

***BABELAY FARMS SUBDIVISION
Knox County***

TRAFFIC IMPACT STUDY

***Prepared For:
McCampbell Drive Partnership, LLC***

Prepared By:



**ENGINEERS
PLANNERS
ECONOMISTS**

Wilbur Smith Associates

April 2004

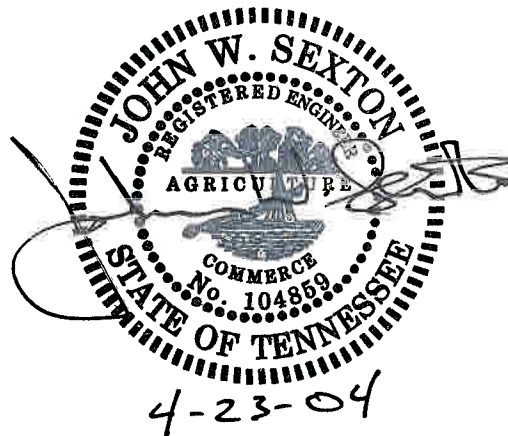
**BABELAY FARMS
SUBDIVISION
Knox County, Tennessee**

TRAFFIC IMPACT STUDY

Prepared for

McCAMPBELL DRIVE PARTNERSHIP, LLC

**815 Sunnydale Road
Knoxville, Tennessee 37923**



April 2004

Prepared by

WILBUR SMITH ASSOCIATES

**1100 Marion Street, Suite 200
Knoxville, Tennessee 37921**

TABLE OF CONTENTS

Executive Summary.....	1
Introduction.....	2
Data Collection and General Site Description.....	5
Current Traffic Conditions.....	9
Background Growth of Traffic Volumes and Associated Traffic Conditions.....	11
Trip Generation and Trip Distribution of Site Traffic.....	13
Traffic Conditions With Development.....	16
Evaluation of the At-grade Railroad Crossing on McCampbell Drive.....	19
Evaluation of the Internal Site Roadway Features.....	21
Conclusions and Recommendations.....	24
Appendices.....	27
Count Data	
TDOT "ADAM" Printouts, Stations 33 and 283	
Turning Movement Count Data	
Mechanical Counter Data	
TDOT Monthly Variation Factors	
Highway Capacity Software Output Reports	
Traffic Signal Warrant Worksheets	
Turn Lane Warrant Worksheets	
Trip Generation Worksheets and Regression Data	
Railroad Crossing Evaluation Worksheets	
Application of Truck Turning Template (WB-50) to Circular Intersection	
Minimum Width Worksheet (McCampbell Drive)	
Functional Plan (McCampbell Drive at Washington Pike)	

LIST OF FIGURES

Figure 1: Location Map.....	3
Figure 2: Site Plan.....	4
Figure 3: 2004 Peak Hour Volumes.....	8
Figure 4: 2009 Peak Hour Volumes Without Development.....	12
Figure 5: Site Traffic.....	15
Figure 6: 2009 Peak Hour Volumes With Development.....	17

LIST OF TABLES

Table 1: ADT Data Summary.....	7
Table 2: 2004 Capacity Analysis Summary.....	9
Table 3: 2009 Capacity Analysis Summary (without Babelay Farms site traffic).....	11
Table 4: Babelay Farms Residential Development Trip Generation Summary.....	13
Table 5: 2009 Capacity Analysis Summary (with Babelay Farms site traffic).....	16
Table 6: Theoretical Railroad Crossing Accidents Upon Site Buildout.....	19

Executive Summary

A new residential development, Babelay Farms, is proposed to be constructed on McCampbell Drive in northeast Knox County. The proposed development includes 108 condominium units and 215 single-family lots, and buildout is expected to be complete by 2009. Daily traffic volumes on McCampbell Drive are projected to increase from their current level of approximately 400 vehicles per day to more than 1800 vehicles per day west of the site and 2300 vehicles per day to the east.

Wilbur Smith Associates (WSA) collected data on geometric and traffic conditions, estimated traffic volumes at the buildout year, and conducted numerous analyses to quantify the anticipated impacts of the development. The resulting intersection performance is summarized below:

Intersection	Approach	Level of Service					
		2004		2009 without site		2009 with site	
		AM	PM	AM	PM	AM	PM
Anderson Road at Tazewell Pike	Westbound	A	A	A	A	A	A
	Northbound	E	C	F	C	F	D
McCampbell Drive at Washington Pike	Eastbound	B	A	B	A	B	A
	Southbound	D	C	D	C	F	E
McCampbell Drive at East Site Driveway	Westbound	-	-	-	-	A	A
	Northbound	-	-	-	-	A	A
McCampbell Drive at West Site Driveway	Westbound	-	-	-	-	A	A
	Northbound	-	-	-	-	A	A

WSA reviewed key elements of the site plan including proposed pavement widths and operation of a traffic circle and one-way alleys. The consultant also evaluated the anticipated safety performance of an at-grade railroad crossing on McCampbell Drive.

As a result of these study activities, the following improvements are recommended:

- ❖ Reconstruct the intersection of McCampbell Drive with Washington Pike to create a 90-degree intersection. Provide separate left- and right-turn lanes on McCampbell Drive and an eastbound left-turn lane on Washington Pike.
- ❖ Widen McCampbell Drive to at least 26 feet from Washington Pike to the west site access driveway.
- ❖ Modify the internal site roads:
 - Widen all boulevard pavement widths to 18 feet;
 - Widen all one-way alleys to 17 feet;
 - Adjust all intersections to accommodate a WB-50 truck design vehicle;
 - Sign the approaches to the traffic circle as STOP or YIELD control and install one-way signing to indicate the appropriate direction of travel in the traffic circle;
 - Channelize the traffic circle entry points to prevent wrong-way entry into the traffic circle; and
 - Widen the circulating road pavement width to at least 17 feet and adjust the entry and exit points to accommodate a WB-50 truck design vehicle.
- ❖ Assemble data on at-grade railroad crossings similar in geometric configuration and traffic/train volumes to the crossing on McCampbell Drive. These data should be reviewed in deciding whether increased protection (flashing lights or gates) are required at the McCampbell Drive crossing.
- ❖ No improvements are recommended at the intersection of Anderson Road with Tazewell Pike. While some geometric improvements are discussed herein, they are not development-driven and would be better accomplished as a part of more comprehensive system improvements on Tazewell Pike.

Introduction

A new residential development, Babelay Farms, is proposed to be constructed in Knox County between Tazewell Pike (SR 331) and Washington Pike. The site driveways will intersect McCampbell Drive approximately 0.8 mile west of its terminus at Washington Pike and approximately 0.6 mile east of its terminus at Anderson Road. The proposed development includes two condominium sections of 52 and 56 units, respectively, and 215 single-family lots. Figure 1 is a location map indicating the proposed site and area roadways. Figure 2 is a site plan on which are indicated the proposed subdivision streets and access points on McCampbell Drive. The subdivision is expected to be occupied within five years, or by 2009.

In accordance with the Knoxville-Knox County Metropolitan Planning Commission's (MPC) Traffic Access and Impact Study Guidelines and Procedures, the developer was required to submit a traffic impact study for Babelay Farms. The scope was defined to comply with the requirements of a Level II traffic impact study and included an assessment of traffic conditions at each of the proposed access points on McCampbell Drive and at the intersections of McCampbell Drive with Washington Pike and Anderson Road with Tazewell Pike. Other study elements included geometric issues such as sight distance and intersection layout at the above intersections and the anticipated safety performance of an at-grade railroad crossing on McCampbell Drive. The proposed site plan incorporates some innovative features including a circular roadway intersection and one-way alleys for access to the single-family units. The reviewing agencies charged the study engineer with evaluating these features for compliance with published design standards. The discussion, figures, tables, and appendices that follow document the engineer's findings, conclusions, and recommendations in regard to the proposed development.

Figure 1: Location Map

Figure 2: Site Plan

Data Collection and General Site Description

As noted above, Babelay Farms will consist of 215 single-family detached housing units and 108 condominium units located on 107.4 acres. The current site plan provides two access points on McCampbell Drive approximately 1000 feet apart. The primary site access roadways are boulevards with 16-foot traffic lanes separated by a 25-foot median. Other site roadways consist of two-lane two-way roads 26 feet in width and one-way alleys 12 feet in width. The site roadway layout provides alternate access routes for nearly every unit so that emergency service providers will not be prevented from reaching a unit if a particular route is blocked. One exception is the condominium section on the west portion of the site with a single cul-de-sac access route. It is expected that site topography may preclude the provision of an additional access route for this portion of the site.

WSA conducted a field investigation in the environs of the proposed development to note any existing or potential geometric deficiencies. McCampbell Drive is a 16-foot wide, two-lane local road with no shoulders. The speed limit is not posted, but the operating speed is assumed to be 30 m.p.h. given the narrow pavement. WSA measured intersection sight distance at the proposed access points. At the east driveway, the available sight distance is greater than 1200 feet to the west (left) and 560 feet to the east (right). At the west driveway, the available sight distance is 633 feet to the west (left) and 825 feet to the east (right).

The intersection of McCampbell Drive at Washington Pike consists of three approach legs with stop control on McCampbell Drive. All approaches are single lanes 8 feet wide on McCampbell Drive and 11 to 12 feet wide on Washington Pike. However, eastbound Washington Pike has an exclusive left-turn lane at Murphy Road (approximately 300 feet east of McCampbell Drive), and the storage bay for this turn lane traverses the McCampbell Drive intersection. This provides storage for vehicles turning left onto McCampbell Drive. McCampbell Drive intersects Washington Pike at an angle of approximately 30 degrees. It is desirable to have an intersection angle of 90 degrees, and the minimum is 60 degrees (*Minimum Subdivision Regulations for Knoxville and Knox County*, Section 62-81). Sight distance from McCampbell Drive is 1200 feet to the east (left) and 300 feet to the west (right). The posted speed limit on Washington Pike is 40 m.p.h.

The intersection of Anderson Road at Tazewell Pike also consists of three approach legs with stop control on Anderson Road. All approaches are single lanes 9 feet wide on Anderson Road and 11 feet wide on Tazewell Pike. Sight distance from Anderson Road is 765 feet to the west (left) and 936 feet to the east (right). The posted speed limit on Tazewell Pike is 45 m.p.h.

McC Campbell Drive intersects Anderson Road approximately 1500 feet south of Tazewell Pike and is stop-controlled at Anderson Road. Both roads are relatively low in volume, and further evaluation of this intersection was not included in the scope of this study.

The at-grade railroad crossing noted earlier is located on McC Campbell Drive approximately 2000 feet east of Anderson Road. The railroad track (owned by Norfolk Southern Railway) is a single track with passive protection (crossbuck signs and pavement markings only, no STOP signs, flashers or gates). Norfolk Southern indicated that daily train traffic consists of two train movements, both of which occur at night (between 6 p.m. and approximately 6 a.m.) The maximum train speed at the crossing is 30 m.p.h. Knox County's Department of Engineering and Public Works reviewed crash data for McC Campbell Drive covering the past three years, and there were no reported train-auto crashes at the crossing during that period. WSA measured sight distance at the crossing and found it to be greater than 600 feet to the east and greater than 1000 feet to the west.

Average daily traffic (ADT) volumes were obtained from the MPC website and from Tennessee Department of Transportation (TDOT) data. Several count stations are located within the study area, and their data are summarized in Table 1. Current daily traffic volumes on Washington Pike and Tazewell Pike are in the ranges of 6500 to 8800 vehicles per day and 11,300 to 13,300 vehicles per day, respectively, while traffic on McC Campbell Drive is approximately 300 vehicles per day.

Table 1: ADT Data Summary

Station #	Location	Maintained by	ADT (Year) ²	Annual Growth Rate
33	Washington Pike east of Murphy Road	TDOT	6,499 (2003)	3.2% ³
35	Washington Pike west of Mill Road	MPC	8,760 (2002)	9.9% ⁴
223	McC Campbell Drive west of Washington Pike	MPC	300 (2002)	(See note 5)
283	Tazewell Pike east of Murphy Road	TDOT	13,282 (2003)	2.8% ³
383	Tazewell Pike east of Shannondale Road	City ¹	11,276 (2002)	(See note 5)
384	Tazewell Pike east of Murphy Road	City ¹	13,092 (2002)	(See note 5)

Notes:

1. City of Knoxville
2. Most recent year for which data were available.
3. See Appendix for TDOT "ADAM" software outputs used to estimate future traffic volumes and growth rates.
4. Based on two years of data
5. Only one data point was available, so no growth rate could be calculated.

WSA conducted 8-hour turning movement counts at the intersections of McC Campbell Drive with Washington Pike and Anderson Road with Tazewell Pike on Thursday, April 15, 2004. The count hours were 7 a.m. to 9 a.m., 11 a.m. to 1 p.m. and 2 p.m. to 6 p.m. to capture traffic volumes associated with the peak hours throughout the typical weekday. WSA also placed mechanical traffic counters at each end of McC Campbell Drive to measure traffic thereon over the course of a 24-hour period. The mechanical counters were in place from 1 p.m. on Thursday, April 15 until 1 p.m. on Friday, April 16. The data sheets are contained in the Appendix. Because traffic varies by day of the week and month of the year, an adjustment factor was applied to normalize the count data. TDOT publishes variation factors for such applications (see Appendix). The factor for a Thursday count in April for an urban location is 0.90. This factor was applied to the turning movement and mechanical count data. Figure 3 presents the AM and PM peak-hour traffic volumes as recorded in the counts. For comparison, the 24-hour volumes recorded by the mechanical counters on McC Campbell Drive were 425 vehicles per day on the east end and 482 vehicles per day on the west end.

Figure 3: 2004 Peak Hour Volumes

Current Traffic Conditions

Unsignalized intersection capacity analyses were performed for the AM and PM peak hours to evaluate current traffic conditions at the intersections of McCampbell Drive with Washington Pike and Anderson Road with Tazewell Pike. The methodology of the *2000 Highway Capacity Manual* as contained in the *Highway Capacity Software* was used. One of the measures employed in such analyses is "level of service" (LOS), a qualitative statement of the acceptability of traffic conditions based on delay. The LOS index ranges from LOS A, indicating excellent traffic conditions with minimal delay, to LOS F indicating very congested conditions with excessive delay. LOS D generally is considered the minimum acceptable condition in urban areas.

Based on the capacity analyses, current AM and PM peak-hour traffic conditions are as summarized in Table 2. More detailed information is provided in the computer output reports in the Appendix. Traffic conditions generally are acceptable during both peak hours with one exception. Northbound drivers on Anderson Road experience LOS E conditions during the AM peak period. Most of these are left-turn vehicles that are delayed by the flow of Tazewell Pike traffic.

Table 2: 2004 Capacity Analysis Summary

Intersection	Approach	Level of Service	
		AM	PM
Anderson Road at Tazewell Pike	Westbound	A	A
	Northbound	E	C
McCampbell Drive at Washington Pike	Eastbound	B	A
	Southbound	D	C

Traffic signal warrant analyses were performed to assess the need for signalization at the intersections. The *Manual on Uniform Traffic Control Devices*, or MUTCD (Federal Highway Administration, 2003), outlines eight traffic signal warrants and provides guidance on whether a traffic signal installation is justified. Three of the warrants are based on intersection volumes and were used in this study. Warrant 1 (Eight-Hour Vehicular Volume) is intended for applications where a large sustained volume of intersection traffic is the principal reason to consider installing a traffic control signal or where the 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) is used where the main reason to consider a signal is because of the volume of intersecting traffic. Warrant 3 (Peak Hour) is applied at locations prone to severe peaking characteristics but with lesser volumes at other times (for example, at a factory with heavy shift-change volumes) where for a minimum of 1 hour of an average day, the minor-street traffic experiences substantial delay when entering or crossing the major street. The remaining warrants consider pedestrian volumes, presence of school crossings, coordinated traffic signal systems, crash experience, and intersections of two major routes. None of these were deemed applicable for this study.

While the current volumes on the major roads (Tazewell Pike and Washington Pike) exceed the major road warrant volume thresholds, the side street volumes (on Anderson Road and on McCampbell Drive) are too low to satisfy any of the volume-based traffic signal warrants. The signal warrant worksheets are contained in the Appendix.

WSA also evaluated the need for auxiliary (left-turn and right-turn) lanes at the intersections of McCampbell Drive with Washington Pike and Anderson Road with Tazewell Pike using the criteria set forth in Knox County's *Access Control and Driveway Design Policy*. The warrant thresholds for the auxiliary lanes are based on volumes and speeds. The evaluations indicated that a westbound left-turn lane is currently warranted on Tazewell Pike at Anderson Road during the AM peak but not during the PM peak. No other turn lanes are currently warranted. The analysis worksheets are contained in the Appendix.

Background Growth of Traffic Volumes and Associated Traffic Conditions

ADT data were presented in Table 1. The two count stations maintained by TDOT provide ADT data from 1985 to 2003, so the growth trends observed therein are assumed to be very reliable. The observed growth rates at the two TDOT stations range from 2.8% to 3.2% per year. Thus, a 3% annual growth rate was assumed for study purposes. The planning horizon for this study is 2009 based on the anticipated buildout year of the subject development. Therefore, the 2004 traffic count volumes were increased by a factor of 1.15 (5 years at 3% per year) to estimate traffic volumes in 2009 without Babelay Farms site traffic. Figure 4 presents the resulting 2009 AM and PM peak-hour traffic volumes without the proposed development.

Unsignalized intersection capacity analyses were performed using the volumes of Figure 4. Based on the capacity analyses, 2009 AM and PM peak-hour traffic conditions are as summarized in Table 3. More detailed information is provided in the computer output reports in the Appendix. Conditions for northbound drivers on Anderson Road will decline to LOS F conditions during the AM peak period. All other approach levels of service will remain acceptable as at present.

Table 3: 2009 Capacity Analysis Summary (without Babelay Farms site traffic)

Intersection	Approach	Level of Service	
		AM	PM
Anderson Road at Tazewell Pike	Westbound	A	A
	Northbound	F	C
McC Campbell Drive at Washington Pike	Eastbound	B	A
	Southbound	D	C

Traffic signal warrant and turn-lane warrant analyses were performed using the 2009 background traffic volumes. The results were identical to those using the 2004 volumes (no traffic signal warrants met, a westbound left-turn lane on Tazewell Pike at Anderson Road warranted in the AM peak hour only.) The analysis worksheets are contained in the Appendix.

Figure 4: 2009 Peak Hour Volumes Without Development

Trip Generation and Trip Distribution of Site Traffic

Table 4 shows the daily, AM and PM peak-hour traffic expected to be generated by the proposed Babelay Farms residential development. The data and procedures of *Trip Generation, 7th Edition*, published by the Institute of Transportation Engineers, were employed to estimate the volumes generated by the single-family units. The MPC has developed local data for multi-family housing based on area studies and specifies that these trip generation rates be used for condominium units. The detailed data and worksheets for the trip generation calculations are contained in the Appendix.

Table 4: Babelay Farms Residential Development Trip Generation Summary

Land Use	# of Units	Weekday Trips			AM Peak Hour Trips			PM Peak Hour Trips		
		In	Out	Total	In	Out	Total	In	Out	Total
Single-family	215	1051 (50%)	1052 (50%)	2103	40 (25%)	120 (75%)	160	134 (63%)	79 (37%)	213
Condominium	108	512 (50%)	511 (50%)	1023	13 (22%)	44 (78%)	57	45 (55%)	37 (45%)	82
Total	323	1563	1563	3126	53	164	217	179	116	295

The directional distribution of traffic generated by Babelay Farms was estimated based on existing traffic patterns and adjusted in accordance with engineering judgement. It is expected that most site traffic will depart to and arrive from the west given the presence of activity centers in Knoxville. There are few attractions to the east. However, it is more difficult to predict whether Babelay Farms residents will utilize Washington Pike or Tazewell Pike for their travel routes. The mechanical counts conducted as a part of this study indicate very similar traffic volumes on both ends of McCampbell Drive, but the current population density is so sparse and the volumes so low that these counts are inconclusive in regard to trip distribution. Also, it is suspected that much of the current McCampbell Drive traffic is cut-through in nature rather than locally generated.

On a broader scale, Washington Pike provides a more direct route to Interstate 640 (which is assumed to be the primary commuter route for persons in the study area) than does Tazewell Pike. Also, persons departing Babelay Farms to the west are able to make a right turn onto Washington Pike whereas they must make a left turn onto Tazewell Pike. Thus, it is expected that more of the site traffic will use Washington Pike than Tazewell Pike for convenience of

travel. For study purposes, it was assumed that 60% of the site traffic would travel via Washington Pike (10% to and from the east, and 50% to and from the west). The remaining site traffic was assumed to be distributed with 10% to and from the east and 20% to and from the west on Tazewell Pike, and 10% to and from the west via Anderson Road. These directional splits were applied to the projected site traffic. Figure 5 presents the resulting traffic volumes at the study intersections and site driveways.

Figure 5: Site Traffic

Traffic Conditions With Development

The 2009 background growth volumes of Figure 4 were combined with the traffic volumes expected to be generated by Babelay Farms. The combined volumes are presented in Figure 6. Intersection capacity analyses were conducted based on the volumes of Figure 6 and are summarized in Table 5. The added site traffic is expected to have minimal impact on traffic conditions at the intersection of Anderson Road with Tazewell Pike with continued LOS F conditions for Anderson Road drivers during the AM peak hour and a decline from LOS C to LOS D in the PM peak hour. Southbound drivers on McCampbell Drive will experience unacceptable (LOS E to F) conditions during both peak hours with the added site traffic.

Table 5: 2009 Capacity Analysis Summary (with Babelay Farms site traffic)

Intersection	Approach	Level of Service	
		AM	PM
Anderson Road at Tazewell Pike	Westbound	A	A
	Northbound	F	D (C*)
McCampbell Drive at Washington Pike	Eastbound	B	A
	Southbound	F(D*)	E (C*)
McCampbell Drive at East Site Driveway	Westbound	A	A
	Northbound	A	A
McCampbell Drive at West Site Driveway	Westbound	A	A
	Northbound	A	A

* Letters in parentheses are LOS from 2009 no-build of Table 3 and indicate that LOS has changed from no-build to build scenario.

Traffic signal warrant analyses were performed using the 2009 combined (background plus site) traffic volumes. The primary impact of site traffic upon the traffic signal warrant will be on the peak-hour warrant. Traffic generated by residential developments is generally concentrated during the peak hours with lesser volumes throughout the rest of the day. The peak-hour warrant was tested for the intersections of McCampbell Drive with Washington Pike and Anderson Road with Tazewell Pike. The worksheet is contained in the Appendix.

Figure 6: 2009 Peak Hour Volumes With Development

The warrant thresholds are met during the AM peak hour at the intersection of McCampbell Drive with Washington Pike. However, most of the side street traffic at the intersection is right-turn traffic that will have available gaps created by the traffic signal at Murphy Road. Thus, the need for signalization at this intersection is not clearly indicated. The warrant thresholds are barely exceeded during both peak hours at the intersection of Anderson Road with Tazewell Pike. The projected side street volumes are 79 and 80 vehicles, respectively, during the AM and PM peak hours; the warrant threshold is 75 vehicles. Here also, the need for signalization is not clearly indicated. It is further emphasized that meeting the peak-hour signal warrant presents a relatively weak case for signalization in the absence of satisfaction of the eight-hour and four-hour warrants. While signalization may provide needed benefits during the peak hours, it can also create undue delay during other periods of the day.

The need for auxiliary turn lanes at the intersections of McCampbell Drive with Washington Pike and Anderson Road with Tazewell Pike was evaluated based on the volumes of Figure 6. With the added site traffic, a westbound left-turn lane on Tazewell Pike at Anderson Road will be warranted in both the AM and PM peak hours. Further, an eastbound right-turn lane will be warranted at the intersection during the PM peak hour. An eastbound left-turn lane will be warranted on Washington Pike at McCampbell Drive during both peak hours, but no right-turn lane will be warranted at the intersection. The evaluation worksheets are contained in the Appendix.

Evaluation of the At-grade Railroad Crossing on McCampbell Drive

The past safety record of the subject railroad crossing, as evidenced over the past three years of crash data, is excellent with no reported train-auto crashes. There are several factors that likely contribute to this trend including minimal vehicular traffic (ADT of 300 to 400), minimal train movements (2 trains per day), and off-peak train traffic (generally occurring during the overnight hours). Low approach speeds are also beneficial. The train speeds are cited to be no more than 30 m.p.h., and vehicle speeds at the crossing likely are low due to the presence of horizontal turns on both approaches near the crossing.

Upon construction of Babelay Farms, vehicular traffic volumes will increase substantially to an estimated ADT of 1805 vehicles per day at the crossing (see railroad crossing assessment worksheet in the Appendix). It is desirable to know if increased protection measures are in order given the projected increase in vehicle exposure. WSA consulted the *Railroad-Highway Grade Crossing Handbook* (FHWA, 1986, also on the Web at <http://www.fhwa.dot.gov/tfhr/safety/pubs/86215/86215.pdf>) for guidance in evaluating the impact of the increase in vehicular traffic volume. Two accident prediction models were utilized: the Peabody-Dimmick formula (pp. 63 and 66) and the U.S. DOT Accident Prediction Equations (pp. 70-78). The most pertinent pages are contained in the Appendix to this report. The current passive protection (crossbuck signs and pavement markings) and active protection with flashing lights were tested, and the results are summarized in Table 6.

Table 6: Theoretical Railroad Crossing Accidents Upon Site Buildout

Prediction model	Predicted accidents with signs and markings only	Predicted accidents with flashing lights
Peabody-Dimmick	2.88 in 5 years	1.53 in 5 years
U.S. DOT	0.042 per year	0.059 per year

It is unclear why the predicted accident rate increased with the greater level of protection using the U.S. DOT model. The Peabody-Dimmick model seems more reasonable. Also, the order of magnitude of the results using the two models is not consistent. Thus, it is difficult to make a recommendation for increased crossing protection based on the accident prediction models.

It would be helpful to have a threshold based on vehicular traffic volumes, train movements, train speed, and other factors to help indicate the need for increased level of protection at a given railroad grade crossing. However, "National warrants for the installation of flashing light signals have not been developed" (Handbook, p. 106). In the absence of published warrant thresholds, it is advisable to use local empirical data to assess the need for increased crossing protection. While the collection of such data is beyond the scope of this study, it is expected that information could be assembled to compare crossings with similar geometric and operational characteristics as are expected at the subject crossing upon site buildout. This information should guide the decision as to whether an increased level of protection is required.

Evaluation of the Internal Site Roadway Features

WSA reviewed the general site roadway system as well as the specific features identified in the Introduction to this study (one-way alleys and the circular intersection). The site includes primary roadways of a boulevard-type design with two single traffic lanes separated by a median (Roads 1, 2, 3, and a portion of Road 7); secondary two-lane two-way roads (Roads 4, 6, and the balance of 7); and several one-way alleys presumably providing rear access to the single-family lots.

The boulevards are shown in the site plan with 16-foot traffic lanes and a 25-foot median. Knox County's standard for boulevards specifies 18-foot traffic lanes to accommodate parked or stalled vehicles (8 feet of the pavement width) without impeding traffic in the remaining 10 feet of pavement. The proposed boulevard widths should be adjusted to provide the minimum pavement width per Knox County standards. The intersections of the boulevards and all other site roads should be evaluated to ensure that a large truck (WB-50 design vehicle) such as a moving van can execute turns without tracking beyond the pavement edge. Median noses and intersection pavement widths may require modification.

The two-lane two-way roads as shown in the site plan are 26 feet wide and satisfy Knox County's minimum width for local roads (*Minimum Subdivision Regulations for Knoxville and Knox County*, section 62-53). This 26-foot minimum likely reflects the same concern as with the boulevard width, which is to provide pavement width (8 feet) for parked or stalled vehicles without impeding the traffic lanes (two at 9 feet each; 9 feet is the absolute minimum lane width).

The one-way alleys are shown 12 feet wide in the site plan. The pertinent subdivision regulations do not specify a minimum width for alleys but rather state that they "shall have sufficient pavement widths to adequately serve the anticipated vehicular traffic" (section 62-54). It is assumed that the Babelay Farms alleys will be curbed, so vehicles will not be able to pass on the shoulder. Thus, a stalled or parked vehicle in an alley will block traffic thereon. The alley pavement width should be adjusted to provide lateral clearance for maneuvering around

such a stopped vehicle. The appropriate minimum pavement width is 17 feet (8 feet for the stopped vehicle and 9 feet for moving vehicles).

The circular intersection roadway (Road 5, at the common termini of Roads 1, 2, and 7) has an inner diameter of 184 feet and an outer diameter of 216 feet. The circulating road pavement width is 16 feet, so one-way operation is implied. Entry/exit point grades are 1% to 3% with the grades extending well away from the circle. The circulating roadway is proposed to have a grade of up to 7%, but it is unclear as to the impact of the grade on operation of traffic, particularly at the entry/exit points. The proposed use of the central island is a park, so it is expected that substantial volumes of pedestrian and bicycle traffic will be present and may include children.

The layout of Road 5 and its approaches as shown in the site plan is a traffic circle and not a roundabout. The entry/exit points are similar to typical street intersections requiring turns of approximately 90 degrees. This requires that approaching drivers slow or stop at the entry points, enhancing safety for park users. However, the relatively large diameter of the circulating roadway may not inhibit speeds as much as would be desirable given the presence of the park.

Given the anticipated operation of the traffic circle, the approach legs should be signed with STOP or YIELD signs, and one-way signing should be provided to indicate the appropriate direction of travel on the circulating roadway. It would be beneficial to provide channelization at the entry points to physically prevent wrong-way entry into the circulating roadway. The traffic circle as shown likely will not accommodate large trucks, such as moving vans, that may pass through the intersection. The Appendix contains application of a 45-foot turning radius WB-50 design vehicle on one of the approach legs. The current pavement width of 16 feet on the approaches and circulating roadway combined with the 25-foot curb radius require that such trucks track off of the pavement. The dimensions should be adjusted to accommodate large vehicles, either by widening the circulating roadway pavement width or by increasing the curb radii at all entry and exit points. Further, the minimum width for Road 5 should be increased to 17 feet or greater to allow vehicles to traverse around a stopped vehicle.

If a true roundabout is desired, it should be designed in accordance with the standards and principles set forth in *Roundabouts: An Informational Guide* (FHWA, June 2000) or similar nationally accepted standards. Some of the key elements applicable to the case at hand include:

- Determination of an appropriate speed through the roundabout (presumably the subdivision street speed limit of 25 m.p.h., or perhaps a lower speed given the presence of the park);
- Splitter islands with directional channelization to guide one-way traffic flow at the entry and exit points;
- Appropriate diameter (the desirable size of the outer diameter is 100 to 130 feet);
- Accommodation of pedestrians and bicycles;
- Accommodation of trucks, by means of a slightly raised apron around the central island if necessary;
- Provision of adequate sight distance on the approaches and in the roundabout; and
- Maintaining suitable grades in the roundabout (preferably less than 4%).

There is no compelling reason to prefer the roundabout over the traffic circle. The above elements are offered for informational purposes only.

Conclusions and Recommendations

Based upon the above data and analyses, WSA arrived at the following conclusions and sets forth the following recommendations in regard to the Babelay Farms residential development.

Anderson Road at Tazewell Pike:

This intersection currently includes single lanes on all approaches. Sight distance is adequate given the posted speed on Tazewell Pike. Northbound Anderson Road drivers encounter LOS E conditions in the AM peak hour. These are mostly left-turning vehicles that must await gaps in Tazewell Pike traffic. This movement will decline to LOS F with future background traffic growth and will be further exacerbated by site traffic. Signalization would serve Anderson Road traffic but is not justified given the volumes.

A westbound left-turn lane on Tazewell Pike is presently warranted during the AM peak hour. The warrant will also be met in the PM peak hour upon site buildout. An eastbound right-turn lane on Tazewell Pike is expected to be warranted in the PM peak hour with site buildout. No improvements are recommended at this intersection in conjunction with the Babelay Farms development since conditions are largely driven by non-site traffic. However, as system improvements are being considered on Tazewell Pike, it is recommended that the left- and right-turn lanes and reassessment of the traffic signal warrants be included in the planning process.

McC Campbell Drive at Washington Pike:

Current traffic conditions are acceptable (LOS D or better) at this intersection but are projected to decline to LOS E or F for southbound McC Campbell Drive traffic upon site buildout. Much of the McC Campbell Drive traffic is expected to be right-turns that may take advantage of gaps in Washington Pike traffic created by the traffic signal at Murphy Road, and signalization of this intersection is not justified. However, the intersection skew angle is severe, and intersection sight distance to the west is inadequate (300 feet available whereas the minimum required based on the Washington Pike posted speed limit of 40 m.p.h. is 400 feet). It is recommended that this intersection be realigned to create an angle as close to 90 degrees as possible. Sight distance to the west should be increased insofar as possible. Given the predominant

southbound right-turn volume, separate left- and right-turn lanes should be provided for McCampbell Drive traffic. This will not provide a significant improvement in LOS, but it will greatly benefit drivers making the southbound right turn. Also, an eastbound left-turn lane should be provided on Washington Pike.

A functional plan has been developed as part of an advance planning report for Washington Pike improvements. The plan incorporates the recommended realignment of McCampbell Drive and eastbound left-turn lane on Washington Pike along with widening of Washington Pike to a 4-lane divided facility. The pertinent sheet from the functional plan is contained in the Appendix. It should be noted that the improvements illustrated in the functional plan are not yet in Knox County's funding process.

Widening of McCampbell Drive:

With site buildout, traffic volumes on McCampbell Drive will increase substantially. The projected ADT is greater than 2300 vehicles per day east of the site and 1800 vehicles per day to the west (see Appendix). It is expected that most site traffic will utilize the east end of McCampbell Drive as discussed under trip distribution. Given this site impact, McCampbell Drive should be widened beyond its current 16 feet of pavement width.

The recommended minimum pavement width for local roads of 1500 to 2000 ADT and speeds of 30 to 40 m.p.h. is 32 feet and includes two 10-foot traffic lanes and two 6-foot shoulders (*Roadway Widths for Low-Traffic-Volume Roads*, Transportation Research Board, 1994, Table 29a, level terrain). Knox County's minimum width for local roads is 26 feet as cited earlier. It is recommended that McCampbell Drive be widened from Washington Pike to the west site driveway to a width of at least 26 feet. Widening of the roadway west of the site may be deferred until traffic patterns more clearly demonstrate the assumed trip distribution and/or as Tazewell Pike improvements make it a more attractive route.

Internal site roadways and the site driveways on McCampbell Drive:

Some deficiencies were noted regarding the site roads. It is recommended that the boulevard-type site roads be modified to comply with Knox County standards (18 feet of pavement width

for each traffic lane). It is also recommended that the alleys be widened to at least 17 feet. All intersections should be modified as required to accommodate a WB-50 design vehicle.

The traffic circle approaches should be signed as STOP or YIELD control, and one-way signing should be provided. It is recommended that the entry approaches be channelized to prohibit wrong-way entry into the traffic circle. It is recommended that the circle itself (Road 5) be constructed to a width of no less than 17 feet. It is also recommended that the entry and exit radii, median noses, and Road 5 width be modified to accommodate a WB-50 design vehicle.

The available sight distance at the two site driveways is adequate, exceeding the required minimum of 400 feet (based on an assumed speed of 40 m.p.h. on McCampbell Drive upon its widening). The proposed single-lane approaches are expected to provide adequate capacity (LOS A in both peak hours at both driveways). No turn lanes are indicated as needed on McCampbell Drive at the driveways. Separation of the driveways between each other and adjacent intersections is adequate.

Railroad grade crossing:

It is not clear whether active warning devices are necessary at the crossing given the projected increase in traffic volumes. The decision to install flashing lights or gates should be guided by a review of accident experience at similar crossings.

Appendices

Count Data

TDOT "ADAM" Printouts, Stations 33 and 283

Turning Movement Count Data

Mechanical Counter Data

TDOT Monthly Variation Factors

Highway Capacity Software Output Reports

Traffic Signal Warrant Worksheets

Turn Lane Warrant Worksheets

Trip Generation Worksheets and Regression Data

Railroad Crossing Evaluation Worksheets

Application of Truck Turning Template (WB-50) to Circular Intersection

Minimum Width Worksheet (McC Campbell Drive)

Functional Plan (McC Campbell Drive at Washington Pike)

LOCATION MAP
BABELAY FARMS RESIDENTIAL DEVELOPMENT
Knox County, Tennessee

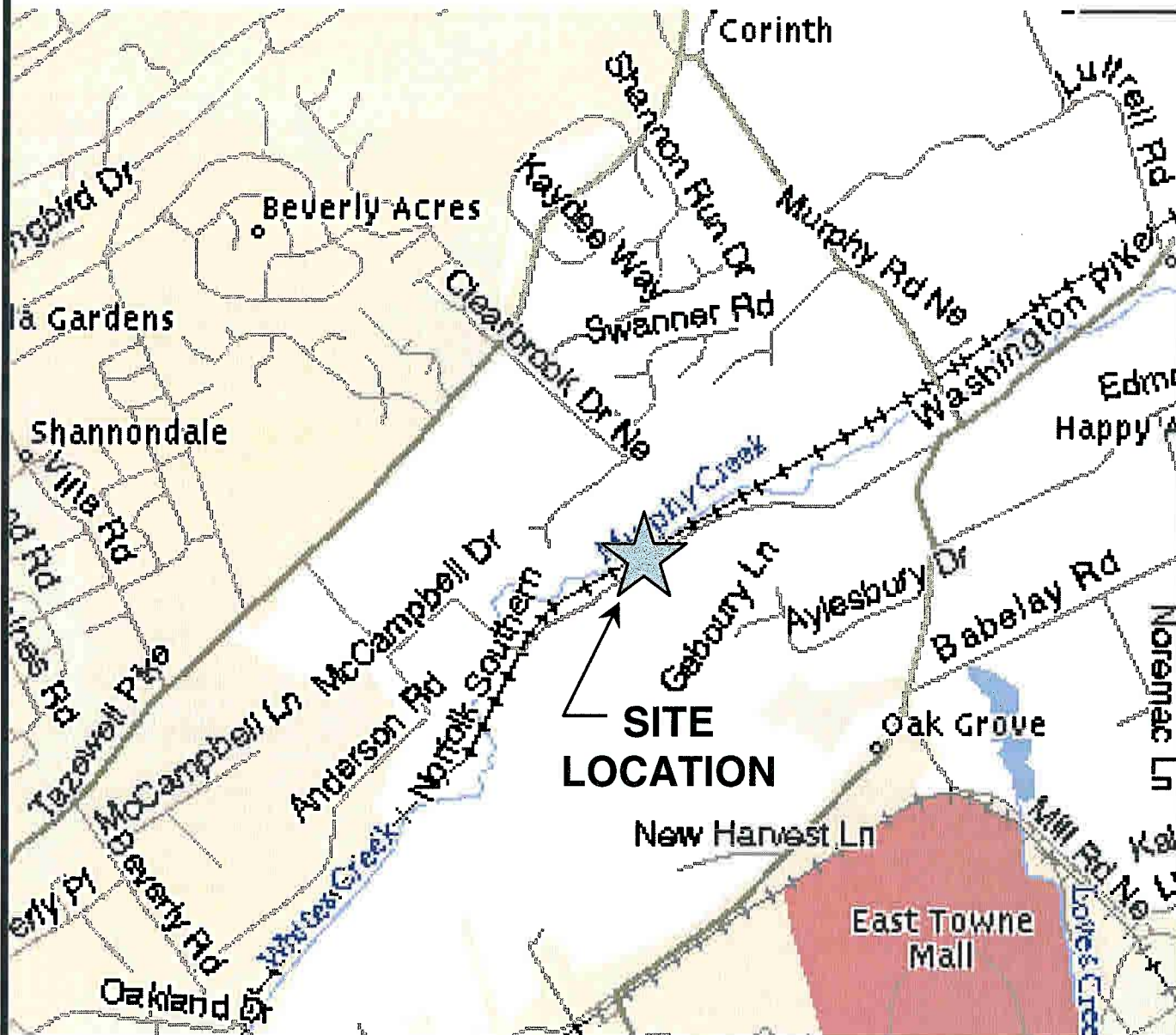


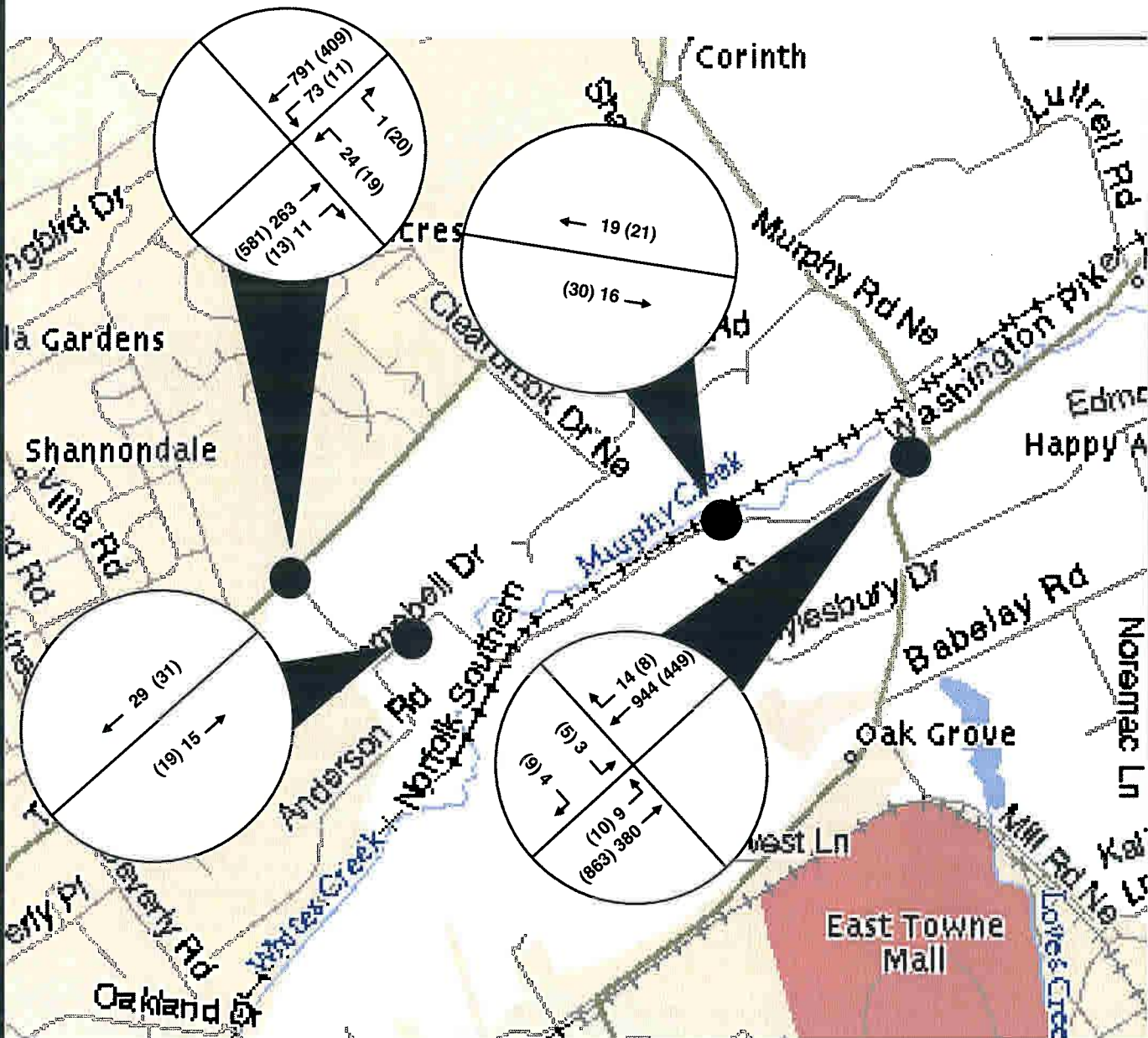
Figure 1

SITE PLAN
BABELAY FARMS RESIDENTIAL DEVELOPMENT
Knox County, Tennessee



Figure 2

2004 PEAK HOUR VOLUMES
BABELAY FARMS RESIDENTIAL DEVELOPMENT
 Knox County, Tennessee



LEGEND

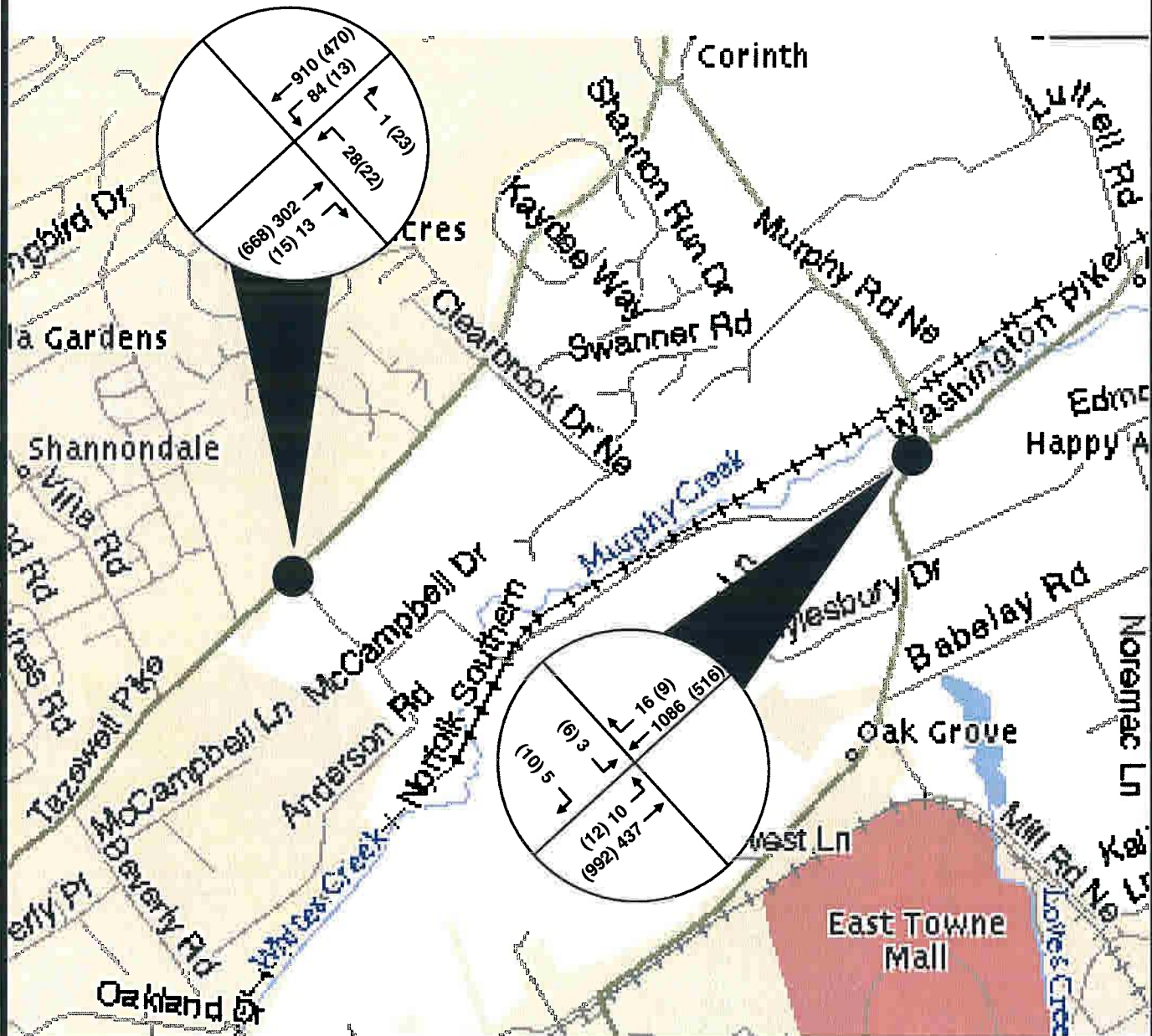
239 (300) —↑ Turning Movement Volume AM (PM)



Figure 3

2009 PEAK HOUR VOLUMES WITHOUT DEVELOPMENT BABELAY FARMS RESIDENTIAL DEVELOPMENT

Knox County, Tennessee



LEGEND

239 (300) —↑ Turning Movement Volume AM (PM)



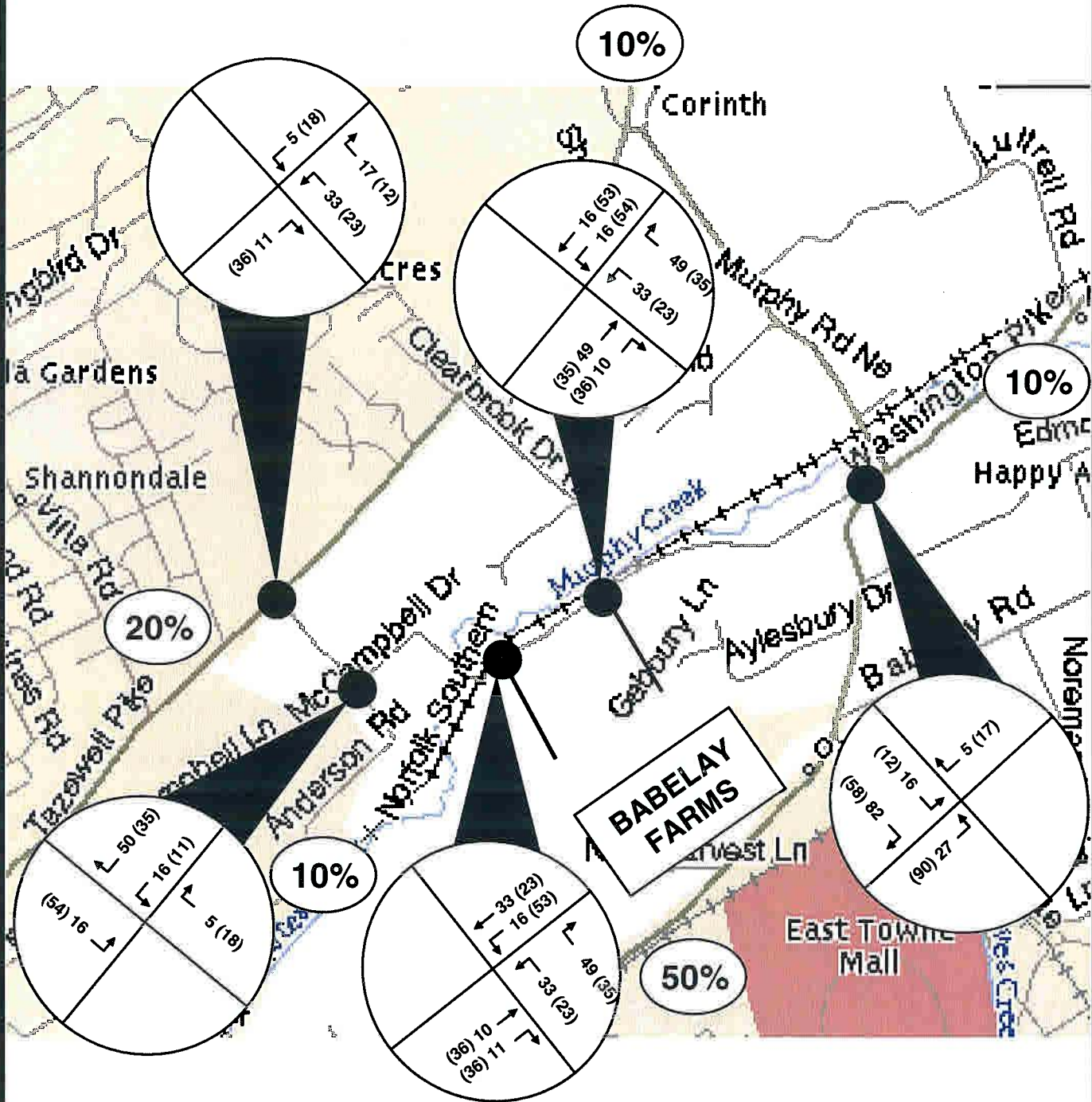
Wilbur Smith Associates

Figure 4

SITE TRAFFIC

BABELAY FARMS RESIDENTIAL DEVELOPMENT

Knox County, Tennessee



LEGEND

- 239 (300) → Turning Movement Volume AM (PM)
- (XX%) Directional Split of Site Traffic

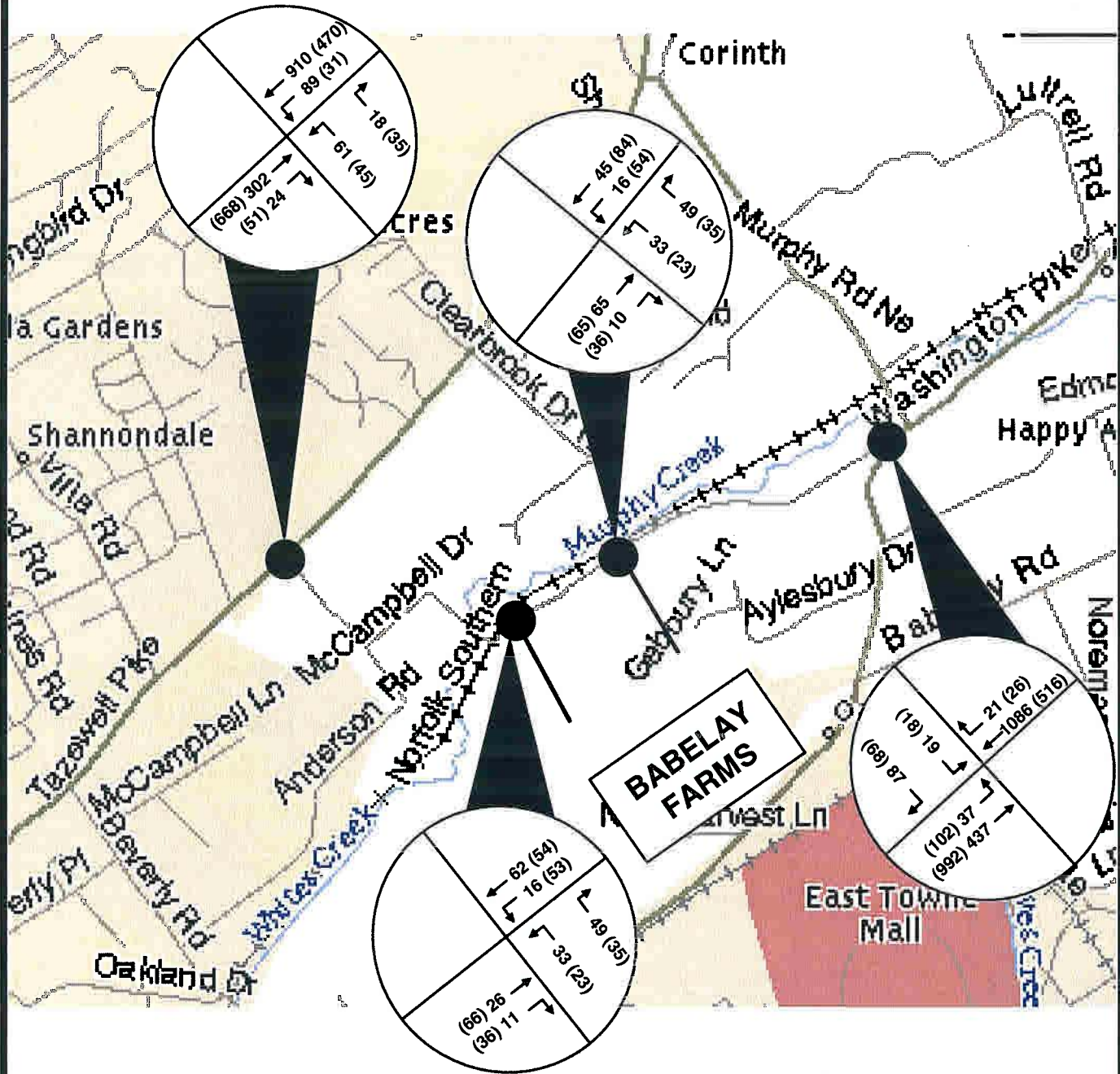


Wilbur Smith Associates

Figure 5

2009 PEAK HOUR VOLUMES WITH DEVELOPMENT BABELAY FARMS RESIDENTIAL DEVELOPMENT

Knox County, Tennessee



LEGEND

239 (300) —↑ Turning Movement Volume AM (PM)



Wilbur Smith Associates

Figure 6