AJAX ENGINEERING

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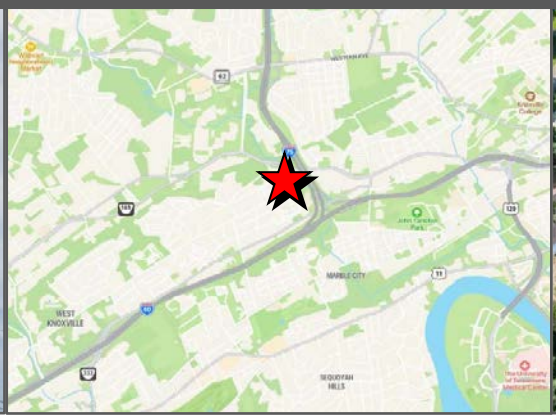
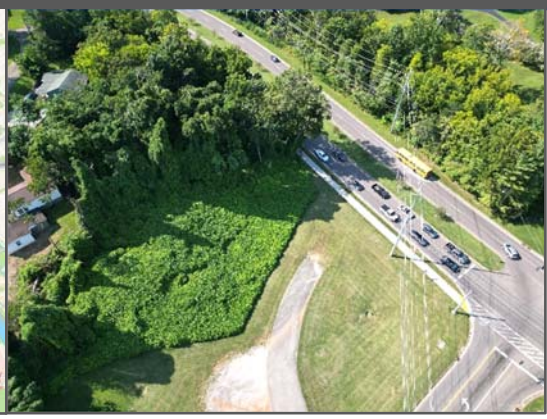
Transportation Impact Study

Shell Food Mart

Knoxville, Tennessee





Revised October 2023

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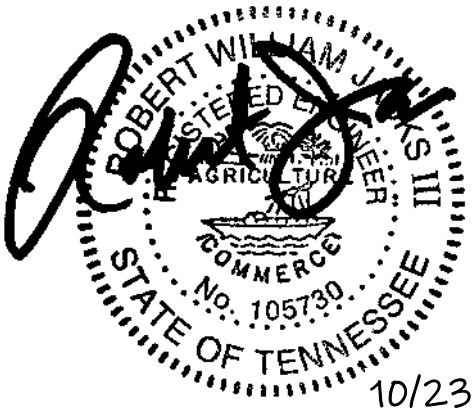

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EXECUTIVE SUMMARY

Preface:

Mr. Jay Patel is proposing a commercial development on the west side of Knoxville, TN, adjacent to the intersection of Middlebrook Pike and Lonas Drive. The commercial development will include a gas station with twelve vehicle fueling positions and a 5,000 square feet convenience market on 1.13 +/- acres and is named and referenced in this study as "Shell Food Mart". This development is anticipated to be fully built out and operational by 2025 and proposes two entrances, one on the north and one on the east side of the property. This study's primary purpose is to determine and evaluate the potential impacts of the development on the adjacent transportation system. The study includes a review of the primary access roads, the adjacent intersection of Middlebrook Pike and Lonas Drive, and the two proposed entrances for the development. The report is a Level 1 study established by Knoxville/Knox County Planning. Recommendations and mitigation measures are offered if transportation operations are projected to be below recognized engineering standards.

Study Results:

The findings of this study include the following:

- The Shell Food Mart development is estimated to generate 3,086 trips at full build-out and operations on an average weekday. Of these daily trips, 324 are estimated to occur during the AM peak hour and 273 in the PM peak hour in 2025. However, most of these trips are expected to be comprised of motorists already traveling through the adjacent Middlebrook Pike and Lonas Drive corridors.
- The adjacent intersection of Middlebrook Pike and Lonas Drive operates under traffic signal control. With some minor signal timing modifications, the intersection is projected to operate adequately with respect to vehicle delays and queues in 2025, with the developments' generated traffic. The projected 2025 trips generated from the proposed commercial development are calculated to marginally increase vehicle delays at this intersection.
- The Shell Food Mart development will have two entrances, one on Middlebrook Pike and one on Lonas Drive. These entrances are expected to operate well with respect to vehicle delays and operations when the recommendations in this study are followed. However, during peak hours, vehicles exiting these entrances will have to wait for gaps in the vehicle streams and queues forming on the adjacent streets and experience internal vehicle exiting queues.

Recommendations:

The following is a summary of recommendations based on the study analyses. The recommendations are offered to minimize the impacts of the proposed development on the adjacent transportation system while attempting to achieve an acceptable traffic flow and improved safety. The recommendations marked with an asterisk indicate a transportation need not particularly associated with the proposed development's projected impacts. More details regarding all these recommendations are discussed at the end of the report.

- It is recommended that the City of Knoxville slightly modify the traffic signal timing to reduce the vehicle delays for the northbound approach of Lonas Drive. This recommendation is pertinent to not only the projected conditions but also the existing conditions. According to this study's results, it is recommended to include adding 10 seconds of green time to the northbound approach of Lonas Drive at the traffic signal during the PM peak hour while reducing the same amount from the mainline approaches on Middlebrook Pike.

* • Due to the projected vehicle queues on the Middlebrook Pike westbound left-turn lane at the signalized intersection calculated to extend past the provided lane storage, even without the project being constructed, the Tennessee Department of Transportation (TDOT) and the City should consider extending the westbound left-turn lane on Middlebrook Pike an additional 65 feet minimum, for a total of 175 feet of storage. This need will become more pertinent if more green time is assigned to the northbound approach of Lonas Drive at the traffic signal as recommended to reduce vehicle delays on this approach.

* • In the future, with continued overall traffic growth, TDOT and the City may need to consider adding an exclusive eastbound right-turn lane on Middlebrook Pike at Lonas Drive and a second northbound left-turn lane on Lonas Drive due to the existing and projected high left and right-turn vehicular volumes.

- The Main Entrance on Middlebrook Pike will be designed and constructed as right-turn-in/right-turn-out (RIRO) only. This entrance is proposed as RIRO only due to the existing raised grassed center median on Middlebrook Pike. It is recommended that the proposed Main Entrance follow the Tennessee Department of Transportation (TDOT) driveway entrance guidelines, and the following should be considered in the design and construction:
    - The entering and exiting lanes should have a width and inner radius to facilitate the largest expected-sized vehicle entering and exiting at Middlebrook Pike, which is expected to be gas delivery trucks, most likely

from the gas terminals located a mile west along Middlebrook Pike. The layout and elements of the intersection should follow all TDOT and City of Knoxville standards.

- The island separating the entering and exiting movements should be raised concrete with traversable curbs to facilitate large trucks delivering convenience market items and gasoline.
- Traffic signage with breakaway posts at this intersection should include a Stop Sign (R1-1), a Keep Right Sign (R4-7), a No Left Turn Sign (R3-2), a Do Not Enter Sign (R5-1), and One Way Signs (R6-1R). These signs should be installed facing the appropriate direction. Three reflective raised pavement markers should be located at the island corner radius points – one in the center and 2-foot spacing on either side of the corners. The Stop Sign (R1-1) should be supplemented with a 24" white stop bar on the exiting lane approaching Middlebrook Pike, a minimum of 4 feet away from the proposed crosswalk for the sidewalk/greenway.

- It is recommended that the sidewalk at the Main Entrance be installed with pavement markings and other items to reduce the potential turning vehicle conflicts with pedestrians and bicyclists on the Middlebrook Greenway. It is recommended that the pavement markings be installed with thermoplastic materials. The recommended pavement markings include designated white crosswalks, detectable surfaces, and advance pavement markings on the sidewalk/greenway. The pavement markings on the sidewalk should include white yield symbols and wording to include "Path Xing". Alternative sidewalk delineations across the entrance could include green-colored pavement. Details regarding the appropriate and desired treatments to reduce pedestrian and bicycle conflicts should be discussed during the detailed design review with TDOT and the City of Knoxville.
- Intersection sight distance for pedestrians and motorists at the Main Entrance at Middlebrook Pike must not be impacted by future landscaping or signage. The sidewalk approaches to the Main Entrance should have clear sight lines to fully allow greenway users to see approaching entering and exiting vehicles.
- Based on a posted speed limit of 45-mph on Middlebrook Pike, the required ISD is 430 feet, looking to the west for exiting right-turning vehicles at the Main Entrance. The available sight distance was visually estimated to be 375 feet to the west on Middlebrook Pike. The sight distance is reduced to the west due to vegetation growing from the adjacent cut slope along the south side of

Middlebrook Pike. This vegetation must be removed and reduced to allow the maximum sight distance. A licensed land surveyor must measure the currently available sight distance to confirm the visual approximation and define the amount of vegetation removal needed to meet the required sight distance to the west. The site designer must also verify that this distance will be available based on the final site plans.

- The construction of the Main Entrance on Middlebrook Pike will require a TDOT Highway Entrance Permit. The developer will need to apply for this permit and coordinate with TDOT regarding their specific requirements for this entrance.
- It is recommended that the Secondary Entrance on Lonas Drive be constructed with different-sized radii. It is recommended that the entrance's southern edge radius be 15 feet to reduce the exiting vehicle speeds, thus reducing the potential of cut-thru traffic. On the entrance's northern side, it is recommended that the radius be constructed at 25 feet to help facilitate entering vehicles from the north. If curbs are constructed at this entrance, they should be traversable to allow for potential large trucks to enter and exit.
- Sight distances from the proposed Secondary Entrance at Lonas Drive must not be impacted by future landscaping and signage. The required ISD is 390 feet looking to the south and 170 feet to the north for exiting left and right-turning vehicles at the Secondary Entrance. The available sight distance was visually estimated to be 325 feet to the south on Lonas Drive. The sight distance is reduced to the south due to the horizontal curvature of Lonas Drive and the vegetation growing on the east side of Lonas Drive. This vegetation must be removed or reduced to allow the maximum sight distance. A licensed land surveyor must measure the currently available sight distance to confirm the visual approximation and define the amount of vegetation removal needed to meet the required sight distance to the south. The site designer must also verify that this distance will be available based on the final site plans.
- It is not explicitly recommended that the Secondary Entrance not be constructed with dual exiting lanes, allowing separate left and right-turning movements. However, an additional exiting lane would help reduce vehicle queue lengths and delays, particularly for right-turning movements toward the south onto Lonas Drive. If a dual exiting lane is desired, it should be taken under advisement due to the proximity to the signalized intersection and the high-level decision-making required by exiting motorists to find gaps in the oncoming traffic. The horizontal curvature of Lonas Drive at the proposed location could be detrimental, and side-

by-side vehicles in dual exiting lanes could restrict each other's sight distance.

- With the high number of existing eastbound right-turns occurring on Middlebrook Pike to Lonas Drive, the potential for cut-thru traffic at this location is very high. Cut-thru traffic would be potentially dangerous due to the nature of gas station/convenience market activities, which include walking customers, vehicles backing out of parking spaces, gas pump maneuvers, and delivery trucks. It is recommended that the site designer include a raised crosswalk that would dissuade motorists from cutting through the development.
- A site layout to include a sidewalk from the existing KAT bus stop on Middlebrook Pike to the convenience market building is recommended. Installing a sidewalk across the property to and from the building would facilitate pedestrian or bicycle traffic to and from the transit stop and the greenway without forcing these potential customers to cross the parking lot and internal drives, which would be hazardous due to potential vehicle conflicts.
- Sidewalks are proposed along the front and adjacent to the convenience market and are recommended to be installed across the property to and from the KAT bus stop and greenway. Sidewalks should have appropriate ADA-compliant ramps at intersection corners, and the internal sidewalks are recommended to be 5 feet minimum in width to meet the City of Knoxville regulations. Sidewalk ramps must include detectable surfaces to meet ADA requirements.
- According to the City of Knoxville regulations, bicycle spaces must be provided for this proposed development. With nineteen vehicle parking spaces, four bicycle parking spaces are required for this proposed development. These spaces should be designed according to the regulations listed in Section 11.9 of the City of Knoxville's Zoning Code User's Manual.
- All road grade and intersection elements should be designed to AASHTO, TDOT, and City of Knoxville specifications and guidelines to ensure proper transportation operations.

DESCRIPTION OF EXISTING CONDITIONS

- **STUDY AREA:**

The proposed location of this new commercial development is shown on a map in Figure 1. This development will be located on the southwest corner of the Middlebrook Pike and Lonas Drive intersection on the west side of Knoxville, TN. The commercial development will comprise two entrances with internal pavement and parking areas on 1.13± acres. The development will include a gas station and a convenience market. The Main Entrance to the development will be to the north at Middlebrook Pike and will be right-turn-in/right-turn-out (RIRO) only due to the existing divided raised grass median in the center of Middlebrook Pike. The Secondary Entrance will tie to the east side to Lonas Drive, north of Kim Watt Drive and south of Middlebrook Pike.

View of Development Site from Southwest Corner of Property (Looking Northeast)

The adjacent Middlebrook Pike corridor is moderately occupied with commercial developments, business services, and residential properties near the proposed development site. Overall, the proposed development property is in a suburbanized area and just a short distance from an overpass of Interstate 640 to the east. South College is also nearby, south of the development site.

The development site is flat on the frontage along Middlebrook Pike and Lonas Drive but has a steep slope on the property's rear (western side). The property near the adjacent roadways is covered in grass that is maintained. The property currently has an asphalt paved entrance on Lonas Drive with a short driveway in the center. Towards the rear, the sloped area is covered with trees with a heavy blanket of kudzu. A large area of the southwest corner of the signalized intersection is outside the development property line and is bisected by powerlines and other utilities. The development site to the north and east provides approximately 150 feet of road frontage along Middlebrook Pike and 200 feet on Lonas Drive, respectively.

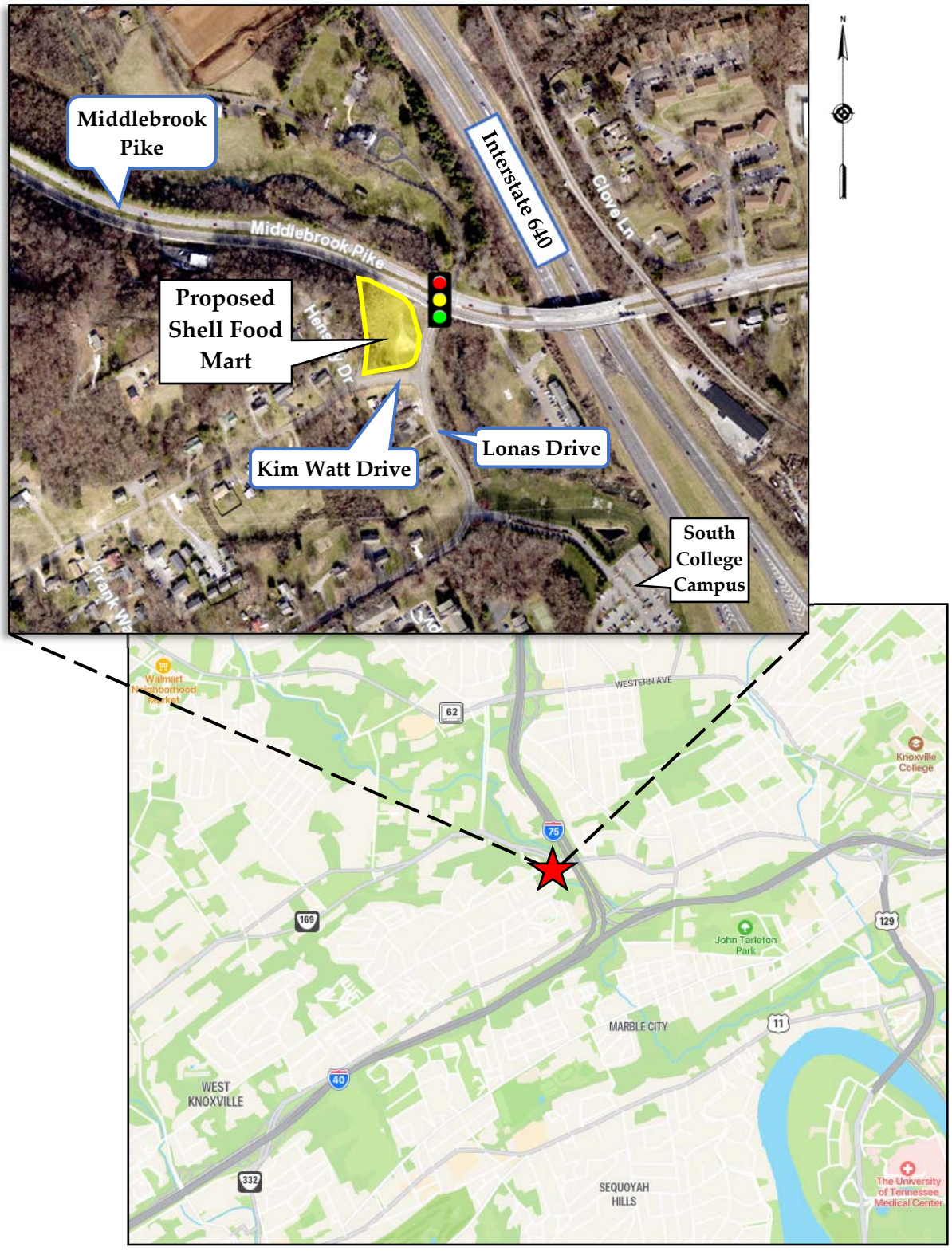


Figure 1
Location Map

- **EXISTING ROADWAYS:**

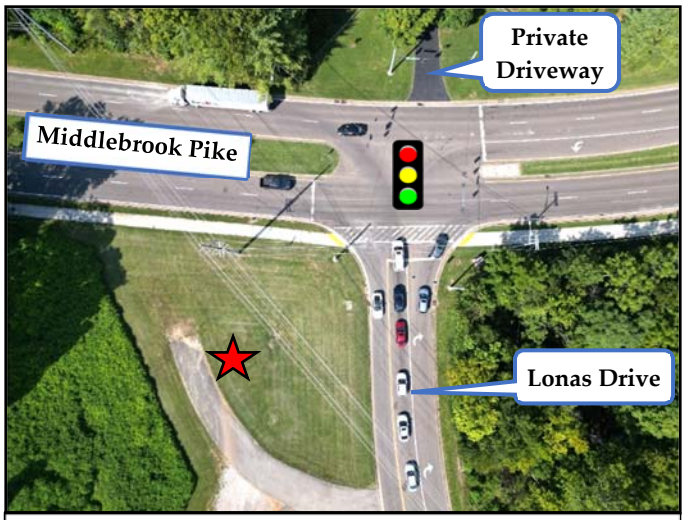
Table 1 lists the characteristics of the existing primary roadways adjacent to the development property that were reviewed in the study:

TABLE 1
STUDY CORRIDOR CHARACTERISTICS

NAME	CLASSIFICATION [1]	SPEED LIMIT	LANES	ROAD WIDTH [2]	TRANSIT [3]	PEDESTRIAN FACILITIES	BICYCLE FACILITIES
Middlebrook Pike (SR 169)	Major Arterial	45 mph	4 divided	76 feet	KAT / Route 13	8' sidewalk / greenway on south side	No bike lanes
Lonas Drive	Major Collector	35 mph	2 undivided	39 feet	None	None	No bike lanes

[1] 2018 Major Road Plan by Knoxville/Knox County Planning
[2] Edge of curb to edge of curb or edge of pavements near project site
[3] According to Knoxville Area Transit System Map

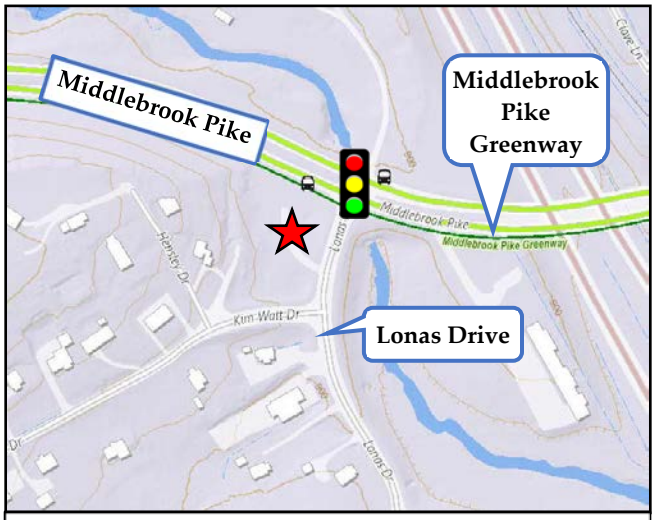
Middlebrook Pike (SR 169) is a 4-lane major arterial that traverses in a generally east-west direction. Middlebrook Pike is 11.7 miles long and runs between Lovell Road/Ball Camp Pike on the west side to the Western Avenue (SR 62) at University Avenue intersection on the east side. Closer to the study area, just to the west of the development site, Middlebrook Pike provides access to Ed Shouse Drive north to Western Avenue for access to Interstate 640. Two miles to the east, using a short jaunt via North Twenty-First Street, Middlebrook Pike provides access to Interstate 40, 75, and Alcoa Highway via a complex interchange. The posted speed limit on Middlebrook Pike is 45 mph at the project site.



Intersection of Middlebrook Pike at Lonas Drive and Private Driveway

Middlebrook Pike is a divided highway with a raised grassed median adjacent to the proposed development site. The travel lanes are approximately 11.5 feet wide, and the right-of-way width is variable at the development site. The raised grassed median is 18 feet in width at the location of the proposed Main Entrance, and the center median is lined with black hawthorn and oak trees.

Center median openings along Middlebrook Pike are few near the development site, with the closest being provided at the signalized intersection with Lonas Drive. This opening includes an exclusive westbound left-turn lane on Middlebrook Pike with 110 feet of vehicle storage. Middlebrook Pike has 6" concrete curbs with 24" gutters. An 8-foot sidewalk/greenway is provided on the south side of Middlebrook Pike. This greenway is part of the City of Knoxville's greenway system and is appropriately named the "Middlebrook Pike Greenway". A small grass strip separates the greenway path from the edge of Middlebrook Pike.



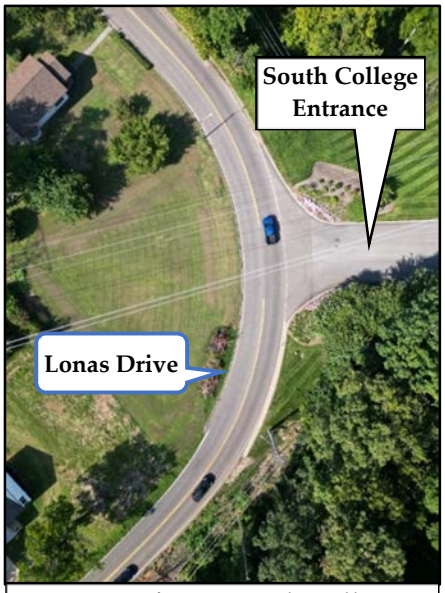
Middlebrook Pike Greenway and KAT Transit System Route 13 at Lonas Drive

Utility street lights are provided along Middlebrook Pike and Lonas Drive for roadway illumination in the adjacent study area. Middlebrook Pike will provide the primary road access to and from the proposed commercial development via the "Main Entrance".

Lonas Drive is classified as a Major Collector and generally traverses in a southwest-northeast direction. Lonas Drive begins at Gate Lane on the southwest end and terminates 2.6 miles to the northeast at the signalized intersection with Middlebrook Pike. At its beginning at Gate Lane, Lonas Drive traverses to the northeast across a signalized intersection with Weisgarber Road. It continues to Middlebrook Pike, making a sharp horizontal turn to the north just before the signalized intersection.

Access to South College is provided via a private entrance at the sharp horizontal curve on Lonas Drive just before Middlebrook Pike. On their website, South College is described as "a regionally accredited private co-educational, non-sectarian academic institution with non-residential campuses in Knoxville and Nashville, Tennessee; Asheville, North Carolina; Atlanta, Georgia; Indianapolis, Indiana; Pittsburgh, Pennsylvania and Orlando, Florida. Students can pursue academic programs at all levels, including professional certificates and associate, bachelor's, master's, and doctoral degrees." The College does not provide any on-site residences or dormitories. Their main campus is at the Lonas Drive location, and a second campus in Knoxville is located off Parkside Drive further west in Knoxville near Lovell Road.

The South College entrance is 530 feet south of the proposed Shell Food Mart property. According to online sources, South College has around 5,000+ full-time, part-time, in-person, & online students.



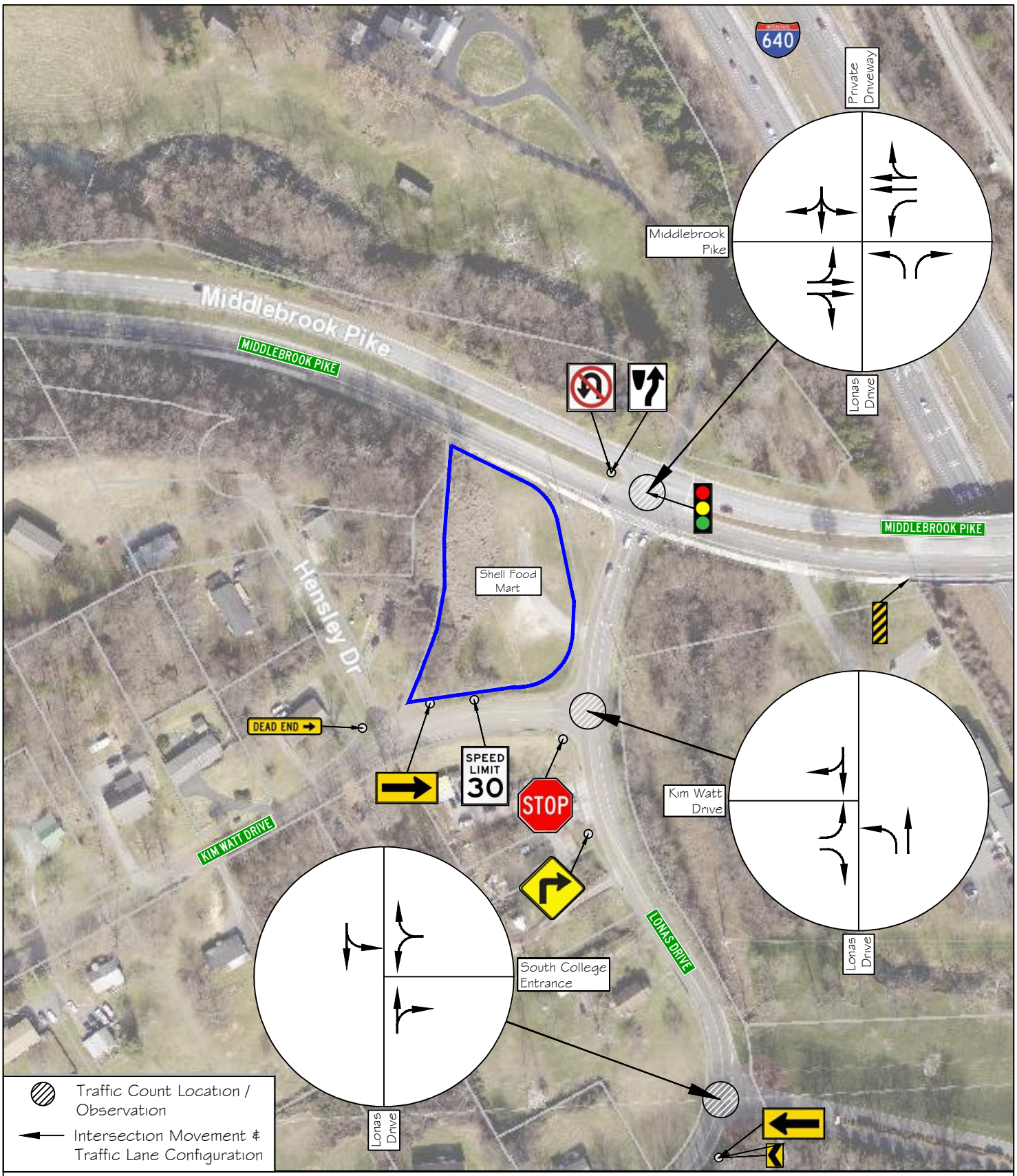
Lonas Drive at South College Entrance

Other than South College, Lonas Drive primarily provides access to several residential subdivisions, apartment complexes, and standalone single-family detached houses. However, on its western end, Lonas Drive provides access to the corporate offices for Pilot Flying J. Immediately to the south and adjacent to the proposed development property, Kim Watt Drive intersects Lonas Drive and runs parallel to Lonas Drive to the west. Kim Watt Drive primarily provides access to residential properties.

At the intersection with Middlebrook Pike, Lonas Drive has separate left and right lanes. Across Middlebrook Pike from Lonas Drive, a private driveway forms the north approach of the intersection, and vehicles from this private driveway are provided with their own green phase at the traffic signal when actuated. Very few vehicles enter and exit this driveway since it only provides access to a private tract on the north side of the intersection. "Middlebrook" is located on this northern tract, a historic house built around 1845 and listed on the National Register of Historic Places. According to Wikipedia, the house "was constructed circa 1845 by Gideon Morgan Hazen and is one of the oldest existing frame residences in Knoxville".

A faded 10-foot zebra-pattern crosswalk is present on Lonas Drive at Middlebrook Pike. No pedestrian push buttons or walk indicators are provided for pedestrians or bicyclists on the sidewalk/greenway crossing Lonas Drive. Lonas Drive will provide secondary access to and from the proposed commercial development via the "Secondary Entrance". The travel lanes on Lonas Drive are approximately 11.5 feet in width, and the ROW is variable at the development site.

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



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NOT TO SCALE

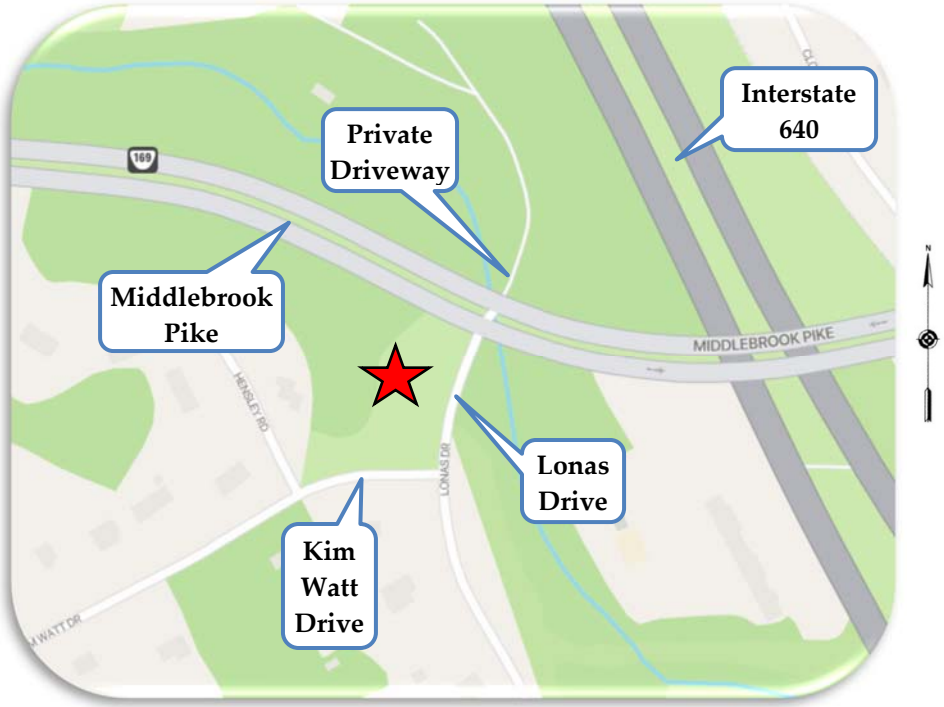
NORTH

FIGURE 2

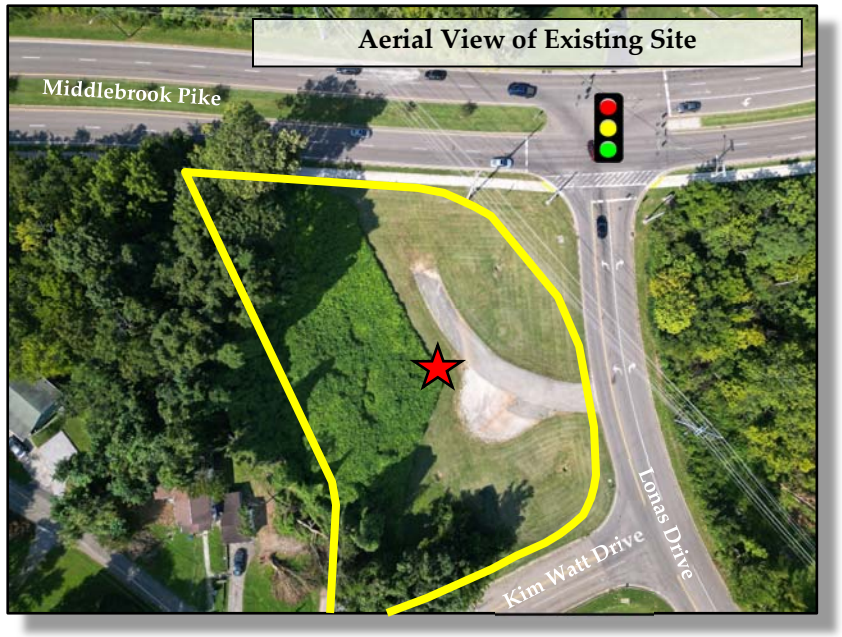
Shell Food Mart

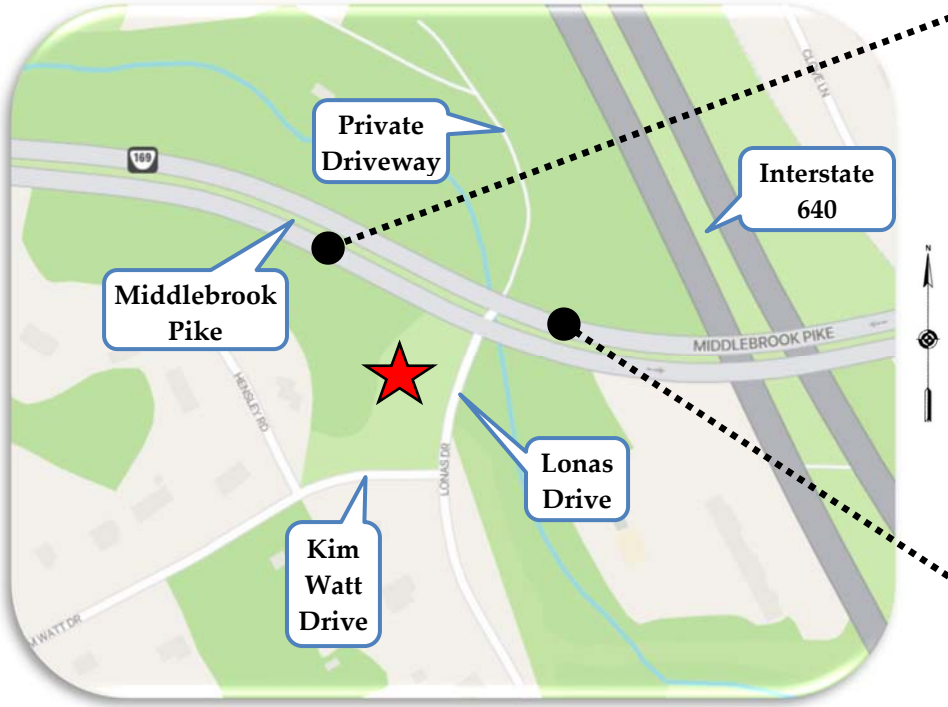
Traffic Count Locations, Traffic Signage & Existing Lane Configurations

PHOTO EXHIBITS

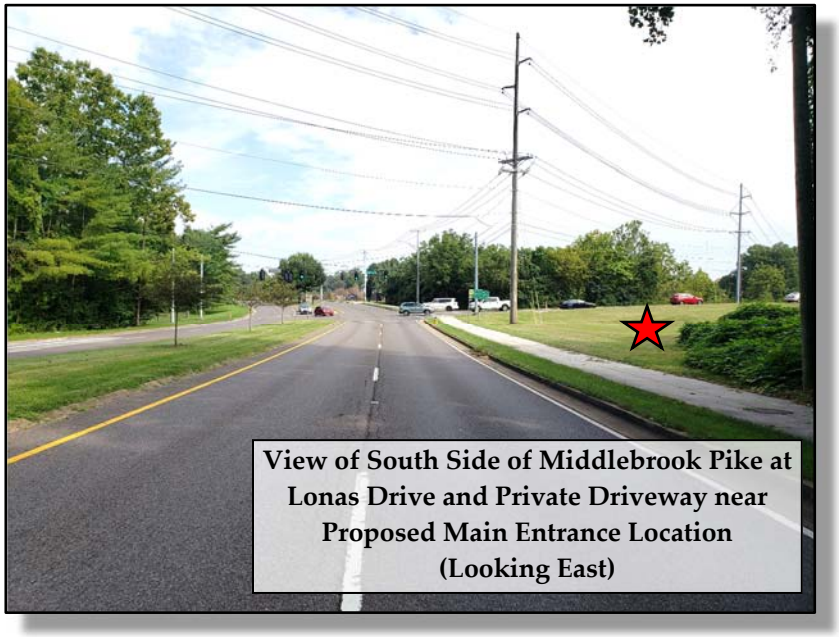


Middlebrook Pike at Lonas Drive and Private Driveway

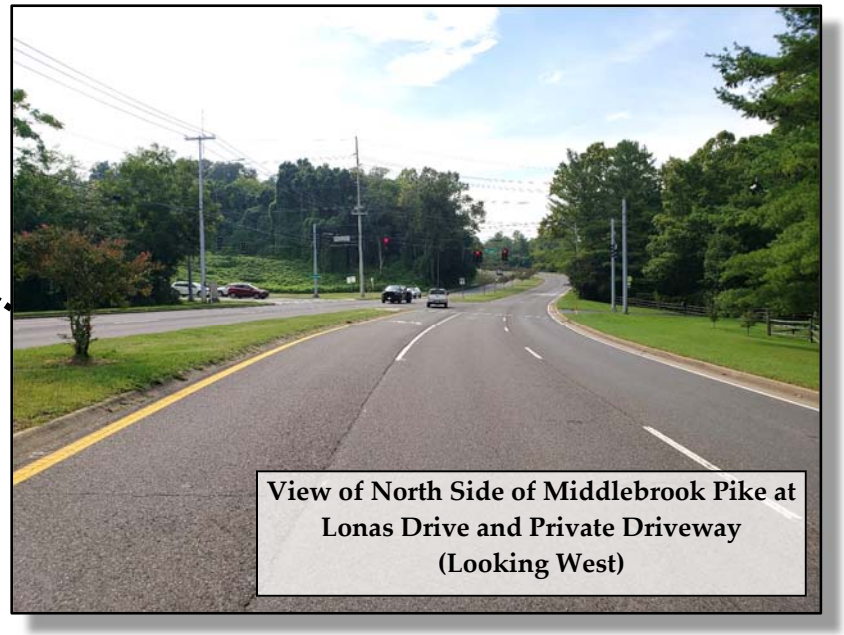




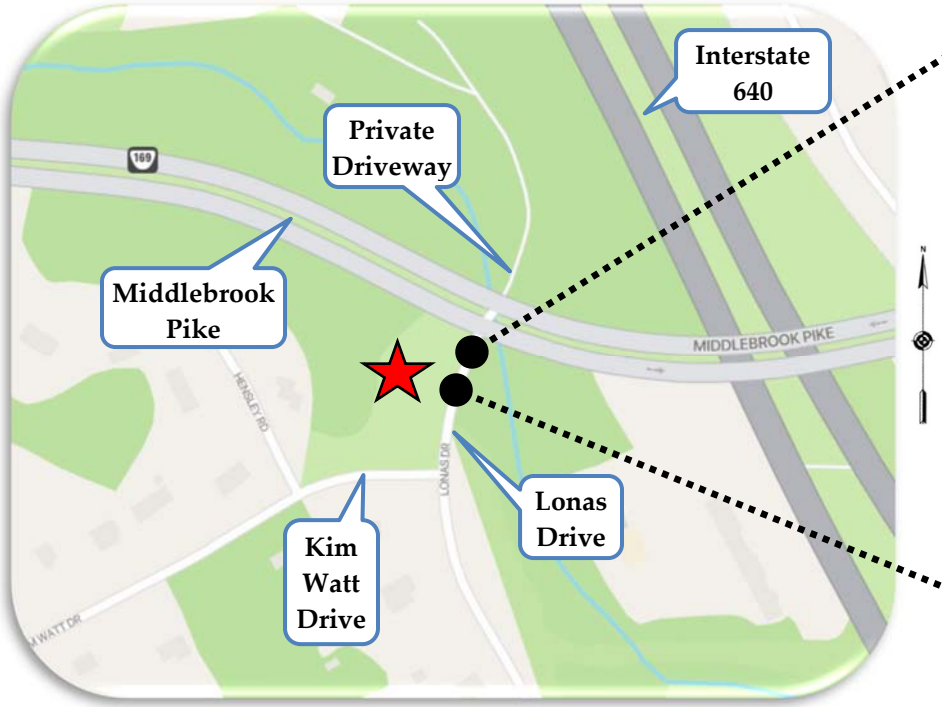
Middlebrook Pike at Lonas Drive and Private Driveway



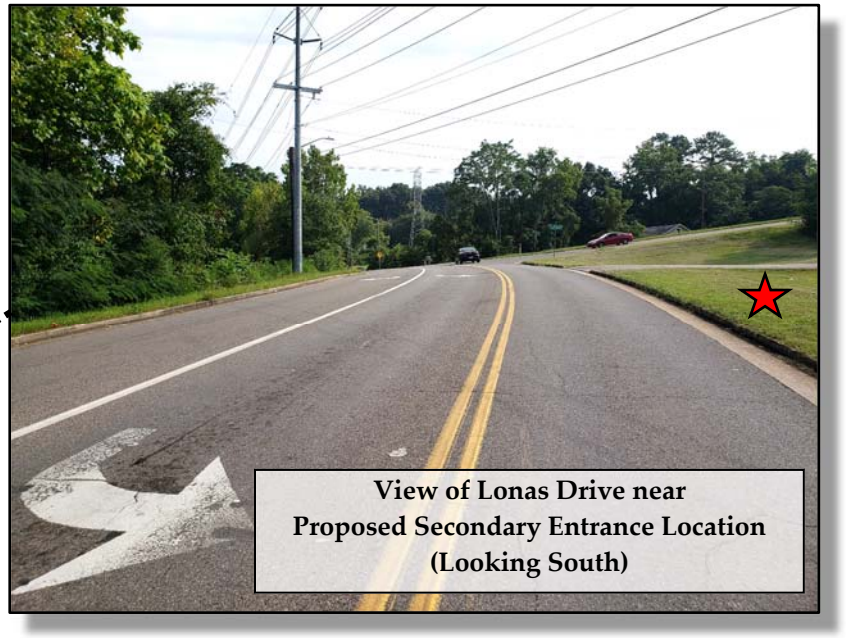
View of South Side of Middlebrook Pike at Lonas Drive and Private Driveway near Proposed Main Entrance Location (Looking East)



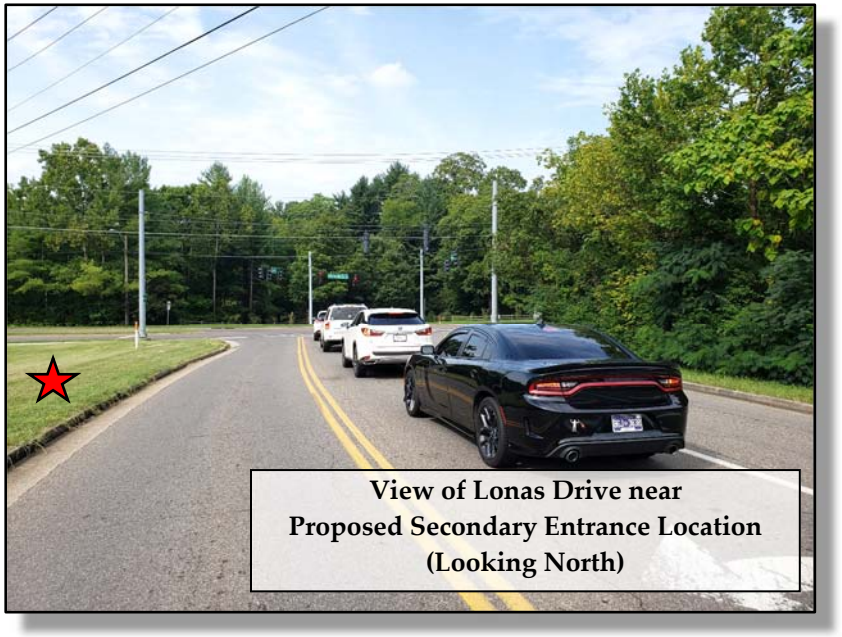
View of North Side of Middlebrook Pike at Lonas Drive and Private Driveway (Looking West)



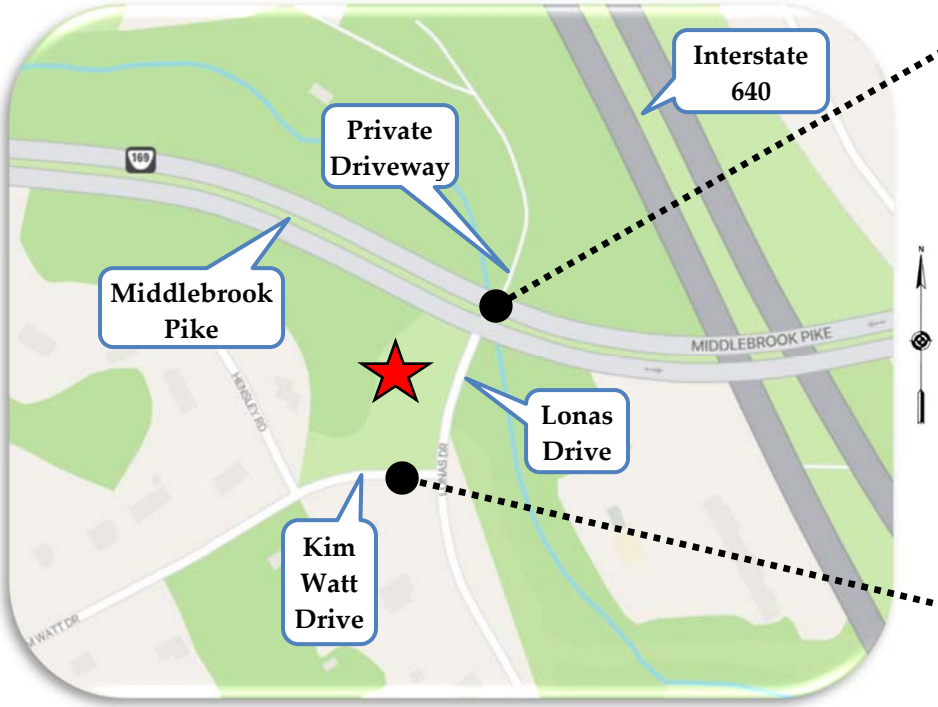
Middlebrook Pike at Lonas Drive and Private Driveway



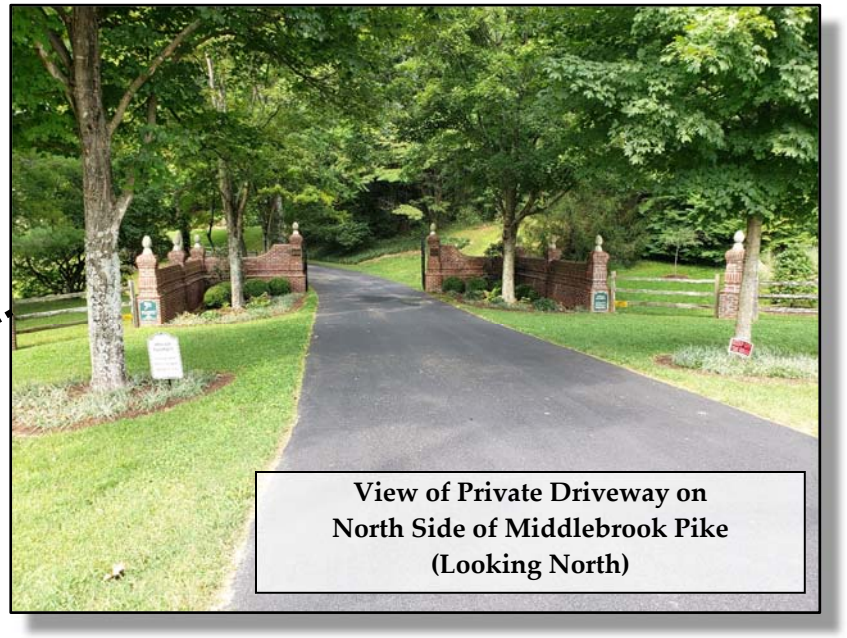
View of Lonas Drive near Proposed Secondary Entrance Location (Looking South)



View of Lonas Drive near Proposed Secondary Entrance Location (Looking North)



Middlebrook Pike at Lonas Drive and Private Driveway



View of Private Driveway on North Side of Middlebrook Pike (Looking North)

View of Kim Watt Drive at Lonas Drive (Looking East)

- **EXISTING TRANSPORTATION VOLUMES PER MODE**:

Two annual vehicular traffic count locations exist near the study area, and the Tennessee Department of Transportation (TDOT) conducts these counts. The count location data is the following and can be viewed with further details in Appendix A:

- Existing vehicular roadway traffic:
  TDOT reported an Average Daily Traffic (ADT) on Middlebrook Pike, east of the development site and east of Interstate 640, at 14,141 vehicles per day in 2022. From 2012 to 2022, this count station has indicated a -0.8% average annual traffic growth rate.

  TDOT reported an Average Daily Traffic (ADT) on Lonas Drive, southwest of the development site, at 6,628 vehicles per day in 2022. From 2012 to 2022, this count station has indicated a +2.6% average annual traffic growth rate.

- Existing bicycle and pedestrian volumes:
  The average daily pedestrian and bicycle traffic is unknown along Middlebrook Pike and Lonas Drive. However, with a sidewalk/greenway on the south side of Middlebrook Pike, this corridor is assumed to have a fair amount of pedestrian and bicyclist activity. During the 8-hour traffic count for this project, two bicyclists and six pedestrians were observed on Middlebrook Pike on the sidewalk/greenway. Five pedestrians were observed on Lonas Drive, even though this roadway does not provide a sidewalk or greenway.

  An online website, strava.com, provides "heat" maps detailing routes taken by pedestrians, joggers, and bicyclists. The provided heat maps show the last two years of data, are updated monthly, and are gathered from individuals allowing their smart devices to track and compile their routes (millions of users). The activities in the maps are shown on the roads with color intensities with darker

Strava Heat Map for Bicyclists

colors signifying higher activity. The Strava heat maps show bicycle and pedestrian activity along Middlebrook Pike and Lonas Drive, with slightly higher bicyclist activity overall. Considerable bicycle activity is shown on both sides of Middlebrook Pike, indicating, at a minimum, that bicyclists are traveling in the westbound vehicle travel lanes and might be traveling in the eastbound vehicle travel lanes. Lower bicyclist activity is shown occurring on Lonas Drive and Kim Watt Drive. A fair amount of pedestrian traffic is shown on the southern side of Middlebrook Pike along the sidewalk/greenway. From the Strava image, it appears that pedestrian activity to and from the south of Middlebrook Pike utilizes Kim Watt Drive rather than Lonas Drive, assumed to be primarily due to pedestrians avoiding the higher volumes and vehicle speeds on Lonas Drive.

Strava Heat Map for Pedestrian and Joggers

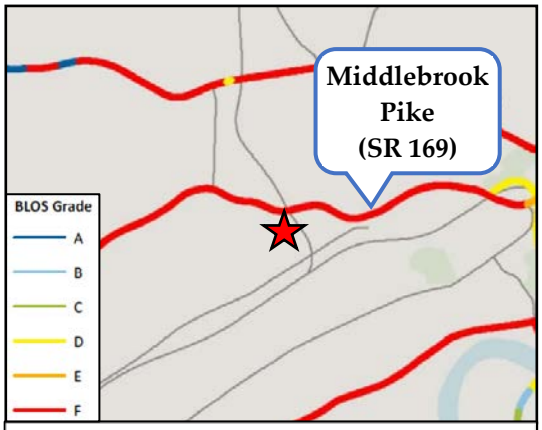
- **PEDESTRIAN AND BICYCLE FACILITIES**:

The Middlebrook Greenway will be adjacent to the proposed development and will allow bicyclists and pedestrians within reach of the greenway system in the area to travel to and from the proposed development outside the roadway vehicle lanes.

The Middlebrook Pike Greenway is 2.1 miles in length. It begins on the west side near the Knoxville Utilities Board (KUB) headquarters. To the east, this greenway ends at the intersection with Proctor Street. Roughly mid-way along the greenway, at Liberty Street, the Middlebrook Pike Greenway switches to the north side of Middlebrook Pike while providing a connection to the "Liberty Greenway" to the south. According to the City of Knoxville, its greenways can be used for "walking, running, bicycling, walking leashed dogs, skating, pushing strollers, using wheelchairs, and rollerblading."

Strava data shows that some bicyclists travel in the Middlebrook Pike vehicle lanes. Other than the greenway, bicycle lanes are not provided on Middlebrook Pike. TDOT has published mapping illustrating the Bicycle Level of Service (BLOS) for State Routes in Knox County. BLOS

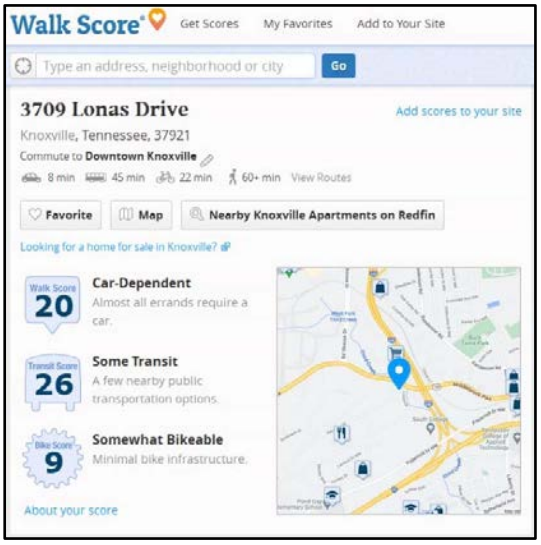
is a nationally used measure of bicyclist comfort based on a roadway's geometry and traffic conditions. BLOS A designates the route as most suitable for bicyclists and BLOS F as the least suitable. The BLOS for Middlebrook Pike (SR 169) along the development site road frontage shows a grade of F.



Mapping of Bicycle Level of Service (BLOS) - TDOT

- **<u>WALK SCORE</u>:**

A private company offers a website at <u>walkscore.com</u> that grades and gives scores to locations within the United States based on "walkability", "bikeability", and transit availability based on a patented system. According to the website, the numerical values assigned for the Walk Score and the Bike Score are based on the distance to the closest amenity in various relevant categories (businesses, schools, parks, etc.) and are graded from 0 to 100.

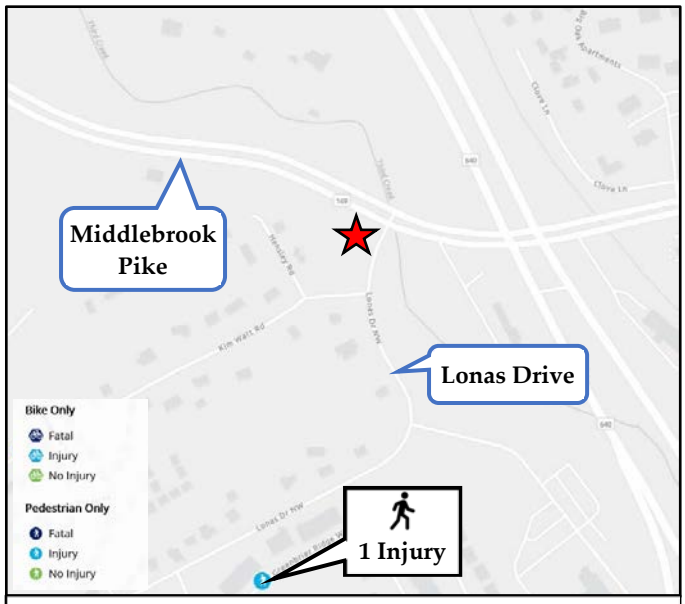


Appendix B shows maps and other information for the Walk, Transit, and Bike Score at the development property address at 3709 Lonas Drive. The project site location is graded with a Walk Score of 20. This Walk Score indicates that the site is car-dependent and that most errands currently require a vehicle for travel to and from the development property. The site is given a Transit Score of 26 since public transportation is available near the development site. The site has a Bike Score of 9, indicating minimal bike infrastructure. These scores indicate that the development site has some potential for allowing and generating alternate transportation modes to and from the site.

Overall, it is estimated that minimal pedestrian and bicycle traffic will occur to and from the proposed Shell Food Mart from the surrounding residential areas and developments. The new

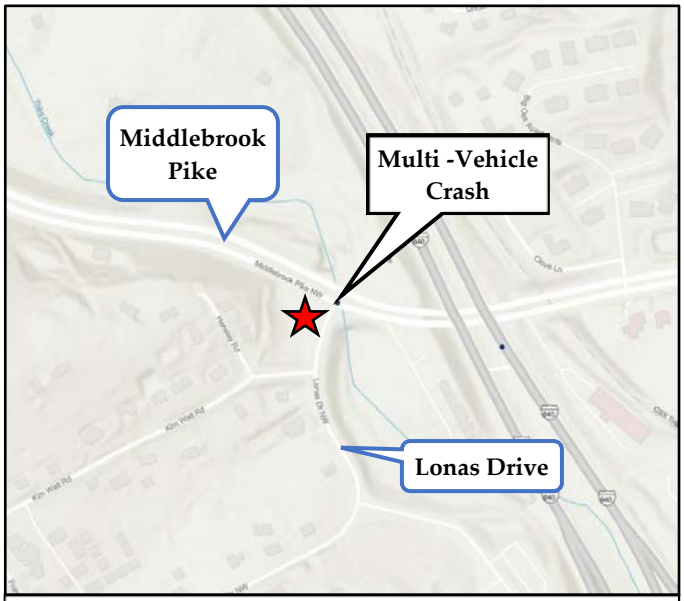
development could generate some of this non-motorized activity but is not expected to generate measurable bicycle or pedestrian trips that would significantly reduce vehicle trips. Thus, these potential vehicle trip reductions are ignored for the study analyses.

- **CRASH DATA**:



Pedestrian / Bicycle Crash Data in Study Area

The Knoxville Transportation Planning Organization (TPO) provided a 2020 update to bicycle and pedestrian crash data for Knox County and other surrounding counties. The data shows none of these types of crashes have occurred near the development site. The closest incident occurred to the south, within the Greenbriar Ridge Apartment Complex off Lonas Drive, and involved a pedestrian injury.



Vehicular Crash Data in Study Area

The Knoxville TPO also provides data related to "Life-Altering Traffic Crashes". This data lists the location of traffic crashes in the Knoxville region that resulted in a fatality or serious injury between October 2016 and September 2021. The data shows one serious single injury incident near the development site. This multi-vehicle crash with a serious injury occurred on March 26th, 2021, at the Middlebrook Pike and Lonas Drive intersection. No crash factors for this incident are listed as being identified.

After further review of the intersection, a fatal crash that was not listed in the TPO data was discovered in local online news

reports. On October 31st, 2019, a single vehicle with a single occupant was found to have left the roadway and had crashed into a utility pole on the southwest corner of the intersection. The cause of this crash was not found in local news report searches. It is unknown why this incident was not listed in the TPO data.

- **TRANSIT SERVICES:**

The City of Knoxville has a network of public transit opportunities offered by Knoxville Area Transit (KAT). Bus service is currently available adjacent to the development site, and the overall KAT bus system map is provided in Appendix C.

The public transit bus service on Middlebrook Pike and adjacent to the site is provided at a bus stop on the southwest corner of Middlebrook Pike at Lonas Drive. This bus service is on Route 13, "Beaumont". This route only operates on weekdays and does not operate on weekends. The route map is included in Appendix C. KAT had to reduce its service schedule due to workforce shortages. These changes took place on August 29th, 2022, and the reduced schedule for this route is also included in Appendix C. Other transit services in the area include the East Tennessee Human Resource Agency (ETHRA) and the Community Action Committee (CAC), which provides transportation services when requested.

KAT Route 13 - Beaumont

Even though public transit will be available adjacent to the development and will likely draw a few customers, to ensure a conservative analysis of the road system for the analysis, the proposed development is assumed not to have any reduced vehicle trips due to public transit usage.

PROJECT DESCRIPTION

- **LOCATION AND SITE PLAN:**

The preliminary plan layout with twelve vehicle fueling positions and a 5,000 ft² convenience market is designed by Ardurra and is shown in Figure 3. (Note: Ardurra has since updated the preliminary plan layout shown in Figure 3 to reflect the proposed minor layout modifications recommendations in this study; however, the preliminary plan is used in this report for illustrative purposes. The updated plan is shown in Appendix M and includes a revised location for the Main Entrance and minor changes to the internal layout.) The design proposes two entrances for the development: the Main Entrance on Middlebrook Pike to the north and a Secondary Entrance to the east on Lonas Drive. The Main Entrance for the proposed development will tie into Middlebrook Pike, approximately 190 feet (centerline to centerline) to the west of the signalized intersection with Lonas Drive. The proposed Main Entrance on Middlebrook Pike will be constructed as right-turn-in/right-turn-out only since the center grassed median is raised with concrete curbing. The existing median will not allow for entering and exiting left turns, and the development is not requesting a median opening for this entrance. A Secondary Entrance for the proposed Shell Food Mart development will tie into Lonas Drive approximately 100 feet north of the Kim Watt Drive centerline and 200 feet south of the Middlebrook Pike centerline.

The site plan in Figure 3 shows one building. The building will house a convenience market with typical gas station/convenience market merchandise. Nineteen parking spaces, including one ADA-accessible parking space, are shown in the internal pavement area. A trash dumpster will be located on the south side of the property. A long retaining wall will be constructed behind the convenience market building due to the steep hillside on the western portion of the property. The twelve-vehicle fueling positions will be constructed south of the proposed Main Entrance off Middlebrook Pike, and the underground gasoline storage tanks will be installed just east of the vehicle gas pumps.

The schedule for completing this new development depends on construction timelines. This project is also contingent on permitting, design, and other regulatory approvals. Currently, the developer is confident in projecting that this development will be built within an abbreviated timeframe. Based on this forecast, this study assumed that the total construction build-out of the development and available for business operations would occur within the next two years (2025).

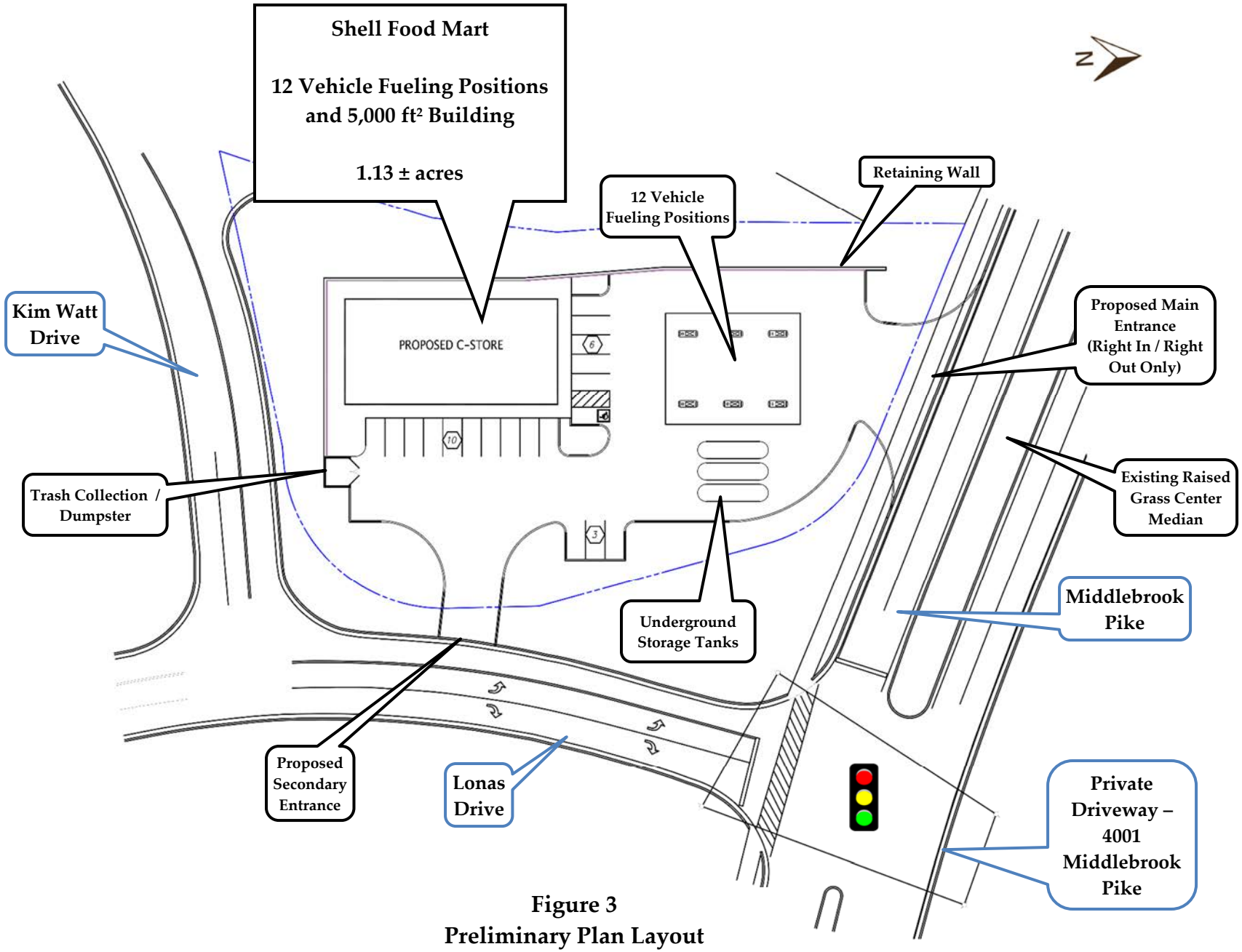


Figure 3
Preliminary Plan Layout
Shell Food Mart

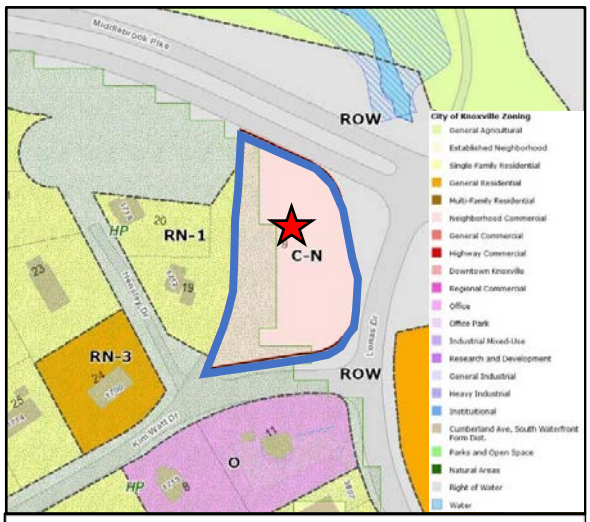
Not to Scale

- **PROPOSED USES AND ZONING REQUIREMENTS:**

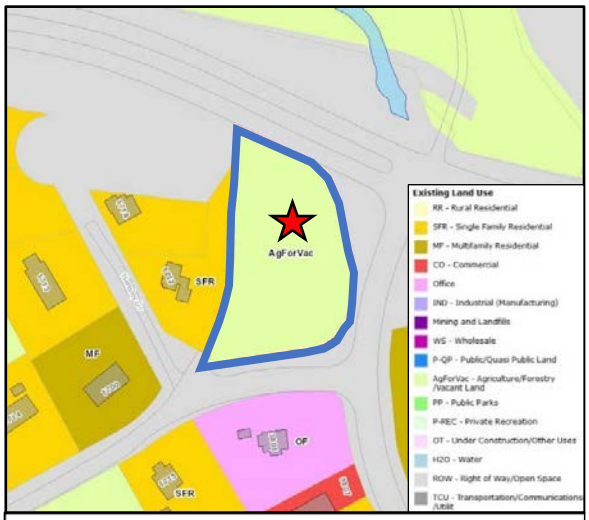
The existing single parcel comprising the Shell Food Mart development property is in the City of Knoxville and zoned as Neighborhood Commercial (C-N) and is not being proposed to be changed. The Neighborhood Commercial (C-N) zone "is intended to provide for an environment of integrated residential development and small-scale commercial and service uses, predominantly serving nearby residential neighborhoods." The most recently published online KGIS zoning map is provided in Appendix D. The existing adjacent surrounding zoning and land uses are the following:

- Middlebrook Pike binds the development site to the north. To the north of the development site and across Middlebrook Pike, one parcel is zoned as Agricultural (A) and is occupied by Middlebrook, a historic house. In addition to the historic house, the property has several standalone buildings with a maintained lawn, a field, and woodlands. In addition, this property to the north of Middlebrook Pike is bisected by Third Creek. The creek and its floodway are zoned as Floodway (F). This property has singular road access to the south to Middlebrook Pike via the Private Driveway that comprises the north approach at the signalized intersection with Lonas Drive.
- Lonas Drive binds the development site to the east. To the east of the development site and across Lonas Drive, most of the property is zoned as Right-of-Way (ROW). To the southeast, one parcel is zoned as General Residential Neighborhood (RN-5) and is occupied by The Reserve at Third Creek, a small apartment complex adjacent to Interstate 640. Third Creek also bisects the apartment complex property, and a portion of the parcel is zoned as Floodway (F). The Reserve at Third Creek has singular road access to Middlebrook Pike to the north, 200 feet (centerline to centerline) east of the signalized intersection with Lonas Drive.
- Kim Watt Drive binds the development site to the south. To the south of the development site and across Kim Watt Drive, a parcel is zoned as Office (O). According to Google Maps, it is occupied by Cooltech, an HVAC and refrigeration business operating in a former single-family detached house. This business has road access to Lonas Drive to the east but does not have road access to the north to Kim Watt Drive. This business driveway is 90 feet (centerline to centerline) south of Kim Watt Drive.
- To the west, the development property is adjacent to two parcels occupied by two single-family detached houses, and both are zoned as Single-Family Residential

Neighborhood (RN-1). These homes have driveway connections to Hensley Drive, a short, dead-end, narrow road to the west. These properties and the western portion of the development property are within the Hillside Protection (HP) overlay, which protects topographic features to prevent damage due to flooding and erosion.



KGIS Existing Zoning Map



KGIS Existing Land Use Map

- **ON-SITE CIRCULATION:**

The proposed development's internal pavement and layout will be designed and constructed to the City of Knoxville's specifications. The internal road surface will be asphalt or concrete paved. The developer will maintain the parking areas and internal pavement in the development after construction, and it will remain privately owned.

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

Besides customer passenger vehicles, the internal pavement areas will provide access to service, delivery, maintenance, and fire protection/rescue vehicles. In particular, the site will be designed for gasoline truck deliveries and other large delivery trucks. None of these non-passenger vehicle types should impact adjacent roadway operations other than when they occasionally enter and exit the development.

The development's internal pavement will accommodate the larger vehicle types and customers' standard passenger vehicles. The internal pavement areas will be designed and constructed to

the City of Knoxville's specifications and are expected to be adequate for fire protection and rescue vehicles, trash collection trucks, single-unit delivery trucks, and gasoline delivery trucks.

ANALYSIS OF EXISTING AND PROJECTED CONDITIONS

EXISTING TRAFFIC CONDITIONS:

This study conducted a 6-hour traffic count at the signalized intersection of Middlebrook Pike at Lonas Drive and the Private Driveway adjacent to the proposed development site on Thursday, August 24th, 2023. While not explicitly requested by Knoxville/Knox County Planning, two other nearby intersections were also counted for 6 hours. These intersections included Lonas Drive at Kim Watt Drive and Lonas Drive at the South College Entrance. Manual traffic counts were conducted to tabulate the peak period volumes, travel directions, and vehicle patterns near the proposed development site. Local public schools were in session when the traffic counts were conducted and had been open for two weeks. This two-week wait before counting allowed traffic patterns to normalize after school children returned from the summer break. Based on the traffic volumes collected, the AM and PM peak hours were observed at 7:30 – 8:30 a.m. and 4:45 – 5:45 p.m. at all three intersections.

The manual tabulated traffic counts can be reviewed in Figure 4a and Appendix E; some observations from the count are listed below.

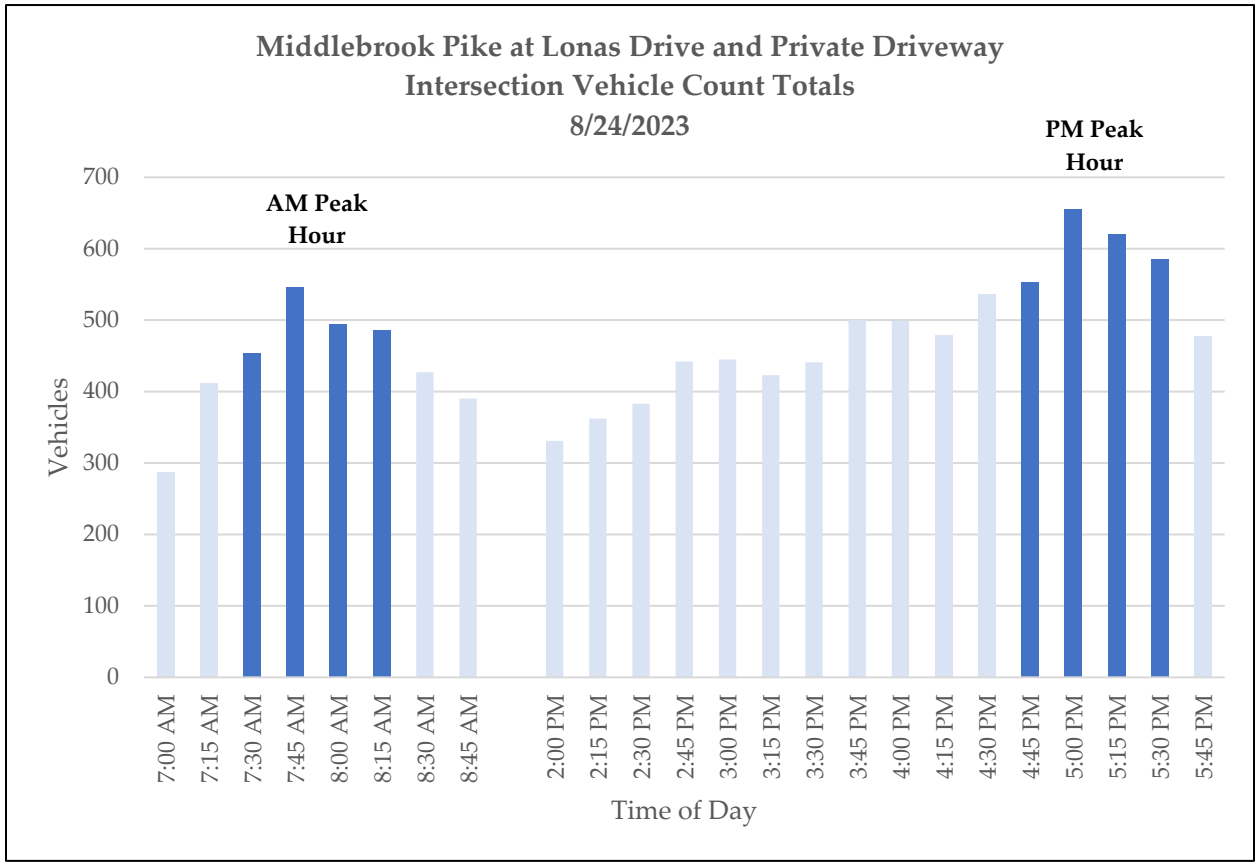
- Most traffic observed during the traffic counts were typical passenger vehicles; however, the thru traffic on Middlebrook Pike had a fair amount of heavy and large vehicles, including semi-tractor-trailers, trash collection trucks, school buses, concrete mixer trucks, and KAT buses. The semi-tractor-trailer traffic consisted of a noticeable amount of gas tanker trucks, particularly on Middlebrook Pike in the westbound direction. This occurrence is presumed to be due to the nearby petroleum product terminals located one mile west and north of Middlebrook Pike.
- There are two KAT bus stops on Middlebrook Pike adjacent to Lonas Drive, one on the north side next to the Private Driveway and one on the south side, west of the intersection with Lonas Drive. During the traffic count, no KAT buses were observed stopping at these bus stops.
- No school bus stops were observed on Middlebrook Pike adjacent to the development site. However, school buses were observed stopping on Lonas Drive and Kim Watt Drive adjacent to the development site during the afternoon, with a handful of students exiting and walking home. All these students, except one, were observed

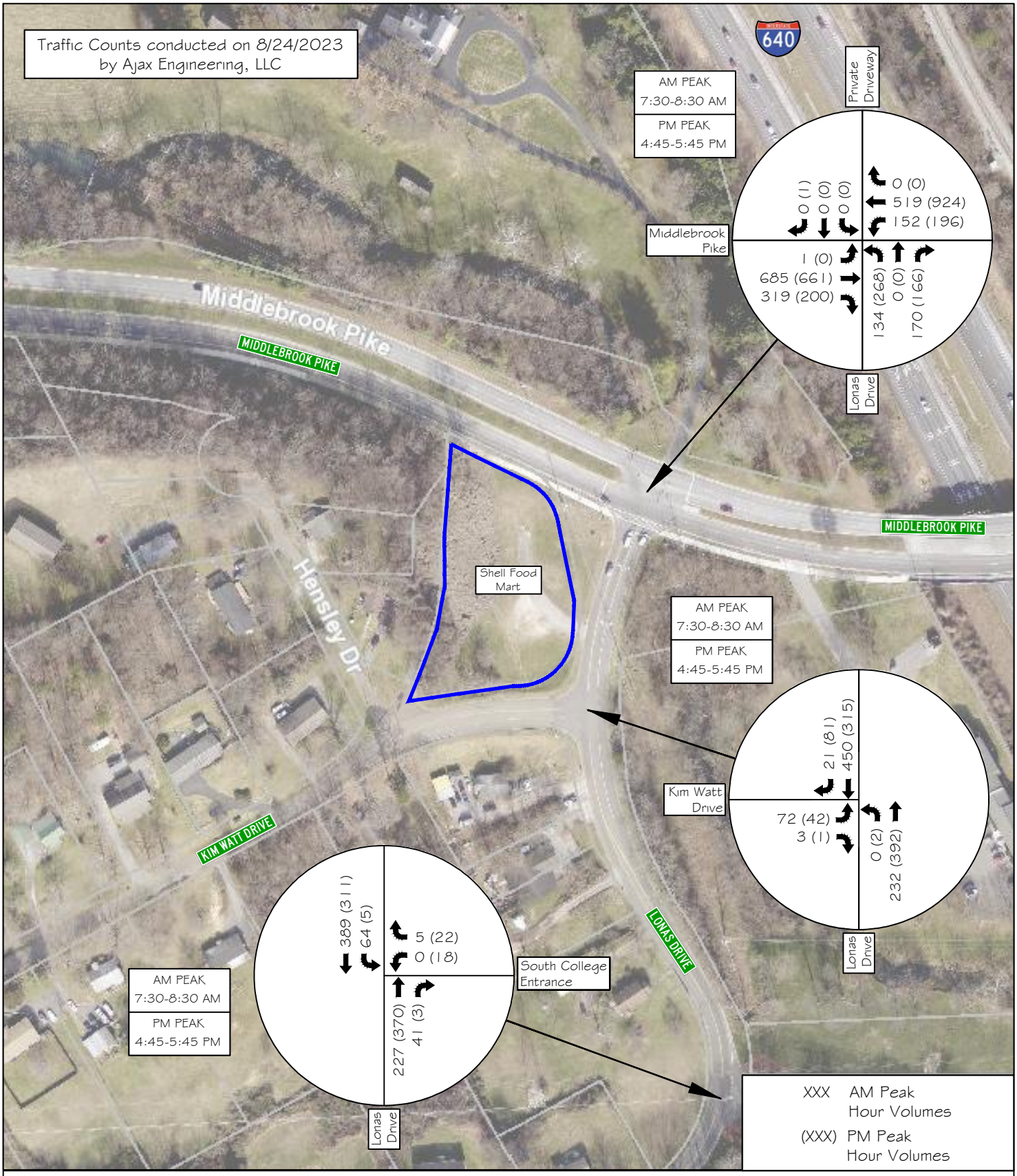
walking from their bus stops on Lonas Drive and Kim Watt Drive, where they crossed Lonas Drive towards the east, presumably to The Reserve at Third Creek apartments. The lone student who did not follow this pattern walked north on Lonas Drive and turned westbound onto the greenway/sidewalk along Middlebrook Pike. A single student was observed walking from the east on Middlebrook Pike towards Lonas Drive during the morning. This student was also assumed to be from The Reserve at Third Creek apartments. It is presumed that the school bus stops for these students are on Lonas Drive and Kim Watt Drive because the apartment complex does not have a center median opening that would allow for an easy return to Lonas Drive and Kim Watt Drive, where most school-age children on the bus route are likely concentrated on the route. Overall, none of the school-age children were observed crossing Lonas Drive at the crosswalk.

- Only two pedestrians were observed on the Middlebrook Pike greenway/sidewalk beside the handful of school-age children. Both pedestrians crossed Lonas Drive at the crosswalk and were walking westbound.
- Two bicyclists were observed during the traffic counts. Neither was observed riding on the greenway/sidewalk, with both traveling in the vehicle lanes on Middlebrook Pike. One was observed traveling eastbound in the morning, and one was westbound in the afternoon. It was not determined if this was the same individual.
- Several U-turns occurred on the westbound Middlebrook Pike approach at Lonas Drive back towards the east. Eighteen vehicles were observed performing this maneuver during the 6-hour traffic count. It is presumed that most of these are performed by residents of The Reserve at Third Creek apartments since they are not provided a center median opening in Middlebrook Pike that would allow a direct left turn from the east. The eastbound Middlebrook Pike approach at Lonas Drive is posted with a No U-turn sign at the end of the center median. However, seven vehicles made this illegal turn. Remarkably, one of the vehicles included a national brand delivery truck that had to reverse itself in the center of the intersection to complete the maneuver. This illegal maneuver caused a short backup for westbound traffic on Middlebrook Pike.
- The Private Driveway on the north side of the signalized intersection had a minuscule amount of vehicle traffic. When activated by a vehicle presence, this approach is given a separate green phase. This green phase only occurred a few times during the traffic count.
- As seen in the data, the eastbound approach of Middlebrook Pike at Lonas Drive

included a very high amount of right-turn movements onto Lonas Drive. In the AM peak hour, over 300 vehicles made this turn, nearly a third of all traffic movements on this approach. Fewer vehicles made this turn in the PM peak hour, but it still had a high level with 200 right-turns. Based on these observations, the eastbound outside lane of Middlebrook Pike at Lonas Drive can be considered a de facto right-turn lane.

- Likewise, the northbound approach of Lonas Drive had a very high number of left-turning movements, with nearly 300 vehicles in the PM peak hour.
- The maximum observed vehicle queues on Lonas Drive from Middlebrook Pike were from left-turning vehicles waiting to turn towards the west onto Middlebrook Pike. During the traffic count, this queue was observed occasionally extending far enough to block vehicles on Kim Watt Drive from turning left toward the north.





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

NOT TO SCALE

NORTH

FIGURE 4a

Shell Food Mart

2023 Peak Hour Traffic Volumes - EXISTING TRAFFIC CONDITIONS

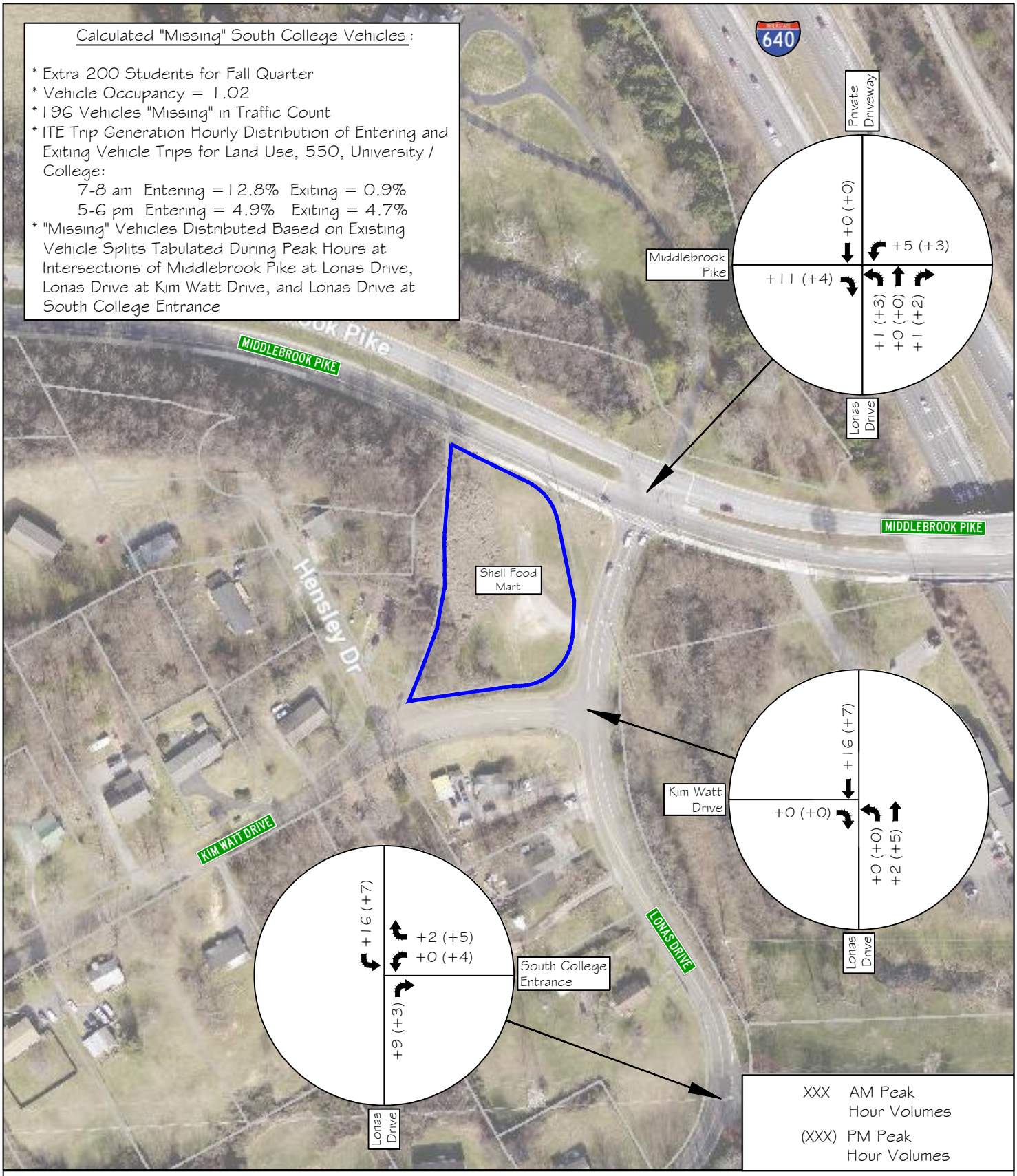
South College is located near the study area and was operating during its Summer Quarter when the traffic counts were conducted for this study. In the scope of work, Knoxville/Knox County Planning expressed concerns that the traffic count results may not accurately reflect higher attendance conditions that could occur during their Fall Quarter. Thus, an attempt was made to ascertain whether the College would have additional generated traffic if the traffic counts were conducted while operating under their Fall Quarter, which begins in late September.

Since this College is privately operated and includes online and in-person students, obtaining an accurate accounting of student enrollment and in-person attendance was difficult. Nonetheless, their Director of Facilities estimated that their Fall Quarter would have an additional 200 students attending. Due to the possibility that these "missing" students were not accounted for, the traffic count at the intersection of Lonas Drive at the South College Entrance was conducted. This 6-hour traffic count tabulated the existing splits/totals of the College's entering and exiting traffic.

Several assumptions were made to estimate the amount of potential "missing" College traffic. Taking their estimate of 200 extra students attending in the Fall Quarter, it can be assumed that most of these will be single-occupancy trips. According to the 2008 East Tennessee Travel Study (shown in Appendix F) prepared for the Knoxville Regional Transportation Planning Organization, the average vehicle occupancy rate in the area for School - University is 1.02 persons per vehicle. Thus, it can be assumed that an additional 196 vehicles could enter and exit the South College Entrance during the Fall Quarter. Other percentages were assumed based on the Institute of Transportation Engineers (ITE) Trip Generation Manual, 11th Edition data for "Hourly Distribution of Entering and Exiting Vehicle Trips by Land Use" (in Appendix F) to determine when these "missing" vehicles may be entering and exiting during the peak hours of a day. For Land Use Code 550, University/College, the entering and exiting percentages given for 7 – 8 a.m. and 5 – 6 p.m. approximate the observed peak times and yield the following:

7 – 8 a.m.	Enter = 12.8%	Trips = +25 vehicles
	Exit = 0.9%	Trips = +2 vehicles
5 – 6 p.m.	Enter = 4.9%	Trips = +10 vehicles
	Exit = 4.7%	Trips = +9 vehicles

Multiplying these percentages above by 196 vehicles results in the "missing" volumes shown above and in Figure 4b. The volumes shown in Figure 4b were distributed by the existing splits observed at the intersections during the peak hours.



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NOT TO SCALE

NORTH

FIGURE 4b

Shell Food Mart

Calculated "Missing" South College Vehicles during 8/24/2023 Traffic Count

Capacity analyses were undertaken to determine the Level of Service (LOS) for the existing 2023 intersection traffic volumes shown in Figure 4a. The capacity analyses were calculated following the Highway Capacity Manual (HCM) methods and utilizing Synchro Traffic Software (Version 11).

Methodology:

LOS is a qualitative measurement developed by the transportation profession to express how well an intersection or roadway performs based on a driver's perception. LOS designations include LOS A through LOS F. The designation of LOS A signifies a roadway or intersection operating at best, while LOS F signifies road operations at worst. This grading system provides a reliable, straightforward means to communicate road operations to the public. The HCM lists level of service criteria for unsignalized intersections and signalized intersections.

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

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

streets. Thus, the LOS for a two-way stop (or yield) controlled intersection is defined by the delay for each minor approach and major street left-turn movements. Table 2 lists the level of service criteria for unsignalized intersections. The analysis results of unsignalized intersections using the HCM methodologies are conservative due to the more significant vehicle gap parameters used in the method. More often, in normal road conditions, drivers are more willing to accept smaller gaps in traffic than what is modeled using the HCM methodology. The unsignalized intersection methodology also does not account for more significant gaps sometimes produced by nearby upstream and downstream signalized intersections. For unsignalized intersections, in most instances, the upper limit of acceptable delay during peak hours is the LOS D/E boundary at 35 seconds.

For signalized intersections, LOS is based on delay (in seconds) for various movements within the intersection and the overall operation of all the traffic entering the intersection. This delay measures driver discomfort, frustration, fuel consumption, and lost travel time and depends 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. For signalized intersections, in most instances, the upper limit of acceptable delay during peak hours is the LOS D/E boundary at 55 seconds. Table 3 lists the level of service criteria for signalized intersections.

TABLE 2
LEVEL OF SERVICE AND DELAY FOR UNSIGNALIZED INTERSECTIONS

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

Source: Highway Capacity Manual, 6th Edition

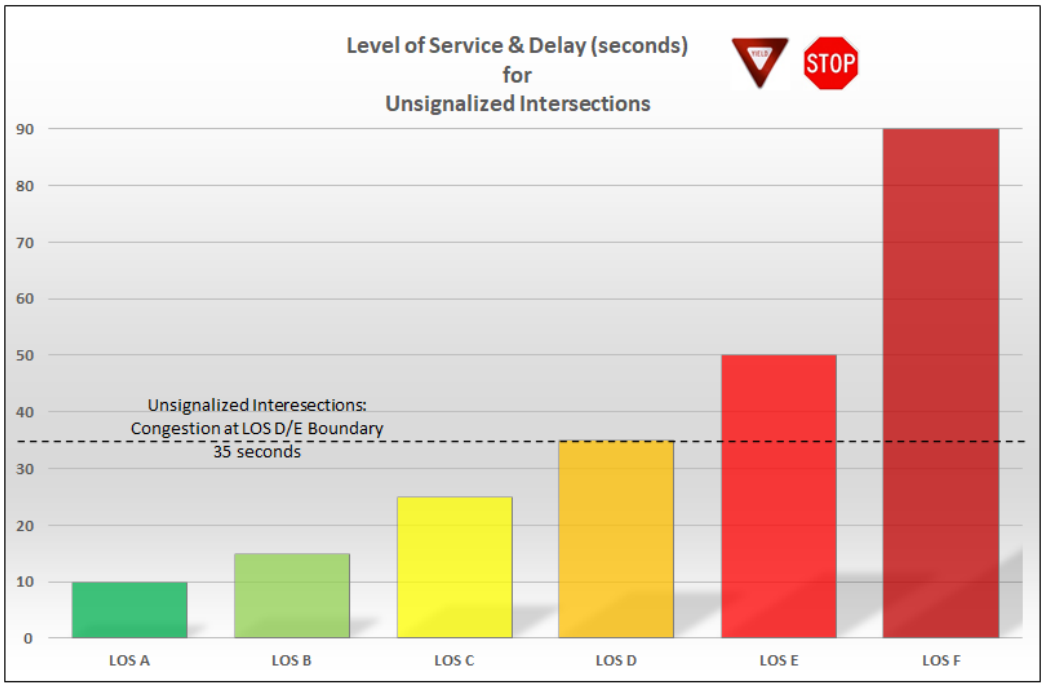
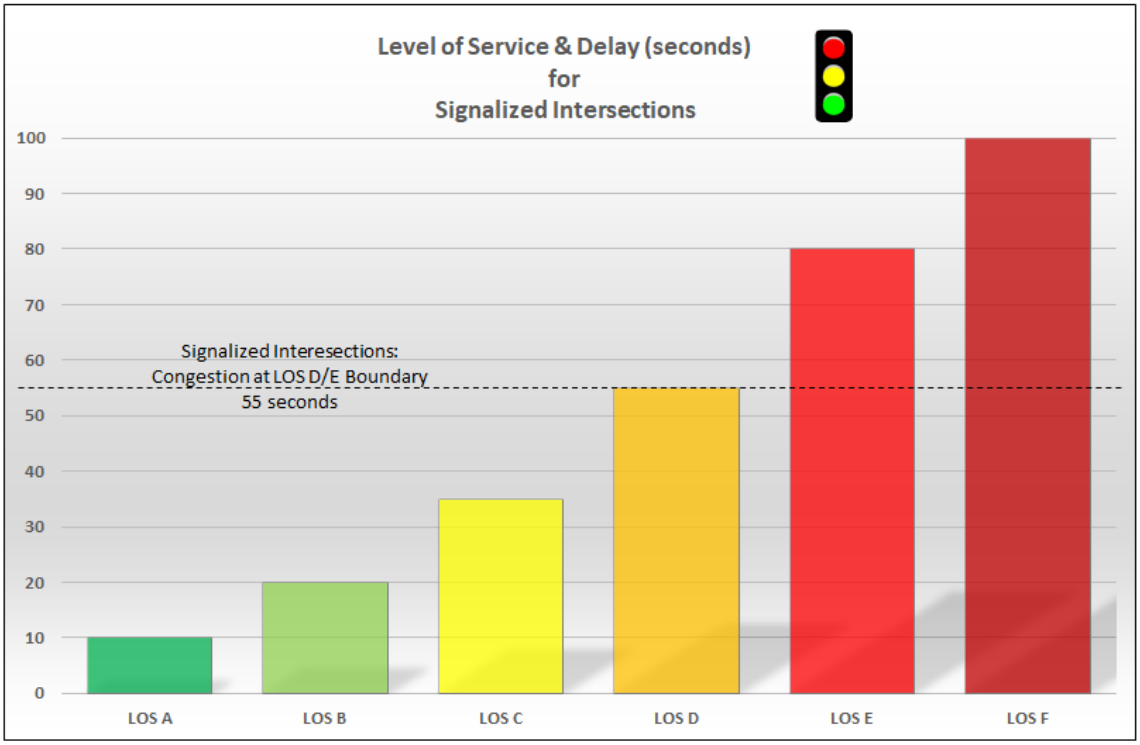


TABLE 3
LEVEL OF SERVICE AND DELAY FOR SIGNALIZED INTERSECTIONS

LEVEL OF SERVICE	DESCRIPTION	CONTROL DELAY (seconds/vehicle)
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 - 20
C	Higher delays with individual cycle failures may begin at this level. Many vehicles may still pass through without stopping.	> 20 - 35
D	Approaching unstable flow. The influence of congestion becomes more noticeable. Many vehicles stop.	> 35 - 55
E	Considered the limit of acceptable delay. High delays indicated by poor progression, long cycle lengths, and high v/c ratios.	> 55 - 80
F	Unacceptable delay occurs. Progression is extremely poor with long cycle lengths and high v/c ratios.	>80

Source: Highway Capacity Manual, 6th Edition



Intersection capacity results from the existing 2023 peak hour traffic are shown in Table 4. 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. Appendix G includes the worksheets for the existing 2023 peak hour capacity analyses. The intersections of Lonas Drive at Kim Watt Drive and Lonas Drive at the South College Entrance are provided as a courtesy in the existing conditions table since they were not included in the requested scope of work by Knoxville/Knox County.

As shown in Table 4, the intersections are calculated to operate with good to average LOS and reasonable vehicle delays in the existing 2023 conditions. The only exception is for the northbound approach of Lonas Drive at Middlebrook Pike in the PM peak hour, where these vehicles are calculated to operate with elevated delays. The results in Table 4 do not include the "missing" vehicles from South College calculated previously; however, they are included in the projected conditions and analyses later in the report.

TABLE 4
2023 INTERSECTION CAPACITY ANALYSIS RESULTS -
EXISTING TRAFFIC CONDITIONS

INTERSECTION	TRAFFIC CONTROL	APPROACH/ MOVEMENT	AM PEAK			PM PEAK		
			LOS [a]	DELAY [b] (seconds)	v/c [c]	LOS [a]	DELAY [b] (seconds)	v/c [c]
Middlebrook Pike (EB & WB) at Lonas Drive (NB) and Private Driveway (SB)	Signalized	Eastbound	B	11.4		B	14.7	
		Westbound	A	4.3		A	7.9	
		Northbound	D	43.4		F	86.2	
		Southbound	A	0.0		D	54.0	
		Summary	B	14.2	0.620	C	24.3	0.710
Lonas Drive (SB & NB) at Kim Watt Drive (EB)	Unsignalized	Eastbound Left	C	18.1	0.270	C	15.0	0.150
		Eastbound Right	B	12.8	0.030	B	10.8	0.010
		Northbound Left	*	*	*	A	0.2	0.000
Lonas Drive (SB & NB) at South College Entrance (WB)	Unsignalized	Westbound Left/Right	B	10.1	0.020	B	14.0	0.140
		Southbound Left	A	2.2	0.080	A	0.4	0.010

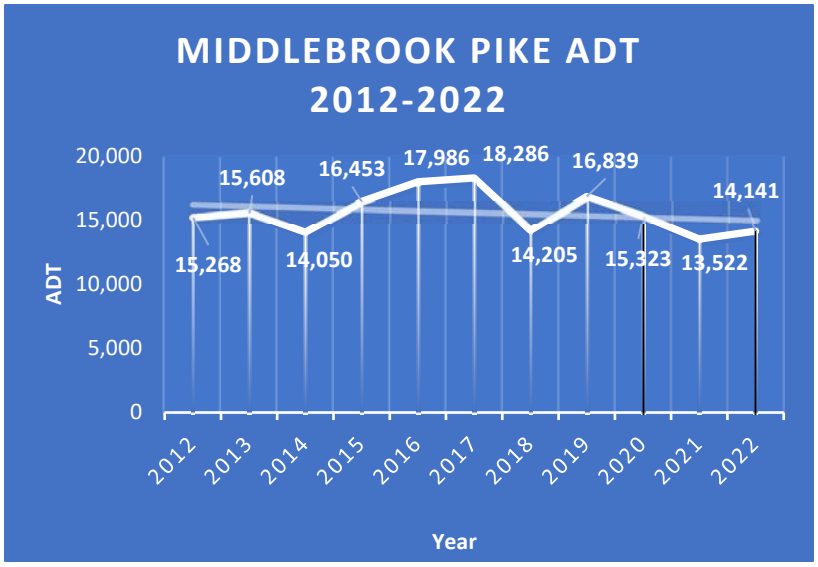
Note: All analyses were calculated in Synchro 11 software and reported with HCM 2000 methodology
[a] Level of Service , [b] Average Delay (sec/vehicle) , [c] Volume-to-Capacity Ratio
* = No Reportable Volumes

The signal timing used to analyze the Middlebrook Pike at Lonas Drive and Private Driveway intersection was obtained from the City of Knoxville and is included in Appendix H. The traffic signal operates on a 110-second cycle length and in an actuated-coordinated system. The signal timings were not changed or optimized for the existing analysis and were used as given.

- **PROJECTED TRAFFIC CONDITIONS (WITHOUT THE PROJECT):**

Horizon year traffic conditions represent the projected traffic volumes in the study area without the proposed project being developed (no-build option). This proposed development's build-out and full occupancy for customer sales are assumed to occur by 2025.

Vehicular traffic on Middlebrook Pike in the study area has shown negative annual growth over the past ten years (-0.8%), according to the TDOT traffic count station and as shown in Appendix A. Lonas Drive has seen a moderate growth of 2.6% over the past ten years. For this study, an annual growth rate of +1% was assumed to calculate future volumes up to 2025 to account for potential growth on Middlebrook Pike, and a 3% rate was assumed for Lonas Drive.



The 1% annual growth rate was applied to the existing 2023 thru volumes on Middlebrook Pike at the intersection to calculate the future volumes in the 2025 horizon year without the potential development traffic. The 3% annual growth rate was applied to the existing 2023 entering and exiting volumes to and from Lonas Drive at the intersection. These slightly higher rates than the observed TDOT growth rates were used to provide a conservative analysis.

Capacity analyses were undertaken to determine the projected LOS in 2025 without the project at the signalized intersection. The signal timings were not changed or optimized for these capacity analyses in the projected conditions. The results are shown in Table 5, and Appendix G includes the capacity analysis worksheets.

The results in Table 5 show slightly worse vehicle delays for all the approaches in the 2025 projected conditions without the developments' generated trips versus the existing 2023 conditions. Figure 5 shows the projected 2025 traffic volumes without the project at the

intersection during the AM and PM peak hours. The volumes in Figure 5 and the results in Table 5 include the calculated "missing" vehicles from South College and the assumed future growth rates of 1% and 3%.

TABLE 5
2025 INTERSECTION CAPACITY ANALYSIS RESULTS -
PROJECTED TRAFFIC CONDITIONS (WITHOUT THE PROJECT)

INTERSECTION	TRAFFIC CONTROL	APPROACH/ MOVEMENT	AM PEAK			PM PEAK		
			LOS [a]	DELAY [b] (seconds)	v/c [c]	LOS [a]	DELAY [b] (seconds)	v/c [c]
Middlebrook Pike (EB & WB) at Lonas Drive (NB) and Private Driveway (SB)	Signalized	Eastbound	B	12.9		B	15.1	
		Westbound	A	5.0		A	8.4	
		Northbound	E	43.6		F	101.2	
		Southbound	A	0.0		D	54.0	
		Summary	B	15.4	0.660	C	27.8	0.770

Note: All analyses were calculated in Synchro 11 software and reported with HCM 2000 methodology
[a] Level of Service , [b] Average Delay (sec/vehicle) , [c] Volume-to-Capacity Ratio

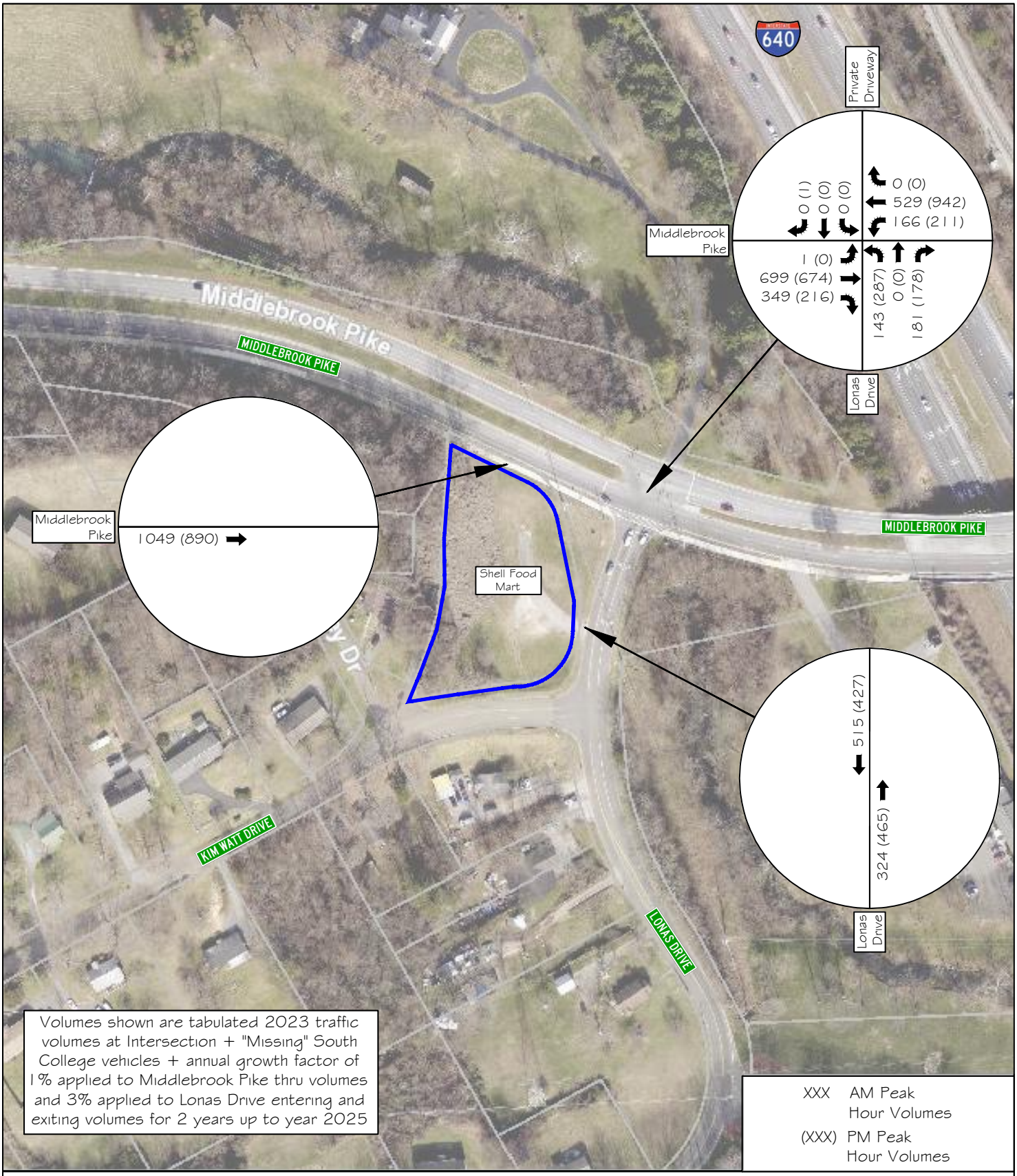


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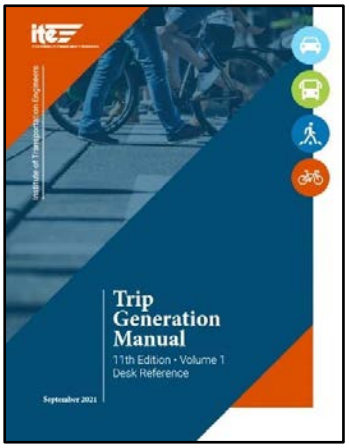
FIGURE 5

Shell Food Mart

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

- **TRIP GENERATION:**



A generated trip is a single or one-direction vehicle movement entering or exiting the study site. The estimated amount of traffic the proposed gas station/convenience market will generate was calculated based on rates and equations provided by the Trip Generation Manual, 11th Edition, an Institute of Transportation Engineers (ITE) publication. The Trip Generation Manual is the most popular resource for determining trip generation rates when transportation impact studies are produced. The Manual includes data for various land uses and provides a method for calculating generated trips based on development variables such as the number of dwelling units and building square footage. The data and calculations from ITE for the proposed land use in this study are shown in Appendix I.

For Land Use 945, Convenience Store / Gas Station, many subcategories with different independent variables are presented in the Trip Generation Manual to calculate generated trips. These units include rates based on the number of vehicle fueling positions (VFP) at the site, the convenience store's gross floor area (GFA), the number of employees, and the peak hour traffic of the adjacent roads. For the study, trip generation results were calculated in several ways based on the different subcategories and independent variables. The variables included twelve vehicle fueling positions, a 5,000 ft^2 convenience market, an expectation of three employees, and peak hour traffic on the adjacent Middlebrook Pike and Lonas Drive. The peak hour traffic for the adjacent streets was surmised from the nearby TDOT counting station data. All these alternate results were shared with the reviewing agency for their input.

After consultation with Knoxville/Knox County Planning and the Knoxville Engineering Department, it was determined that the most reasonable trip generation results were obtained by classifying the subcategory based on a GFA of between 4 – 5.5k square feet and using VFPs as the independent variable. A summary of this information is presented in the following:

TABLE 6a
TRIP GENERATION FOR SHELL FOOD MART

ITE LAND USE CODE	LAND USE DESCRIPTION	LAND USE	INDEPENDENT VARIABLE	TRIPS GENERATED ON WEEKDAY	TRIPS GENERATED IN AM PEAK HOUR			TRIPS GENERATED IN PM PEAK HOUR		
					ENTER	EXIT	TOTAL	ENTER	EXIT	TOTAL
#945	Convenience Store / Gas Station	GFA (4 - 5.5k)	12 Vehicle Fueling Positions	3,086	50%	50%		50%	50%	
					162	162	324	137	136	273
Total New Volume Site Development Trips				**3,086**	**162**	**162**	**324**	**137**	**136**	**273**

ITE Trip Generation Manual, 11th Edition - Average Rates

As shown in Table 6a, the total weekday traffic volumes generated by this development could be expected to be 3,086 vehicles.

Furthermore, as a broad category, generated trips can be categorized further as primary (new), pass-by, and internal trips.

> *Methodology:*
> Not all trips generated by a development are primary (new) trips. For some land uses, the trips generated by a proposed development are captured from the adjacent street system and do not generate an entirely "new" trip. A pass-by trip is an intermediate stop between an existing origin and a destination without a route diversion. These types of trips are known as pass-by trips and are assumed to already occur on the adjacent street. Considerable research has examined these trip types, and national and local rates have been published. Research has shown that fast food restaurants and larger convenience markets can experience pass-by trip rates of 75% and greater.
>
> Other trips a development generates that should not be added to the adjacent street or intersections are internal. These trips are self-explanatory and can be categorized for developments with complementary land uses such as retail, residential, office, hotel, and restaurants. For example, a customer of a retail shop may decide to eat at the adjacent restaurant in the same development. Similarly, nearby residents within a reasonable distance may walk and eat at an adjacent restaurant instead of using a vehicle for travel.

ITE has documented significant pass-by trip data for gas station/convenience markets. ITE lists average pass-by trip percentages of 60% in the AM peak hour and 56% in the PM peak hour for gas station/convenience markets with two to eight vehicle fueling stations in the Trip Generation,

11th Edition. Pass-by trip percentage data and averages from ITE for the proposed land use are shown in Appendix I. Knoxville/Knox County Planning also agreed to these pass-by trip percentages used in this study. While it could be expected that some minor amounts of trips could technically be considered internal between the convenience market and the gas pumps, no internal trip discounts were applied. Thus, once considering pass-by trips, the overall trip generation volumes for the Shell Food Mart development can be tabulated as the following:

TABLE 6b
TRIP GENERATION FOR SHELL FOOD MART
WITH PASS-BY VEHICLE TRIPS

ITE LAND USE CODE	LAND USE DESCRIPTION	LAND USE	INDEPENDENT VARIABLE	TRIPS GENERATED IN AM PEAK HOUR			TRIPS GENERATED IN PM PEAK HOUR		
				ENTER	EXIT	TOTAL	ENTER	EXIT	TOTAL
#945	Convenience Store / Gas Station	GFA (4 - 5.5k)	12 Vehicle Fueling Positions	50%	50%		50%	50%	
				162	162	324	137	136	273
			External Vehicle Trips - Total	**162**	**162**	**324**	**137**	**136**	**273**
			Pass-by Vehicle Trips	-97	-97	-194	-77	-76	-153
			Total New Primary Vehicle Trips	**65**	**65**	**130**	**60**	**60**	**120**

ITE Trip Generation Manual, 11th Edition
For Land Use #945 = 60% AM Peak Hour / 56% PM Peak Hour based on ITE Trip Generation 2021 Pass-by Trip Rates

For the proposed development, it is estimated that 65 vehicles will enter and 65 will exit, for a total of 130 new trips during the AM peak hour in the year 2025. Similarly, it is estimated that 60 vehicles will enter and 60 will exit, for a total of 120 new trips during the PM peak hour in the year 2025. The difference between the total external and new primary trips will be the pass-by trips comprised of motorists traveling on Middlebrook Pike and Lonas Drive and already passing by the development property.

- **TRIP DISTRIBUTION AND ASSIGNMENT:**

The projected trip distribution and assignment for the Shell Food Mart development are based on the existing traffic volumes, observed directional vehicle flows, and engineering judgment.

As with the trip generation methodology approval, the projected distribution of primary and pass-by trips presented in the following was discussed with Knoxville/Knox County Planning and approved for this study.

For the primary trips, the vast majority were assumed to be comprised of traffic from the south via Lonas Drive. This majority would include the single-family houses and apartment developments along Kim Watt Drive and Lonas Drive. In addition to the residences, the primary trips from the south would include students and employees from the nearby South College. Due to the presence of an existing Weigel's gas station/convenience market a bit further to the west on Middlebrook Pike and similar developments to the north at Western Avenue via Ed Shouse Drive, it is assumed that there would be much less potential for primary trips to and from the west on Middlebrook Pike. Primary trips to and from the east on Middlebrook Pike were also assumed to be minimal. However, the potential for primary trips is assumed to be slightly more significant to and from the east than the west due to the residences and businesses around Middlebrook Pike further to the east. The residences would include Big Oak Apartments and the single-family houses around Keith Avenue on the north side of Middlebrook Pike. As seen in Figure 6a, for primary trip distribution, it is assumed primary trips for the Shell Food Mart will consist of 10% to and from the west, 20% to and from the east, and 70% to and from the south.

For pass-by trips, many aspects were considered to assume the distribution and assignment for these types of trips. The development will have two entrances: the Main Entrance on Middlebrook Pike and the Secondary Entrance on Lonas Drive. The Main Entrance on Middlebrook Pike will be RIRO only since there is a raised center median on Middlebrook Pike. The Secondary Entrance on Lonas Drive will allow full-turning movements. Figure 6b shows the assumed trip distribution for pass-by trips and notes the logic applied for the entering and exiting pass-by trips. The following is a further explanation of the assumptions that were made for pass-by trips:

Entering Pass-by Trip Assumptions:

- 65% of pass-by trips will enter the development from the west side of Middlebrook Pike in the AM peak hour: 50% comprises eastbound Middlebrook Pike traffic, and 15% comprises southbound Lonas Drive traffic. 60% of pass-by trips will enter the development from the west side of Middlebrook Pike in the PM peak hour: 50% comprises eastbound Middlebrook Pike traffic, and 10% comprises southbound Lonas Drive traffic. The slight reduction of pass-by trips from the west on Middlebrook Pike in the PM peak hour is due to the overall observed pattern of heavier eastbound travel toward downtown Knoxville in the morning.
- 15% of pass-by trips will enter the development from the east side of Middlebrook Pike in the AM peak hour: 5% comprises westbound Middlebrook Pike traffic, and 10% comprises southbound Lonas Drive traffic. 20% of pass-by trips will enter the development from the east side of Middlebrook Pike in the PM peak hour: 5% comprises westbound Middlebrook Pike traffic, and 15% comprises southbound Lonas Drive traffic. The slight increase from the east in the PM peak hour is due to the observed pattern of heavier westbound travel away from downtown Knoxville in the afternoon.
- 20% of pass-by trips will enter the development from the south side via Lonas Drive in the AM and PM peak hours.

Exiting Pass-by Trip Assumptions:

- 75% of pass-by trips from Middlebrook Pike's west side with an eastbound destination are assumed to exit at the Main Entrance on Middlebrook Pike and 25% at the Secondary Entrance on Lonas Drive.
- For pass-by trips from the south on Lonas Drive, if their overall destination is towards the east on Middlebrook Pike, 75% are assumed to exit at the Main Entrance, with the remaining 25% assumed to exit at the Secondary Entrance. For pass-by trips from the south on Lonas Drive, all are assumed to exit at the Secondary Entrance if their overall destination is towards the west on Middlebrook Pike. The overall east or west destination designation was based on the existing tabulated splits observed during the AM and PM peak hours, either to the left or right from Lonas Drive. In the AM peak hour, northbound left and right turns on the Lonas Drive at Middlebrook Pike were observed with a split of 45% and 55%, respectively, and in the PM peak hour, the left and right turns were observed with a split of 60% and 40%, respectively.

The percentages shown in Figures 6a and 6b only pertain to the trips generated by the development calculated from the ITE data shown in Tables 6a and 6b. Since the development will have two entrances with several directions of movement, several Microsoft Excel spreadsheets were developed for this study to calculate trip distribution and volumes at all the intersections based on the assumed percentages. These spreadsheets are presented in Appendix J.

Figures 7a and 7b show the Traffic Assignment of the computed trips generated by the development (from Tables 6a and 6b) based on the assumed distribution of trips shown in Figures 6a and 6b. Figure 7a shows the assignment of the primary generated trips, and Figure 7b shows the assigned pass-by trips to the study intersections.

(Due to rounding in the Excel spreadsheet calculating process, the trips shown in Figures 7a and 7b and the subsequent traffic volumes entering and exiting the site in Figure 8 may have a +/- one vehicle variance.)

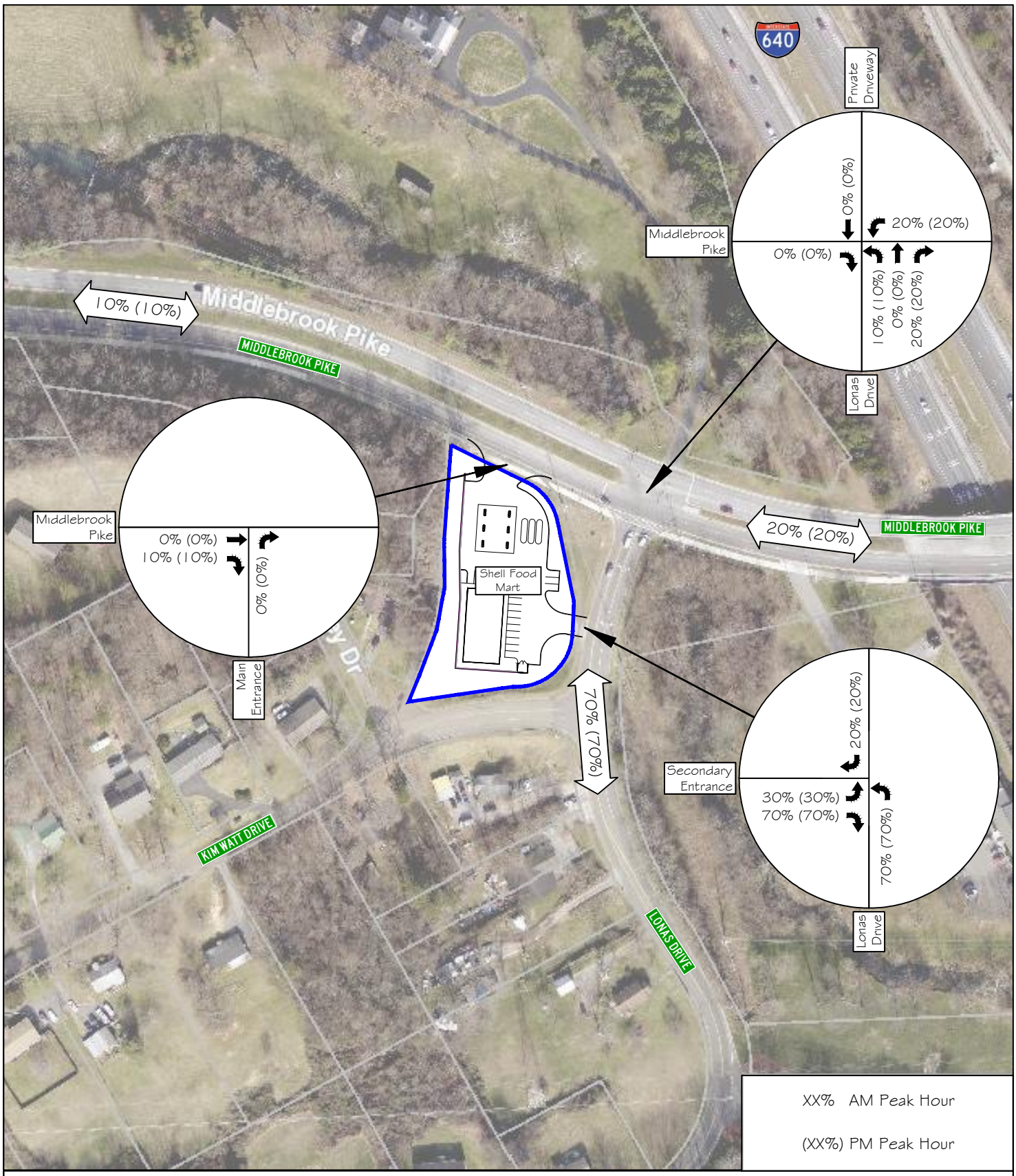


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FIGURE 6a

Shell Food Mart

Directional Distribution of Generated Traffic during AM and PM Peak Hour - Primary Trips

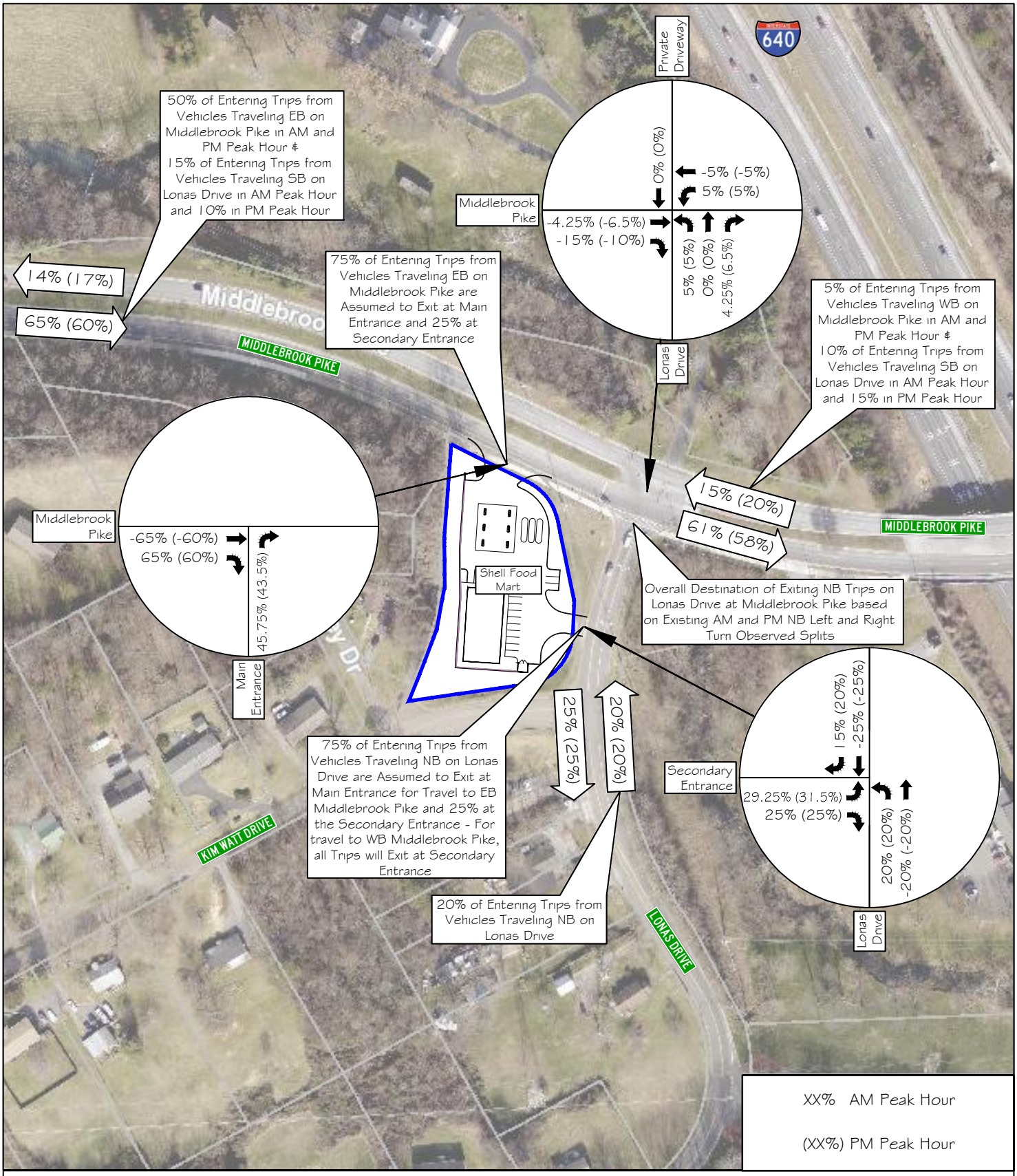

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FIGURE 6b

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Directional Distribution of Generated Traffic during AM and PM Peak Hour - Pass-By Trips

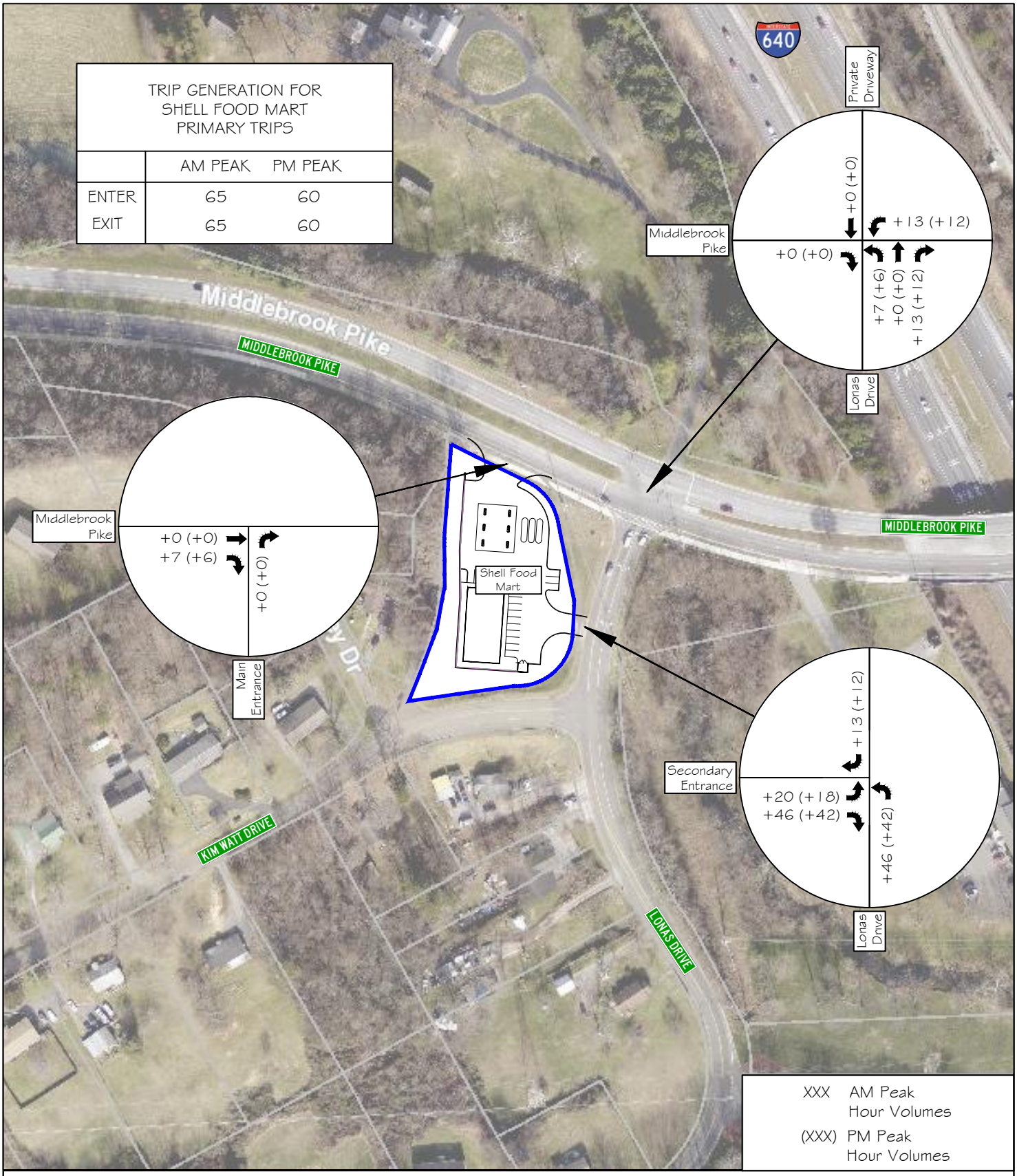

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FIGURE 7a

Shell Food Mart

Traffic Assignment of Generated Traffic during AM and PM Peak Hour - Primary Trips

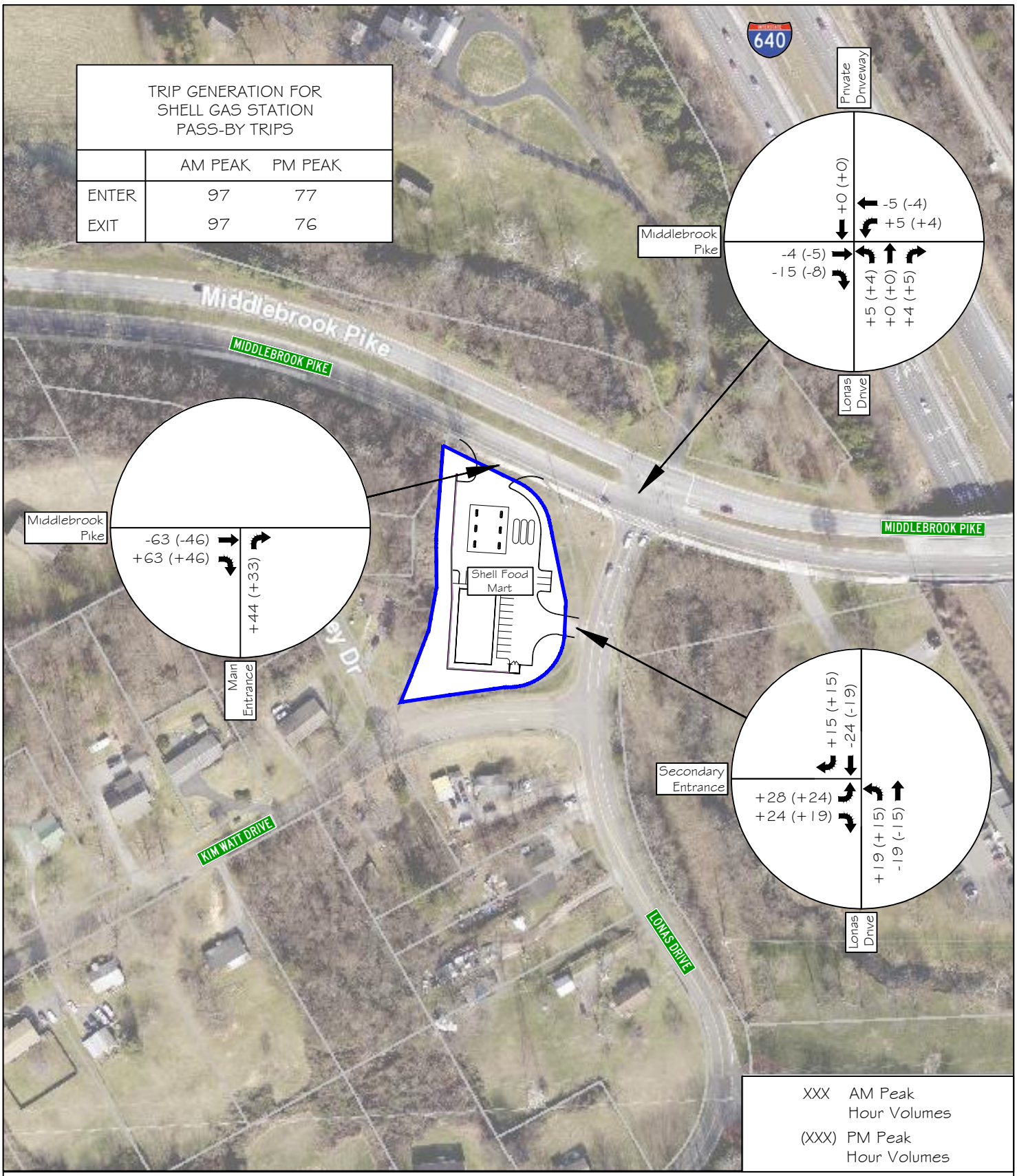

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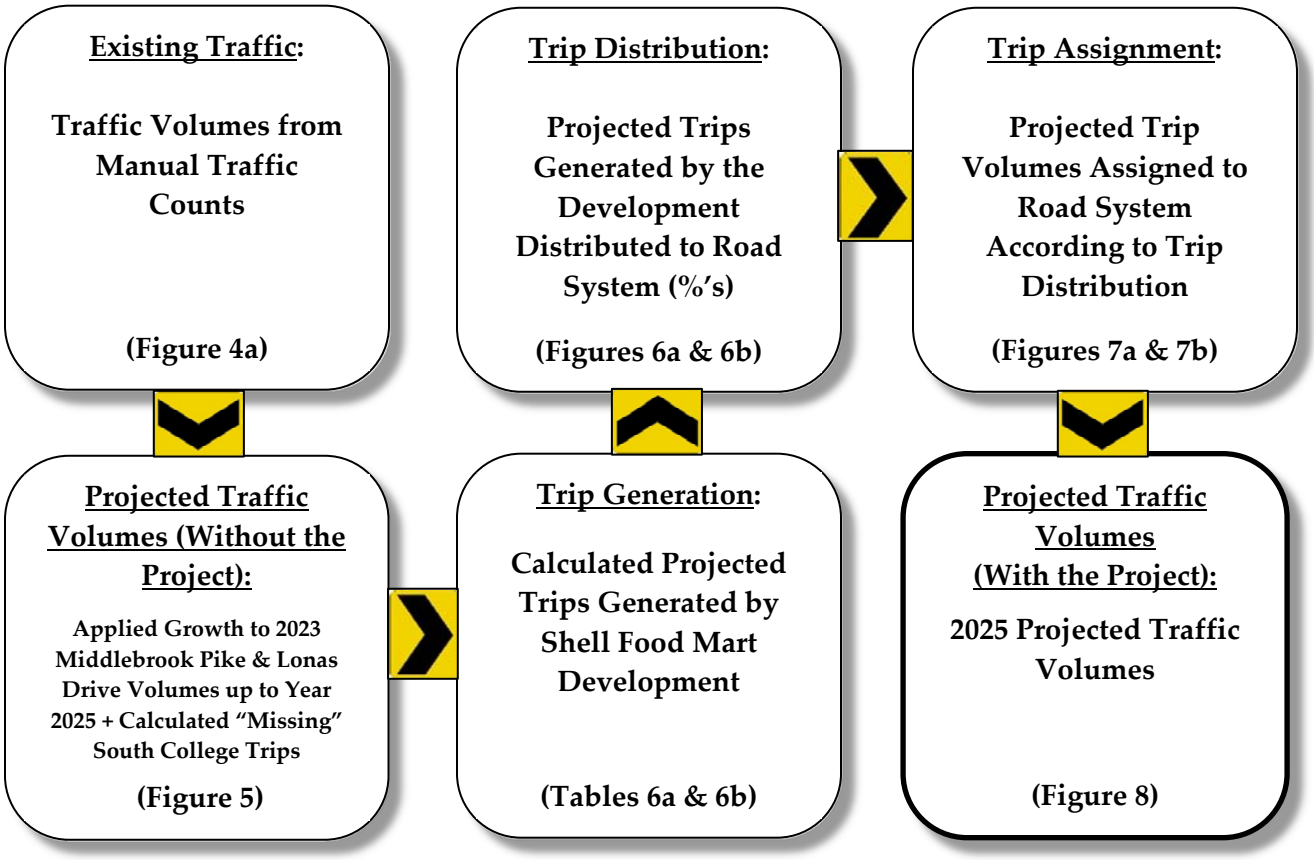
FIGURE 7b

Shell Food Mart

Traffic Assignment of Generated Traffic during AM and PM Peak Hour - Pass-By Trips

- **PROJECTED TRAFFIC CONDITIONS (WITH THE PROJECT):**

Overall, several additive steps were taken to estimate the total projected traffic volumes at the studied intersections when the Shell Food Mart development is constructed and open for business in 2025. The steps are illustrated below for clarity and review:



The calculated peak hour trips generated by the Shell Food Mart development were added to the 2025 projected horizon year traffic (Figure 5) by following the predicted trip distributions and assignments (Figures 6a & 6b and 7a & 7b). This procedure was completed to obtain the total projected traffic volumes at the studied intersections when the proposed development is fully built and open for business in 2025. Figure 8 shows the projected 2025 AM and PM peak hour volumes with the generated development traffic at the studied intersections.

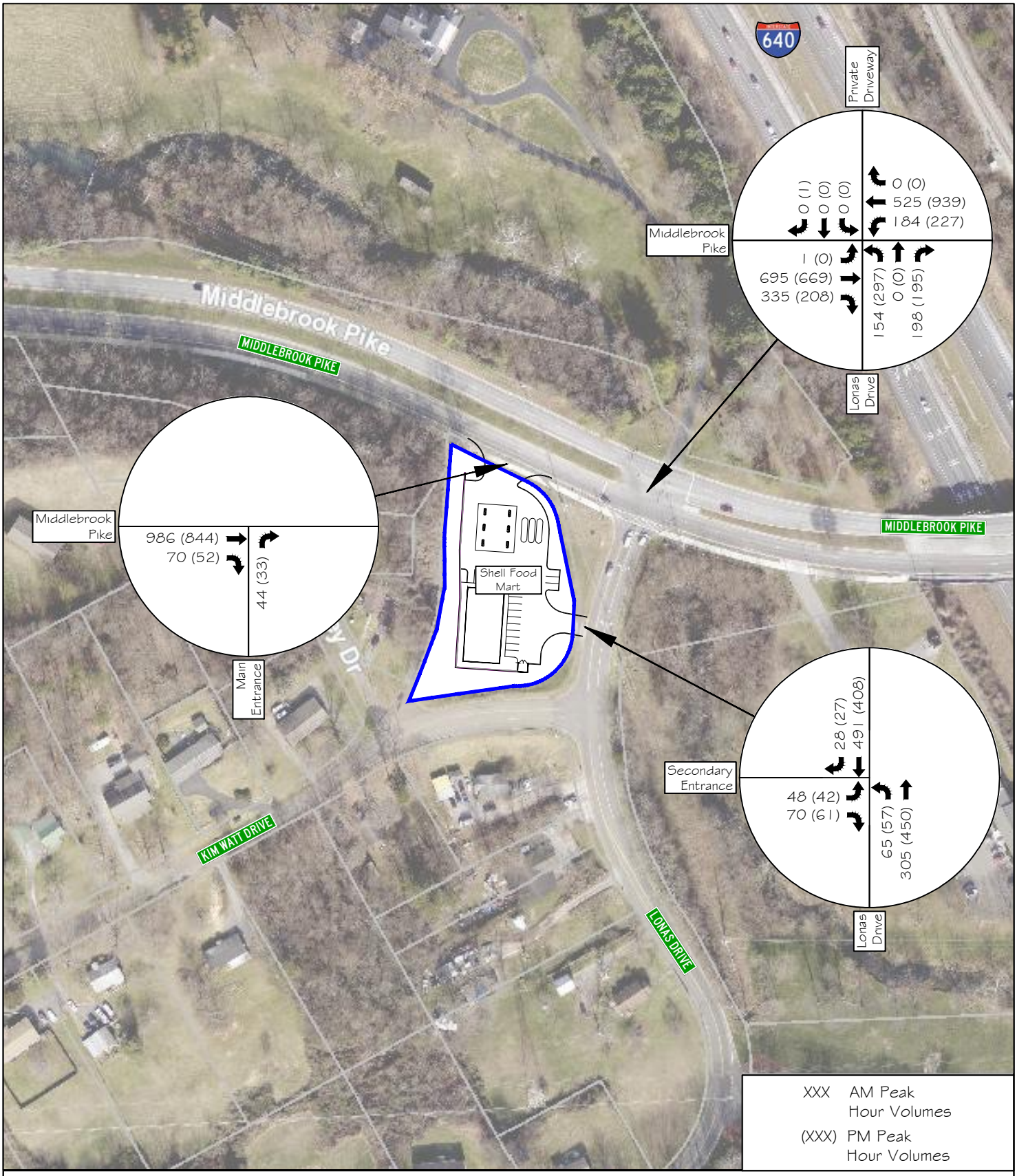


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FIGURE 8

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2025 Peak Hour Traffic Volumes - OPENING YEAR TRAFFIC (WITH THE PROJECT)

Capacity analyses were conducted to determine the projected LOS at the intersections with the development traffic in 2025. The projected 2025 peak hour capacity results for the intersections with the project resulted in good to average LOS and vehicle delays, as shown in Table 7. The exception is, once again, the northbound approach of Lonas Drive at Middlebrook Pike. Based on the capacity analyses, both proposed entrances are calculated to have minimal vehicle delays. Appendix G includes the worksheets for these capacity analyses. There was a minimal increase in vehicle delays at the signalized intersection shown in Table 7 with the development's generated traffic compared to the results shown in Table 5 without the project.

TABLE 7
2025 INTERSECTION CAPACITY ANALYSIS RESULTS -
PROJECTED TRAFFIC CONDITIONS (WITH THE PROJECT)

INTERSECTION	TRAFFIC CONTROL	APPROACH/ MOVEMENT	AM PEAK			PM PEAK		
			LOS [a]	DELAY [b] (seconds)	v/c [c]	LOS [a]	DELAY [b] (seconds)	v/c [c]
Middlebrook Pike (EB & WB) at Lonas Drive (NB) and Private Driveway (SB)	Signalized	Eastbound	B	13.9		B	15.4	
		Westbound	A	5.7		A	8.7	
		Northbound	D	44.2		F	108.3	
		Southbound	A	0.0		D	54.0	
		Summary	B	16.6	0.700	C	30.2	0.810
Middlebrook Pike (EB) at Main Entrance (NB)	Unsignalized	Northbound Right	B	13.6	0.100	B	12.3	0.070
Lonas Drive (SB & NB) at Secondary Entrance (EB)	Unsignalized	Eastbound Left/Right	C	19.6	0.350	C	16.9	0.270
		Northbound Left	A	3.9	0.070	A	2.7	0.060

Note: All analyses were calculated in Synchro 11 software and reported with HCM 2000 methodology
[a] Level of Service , [b] Average Delay (sec/vehicle) , [c] Volume-to-Capacity Ratio

- **POTENTIAL TRANSPORTATION SAFETY ISSUES:**

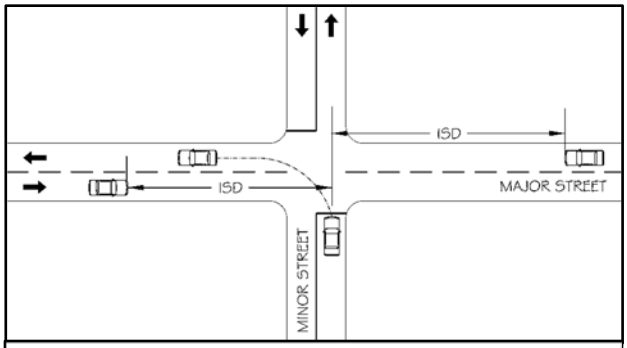
The study area was investigated for potential existing and future safety issues when the development is completed. The adjacent transportation system's features are discussed in the following pages.

o EVALUATION OF SIGHT DISTANCE

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

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

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



Intersection Sight Distance Diagram

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

With a posted speed limit of 45-mph on Middlebrook Pike at the proposed Main Entrance, the ISD is 430 feet calculated based on AASHTO's (American Association of State Highway Transportation Officials) and TDOT's guidance. This distance is required for a motorist to safely make a right turn to exit the Main Entrance at Middlebrook Pike. The Main Entrance will be RIRO only, and left turns will not be allowed.

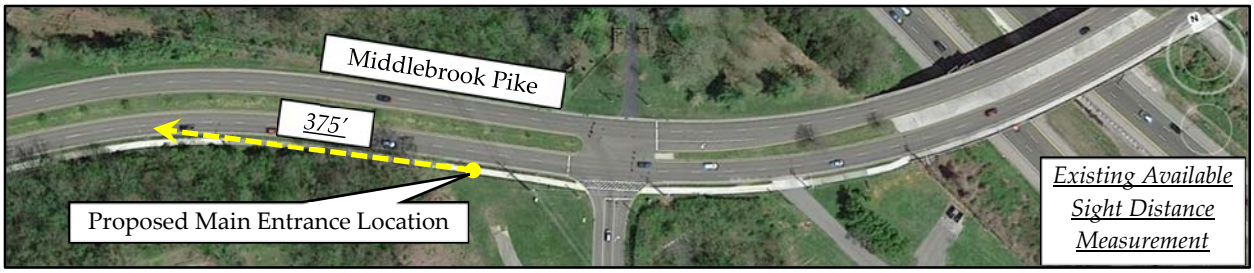
Lonas Drive is posted with a speed limit of 35-mph. The Shell Food Mart development proposes a Secondary Entrance on this existing road. With a posted speed limit of 35-mph on Lonas Drive at the proposed Secondary Entrance, the ISD is calculated to be 390 feet. This distance is required, looking to the south for exiting left-turning vehicles to the north towards Middlebrook Pike.

Visual observations of the sight distances at the proposed entrances were undertaken. Using a Nikon Laser Rangefinder at the proposed Main Entrance location, the available sight distance was visually estimated to be 375 feet to the west on Middlebrook Pike. The sight distance is reduced to the west due to vegetation growing from the adjacent cut slope along Middlebrook Pike. Based on visual observation, the available sight distance from the proposed Main Entrance at Middlebrook Pike will be less than adequate for exiting right-turn motorists.

At the proposed Secondary Entrance on Lonas Drive, the available sight distance was visually estimated to be 325 feet to the south. The current available sight distance is less than adequate for exiting left-turning vehicles. The sight distance is reduced to the south due to the horizontal curvature of Lonas Drive and the vegetation growing on the east side of Lonas Drive.

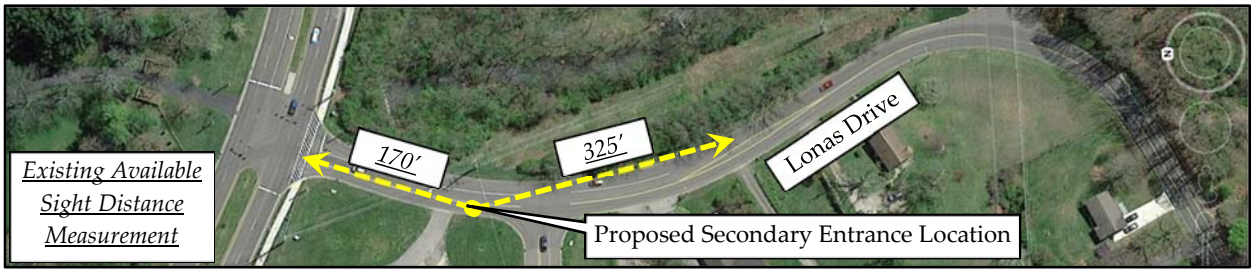
It can be assumed that vehicles turning from Middlebrook Pike at the traffic signal to the south onto Lonas Drive will have reduced speeds necessary to complete their turning movements. The available sight distance to the north at the proposed Secondary Entrance location on Lonas Drive for exiting turns will be 170 feet, which is the distance to the north from the proposed entrance to Middlebrook Pike. Based on an assumed turning vehicle speed of 15-mph approaching the Secondary Entrance from the north on Lonas Drive, the ISD can be calculated to be 170 feet for exiting left turns and 145 feet for exiting right turns, thus adequate.

Images of the existing sight distances at the proposed entrance locations are labeled below with the ISD and rangefinder-measured sight distances.



View of Sight Distance on Middlebrook Pike at the Proposed Main Entrance Location (Looking West)

View of Sight Distance on Middlebrook Pike at the Proposed Main Entrance Location (Looking East)



View of Sight Distance on Lonas Drive at the Proposed Secondary Entrance Location (Looking North)

View of Sight Distance on Lonas Drive at the Proposed Secondary Entrance Location (Looking South)

- **EVALUATION OF TURN LANE THRESHOLDS**

The need for separate turn lanes was evaluated in the projected 2025 conditions for the proposed Main Entrance on Middlebrook Pike and the proposed Secondary Entrance on Lonas Drive. The evaluation did not include left turns on Middlebrook Pike since Middlebrook Pike has a raised concrete median, and the Main Entrance will be RIRO. The evaluation also did not include left turns on Lonas Drive at the Secondary Entrance since there is already a separate northbound left-turn lane for the traffic signal that would allow turns.

The criteria used for the turn lane evaluation on Middlebrook Pike was based on TDOT's "Highway System Access Manual" since it is a State Route. The evaluation was based on the posted speed limit of 45-mph on Middlebrook Pike. The criteria used for the turn lane evaluation on Lonas Drive was based on Knox County's "Access Control and Driveway Design Policy" since it is not a State Route. The location of the Secondary Entrance on Lonas Drive is within a 35-mph speed zone; thus, it was evaluated based on this speed. These design policies relate vehicle volume thresholds based on prevailing speeds for two- and four-lane roadways.

According to TDOT's guidelines, a separate eastbound right-turn lane on Middlebrook Pike at the proposed Main Entrance is warranted based on the projected 2025 peak hour traffic volumes. According to Knox County's guidelines, a southbound right-turn lane on Lonas Drive at the Secondary Entrance is not warranted in the projected 2025 conditions. The worksheets for these evaluations are provided in Appendix K.

- **PROJECTED VEHICLE QUEUES**

An additional software program was used to calculate the 2025 AM and PM peak hour projected vehicle queues at the studied intersections. The previously mentioned Synchro Traffic Software includes SimTraffic. The Synchro portion of the software performs the macroscopic calculations for intersections, and SimTraffic performs micro-simulation and animation of vehicular traffic. SimTraffic (Version 11) software was utilized to estimate the projected vehicle queues.

The 95th percentile vehicle queue is the recognized measurement in the traffic engineering profession as the design standard used when considering vehicle queue lengths. A 95th percentile vehicle queue length means 95% certainty that the vehicle queue will not extend beyond that point. The calculated vehicle queue results were based on averaging the outcome obtained

during ten traffic simulations. The 95th percentile vehicle queue lengths at the studied intersections are shown in Table 8 for the projected 2025 conditions with the project. The vehicle queue worksheet results from the SimTraffic software are in Appendix L.

TABLE 8
TURN LANE STORAGE & VEHICLE QUEUE SUMMARY -
2025 PROJECTED PEAK HOUR TRAFFIC (WITH THE PROJECT)

INTERSECTION	APPROACH/ MOVEMENT	STORAGE LENGTH (ft)	SIMTRAFFIC 95th PERCENTILE QUEUE LENGTH (ft)		ADEQUATE LENGTH?
			AM PEAK HOUR	PM PEAK HOUR	
Middlebrook Pike (EB & WB) at Lonas Drive (NB) and Private Driveway (SB)	Eastbound Left/Thru	n/a	199	220	n/a
	Eastbound Thru/Right	n/a	209	216	n/a
	Westbound Left	110	131	158	No
	Westbound Thru	n/a	115	166	n/a
	Westbound Thru/Right	n/a	68	135	n/a
	Northbound Left	400	168	198	Yes
	Northbound Right	n/a	179	178	n/a
Middlebrook Pike (EB) at Main Entrance (NB)	Northbound Right	n/a	59	55	n/a
Lonas Drive (SB & NB) at Secondary Entrance (EB)	Eastbound Left/Right	n/a	90	142	n/a

Note: 95th percentile queues were calculated in SimTraffic 11 software

For the 2025 conditions with the project, the westbound left-turn lane on Middlebrook Pike at the traffic signal is calculated to have vehicle queues slightly longer than the provided storage length of 110 feet, which would cause a spill back onto the inside westbound lane of Middlebrook Pike. In the 2025 PM peak hour, the results in Table 8 show that the westbound left-turn lane is calculated to have a 95th percentile vehicle queue of 158 feet, 48 feet longer than the storage currently provided. However, a subsequent analysis determined that this lane will also experience spill back in the 2025 projected condition peak hours even without the project being constructed. These vehicle queue results without the project are also included in Appendix L.

In Table 8, the maximum exiting queue at the proposed Main Entrance is shown to occur in the AM peak hour with a distance of 59 feet. This queue length translates to just over two passenger vehicles, assuming a passenger car length of 25 feet. For the proposed Secondary Entrance, the maximum exiting queue is calculated to be 142 feet in the PM peak hour. This queue length translates to just under six passenger vehicles. Ultimately, the calculated vehicle queues at the proposed entrances better indicate their projected operations rather than the capacity analyses. This is because the vehicle queue results take into account the impedance produced by the vehicle queues that form on the eastbound and northbound approaches at the traffic signal.

CONCLUSIONS & RECOMMENDATIONS

The following is an overview of recommendations to minimize the transportation impacts of the proposed Shell Food Mart development on the adjacent transportation system while attempting to achieve an acceptable traffic flow and improved safety.

1

Middlebrook Pike at Lonas Drive and Private Driveway: The projected 2025 level of service calculations for the intersection of Middlebrook Pike at Lonas Drive and Private Driveway resulted in reasonable vehicle delays for all the approaches except for the northbound approach of Lonas Drive, particularly in the PM peak hour. The trips generated by the proposed development are not expected to impact this intersection in the future appreciably. No specific recommendations are offered for this intersection due to the inclusion of the proposed development; however, it is believed that the calculated northbound vehicle delays could be reduced by modifying the existing signal timing.

The signal timing for the projected 2025 PM peak hour volumes was modified in the Synchro software to reduce vehicle delays for the northbound approach but kept the same cycle length of 110 seconds. Ten seconds of green time was added to the northbound approach to reduce the vehicle delay in the PM peak hour and subsequently reduced the green time for Middlebrook Pike's eastbound and westbound approaches, resulting in the mainline having slightly increased vehicle queue lengths.

Increasing the green time by 10 seconds for the northbound approach of Lonas Drive resulted in a significant delay reduction for the vehicles on this approach. The results of this modified PM signal timing are shown below. The capacity analysis results are included in Appendix G. The results in Tables 9 and 10 show the potential reduction in vehicle delays and queues in the PM peak hour for the northbound approach compared to the PM peak hour results (Tables 7 and 8) obtained by leaving the traffic signal timing as-is (the AM signal timing was not changed). Green and red denote the table changes, showing the decreases and increases, respectively.

TABLE 9
2025 INTERSECTION CAPACITY ANALYSIS RESULTS -
PROJECTED TRAFFIC CONDITIONS (WITH THE PROJECT) - REVISED SIGNAL TIMING

INTERSECTION	TRAFFIC CONTROL	APPROACH/ MOVEMENT	AM PEAK			PM PEAK		
			LOS [a]	DELAY [b] (seconds)	CHANGE [c] (seconds)	LOS [a]	DELAY [b] (seconds)	CHANGE [c] (seconds)
Middlebrook Pike (EB & WB) at Lonas Drive (NB) and Private Driveway (SB)	Signalized	Eastbound	B	13.4	NO CHANGES MADE	C	19.5	4.1
		Westbound	A	5.3		B	11.2	2.5
		Northbound	D	44.1		D	52.1	-56.2
		Southbound	A	0.0		D	54.0	0.0
		Summary	B	16.1		C	22.0	-8.2

Note: All analyses were calculated in Synchro 11 software and reported with HCM 2000 methodology
[a] Level of Service , [b] Average Delay (sec/vehicle)
[c] Difference between 2025 Projected Vehicle Delay (Table 7) versus 2025 Projected Vehicle Delay with Revised Signal Timing (Table 9)

TABLE 10
TURN LANE STORAGE & VEHICLE QUEUE SUMMARY -
2025 PROJECTED PEAK HOUR TRAFFIC (WITH THE PROJECT) - REVISED SIGNAL TIMING

INTERSECTION	APPROACH/ MOVEMENT	SIMTRAFFIC 95th PERCENTILE QUEUE LENGTH (ft)			
		AM PEAK HOUR	CHANGE [a] (feet)	PM PEAK HOUR	CHANGE [a] (feet)
Middlebrook Pike (EB & WB) at Lonas Drive (NB) and Private Driveway (SB)	Eastbound Left/Thru	199	NO CHANGES MADE	227	7
	Eastbound Thru/Right	209		208	-8
	Westbound Left	131		139	-19
	Westbound Thru	115		184	18
	Westbound Thru/Right	68		164	29
	Northbound Left	168		207	9
	Northbound Right	179		165	-13
Middlebrook Pike (EB) at Main Entrance (NB)	Northbound Right	59		46	-9
Lonas Drive (SB & NB) at Secondary Entrance (EB)	Eastbound Left/Right	90		99	-43

Note: 95th percentile queues were calculated in SimTraffic 11 software

Based on these results, the City of Knoxville is recommended to slightly modify the traffic signal timing to reduce the vehicle delays for the northbound approach on Lonas Drive for the existing and projected conditions. As shown in Table 10, this signal timing modification also decreased the projected vehicle queues for the eastbound exiting movements at the Secondary Entrance.

Furthermore, due to the projected vehicle queues on the Middlebrook Pike westbound left-turn lane at the signalized intersection calculated to extend past the provided lane

storage, even without the project being constructed, TDOT and the City should consider extending the storage an additional 65 feet minimum, for a total storage length of 175 feet. Also, in the future, with continued overall traffic growth, TDOT and the City may need to consider adding an exclusive eastbound right-turn lane on Middlebrook Pike at Lonas Drive and a second northbound left-turn lane on Lonas Drive due to existing and projected high left and right-turn vehicular volumes.

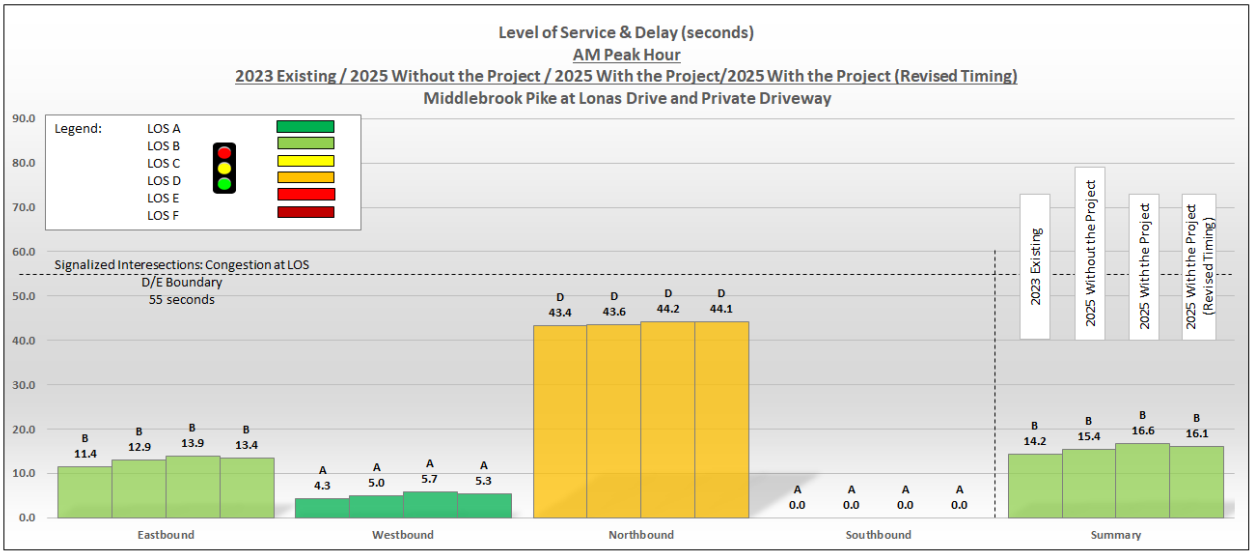
However, some drawbacks of providing an eastbound right-turn lane on Middlebrook Pike include costs and lack of vehicle storage availability. The expenses would include relocating underground utilities, including an existing fire hydrant, relocating the strain pole for the traffic signal at the intersection, and relocating a large pole for overhead electric power transmission. This overhead electric pole supports the powerlines that cross Lonas Drive and Middlebrook Pike. Adding a turn lane would also impact the location of the existing KAT bus stop. The distance between the Proposed Main Entrance exiting lane and Lonas Drive will be approximately 100 feet, which would provide minimal vehicle storage. The updated proposed site plan by Ardurra for the Shell Food Mart indicates that the site property could absorb a new eastbound right-turn lane on Middlebrook Pike but would require a modification of the proposed internal sidewalk from the existing Greenway to the building. Adding a turn lane on Middlebrook Pike would most likely also require modification of the Proposed Main Entrance's exiting lane. Adding an eastbound right-turn lane on Middlebrook Pike should not be determinantal to the site's driveway throat lengths or internal circulation.

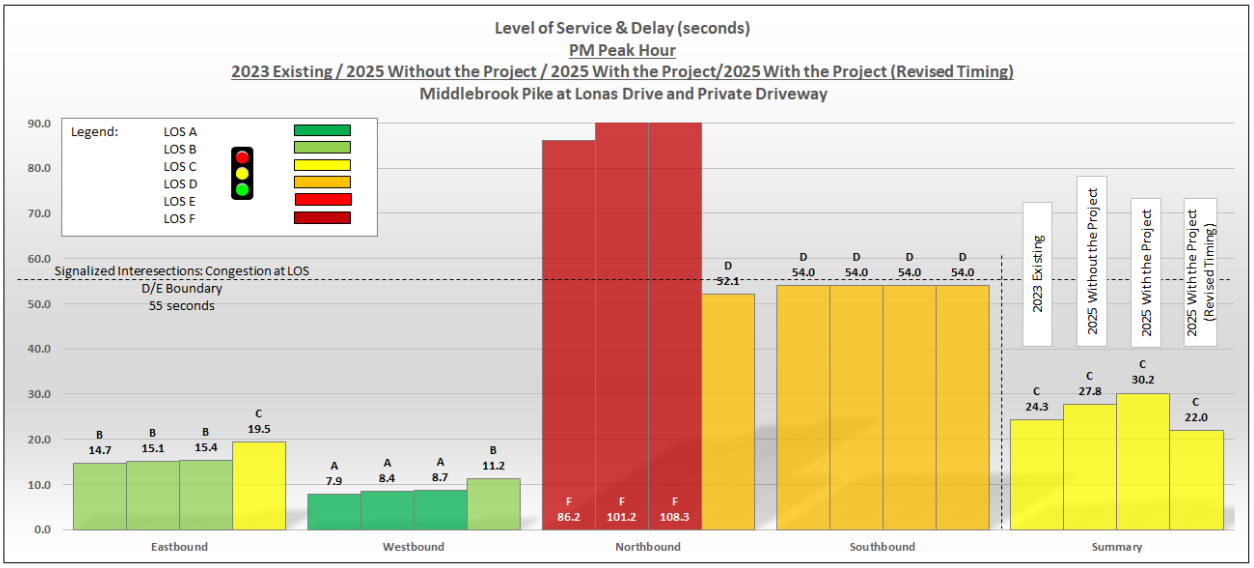
A summary of the Middlebrook Pike at Lonas Drive and Private Driveway intersection capacity analysis results is presented in Table 11. This table provides a side-by-side summary and comparison of the intersection for the 2023 existing conditions, projected conditions in 2025 without the project, the projected conditions in 2025 with the project, and the projected conditions in 2025 with the slightly modified signal timing in the PM peak hour.

TABLE 11
INTERSECTION CAPACITY ANALYSIS SUMMARY
MIDDLEBROOK PIKE AT LONAS DRIVE AND PRIVATE DRIVEWAY

APPROACH / PEAK HOUR MOVEMENT	2023 EXISTING			2025 WITHOUT THE PROJECT			2025 WITH THE PROJECT			2025 WITH THE PROJECT (REVISED TIMING)		
	LOS[a]	Delay[b]	v/c[c]	LOS[a]	Delay[b]	v/c[c]	LOS[a]	Delay[b]	v/c[c]	LOS[a]	Delay[b]	v/c[c]
AM Peak												
Eastbound	B	11.4		B	12.9		B	13.9		B	13.4	
Westbound	A	4.3		A	5.0		A	5.7		A	5.3	
Northbound	D	43.4		D	43.6		D	44.2		D	44.1	
Southbound	A	0.0		A	0.0		A	0.0		A	0.0	
Summary	B	14.2	0.620	B	15.4	0.660	B	16.6	0.700	B	16.1	0.680
PM Peak												
Eastbound	B	14.7		B	15.1		B	15.4		C	19.5	
Westbound	A	7.9		A	8.4		A	8.7		B	11.2	
Northbound	F	86.2		F	101.2		F	108.3		D	52.1	
Southbound	D	54.0		D	54.0		D	54.0		D	54.0	
Summary	C	24.3	0.710	C	27.8	0.770	C	30.2	0.810	C	22.0	0.780

Note: All analyses were calculated in Synchro 11 software and reported with HCM 2000 methodology
[a] Level of Service , [b] Average Delay (sec/vehicle) , [c] Volume-to-Capacity Ratio





2 **Middlebrook Pike at the Proposed Main Entrance**: The 2025 projected level of service calculations for this intersection resulted in low vehicle delays with the exit operating with RIRO only conditions. Based on the capacity analysis, the intersection will appropriately handle entering and exiting traffic. However, it should be noted that during peak hours, vehicles exiting this entrance will experience queues due to having to wait for gaps in the eastbound Middlebrook Pike streams and queues that form at the traffic signal. During the existing conditions, vehicle queues on the eastbound outside lane at the traffic signal were observed to extend past the proposed location of the Main Entrance and are expected to occur in future conditions.

2a) The 2025 projected eastbound right-turn volumes on Middlebrook Pike entering the Main Entrance are just over the threshold to warrant an exclusive eastbound right-turn lane based on TDOT's guidelines. However, the outside eastbound lane on Middlebrook Pike at the proposed Main Entrance location currently operates as a de facto right-turn lane for vehicles turning south onto Lonas Drive. In the AM peak hour, over 300 vehicles were observed turning right, which caused vehicle queues even when the eastbound approach had a green indication at the traffic signal and not just when there was a red (stop) indication due to the high number of right-turns. In general, a right-turn lane at a signalized intersection should be considered when the right-turn volume and adjacent thru-lane volumes are more than 300 vehicles per hour. Theoretically, the number of right-turning vehicles on Middlebrook Pike at Lonas Drive during peak hours currently justifies the need for an exclusive eastbound right-turn lane.

The primary purpose of warranting an exclusive right-turn lane is to reduce the potential for rear-end crashes and reduce the time that turning vehicles impacts the flow of thru vehicles. Since the outside eastbound lane on Middlebrook Pike is already operating as a de facto right-turn lane, an exclusive right-turn lane built just for the proposed development's Main Entrance is not justified. Any advantage of providing an exclusive right-turn lane specifically for the proposed development would be negated by the traffic flow blockage and turbulence already occurring from the high number of right-turns onto Lonas Drive.

2b) This entrance intersection will be designed as RIRO only. This entrance is proposed as RIRO due to the existing raised grassed center median on Middlebrook Pike. It is

recommended that the proposed Main Entrance follow TDOT driveway entrance guidelines, and the following should be considered in the design and construction:

i) The entering and exiting lanes should have a width and inner radius to facilitate the largest expected-sized vehicle entering and exiting at Middlebrook Pike, which is expected to be gas delivery trucks, most likely from the gas terminals located a mile west along Middlebrook Pike. The layout and elements of the intersection should follow all TDOT and City of Knoxville standards.

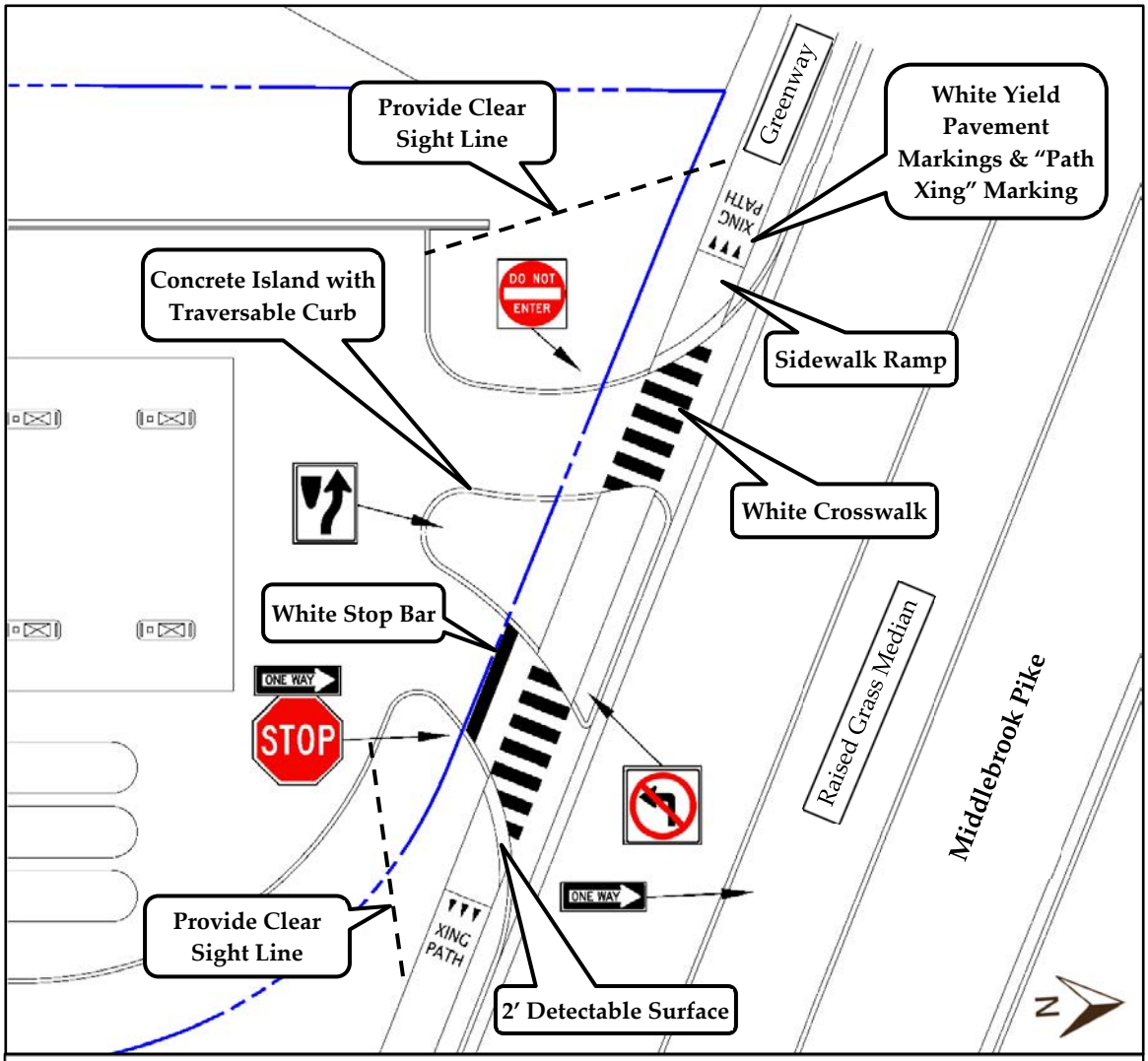
ii) The island separating the entering and exiting movements should be raised concrete with traversable curbs to facilitate large trucks delivering convenience market items and gasoline.

iii) The image below shows a revised site layout for the Main Entrance from what is shown in Figure 3. As shown below, traffic signage with breakaway posts at this intersection should include a Stop Sign (R1-1), a Keep Right Sign (R4-7), a No Left Turn Sign (R3-2), a Do Not Enter Sign (R5-1) and One Way Signs (R6-1R). These signs should be installed facing the appropriate direction. Three reflective raised pavement markers should be located at the island corner radius points – one in the center and 2-foot spacing on either side of the corners. The Stop Sign (R1-1) should be supplemented with a 24" white stop bar on the exiting lane approaching Middlebrook Pike, a minimum of 4 feet away from the proposed crosswalk for the sidewalk/greenway.

While it was not observed to be heavily traveled, the sidewalk (Middlebrook Greenway) has a high potential for pedestrian and bicyclist conflicts. The eastbound grade on Middlebrook Pike approaching the proposed Main Entrance is downhill, approximately 2%. With this road grade and a posted speed limit of 45 mph, right-turning vehicles into the Main Entrance could turn at a fairly high speed. It would be beneficial to reduce the entering curb radius to slow turning speeds; however, a larger radius (40') will be necessary to allow large trucks to enter the development, even with a traversable center island.

It is recommended that the sidewalk at the Main Entrance be installed with pavement markings and other items to reduce the potential turning vehicle conflicts with pedestrians and bicyclists on the Middlebrook Greenway. It is recommended that these pavement markings be installed with thermoplastic materials. The recommended pavement markings in the image include

designated white crosswalks, detectable surfaces, and advance pavement markings on the sidewalk/greenway. The pavement markings on the sidewalk are shown with white yield symbols and wording to include "Path Xing". Alternative sidewalk delineations across the entrance could include green-colored pavement. Details regarding the appropriate and desired treatments to reduce pedestrian and bicycle conflicts should be discussed during the detailed design review with TDOT and the City of Knoxville.



Proposed Main Entrance at Middlebrook Pike

2c) Intersection sight distance for pedestrians and motorists at the Main Entrance at Middlebrook Pike must not be impacted by future landscaping or signage. The sidewalk approaches to the Main Entrance should have clear sight lines to fully allow greenway users to see approaching entering and exiting vehicles.

Based on a posted speed limit of 45-mph on Middlebrook Pike, the required ISD is 430 feet, looking to the west for exiting right-turning vehicles at the Main Entrance. The available sight distance was visually estimated to be 375 feet to the west on Middlebrook Pike. The sight distance is reduced to the west due to vegetation growing from the adjacent cut slope along the south side of Middlebrook Pike. This vegetation must be removed or reduced to allow the maximum sight distance. A licensed land surveyor must measure the currently available sight distance to confirm the visual approximation and define the amount of vegetation removal needed to meet the required sight distance to the west. The site designer must also verify that this distance will be available based on the final site plans.

View of Vegetation Obstruction on the South Side of Middlebrook Pike and West of Proposed Main Entrance Location

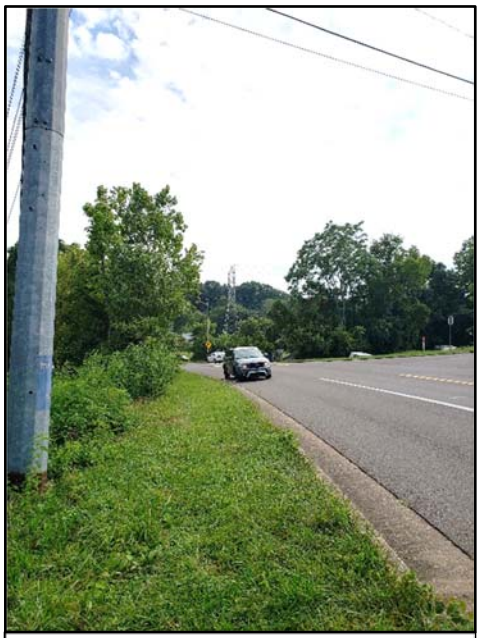
2d) The 95th percentile vehicle queue lengths were calculated for the exiting northbound approach at this intersection for the 2025 projected conditions with the project, and the calculated vehicle queues are reasonable. The northbound exiting lane at Middlebrook Pike will be right-turn-out only. The longest queue in the projected 2025 conditions (with the modified PM signal timing) is calculated to be 59 feet in the AM peak hour and 46 feet in the PM peak hour. These queue lengths translate to around two passenger vehicles at their maximum, assuming a passenger car length of 25 feet.

2e) The City of Knoxville requires specific corner clearance distances between intersecting streets. The proposed Main Entrance will be a private driveway located 190 feet (centerline to centerline) away from Lonas Drive. This distance exceeds the City of Knoxville spacing requirement of 150 feet from Lonas Drive, a collector street.

2f) The construction of the Main Entrance on Middlebrook Pike will require a TDOT Highway Entrance Permit. The developer will need to apply for this permit and coordinate with TDOT regarding their specific requirements for this entrance.

3 **Lonas Drive at the Proposed Secondary Entrance**: The 2025 projected level of service calculations for this intersection resulted in low vehicle delays with the exit operating with full turning movements. Based on the capacity analysis, the intersection will appropriately handle entering and exiting traffic. However, it should be noted that during peak hours, vehicles exiting this entrance will experience queues due to waiting for gaps in the northbound Lonas Drive streams and queues that form at the traffic signal to exit to the left towards Middlebrook Pike. During the existing conditions, vehicle queues on the northbound approach at the traffic signal were observed to extend past the proposed location of the Secondary Entrance and are expected in future conditions. Furthermore, vehicle queues during peak periods at this entrance may persuade exiting left-turning motorists to re-route to the Main Entrance.

3a) It is recommended that this entrance be constructed with different-sized radii. It is recommended that the entrance's southern edge radius be 15 feet to reduce the exiting vehicle speeds, thus reducing the potential of cut-thru traffic. On the entrance's northern side, it is recommended that the radius be constructed at 25 feet to help facilitate entering vehicles from the north. Due to the limited spacing between the proposed Secondary Entrance and the intersection of Middlebrook Pike at Lonas Drive, it is imperative that vehicles from the north not be hindered from entering. Any entering disruption could easily spill back to the signalized intersection operations. If curbs are constructed at this entrance, they should be traversable to allow for potential large trucks to enter and exit.



View of Vegetation Obstruction on the East Side of Lonas Drive and South of Proposed Secondary Entrance Location

3b) Sight distances from the proposed Secondary Entrance at Lonas Drive must not be impacted by future landscaping and signage.

The required ISD is 390 feet looking to the south and 170 feet to the north for exiting left and right-turning vehicles at the Secondary Entrance. The available sight distance was visually estimated to be 325 feet to the south on Lonas Drive. The sight distance is reduced to the south due to the

horizontal curvature of Lonas Drive and the vegetation growing on the east side of Lonas Drive. This vegetation must be removed or reduced to allow the maximum sight distance. A licensed land surveyor must measure the currently available sight distance to confirm the visual approximation and define the amount of vegetation removal needed to meet the required sight distance to the south. The site designer must also verify that this distance will be available based on the final site plans.

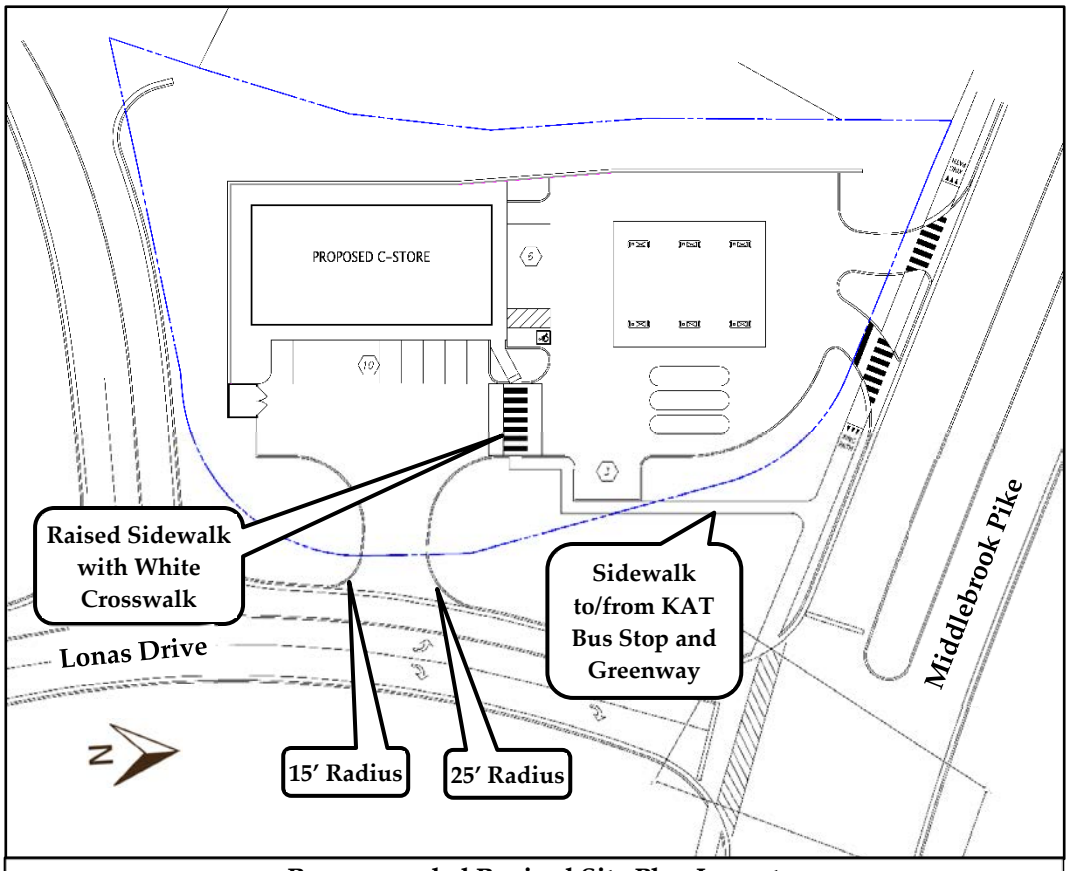
3c) The 95th percentile vehicle queue lengths were calculated for the exiting eastbound approach at this intersection for the 2025 projected conditions with the project, and the calculated vehicle queues are reasonable. The eastbound exiting lane at Lonas Drive will allow both left and right turns. The longest queue in the projected 2025 conditions (with the modified PM signal timing) is calculated to be 58 feet in the AM peak hour and 75 feet in the PM peak hour. These queue lengths translate to just under three passenger vehicles in the AM and three in the PM peak hour.

3d) The proposed Secondary Entrance will be a private driveway located 200 feet (centerline to centerline) away from Lonas Drive and 100 feet from the centerline of Kim Watt Drive. This distance exceeds the City of Knoxville spacing requirement of 150 feet from Middlebrook Pike, an arterial street, and 50 feet spacing required from Kim Watt Drive, a local street.

3e) It is not explicitly recommended that the Secondary Entrance not be constructed with dual exiting lanes, allowing separate left and right-turning movements. However, an additional exiting lane would help reduce vehicle queue lengths and delays, particularly for right-turning movements toward the south onto Lonas Drive. If a dual exiting lane is desired, it should be taken under advisement due to the proximity to the signalized intersection and the high-level decision-making required by exiting motorists to find gaps in the oncoming traffic. The horizontal curvature of Lonas Drive at the proposed location could be detrimental, and side-by-side vehicles in dual exiting lanes could restrict each other's sight distance.

4 **Shell Food Mart Internal Drives and Parking Areas:** The current site plan shows two entrance driveways constructed for the development with pavement areas to facilitate customers, market, and gasoline deliveries, as shown in Figure 3 and below. (Note: Ardurra has since updated the preliminary plan layout shown in Figure 3 to reflect the proposed minor layout modifications recommendations in this study; however, the preliminary plan is used in this report for illustrative purposes.)

4a) With the high number of existing eastbound right-turns occurring on Middlebrook Pike to Lonas Drive, the potential for cut-thru traffic at this location is very high. Cut-thru traffic would be potentially dangerous due to the nature of gas station/convenience market activities, which include walking customers, vehicles backing out of parking spaces, gas pump maneuvers, and delivery trucks. It is recommended that the site designer include a raised crosswalk that would dissuade motorists from cutting through the development. The most appropriate location for placing a raised crosswalk is shown in the image below. The site design layout has been slightly revised to fit the raised crosswalk at the location. The image below overall shows a revised site layout for the development from what is shown in Figure 3.



Recommended Revised Site Plan Layout

KAT Bus Stop on Middlebrook Pike at Lonas Drive – Route 13,

The revisions to the site layout included shifting the parking spaces adjacent to the store, the three parking spaces near the underground gasoline storage tanks, and modifying the sidewalk. Typically, a raised crosswalk consists of a 10-foot-wide raised pavement section with 6-foot ramped approaches on each end, and these dimensions were used in the revised layout shown in the image. The raised sidewalk should be at a height to allow the adjacent sidewalks outside the aisleway to be flush. The revised layout includes a sidewalk from the existing KAT bus stop on Middlebrook Pike to the convenience market building. Installing a sidewalk across the property to and from the building would facilitate pedestrian or bicycle traffic to and from the transit stop and the greenway without forcing these potential customers to cross the parking lot and internal drives, which would be hazardous due to potential vehicle conflicts.

4b) Sidewalks are proposed along the front and adjacent to the convenience market and are recommended to be installed across the property to and from the KAT bus stop and greenway. Sidewalks should have appropriate ADA-compliant ramps at intersection corners, and the internal sidewalks are recommended to be 5 feet minimum in width to meet the City of Knoxville regulations. Sidewalk ramps must include detectable surfaces to meet ADA requirements.

4c) According to the City of Knoxville regulations, bicycle spaces must be provided for this proposed development. The number of spaces required is based on the land use category and the total required motor vehicle parking spaces. With nineteen vehicle parking spaces, four bicycle parking spaces are required for this proposed development. These spaces should be designed according to the regulations listed in Section 11.9 of the City of Knoxville's Zoning Code User's Manual.

4d) The construction of this development with the two entrances, with one restricted to RIRO, may lead to increased illegal U-turns occasionally occurring at this intersection from vehicles heading eastbound and turning back to the west. This movement is

already posted as being illegal. Unfortunately, for this location, increased law enforcement is the only reasonable means of reducing this illegal movement.

4e) All road grade and intersection elements should be designed to AASHTO, TDOT, and City of Knoxville specifications and guidelines to ensure proper transportation operations.

APPENDIX A

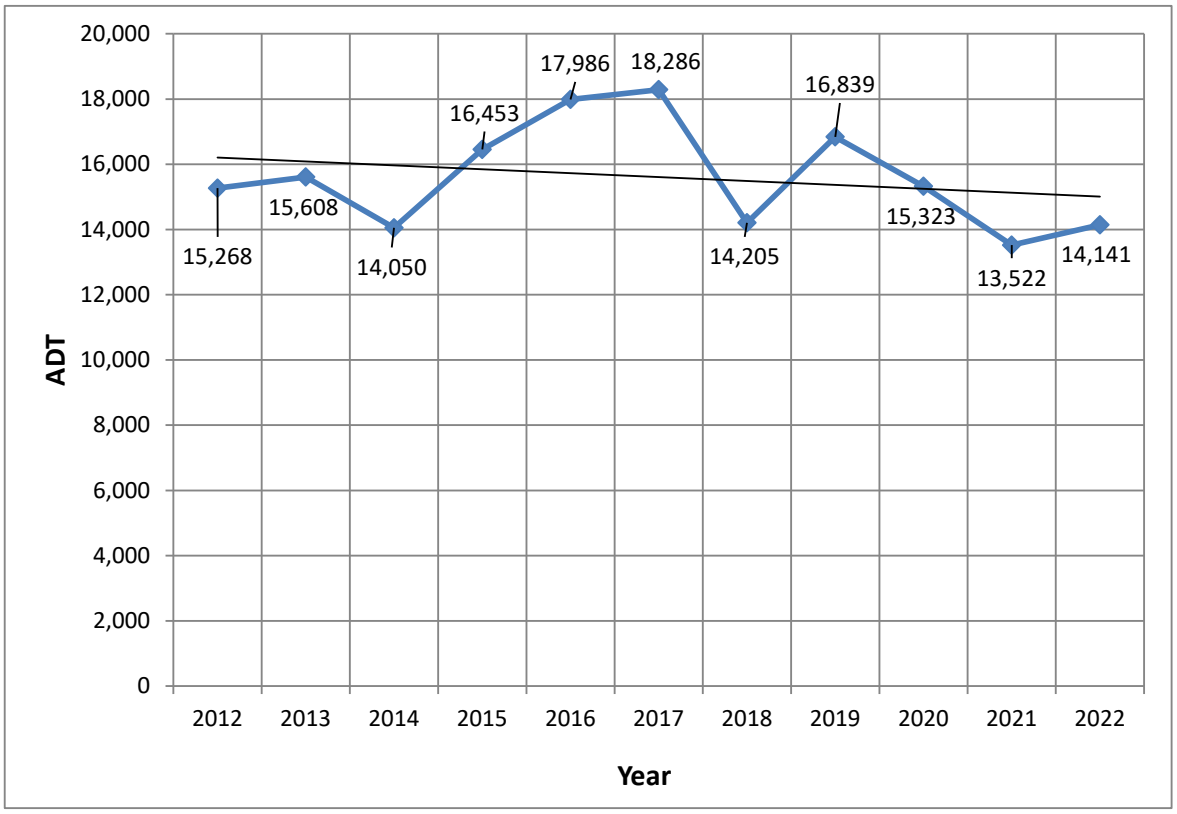
HISTORICAL TRAFFIC COUNT DATA

Historical Traffic Counts

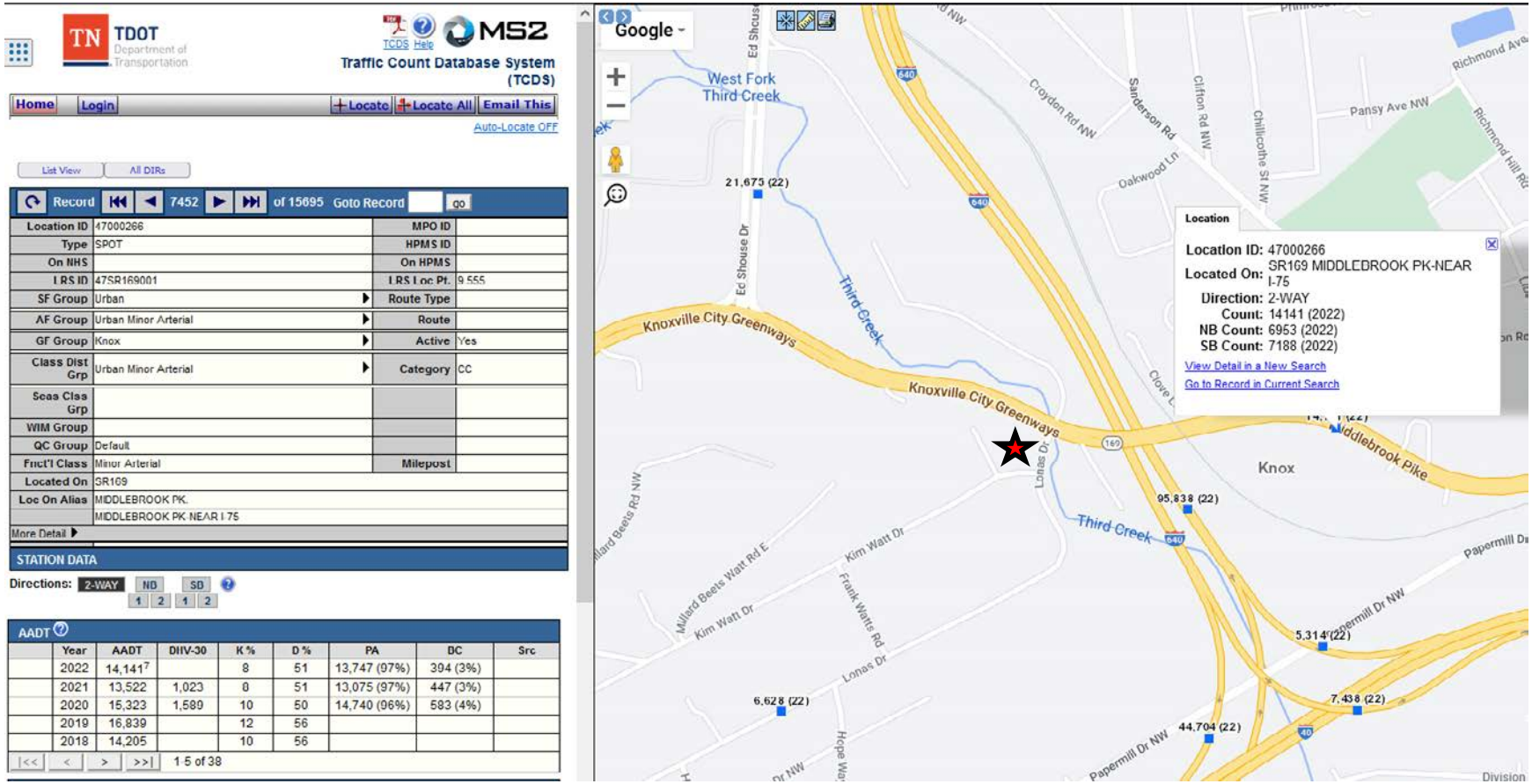
Organization: TDOT
Station ID #: 47000266
Location: Middlebrook Pike, east of Interstate 640

YEAR	ADT
2012	15,268
2013	15,608
2014	14,050
2015	16,453
2016	17,986
2017	18,286
2018	14,205
2019	16,839
2020	15,323
2021	13,522
2022	14,141

Trendline



2012 - 2022 Growth Rate = -7.4%
Average Annual Growth Rate = -0.8%

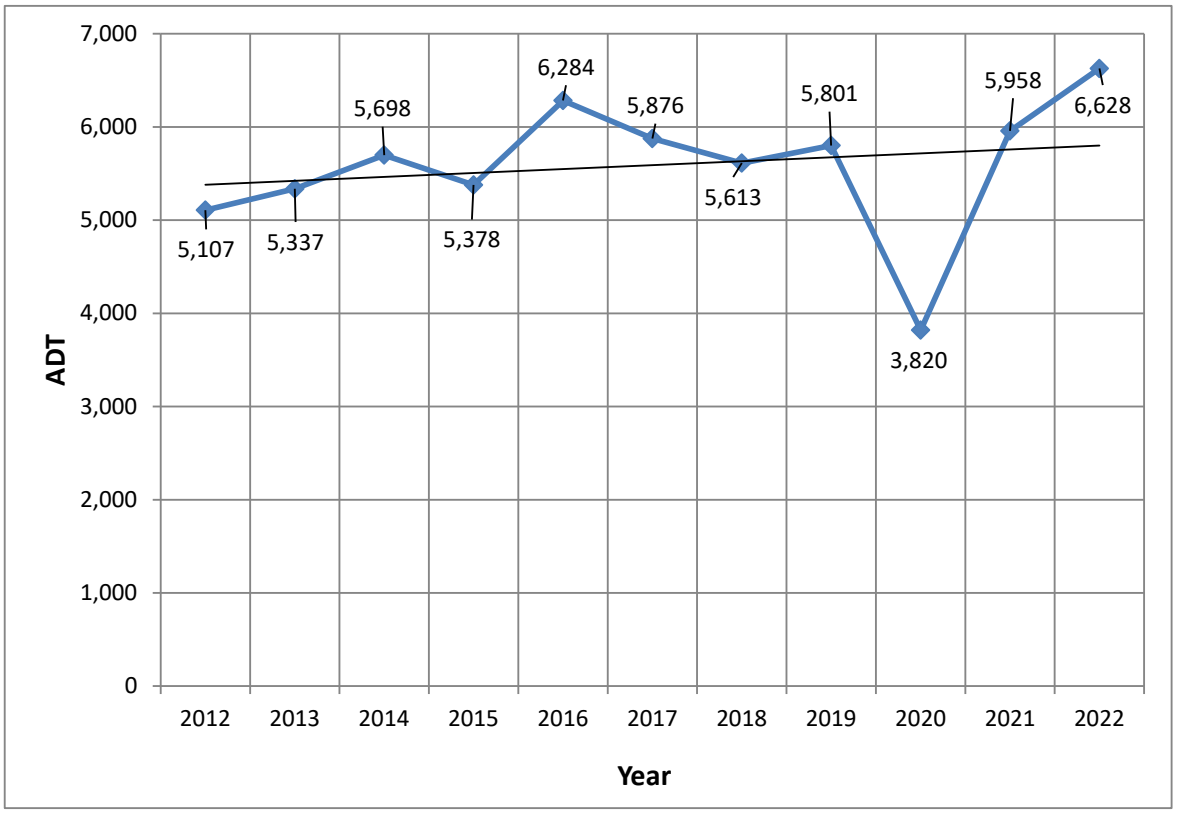

TN TDOT Department of Transportation
TCDS Help MS2
Traffic Count Database System (TCDS)
Home Login Locate Locate All Email This
Auto-Locate OFF
List View All DIRs
Record 7452 of 15695 Goto Record go
Location ID 47000266 MPO ID
Type SPOT HPMS ID
On NHS On HPMS
LRS ID 47SR169001 LRS Loc Pt. 9.555
SF Group Urban Route Type
AF Group Urban Minor Arterial Route
GF Group Knox Active Yes
Class Dist Grp Urban Minor Arterial Category CC
Seas Clss Grp
WIM Group
QC Group Default
Fnct'l Class Minor Arterial Milepost
Located On SR169
Loc On Alias MIDDLEBROOK PK.
MIDDLEBROOK PK NEAR I 75
More Detail
STATION DATA
Directions: 2-WAY ND SD
1 2 1 2
AADT
Year AADT DHV-30 K % D % PA DC Src
2022 14,141[7]
2021 13,522 1,023 8 51 13,075 (97%) 447 (3%)
2020 15,323 1,589 10 50 14,740 (96%) 583 (4%)
2019 16,839 12 56
2018 14,205 10 56
|<< < > >>| 1-5 of 38
Google
West Fork Third Creek
Croydon Rd NW
Sanderson Rd
Clifton Rd NW
Chillicothe St NW
Pansy Ave NW
Richmond Ave
Oakwood Ln
Ed Shouse Dr
21,675 (22)
Knoxville City Greenways
Third Creek
Knoxville City Greenways
Middlebrook Pike
Knox
Lonas Dr
95,838 (22)
Third Creek
Kim Watt Dr
Millard Beets Watt Rd E
Frank Watts Rd
Papermill Dr NW
5,314 (22)
6,628 (22)
7,438 (22)
44,704 (22)
Papermill Dr NW
Division
Location
Location ID: 47000266
Located On: SR169 MIDDLEBROOK PK-NEAR I-75
Direction: 2-WAY
Count: 14141 (2022)
NB Count: 6953 (2022)
SB Count: 7188 (2022)
View Detail in a New Search
Go to Record in Current Search

Historical Traffic Counts

Organization: TDOT
Station ID #: 47000486
Location: Lonas Drive, east of Hollywood Road

YEAR	ADT
2012	5,107
2013	5,337
2014	5,698
2015	5,378
2016	6,284
2017	5,876
2018	5,613
2019	5,801
2020	3,820
2021	5,958
2022	6,628

Trendline



2012 - 2022 Growth Rate = 29.8%
Average Annual Growth Rate = 2.6%

TN TDOT Department of Transportation

TCDS Help MS2

Traffic Count Database System (TCDS)

Home | Login | Locate | Locate All | Email This

Auto-Locate OFF

List View | All DIRs

Record 7660 of 15695 Goto Record go

Location ID	47000486	MPO ID	
Type	SPOT	HPMS ID	
On NHS		On HPMS	
LRS ID	4705667001	LRS Loc Pt.	0.549
SF Group	Urban	Route Type	
AF Group	Urban Minor Collector	Route	
GF Group	Knox	Active	Yes
Class Dist Grp	Urban Minor Collector	Category	CC
Seas Clss Grp			
WIM Group			
QC Group	Default		
Fnct'l Class	Minor Collector	Milepost	
Located On	05667		
Loc On Alias	LONAS DR.		
	KNOXVILLE		
More Detail			

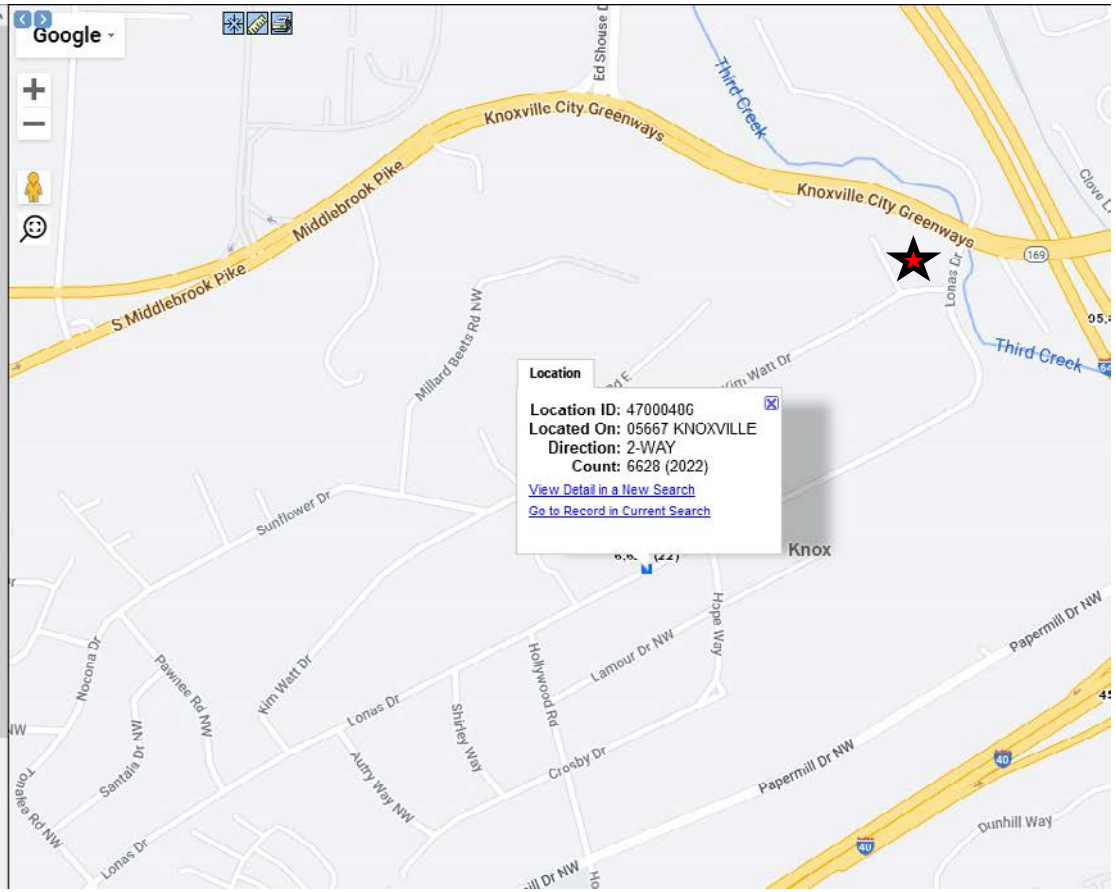
STATION DATA

Directions: 2-WAY

AADT

	Year	AADT	DHV-30	K %	D %	PA	BC	Src
	2022	6,628	654	10	65	6,462 (97%)	166 (3%)	
	2021	5,950	495	0	65	5,074 (99%)	04 (1%)	
	2020	3,820	506	13	65	3,689 (97%)	131 (3%)	
	2019	5,801		12	65			
	2018	5,613		10	65			

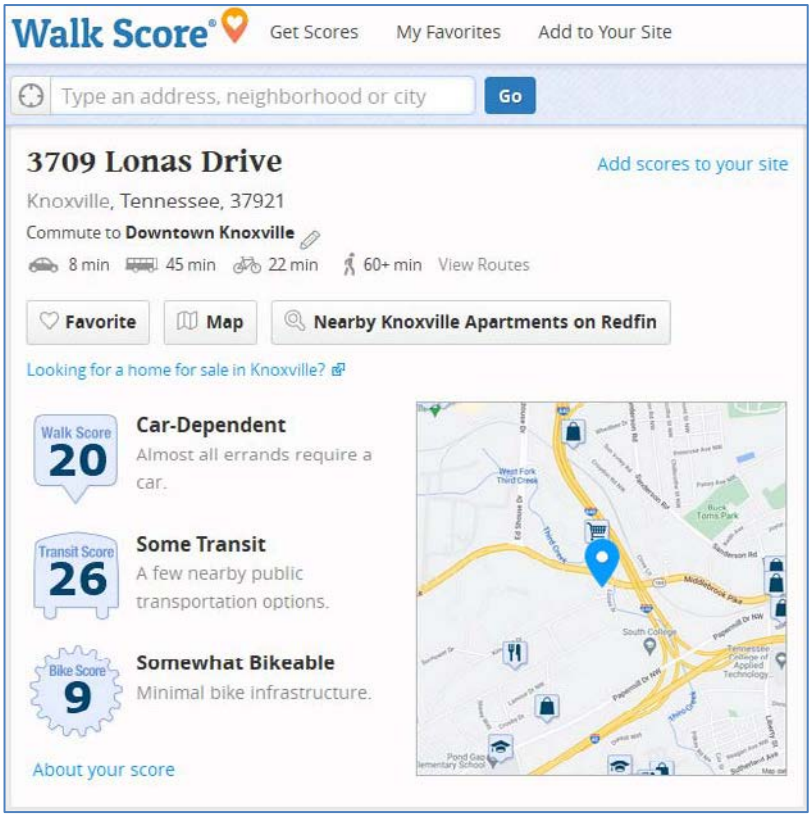
|<< < > >>| 1-5 of 13



APPENDIX B

WALK SCORE

WALKSCORE
(from walkscore.com)



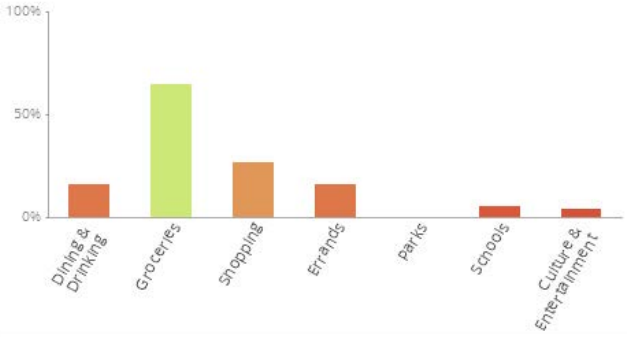
Scores for 3709 Lonas Drive

Walk Score 20 | Transit Score 26 | Bike Score 9

Walk Score | Transit Score | Bike Score

Score Details | **What is Walk Score**

The Walk Score for 3709 Lonas Drive is based on the following categories.



Scores for 3709 Lonas Drive

Walk Score 20 | Transit Score 26 | Bike Score 9

Walk Score | **Transit Score** | Bike Score

Transit Score measures how well a location is served by public transit based on the distance and type of nearby transit lines.

90–100	**Rider's Paradise** World-class public transportation
70–89	**Excellent Transit** Transit is convenient for most trips
50–69	**Good Transit** Many nearby public transportation options
25–49	**Some Transit** A few nearby public transportation options
0–24	**Minimal Transit** It is possible to get on a bus

Scores for 3709 Lonas Drive

Walk Score 20 | Transit Score 26 | Bike Score 9

Walk Score	Transit Score	Bike Score

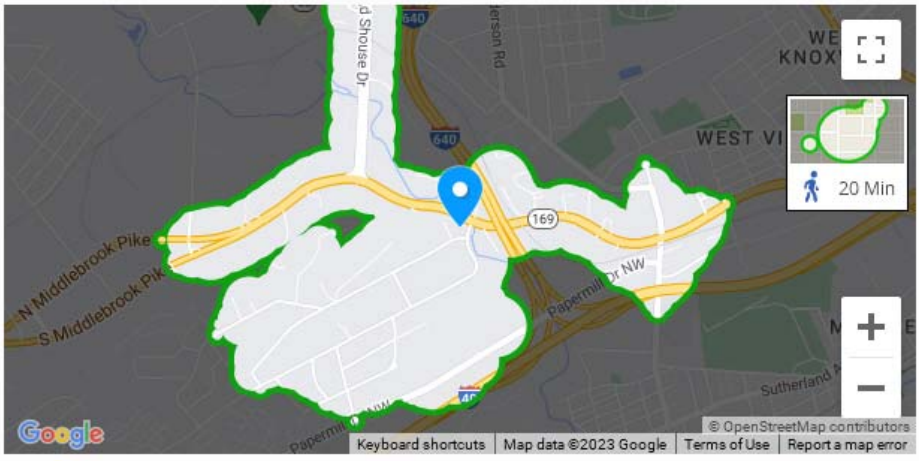
Bike Score measures whether an area is good for biking based on bike lanes and trails, hills, road connectivity, and destinations.

90–100	**Biker's Paradise** Daily errands can be accomplished on a bike
70–89	**Very Bikeable** Biking is convenient for most trips
50–69	**Bikeable** Some bike infrastructure
0–49	**Somewhat Bikeable** Minimal bike infrastructure

Travel Time Map

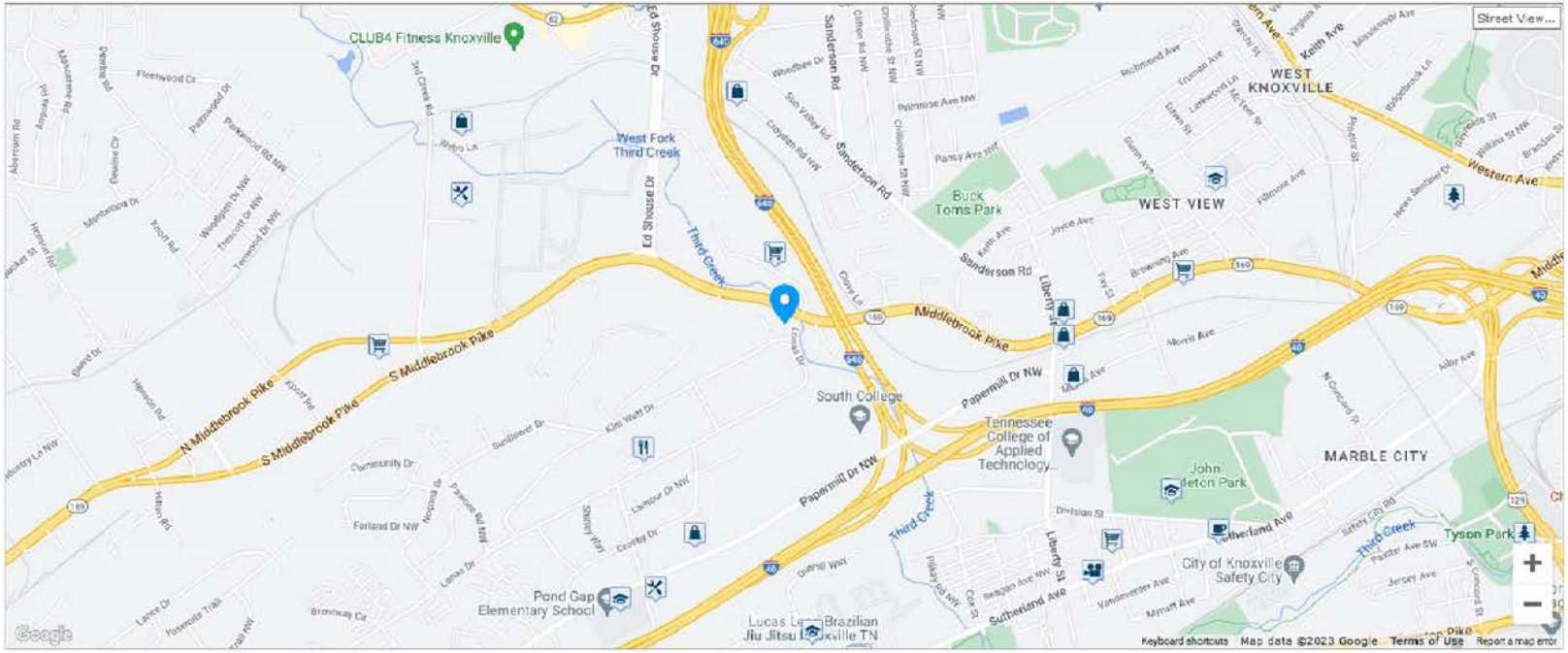
Add to your site

Explore how far you can travel by car, bus, bike and foot from 3709 Lonas Drive.



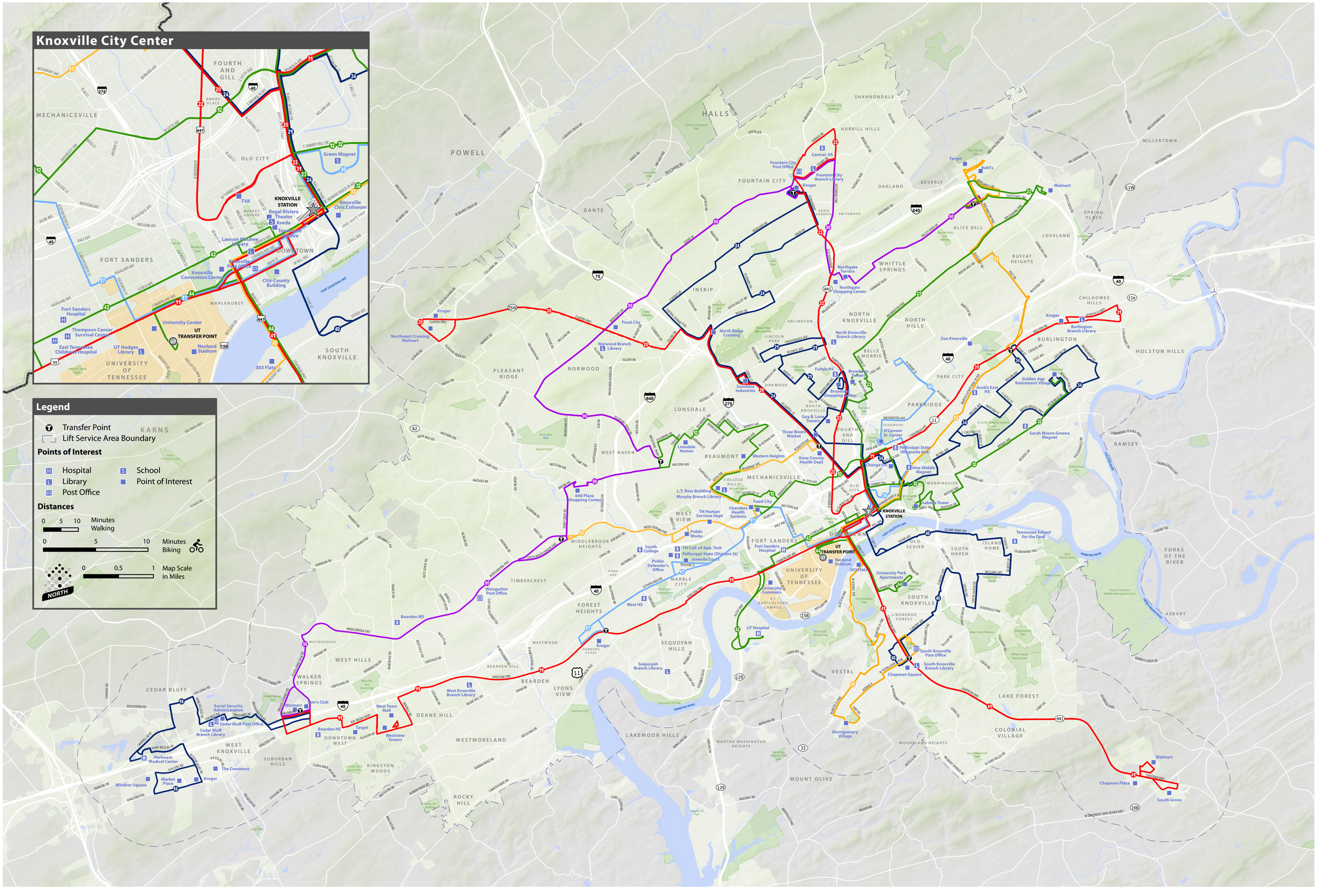
What's Nearby

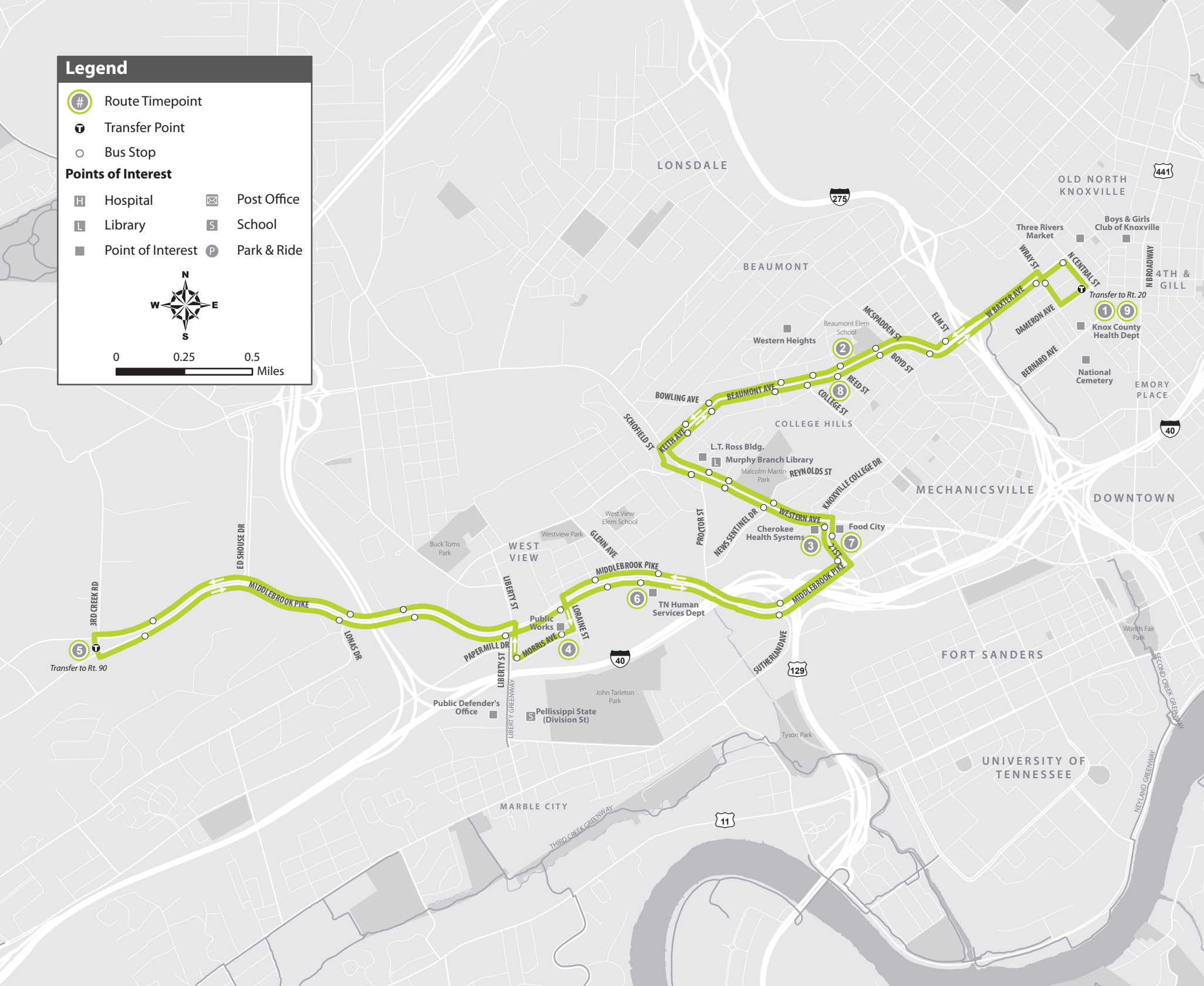
Restaurants:	El Tipico	.5mi
Coffee:	The Golden Roast Coffee Roa...	1.2mi
Bars:	Oakey's Sports Grill	16mi
Groceries:	Middlebrook	.1mi
Parks:	Badger Field	1.6mi
Schools:	Pond Gap Elementary School	.8mi
Shopping:	Juan's Quality Lawncare	.5mi
Entertainment:	Redbox	.8mi
Errands:	Gifts of Touch Message & Refl...	.8mi
Search Nearby:		



APPENDIX C

KNOXVILLE AREA TRANSIT MAP AND INFORMATION


Knoxville City Center
KNOXVILLE STATION
UT TRANSFER POINT
Legend
Transfer Point
Lift Service Area Boundary
Points of Interest
Hospital
Library
Post Office
School
Point of Interest
Distances
0 5 10 Minutes Walking
0 5 10 Minutes Biking
0 0.5 1 Map Scale in Miles
NORTH
MECHANICSVILLE
FOURTH AND GILL
OLD CITY
DOWNTOWN
FORT SANDERS
MAPLEHURST
UNIVERSITY OF TENNESSEE
SOUTH KNOXVILLE
HALLS
POWELL
DANTE
FOUNTAIN CITY
SHANNONDALE
HARRILL HILLS
OAKLAND
BEVERLY
ALICE BELL
WHITTLE SPRINGS
NORTH KNOXVILLE
NORTH HILLS
INSKIP
ARLINGTON
LINCOLN PARK
OAKWOOD
BELLE MORRIS
PARK CITY
PARKRIDGE
OLD NORTH KNOXVILLE
BEAUMONT
WEST VIEW
COLLEGE HILLS
MORNINGSIDE
OLD SEVIER
SOUTH HAVEN
ISLAND HOME
LOVELAND
SPRING PLACE
BUFFAT HEIGHTS
CHILHOWEE HILLS
BURLINGTON
HOLSTON HILLS
MILLERTOWN
RAMSEY
FORKS OF THE RIVER
ASBURY
LAKE FOREST
COLONIAL VILLAGE
MOORLAND HEIGHTS
MOUNT OLIVE
MARTHA WASHINGTON HEIGHTS
LAKEMOOR HILLS
ROCKY HILL
WESTMORELAND
DEANE HILL
BEARDEN
LYONS VIEW
SEQUOYAH HILLS
VESTAL
LINDBERGH FOREST
TIMBERCREST
FOREST HEIGHTS
WESTWOOD
WEST HILLS
WALKER SPRINGS
CEDAR BLUFF
WEST KNOXVILLE
SUBURBAN HILLS
KINGSTON WOODS
DOWNTOWN WEST
WEST HAVEN
MIDDLEBROOK HEIGHTS
PLEASANT RIDGE
NORWOOD
LONSDALE
KARNS
Green Magnet
Knoxville Civic Coliseum
Regal Riviera Theater
Aveda
Tennessee Theatre
Lawson McGhee Library
Knoxville Police Dept
Knoxville Convention Center
City-County Building
TVA
Fort Sanders Hospital
Thompson Cancer Survival Center
East Tennessee Children's Hospital
University Center
UT Hodges Library
Neyland Stadium
303 Flats
Fountain City Post Office
Fountain City Branch Library
Central HS
Kroger
Target
Kohl's
Walmart
Northgate Terrace
Northgate Shopping Center
Zoo Knoxville
Burlington Branch Library
Golden Age Retirement Village
Austin East HS
Sarah Moore Greene Magnet
Vine Middle Magnet
Isabella Tower
Pellissippi State (Magnolia Ave)
O'Connor Sr. Center
Broadway Towers
Broadway Shopping Center
Fulton HS
Guy B. Love Towers
Three Rivers Market
Knox County Health Dept
Change Ctr
Tennessee School for the Deaf
University Commons
UT Agriculture Campus
UT Hospital
University Park Apartments
South Knoxville Post Office
South Knoxville Branch Library
Chapman Square
Montgomery Village
Chapman Plaza
South Grove
Walmart
Northwest Crossing Walmart
Kroger
Food City
Norwood Branch Library
Sunshine Industries
North Ridge Crossing
North Knoxville Branch Library
Lonsdale Homes
Western Heights
Food City
Cherokee Health Systems
L.T. Ross Building
Murphy Branch Library
640 Plaza Shopping Center
TN Human Services Dept
Public Works
South College
TN Coll. of App. Tech
Pellissippi State (Division St)
Juvenile Court
Public Defender's Office
West HS
Weisgarber Post Office
Bearden MS
Kroger
Sequoyah Branch Library
West Knoxville Branch Library
Sam's Club
Walmart
West Town Mall
Bearden HS
Target
Westview Towers
Cedar Bluff Post Office
Cedar Bluff Branch Library
Social Security Administration
Parkwest Medical Center
The Commons
Windsor Square
Market Place
Kroger

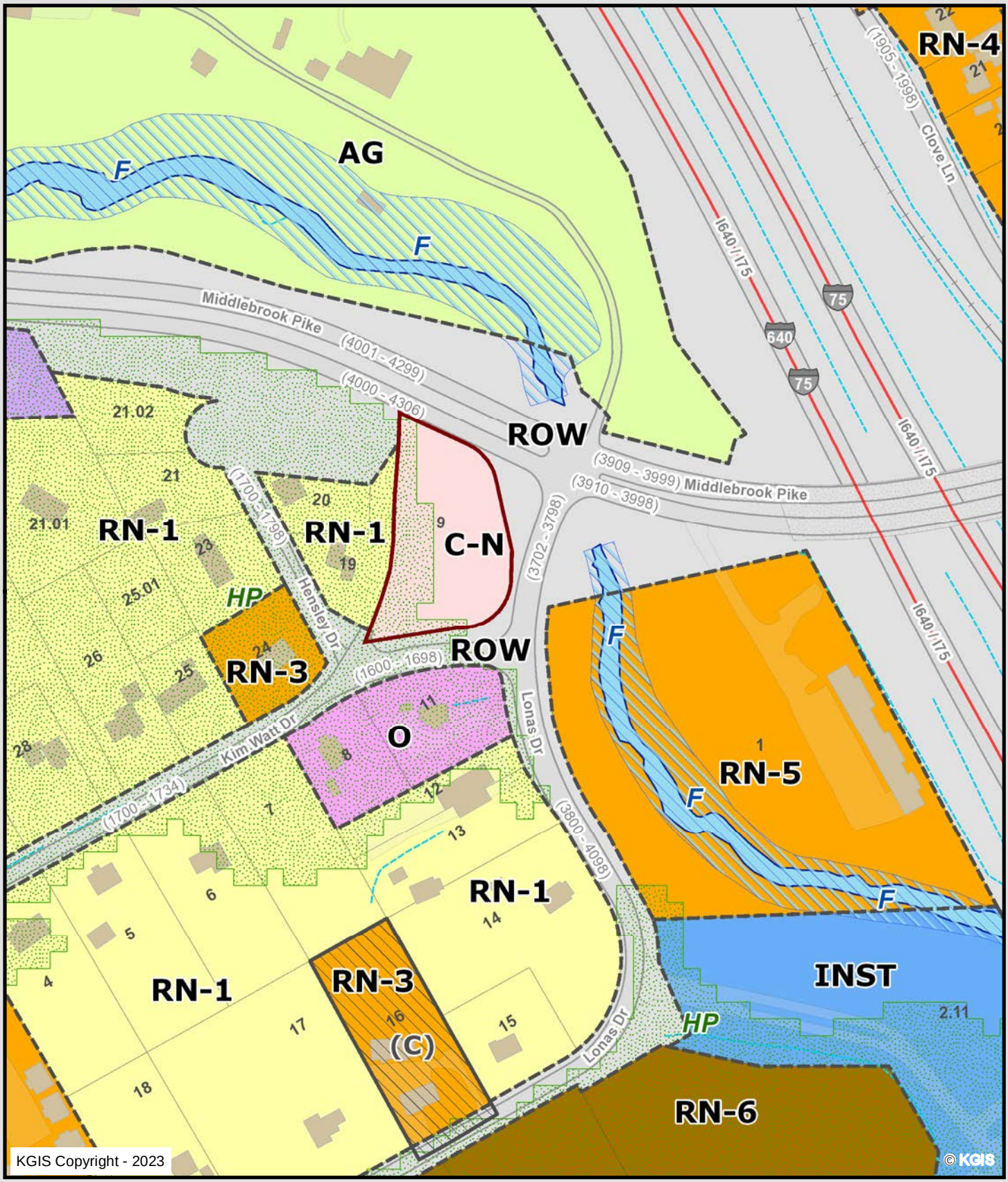

Legend
Route Timepoint
Transfer Point
Bus Stop
Points of Interest
Hospital
Library
Point of Interest
Post Office
School
Park & Ride
N
W
E
S
0
0.25
0.5
Miles
LONSDALE
BEAUMONT
OLD NORTH KNOXVILLE
4TH & GILL
COLLEGE HILLS
MECHANICSVILLE
DOWNTOWN
WEST VIEW
FORT SANDERS
UNIVERSITY OF TENNESSEE
MARBLE CITY
EMORY PLACE
Three Rivers Market
Boys & Girls Club of Knoxville
Knox County Health Dept
National Cemetery
Western Heights
Beaumont Elem School
L.T. Ross Bldg.
Murphy Branch Library
Malcolm Martin Park
West View Elem School
Westview Park
Buck Toms Park
Cherokee Health Systems
Food City
TN Human Services Dept
Public Works
Public Defender's Office
Pellissippi State (Division St)
John Tarleton Park
Tyson Park
Worlds Fair Park
Transfer to Rt. 20
Transfer to Rt. 90
WRAY ST
N CENTRAL ST
N BROADWAY
DAMERON AVE
BERNARD AVE
W BAXTER AVE
ELM ST
MCSPADDEN ST
BOYD ST
REED ST
COLLEGE ST
BEAUMONT AVE
BOWLING AVE
KEITH AVE
SCHOFIELD ST
REYNOLDS ST
KNOXVILLE COLLEGE DR
WESTERN AVE
PROCTOR ST
NEWS SENTINEL DR
21ST
MIDDLEBROOK PIKE
GLENN AVE
LIBERTY ST
LORAINE ST
MORRIS AVE
PAPER MILL DR
LONAS DR
ED SHOUSE DR
3RD CREEK RD
SUTHERLAND AVE
LIBERTY GREENWAY
THIRD CREEK GREENWAY
SECOND CREEK GREENWAY
NEYLAND GREENWAY
275
441
40
129
11

Route 13 - Beaumont: Weekdays

Going from the Health Department					*Going toward the Health Department*			
Health Department Dameron	**Beaumont @ Reed**	**Cherokee Health**	**Public Works Complex**	**Middlebrook @ 3rd Creek**	**State Office Bldg.**	**Cherokee Health**	**Beaumont @ Reed**	**Health Department Dameron**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
9:25 AM	9:32 AM	9:39 AM	9:45 AM	9:52 AM	9:59 AM	10:03 AM	10:07 AM	10:15 AM
10:25 AM	10:32 AM	10:39 AM	10:45 AM	10:52 AM	10:59 AM	11:03 AM	11:07 AM	11:15 AM
11:25 AM	11:32 AM	11:39 AM	11:45 AM	11:52 AM	11:59 AM	12:03 PM	12:07 PM	12:15 PM
12:25 PM	12:32 PM	12:39 PM	12:45 PM	12:52 PM	12:59 PM	1:03 PM	1:07 PM	1:15 PM
1:25 PM	1:32 PM	1:39 PM	1:45 PM	1:52 PM	1:59 PM	2:03 PM	2:07 PM	2:15 PM
2:25 PM	2:32 PM	2:39 PM	2:45 PM	2:52 PM	2:59 PM	3:03 PM	3:07 PM	3:15 PM
3:25 PM	3:32 PM	3:39 PM	3:45 PM	3:52 PM	3:59 PM	4:03 PM	4:07 PM	4:15 PM
4:25 PM	4:32 PM	4:39 PM	4:45 PM	4:52 PM				

APPENDIX D

ZONING MAP



Zoning Map

8.3.2023

Knoxville - Knox County - KUB Geographic Information System

Printed: 8/3/2023 at 3:34:19 PM

0 100 200 400

ft

APPENDIX E

MANUAL TRAFFIC COUNT DATA

TRAFFIC COUNT DATA

Major Street: Middlebrook Pike (EB and WB)
Minor Street: Lonas Drive (NB) / Private Driveway (SB)
Traffic Control: Traffic Signal

8/24/2023 (Thursday)
Mostly Sunny and Hot / Brief Afternoon Shower
Conducted by: Ajax Engineering

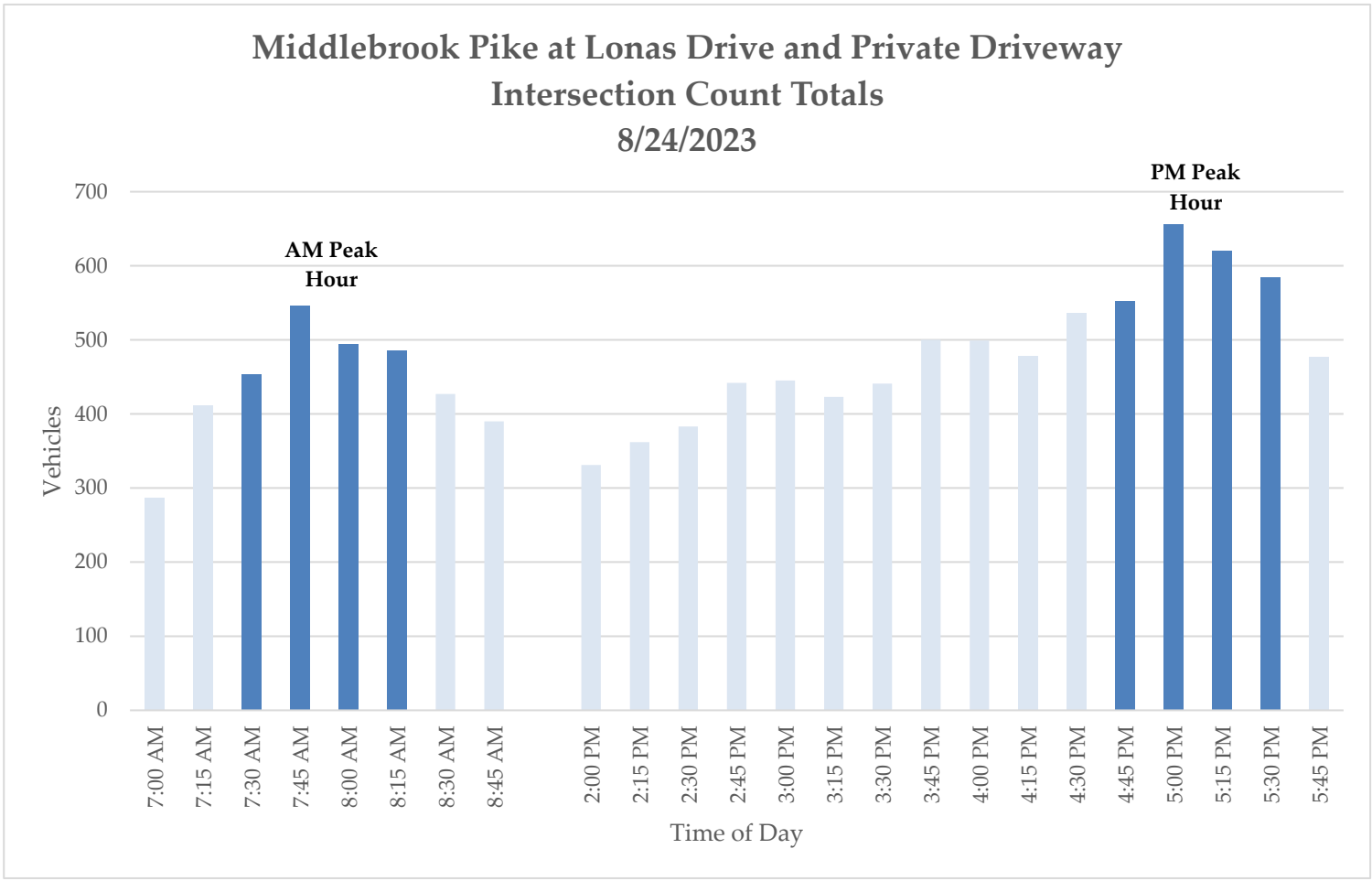
	Private Driveway			Middlebrook Pike			Lonas Drive			Middlebrook Pike				
TIME	SOUTHBOUND			WESTBOUND			NORTHBOUND			EASTBOUND			VEHICLE	PEAK
BEGIN	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	TOTAL	HOUR
7:00 AM	0	0	0	10	121	0	22	0	20	0	86	28	287	
7:15 AM	0	0	0	19	153	0	42	0	36	0	112	50	412	
7:30 AM	0	0	0	30	116	0	41	0	55	0	157	55	454	**7:30 AM - 8:30 AM**
7:45 AM	0	0	0	32	146	0	29	0	46	0	210	83	546	
8:00 AM	0	0	1	43	122	0	27	0	40	0	163	99	495	
8:15 AM	0	0	0	47	135	0	37	0	29	1	155	82	486	
8:30 AM	0	0	0	40	127	0	22	0	25	1	135	77	427	
8:45 AM	0	1	0	23	123	0	32	0	20	0	111	80	390	
TOTAL	0	1	1	244	1043	0	252	0	271	2	1129	554	3497	
2:00 PM	0	0	0	27	129	0	35	0	19	2	91	28	331	
2:15 PM	0	0	0	23	119	0	38	0	22	1	118	41	362	
2:30 PM	0	0	0	27	155	0	47	0	14	0	104	36	383	
2:45 PM	0	0	0	39	166	0	54	0	33	2	113	35	442	
3:00 PM	0	0	0	43	173	0	43	0	24	0	131	31	445	
3:15 PM	0	0	0	40	140	1	57	0	24	0	115	46	423	
3:30 PM	0	1	0	30	148	0	58	0	31	0	130	43	441	
3:45 PM	0	0	0	53	202	0	37	0	29	0	133	46	500	
4:00 PM	0	0	0	37	159	0	51	0	27	1	166	58	499	
4:15 PM	0	0	1	46	178	0	45	0	26	1	136	46	479	
4:30 PM	0	0	0	45	213	0	46	0	21	0	150	61	536	
4:45 PM	0	0	0	42	211	0	62	0	35	0	153	50	553	**4:45 PM - 5:45 PM**
5:00 PM	0	0	0	64	245	0	71	0	47	0	182	47	656	
5:15 PM	0	0	0	44	246	0	69	0	46	0	170	46	621	
5:30 PM	0	0	0	46	222	0	66	0	38	0	156	57	585	
5:45 PM	0	0	0	43	151	0	54	0	23	0	157	49	477	
TOTAL	0	1	1	649	2857	1	833	0	459	7	2205	720	7733	

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

	Private Driveway			Middlebrook Pike			Lonas Drive			Middlebrook Pike		
TIME	SOUTHBOUND			WESTBOUND			NORTHBOUND			EASTBOUND		
BEGIN	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT
7:30 AM	0	0	0	30	116	0	41	0	55	0	157	55
7:45 AM	0	0	0	32	146	0	29	0	46	0	210	83
8:00 AM	0	0	1	43	122	0	27	0	40	0	163	99
8:15 AM	0	0	0	47	135	0	37	0	29	1	155	82
TOTAL	**0**	**0**	**1**	**152**	**519**	**0**	**134**	**0**	**170**	**1**	**685**	**319**
PHF	**-**	**-**	**0.25**	**0.81**	**0.89**	**-**	**0.82**	**-**	**0.77**	**0.25**	**0.82**	**0.81**
TRUCK %	**0.0%**	**0.0%**	**0.0%**	**1.3%**	**4.4%**	**0.0%**	**0.8%**	**0.0%**	**1.2%**	**0.0%**	**4.4%**	**1.3%**

2023 PM Peak Hour **4:45 PM - 5:45 PM**

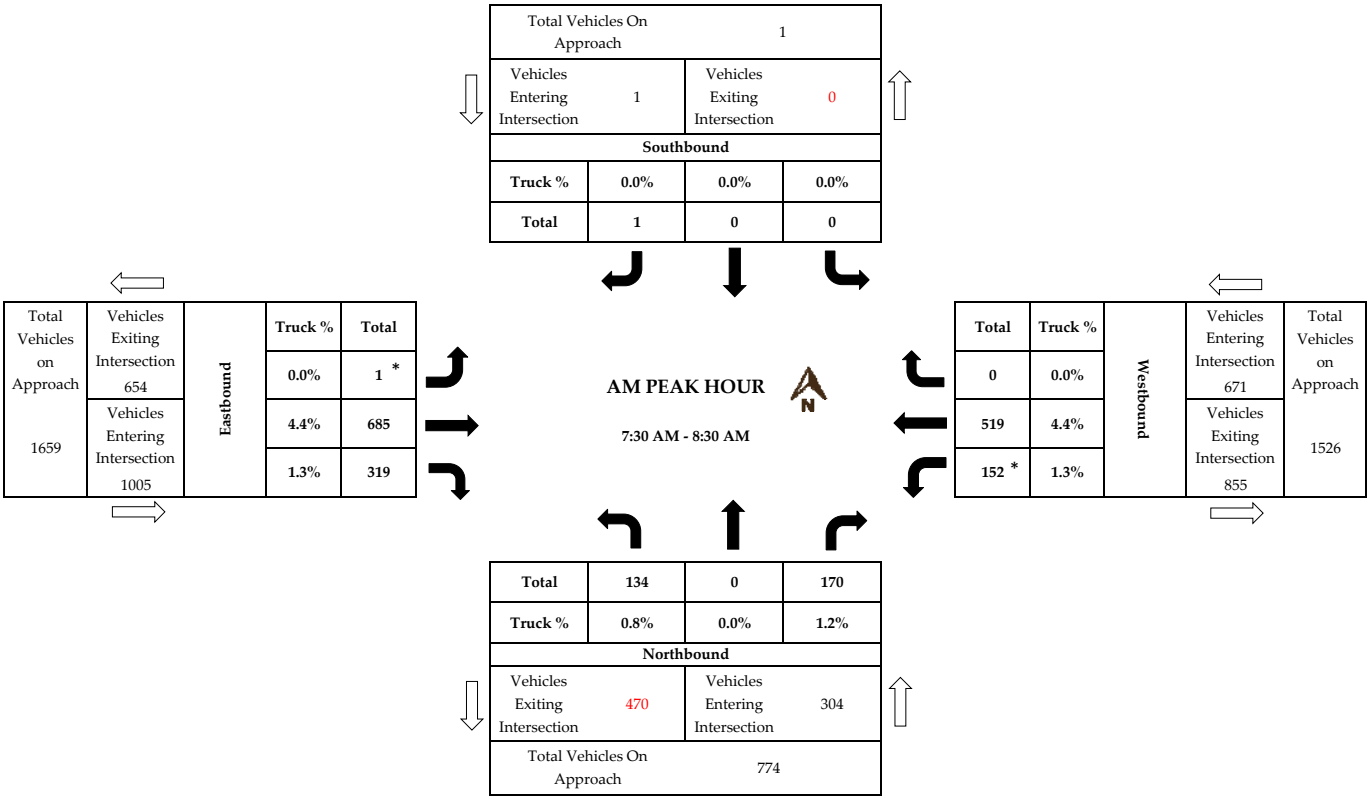
	Private Driveway			Middlebrook Pike			Lonas Drive			Middlebrook Pike		
TIME	SOUTHBOUND			WESTBOUND			NORTHBOUND			EASTBOUND		
BEGIN	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT
4:45 PM	0	0	0	42	211	0	62	0	35	0	153	50
5:00 PM	0	0	0	64	245	0	71	0	47	0	182	47
5:15 PM	0	0	0	44	246	0	69	0	46	0	170	46
5:30 PM	0	0	0	46	222	0	66	0	38	0	156	57
TOTAL	**0**	**0**	**0**	**196**	**924**	**0**	**268**	**0**	**166**	**0**	**661**	**200**
PHF	**-**	**-**	**-**	**0.77**	**0.94**	**-**	**0.94**	**-**	**0.88**	**-**	**0.91**	**0.88**
TRUCK %	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**1.8%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**3.9%**	**0.0%**


Middlebrook Pike at Lonas Drive and Private Driveway
Intersection Count Totals
8/24/2023
AM Peak Hour
PM Peak Hour
Vehicles
700
600
500
400
300
200
100
0
7:00 AM
7:15 AM
7:30 AM
7:45 AM
8:00 AM
8:15 AM
8:30 AM
8:45 AM
2:00 PM
2:15 PM
2:30 PM
2:45 PM
3:00 PM
3:15 PM
3:30 PM
3:45 PM
4:00 PM
4:15 PM
4:30 PM
4:45 PM
5:00 PM
5:15 PM
5:30 PM
5:45 PM
Time of Day

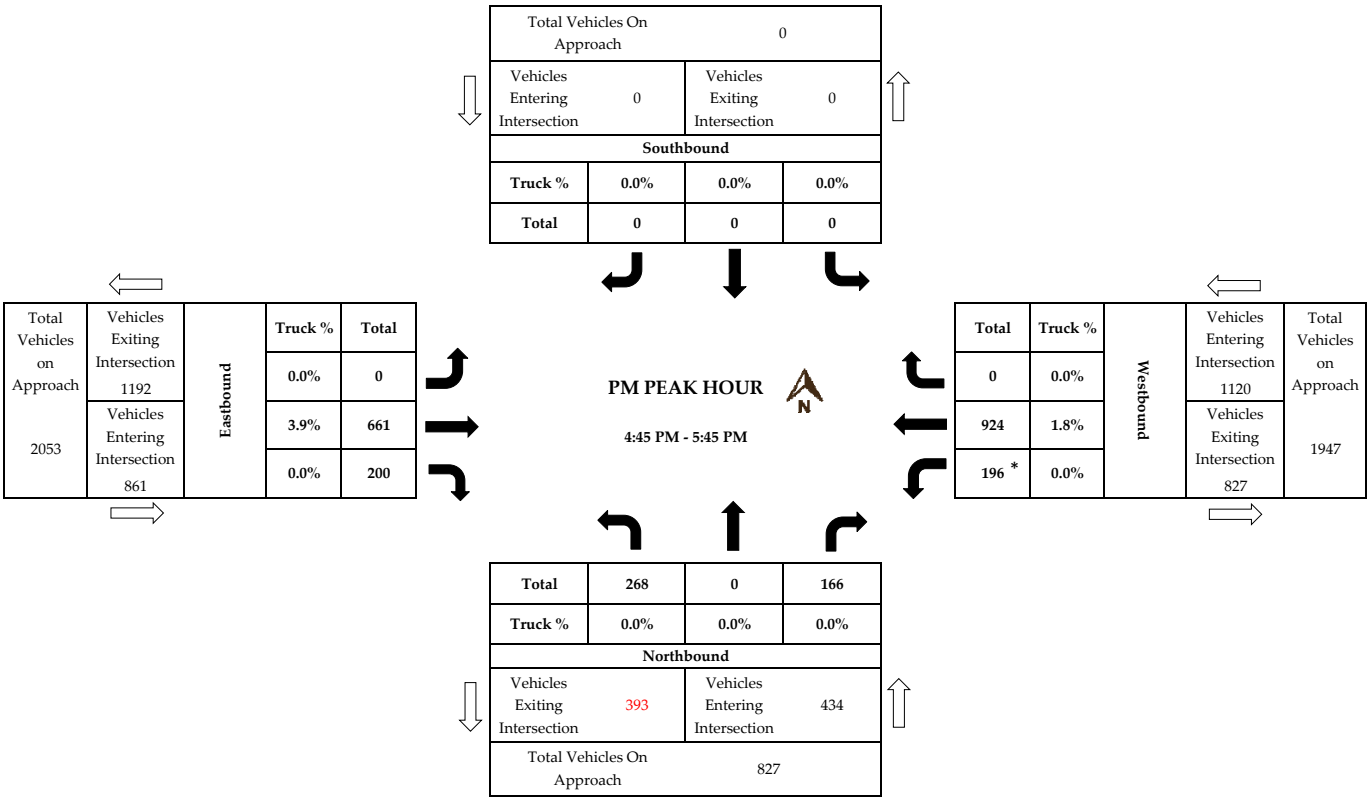
PEAK HOUR DATA

Major Street: Middlebrook Pike (EB and WB)
Minor Street: Lonas Drive (NB) / Private Driveway (SB)
Traffic Control: Traffic Signal

8/24/2023 (Thursday)
Mostly Sunny and Hot / Brief Afternoon Shower
Conducted by: Ajax Engineering



* Includes 1 U-Turn Movement



** Includes 3 U-Turn Movements

TRAFFIC COUNT DATA

Major Street: Lonas Drive (SB and NB)
Minor Street: Kim Watt Drive (EB)
Traffic Control: Stop Sign on Kim Watt Drive

8/24/2023 (Thursday)
Mostly Sunny and Hot / Brief Afternoon Shower
Conducted by: Ajax Engineering

	Lonas Drive		Lonas Drive		Kim Watt Drive			
TIME	SOUTHBOUND		NORTHBOUND		EASTBOUND		VEHICLE	PEAK
BEGIN	THRU	RT	LT	THRU	LT	RT	TOTAL	HOUR
7:00 AM	37	1	0	34	8	1	81	
7:15 AM	65	4	2	61	17	0	149	
7:30 AM	80	5	0	71	25	0	181	**7:30 AM - 8:30 AM**
7:45 AM	108	7	0	58	17	0	190	
8:00 AM	139	3	0	48	19	3	212	
8:15 AM	123	6	0	55	11	0	195	
8:30 AM	110	7	0	38	9	0	164	
8:45 AM	98	6	0	47	5	0	156	
TOTAL	760	39	2	412	111	4	1328	
2:00 PM	49	6	1	46	8	0	110	
2:15 PM	58	6	2	56	4	0	126	
2:30 PM	56	7	1	53	8	2	127	
2:45 PM	67	7	1	82	5	1	163	
3:00 PM	65	9	2	59	8	0	143	
3:15 PM	78	8	0	78	3	2	169	
3:30 PM	66	8	0	81	8	0	163	
3:45 PM	92	7	1	59	7	2	168	
4:00 PM	83	12	0	71	7	0	173	
4:15 PM	74	18	0	66	5	0	163	
4:30 PM	95	11	2	59	8	0	175	
4:45 PM	72	20	1	84	13	1	191	**4:45 PM - 5:45 PM**
5:00 PM	88	23	0	111	7	0	229	
5:15 PM	72	18	0	99	16	0	205	
5:30 PM	83	20	1	98	6	0	208	
5:45 PM	77	15	0	67	10	1	170	
TOTAL	1175	195	12	1169	123	9	2683	

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

	Lonas Drive		Lonas Drive		Kim Watt Drive	
TIME	SOUTHBOUND		NORTHBOUND		EASTBOUND	
BEGIN	THRU	RT	LT	THRU	LT	RT
7:30 AM	80	5	0	71	25	0
7:45 AM	108	7	0	58	17	0
8:00 AM	139	3	0	48	19	3
8:15 AM	123	6	0	55	11	0
TOTAL	**450**	**21**	**0**	**232**	**72**	**3**
PHF	**0.81**	**0.75**	**-**	**0.82**	**0.72**	**0.25**

2023 PM Peak Hour **4:45 PM - 5:45 PM**

	Lonas Drive		Lonas Drive		Kim Watt Drive	
TIME	SOUTHBOUND		NORTHBOUND		EASTBOUND	
BEGIN	THRU	RT	LT	THRU	LT	RT
4:45 PM	72	20	1	84	13	1
5:00 PM	88	23	0	111	7	0
5:15 PM	72	18	0	99	16	0
5:30 PM	83	20	1	98	6	0
TOTAL	**315**	**81**	**2**	**392**	**42**	**1**
PHF	**0.89**	**0.88**	**0.50**	**0.88**	**0.66**	**0.25**

TRAFFIC COUNT DATA

Major Street: Lonas Drive (SB and NB) 8/24/2023 (Thursday)
Minor Street: South College Entrance (WB) Mostly Sunny and Hot / Brief Afternoon Shower
Traffic Control: Stop Control on South College Entrance Conducted by: Ajax Engineering

	Lonas Drive		South College Entrance		Lonas Drive			
TIME	SOUTHBOUND		WESTBOUND		NORTHBOUND		VEHICLE	PEAK
BEGIN	LT	THRU	LT	RT	THRU	RT	TOTAL	HOUR
7:00 AM	3	35	0	0	34	1	73	
7:15 AM	1	64	0	1	60	2	128	
7:30 AM	9	71	0	0	71	4	155	**7:30 AM - 8:30 AM**
7:45 AM	8	100	0	1	57	4	170	
8:00 AM	22	120	0	0	48	18	208	
8:15 AM	25	98	0	4	51	15	193	
8:30 AM	22	88	0	1	37	7	155	
8:45 AM	12	86	0	1	46	10	155	
TOTAL	102	662	0	8	404	61	1237	
2:00 PM	0	49	3	4	42	2	100	
2:15 PM	1	57	2	3	53	3	119	
2:30 PM	3	55	2	2	51	0	113	
2:45 PM	1	67	4	5	77	3	157	
3:00 PM	1	64	2	3	56	0	126	
3:15 PM	2	78	2	1	77	2	162	
3:30 PM	0	66	0	4	77	3	150	
3:45 PM	3	91	5	4	55	4	162	
4:00 PM	1	82	4	4	67	1	159	
4:15 PM	3	71	3	3	63	2	145	
4:30 PM	2	93	2	5	54	2	158	
4:45 PM	0	73	3	6	78	1	161	**4:45 PM - 5:45 PM**
5:00 PM	0	88	8	8	103	1	208	
5:15 PM	3	69	2	2	97	0	173	
5:30 PM	2	81	5	6	92	1	187	
5:45 PM	0	78	3	1	66	0	148	
TOTAL	22	1162	50	61	1108	25	2428	

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

	Lonas Drive		South College Entrance		Lonas Drive	
TIME	SOUTHBOUND		WESTBOUND		NORTHBOUND	
BEGIN	LT	THRU	LT	RT	THRU	RT
7:30 AM	9	71	0	0	71	4
7:45 AM	8	100	0	1	57	4
8:00 AM	22	120	0	0	48	18
8:15 AM	25	98	0	4	51	15
TOTAL	**64**	**389**	**0**	**5**	**227**	**41**
PHF	**0.64**	**0.81**	**-**	**0.31**	**0.80**	**0.57**

2023 PM Peak Hour **4:45 PM - 5:45 PM**

	Lonas Drive		South College Entrance		Lonas Drive	
TIME	SOUTHBOUND		WESTBOUND		NORTHBOUND	
BEGIN	LT	THRU	LT	RT	THRU	RT
4:45 PM	0	73	3	6	78	1
5:00 PM	0	88	8	8	103	1
5:15 PM	3	69	2	2	97	0
5:30 PM	2	81	5	6	92	1
TOTAL	**5**	**311**	**18**	**22**	**370**	**3**
PHF	**0.42**	**0.88**	**0.56**	**0.69**	**0.90**	**0.75**

APPENDIX F

VEHICLE OCCUPANCY DATA AND ITE TIME OF DAY DISTRIBUTION DATA

6. Vehicle Information

This chapter presents general vehicle characteristics, including occupancy levels, vehicle age, and popular vehicle makes and models.

6.1 Vehicle Occupancy

As presented in Table 6.1, the average vehicle occupancy for personal vehicles per trip was 1.70 persons. Of all trip purposes, trips to grade school had the highest vehicle occupancy, with two and a half persons per vehicle (2.50). Trips to college/university locations had the lowest average vehicle occupancy, with 1.02 persons per vehicle.

Table 6.2 shows a similar pattern. Home-based school trips had the highest average vehicle occupancy, while home-based work trips had the lowest.

Table 6.1: Average Vehicle Occupancy by Trip Purpose (Travel To)

Travel To:	Occupancy
School – grade	2.50
Pick up/drop off at work	2.29
Church activities	2.26
Pick up/drop off at school	2.22
Change mode of transportation	2.11
Pick up/drop off at other place	2.10
Loop trip	2.00
Social/recreational	1.99
Eat meals outside of home	1.90
Civic activities	1.78
Medical/dental	1.76
Shopping – major	1.70
Personal activities at home	1.69
Shopping – incidental	1.62
Personal business	1.51
Volunteer	1.41
Work (other than at home)	1.13
Work at home	1.11
School - university	1.02
Overall	1.70

Base: 11,522 vehicle trips.

Hourly Distribution of Entering and Exiting Vehicle Trips by Land Use			
Source: ITE *Trip Generation Manual* , 11th Edition			
Land Use Code	550		
Land Use	University/College		
Setting	General Urban/Suburban		
Time Period	Weekday		
# Data Sites	1		
	% of 24-Hour Vehicle Trips		
Time	Total	Entering	Exiting
12:00 - 1:00 AM	0.1%	0.1%	0.1%
1:00 - 2:00 AM	0.0%	0.0%	0.0%
2:00 - 3:00 AM	0.0%	0.0%	0.0%
3:00 - 4:00 AM	0.1%	0.1%	0.1%
4:00 - 5:00 AM	0.0%	0.0%	0.0%
5:00 - 6:00 AM	0.0%	0.0%	0.0%
6:00 - 7:00 AM	0.2%	0.2%	0.1%
7:00 - 8:00 AM	6.9%	12.8%	0.9%
8:00 - 9:00 AM	4.8%	7.3%	2.3%
9:00 - 10:00 AM	9.1%	11.8%	6.3%
10:00 - 11:00 AM	13.7%	16.4%	11.0%
11:00 - 12:00 PM	7.5%	7.3%	7.8%
12:00 - 1:00 PM	14.0%	11.0%	17.2%
1:00 - 2:00 PM	9.2%	8.3%	10.1%
2:00 - 3:00 PM	6.1%	3.9%	8.4%
3:00 - 4:00 PM	8.1%	5.3%	11.0%
4:00 - 5:00 PM	3.6%	3.1%	4.0%
5:00 - 6:00 PM	4.8%	4.9%	4.7%
6:00 - 7:00 PM	5.2%	5.3%	5.1%
7:00 - 8:00 PM	1.9%	0.8%	3.0%
8:00 - 9:00 PM	2.9%	0.8%	5.1%
9:00 - 10:00 PM	1.7%	0.7%	2.8%
10:00 - 11:00 PM	0.1%	0.0%	0.1%
11:00 - 12:00 AM	0.0%	0.0%	0.0%

12:00 - 1:00 AM	0.1%	0.1%	0.1%
12:15 - 1:15 AM			
12:30 - 1:30 AM			
12:45 - 1:45 AM			
1:00 - 2:00 AM	0.0%	0.0%	0.0%
1:15 - 2:15 AM			
1:30 - 2:30 AM			
1:45 - 2:45 AM			
2:00 - 3:00 AM	0.0%	0.0%	0.0%

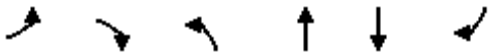
2:15 - 3:15 AM			
2:30 - 3:30 AM			
2:45 - 3:45 AM			
3:00 - 4:00 AM	0.1%	0.1%	0.1%
3:15 - 4:15 AM			
3:30 - 4:30 AM			
3:45 - 4:45 AM			
4:00 - 5:00 AM	0.0%	0.0%	0.0%
4:15 - 5:15 AM			
4:30 - 5:30 AM			
4:45 - 5:45 AM			
5:00 - 6:00 AM	0.0%	0.0%	0.0%
5:15 - 6:15 AM			
5:30 - 6:30 AM			
5:45 - 6:45 AM			
6:00 - 7:00 AM	0.2%	0.2%	0.1%
6:15 - 7:15 AM			
6:30 - 7:30 AM			
6:45 - 7:45 AM			
7:00 - 8:00 AM	6.9%	12.8%	0.9%
7:15 - 8:15 AM			
7:30 - 8:30 AM			
7:45 - 8:45 AM			
8:00 - 9:00 AM	4.8%	7.3%	2.3%
8:15 - 9:15 AM			
8:30 - 9:30 AM			
8:45 - 9:45 AM			
9:00 - 10:00 AM	9.1%	11.8%	6.3%
9:15 - 10:15 AM			
9:30 - 10:30 AM			
9:45 - 10:45 AM			
10:00 - 11:00 AM	13.7%	16.4%	11.0%
10:15 - 11:15 AM			
10:30 - 11:30 AM			
10:45 - 11:45 AM			
11:00 - 12:00 PM	7.5%	7.3%	7.8%
11:15 - 12:15 PM			
11:30 - 12:30 PM			
11:45 - 12:45 PM			
12:00 - 1:00 PM	14.0%	11.0%	17.2%
12:15 - 1:15 PM			
12:30 - 1:30 PM			
12:45 - 1:45 PM			
1:00 - 2:00 PM	9.2%	8.3%	10.1%
1:15 - 2:15 PM			
1:30 - 2:30 PM			
1:45 - 2:45 PM			

2:00 - 3:00 PM	6.1%	3.9%	8.4%
2:15 - 3:15 PM			
2:30 - 3:30 PM			
2:45 - 3:45 PM			
3:00 - 4:00 PM	8.1%	5.3%	11.0%
3:15 - 4:15 PM			
3:30 - 4:30 PM			
3:45 - 4:45 PM			
4:00 - 5:00 PM	3.6%	3.1%	4.0%
4:15 - 5:15 PM			
4:30 - 5:30 PM			
4:45 - 5:45 PM			
5:00 - 6:00 PM	4.8%	4.9%	4.7%
5:15 - 6:15 PM			
5:30 - 6:30 PM			
5:45 - 6:45 PM			
6:00 - 7:00 PM	5.2%	5.3%	5.1%
6:15 - 7:15 PM			
6:30 - 7:30 PM			
6:45 - 7:45 PM			
7:00 - 8:00 PM	1.9%	0.8%	3.0%
7:15 - 8:15 PM			
7:30 - 8:30 PM			
7:45 - 8:45 PM			
8:00 - 9:00 PM	2.9%	0.8%	5.1%
8:15 - 9:15 PM			
8:30 - 9:30 PM			
8:45 - 9:45 PM			
9:00 - 10:00 PM	1.7%	0.7%	2.8%
9:15 - 10:15 PM			
9:30 - 10:30 PM			
9:45 - 10:45 PM			
10:00 - 11:00 PM	0.1%	0.0%	0.1%
10:15 - 11:15 PM			
10:30 - 11:30 PM			
10:45 - 11:45 PM			
11:00 - 12:00 AM	0.0%	0.0%	0.0%
11:15 - 12:15 AM			
11:30 - 12:30 AM			
11:45 - 12:45 AM			

APPENDIX G

CAPACITY ANALYSES – HCM WORKSHEETS (SYNCHRO 11)

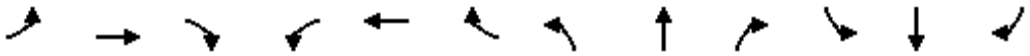
EXISTING CONDITIONS



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	72	3	0	232	450	21
Future Volume (Veh/h)	72	3	0	232	450	21
Sign Control	Stop			Free	Free	
Grade	-11%			3%	2%	
Peak Hour Factor	0.72	0.25	0.90	0.82	0.81	0.75
Hourly flow rate (vph)	100	12	0	283	556	28
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)					285	
pX, platoon unblocked	0.98	0.98	0.98			
vC, conflicting volume	712	570	584			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	697	552	567			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	73	97	100			
cM capacity (veh/h)	374	474	997			

Direction, Lane #	EB 1	EB 2	NB 1	NB 2	SB 1
Volume Total	100	12	94	189	584
Volume Left	100	0	0	0	0
Volume Right	0	12	0	0	28
cSH	374	474	997	1700	1700
Volume to Capacity	0.27	0.03	0.00	0.11	0.34
Queue Length 95th (ft)	27	2	0	0	0
Control Delay (s)	18.1	12.8	0.0	0.0	0.0
Lane LOS	C	B			
Approach Delay (s)	17.5		0.0		0.0
Approach LOS	C				

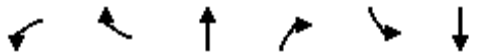
Intersection Summary			
Average Delay	2.0		
Intersection Capacity Utilization	35.6%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	1	685	319	152	519	0	134	0	170	0	0	0
Future Volume (vph)	1	685	319	152	519	0	134	0	170	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-2%			-4%			1%	
Total Lost time (s)		6.0		5.0	6.0			5.0	5.0			
Lane Util. Factor		0.95		1.00	0.95			1.00	1.00			
Frt		0.95		1.00	1.00			1.00	0.85			
Flt Protected		1.00		0.95	1.00			0.95	1.00			
Satd. Flow (prot)		3369		1805	3506			1823	1631			
Flt Permitted		0.95		0.17	1.00			0.95	1.00			
Satd. Flow (perm)		3213		319	3506			1823	1631			
Peak-hour factor, PHF	0.25	0.82	0.81	0.81	0.89	0.90	0.82	0.90	0.77	0.90	0.90	0.25
Adj. Flow (vph)	4	835	394	188	583	0	163	0	221	0	0	0
RTOR Reduction (vph)	0	35	0	0	0	0	0	0	164	0	0	0
Lane Group Flow (vph)	0	1198	0	188	583	0	0	163	57	0	0	0
Heavy Vehicles (%)	0%	4%	1%	1%	4%	0%	1%	0%	1%	0%	0%	0%
Turn Type	Perm	NA		pm+pt	NA		Split	NA	pt+ov			
Protected Phases		2		1	6		3	3	1 3	4	4	
Permitted Phases	2			6								
Actuated Green, G (s)		72.4		85.7	85.7			13.3	26.6			
Effective Green, g (s)		72.4		85.7	85.7			13.3	26.6			
Actuated g/C Ratio		0.66		0.78	0.78			0.12	0.24			
Clearance Time (s)		6.0		5.0	6.0			5.0				
Vehicle Extension (s)		2.0		2.0	2.0			2.0				
Lane Grp Cap (vph)		2114		360	2731			220	394			
v/s Ratio Prot				c0.04	0.17			c0.09	0.04			
v/s Ratio Perm		c0.37		0.37								
v/c Ratio		0.57		0.52	0.21			0.74	0.15			
Uniform Delay, d1		10.3		6.3	3.2			46.7	32.8			
Progression Factor		1.00		1.00	1.00			1.00	1.00			
Incremental Delay, d2		1.1		0.6	0.2			11.1	0.1			
Delay (s)		11.4		6.9	3.4			57.8	32.8			
Level of Service		B		A	A			E	C			
Approach Delay (s)		11.4			4.3			43.4			0.0	
Approach LOS		B			A			D			A	

Intersection Summary			
HCM 2000 Control Delay	14.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	21.0
Intersection Capacity Utilization	65.1%	ICU Level of Service	C
Analysis Period (min)	15		

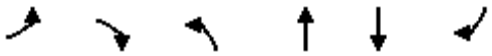
c Critical Lane Group



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	0	5	227	41	64	389
Future Volume (Veh/h)	0	5	227	41	64	389
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.90	0.31	0.80	0.56	0.64	0.80
Hourly flow rate (vph)	0	16	284	73	100	486
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						813
pX, platoon unblocked						
vC, conflicting volume	1006	320			357	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1006	320			357	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	98			92	
cM capacity (veh/h)	247	725			1213	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	16	357	586
Volume Left	0	0	100
Volume Right	16	73	0
cSH	725	1700	1213
Volume to Capacity	0.02	0.21	0.08
Queue Length 95th (ft)	2	0	7
Control Delay (s)	10.1	0.0	2.2
Lane LOS	B		A
Approach Delay (s)	10.1	0.0	2.2
Approach LOS	B		

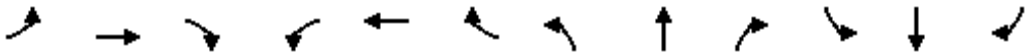
Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	51.8%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	42	1	2	392	315	81
Future Volume (Veh/h)	42	1	2	392	315	81
Sign Control	Stop			Free	Free	
Grade	-11%			3%	2%	
Peak Hour Factor	0.66	0.25	0.50	0.88	0.89	0.88
Hourly flow rate (vph)	64	4	4	445	354	92
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)					285	
pX, platoon unblocked	0.96	0.96	0.96			
vC, conflicting volume	630	400	446			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	591	350	399			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	85	99	100			
cM capacity (veh/h)	424	624	1121			

Direction, Lane #	EB 1	EB 2	NB 1	NB 2	SB 1
Volume Total	64	4	152	297	446
Volume Left	64	0	4	0	0
Volume Right	0	4	0	0	92
cSH	424	624	1121	1700	1700
Volume to Capacity	0.15	0.01	0.00	0.17	0.26
Queue Length 95th (ft)	13	0	0	0	0
Control Delay (s)	15.0	10.8	0.2	0.0	0.0
Lane LOS	C	B	A		
Approach Delay (s)	14.8		0.1		0.0
Approach LOS	B				

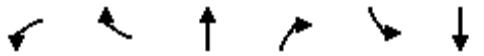
Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	31.5%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	661	200	196	924	0	268	0	166	0	0	1
Future Volume (vph)	0	661	200	196	924	0	268	0	166	0	0	1
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-2%			-4%			1%	
Total Lost time (s)		6.0		5.0	6.0			5.0	5.0		5.0	
Lane Util. Factor		0.95		1.00	0.95			1.00	1.00		1.00	
Frt		0.96		1.00	1.00			1.00	0.85		0.86	
Flt Protected		1.00		0.95	1.00			0.95	1.00		1.00	
Satd. Flow (prot)		3412		1823	3575			1841	1647		1635	
Flt Permitted		1.00		0.22	1.00			0.95	1.00		1.00	
Satd. Flow (perm)		3412		430	3575			1841	1647		1635	
Peak-hour factor, PHF	0.90	0.91	0.88	0.77	0.94	0.90	0.94	0.90	0.88	0.90	0.90	0.90
Adj. Flow (vph)	0	726	227	255	983	0	285	0	189	0	0	1
RTOR Reduction (vph)	0	23	0	0	0	0	0	0	146	0	1	0
Lane Group Flow (vph)	0	930	0	255	983	0	0	285	43	0	0	0
Heavy Vehicles (%)	0%	4%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%
Turn Type		NA		pm+pt	NA		Split	NA	pt+ov		NA	
Protected Phases		2		1	6		3	3	1 3	4	4	
Permitted Phases	2			6								
Actuated Green, G (s)		62.9		77.0	77.0			16.0	25.1		1.0	
Effective Green, g (s)		62.9		77.0	77.0			16.0	25.1		1.0	
Actuated g/C Ratio		0.57		0.70	0.70			0.15	0.23		0.01	
Clearance Time (s)		6.0		5.0	6.0			5.0			5.0	
Vehicle Extension (s)		2.0		2.0	2.0			2.0			2.0	
Lane Grp Cap (vph)		1951		416	2502			267	375		14	
v/s Ratio Prot		0.27		c0.05	0.27			c0.15	0.03		c0.00	
v/s Ratio Perm				c0.38								
v/c Ratio		0.48		0.61	0.39			1.07	0.12		0.00	
Uniform Delay, d1		13.9		8.2	6.8			47.0	33.6		54.0	
Progression Factor		1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2		0.8		1.9	0.5			74.1	0.0		0.0	
Delay (s)		14.7		10.1	7.3			121.1	33.7		54.0	
Level of Service		B		B	A			F	C		D	
Approach Delay (s)		14.7			7.9			86.2			54.0	
Approach LOS		B			A			F			D	

Intersection Summary			
HCM 2000 Control Delay	24.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	21.0
Intersection Capacity Utilization	85.9%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

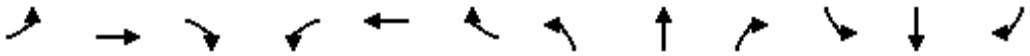


Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	18	22	370	3	5	311
Future Volume (Veh/h)	18	22	370	3	5	311
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.56	0.69	0.90	0.75	0.42	0.90
Hourly flow rate (vph)	32	32	411	4	12	346
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						813
pX, platoon unblocked						
vC, conflicting volume	783	413			415	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	783	413			415	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	91	95			99	
cM capacity (veh/h)	361	643			1155	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	64	415	358
Volume Left	32	0	12
Volume Right	32	4	0
cSH	463	1700	1155
Volume to Capacity	0.14	0.24	0.01
Queue Length 95th (ft)	12	0	1
Control Delay (s)	14.0	0.0	0.4
Lane LOS	B		A
Approach Delay (s)	14.0	0.0	0.4
Approach LOS	B		

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	30.4%	ICU Level of Service	A
Analysis Period (min)	15		

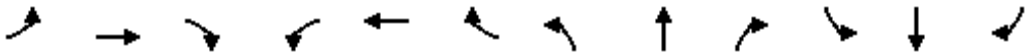
PROJECTED CONDITIONS (WITHOUT THE PROJECT)



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	1	699	349	166	529	0	143	0	181	0	0	0
Future Volume (vph)	1	699	349	166	529	0	143	0	181	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-2%			-4%			1%	
Total Lost time (s)		6.0		5.0	6.0			5.0	5.0			
Lane Util. Factor		0.95		1.00	0.95			1.00	1.00			
Frt		0.95		1.00	1.00			1.00	0.85			
Flt Protected		1.00		0.95	1.00			0.95	1.00			
Satd. Flow (prot)		3362		1805	3506			1823	1631			
Flt Permitted		0.95		0.15	1.00			0.95	1.00			
Satd. Flow (perm)		3207		285	3506			1823	1631			
Peak-hour factor, PHF	0.25	0.82	0.81	0.81	0.89	0.90	0.82	0.90	0.77	0.90	0.90	0.25
Adj. Flow (vph)	4	852	431	205	594	0	174	0	235	0	0	0
RTOR Reduction (vph)	0	41	0	0	0	0	0	0	156	0	0	0
Lane Group Flow (vph)	0	1246	0	205	594	0	0	174	79	0	0	0
Heavy Vehicles (%)	0%	4%	1%	1%	4%	0%	1%	0%	1%	0%	0%	0%
Turn Type	Perm	NA		pm+pt	NA		Split	NA	pt+ov			
Protected Phases		2		1	6		3	3	1 3	4	4	
Permitted Phases	2			6								
Actuated Green, G (s)		70.5		85.3	85.3			13.7	28.5			
Effective Green, g (s)		70.5		85.3	85.3			13.7	28.5			
Actuated g/C Ratio		0.64		0.78	0.78			0.12	0.26			
Clearance Time (s)		6.0		5.0	6.0			5.0				
Vehicle Extension (s)		2.0		2.0	2.0			2.0				
Lane Grp Cap (vph)		2055		356	2718			227	422			
v/s Ratio Prot				c0.05	0.17			c0.10	0.05			
v/s Ratio Perm		c0.39		0.39								
v/c Ratio		0.61		0.58	0.22			0.77	0.19			
Uniform Delay, d1		11.6		7.9	3.3			46.6	31.7			
Progression Factor		1.00		1.00	1.00			1.00	1.00			
Incremental Delay, d2		1.3		1.4	0.2			13.0	0.1			
Delay (s)		12.9		9.3	3.5			59.6	31.8			
Level of Service		B		A	A			E	C			
Approach Delay (s)		12.9			5.0			43.6			0.0	
Approach LOS		B			A			D			A	

Intersection Summary			
HCM 2000 Control Delay	15.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	21.0
Intersection Capacity Utilization	67.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

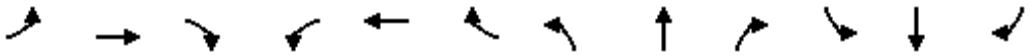


Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	674	216	211	942	0	287	0	178	0	0	1
Future Volume (vph)	0	674	216	211	942	0	287	0	178	0	0	1
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-2%			-4%			1%	
Total Lost time (s)		6.0		5.0	6.0			5.0	5.0		5.0	
Lane Util. Factor		0.95		1.00	0.95			1.00	1.00		1.00	
Frt		0.96		1.00	1.00			1.00	0.85		0.86	
Flt Protected		1.00		0.95	1.00			0.95	1.00		1.00	
Satd. Flow (prot)		3408		1823	3575			1841	1647		1635	
Flt Permitted		1.00		0.21	1.00			0.95	1.00		1.00	
Satd. Flow (perm)		3408		408	3575			1841	1647		1635	
Peak-hour factor, PHF	0.90	0.91	0.88	0.77	0.94	0.90	0.94	0.90	0.88	0.90	0.90	0.90
Adj. Flow (vph)	0	741	245	274	1002	0	305	0	202	0	0	1
RTOR Reduction (vph)	0	25	0	0	0	0	0	0	155	0	1	0
Lane Group Flow (vph)	0	961	0	274	1002	0	0	305	47	0	0	0
Heavy Vehicles (%)	0%	4%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%
Turn Type		NA		pm+pt	NA		Split	NA	pt+ov		NA	
Protected Phases		2		1	6		3	3	1 3	4	4	
Permitted Phases	2			6								
Actuated Green, G (s)		62.6		77.0	77.0			16.0	25.4		1.0	
Effective Green, g (s)		62.6		77.0	77.0			16.0	25.4		1.0	
Actuated g/C Ratio		0.57		0.70	0.70			0.15	0.23		0.01	
Clearance Time (s)		6.0		5.0	6.0			5.0			5.0	
Vehicle Extension (s)		2.0		2.0	2.0			2.0			2.0	
Lane Grp Cap (vph)		1939		406	2502			267	380		14	
v/s Ratio Prot		0.28		c0.06	0.28			c0.17	0.03		c0.00	
v/s Ratio Perm				c0.41								
v/c Ratio		0.50		0.67	0.40			1.14	0.12		0.00	
Uniform Delay, d1		14.2		8.8	6.9			47.0	33.5		54.0	
Progression Factor		1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2		0.9		3.5	0.5			99.0	0.1		0.0	
Delay (s)		15.1		12.3	7.4			146.0	33.5		54.0	
Level of Service		B		B	A			F	C		D	
Approach Delay (s)		15.1			8.4			101.2			54.0	
Approach LOS		B			A			F			D	

Intersection Summary			
HCM 2000 Control Delay	27.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	21.0
Intersection Capacity Utilization	88.3%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

PROJECTED CONDITIONS (WITH THE PROJECT)



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	1	695	335	184	525	0	154	0	198	0	0	0
Future Volume (vph)	1	695	335	184	525	0	154	0	198	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-2%			-4%			1%	
Total Lost time (s)		6.0		5.0	6.0			5.0	5.0			
Lane Util. Factor		0.95		1.00	0.95			1.00	1.00			
Frt		0.95		1.00	1.00			1.00	0.85			
Flt Protected		1.00		0.95	1.00			0.95	1.00			
Satd. Flow (prot)		3366		1805	3506			1823	1631			
Flt Permitted		0.95		0.15	1.00			0.95	1.00			
Satd. Flow (perm)		3210		286	3506			1823	1631			
Peak-hour factor, PHF	0.25	0.82	0.81	0.81	0.89	0.90	0.82	0.90	0.77	0.90	0.90	0.25
Adj. Flow (vph)	4	848	414	227	590	0	188	0	257	0	0	0
RTOR Reduction (vph)	0	40	0	0	0	0	0	0	154	0	0	0
Lane Group Flow (vph)	0	1226	0	227	590	0	0	188	103	0	0	0
Heavy Vehicles (%)	0%	4%	1%	1%	4%	0%	1%	0%	1%	0%	0%	0%
Turn Type	Perm	NA		pm+pt	NA		Split	NA	pt+ov			
Protected Phases		2		1	6		3	3	1 3	4	4	
Permitted Phases	2			6								
Actuated Green, G (s)		68.8		84.7	84.7			14.3	30.2			
Effective Green, g (s)		68.8		84.7	84.7			14.3	30.2			
Actuated g/C Ratio		0.63		0.77	0.77			0.13	0.27			
Clearance Time (s)		6.0		5.0	6.0			5.0				
Vehicle Extension (s)		2.0		2.0	2.0			2.0				
Lane Grp Cap (vph)		2007		370	2699			236	447			
v/s Ratio Prot				c0.06	0.17			c0.10	0.06			
v/s Ratio Perm		0.38		c0.41								
v/c Ratio		0.61		0.61	0.22			0.80	0.23			
Uniform Delay, d1		12.5		8.7	3.5			46.4	30.9			
Progression Factor		1.00		1.00	1.00			1.00	1.00			
Incremental Delay, d2		1.4		2.1	0.2			15.8	0.1			
Delay (s)		13.9		10.8	3.7			62.2	31.0			
Level of Service		B		B	A			E	C			
Approach Delay (s)		13.9			5.7			44.2			0.0	
Approach LOS		B			A			D			A	

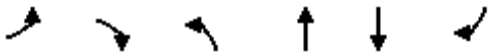
Intersection Summary			
HCM 2000 Control Delay	16.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	21.0
Intersection Capacity Utilization	67.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	986	70	0	676	0	44
Future Volume (Veh/h)	986	70	0	676	0	44
Sign Control	Free			Free	Stop	
Grade	-2%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1072	76	0	735	0	48
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				204		
pX, platoon unblocked					0.96	
vC, conflicting volume			1148		1478	574
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1148		1409	574
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	90
cM capacity (veh/h)			604		126	467

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	715	433	368	368	48
Volume Left	0	0	0	0	0
Volume Right	0	76	0	0	48
cSH	1700	1700	1700	1700	467
Volume to Capacity	0.42	0.25	0.22	0.22	0.10
Queue Length 95th (ft)	0	0	0	0	9
Control Delay (s)	0.0	0.0	0.0	0.0	13.6
Lane LOS					B
Approach Delay (s)	0.0		0.0		13.6
Approach LOS					B

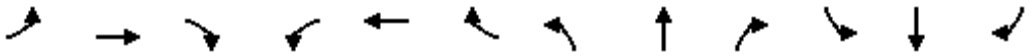
Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	39.5%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	48	70	65	305	491	28
Future Volume (Veh/h)	48	70	65	305	491	28
Sign Control	Stop			Free	Free	
Grade	0%			-4%	2%	
Peak Hour Factor	0.90	0.90	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	53	78	71	332	534	30
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)					192	
pX, platoon unblocked	0.97	0.97	0.97			
vC, conflicting volume	857	549	564			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	840	523	539			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	81	84	93			
cM capacity (veh/h)	279	490	1012			

Direction, Lane #	EB 1	NB 1	NB 2	SB 1
Volume Total	131	182	221	564
Volume Left	53	71	0	0
Volume Right	78	0	0	30
cSH	375	1012	1700	1700
Volume to Capacity	0.35	0.07	0.13	0.33
Queue Length 95th (ft)	38	6	0	0
Control Delay (s)	19.6	3.9	0.0	0.0
Lane LOS	C	A		
Approach Delay (s)	19.6	1.7		0.0
Approach LOS	C			

Intersection Summary			
Average Delay	3.0		
Intersection Capacity Utilization	54.8%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	669	208	227	939	0	297	0	195	0	0	1
Future Volume (vph)	0	669	208	227	939	0	297	0	195	0	0	1
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-2%			-4%			1%	
Total Lost time (s)		6.0		5.0	6.0			5.0	5.0		5.0	
Lane Util. Factor		0.95		1.00	0.95			1.00	1.00		1.00	
Frt		0.96		1.00	1.00			1.00	0.85		0.86	
Flt Protected		1.00		0.95	1.00			0.95	1.00		1.00	
Satd. Flow (prot)		3410		1823	3575			1841	1647		1635	
Flt Permitted		1.00		0.22	1.00			0.95	1.00		1.00	
Satd. Flow (perm)		3410		414	3575			1841	1647		1635	
Peak-hour factor, PHF	0.90	0.91	0.88	0.77	0.94	0.90	0.94	0.90	0.88	0.90	0.90	0.90
Adj. Flow (vph)	0	735	236	295	999	0	316	0	222	0	0	1
RTOR Reduction (vph)	0	24	0	0	0	0	0	0	170	0	1	0
Lane Group Flow (vph)	0	947	0	295	999	0	0	316	52	0	0	0
Heavy Vehicles (%)	0%	4%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%
Turn Type		NA		pm+pt	NA		Split	NA	pt+ov		NA	
Protected Phases		2		1	6		3	3	1 3	4	4	
Permitted Phases	2			6								
Actuated Green, G (s)		62.0		77.0	77.0			16.0	26.0		1.0	
Effective Green, g (s)		62.0		77.0	77.0			16.0	26.0		1.0	
Actuated g/C Ratio		0.56		0.70	0.70			0.15	0.24		0.01	
Clearance Time (s)		6.0		5.0	6.0			5.0			5.0	
Vehicle Extension (s)		2.0		2.0	2.0			2.0			2.0	
Lane Grp Cap (vph)		1922		417	2502			267	389		14	
v/s Ratio Prot		0.28		c0.06	0.28			c0.17	0.03		c0.00	
v/s Ratio Perm				c0.43								
v/c Ratio		0.49		0.71	0.40			1.18	0.13		0.00	
Uniform Delay, d1		14.5		9.0	6.9			47.0	33.1		54.0	
Progression Factor		1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2		0.9		4.4	0.5			114.1	0.1		0.0	
Delay (s)		15.4		13.4	7.3			161.1	33.2		54.0	
Level of Service		B		B	A			F	C		D	
Approach Delay (s)		15.4			8.7			108.3			54.0	
Approach LOS		B			A			F			D	

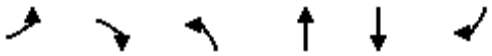
Intersection Summary			
HCM 2000 Control Delay	30.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	21.0
Intersection Capacity Utilization	88.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	844	52	0	0	0	33
Future Volume (Veh/h)	844	52	0	0	0	33
Sign Control	Free			Free	Stop	
Grade	-2%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	917	57	0	0	0	36
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				204		
pX, platoon unblocked						
vC, conflicting volume			974		946	487
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			974		946	487
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	93
cM capacity (veh/h)			704		264	532

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	611	363	0	0	36
Volume Left	0	0	0	0	0
Volume Right	0	57	0	0	36
cSH	1700	1700	1700	1700	532
Volume to Capacity	0.36	0.21	0.00	0.22	0.07
Queue Length 95th (ft)	0	0	0	0	5
Control Delay (s)	0.0	0.0	0.0	0.0	12.3
Lane LOS					B
Approach Delay (s)	0.0		0.0		12.3
Approach LOS					B

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	35.0%	ICU Level of Service	A
Analysis Period (min)	15		

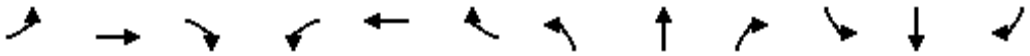


Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	42	61	57	450	408	27
Future Volume (Veh/h)	42	61	57	450	408	27
Sign Control	Stop			Free	Free	
Grade	0%			-4%	2%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	46	66	62	489	443	29
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)					192	
pX, platoon unblocked	0.95	0.95	0.95			
vC, conflicting volume	826	458	472			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	789	400	415			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	85	88	94			
cM capacity (veh/h)	297	574	1094			

Direction, Lane #	EB 1	NB 1	NB 2	SB 1
Volume Total	112	225	326	472
Volume Left	46	62	0	0
Volume Right	66	0	0	29
cSH	415	1094	1700	1700
Volume to Capacity	0.27	0.06	0.19	0.28
Queue Length 95th (ft)	27	4	0	0
Control Delay (s)	16.9	2.7	0.0	0.0
Lane LOS	C	A		
Approach Delay (s)	16.9	1.1		0.0
Approach LOS	C			

Intersection Summary			
Average Delay	2.2		
Intersection Capacity Utilization	53.3%	ICU Level of Service	A
Analysis Period (min)	15		

PROJECTED CONDITIONS (WITH THE PROJECT) – REVISED SIGNAL TIMING



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	669	208	227	939	0	297	0	195	0	0	1
Future Volume (vph)	0	669	208	227	939	0	297	0	195	0	0	1
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-2%			-4%			1%	
Total Lost time (s)		6.0		5.0	6.0			5.0	5.0		5.0	
Lane Util. Factor		0.95		1.00	0.95			1.00	1.00		1.00	
Frt		0.96		1.00	1.00			1.00	0.85		0.86	
Flt Protected		1.00		0.95	1.00			0.95	1.00		1.00	
Satd. Flow (prot)		3410		1823	3575			1841	1647		1635	
Flt Permitted		1.00		0.18	1.00			0.95	1.00		1.00	
Satd. Flow (perm)		3410		354	3575			1841	1647		1635	
Peak-hour factor, PHF	0.90	0.91	0.88	0.77	0.94	0.90	0.94	0.90	0.88	0.90	0.90	0.90
Adj. Flow (vph)	0	735	236	295	999	0	316	0	222	0	0	1
RTOR Reduction (vph)	0	25	0	0	0	0	0	0	148	0	1	0
Lane Group Flow (vph)	0	946	0	295	999	0	0	316	74	0	0	0
Heavy Vehicles (%)	0%	4%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%
Turn Type		NA		pm+pt	NA		Split	NA	pt+ov		NA	
Protected Phases		2		1	6		3	3	1 3	4	4	
Permitted Phases	2			6								
Actuated Green, G (s)		52.8		70.8	70.8			22.2	35.2		1.0	
Effective Green, g (s)		52.8		70.8	70.8			22.2	35.2		1.0	
Actuated g/C Ratio		0.48		0.64	0.64			0.20	0.32		0.01	
Clearance Time (s)		6.0		5.0	6.0			5.0			5.0	
Vehicle Extension (s)		2.0		2.0	2.0			2.0			2.0	
Lane Grp Cap (vph)		1636		401	2301			371	527		14	
v/s Ratio Prot		0.28		c0.09	0.28			c0.17	0.05		c0.00	
v/s Ratio Perm				c0.39								
v/c Ratio		0.58		0.74	0.43			0.85	0.14		0.00	
Uniform Delay, d1		20.6		12.8	9.7			42.3	26.6		54.0	
Progression Factor		1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2		1.5		5.9	0.6			16.3	0.0		0.0	
Delay (s)		22.1		18.7	10.3			58.7	26.7		54.0	
Level of Service		C		B	B			E	C		D	
Approach Delay (s)		22.1			12.2			45.5			54.0	
Approach LOS		C			B			D			D	

Intersection Summary			
HCM 2000 Control Delay	22.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	21.0
Intersection Capacity Utilization	88.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

APPENDIX H

CITY OF KNOXVILLE TRAFFIC SIGNAL INFORMATION

Intersection Name : Middlebrook Pike & Lonas Drive

Basic Timing (seconds)	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
Min Green	5	15	5	6		15		
Gap / Extension	2	2	2	1		2		
Max 1	25	55	30	20		55		
Max 2	30	60	35	25		60		
Yellow Clearance	4	4.5	4	4		4.5		
Red Clearance	1	1	1	1		1		
Walk								
Pedestrian Clearance								
Max Recall		X				X		
Active (Enable) Phases	X	X	X	X		X		
Flashing Yellow Arrow								
Overlaps (1-4)								

Coordination Timing/(seconds)

Split #	Coord. Phase	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
Split 1	2	17	61	21	11		78	21	11
Split 2	2	15	39	25	11		54	25	11
Split 3	2	20	47	32	11		67	32	11
Split 4									
Split 5									
Split 6									

Pattern Table					Lead / Lag		Fixed / Floating	Fixed
Pattern#	Cycle	Offset	Split	Seq. #	Phase #		End / Beginning	Beginning
1	110	76	1	1			Intersection ID#	
2	90	63	2	1			I/P Address	
3	110	61	3	1			Hub Address	
4							Radio Address	
5							Comm. Type	
6							Detection	Loops

Day Plan Events

Day Plan	HH:MM	Pattern	Day Plan	HH:MM	Pattern
1	0:00	FREE	2	0:00	FREE
	6:00	1		5:00	2
	9:00	2		22:00	FREE
	15:00	3			
	19:00	FREE			

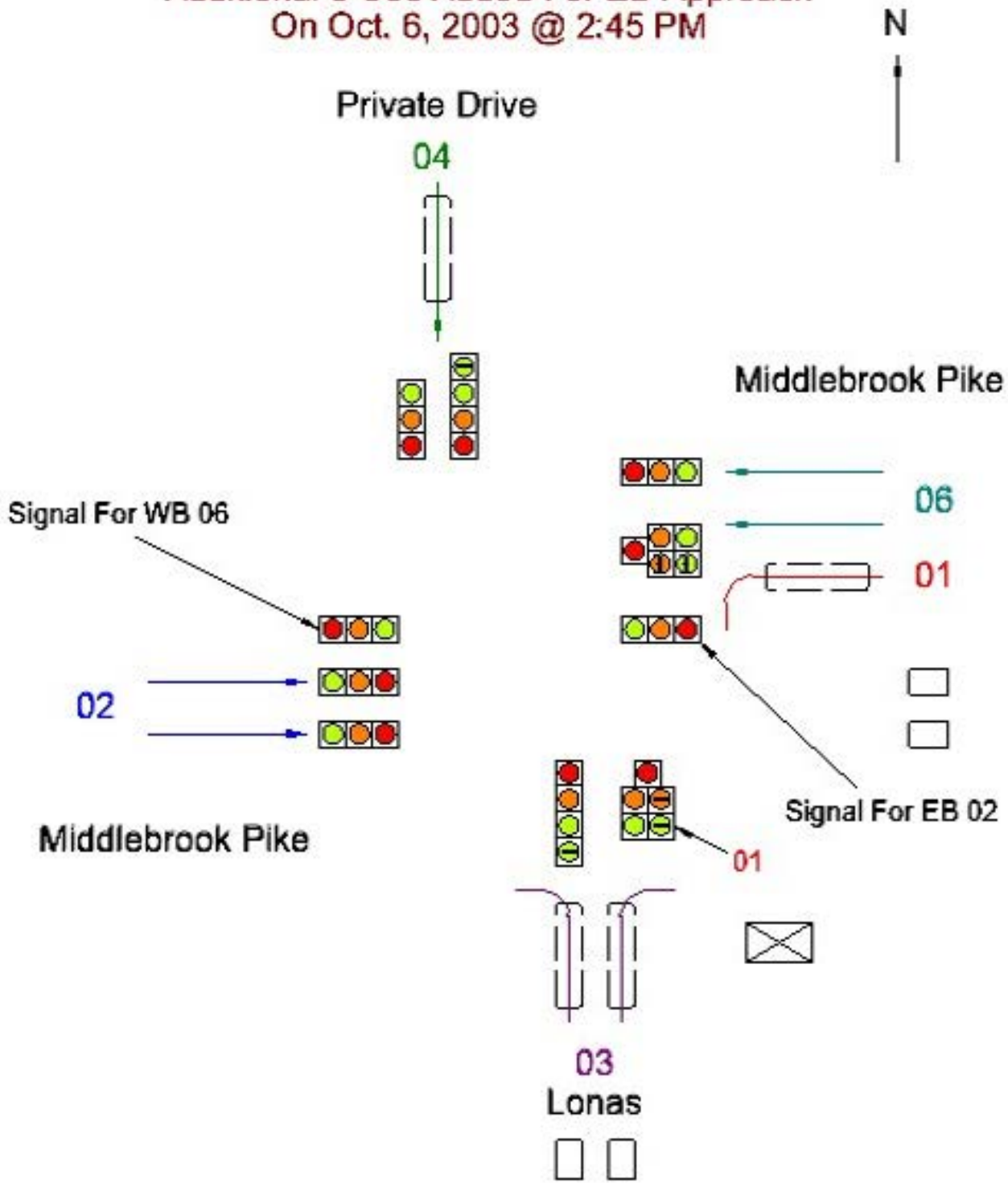
Year Plan Scheduler

Plan	Month of Year: 01 - 12	Day of Month: 01 - 31	Plan
M - F	01-12	01-31	1
SAT	01-12	01-31	2
SUN	01-12	01-31	2

Notes :

Middlebrook Pk & Lonas

Additional 3-Sec Added For EB Approach
On Oct. 6, 2003 @ 2:45 PM



APPENDIX I

ITE TRIP GENERATION RATES AND PASS-BY TRIP RATES

Land Use: 945
Convenience Store/Gas Station

Description

A convenience store/gas station is a facility with a co-located convenience store and gas station. The convenience store sells grocery and other everyday items that a person may need or want as a matter of convenience. The gas station sells automotive fuels such as gasoline and diesel.

A convenience store/gas station is typically located along a major thoroughfare to optimize motorist convenience. Extended hours of operation (with many open 24 hours, 7 days a week) are common at these facilities.

The convenience store product mix typically includes pre-packaged grocery items, beverages, dairy products, snack foods, confectionary, tobacco products, over-the-counter drugs, and toiletries. A convenience store may sell alcohol, often limited to beer and wine. Coffee and pre-made sandwiches are also commonly sold at a convenience store. Made-to-order food orders are sometimes offered. Some stores offer limited seating.

The sites in this land use include both self-pump and attendant-pumped fueling positions and both pre-pay and post-pay operations.

Convenience store (Land Use 851), gasoline/service station (Land Use 944), and truck stop (Land Use 950) are related uses.

Land Use Subcategory

Multiple subcategories were added to this land use to allow for multi-variable evaluation of sites with single-variable data plots. All study sites are assigned to one of three subcategories, based on the number of vehicle fueling positions (VFP) at the site: between 2 and 8 VFP, between 9 and 15 VFP, and between 16 and 24 VFP. For each VFP range subcategory, data plots are presented with GFA as the independent variable for all time periods and trip types for which data are available. The use of both GFA and VFP (as the independent variable and land use subcategory, respectively) provides a significant improvement in the reliability of a trip generation estimate when compared to the single-variable data plots in prior editions of *Trip Generation Manual*.

Further, the study sites were also assigned to one of three other subcategories, based on the gross floor area (GFA) of the convenience store at the site: between 2,000 and 4,000 square feet, between 4,000 and 5,500 square feet, and between 5,500 and 10,000 square feet. For each GFA subcategory range, data plots are presented with VFP as the independent variable for all time periods and trip types for which data are available. The use of both VFP and GFA (as the independent variable and land use subcategory, respectively) provides a significant improvement in the reliability of a trip generation estimate when compared to the single-variable data plots in prior editions of *Trip Generation Manual*.

When analyzing the convenience store/gas station land use with each combination of GFA and VFP values as described above, the two sets of data plots will produce two estimates of site-generated trips. Both values can be considered when determining a site trip generation estimate.

Data plots are also provided for three additional independent variables: AM peak hour traffic on adjacent street, PM peak hour traffic on adjacent street, and employees. These independent variables are intended to be analyzed as single independent variables and do not have sub-categories associated with them. Within the data plots and within the ITETripGen web app, these plots are found under the land use subcategory "none."

Additional Data

ITE recognizes there are existing convenience store/gas station sites throughout North America that are larger than the sites presented in the data plots. However, the ITE database does not include any site with more than 24 VFP or any site with gross floor area greater than 10,000 square feet. Submission of trip generation data for larger sites is encouraged.

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

The sites were surveyed in the 1980s, the 1990s, the 2000s, and the 2010s in Alberta (CAN), Arkansas, California, Connecticut, Delaware, Florida, Indiana, Iowa, Kentucky, Maryland, Massachusetts, Minnesota, Nevada, New Hampshire, New Jersey, Pennsylvania, Rhode Island, South Dakota, Texas, Utah, Vermont, Washington, and Wisconsin.

Source Numbers

221, 245, 274, 288, 300, 340, 350, 351, 352, 355, 359, 385, 440, 617, 718, 810, 813, 844, 850, 853, 864, 865, 867, 869, 882, 883, 888, 904, 926, 927, 936, 938, 954, 960, 962, 977, 1004, 1024, 1025, 1027, 1052

Convenience Store/Gas Station - GFA (4-5.5k)
(945)

Vehicle Trip Ends vs: **Vehicle Fueling Positions**
On a: **Weekday**

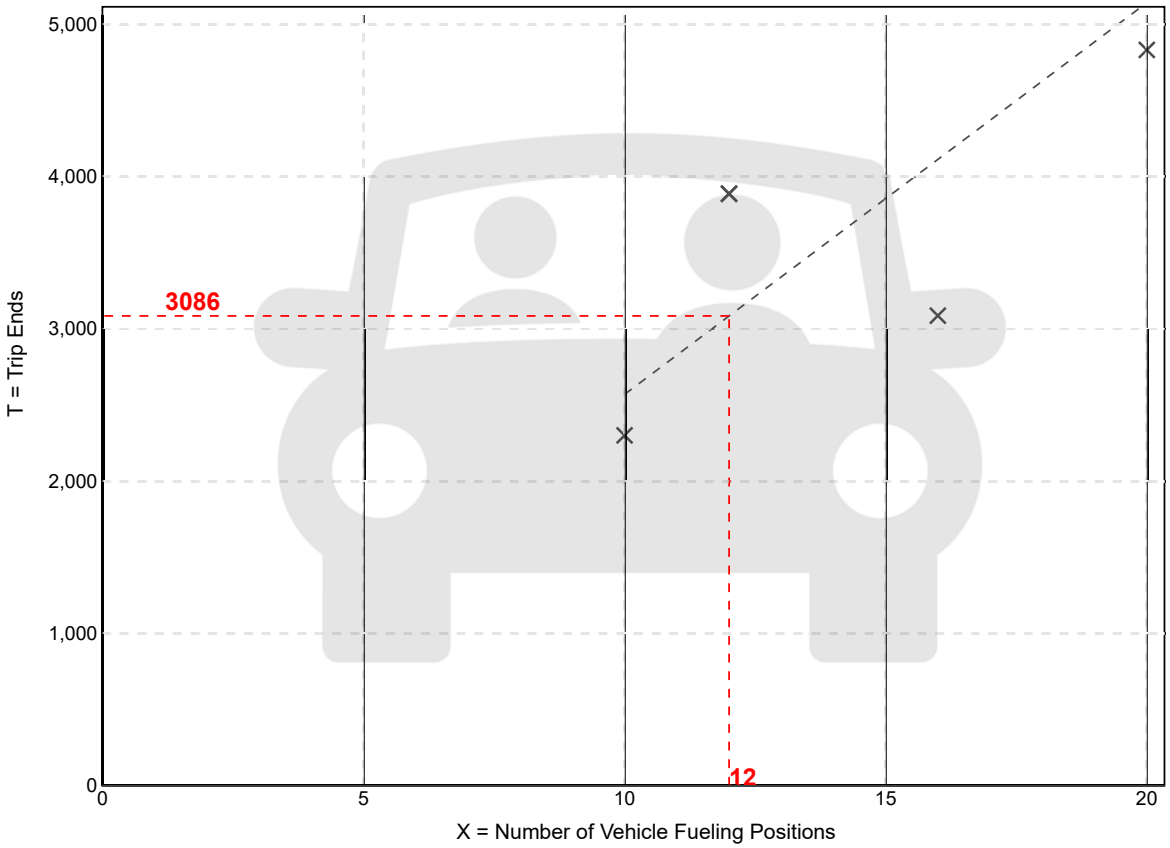
Setting/Location: **General Urban/Suburban**
Number of Studies: 5
Avg. Num. of Vehicle Fueling Positions: 14
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Vehicle Fueling Position

Average Rate	Range of Rates	Standard Deviation
257.13	193.00 - 324.17	57.53

Data Plot and Equation

Caution – Small Sample Size



Fitted Curve Equation: Not Given

R^2= ****

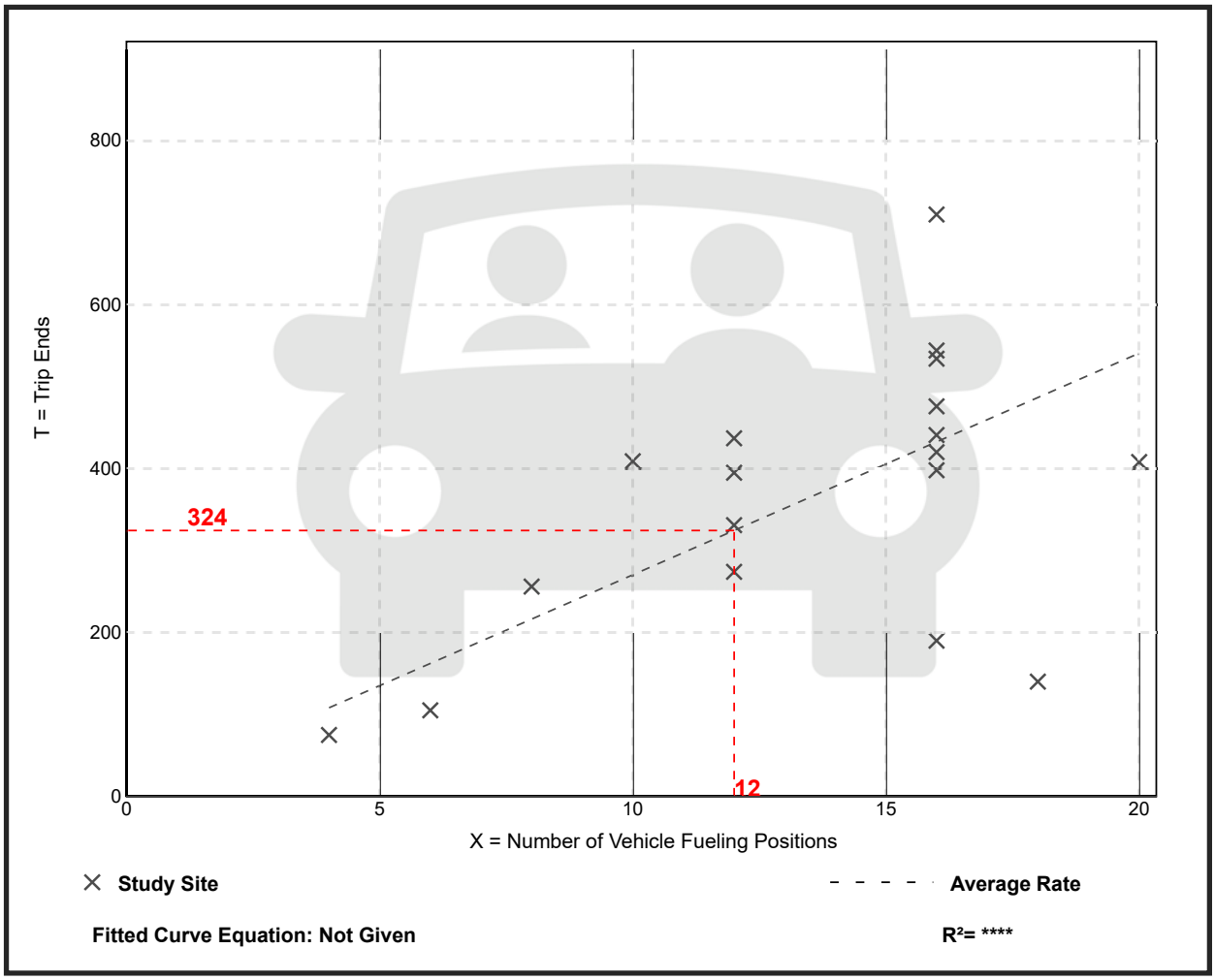
Convenience Store/Gas Station - GFA (4-5.5k)
(945)

Vehicle Trip Ends vs:	**Vehicle Fueling Positions**
On a:	**Weekday,**
	Peak Hour of Adjacent Street Traffic,
	One Hour Between 7 and 9 a.m.
Setting/Location:	**General Urban/Suburban**
Number of Studies:	18
Avg. Num. of Vehicle Fueling Positions:	13
Directional Distribution:	50% entering, 50% exiting

Vehicle Trip Generation per Vehicle Fueling Position

Average Rate	Range of Rates	Standard Deviation
27.04	7.78 - 44.38	9.88

Data Plot and Equation



Fitted Curve Equation: Not Given

R^2= **

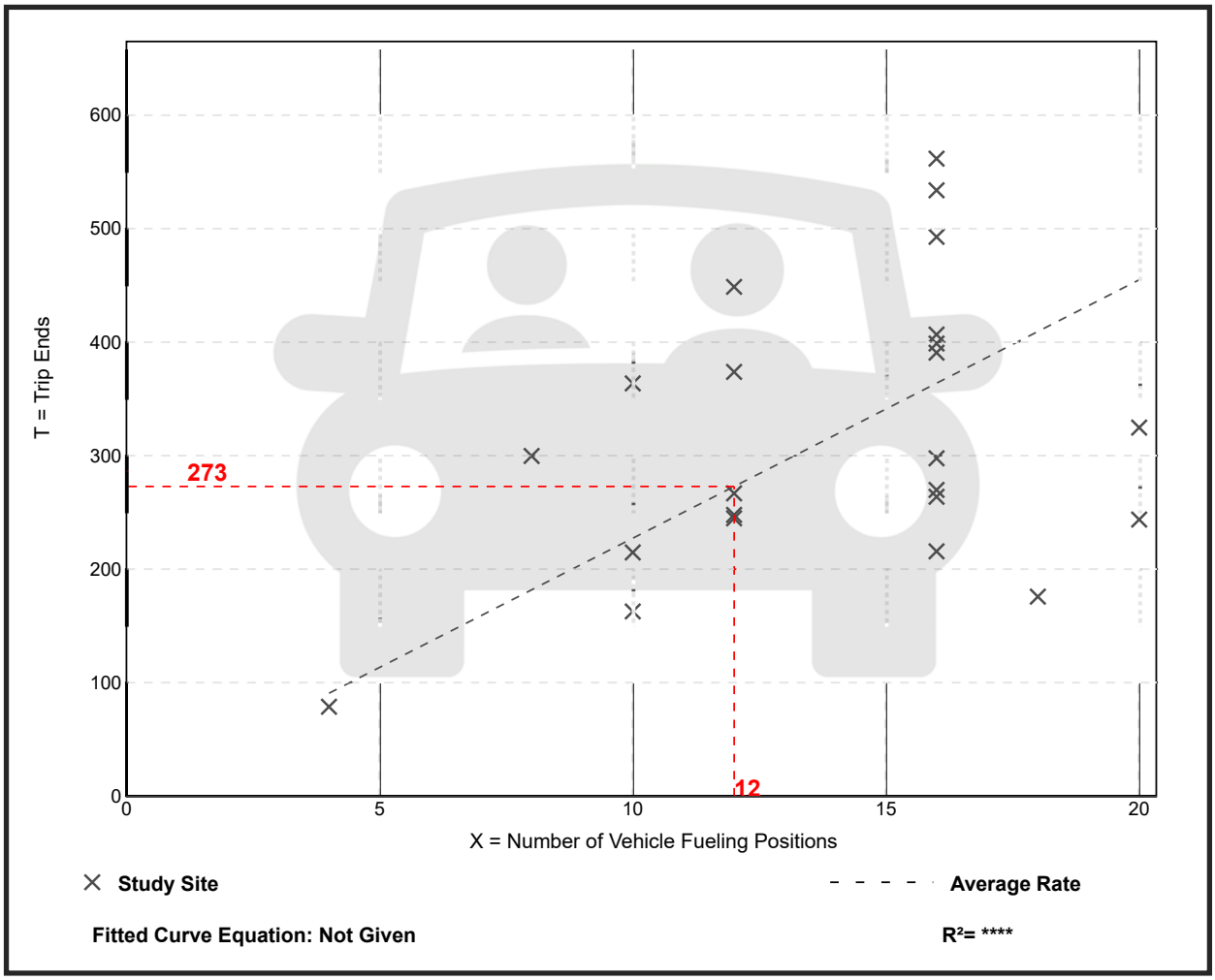
Convenience Store/Gas Station - GFA (4-5.5k)
(945)

Vehicle Trip Ends vs:	**Vehicle Fueling Positions**
On a:	**Weekday,**
	Peak Hour of Adjacent Street Traffic,
	One Hour Between 4 and 6 p.m.
Setting/Location:	**General Urban/Suburban**
Number of Studies:	23
Avg. Num. of Vehicle Fueling Positions:	14
Directional Distribution:	50% entering, 50% exiting

Vehicle Trip Generation per Vehicle Fueling Position

Average Rate	Range of Rates	Standard Deviation
22.76	9.78 - 37.50	8.49

Data Plot and Equation



Trip Gen Manual, 11th Edition • Institute of Transportation Engineers

Vehicle Pass-By Rates by Land Use

Source: ITE *Trip Generation Manual* , 11th Edition

Land Use Code	945									
Land Use	Convenience Store/Gas Station									
Setting	General Urban/Suburban									
Time Period	Weekday AM Peak Period									
# Data Sites	16 Sites with between 2 and 8 VFP					28 Sites with between 9 and 20 VFP				
Average Pass-By Rate	60% for Sites with between 2 and 8 VFP					76% for Sites with between 9 and 20 VFP				
	Pass-By Characteristics for Individual Sites									
		State or	Survey		Pass-By	Non-Pass-By Trips			Adj Street Peak	
GFA (000)	VFP	Province	Year	# Interviews	Trip (%)	Primary (%)	Diverted (%)	Total (%)	Hour Volume	Source
2	8	Maryland	1992	46	87	13	0	13	2235	25
2.1	6	Maryland	1992	26	58	23	19	42	2080	25
2.1	6	Maryland	1992	26	58	23	19	42	2080	25
2.2	8	Maryland	1992	31	47	34	19	53	1785	25
2.2	< 8	Indiana	1993	79	56	6	38	44	635	2
2.2	8	Maryland	1992	35	78	9	13	22	7080	25
2.3	6	Maryland	1992	37	32	41	27	68	2080	25
2.3	< 8	Kentucky	1993	58	64	5	31	36	1255	2
2.3	6	Maryland	1992	37	32	41	27	68	2080	25
2.4	< 8	Kentucky	1993	—	48	17	35	52	1210	2
2.6	< 8	Kentucky	1993	—	72	15	13	28	940	2
2.8	< 8	Kentucky	1993	—	54	11	35	46	1240	2
3	< 8	Indiana	1993	62	74	10	16	26	790	2
3.6	< 8	Kentucky	1993	49	67	4	29	33	1985	2
3.7	< 8	Kentucky	1993	49	66	16	18	34	990	2
4.694	12	Maryland	2000	—	72	—	—	28	2440	30
4.694	12	Maryland	2000	—	78	—	—	22	1561	30
4.694	12	Maryland	2000	—	79	—	—	21	2764	30
4.848	12	Virginia	2000	—	55	—	—	45	1398	30
5.06	12	Pennsylvania	2000	—	84	—	—	16	3219	30
5.242	12	Virginia	2000	—	74	—	—	26	1160	30
5.242	12	Virginia	2000	—	71	—	—	29	548	30
5.488	12	Delaware	2000	—	80	—	—	20	—	30

5.5	12	Pennsylvania	2000	—	85	—	—	15	2975	30
4.2	< 8	Kentucky	1993	47	62	19	19	38	1705	2
4.694	16	Maryland	2000	—	90	—	—	10	2278	30
4.694	16	Delaware	2000	—	74	—	—	26	2185	30
4.694	16	Delaware	2000	—	58	—	—	42	962	30
4.694	16	Delaware	2000	—	84	—	—	16	2956	30
4.694	16	New Jersey	2000	—	79	—	—	21	1859	30
4.694	20	Delaware	2000	—	84	—	—	16	3864	30
4.848	16	Virginia	2000	—	68	—	—	32	2106	30
4.848	16	Virginia	2000	—	85	—	—	15	2676	30
4.848	16	Virginia	2000	—	75	—	—	25	3244	30
4.848	16	Virginia	2000	—	71	—	—	29	1663	30
4.993	16	Pennsylvania	2000	—	75	—	—	25	1991	30
5.094	16	New Jersey	2000	—	86	—	—	14	1260	30
5.5	16	Pennsylvania	2000	—	82	—	—	18	1570	30
5.543	16	Pennsylvania	2000	—	84	—	—	16	1933	30
5.565	16	Pennsylvania	2000	—	77	—	—	23	2262	30
5.565	16	Pennsylvania	2000	—	68	—	—	32	2854	30
5.565	16	New Jersey	2000	—	58	—	—	42	1253	30
5.565	16	New Jersey	2000	—	79	—	—	21	1928	30
5.565	16	New Jersey	2000	---	84	---	---	16	1953	30

Vehicle Pass-By Rates by Land Use

Source: ITE *Trip Generation Manual* , 11th Edition

Land Use Code	945									
Land Use	Convenience Store/Gas Station									
Setting	General Urban/Suburban									
Time Period	Weekday PM Peak Period									
# Data Sites	12 Sites with between 2 and 8 VFP					28 Sites with between 9 and 20 VFP				
Average Pass-By Rate	56% for Sites with between 2 and 8 VFP					75% for Sites with between 9 and 20 VFP				
	Pass-By Characteristics for Individual Sites									
		State or	Survey		Pass-By	Non-Pass-By Trips			Adj Street Peak	
GFA (000)	VFP	Province	Year	# Interviews	Trip (%)	Primary (%)	Diverted (%)	Total (%)	Hour Volume	Source
2.1	8	Maryland	1992	31	52	13	35	48	1785	25
2.1	6	Maryland	1992	30	53	20	27	47	1060	25
2.2	< 8	Indiana	1993	115	48	16	36	52	820	2
2.3	< 8	Kentucky	1993	67	57	16	27	43	1954	2
2.3	6	Maryland	1992	55	40	11	49	60	2760	25
2.4	< 8	Kentucky	1993	—	58	13	29	42	2655	2
2.6	< 8	Kentucky	1993	68	67	15	18	33	950	2
2.8	< 8	Kentucky	1993	—	62	11	27	38	2875	2
3	< 8	Indiana	1993	80	65	15	20	35	1165	2
3.6	< 8	Kentucky	1993	60	56	17	27	44	2505	2
3.7	< 8	Kentucky	1993	70	61	16	23	39	2175	2
4.2	< 8	Kentucky	1993	61	58	26	16	42	2300	2
4.694	12	Maryland	2000	—	78	—	—	22	3549	30
4.694	12	Maryland	2000	—	67	—	—	33	2272	30
4.694	12	Maryland	2000	—	66	—	—	34	3514	30
4.848	12	Virginia	2000	—	71	—	—	29	2350	30
5.06	12	Pennsylvania	2000	—	91	—	—	9	4181	30
5.242	12	Virginia	2000	—	70	—	—	30	2445	30
5.242	12	Virginia	2000	—	56	—	—	44	950	30
5.488	12	Delaware	2000	—	73	—	—	27	—	30
5.5	12	Pennsylvania	2000	—	84	—	—	16	4025	30
4.694	16	Maryland	2000	—	89	—	—	11	2755	30
4.694	16	Delaware	2000	—	73	—	—	27	1858	30

4.694	16	Delaware	2000	—	59	—	—	41	1344	30
4.694	16	Delaware	2000	—	72	—	—	28	3434	30
4.694	16	New Jersey	2000	—	81	—	—	19	1734	30
4.694	20	Delaware	2000	—	76	—	—	24	1616	30
4.848	16	Virginia	2000	—	67	—	—	33	2.954	30
4.848	16	Virginia	2000	—	78	—	—	22	3086	30
4.848	16	Virginia	2000	—	83	—	—	17	4143	30
4.848	16	Virginia	2000	—	73	—	—	27	2534	30
4.993	16	Pennsylvania	2000	—	72	—	—	28	2917	30
5.094	16	New Jersey	2000	—	86	—	—	14	1730	30
5.5	16	Pennsylvania	2000	—	90	—	—	10	2616	30
5.543	16	Pennsylvania	2000	—	87	—	—	13	2363	30
5.565	16	Pennsylvania	2000	—	81	—	—	19	2770	30
5.565	16	Pennsylvania	2000	—	76	—	—	24	3362	30
5.565	16	New Jersey	2000	—	61	—	—	39	1713	30
5.565	16	New Jersey	2000	—	86	—	—	14	1721	30
5.565	16	New Jersey	2000	---	81	---	---	19	2227	30

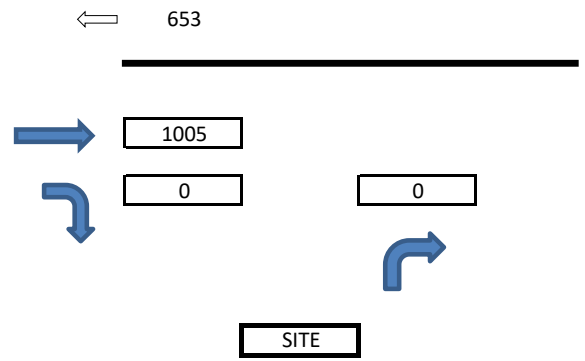
APPENDIX J

TRIP DISTRIBUTION AND ASSIGNMENT SPREADSHEETS

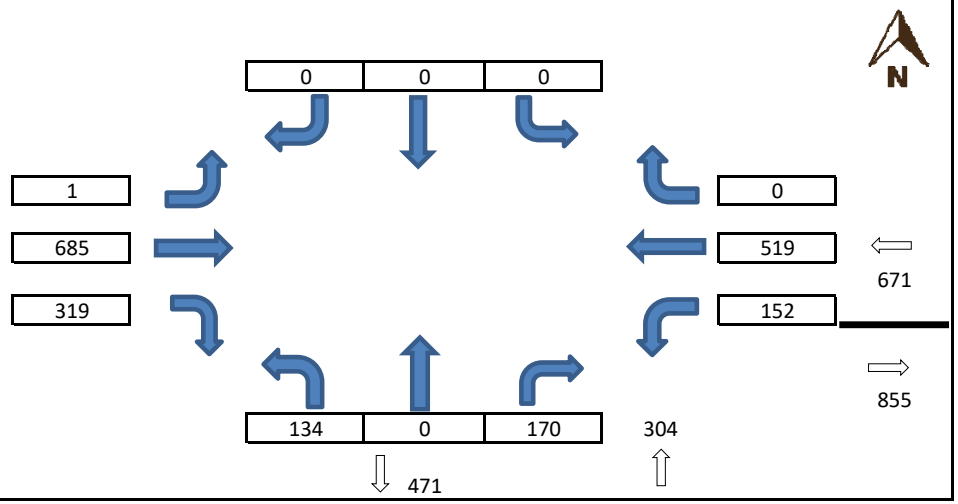
2023 AM PEAK HOUR - Peak Hour Volumes

(from traffic count)

Intersection of Middlebrook Pike at Proposed Main Entrance



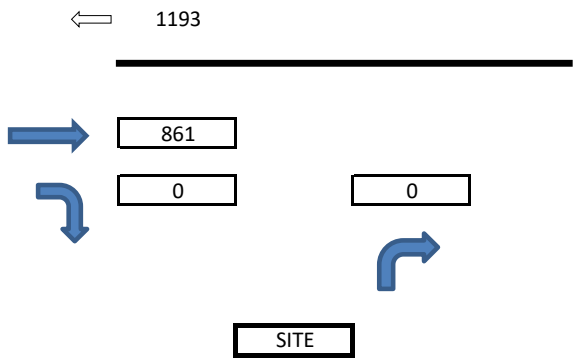
Intersection of Middlebrook Pike at Lonas Drive



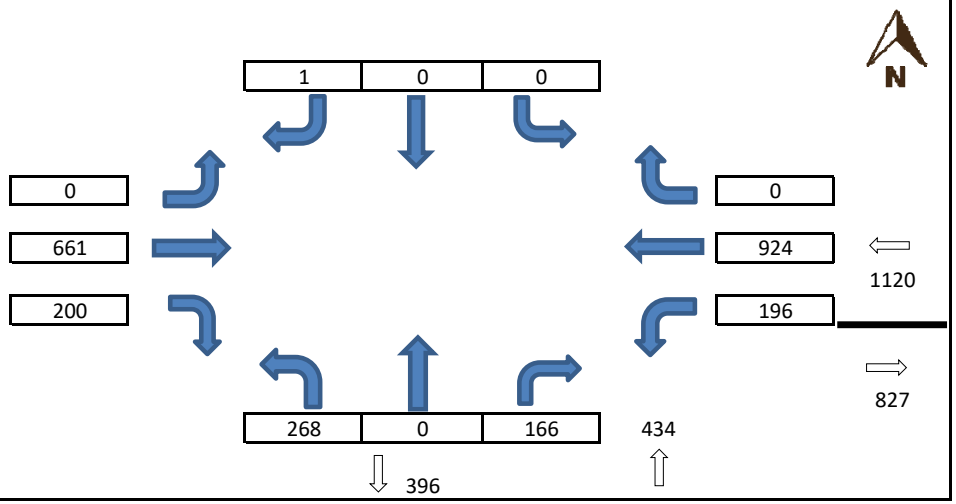
2023 PM PEAK HOUR - Peak Hour Volumes

(from traffic count)

Intersection of Middlebrook Pike at Proposed Main Entrance



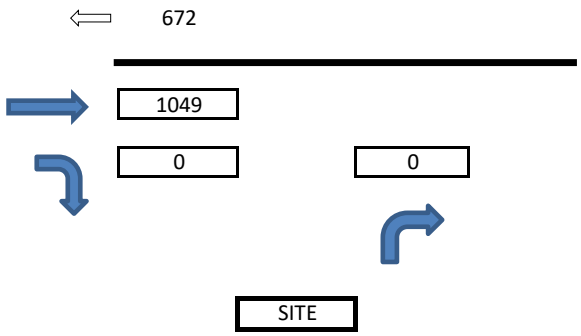
Intersection of Middlebrook Pike at Lonas Drive



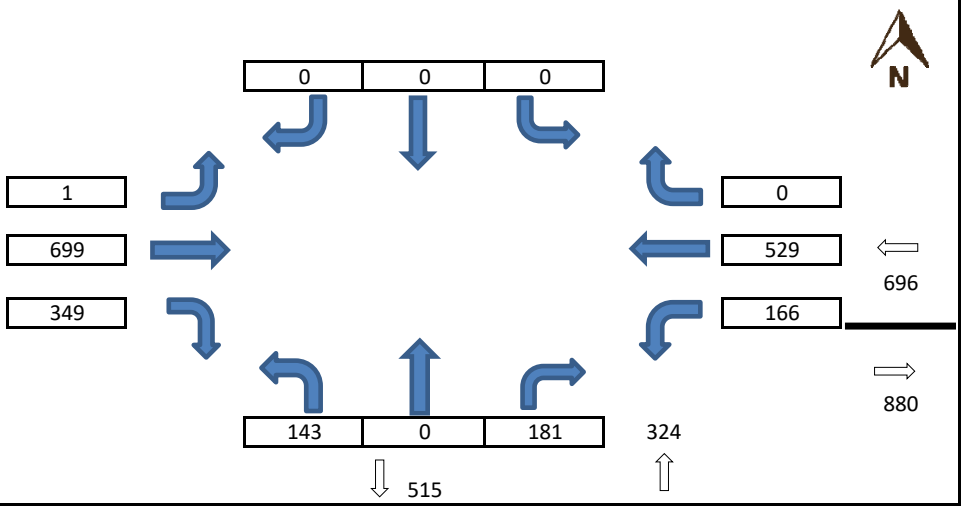
2025 AM PEAK HOUR - Peak Hour Volumes

1% annual growth of thru volumes on Middlebrook Pike for 2 years
3% annual growth of volumes on Lonas Drive for 2 years
0% annual growth to/from Private Driveway 2 years

Intersection of Middlebrook Pike at Proposed Main Entrance



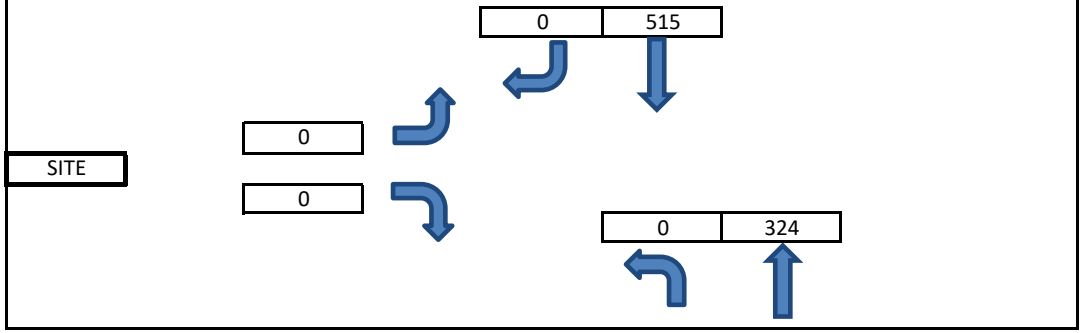
Intersection of Middlebrook Pike at Lonas Drive



Calculated Missing South College Vehicles Added:

AM Peak	Enter from West	Enter from East
	11	5
	Exit to West	Exit to East
	1	1

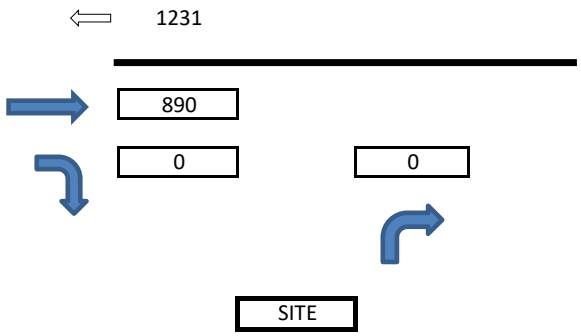
Intersection of Lonas Drive at Second Entrance



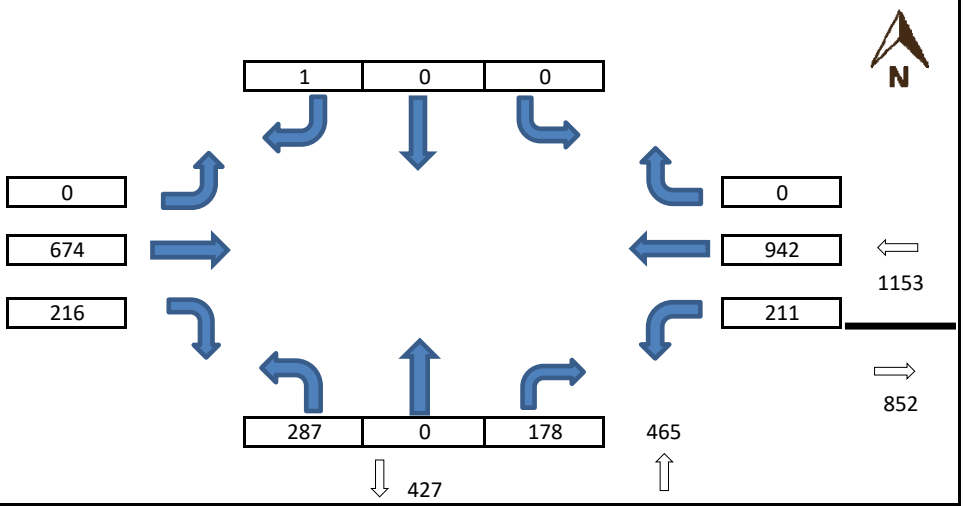
2025 PM PEAK HOUR - Peak Hour Volumes

1% annual growth of thru volumes on Middlebrook Pike for 2 years
3% annual growth of volumes on Lonas Drive for 2 years
0% annual growth to/from Private Driveway 2 years

Intersection of Middlebrook Pike at Proposed Main Entrance



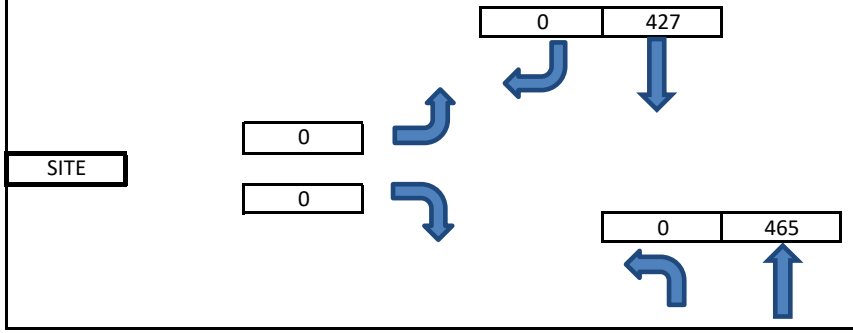
Intersection of Middlebrook Pike at Lonas Drive



Calculated Missing South College Vehicles Added:

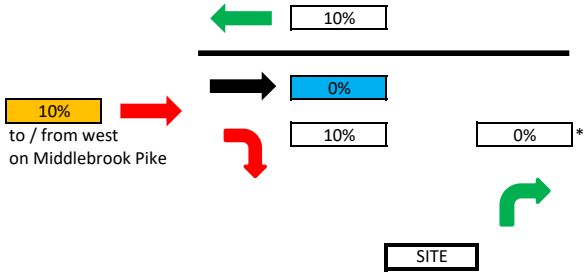
PM Peak	Enter from West	Enter from East
	4	3
	Exit to West	Exit to East
	3	2

Intersection of Lonas Drive at Second Entrance

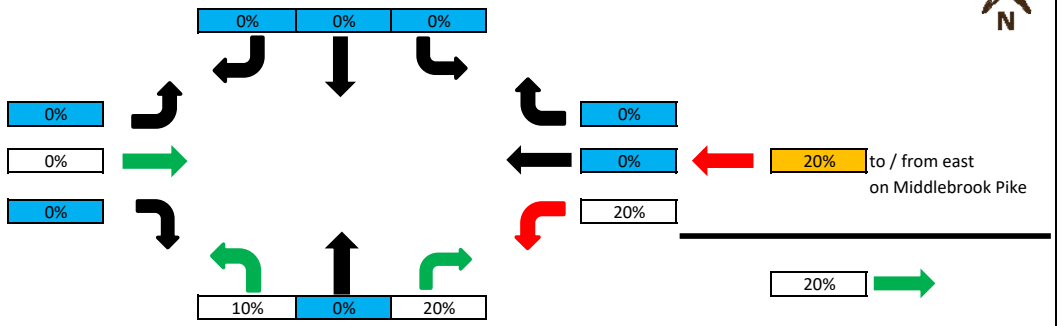


2025 AM PEAK HOUR - Trip Distribution - Primary Trips

Intersection of Middlebrook Pike at Proposed Main Entrance



Intersection of Middlebrook Pike at Lonas Drive



Entering Traffic

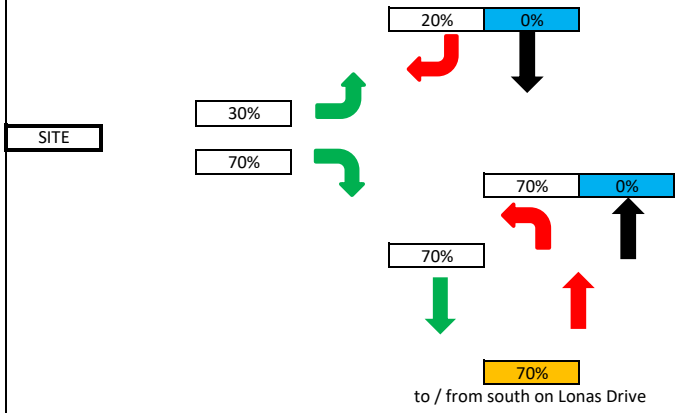
Exiting Traffic

N/A

		Check:	
	Assumed Inputted Value	Enter	Exit
	Calculated Value	100%	100%
	Assumed Zero	100%	100%

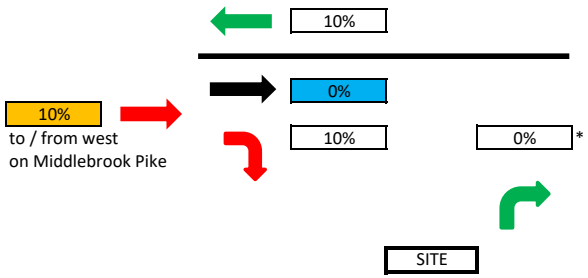
* All eastbound Middlebrook Pike primary traffic exits to the left (NB) at Second Entrance

Intersection of Lonas Drive at Second Entrance

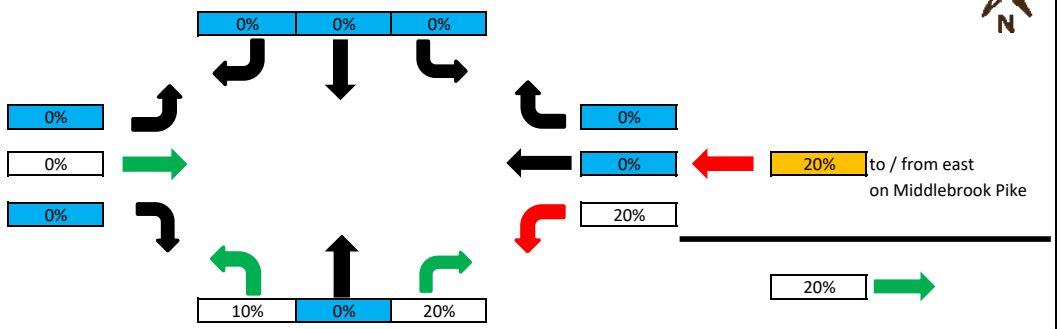


2025 PM PEAK HOUR - Trip Distribution - Primary Trips

Intersection of Middlebrook Pike at Proposed Main Entrance



Intersection of Middlebrook Pike at Lonas Drive



Entering Traffic

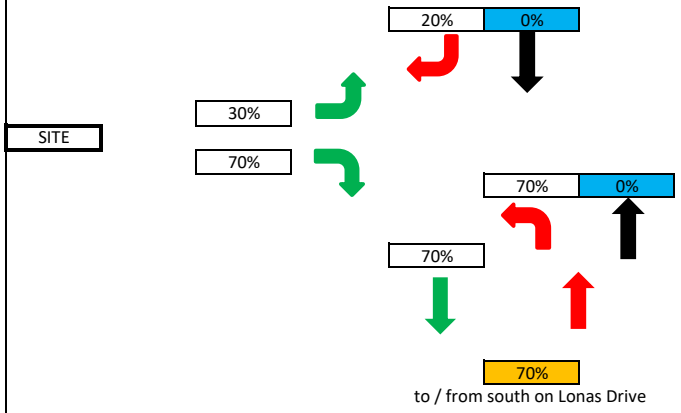
Exiting Traffic

N/A

		Check:	
	Assumed Inputted Value	Enter	Exit
	Calculated Value	100%	100%
	Assumed Zero	100%	100%

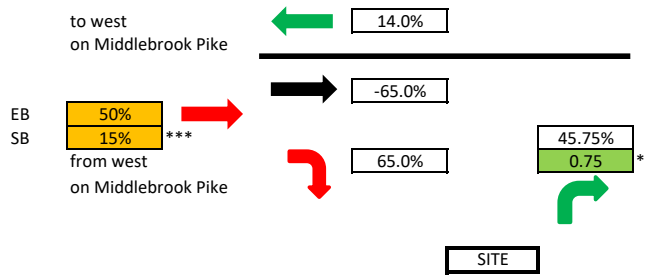
* All eastbound Middlebrook Pike primary traffic exits to the left (NB) at Second Entrance

Intersection of Lonas Drive at Second Entrance

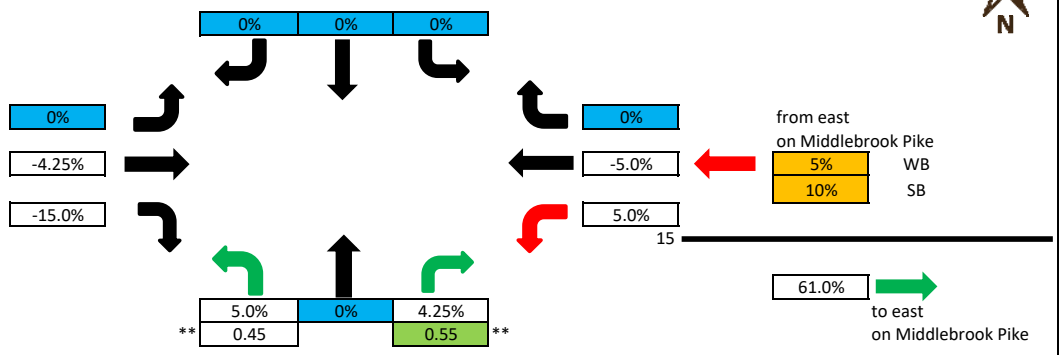


2025 AM PEAK HOUR - Trip Distribution - Pass-by Trips

Intersection of Middlebrook Pike at Proposed Main Entrance



Intersection of Middlebrook Pike at Lonas Drive



Entering Traffic

Exiting Traffic

N/A

	Assumed Inputted Value
	Inputted Assumed Split
	Calculated Value
	Assumed Zero

Check:

Enter	Exit
100%	100%
100%	100%

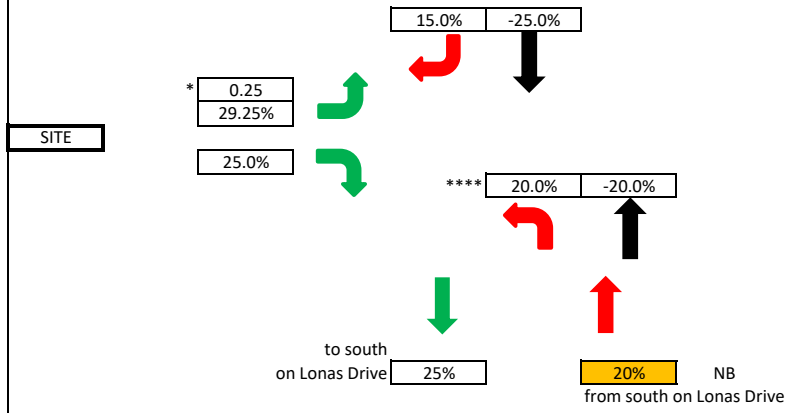
* All eastbound Middlebrook Pike pass-by traffic exits to right at Main Entrance and to the left at Second Entrance based on assumed split

** Split of left and right turns from Lonas Drive based on existing count AM and PM observed splits

*** Assume all SB pass-by trips enter at Main Entrance and exit at Second Entrance

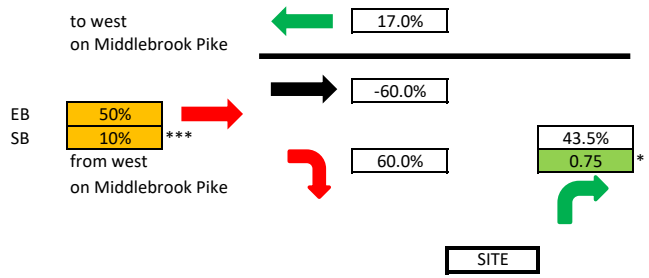
**** All exiting traffic from south exits at either Main Entrance or Secondary Entrance based on assumed split

Intersection of Lonas Drive at Second Entrance

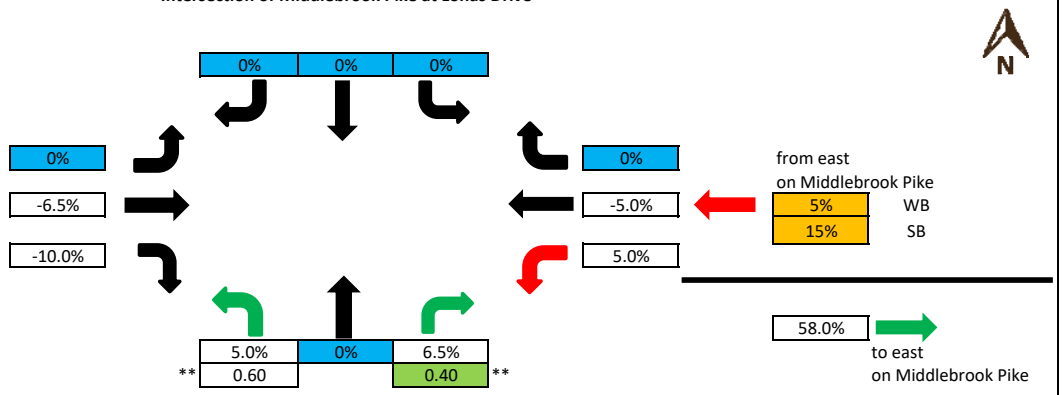


2025 PM PEAK HOUR - Trip Distribution - Pass-by Trips

Intersection of Middlebrook Pike at Proposed Main Entrance



Intersection of Middlebrook Pike at Lonas Drive



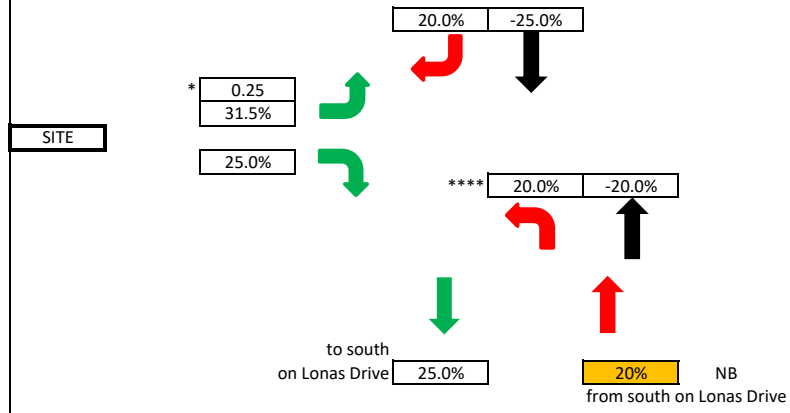
	Assumed Inputted Value
	Inputted Assumed Split
	Calculated Value
	Assumed Zero

Check:

Enter	Exit
100%	100%
100%	100%

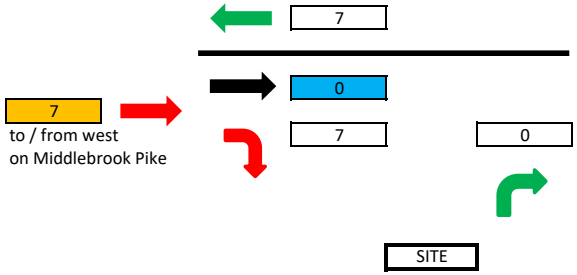
* All eastbound Middlebrook Pike pass-by traffic exits to right at Main Entrance and to the left at Second Entrance based on assumed split
** Split of left and right turns from Lonas Drive based on existing count AM and PM observed splits
*** Assume all SB pass-by trips enter at Main Entrance and exit at Second Entrance
**** All exiting traffic from south exits at either Main Entrance or Secondary Entrance based on assumed split

Intersection of Lonas Drive at Second Entrance

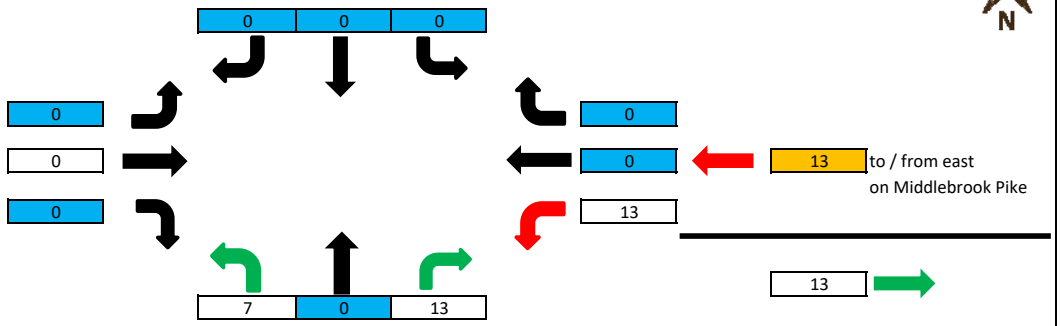


2025 AM PEAK HOUR - Trip Assignment - Primary Trips

Intersection of Middlebrook Pike at Proposed Main Entrance



Intersection of Middlebrook Pike at Lonas Drive



Entering Traffic

Exiting Traffic

N/A

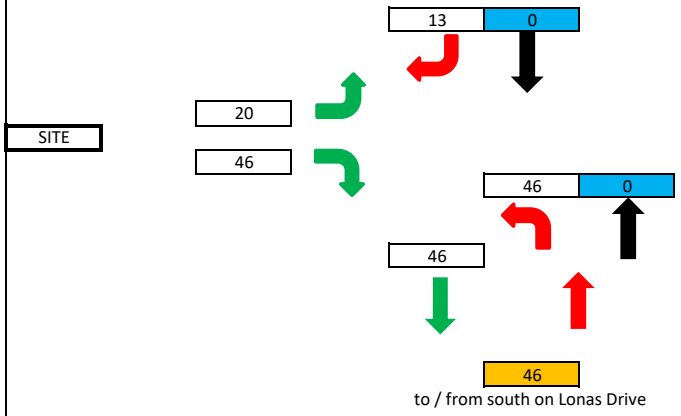
Calculated Value

Assumed Zero

Check:	Enter	Exit
	65	65
	65	65

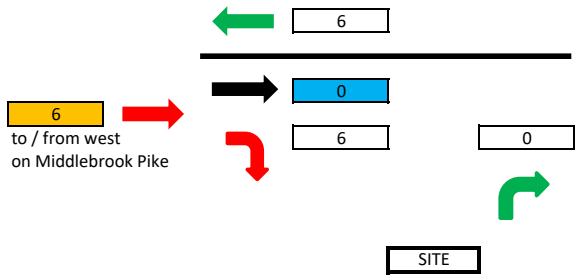
ITE LAND USE CODE	LAND USE	UNITS	GENERATED IN AM PEAK HOUR ENTER	EXIT	TOTAL
#945	Gas Station	6 pumps			
	External Vehicle Trips - Total		162	162	324
	Total New Primary Vehicle Trips		**65**	**65**	**130**

Intersection of Lonas Drive at Second Entrance

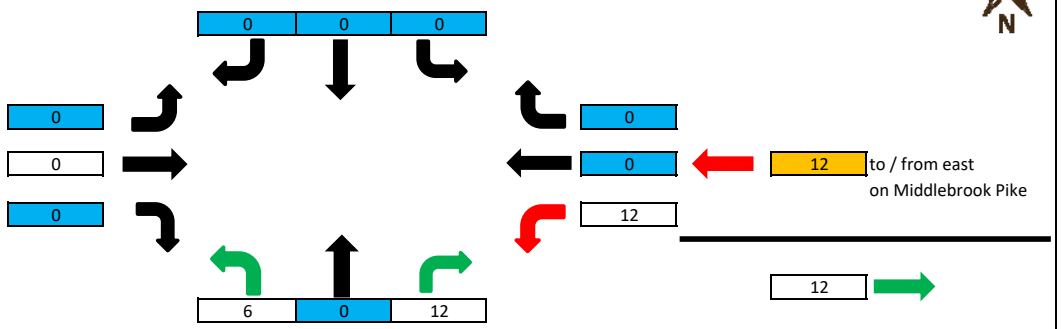


2025 PM PEAK HOUR - Trip Assignment - Primary Trips

Intersection of Middlebrook Pike at Proposed Main Entrance



Intersection of Middlebrook Pike at Lonas Drive



Entering Traffic

Exiting Traffic

N/A

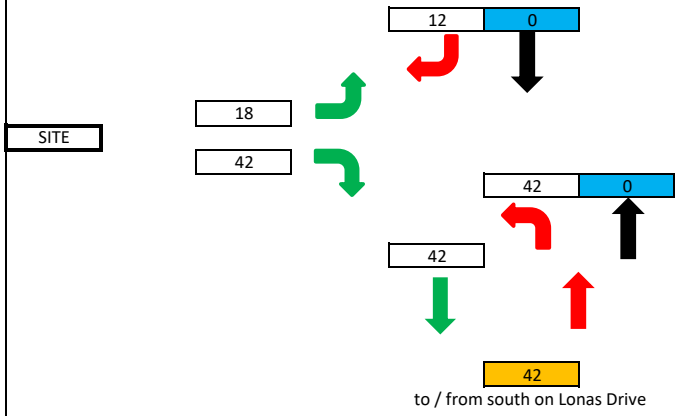
	Calculated Value
	Assumed Zero

Check:

Enter	Exit
60	60
60	60

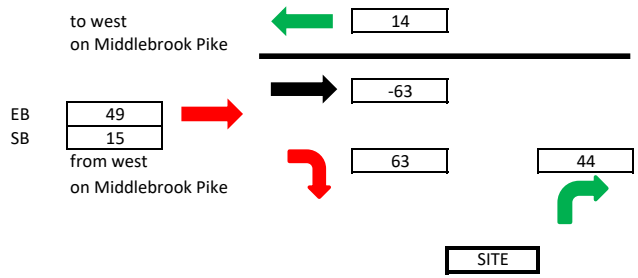
ITE LAND USE CODE	LAND USE	UNITS	GENERATED IN PM PEAK HOUR ENTER	EXIT	TOTAL
#945	Gas Station	6 pumps			
	External Vehicle Trips - Total		137	136	273
	Total New Primary Vehicle Trips		**60**	**60**	**120**

Intersection of Lonas Drive at Second Entrance

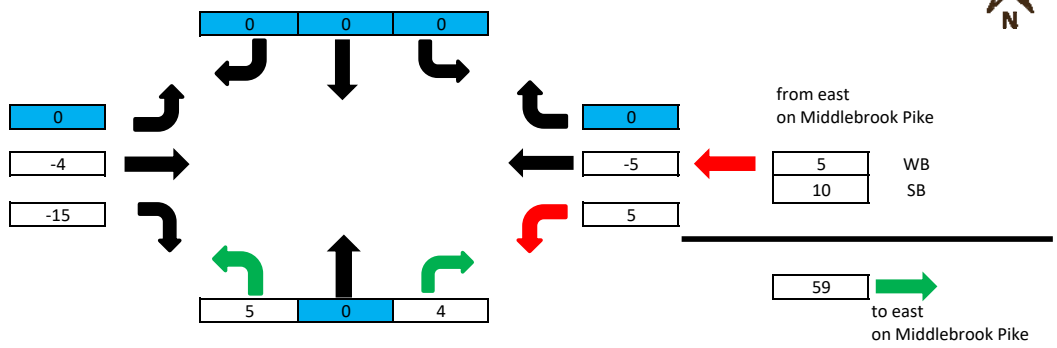


2025 AM PEAK HOUR - Trip Assignment - Pass-by Trips

Intersection of Middlebrook Pike at Proposed Main Entrance



Intersection of Middlebrook Pike at Lonas Drive



Entering Traffic

Exiting Traffic

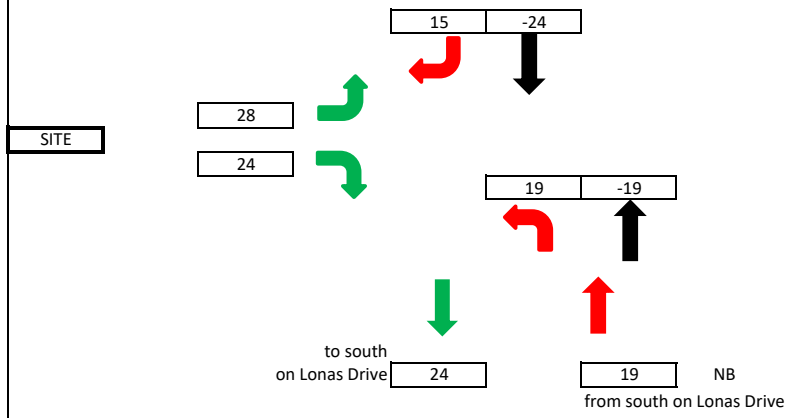
N/A

	Calculated Value
	Assumed Zero

Check:	Enter	Exit
	97	97
	97	97

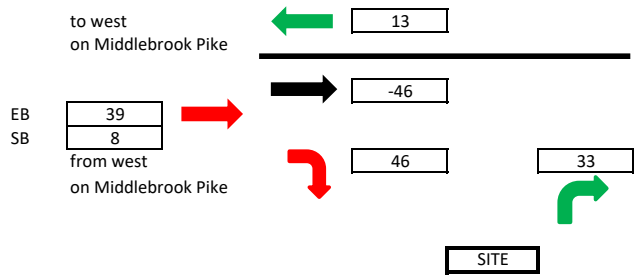
ITE LAND USE CODE	LAND USE	UNITS	GENERATED IN AM PEAK HOUR ENTER	EXIT	TOTAL
#945	Gas Station	6 pumps			
	External Vehicle Trips - Total		162	162	324
	Pass-by Vehicle Trips		**97**	**97**	**194**

Intersection of Lonas Drive at Second Entrance

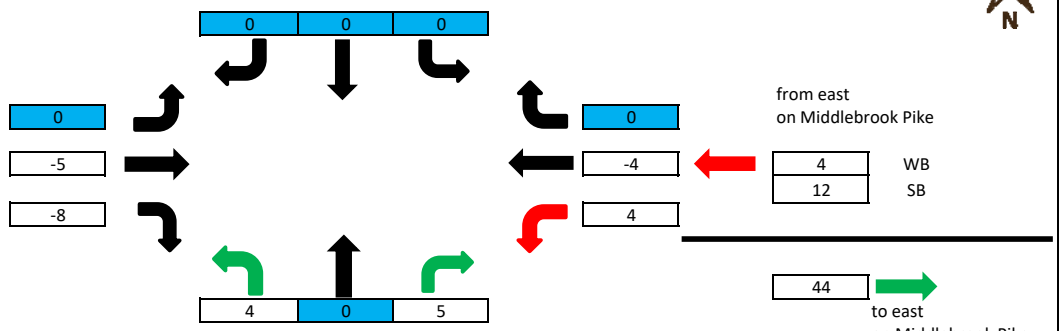


2025 PM PEAK HOUR - Trip Assignment - Pass-by Trips

Intersection of Middlebrook Pike at Proposed Main Entrance



Intersection of Middlebrook Pike at Lonas Drive



Entering Traffic

Exiting Traffic

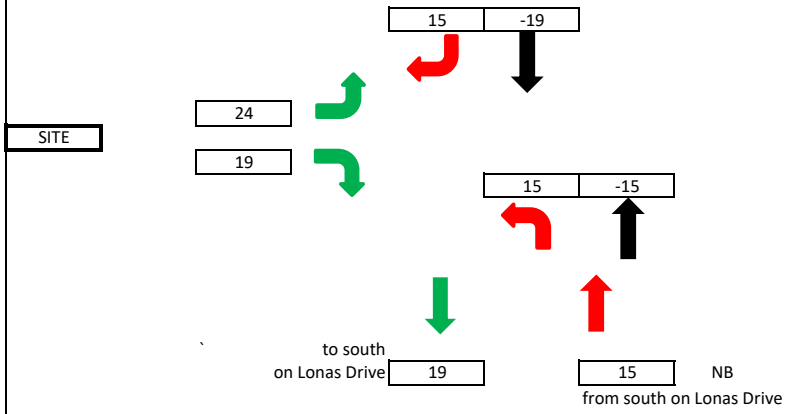
N/A

	Calculated Value
	Assumed Zero

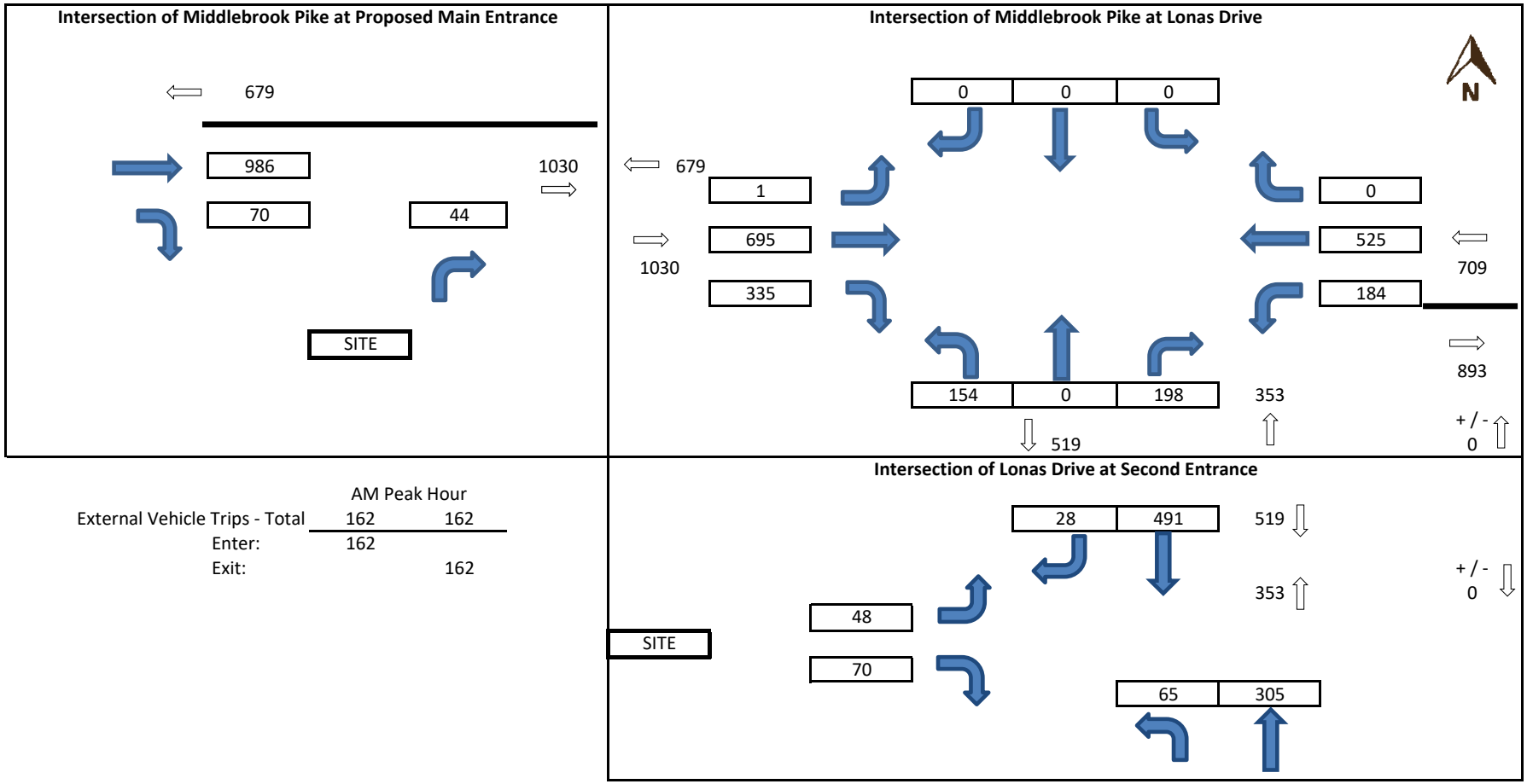
Check:	Enter	Exit
	77	76
	77	76

ITE LAND USE CODE	LAND USE	UNITS	GENERATED IN PM PEAK HOUR ENTER	EXIT	TOTAL
#945	Gas Station	6 pumps			
	External Vehicle Trips - Total		137	136	273
	Pass-by Vehicle Trips		**77**	**76**	**153**

Intersection of Lonas Drive at Second Entrance

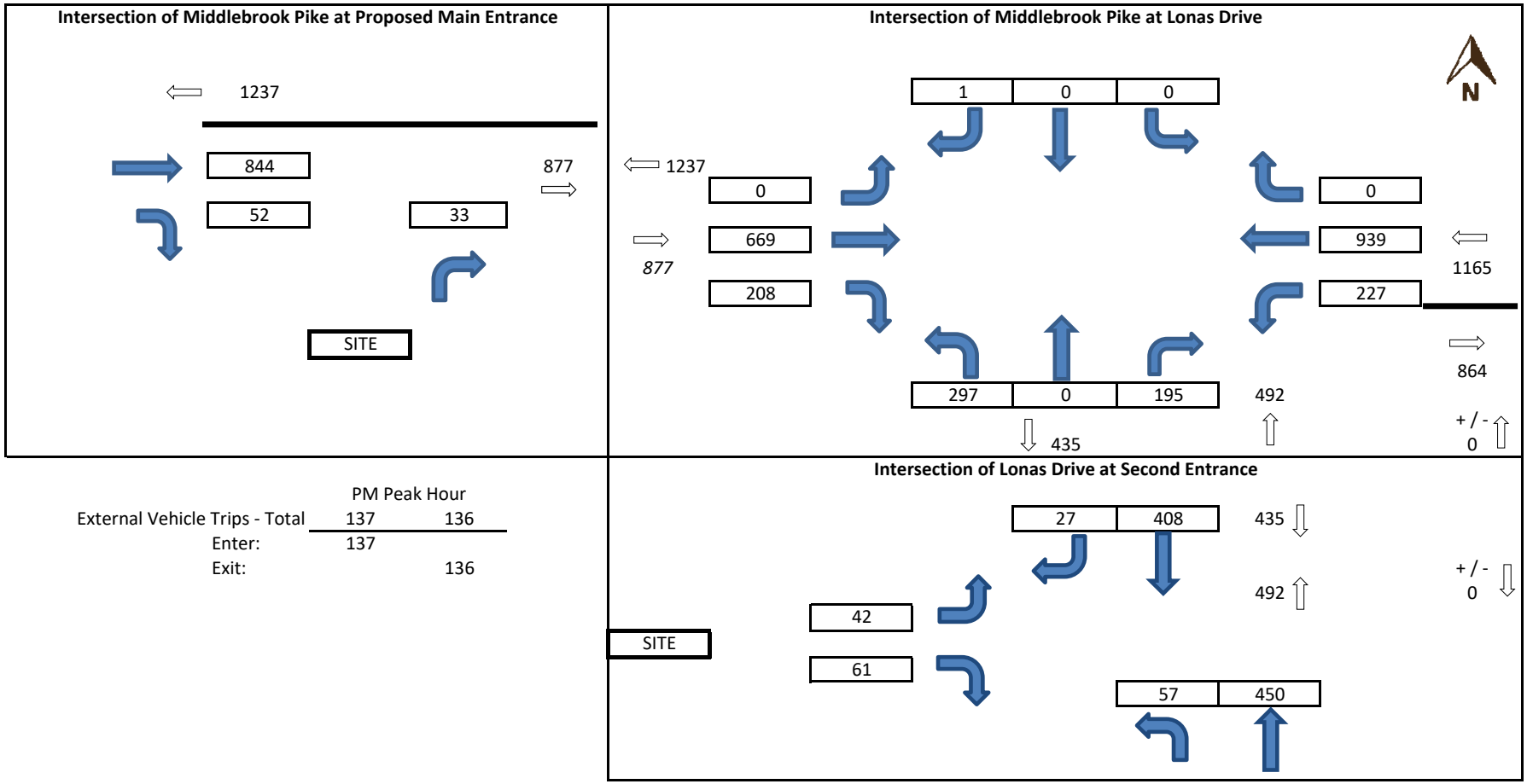


2025 AM PEAK HOUR - Projected Peak Hour Volumes



	AM Peak Hour	
External Vehicle Trips - Total	162	162
Enter:	162	
Exit:		162

2025 PM PEAK HOUR - Projected Peak Hour Volumes



	PM Peak Hour	
External Vehicle Trips - Total	137	136
Enter:	137	
Exit:		136

APPENDIX K

TDOT AND KNOX COUNTY TURN LANE VOLUME THRESHOLD WORKSHEETS

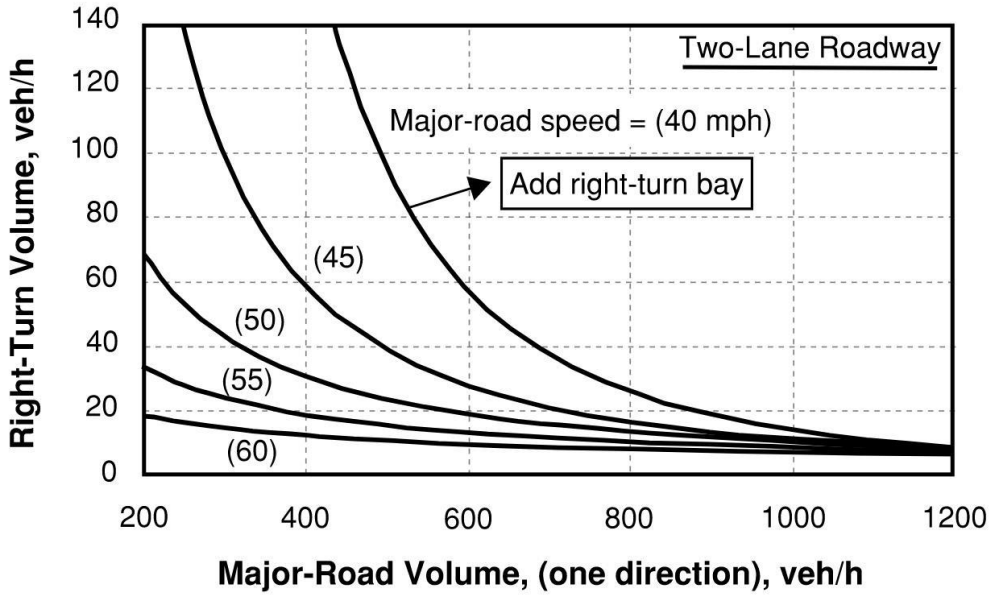


Figure 3-18: Right-Turn Lane Warrant along Two-Lane Roadway (Unsignalized Intersection with Two-Way Stop-Control)[24]

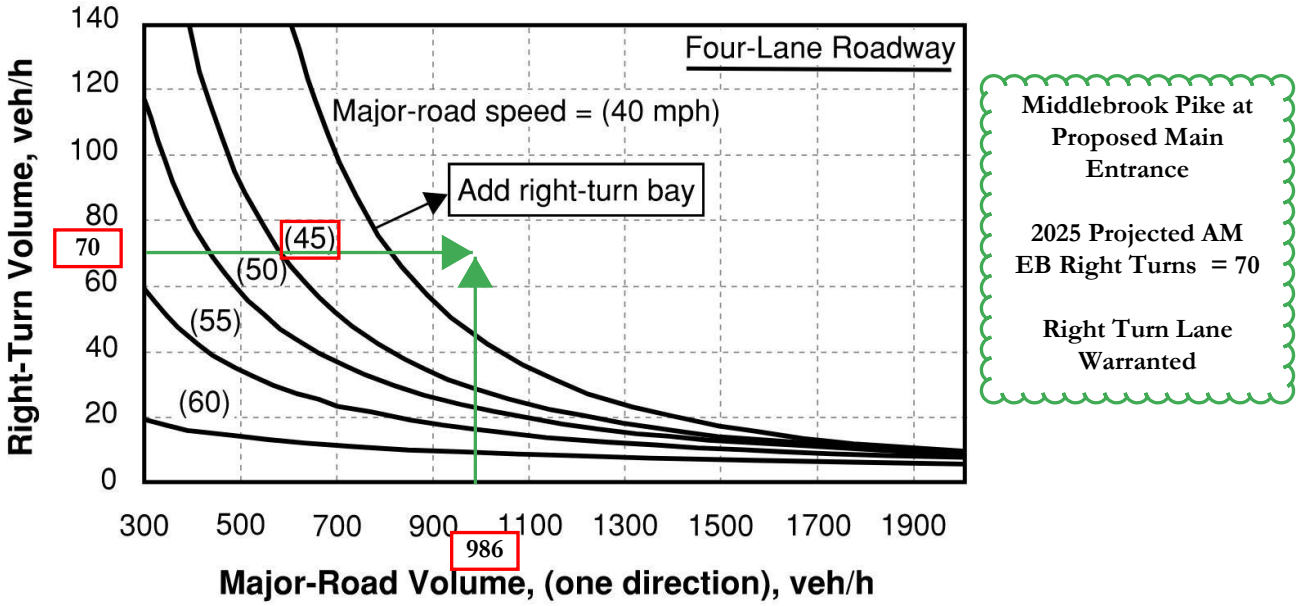


Figure 3-19: Right-Turn Lane Warrant along Four-Lane Roadway (Unsignalized Intersection with Two-Way Stop-Control) [25]

[24] TRB, NCHRP 457, Evaluating Intersection Improvements (2001)
[25] TRB, NCHRP 457, Evaluating Intersection Improvements (2001)

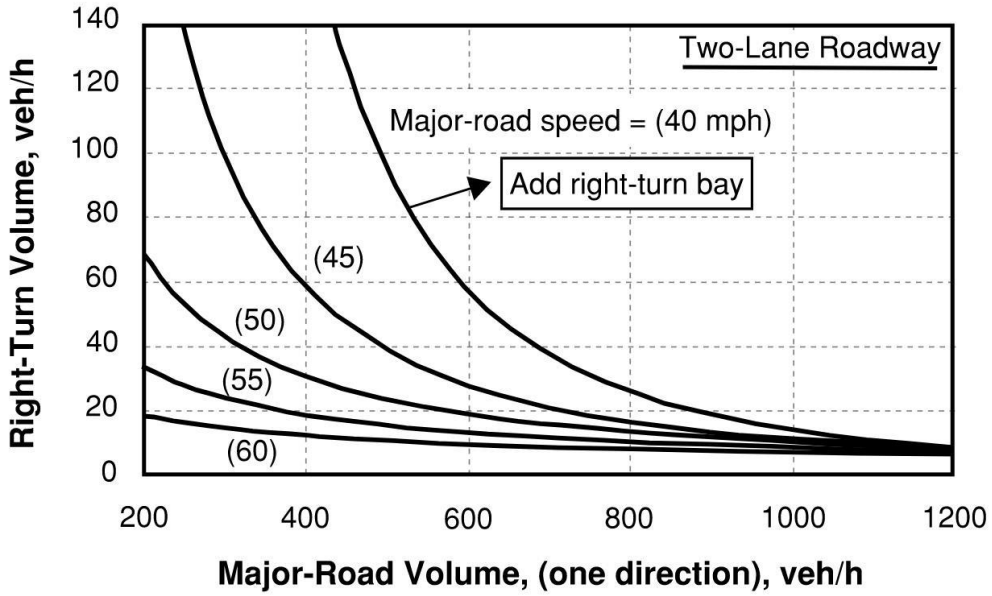


Figure 3-18: Right-Turn Lane Warrant along Two-Lane Roadway (Unsignalized Intersection with Two-Way Stop-Control)[24]

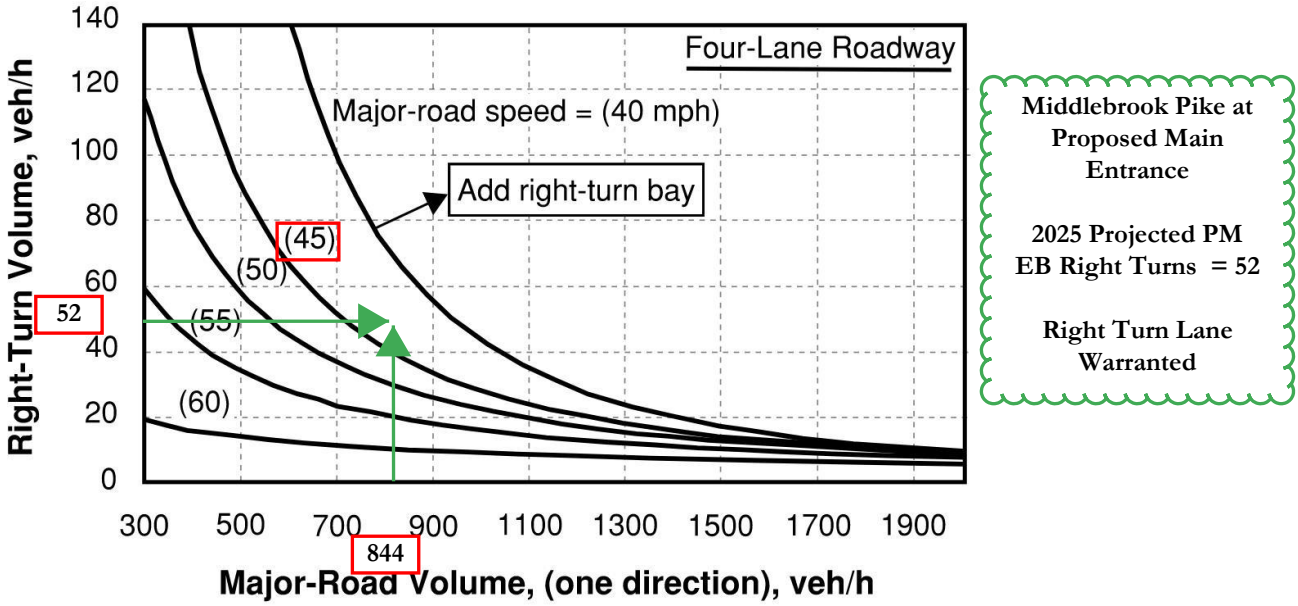


Figure 3-19: Right-Turn Lane Warrant along Four-Lane Roadway (Unsignalized Intersection with Two-Way Stop-Control) [25]

[24] TRB, NCHRP 457, Evaluating Intersection Improvements (2001)
[25] TRB, NCHRP 457, Evaluating Intersection Improvements (2001)

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

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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
200 - 249 250 - 299	Yes			Yes Yes	Yes Yes	Yes Yes
300 - 349 350 - 399	Yes Yes			Yes Yes	Yes Yes	Yes Yes
400 - 449 450 - 499	Yes Yes		Yes	Yes Yes	Yes Yes	Yes Yes
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

28

Lonas Drive at Secondary Entrance

2025 Projected AM SB Right Turns = 28

Right Turn Lane NOT Warranted

* Or through volume only if a left-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

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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
200 - 249 250 - 299	Yes			Yes Yes	Yes Yes	Yes Yes
300 - 349 350 - 399	Yes Yes			Yes Yes	Yes Yes	Yes Yes
400 - 449 450 - 499	Yes Yes			Yes Yes	Yes Yes	Yes Yes
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

27

Lonas Drive at Secondary Entrance

2025 Projected PM SB Right Turns = 27

Right Turn Lane NOT Warranted

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

APPENDIX L

SIMTRAFFIC VEHICLE QUEUE WORKSHEETS

Intersection: 1: Lonas Drive/Private Driveway & Middlebrook Pike

Movement	EB	EB	WB	WB	WB	NB	NB
Directions Served	LT	TR	L	T	TR	LT	R
Maximum Queue (ft)	244	253	154	145	94	201	221
Average Queue (ft)	119	111	66	46	30	97	112
95th Queue (ft)	208	210	118	104	74	168	188
Link Distance (ft)	1024	1024		1297	1297	202	202
Upstream Blk Time (%)						1	1
Queuing Penalty (veh)						1	1
Storage Bay Dist (ft)			110				
Storage Blk Time (%)			2	0			
Queuing Penalty (veh)			5	0			

Intersection: 1: Lonas Drive/Private Driveway & Middlebrook Pike

Movement	EB	EB	WB	WB	WB	NB	NB	SB
Directions Served	LT	TR	L	T	TR	LT	R	LTR
Maximum Queue (ft)	216	194	159	184	146	284	194	9
Average Queue (ft)	115	88	75	78	62	246	97	1
95th Queue (ft)	189	167	130	139	119	334	165	9
Link Distance (ft)	1024	1024		1297	1297	202	202	157
Upstream Blk Time (%)						51	0	
Queuing Penalty (veh)						111	0	
Storage Bay Dist (ft)			110					
Storage Blk Time (%)			3	1				
Queuing Penalty (veh)			15	2				

Intersection: 1: Lonas Drive/Driveway & Middlebrook Pike

Movement	EB	EB	WB	WB	WB	NB	NB
Directions Served	LT	TR	L	T	TR	LT	R
Maximum Queue (ft)	215	218	158	150	85	174	177
Average Queue (ft)	121	121	74	49	27	102	113
95th Queue (ft)	199	209	131	115	68	168	179
Link Distance (ft)	139	139		1300	1300	112	112
Upstream Blk Time (%)	4	5				10	12
Queuing Penalty (veh)	23	26				18	22
Storage Bay Dist (ft)			110				
Storage Blk Time (%)			3	0			
Queuing Penalty (veh)			8	0			

Intersection: 4: Lonas Drive & Secondary Entrance

Movement	EB	NB	NB	SB
Directions Served	LR	LT	T	TR
Maximum Queue (ft)	112	82	46	76
Average Queue (ft)	50	27	3	5
95th Queue (ft)	90	66	25	39
Link Distance (ft)	111	307	307	112
Upstream Blk Time (%)	1			0
Queuing Penalty (veh)	0			1
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 6: Main Entrance & Middlebrook Pike

Movement	EB	EB	NB
Directions Served	T	TR	R
Maximum Queue (ft)	38	64	72
Average Queue (ft)	1	5	29
95th Queue (ft)	17	35	59
Link Distance (ft)	803	803	99
Upstream Blk Time (%)			0
Queuing Penalty (veh)			0
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Network Summary

Network wide Queuing Penalty: 100

Intersection: 1: Lonas Drive/Driveway & Middlebrook Pike

Movement	EB	EB	WB	WB	WB	NB	NB	SB
Directions Served	LT	TR	L	T	TR	LT	R	LTR
Maximum Queue (ft)	222	214	178	200	167	192	179	18
Average Queue (ft)	143	135	91	86	67	176	105	1
95th Queue (ft)	220	216	158	166	135	198	178	10
Link Distance (ft)	139	139		1300	1300	112	112	159
Upstream Blk Time (%)	8	11				76	12	
Queuing Penalty (veh)	34	48				188	30	
Storage Bay Dist (ft)			110					
Storage Blk Time (%)			7	2				
Queuing Penalty (veh)			34	3				

Intersection: 4: Lonas Drive & Secondary Entrance

Movement	EB	NB	NB	SB
Directions Served	LR	LT	T	TR
Maximum Queue (ft)	125	320	298	122
Average Queue (ft)	102	233	102	64
95th Queue (ft)	142	400	338	155
Link Distance (ft)	111	307	307	112
Upstream Blk Time (%)	87	35	8	15
Queuing Penalty (veh)	0	0	0	66
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 6: Main Entrance & Middlebrook Pike

Movement	EB	EB	NB
Directions Served	T	TR	R
Maximum Queue (ft)	98	98	62
Average Queue (ft)	9	10	24
95th Queue (ft)	56	64	55
Link Distance (ft)	803	803	99
Upstream Blk Time (%)			1
Queuing Penalty (veh)			0
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Network Summary

Network wide Queuing Penalty: 403

Intersection: 1: Lonas Drive/Driveway & Middlebrook Pike

Movement	EB	EB	WB	WB	WB	NB	NB	SB
Directions Served	LT	TR	L	T	TR	LT	R	LTR
Maximum Queue (ft)	222	211	165	225	190	191	175	25
Average Queue (ft)	152	131	82	105	88	158	96	1
95th Queue (ft)	227	208	139	184	164	207	165	11
Link Distance (ft)	139	139		1300	1300	112	112	159
Upstream Blk Time (%)	10	6				35	8	
Queuing Penalty (veh)	44	28				87	19	
Storage Bay Dist (ft)			110					
Storage Blk Time (%)			4	4				
Queuing Penalty (veh)			19	10				

Intersection: 4: Lonas Drive & Secondary Entrance

Movement	EB	NB	NB	SB
Directions Served	LR	LT	T	TR
Maximum Queue (ft)	117	186	45	115
Average Queue (ft)	52	57	2	19
95th Queue (ft)	99	135	21	84
Link Distance (ft)	111	307	307	112
Upstream Blk Time (%)	3			2
Queuing Penalty (veh)	0			7
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 6: Main Entrance & Middlebrook Pike

Movement	EB	EB	NB
Directions Served	T	TR	R
Maximum Queue (ft)	72	40	46
Average Queue (ft)	7	3	21
95th Queue (ft)	38	21	46
Link Distance (ft)	803	803	99
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Network Summary

Network wide Queuing Penalty: 213

APPENDIX M

RESPONSE LETTER TO ADDRESS COMMENTS

AJAX ENGINEERING
CIVIL ENGINEERING / TRAFFIC ENGINEERING

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

October 23, 2023

PROJECT NAME: Shell Food Mart (11-B-23-U)
TO: Knoxville-Knox County Planning
SUBJECT: Response Document for Shell Food Mart TIS Review Comments

Knoxville-Knox County Planning, City of Knoxville Engineering, and TDOT:

The following response document addresses the comments in an email from Mike Conger, PE, dated October 19, 2023. This letter is added to the end of the revised report in Appendix M.

1. **The site engineer needs to address the sight distance requirements to determine whether or not they can all be achieved and what specific areas must be cleared and if that can be maintained moving forward. If not achievable then see the additional TDOT comments copied below regarding removal of a right turn egress from the site. This comment does not affect the TIA unless determined that right turn egress is not permitted to Middlebrook Pk and that traffic would have to be accounted for at the other study intersections.**

   Response: The site engineer's land surveyor has measured the available sight distance at the proposed entrance locations on Middlebrook Pike and Lonas Drive. According to the land surveyor, the required sight distance is achievable. The site engineer and land surveyor will identify any vegetation that needs to be removed and/or maintained to provide the required sight distance. Since the required sight distance has been deemed achievable, no modifications to the TIS have been made.

2. **Pages 62 and 63 include multiple references to "westbound" right turns, which likely should have been noted as eastbound instead. Please review and revise as necessary.**

   Response: This correction has been made on Pages 62 and 63.

3. **Please provide all study-area existing roadway lane width and right-of-way width (if known) measurements in the Existing Conditions section.**

   Response: A sentence has been added in the last paragraph on Page 8 to describe the lane widths and the ROW on Middlebrook Pike. A sentence has been added in the second to last paragraph on Page 10 to describe the lane widths and the ROW on Lonas Drive.

4. **Regarding the potential need for an eastbound right turn lane on Middlebrook Pk at Lonas Dr - the reviewing agencies believe that this can be left as a situation to monitor moving forward without requiring any immediate mitigation other than to ensure that the site plan is designed in such a way to accommodate a future potential right turn lane, i.e. the driveway throats and other site circulation features would still function adequately if a right turn lane was constructed. Please discuss this in the TIA as to any potential issues that the additional width on Middlebrook Pk from a new right turn lane might have in terms of impact to the access and on-site circulation and address accordingly.**

   Response: A discussion regarding this turn lane has been added on Page 60.

TDOT Comments:

- **If 430' of intersection sight distance cannot be obtained at the entrance to SR-169, Middlebrook Pike, then TDOT will not allow right turns out of this driveway and it will be restricted to a right-in only**
  - **If they can show that by clearing vegetation, they can obtain the necessary sight distance, an exit onto SR-169 may be considered. They would also need to ensure their driveway still meets our corner clearance requirements from the ROW line along Lonas which would be a minimum of 150' so simply shifting the driveway closer to Lonas may not be an option.**

  Response: As stated previously, the site engineer's land surveyor has measured the available sight distance at the proposed entrance locations on Middlebrook Pike and Lonas Drive. According to the land surveyor, the required sight distance is achievable. The site engineer and land surveyor will identify any vegetation that needs to be removed and/or maintained to provide the required sight distance. Since the required sight distance has been deemed achievable, no modifications to the TIS have been made.

- **(Info Only) While the westbound left turn lane from SR-169 to Lonas is shorter than we would like, there is not much room to lengthen it with the bridge to I-75/I-640. From a quick review of the crashes at the intersection, there were none directly related to this turn lane (primarily side swipe or rear end on WB SR-169). This may be a situation that we need to continue to monitor and if conditions change, then we can look at a larger project to modify the bridge and lengthen the turn lane.**

  Response: This comment by TDOT is noted and understood. No changes to the TIS have been made based on this comment.

- **(Info Only) For the discussed right turn lane onto Lonas Drive, his projections show 205 right turns in the PM peak hour and 335 right turns in the AM peak hour. TDOT's HSAM currently recommends a right turn lane at a signalized intersection with 300 right turns per hour and with the adjacent through lane carrying at least 300 vehicles per hour. I recommend this be another item that TDOT and the City monitors for future growth.**

Response: This comment by TDOT is noted and understood. No changes to the TIS have been made based on this comment.

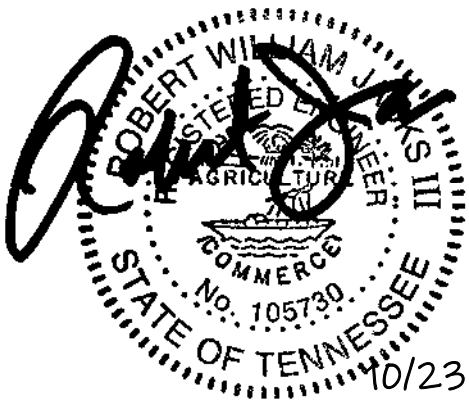
In addition to the revisions listed above, other changes in the report include the following:

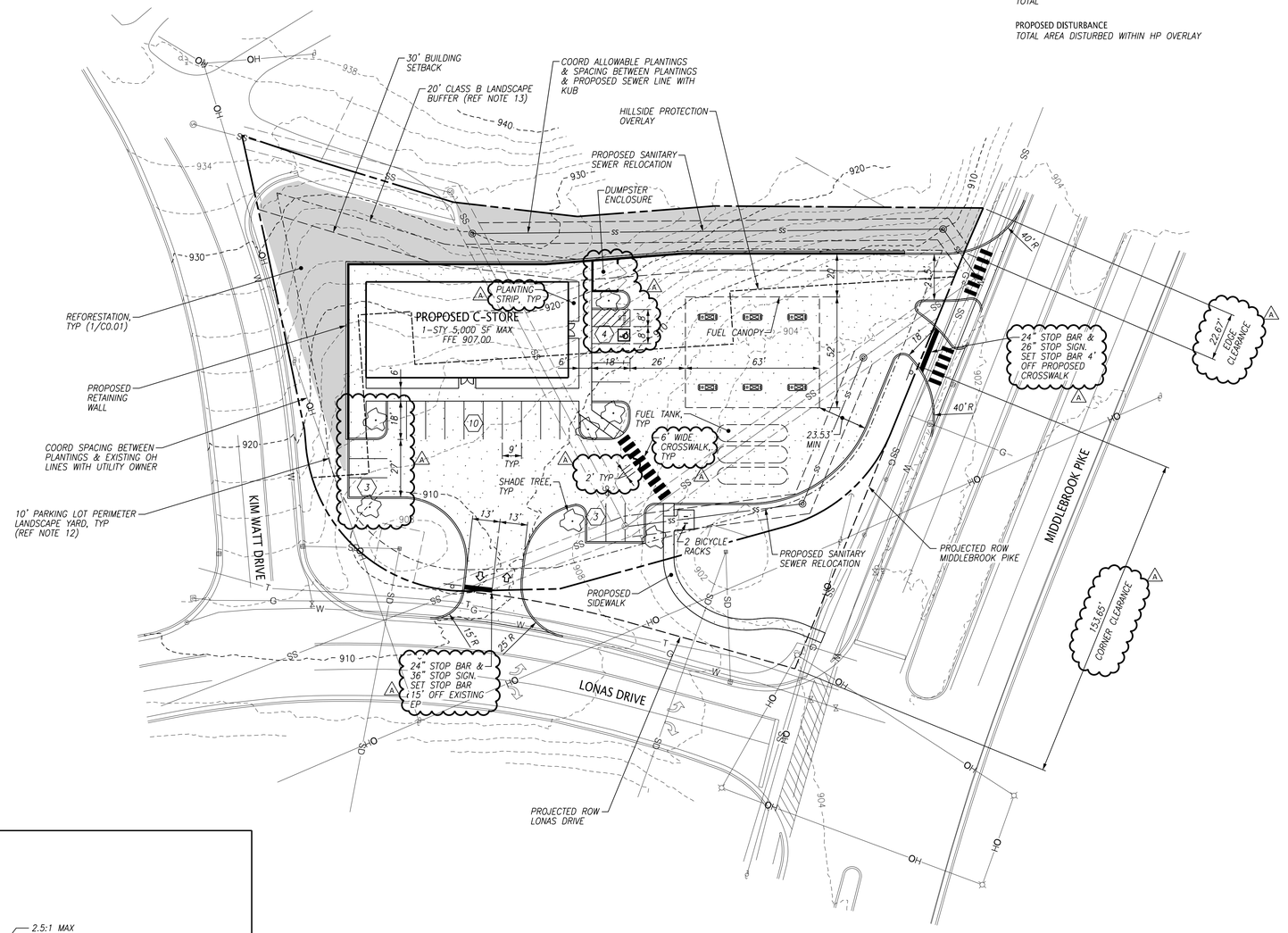
- Updated Title Page
- Updated Table of Contents
- Updated Page Footers
- On Page 21, added additional information about the updated site plan and noted its inclusion in Appendix M
- Added Appendix M to include this response letter

If you have any questions or further comments, please get in touch with me. I look forward to your approval.

Sincerely,

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





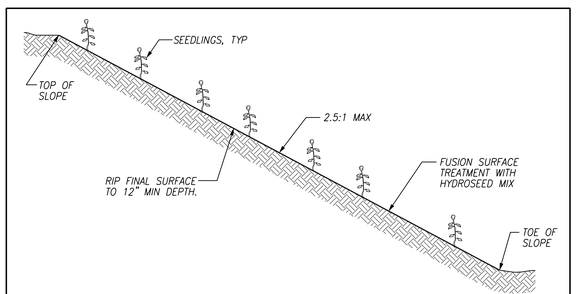
HILLSIDE PROTECTION SUMMARY

DISTURBANCE ALLOWED

0.08 AC @ 100% ALLOWABLE DISTURBANCE (<15% SLOPE) =	0.08 AC
0.12 AC @ 50% ALLOWABLE DISTURBANCE (15%–25% SLOPE) =	0.06 AC
0.22 AC @ 20% ALLOWABLE DISTURBANCE (25%–40% SLOPE) =	0.04 AC
0.08 AC @ 10% ALLOWABLE DISTURBANCE (> 40% SLOPE) =	0.01 AC
TOTAL	0.19 AC

PROPOSED DISTURBANCE

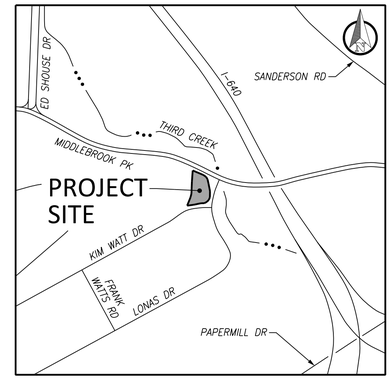
TOTAL AREA DISTURBED WITHIN HP OVERLAY	0.39 AC



NOTES:

1. SEEDLINGS SHALL BE A MIX OF AT LEAST 6 OF THE FOLLOWING SPECIES: AMERICAN PLUM, BLACKGUM, NORTHERN RED OAK, TULIP POPLAR, RED MAPLE, REDBUD, SCARLET OAK, SWEETGUM, SYCAMORE AND WHITE OAK. INSTALL ON 12' X 12' GRID OR 300 PER ACRE. PLANTING DATES RANGE FROM DECEMBER TO MID-APRIL.
2. HYDROSEED SLOPE WITH ERNST NC MOUNTAINS UPL MEADOW MIX (ERNMX 303). APPLY 20 LBS/AC. ADD FERTILIZER TO THE HYDROSEED MIX. USE 19-19-19 AND APPLIED AT A RATE OF 400 LBS/AC. ADD ANNUAL COVER CROP TO THE HYDROSEED MIX AS FOLLOWS: OATS (JANUARY TO FEBRUARY) APPLIED AT 30 LBS/AC; BROWNTOP MILLET (MARCH TO AUGUST) APPLIED AT 10 LBS/AC; WINTER RYE GRAIN (SEPTEMBER TO DECEMBER) APPLIED AT 30 LBS/AC.
3. APPLY FUSION SURFACE TREATMENT (JEN-HILL CONSTRUCTION MATERIALS) AT A RATE OF 4,500 LBS/AC ALONG WITH THE HYDROSEED MIX. OBTAIN A SOIL SAMPLE TO CONFIRM THE APPLICATION RATE. INSTALL PER THE MANUFACTURER'S RECOMMENDATIONS.
4. PROTECT FINISHED SLOPE FROM BEING DISTURBED.

1 / C0.01 REFORESTATION
NTS



LOCATION MAP
(NOT TO SCALE)

NOTES:

1. THE TOPOGRAPHIC & BOUNDARY DATA WAS TAKEN FROM PROFESSIONAL LAND SYSTEMS, DATED MARCH 1, 2023.
2. UNLESS NOTED OTHERWISE, DIMENSIONS ARE TAKEN FROM THE FENCE LINE, PROPERTY LINE, FACE OF CURB, EDGE OF PAVEMENT OR OUTSIDE FACE OF BUILDING.
3. THE MINERAL AGGREGATE BASE AND ASPHALTIC SURFACE COURSES SHALL MEET THE MATERIALS, EQUIPMENT, CONSTRUCTION, AND TESTING REQUIREMENTS OF THESE DRAWINGS, AND THE CITY OF KNOXVILLE DEPARTMENT OF ENGINEERING STANDARD SPECIFICATIONS.
4. CONCRETE CURB AND PAVEMENT SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 4000 PSI AT 28 DAYS. CONCRETE CURB AND PAVEMENT SHALL MEET THE MATERIALS, EQUIPMENT, AND CONSTRUCTION REQUIREMENTS OF THE CITY OF KNOXVILLE DEPARTMENT OF ENGINEERING STANDARD SPECIFICATIONS.
5. TRAFFIC CONTROL DEVICES AND PAVEMENT MARKING SHALL CONFORM TO THE FEDERAL HIGHWAY ADMINISTRATIONS "MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES."
6. PROPERTY CONCERNED REFLECTS PARCEL 093NC009 AS SHOWN IN KNOX COUNTY CLT MAP 093. ZONING FOR THE PROPERTY IS C-N, NEIGHBORHOOD COMMERCIAL DISTRICT. CITY BLOCK NO 50330, WARD NO 48. TOTAL AREA = 1.13± AC.

   OWNER: SCOTT & HOPE DAVIS
   PO BOX 11315
   KNOXVILLE, TN 37939

7. BUILDING SETBACKS ARE 0-FT IN FRONT, 0-FT ON SIDE AND 30-FT IN REAR.
8. RETAINING WALLS TO BE DESIGNED AND SEALED BY AN ENGINEER LICENSED IN THE STATE OF TENNESSEE AND SUBMITTED FOR REVIEW AND APPROVAL PRIOR TO ISSUANCE OF A PERMIT. REFER TO VENDOR'S PLANS FOR RETAINING WALL AND RAILING DETAILS. RAILING SHALL BE PROVIDED FOR RETAINING WALL HEIGHTS THAT EQUAL OR EXCEED 30 INCHES.
9. REMOVE OVER-PAVEMENT OF ASPHALT AND STONE FROM UNDERNEATH LANDSCAPE AREAS UP TO THE LIMITS THAT HAVE BEEN SPECIFIED (REFER TO THE CURB DETAIL) IN ORDER TO PROVIDE A SOLID BASE FOR THE CONCRETE CURB.
10. REFER TO ARCHITECTURAL PLANS FOR ACTUAL BUILDING DIMENSIONS.
11. FUEL CANOPY SHALL HAVE 14' MINIMUM VERTICAL CLEARANCE.
12. PARKING LOT PERIMETER LANDSCAPE YARD SHALL BE PLANTED WITH A MINIMUM OF (3) SHADE AND/OR EVERGREEN TREE'S AND (10) SHRUBS FOR EVERY 100 LINEAR FEET. A MINIMUM OF 50% OF THE SHRUBS SHALL BE EVERGREEN.
13. CLASS B BUFFER YARD SHALL BE PLANTED WITH (1) SHRUB EVERY 3'. A MINIMUM OF 50% OF THE SHRUBS SHALL BE EVERGREEN. BUFFER SHALL ALSO BE PLANTED WITH (1) EVERGREEN TREE FOR EVERY 20' AND (1) SHADE TREE FOR EVERY 30'.

PARKING SUMMARY

REQUIRED PARKING (GAS STATION)	
5,000 SF @ 4 SP/1,000 SF GFA =	20 SPACES
MAXIMUM ALLOWED PARKING (GAS STATION)	
5,000 SF @ 8 SP/1,000 SF GFA =	40 SPACES
TOTAL PARKING PROVIDED	
STANDARD SPACES (9'x18")	19 SPACES
HANDICAP (1 VAN ACCESSIBLE)	1 SPACE
TOTAL	20 SPACES
BICYCLE PARKING	
<50 MOTOR VEHICLE PARKING SPACES REQUIRED	4 SPACES
BICYCLE SPACES PROVIDED	4 SPACES

LEGEND:

	CONCRETE PAVEMENT
	REFORESTATION
	SHADE TREE
1022	EXISTING CONTOUR
	PROPERTY LINE
9	NUMBER OF PARKING SPACES
(1/C2)	DETAIL REF. (DETAIL NO./SHT. NO.)
TYP	TYPICAL

0 30 60
SCALE: FEET

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JAY PATEL
2607 GRAHAM HILL LN
KNOXVILLE, TN 37932
lonasmiddlebrook@gmail.com
912-536-7890

NO.	DATE	REVISION	BY
A	10/26/23	REVISED PER PLANNING STAFF COMMENTS	JCM

LONAS & MIDDLEBROOK C-STORE
0 LONAS DRIVE

SPECIAL USE PLAN

PRELIMINARY
NOT FOR
CONSTRUCTION

JOB NO: 671.001.1
DATE: 09/19/2023

C0.01

SPECIAL USE PLAN
09/19/2023

File Name: J:\671\671.001\DWGS\Special Use\671001cp001.dgn
Plot Date: 10/25/2023

Ajax Engineering, LLC
11812 Black Road
Knoxville, TN 37932
ajaxengineering@gmail.com