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Troutbeck Farm Development

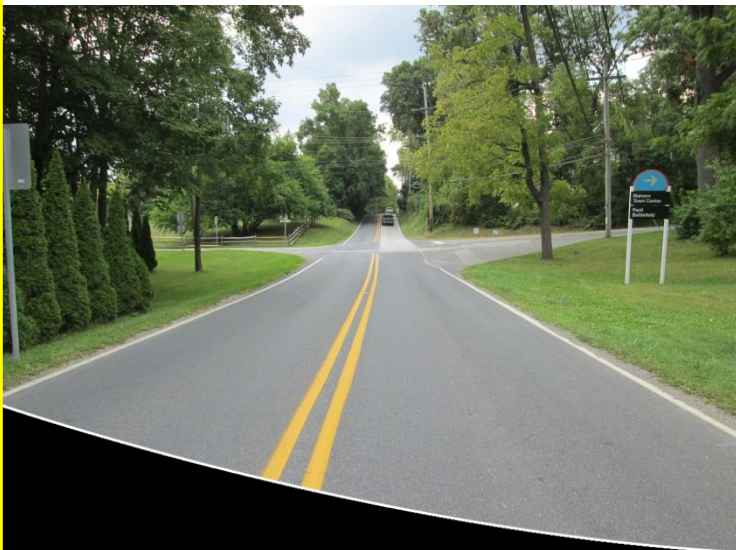
Willistown Township, Chester County PA

For Submission To:

Willistown Township

Last Revised: October 22, 2014

TPD# INLM.A.00002



**TROUTBECK FARM DEVELOPMENT
TRANSPORTATION IMPACT STUDY**

For Submission to:

Willistown Township, Chester County, PA

Prepared For:

**Integrated Land Management
3 Lucas Lane
Malvern, PA 19355**

**October 22, 2014
TPD # INLM.A.00002**

Prepared By:

**Traffic Planning and Design, Inc.
Sanatoga Commons
2500 East High Street, Suite 650
Pottstown, Pennsylvania 19464**

**Phone: (610) 326-3100
Fax: (610) 326-9410
E-mail: TPD@TrafficPD.com
Web Site: www.trafficpd.com**

**Eric Ostimchuk, P.E., PTOE
Principal
Pennsylvania License Number PE061971**

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EXECUTIVE SUMMARY

The purpose of this study is to examine the potential traffic impact associated with the proposed Troutbeck Farm development on the roadway network in Willistown Township, Chester County, PA. Based on this evaluation, the following conclusions were reached:

1. The project scope and the extent of the study area were discussed with Willistown Township. The study area intersections included in this TIS are as follows:
 - Sugartown Road & Monument Road;
 - Sugartown Road & Forest Lane;
 - Monument Road & Hickory Lane;
 - Forest Lane & Hickory Lane;
 - Forest Lane & Oak Tree Lane.
2. The project site is bound by Monument Road to the north, Stonehenge Lane to the east and Forest Lane to the south. The proposed site will consist of 36 single-family homes;
3. Access to the site is proposed via four full-access driveways: one to Forest Lane, and two to Monument Road and a connection to the existing terminus of Friarsheel Lane;
4. **All proposed driveway location sight distances**
5. Upon full build-out, the proposed development is expected to generate 35 new vehicle-trips during the weekday A.M. peak hour and 42 new vehicle-trips during the weekday P.M. peak hour.
6. All overall intersection levels of service (ILOS) will operate at an acceptable ILOS D or better during the 2019 projected condition scenarios. Furthermore, all overall intersection delays fall within PennDOT’s allowable 10-second variance between base (no-build) and projected (build) condition scenarios. Although the overall LOS at Monument Road & Sugartown Road operates acceptably we note delay on the Monument Road approaches.
7. Under the 2019 projected conditions, all approaches and turning movements at the site driveway intersections with the external roadway network will operate at LOS B or better during weekday A.M., and P.M. peak hours.
8. The peak hour volume warrant is not satisfied at the intersection of Monument Road and Sugartown Road under 2019 projected conditions.
9. Levels of Service (LOS) for the study area intersections have been summarized in matrix form. **Table I** details the overall intersection LOS for each study area intersection.



**TABLE I
OVERALL INTERSECTION LEVEL OF SERVICE SUMMARY**

Intersection	Weekday A.M. Peak Hour			Weekday P.M. Peak Hour		
	Existing	2019 Opening Year		Existing	2019 Opening Year	
		Base	Projected		Base	Projected
Monument Road & Sugartown Road	B (13.2)	C (24.0)	D (27.7)	A (7.6)	A (9.7)	B (10.4)
Sugartown Road & Forest Lane	A (3.0)	A (3.2)	A (3.4)	A (2.4)	A (2.6)	A (2.7)
Forest Lane & Oak Tree Lane/Site Access	A (0.3)	A (0.3)	A (1.0)	A (0.3)	A (0.3)	A (0.9)
Forest Lane & Hickory Lane	A (10.0)	B (10.7)	B (10.8)	A (8.3)	A (8.6)	A (8.6)
Hickory Lane & Monument Road	A (2.4)	A (2.4)	A (2.5)	A (6.7)	A (6.8)	A (6.9)
Monument Road & Western Access	-	-	A (0.0)	-	-	A (0.1)
Monument Road & Eastern Access	-	-	A (0.0)	-	-	A (0.1)

Base = No-Build scenario; Projected = Build scenario



INTRODUCTION

Traffic Planning and Design, Inc. (TPD) has completed a Transportation Impact Study (TIS) for the proposed Troutbeck Farm Development in Willistown Township, Chester County, Pennsylvania. The project site is bound by Monument Road to the north, Stonehenge Lane to the east and Forest Lane to the south as shown in **Figure 1**. As shown in **Figure 2**, the proposed site will consist of 36 single-family homes.

This report has been prepared in accordance with PennDOT’s *Policies and Procedures for Transportation Impact Studies*, dated January 28, 2009. The project scope and the extent of the study area were discussed with a representative of Willistown Township.

Site Access Locations

The proposed site will be served by four full-movement driveways: one to Forest Lane, opposite Oak Tree Lane and two to Monument Road, as well as a connection to the existing terminus of Friarsheel Lane.

EXISTING ROADWAY NETWORK

A field review of the existing roadway system in the study area was conducted. The existing roadway characteristics within the study area are summarized in **Table 1**. Photographs of the study area intersections are included in **Appendix A**.

**TABLE 1
ROADWAY CHARACTERISTICS WITHIN STUDY AREA**

Roadway	Ownership	Functional Classification/ Roadway Type	Predominant Directional Orientation	Average Daily Traffic	Posted Speed Limit
Sugartown Road	State (S.R. 2022)	Urban Collector	North-South	4,780	35 mph
Monument Road	Local		East-West	2,205	35 mph
Forest Lane	Local		East-West	2,200	35 mph
Hickory Lane	Local		North-South	2,435	35 mph
Oak Tree lane	Local		North-South	75	35 mph

Bicycle and Pedestrian Facilities

Based on observations during field visits at the study area intersections, there are no pedestrian accommodations present in the vicinity of the proposed development.



Mass Transit Facilities

Chester County and the Willistown Township area are provided with public transportation by SEPTA. Public transportation is available in the vicinity of the proposed site via Malvern Train Station. There are no bus stops in the area of the proposed development.

Crash Data Investigation

Crash data were obtained from PennDOT for the study area intersections. PennDOT defines a reportable crash as follows, “A reportable (crash) is one in which an injury or fatality occurs or if at least one of the vehicles involved requires towing from the scene.” Reportable crashes were tabulated for the five-year time period beginning 01/01/2009 and ending 12/31/2013. For a given intersection, PennDOT considers a crash occurrence of 5 reportable, correctable crashes over a continuous twelve-month period during the past five years to be a threshold value, above which the intersection design should be reviewed to examine if corrective measures can be taken to enhance safety. The number of reportable crashes at the study area intersections is shown in **Table 2**.

**TABLE 2
PENNDOT REPORTABLE CRASH DATA**

Study Area Intersection	Number of Reportable Crashes				
	2009	2010	2011	2012	2013
Sugartown Road & Monument Road	5	2	1	0	1
Oak Tree Lane & Forest Lane	0	0	1	0	0
Sugartown Road & Forest Lane	0	0	0	0	0
Hickory Lane & Monument Road	0	0	0	0	0
Hickory Lane & Forest Lane	0	0	0	0	0

Based on a review of the crash data, there was one, twelve-month period during the past five years where 5 or more crashes occurred that were deemed correctable. The Sugartown Road/Monument Avenue intersection had 5 angle crashes involving an eastbound or westbound vehicle on Monument Road traveling through the intersection which was struck by a southbound vehicle going straight. However, based on a field view and a review of historical photographs, “Cross Traffic Does Not Stop” Signs were installed sometime after 2007. Since 2009, the crashes occurring at the intersection decreased to less than 5 crashes per 12 month period.



EXISTING TRAFFIC CONDITIONS

Manual Turning Movement Counts

Manual traffic counts were conducted on 15-minute intervals during the weekday morning (7:00 to 9:00 A.M.) and weekday evening (4:00 to 6:00 P.M.) peak periods. Data pertaining to heavy vehicles, pedestrians and transit vehicles were observed during the manual counts. Peak hours and count dates for the study area intersections are identified in **Table 3**.

**TABLE 3
MANUAL TRAFFIC COUNT INFORMATION**

Intersection	Date of Traffic Counts	Time Period	Intersection Peak Hour¹
<i>Monument Road & Sugartown Road</i>	Thursday September 18, 2014	Weekday A.M.	7:30 A.M. – 8:30 A.M.
	Wednesday September 17, 2014	Weekday P.M.	5:00 P.M. – 6:00 P.M.
<i>Sugartown Road & Forest Lane</i>	Thursday September 18, 2014	Weekday A.M.	7:30 A.M. – 8:30 A.M.
	Wednesday September 17, 2014	Weekday P.M.	5:00 P.M. – 6:00 P.M.
<i>Forest Lane & Oak Tree Lane</i>	Thursday September 18, 2014	Weekday A.M.	7:15 A.M. – 8:15 A.M.
	Wednesday September 17, 2014	Weekday P.M.	4:45 P.M. – 5:45 P.M.
<i>Forest Lane & Hickory Lane</i>	Thursday September 18, 2014	Weekday A.M.	7:15 A.M. – 8:15 A.M.
	Wednesday September 17, 2014	Weekday P.M.	5:00 P.M. – 6:00 P.M.
<i>Hickory Lane & Monument Road</i>	Thursday September 18, 2014	Weekday A.M.	7:15 A.M. – 8:15 A.M.
	Wednesday September 17, 2014	Weekday P.M.	5:00 P.M. – 6:00 P.M.

1. Peak Hour consists of the four consecutive 15-minute intervals where the highest traffic volumes occur.

Existing condition traffic volumes for the weekday A.M. and weekday P.M. peak hours are illustrated in **Figures 3 and 4**, respectively. Manual traffic count data sheets are provided in **Appendix B**.

Speed Study

TPD conducted a speed study using a Decatur Radar Gun on Forest Lane and Monument Road, in the vicinity of the proposed site driveway locations. The travel speed, as defined by PennDOT, is established by determining the 85th percentile speed, which is the speed which 85% of the drivers travel at or below. Based on the speed study, the 85th percentile speed on Forest Lane in the vicinity of the proposed site driveway location was found to be **30 m.p.h.** westbound around the curve to the left of the proposed driveway. The 85th percentile speed on Monument Road in the vicinity of the proposed site driveway location, was found to be **39 m.p.h.** eastbound, and **37 m.p.h.** westbound. The speed study worksheets are included in **Appendix B**.



PROPOSED SITE ACCESS

The proposed site will be served by four full-movement driveways: one to Forest Lane, opposite Oak Tree Lane and two to Monument Road and a connection to the existing terminus of Friarsheel Lane.

Sight Distance Analysis

A sight distance analysis was prepared for the proposed site driveways. In general, recommended safe sight distances depend upon the posted speed limit and roadway grades. The existing sight distances at the proposed driveways were measured in accordance with PennDOT Publication 282 Highway Occupancy Permit Guidelines and compared to PennDOT’s desirable sight distance standard, which is identified in 67 PA Code Chapter 441.8(h), “Access to and Occupancy of Highways by Driveways and Local Roads.” In addition, measured sight distances at the proposed driveways were compared to PennDOT’s safe stopping sight distance standard, which is calculated by the following equation:

$$SSSD = 1.47VT + V^2/[30(f+g)]$$

SSSD = safe stopping sight distance (acceptable sight distance)

V = Vehicle Speed

T = Perception Reaction Time of Driver (2.5 seconds)

f = Coefficient of Friction for Wet Pavements

g = Percent of Roadway Grade Divided by 100

The posted speed limit and the calculated travel speeds were used in determining the desirable sight distance and the acceptable sight distances at each driveway location. Also, Section 123.-28.K of the Willistown Township ordinance indicates vehicle sight distances for street intersections.

Tables 3-5 show the measured, desirable, acceptable (SSSD), and ordinance sight distances at the site driveways for vehicles entering and exiting the site.

**TABLE 3
SIGHT DISTANCE ANALYSIS
SITE DRIVEWAY TO FOREST LANE**

	<i>Direction</i>	Posted Speed (mph)	Travel Speed (mph)	<i>Sight Distances (feet)</i>					
				Grade ¹ (%)	Twp ²	DES ²	SSSD ²	SSSD ³	EXIST
Exiting Movements	<i>To the left</i>	35	30	2.4%	300	440	242	191	278
	<i>To the right</i>	35	-	-1.6%	300	350	256	-	371
Entering Left Turns	<i>Approaching same direction</i>	35	-	-1.6%	300	300	256	-	350
	<i>Approaching opposite direction</i>	35	30	2.4%	300	300	242	191	335

DES = PennDOT Desirable Sight Distance
SSSD = PennDOT Acceptable Sight Distance
EXIST = Existing (measured) Sight Distance

1 = Roadway Grade Approaching Driveway
2 = Based on the posted speed
3 = Based on the travel speed



**TABLE 4
SIGHT DISTANCE ANALYSIS
WESTERN DRIVEWAY TO MONUMENT RD**

	<i>Direction</i>	Posted Speed (mph)	Travel Speed (mph)	<i>Sight Distances (feet)</i>					
				Grade ¹ (%)	Twp ²	DES ²	SSSD ²	SSSD ³	EXIST
Exiting Movements	<i>To the left</i>	35	39	9.5%	300	440	221	264	450+
	<i>To the right</i>	35	37	-9.6%	300	350	299	334	328
Entering Left Turns	<i>Approaching same direction</i>	35	37	-9.6%	300	300	299	334	400+
	<i>Approaching opposite direction</i>	35	39	9.5%	300	300	221	264	400+

DES = PennDOT Desirable Sight Distance
 SSSD = PennDOT Acceptable Sight Distance
 EXIST = Existing (measured) Sight Distance

1 = Roadway Grade Approaching Driveway
 2 = Based on the posted speed
 3 = Based on the travel speed

**TABLE 5
SIGHT DISTANCE ANALYSIS
EASTERN DRIVEWAY TO MONUMENT RD**

	<i>Direction</i>	Posted Speed (mph)	Travel Speed (mph)	<i>Sight Distances (feet)</i>					
				Grade ¹ (%)	Twp ²	DES ²	SSSD ²	SSSD ³	EXIST
Exiting Movements	<i>To the left</i>	35	39	2.0%	300	440	242	292	340
	<i>To the right</i>	35	37	0%	300	350	249	274	400+
Entering Left Turns	<i>Approaching same direction</i>	35	37	0%	300	300	249	274	400+
	<i>Approaching opposite direction</i>	35	39	2.0%	300	300	242	292	359

DES = PennDOT Desirable Sight Distance
 SSSD = PennDOT Acceptable Sight Distance
 EXIST = Existing (measured) Sight Distance

1 = Roadway Grade Approaching Driveway
 2 = Based on the posted speed
 3 = Based on the travel speed

As shown in **Tables 3-5** above, the measured sight distances at the site driveways exceed PennDOT’s desirable sight distance requirements, with three exceptions. The sight distance for exiting vehicles looking to the left from the Forest Lane access, the sight distance for exiting vehicles looking to the right from the western Monument Road access and exiting vehicles looking to the left from the eastern Monument Road access do not meet the PennDOT desirable sight distance requirement. However, the Forest Lane access and the eastern Monument Road access points are shown to meet the PennDOT SSSD standards.

As shown in Table 1-3, the measured sight distances at the site driveway exceed the Township Ordinance requirements, with one exception: The sight distance looking to the left at the Forest Lane access does not meet the ordinance requirement. However, the sight distance at the Forest Lane access and the eastern Driveway to Monument Road both exceed PennDOT’s SSSD requirement.



As indicated in Table 2, the sight distance to the right looking out of the western access does not meet the acceptable levels as it is hindered by the vertical curve of the roadway. In order to meet the acceptable level of sight distance, the following could be pursued: relocate the access or re-profile Monument Road.

BASE (NO-BUILD) CONDITIONS

Annual Background Growth

A background growth factor for the roadways in the study area was developed based on growth factors for September 2012 to July 2013 obtained from the PennDOT Bureau of Planning and Research (BPR). The PennDOT BPR suggests using a background growth trend factor of 1.91% per year in Chester County for urban non-interstate roadways. As such, the background growth factor was applied annually to yield overall growth percentages of 9.92% (1.91% per year, compounded over 5 years) for the 2019 opening year.

Nearby Proposed Developments

Base (no-build) traffic conditions were calculated to include traffic volumes from proposed developments, which, though not operating under existing conditions, may be operating by the opening year (2019) of the proposed development. Based on discussions with Willistown Township staff, the following nearby planned developments were specifically included in this study:

Applebrook Phase III is a proposed residential development consisting of 33 townhomes. The site is located on the east side of Township Line Road, south of Paoli Pike. Access is proposed via one full movement driveway to Township Line Road. Trip distributions for this development were developed based on existing traffic volumes.

The additional traffic volumes due to background growth and the background development were added to the existing traffic data to produce 2019 base (no-build) condition traffic volumes. Base condition volumes for the weekday A.M. and weekday P.M. peak hours are illustrated in **Figures 5 and 6** for the 2019 conditions. Trip distributions for the background developments are provided in **Appendix C**.

TRIP GENERATION

The trip generation rates for the proposed development were obtained from the manual *Trip Generation*, Ninth Edition, 2012, an Institute of Transportation Engineers (ITE) Informational Report. The statistics in *Trip Generation* are empirical data based on more than 4,800 trip generation studies. The data are categorized by Land Use Codes, with total vehicular trips for a given land use estimated using an independent variable and statistically generated rates or equations.

For the proposed Troutbeck Farm development, Land Use Code 210 (Single-Family Detached Housing) from *Trip Generation* was used to calculate the number of vehicular trips the development will generate during the following time periods: (1) average weekday; (2) weekday A.M. peak hour;



and (3) weekday P.M. peak hour. **Table 6** shows the equations and directional percentages for the analyzed time periods.

**TABLE 6
ITE TRIP GENERATION DATA**

Land Use	ITE #	Time Period	Equations	Entering %	Exiting %
Single-Family Detached Housing	210	Weekday A.M. Peak Hour	$T = 0.70*(X) + 9.74$	25%	75%
		Weekday P.M. Peak Hour	$\ln(T) = 0.90*\ln(X) + 0.51$	63%	37%
		Weekday	$\ln(T) = 0.92*\ln(X) + 2.72$	50%	50%

T = number of site-generated vehicular trips
X = independent variable (dwelling units)

**TABLE 7
TRIP GENERATION SUMMARY**

Land Use	Size	Time Period	Enter	Exit	Total
Single-Family Detached Housing (210)	36 units	Weekday A.M. Peak Hour	9	26	35
		Weekday P.M. Peak Hour	26	16	42
		Average Weekday	206	206	412

X = Independent Variable (dwelling units)

Based on the trip generation analysis summarized in **Table 7**, the Troutbeck Farm development will generate approximately 35 new trips during the weekday A.M. peak hour and 42 new trips during the weekday P.M. peak hour.

Pedestrian Trip Generation

Pedestrian trip generation for the site is expected to be minimal, and all trips to/from the proposed site were assumed to be motor vehicles in order to assume worst-case volumes for assessing traffic impact.

TRIP DISTRIBUTION

The distribution of trips generated by the proposed development was based on the local road network, the existing traffic patterns, the proposed use of the site, and the site driveway locations. The new trips for the proposed development were distributed to the local roadway network based on the percentages shown in **Table 8**.



**TABLE 8
TRIP DISTRIBUTION PERCENTAGES – NEW TRIPS**

Direction - To/From	Assignment (To/From)	Distribution Percentage
East	via Monument Road	30%
West	via Forest Lane	30%
North	via Sugartown Road	5%
	via Hickory Lane	5%
South	via Sugartown Road	30%

The assignment of site-generated trips for the proposed development during the weekday A.M. and P.M. peak hours are shown in **Figures 7 and 8** respectively.

PROJECTED (BUILD) CONDITION TRAFFIC VOLUMES

The site-generated trips for the proposed development were added to the 2019 base (no-build) condition traffic volumes to develop 2019 projected (build) condition traffic volumes.

Projected condition traffic volumes for the opening year of 2019 for the weekday A.M. and P.M., peak hours are shown in **Figures 9 and 10**, respectively. Traffic volume development worksheets are contained in **Appendix D**.

LEVELS OF SERVICE FOR AN INTERSECTION

For analysis of intersections, level of service is defined in terms of delay, which is a measure of driver discomfort and frustration, fuel consumption, and lost travel time. LOS criteria is stated in terms of control delay per vehicle for a one-hour analysis period. Control delay includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. The criteria are shown in **Table 10**. Delay, as it relates to level of service, is a complex measure and is dependent upon a number of variables. For signalized intersections, these variables include the quality of vehicle progression, the cycle length, the green time ratio, and the volume/capacity ratio for the lane group in question. For unsignalized intersections, delay is related to the availability of gaps in the flow of traffic on the major street and the driver’s discretion in selecting an appropriate gap for a particular movement from the minor street (straight across, left or right turn).



**TABLE 10
LEVEL OF SERVICE CRITERIA
UNSIGNALIZED AND SIGNALIZED INTERSECTIONS ¹**

Level of Service	Control Delay Per Vehicle (Seconds)	
	Signalized	Unsignalized
A	≤ 10	≤ 10
B	> 10 and ≤ 20	> 10 and ≤ 15
C	> 20 and ≤ 35	> 15 and ≤ 25
D	> 35 and ≤ 55	> 25 and ≤ 35
E	> 55 and ≤ 80	> 35 and ≤ 50
F	> 80 or v/c > 1.0	> 50 or v/c > 1.0

¹ Obtained from Exhibits 18-4 and 19-1 of the Transportation Research Board’s *Highway Capacity Manual 2010*

CAPACITY ANALYSIS METHODOLOGY

Capacity analyses were conducted for the weekday A.M. and P.M. peak hours at the study area intersections. Where applicable, these analyses were conducted according to the methodologies contained in the 2010 *Highway Capacity Manual* (HCM) using *Synchro 8* software, a Trafficware product. However, due to the 2010 HCM limitations, TPD modeled the following intersection, as described below:

- Hickory Lane & Monument Road- currently the northbound Hickory Lane approach is free-flow, with the other three (3) legs of the intersection being stop-controlled. Since this configuration cannot be modeled in the available software, TPD modeled the intersection as a two-way stop control with the northbound and southbound Hickory Lane approaches being free-flow. In order to calculate the southbound delay, all southbound volumes were added to the left turn movement. Additionally, TPD utilized the 2000 HCM methodology, due to the 2010 HCM’s inability to model this configuration.

The following conditions were analyzed, as applicable:

- Existing conditions;
- 2019 Base conditions (Build-out year without development);
- 2019 Projected conditions (Build-out year with development);

PennDOT’s Transportation Impact Study Guidelines outlined in Strike-Off Letter 470-09-4, dated February 12, 2009 contain the following criteria regarding levels of service:

- Page 29 of the Guidelines state that if evaluation of the With Development Horizon Year Scenario to the Without Development Horizon Year Scenario indicates that the overall intersection level of service has dropped, the applicant will be required to mitigate the level of service if the increase in overall intersection delay is greater than 10-seconds. If the overall intersection delay increase is less than or equal to 10-seconds, mitigation of the intersection will not be required.



- Page 29 of the Guidelines state that for mitigation scenarios, applicants are expected to mitigate the overall intersection LOS to the original Without Development LOS; the 10-second delay variance is not applied to mitigation scenarios. Applicants may be required to address available storage and queue lengths at critical movements or approaches even if the overall LOS requirements are met.
- Page 31 of the Guidelines state that if signalization is the preferred alternative for mitigation, overall intersection LOS C in rural areas and LOS D in urban areas is acceptable.
- Page 31 of the Guidelines states new signalized or unsignalized intersection established to serve as access to the development shall be designed to operate at minimum LOS C for rural areas, and minimum LOS D for urban areas.

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LEVELS OF SERVICE IN THE STUDY AREA

Level of service (LOS) matrices for the study area intersections are shown in **Table 11** for the weekday A.M., and weekday P.M. peak hours.

**TABLE 11
LEVEL OF SERVICE DELAY (SECONDS) SUMMARY**

Intersection	Movement	Weekday A.M. Peak Hour			Weekday P.M. Peak Hour		
		Existing Condition	Opening Year 2019		Existing Condition	Opening Year 2019	
			Base	Projected		Base	Projected
Monument Road & Sugartown Road	EB L/T/R	E	F (75.8)	F (83.3)	C	C	C
	WB L/T/R	C	E	F (60.0)	C	D	D
	NB L/T/R	A	A	A	A	A	A
	SB L/T/R	A	A	A	A	A	A
	ILOS	B (13.2)	C (24.0)	D (27.7)	A (7.6)	A (9.7)	B (10.4)
Sugartown Road & Forest Lane	EB L/R	B	B	B	B	B	B
	NB L/T	A	A	A	A	A	A
	SB T/R	A	A	A	A	A	A
	ILOS	A (3.0)	A (3.2)	A (3.4)	A (2.4)	A (2.6)	A (2.7)
Forest Lane & Oak Tree Lane/Site Access	EB (L)/T/R	A	A	A	A	A	A
	WB L/T(R)	A	A	A	A	A	A
	NB L/T/R	A	A	A	A	A	A
	SB L/T/R	-	-	A	-	-	B
	ILOS	A (0.3)	A (0.3)	A (1.0)	A (0.3)	A (0.3)	A (0.9)
Forest Lane & Hickory Lane	EB L/T	B	B	B	A	A	A
	WB T/R	A	A	A	A	A	A
	SB L/R	A	A	A	A	A	A
	ILOS	A (10.0)	B (10.7)	B (10.8)	A (8.3)	A (8.6)	A (8.6)
Hickory Lane & Monument Road	EB L/T/R	B	B	B	A	A	A
	WB L/T/R	A	B	B	B	B	B
	NB L/T/R	A	A	A	A	A	A
	SB L/T/R	A	A	A	A	A	A
	ILOS	A (2.4)	A (2.4)	A (2.5)	A (6.7)	A (6.8)	A (6.9)
Monument Road & Western Access	EB T/R	-	-	A	-	-	A
	WB L/T	-	-	A	-	-	A
	NB L/R	-	-	A	-	-	A
	ILOS	-	-	A (0.0)	-	-	A (0.1)
Monument Road & Eastern Access	EB T/R	-	-	A	-	-	A
	WB L/T	-	-	A	-	-	A
	NB L/R	-	-	A	-	-	A
	ILOS	-	-	A (0.0)	-	-	A (0.1)

Base = No-Build scenario; Projected = Build scenario; ILOS = Overall Intersection Level of Service;

¹= Projected conditions with implementation of recommended improvements

As shown in **Table 11**, under 2019 projected conditions with the development of the proposed site, all overall intersection delays fall within PennDOT’s allowable 10-second variance between no-build and build condition scenarios.



All approaches and turning movements at the site driveway intersections will operate at LOS B or better under 2019 projected conditions during the weekday A.M. and P.M. peak hours.

SIGNAL WARRANT ANALYSIS

A preliminary traffic signal warrant analysis was conducted at the following intersection in accordance with PennDOT Publication 212, *Official Traffic Control Devices*, Subchapter D, “Highway Traffic Signals”:

- Monument Road and Sugartown Road.

TPD examined traffic volumes at the above intersection to determine if Warrant 3, Peak Hour Volume Warrant, will be satisfied based on opening year traffic volume projections with development of the proposed site (2019 projected conditions). All relevant signal warrant analyses worksheets are included in **Appendix F**.

Warrant 3, Peak Hour Volume Warrant

In order to evaluate Warrant 3, Peak Hour Volume Warrant, TPD utilized the opening year traffic volume projections with development of the proposed site. **Table 12** shows the peak hour major street two-way traffic volumes and the approximate corresponding minor street threshold volume to satisfy the peak hour signal warrant based on a figure in the MUTCD, Chapter 4C.04.

**TABLE 12
PEAK HOUR VOLUME WARRANT ANALYSIS**

Condition	Time Period	Major Street	Minor Street ¹	Threshold Volume	Warrant Satisfied?
		Two-way	(EB or WB)		
2019 Projected	Weekday A.M.	649	270(EB)	347	No
	Weekday P.M.	605	313(WB)	368	No

1. Minor Street – Highest volume minor street approach.
2. Major Street – Sugartown Road; Posted Speed Limit is 35 m.p.h.

95TH PERCENTILE QUEUE ANALYSIS

Queue analyses were conducted at the study area intersections using *Synchro 8* software. For this analysis, the 95th percentile queue is defined as the queue length that is exceeded in 5% of the signal cycles. As an example, for a signal with a 90-second cycle, this means that the 95th percentile queue length will be exceeded during 2 of the 40 signal cycles that occur during the peak hour. The queue analysis results are summarized in **Table 13** for the analyzed peak hours.



TABLE 13
95TH PERCENTILE QUEUE ANALYSIS

Intersection	Movement	Available Storage	Opening Year 2019			
			Weekday A.M. Peak Hour		Weekday P.M. Peak Hour	
			Base	Projected	Base	Projected
Monument Road & Sugartown Road	EB L/T/R	500+	230	248	15	18
	WB L/T/R	500+	58	78	123	133
	NB L/T/R	500+	0	0	0	0
	SB L/T/R	500+	3	3	0	0
Sugartown Road & Forest Lane	EB L/R	500+	33	35	18	20
	NB L/T	500+	3	3	13	13
	SB T/R	500+	0	0	0	0
Oak Tree Lane & Forest Lane	EB (L)/T/R	500+	0	0	0	0
	WB L/T/(R)	500+	0	0	0	0
	NB L/T/R	500+	0	0	0	0
	SB L/T/R	-	-	3	-	3
Forest Lane & Hickory Lane	EB L/T	500+	73	75	23	23
	WB T/R	500+	5	5	18	20
	SB L/R	500+	5	5	18	18
Hickory Lane & Monument Road	EB L/T/R	500+	3	3	0	0
	WB L/T/R	500+	5	5	19	19
	NB L/T/R	500+	0	0	0	0
	SB L/T/R	500+	2	2	2	2
Monument Road & Western Site Access	EB T/R	-	-	0	-	0
	WB L/T	-	-	0	-	0
	NB L/R	-	-	0	-	0
Monument Road & Eastern Site Access	EB T/R	-	-	0	-	0
	WB L/T	-	-	0	-	0
	NB L/R	-	-	0	-	0

As shown in **Table 13**, adequate queue storage will be provided for the turn lanes in 2019 with construction and full build-out of the Troutbeck Farm Development. Queue analysis worksheets are included with the capacity analysis worksheets provided in **Appendix F**.

AUXILIARY TURN LANE ANALYSIS

Methodology

TPD evaluated auxiliary turn lane warrants at the site access intersections. The warrant analysis methodology contained within Chapter 11 of PennDOT’s *Publication 46*, Section 11.17 and Strike-Off Letter 470-08-07 was utilized for this evaluation.

Findings

Table 14 summarizes the results of the auxiliary turn lane analysis at the site access intersections.



**TABLE 14
AUXILIARY TURN LANE ANALYSIS SUMMARY**

Intersection	Auxiliary Lane	Warrant Satisfied?
Forest Lane & Site Access	Eastbound Left-Turn	No
	Westbound Right-Turn	No
Monument Road & Western Access	Eastbound Right-Turn	No
	Westbound Left-Turn	No
Monument Road & Eastern Access	Eastbound Right-Turn	No
	Westbound Left-Turn	No

The calculations for the auxiliary turn lane warrants are included in **Appendix G**.

CONCLUSIONS

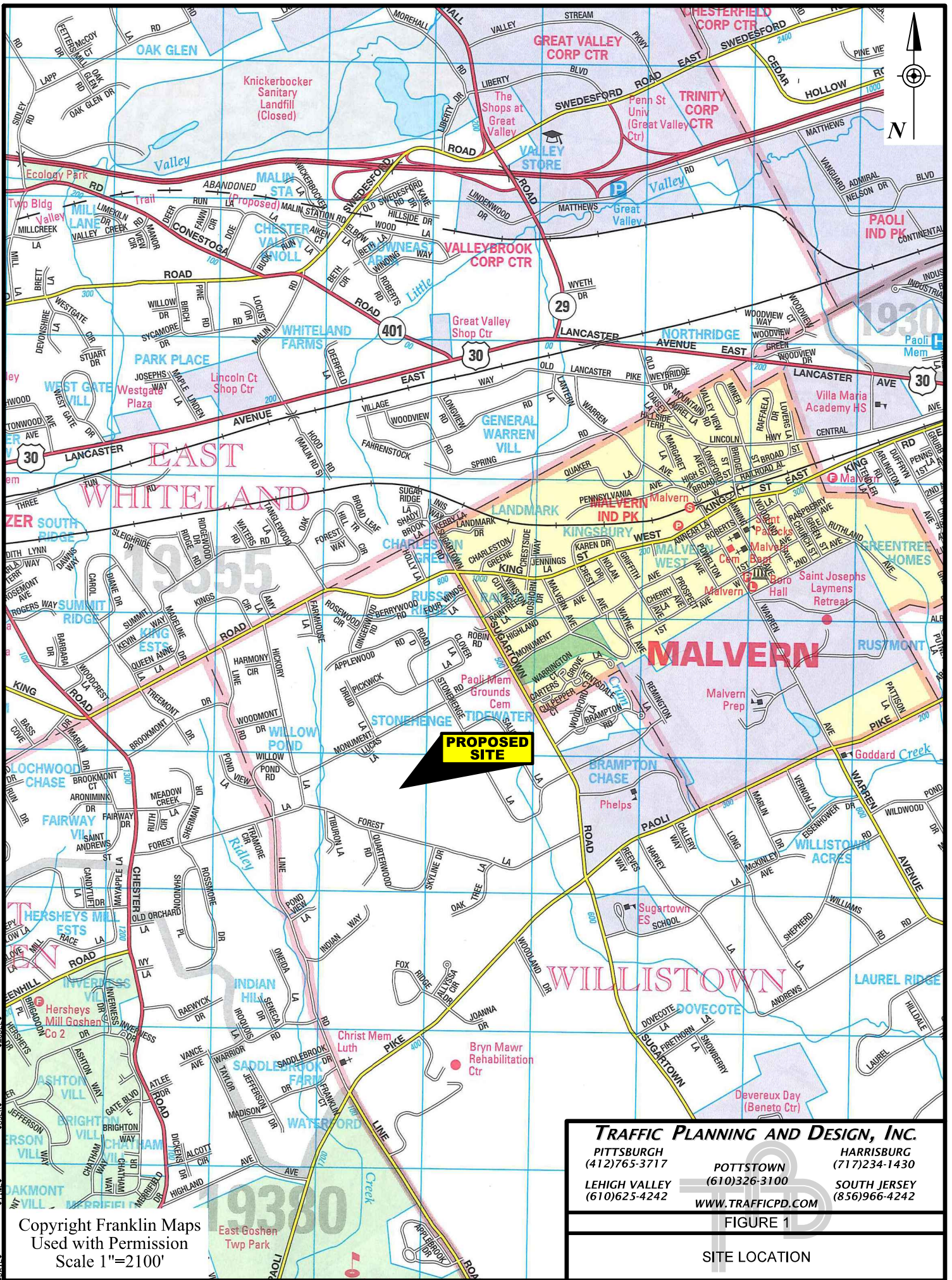
- The purpose of this study is to examine the potential traffic impact associated with the proposed Troutbeck Farm development on the roadway network in Willistown Township, Chester County, PA. Based on this evaluation, the following conclusions were reached:
- The project scope and the extent of the study area were discussed with Willistown Township. The study area intersections included in this TIS are as follows:
 - Sugartown Road & Monument Road;
 - Sugartown Road & Forest Lane;
 - Monument Road & Hickory Lane;
 - Forest Lane & Hickory Lane;
 - Forest Lane & Oak Tree Lane.
- The project site is bound by Monument Road to the north, Stonehenge Lane to the east and Forest Lane to the south. The proposed site will consist of 36 single-family homes;
- Access to the site is proposed via four full-access driveways: one to Forest Lane, and two to Monument Road and a connection to the existing terminus of Friarsheel Lane.
- All proposed driveway location sight distances
- Upon full build-out, the proposed development is expected to generate 35 new vehicle-trips during the weekday A.M. peak hour and 42 new vehicle-trips during the weekday P.M. peak hour.
- All overall intersection levels of service (ILOS) will operate at an acceptable ILOS D or better during the 2019 projected condition scenarios. Furthermore, all overall intersection delays fall within PennDOT’s allowable 10-second variance between base (no-build) and projected (build)



condition scenarios. Although the overall LOS at Monument Road and Sugartown Road operates acceptably, we note delay on the Monument Road approaches.

- Under the 2019 projected conditions, all approaches and turning movements at the site driveway intersections with the external roadway network will operate at LOS B or better during weekday A.M., and P.M. peak hours.
- The peak hour volume warrant is not satisfied at the intersection of Monument Road and Sugartown Road under 2019 projected conditions.

DRAFT

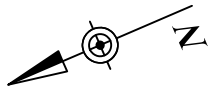


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FIGURE 1
 SITE LOCATION

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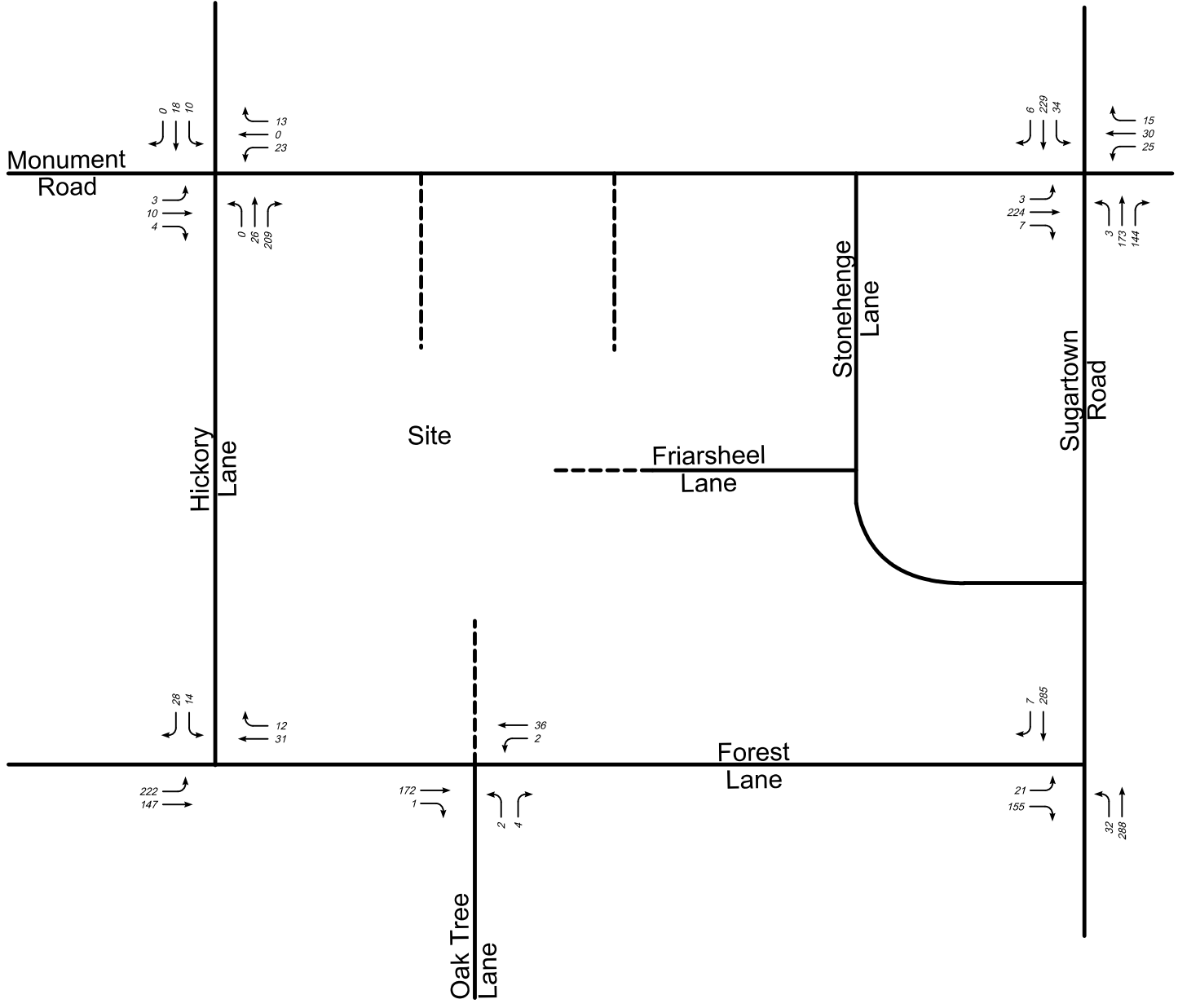
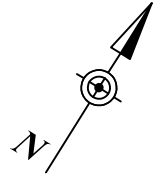
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FIGURE 2
SITE PLAN

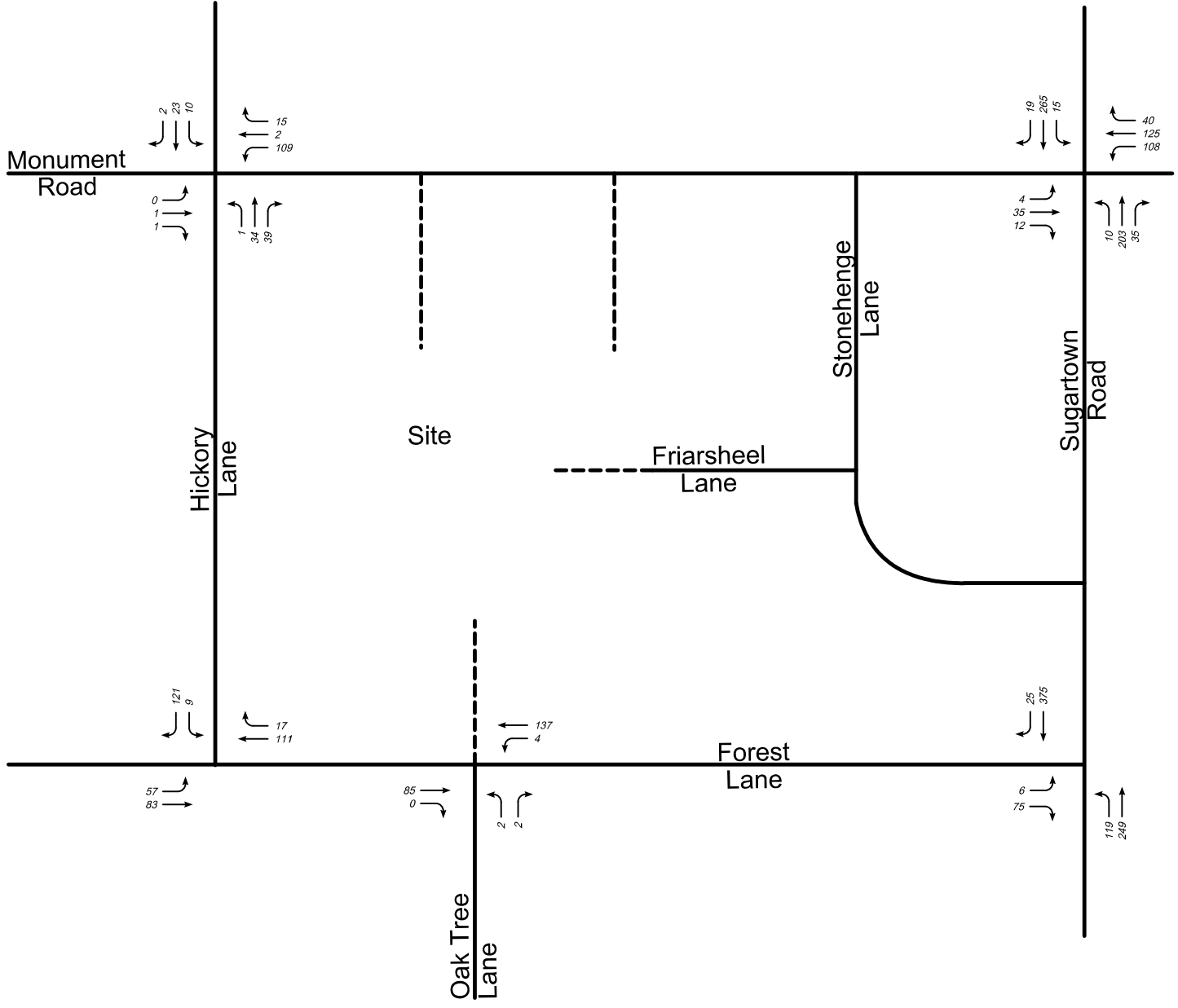
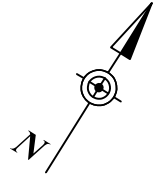


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FIGURE 3
 EXISTING CONDITIONS
 WEEKDAY A.M. PEAK HOUR
 TRAFFIC VOLUMES

\$FILE \$DATE \$TIMES \$USER \$MODEL



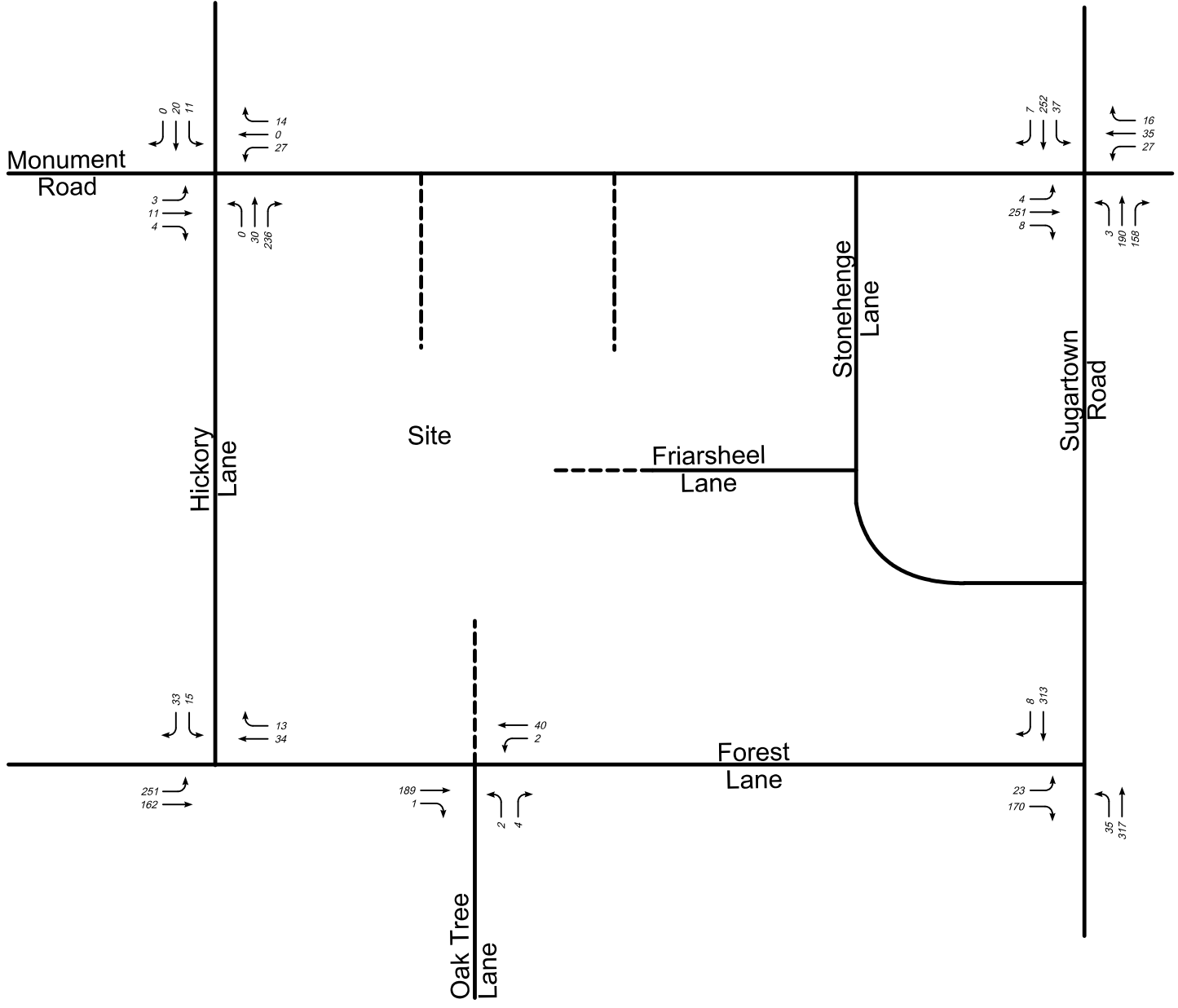
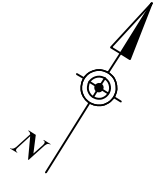
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FIGURE 4
 EXISTING CONDITIONS
 WEEKDAY P.M. PEAK HOUR
 TRAFFIC VOLUMES

\$FILE \$DATE \$USER \$MODEL \$TIME



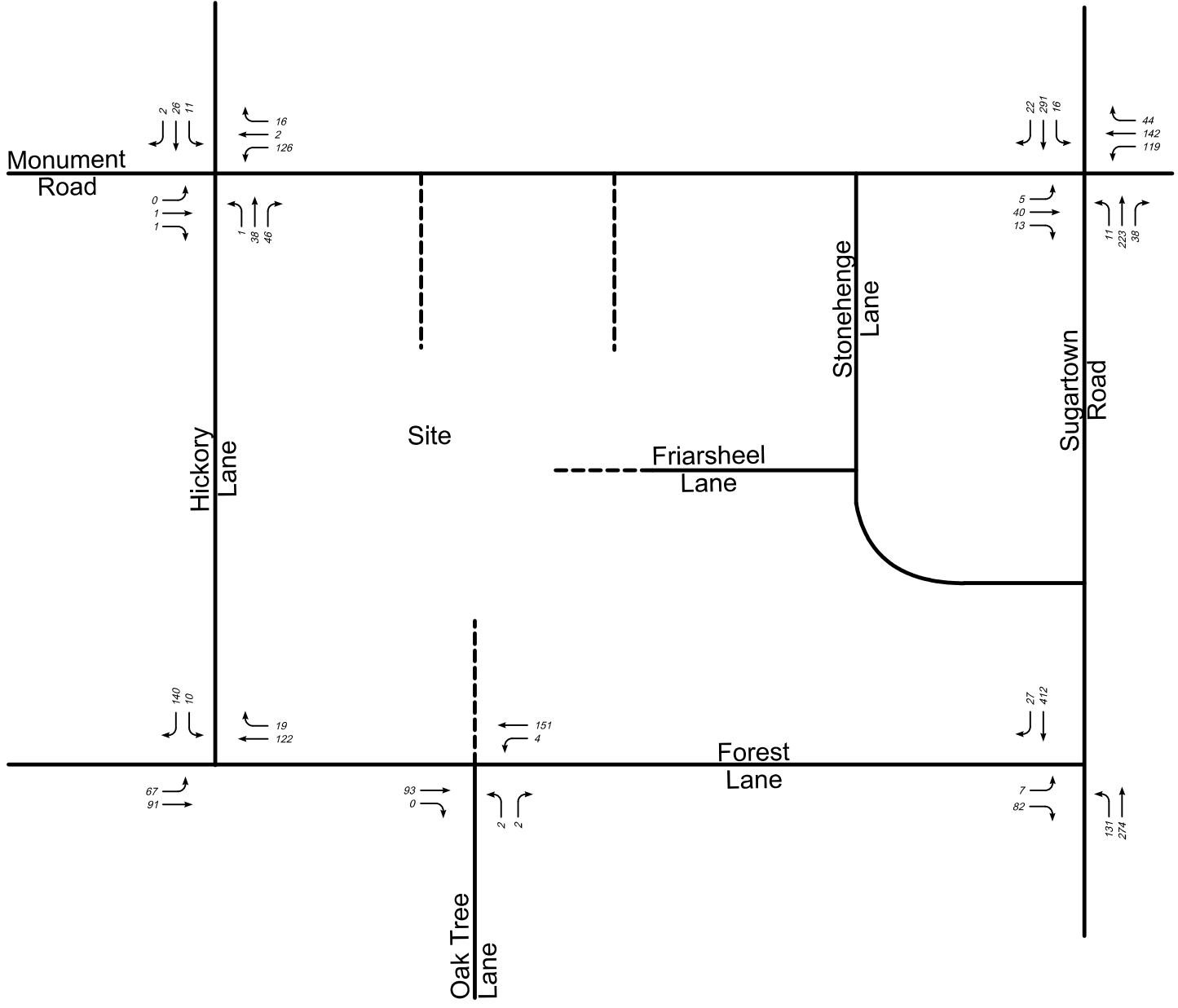
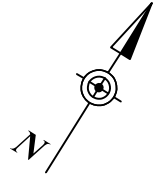
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FIGURE 5

2019 BASE CONDITIONS
 WEEKDAY A.M. PEAK HOUR
 TRAFFIC VOLUMES

\$FILE \$DATE \$USER \$MODEL \$TIME



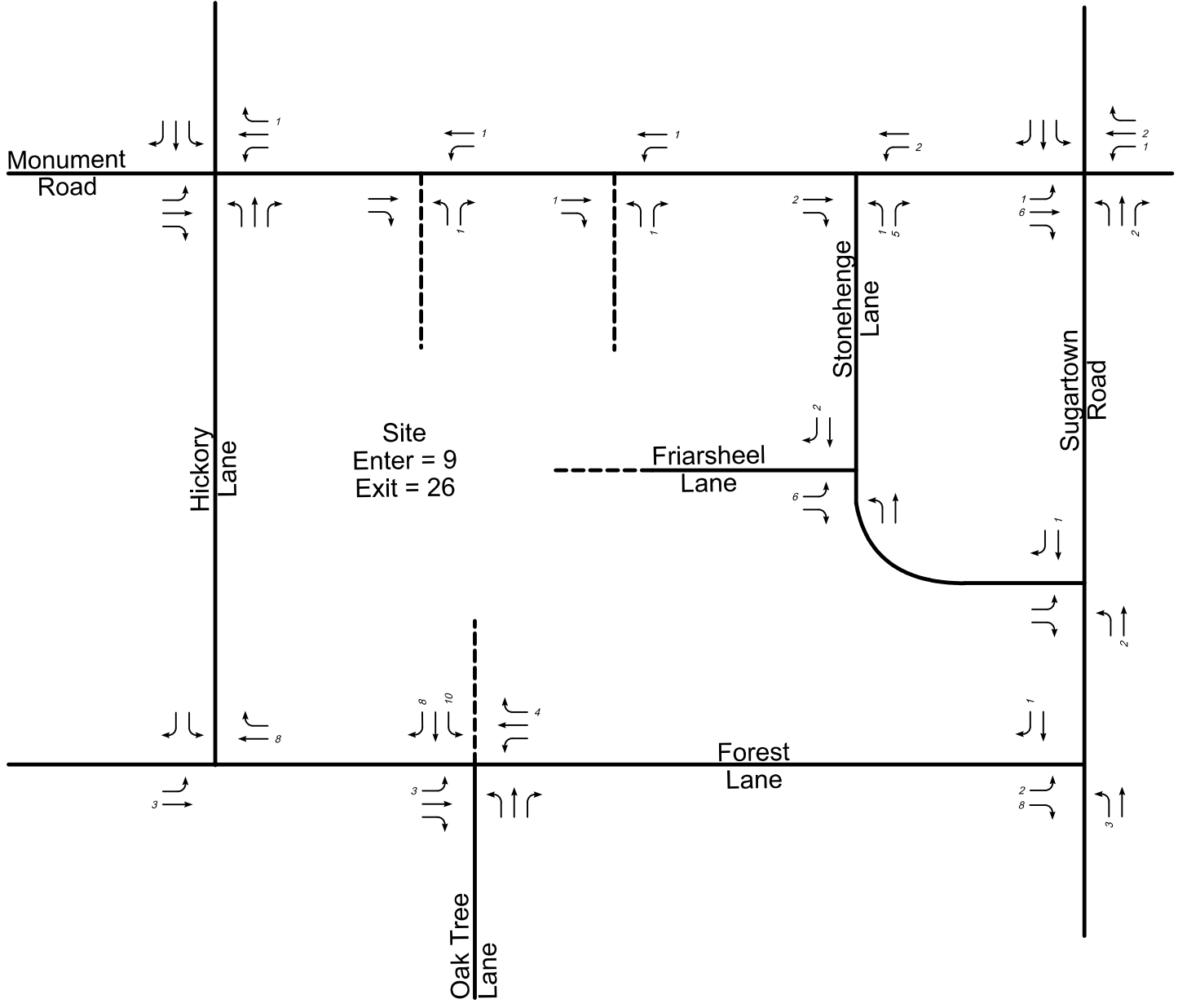
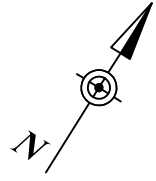
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FIGURE 6

2019 BASE CONDITIONS
 WEEKDAY P.M. PEAK HOUR
 TRAFFIC VOLUMES

\$FILE \$DATE \$USER \$MODEL \$TIME



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----- PROPOSED DRIVEWAY
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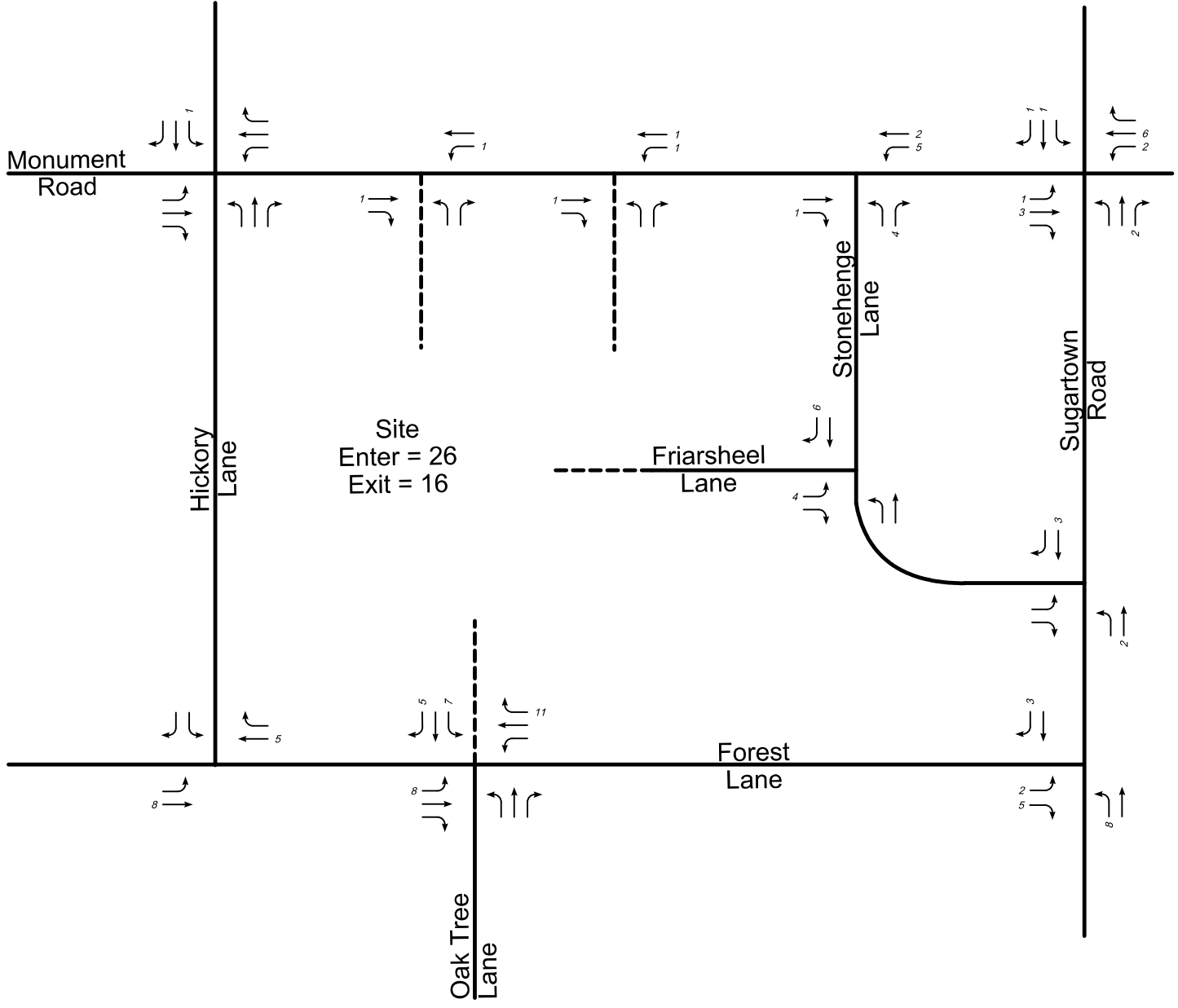
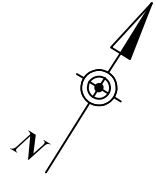
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FIGURE 7

TRIP DISTRIBUTION
 WEEKDAY A.M. PEAK HOUR
 TRAFFIC VOLUMES

\$FILE \$DATE \$USER \$MODEL \$TIME



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----- PROPOSED DRIVEWAY
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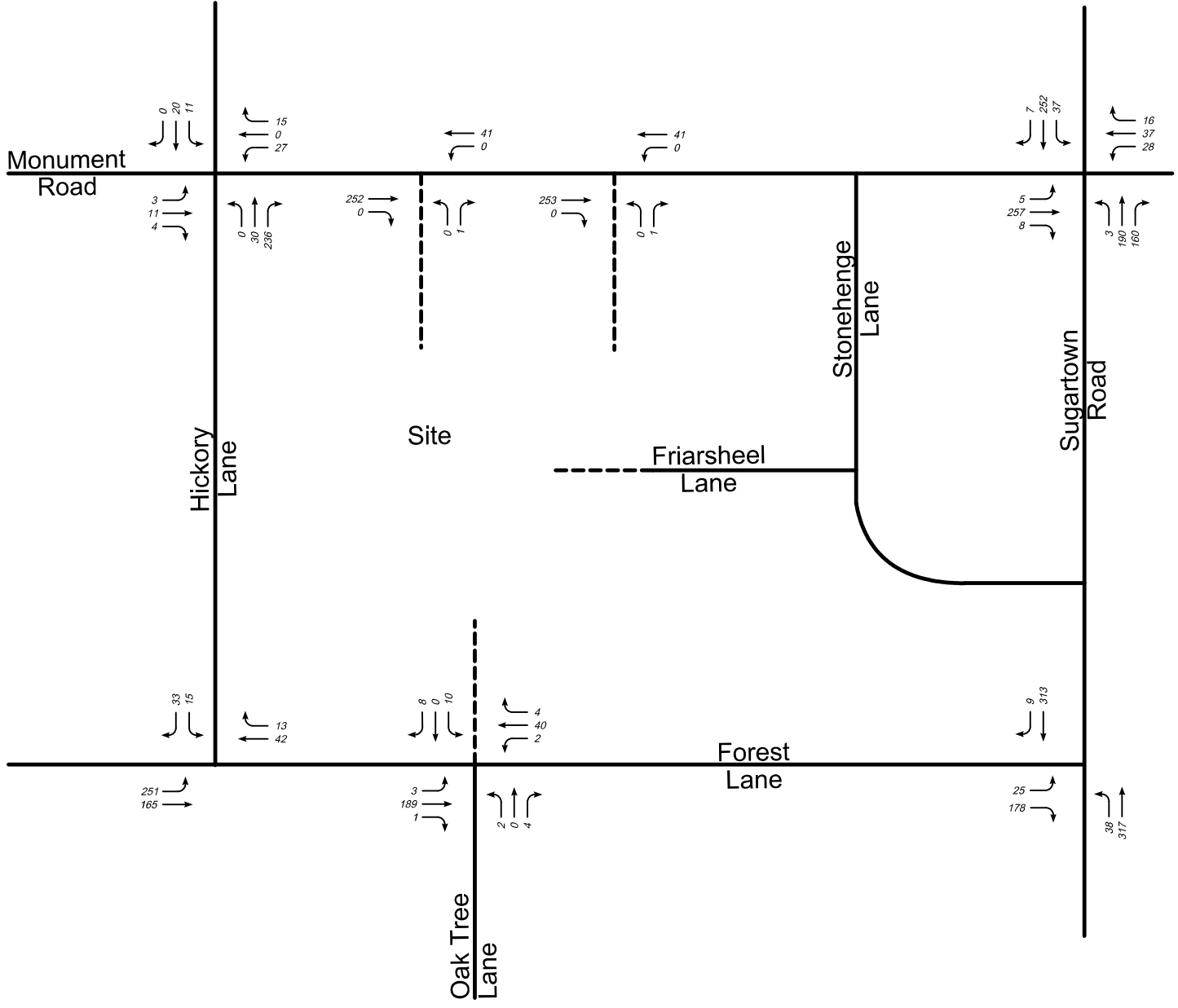
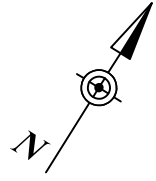
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FIGURE 8

TRIP DISTRIBUTION
 WEEKDAY P.M. PEAK HOUR
 TRAFFIC VOLUMES

\$FILE \$DATE \$USER \$MODEL \$TIMES



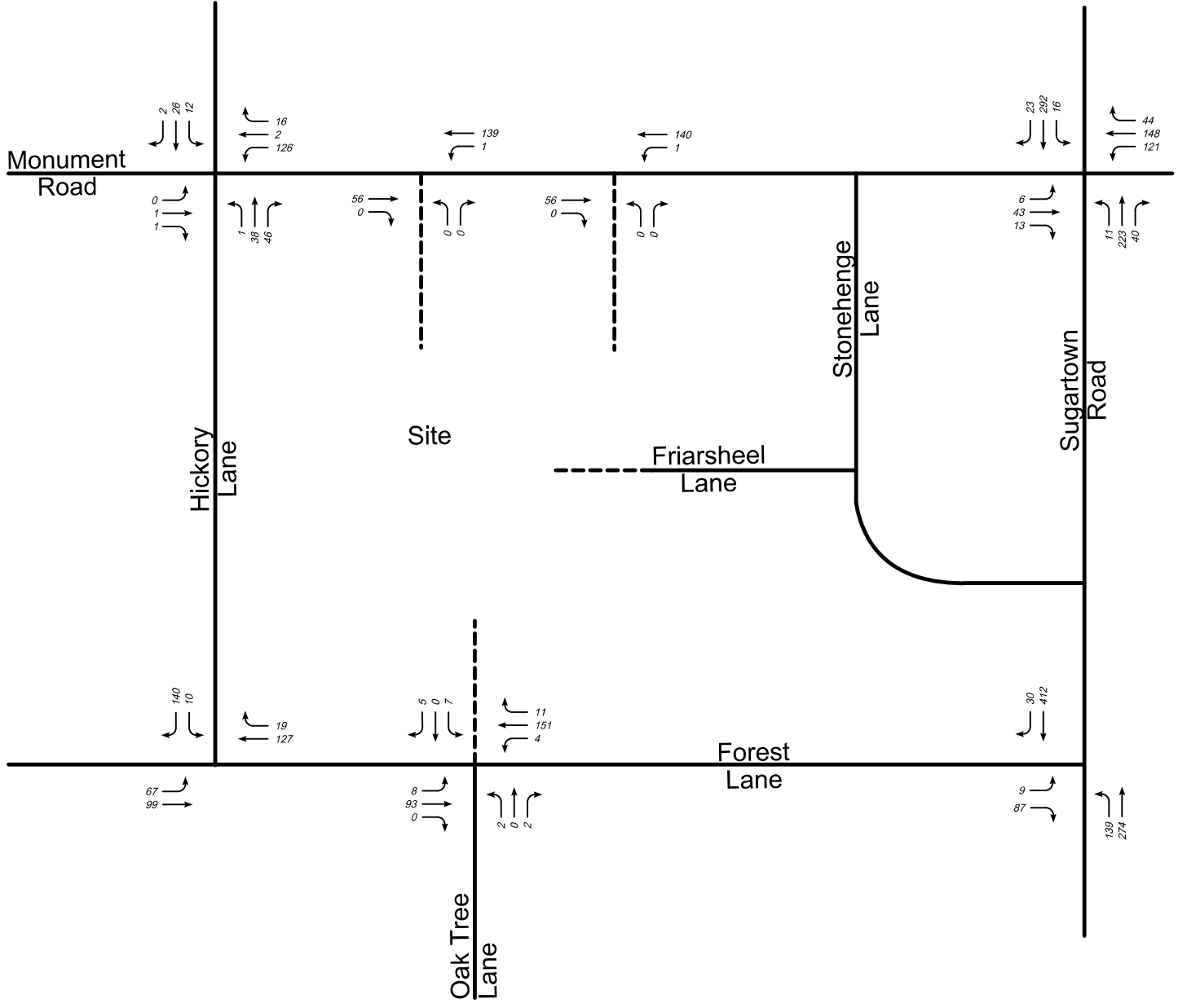
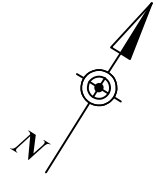
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FIGURE 9

2019 PROJECTED CONDITIONS
 WEEKDAY A.M. PEAK HOUR
 TRAFFIC VOLUMES

\$FILE \$DATE \$USER \$MODEL \$TIME



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FIGURE 10

2019 PROJECTED CONDITIONS
 WEEKDAY P.M. PEAK HOUR
 TRAFFIC VOLUMES

\$FILE \$DATE \$USER \$MODEL \$TIME