	0	1	19	81	0	0	100	7	0	14	0	21	224
11:15 AM	4	76	11	0	91	0	0	0	0	0	25	72	0	0	97	16	0	23	0	39	227
11:30 AM	0	75	9	0	84	0	0	0	0	0	25	84	0	0	109	13	0	17	0	30	223
11:45 AM	4	74	15	0	93	0	0	0	0	0	15	79	0	0	94	3	0	29	0	32	219
Total	10	308	52	0	370	0	1	0	0	1	84	316	0	0	400	39	0	83	0	122	893
12:00 PM	9	70	13	0	92	0	0	0	0	0	21	92	0	0	113	17	0	17	0	34	239
12:15 PM	8	106	6	0	120	0	0	0	0	0	17	93	0	0	110	15	0	30	0	45	275
12:30 PM	7	92	14	0	113	0	0	0	0	0	15	89	0	0	104	17	0	21	0	38	255
12:45 PM	3	71	10	1	85	0	0	0	0	0	21	99	0	0	120	18	0	23	0	41	246
Total	27	339	43	1	410	0	0	0	0	0	74	373	0	0	447	67	0	91	0	158	1015
02:00 PM	5	75	10	0	90	0	0	0	0	0	15	87	0	0	102	17	0	28	1	46	238
02:15 PM	1	90	12	0	103	0	0	0	0	0	21	119	0	0	140	12	0	29	0	41	284
02:30 PM	3	104	14	0	121	0	0	0	0	0	15	115	0	0	130	11	0	28	0	39	290
02:45 PM	4	77	11	0	92	0	0	0	0	0	24	105	0	0	129	12	0	19	0	31	252
Total	13	346	47	0	406	0	0	0	0	0	75	426	0	0	501	52	0	104	1	157	1064
03:00 PM	6	72	9	0	87	0	0	0	0	0	27	120	0	0	147	23	0	36	0	59	293
03:15 PM	5	82	7	0	94	0	0	0	0	0	28	145	0	0	173	10	0	22	0	32	299
03:30 PM	3	100	10	0	113	0	0	0	0	0	25	137	0	0	162	16	0	27	0	43	318
03:45 PM	5	116	19	0	140	0	0	0	0	0	22	154	0	0	176	15	0	35	0	50	366
Total	19	370	45	0	434	0	0	0	0	0	102	556	0	0	658	64	0	120	0	184	1276
04:00 PM	3	92	8	0	103	0	0	0	0	0	33	131	0	0	164	17	0	30	0	47	314
04:15 PM	3	90	9	0	102	0	0	0	0	0	38	167	0	0	205	15	0	22	0	37	344
04:30 PM	5	94	18	0	117	0	0	0	0	0	33	172	0	0	205	16	0	27	0	43	365
04:45 PM	4	111	18	0	133	0	0	0	0	0	23	231	0	0	254	14	0	22	0	36	423
Total	15	387	53	0	455	0	0	0	0	0	127	701	0	0	828	62	0	101	0	163	1446
05:00 PM	4	100	15	0	119	0	0	0	0	0	47	170	0	0	217	16	0	32	0	48	384
05:15 PM	3	96	7	0	106	0	0	0	0	0	42	179	0	0	221	20	0	25	0	45	372
05:30 PM	3	101	9	0	113	0	0	0	0	0	37	195	0	0	232	23	0	22	0	45	390
05:45 PM	4	112	11	0	127	0	0	0	0	0	39	170	0	0	209	20	0	32	0	52	388
Total	14	409	42	0	465	0	0	0	0	0	165	714	0	0	879	79	0	111	0	190	1534
Grand Total	175	3237	348	1	3761	0	1	0	0	1	743	3656	0	0	4399	442	0	860	1	1303	9464
Apprch %	4.7	86.1	9.3	0		0	100	0	0		16.9	83.1	0	0		33.9	0	66	0.1		
Total %	1.8	34.2	3.7	0	39.7	0	0	0	0	0	7.9	38.6	0	0	46.5	4.7	0	9.1	0	13.8	



Tennessee Department of Transportation  
Region 1 Traffic Office

File Name : Strawberry Plains@Brakebill  
Site Code : 00000047  
Start Date : 2/10/2009  
Page No : 2





Intersection of Strawberry Plains Pike and Brakebill Rd. Crash Summary 2005-2007

Collision Type	Cause	Number of Crashes	Total	Percent of Total
Rear End	Stopped Quickly	5	6	35%
	Distracted	1		
	Hydroplane	0		
Right Angle	Pulled in Front	8	10	59%
	Distracted	1		
	Wreckless	1		
Head on	Wreckless	1	1	6%
<b>Total Crashes</b>		<b>17</b>		

Damage	Number of Crashes	Percentage of Total
Property Damage	15	88%
Injury	1	6%
Incapacitating Injury	1	6%
Fatality	0	0%
<b>Total</b>	<b>17</b>	

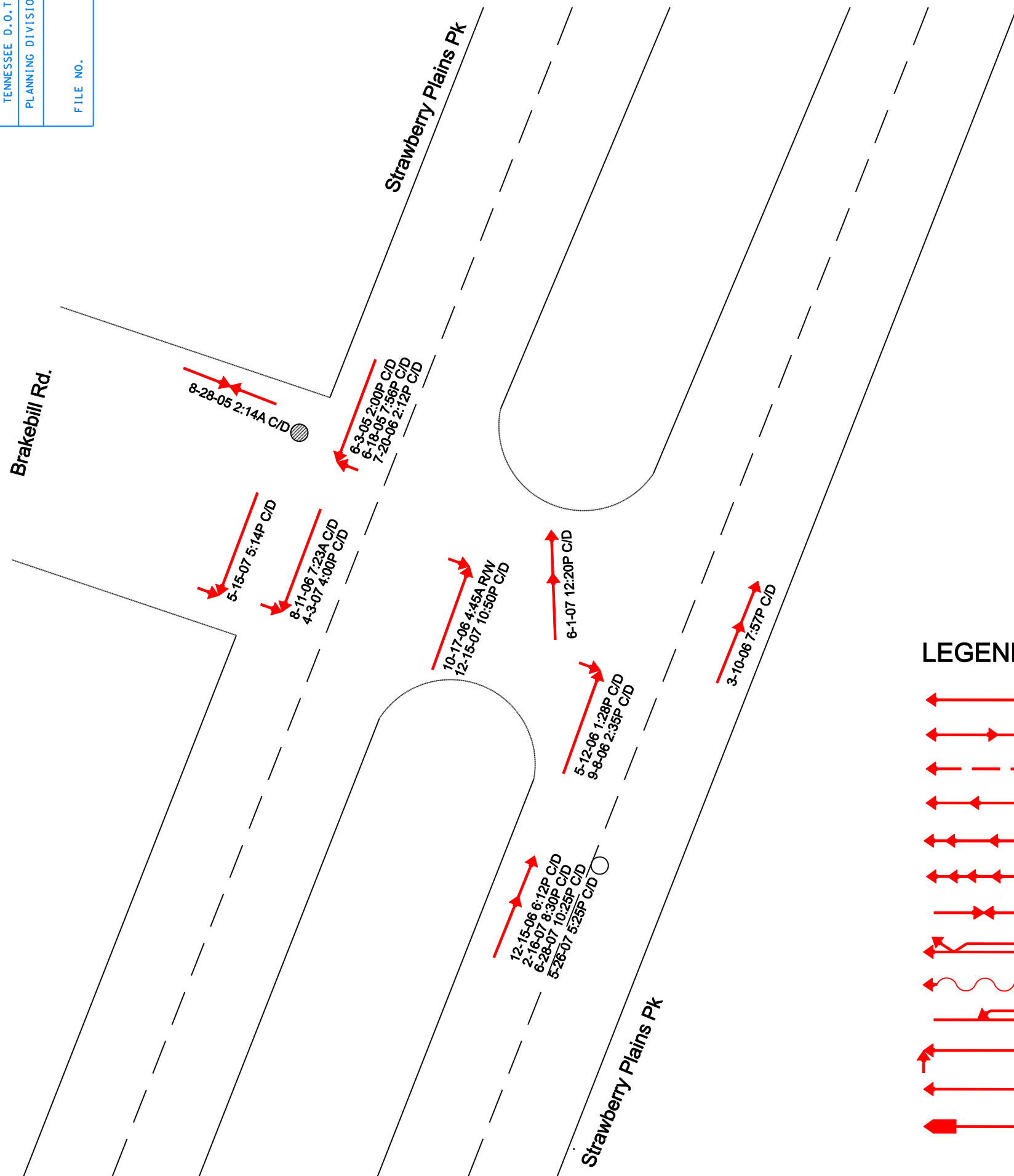
Time of Day	Number of Crashes	Percentage of Total
Day	12	71%
Night	5	29%
<b>Total</b>	<b>17</b>	

Conditions	Number of Crashes	Percentage of Total
C/D	16	94%
R/W	1	6%
Fog	0	0%
<b>Total</b>	<b>17</b>	

State Wide Average Crash Rating	Ra	0.19
Intersection Actual Accident Rate	R	2.6
Intersection Critical Accident Rate	Rc	0.63
Severity Index	SI	0.21
Ratio	R/Rc	4.1

LOCATION Strawberry Plains Pk/ Brakebill Rd.  
 CITY Knoxville COUNTY Knox  
 PERIOD COVERED 2005 to 2007  
 DATE COMPLETED 10/8/09  
 PREPARED BY RPM Transportation Consultants, LLC

TYPE	YEAR	PROJECT NO.	SHEET NO.
RSAR	2009		



NUMBER OF ACCIDENTS			
15	PROPERTY DAMAGE		
1	INCAPACITATING INJURY		
1	OTHER INJURY		
0	FATALITY		
17	TOTAL ACCIDENTS		

DAY	DRY	
	NIGHT	WET
12	5	1

**LEGEND**

- MOVING VEHICLE
- BACKING VEHICLE
- PEDESTRIAN
- REAR END
- THREE CAR REAR END
- FOUR CAR REAR END
- HEAD ON
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- RIGHT ANGLE
- AUTOMOBILE
- HEAVY TRUCKS & BUSES

**LEGEND**

- FATAL ACCIDENT
- INCAPACITATING INJURY
- INJURY ACCIDENT
- PARKED VEHICLE
- FIXED OBJECT
- STOP SIGN ON APPROACH

TIME

A = AM P = PM

PAVEMENT CONDITION

D = DRY I = ICY W = WET

WEATHER

C = CLEAR F = FOG R = RAIN



NOT TO SCALE

STATE OF TENNESSEE  
 DEPARTMENT OF TRANSPORTATION

Intersection  
 of Strawberry Plains Pike  
 and Brakebill Road



**APPENDIX O**

**TRAFFIC SIGNALIZATION WARRANTS**



# Traffic Signal Warrant Analysis

CIVIL ENGINEERING / TRAFFIC ENGINEERING

<b>Project Name</b>	<b>Brakebill Road Development</b>
<b>Project/File #</b>	<b>1803</b>
<b>Scenario</b>	<b>2018 - Existing Traffic Volumes</b>

<b>Intersection Information</b>	
Major Street Name	Strawberry Plains Pike
North/South or East/West	N/S
Speed Limit > 40 mph	No
# of Approach Lanes	2 or more
% of Right Turn Traffic to Include	100%
Minor Street Name	Brakebill Road
# of Approach Lanes	2 or more
% of Right Turn Traffic to Include	100%
Isolated Community < 10,000 pop	No

<b>Additional Warrants to Consider</b>	
Warrant 3, Peak Hour (A - Volume and Delay)	No
All-Way Stop Warrant	No



# Traffic Signal Warrant Analysis

CIVIL ENGINEERING TRAFFIC ENGINEERING

## Strawberry Plains Pike (Major Street) Volume

Northbound Volume by Hour				
Time	Left + U Turns	Through	Right Turns	Peds/Bikes
12 - 1 AM				
1 - 2 AM				
2 - 3 AM				
3 - 4 AM				
4 - 5 AM				
5 - 6 AM				
6 - 7 AM				
7 - 8 AM	56	369		
8 - 9 AM	56	324		
9 - 10 AM				
10 - 11 AM				
11 - 12 PM	71	407		
12 - 1 PM	91	449		
1 - 2 PM				
2 - 3 PM	83	465		
3 - 4 PM	103	579		
4 - 5 PM	140	705		
5 - 6 PM	152	720		
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
<b>Total Vehicles (unadjusted)</b>			<b>4,770</b>	<b>0</b>

Southbound Volume by Hour				
Time	U Turns	Through	Right Turns	Peds/Bikes
12 - 1 AM				
1 - 2 AM				
2 - 3 AM				
3 - 4 AM				
4 - 5 AM				
5 - 6 AM				
6 - 7 AM				
7 - 8 AM	38	717	36	
8 - 9 AM	34	516	29	
9 - 10 AM				
10 - 11 AM				
11 - 12 PM	16	401	38	
12 - 1 PM	29	432	52	
1 - 2 PM				
2 - 3 PM	10	371	48	
3 - 4 PM	26	444	54	
4 - 5 PM	16	439	57	
5 - 6 PM	11	440	44	
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
<b>Total Vehicles (unadjusted)</b>			<b>4,298</b>	<b>0</b>

## Brakebill Road (Minor Street) Volume

Eastbound Volume by Hour				
Time	Left Turns	Through	Right Turns	Peds/Bikes
12 - 1 AM				
1 - 2 AM				
2 - 3 AM				
3 - 4 AM				
4 - 5 AM				
5 - 6 AM				
6 - 7 AM				
7 - 8 AM	37		140	
8 - 9 AM	25		112	
9 - 10 AM				
10 - 11 AM				
11 - 12 PM	43		104	
12 - 1 PM	58		122	
1 - 2 PM				
2 - 3 PM	61		101	
3 - 4 PM	67		108	
4 - 5 PM	58		109	
5 - 6 PM	67		124	
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
<b>Total Vehicles (unadjusted)</b>			<b>1,336</b>	<b>0</b>

Westbound Volume by Hour				
Time	Left Turns	Through	Right Turns	Peds/Bikes
12 - 1 AM				
1 - 2 AM				
2 - 3 AM				
3 - 4 AM				
4 - 5 AM				
5 - 6 AM				
6 - 7 AM				
7 - 8 AM				
8 - 9 AM				
9 - 10 AM				
10 - 11 AM				
11 - 12 PM				
12 - 1 PM				
1 - 2 PM				
2 - 3 PM				
3 - 4 PM				
4 - 5 PM				
5 - 6 PM				
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
<b>Total Vehicles (unadjusted)</b>			<b>0</b>	<b>0</b>



# Traffic Signal Warrant Analysis

## Warrants 1 - 3 (Volume Warrants)

<b>Project Name</b>	Brakebill Road Development
<b>Project/File #</b>	1803
<b>Scenario</b>	2018 - Existing Traffic Volumes

Intersection Information			
Major Street (N/S Road)	Strawberry Plains Pike	Minor Street (E/W Road)	Brakebill Road
Analyzed with	2 or more approach lanes	Analyzed with	2 or more approach lanes
Total Approach Volume	9068 vehicles	Total Approach Volume	1336 vehicles
Total Ped/Bike Volume	0 crossings	Total Ped/Bike Volume	0 crossings
Right turn reduction of	0 percent applied	Right turn reduction of	0 percent applied

No speed or isolated community reduction applied to the warrant thresholds

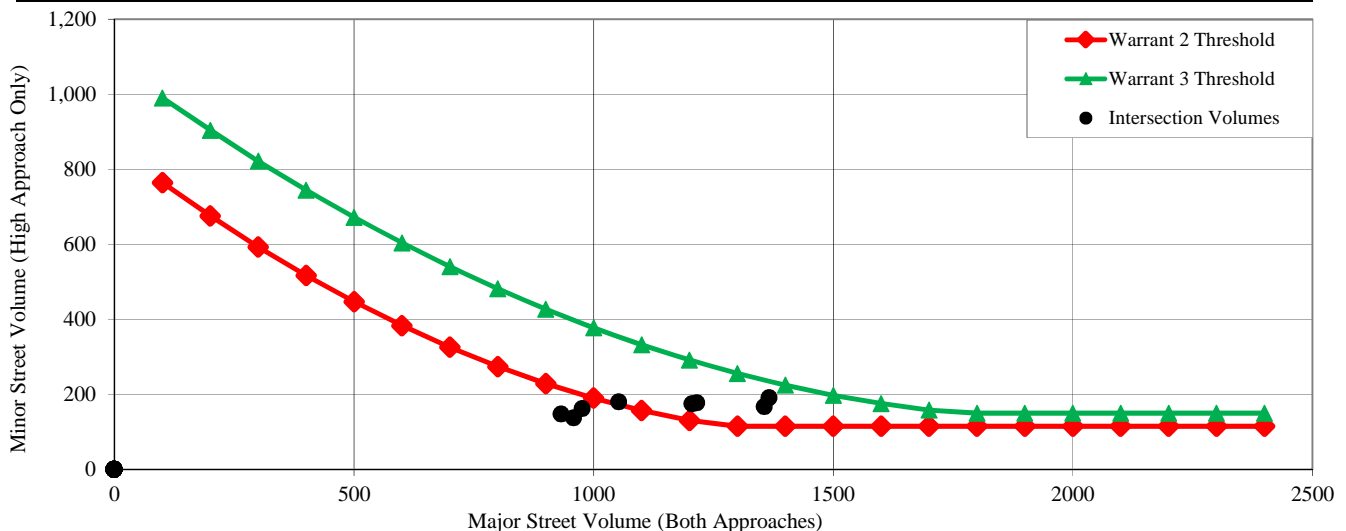
Warrant 1, Eight Hour Vehicular Volume			
Condition Satisfied?	<b>Not satisfied</b>	<b>Condition B Satisfied</b>	<b>Condition A+B* Not satisfied</b>
Required values reached for	0 hours	8 hours	6 (Cond. A) & 8 (Cond. B)
Criteria - Major Street (veh/hr)	600	900	480 (Cond. A) & 720 (Cond. B)
Criteria - Minor Street (veh/hr)	200	100	160 (Cond. A) & 80 (Cond. B)

\* Should be applied only after an adequate trail of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems.

Warrant 2, Four Hour Vehicular Volume	
Condition Satisfied?	<b>Satisfied</b>
Required values reached for	5 hours
Criteria	See Figure Below

Warrant 3, Peak Hour Vehicular Volume		
Condition Satisfied?	<b>Condition A Not Examined</b>	<b>Condition B Not Satisfied</b>
Required values reached for		0 hours
Criteria - Total Approach Volume (veh in one hour)		See Figure Below
Criteria - Minor Street High Side Volume (veh in one hour)		
Criteria - Minor Street High Side Delay (veh-hrs)		

Figure 4C-1 (Warrant 2) & Figure 4C-3 (Warrant 3)





# Traffic Signal Warrant Analysis

CIVIL ENGINEERING / TRAFFIC ENGINEERING

<b>Project Name</b>	<b>Brakebill Road Development</b>
<b>Project/File #</b>	<b>1803</b>
<b>Scenario</b>	<b>2018 - Existing Traffic Volumes</b>

<b>Intersection Information</b>	
Major Street Name	Strawberry Plains Pike
North/South or East/West	N/S
Speed Limit > 40 mph	No
# of Approach Lanes	2 or more
% of Right Turn Traffic to Include	100%
Minor Street Name	Brakebill Road
# of Approach Lanes	1
% of Right Turn Traffic to Include	0%
Isolated Community < 10,000 pop	No

<b>Additional Warrants to Consider</b>	
Warrant 3, Peak Hour (A - Volume and Delay)	No
All-Way Stop Warrant	No



# Traffic Signal Warrant Analysis

CIVIL ENGINEERING TRAFFIC ENGINEERING

## Strawberry Plains Pike (Major Street) Volume

Northbound Volume by Hour				
Time	Left + U Turns	Through	Right Turns	Peds/Bikes
12 - 1 AM				
1 - 2 AM				
2 - 3 AM				
3 - 4 AM				
4 - 5 AM				
5 - 6 AM				
6 - 7 AM				
7 - 8 AM	56	369		
8 - 9 AM	56	324		
9 - 10 AM				
10 - 11 AM				
11 - 12 PM	71	407		
12 - 1 PM	91	449		
1 - 2 PM				
2 - 3 PM	83	465		
3 - 4 PM	103	579		
4 - 5 PM	140	705		
5 - 6 PM	152	720		
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
Total Vehicles (unadjusted)			4,770	0

Southbound Volume by Hour				
Time	U Turns	Through	Right Turns	Peds/Bikes
12 - 1 AM				
1 - 2 AM				
2 - 3 AM				
3 - 4 AM				
4 - 5 AM				
5 - 6 AM				
6 - 7 AM				
7 - 8 AM	38	717	36	
8 - 9 AM	34	516	29	
9 - 10 AM				
10 - 11 AM				
11 - 12 PM	16	401	38	
12 - 1 PM	29	432	52	
1 - 2 PM				
2 - 3 PM	10	371	48	
3 - 4 PM	26	444	54	
4 - 5 PM	16	439	57	
5 - 6 PM	11	440	44	
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
Total Vehicles (unadjusted)			4,298	0

## Brakebill Road (Minor Street) Volume

Eastbound Volume by Hour				
Time	Left Turns	Through	Right Turns	Peds/Bikes
12 - 1 AM				
1 - 2 AM				
2 - 3 AM				
3 - 4 AM				
4 - 5 AM				
5 - 6 AM				
6 - 7 AM				
7 - 8 AM	37		140	
8 - 9 AM	25		112	
9 - 10 AM				
10 - 11 AM				
11 - 12 PM	43		104	
12 - 1 PM	58		122	
1 - 2 PM				
2 - 3 PM	61		101	
3 - 4 PM	67		108	
4 - 5 PM	58		109	
5 - 6 PM	67		124	
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
Total Vehicles (unadjusted)			1,336	0

Westbound Volume by Hour				
Time	Left Turns	Through	Right Turns	Peds/Bikes
12 - 1 AM				
1 - 2 AM				
2 - 3 AM				
3 - 4 AM				
4 - 5 AM				
5 - 6 AM				
6 - 7 AM				
7 - 8 AM				
8 - 9 AM				
9 - 10 AM				
10 - 11 AM				
11 - 12 PM				
12 - 1 PM				
1 - 2 PM				
2 - 3 PM				
3 - 4 PM				
4 - 5 PM				
5 - 6 PM				
6 - 7 PM				
7 - 8 PM				
8 - 9 PM				
9 - 10 PM				
10 - 11 PM				
11 - 12 AM				
Total Vehicles (unadjusted)			0	0



# Traffic Signal Warrant Analysis

## Warrants 1 - 3 (Volume Warrants)

<b>Project Name</b>	Brakebill Road Development
<b>Project/File #</b>	1803
<b>Scenario</b>	2018 - Existing Traffic Volumes

Intersection Information			
Major Street (N/S Road)	Strawberry Plains Pike	Minor Street (E/W Road)	Brakebill Road
Analyzed with	2 or more approach lanes	Analyzed with	1 Approach Lane
Total Approach Volume	9068 vehicles	Total Approach Volume	1336 vehicles
Total Ped/Bike Volume	0 crossings	Total Ped/Bike Volume	0 crossings
Right turn reduction of	0 percent applied	Right turn reduction of	1 percent applied

No speed or isolated community reduction applied to the warrant thresholds

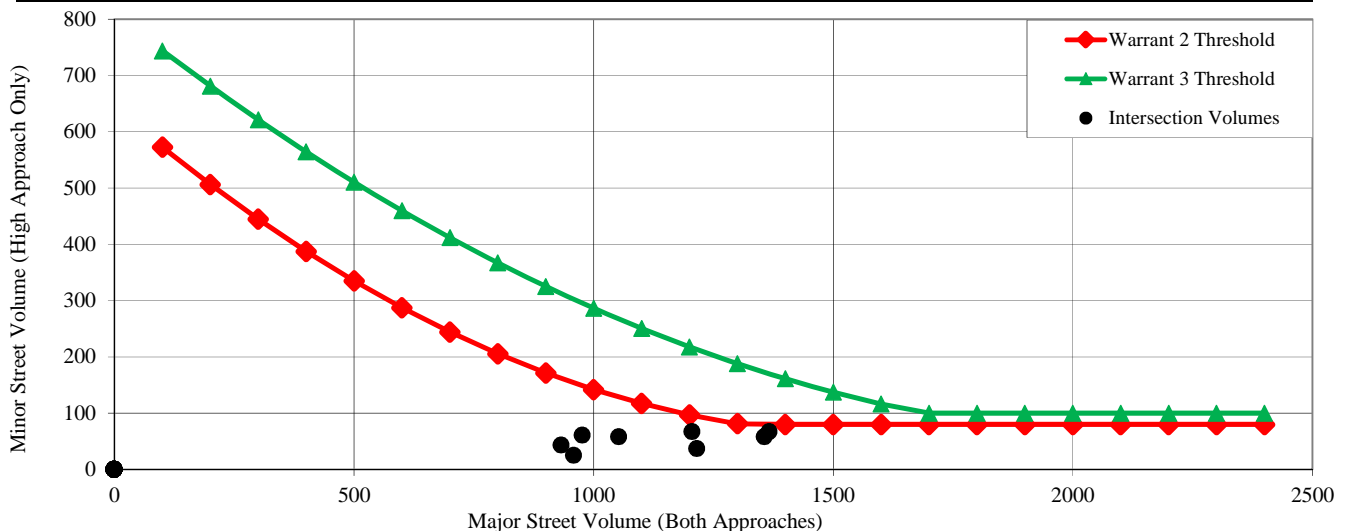
Warrant 1, Eight Hour Vehicular Volume			
Condition Satisfied?	<b>Not satisfied</b>	<b>Not satisfied</b>	<b>Not satisfied</b>
Required values reached for	0 hours	0 hours	0 (Cond. A) & 3 (Cond. B)
Criteria - Major Street (veh/hr)	600	900	480 (Cond. A) & 720 (Cond. B)
Criteria - Minor Street (veh/hr)	150	75	120 (Cond. A) & 60 (Cond. B)

\* Should be applied only after an adequate trail of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems.

Warrant 2, Four Hour Vehicular Volume	
Condition Satisfied?	<b>Not satisfied</b>
Required values reached for	0 hours
Criteria	See Figure Below

Warrant 3, Peak Hour Vehicular Volume		
Condition Satisfied?	<b>Not Examined</b>	<b>Not Satisfied</b>
Required values reached for		0 hours
Criteria - Total Approach Volume (veh in one hour)		See Figure Below
Criteria - Minor Street High Side Volume (veh in one hour)		
Criteria - Minor Street High Side Delay (veh-hrs)		

Figure 4C-1 (Warrant 2) & Figure 4C-3 (Warrant 3)





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

May 30, 2018

**PROJECT NAME: Brakebill Road Development**

**TO: Knoxville/Knox County Metropolitan Planning Commission (MPC)  
City of Knoxville Engineering Department  
Knox County Engineering Department**

**SUBJECT: TIS Comment Response Document for Brakebill Road Development  
Review Comments Dated May 24, 2018**

Dear MPC, City of Knoxville, and Knox County Staff,

The following comment response document is submitted to address comments dated May 24, 2018. Below, the first set of reviewer comments is from John Sexton, PE, Knox County Engineering and the second set of reviewer comments is from Tarren Barrett, MPC. Comments that were noted by both reviewers are addressed in the responses given under John Sexton's review comments.

**John Sexton, PE, Knox County Engineering:**

**Reviewer Comment: Page i: The section headings for pages 51 and 52 should read "Brakebill Road" instead of "Hammer Road".**

**Response:** On Page i, the section headings for pages 51 and 52 have been changed to "Brakebill Road" instead of "Hammer Road".

**Reviewer Comment: Page 1: Under Study Results, first bullet, first line, change "constructing" to "constructed".**

**Response:** On Page 1, under Study Results, first bullet, first line, "constructing" was changed to "constructed".

**Reviewer Comment: Page 7: Under the discussion of Hammer Road, add a statement that it is classified as a minor collector in the study area.**



Response: On Page 7, under the discussion of Hammer Road in the 2<sup>nd</sup> paragraph, second sentence, a statement was added that Hammer Road is classified as a minor collector in the study area.

**Reviewer Comment: Page 16: In the first paragraph, please add a statement that the layout for the proposed warehouse/storage including its driveway is not complete and that the approximate driveway is indicated only with a call-out in Figure 3.**

Response: On Page 16, in the first paragraph, a note has been added that the mini-warehouse driveway location is shown only with a call-out in Figure 3.

**Reviewer Comment: Page 28: Third paragraph, second line change "poor" to "poorly".**

Response: On Page 28, third paragraph, on the second line, the word "poor" was changed to "poorly".

**Reviewer Comment: Page 34: First paragraph, last line change "show" to "shown". It would be helpful to have separate trip distribution and traffic assignment figures for each land use, especially since they each have their own access points. The spreadsheet was hard to follow.**

Response: On Page 34, on the last line, the word "show" was changed to "shown". It was decided that it would be less confusing to keep the same trip distribution and assignment figures since there is overlap with entering and exiting trips at the different intersections. The spreadsheet located in the appendix was enhanced and revised.

**Reviewer Comment: Pages 35-38: Some of the percentages do not add up. In Figure 6A, the split entering from the south on Strawberry Plains Pike and from the east on 1-40 is 24% (18% NB + 6% WB). However, the entering northbound split at Strawberry Plains Pike/Brakebill Road is 25%. Other similar rounding errors in 6A, 6B, 7A and 7B. Please make sure the math adds up throughout by adjusting rounded values.**

Response: On Pages 35-38, the percentages were re-calculated from the trip distribution spreadsheet located in the appendix and the numbers shown in 6A, 6B, 7A, and 7B were adjusted to account for rounding values from the spreadsheet. The trip assigned values from 7A and 7B were also updated in Figure 8.

**Reviewer Comment: Page 46: Rewrite part of line 6 as follows: "TDOT safety funding, the *ratio of the actual crash rate to the critical crash rate (A/C ratio) ....*" (add italicized text)**

Response: Line 6 on Page 46 has been rewritten as “To obtain TDOT safety funding, the ratio of the actual crash rate to the critical crash rate (A/C ratio) would need to be 3.5 or higher.”

**Reviewer Comment: Page 47: Section 2a- Please measure sight distance in the field per County criteria and report here. Section 2b- Please evaluate left- and right-turn lane warrants for this intersection and report here.**

Response: On Page 47, section 2a, a sentence has been included that states that “The sight distance at this intersection is in excess of 450 feet looking north and south from Hammer Road”. The evaluation for left and right turn lane warrants for this intersection has been added to Section 2b and the graphs for this evaluation has been added to Appendix L.

**Reviewer Comment: Page 48: Section 3a- Please measure sight distance in the field at the edge of Hammer Road at the location of Road I and report here.**

Response: On Page 48, section 3a, a sentence has been included that states that “The sight distance at this proposed intersection has been measured by a land surveyor and is more than 400 feet looking east and west from the proposed Road “I”.”

**Reviewer Comment: Page 49: Section 4a- Please measure sight distance in the field at the edge of Brakebill Road at the location of the apartment driveway and report here.**

Response: On Page 49, section 4a, a sentence has been included that states that “However, a land surveyor has not verified the sight distance at this proposed intersection since a design and location of the driveway for the apartment complex has not been finalized. Once the design is finalized, the sight distance will be confirmed based on the Knox County policy and standards.”

**Reviewer Comment: Page 51: The section heading for section 5 should read "Brakebill Road" instead of "Hammer Road". Section 5a- Please measure sight distance in the field at the edge of Brakebill Road at the location of the warehouse/storage driveway and report here.**

Response: On Page 51, the section heading for section 5 has been changed to “Brakebill Road” instead of “Hammer Road”. On Page 51, section 5a, a sentence has been included that states that “A land surveyor has not verified the sight distance at this proposed intersection since a design and location of the driveway for the mini-warehouse facility has not been finalized. Once the design is finalized, the sight distance will be confirmed based on the Knox County policy and standards.”

**Reviewer Comment: Page 52: The section heading for section 6 should read "Brakebill Road" instead of "Hammer Road". Section 6a- Please measure sight distance in the field at the edge of Brakebill Road at the location of Road A and report here.**

**Response:** On Page 52, the section heading for section 6 has been changed to "Brakebill Road" instead of "Hammer Road". Section 6a has been changed to "With a posted speed limit of 30 mph, this would indicate a required sight distance of 300 feet looking north and south for eastbound left and right turn movements at Road "A". The sight distance at this proposed intersection has been measured by a land surveyor and is more than 450 feet looking north and is 325 feet looking south from the proposed Road "A".

**Reviewer Comment: Page 53: Third paragraph, first line change "southbound" to "northbound".**

**Response:** On Page 53, third paragraph, the first line was changed from "southbound" to "northbound".

**Reviewer Comment: Page 54: Section 6e, third line change Hammer Road to Brakebill Road and change Road I to Road A.**

**Response:** On Page 54, section 6e, the third line was changed from "Hammer Road" to "Brakebill Road" and changed from "Road I" to "Road A".

**Reviewer Comment: Page 67: Insert a figure following the discussions of existing public roads to summarize the improvements explicitly recommended in the TIS:**

- Adjust signal timing at Asheville Highway/Brakebill Road
- Add STOP sign and stop bar on Hammer Road at Brakebill Road
- Build a northbound left-turn lane on Brakebill Road at Road A
- Build a second northbound left-turn lane on Strawberry Plains Pike at the I-40 westbound on-ramp
- Signalize the intersection of Brakebill Road/Strawberry Plains Pike
- Remove roadside hazards from Brakebill Road
- Install warning signs for two horizontal curves on Brakebill Road
- Install centerline and edgeline rumblestrips on Brakebill Road

**Response:** Figure 10 on page 72 has been included in the report and shows an overview of the external road and intersection recommendations.

**Tarren Barrett, MPC:**

**Reviewer Comment: Page 1: Change 301 single-family detached home sites to 309 detached and attached home sites. "Self-storage" has been determined as a land use not available.**

Response: The text on page 1 has been changed from 301 single-family detached homes sites to 247 detached and 78 attached homes sites. Also, throughout the report, the amount of residential single-family lots has been updated to include the mix of detached and attached homes. This mix of attached and detached lots has also been updated in the Trip Generation calculations and the subsequent analyses. The term “Self-storage” has been eliminated in all parts of the report. A sentence has been added on Page 18 that mentions that the mini-warehouse facility property will need to be re-zoned in the future to allow this land use.

**Reviewer Comment: Page 2: All recommendations should have a figure or map showing improvements recommended.**

Response: Figure 10 on page 72 has been included in the report and shows an overview of the external road and intersection recommendations.

**Reviewer Comment: Page 3: What is the width of pavement on Brakebill Road?**

Response: On Page 3, the existing width of pavement on Brakebill Road has been added in the discussion at the end of the paragraph.

**Reviewer Comment: Page 4: Concept plan shows 309 attached and detached home sites.**

Response: Throughout the report, the amount of residential single-family lots has been updated to include the mix of detached and attached homes. This mix of attached and detached lots have been updated in the Trip Generation calculations and the subsequent analyses.

**Reviewer Comment: Page 31: Remove blank rows in Table 6a.**

Response: On Page 31, the blank rows have been removed in Table 6a.

**Reviewer Comment: Page 35: Figure 6a shows discrepancies in percentages for directional distribution.**

Response: On Pages 35-38, the percentages were re-calculated from the trip distribution spreadsheet located in the appendix and the numbers shown in 6A, 6B, 7A, and 7B were adjusted to account for rounding values from the spreadsheet. The trip assigned values from 7A and 7B were also updated in Figure 8.

**Reviewer Comment: Page 56: Last paragraph, what is the distance in between Strawberry Plains Pike at Interstate 40 On/Off Ramps and the intersection of Strawberry Plains Pike at Brakebill Road?**

Response: On Page 56, in the last paragraph, the sentence discussing the short distance in between Strawberry Plains Pike at Interstate 40/Off Ramps has been updated that states the distance is approximately 270 feet.

**Reviewer Comment: Page 61: Last paragraph, rephrase first sentence.**

Response: On Page 61, last paragraph, the first sentence has been rephrased and the entire paragraph has been revised to improve its readability.

**Reviewer Comment: Page 64: Under section I, where are the roadside hazards located?**

Response: At the end of section 9 under the Conclusions and Recommendations, starting on page 68, photographs of the roadside hazards that have been located on Brakebill Road have been added to the report.

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

- Updated Page Footers
- Updated Title Page
- Updated Table of Contents
- Updated Figures 6A, 6B, 7A, 7B, and 8
- Added Figure 10
- Updated Tables 6A-6E, 7, 10, and 11
- Updated Appendix G, H, I, L, and M

If you have any questions or further comments, please feel free to contact me at any time. I look forward to your review and approval.

Sincerely,

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

