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EBENEZER ROAD SUBDIVISION

Transportation Impact Analysis Ebenezer Road Knoxville, TN

A Transportation Impact Analysis for the Ebenezer Road Subdivision

Submitted to

Knoxville-Knox County Planning

Revised May 28, 2024 April 26, 2024 Ardurra Project No. 330.029



Submitted By:



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Executive Summary

S&E Properties, LLC is proposing a residential development. The project is located south of the signalized intersection of Kingston Pike (US 11/US 70) at Ebenezer Road in Knox County, Tennessee. The full buildout of the Ebenezer Road Subdivision proposes 113 single-family residential lots and a future development area by others. The current plan for the Future Development Area is a proposed apartment complex with 278 garden style apartment units. Construction is proposed to take place this year and this study assumes full build out for the development will occur in 2027.

The Ebenezer Road Subdivision has a proposed single roadway connection to Ebenezer Road and the proposed future development area has a separate proposed single roadway connection to Ebenezer Road. A roadway connection between the two developments is under consideration for the purpose of emergency access. The exact location will need to be coordinated between the property owners as well as Knox County Engineering and Public Works.

In order to maintain or provide an acceptable level-of-service for each of the intersections studied, some recommendations are presented.

Kingston Pike (SR 70) at Ebenezer Road

After the completion of the Ebenezer Road Subdivision including the future development area the traffic conditions for the signalized intersection of Kingston Pike (US 11/US 70) at Ebenezer Road will operate at an acceptable LOS C during the AM peak hour and a LOS D during the PM peak hour.

The northbound right turn lane (Ebenezer Road) will exceed the available queue storage length of 50 feet less than 50% of the time after the completion of the Ebenezer Road Subdivision and Future Development Area.

There are several existing constraints including the location of guard rails and power poles and the proximity to Ten Mile Creek that would make extending the storage length of the right turn lane difficult to construct.

The existing geometry of the northbound right turn lane is a 50-foot storage length and a 30-foot taper ending at the start of the existing commercial driveway. In order to maximum storage capacity Ardurra recommends relocating the communication pole and widening the 80-foot length of Ebenezer Road between the stop bar and the commercial driveway to match the existing width of 20 feet to allow additional vehicle stacking. Ardurra recommends that any future intersection improvements be reviewed, coordinated and approved by both the City of Knoxville Department of Engineering and Knox County Engineering and Public Works.

Ebenezer Road at Future Development Area

A southbound left turn lane is warranted at the intersection of Ebenezer Road at Future Development Area Roadway per the Knox County Department of Engineering and Public Works handbook, "Access Control and Driveway Design Policy." The southbound left turn lane has a recommended minimum storage length of 50 feet per the AASHTO Greenbook "A Policy on Geometric Design of Highways and Streets."

After the completion of the full buildout of the Ebenezer Road Subdivision including the proposed roadway improvements the intersection of Ebenezer Road at Future Development Area Roadway will operate at an acceptable LOS B or better for each approach during both the AM and PM peak hours.

Ebenezer Road at Subdivision

Neither a southbound left turn lane nor a northbound right turn lane is warranted at the intersection of Ebenezer Road at Ebenezer Subdivision Roadway per the Knox County Department of Engineering and Public Works handbook, "Access Control and Driveway Design Policy."

After the completion of the full buildout of the Ebenezer Road Subdivision the intersection of Ebenezer Road at Subdivision Roadway will operate at an acceptable LOS B or better for each approach during both the AM and PM peak hours.

1 Introduction

1.1 Project Description

This report provides a summary of a transportation impact analysis that was performed for the Ebenezer Road Subdivision residential development. The Ebenezer Road Subdivision proposes 113 single-family residential lots and a future development area by others. The current plan for the Future Development Area is a proposed apartment complex with 278 garden style apartment units. The project is located south of the signalized intersection of Kingston Pike (US 11/US 70) at Ebenezer Road in Knox County, Tennessee. The location of the site is shown in Figure 1.

Construction is proposed to take place this year and this study assumes full build out for the subdivision and the future development area will occur in 2027.

The Ebenezer Road Subdivision has a proposed single roadway connection to Ebenezer Road and the proposed future development area has a separate proposed single roadway connection to Ebenezer Road. A roadway connection between the two developments is under consideration for the purpose of emergency access. The exact location will need to be coordinated between the property owners as well as Knox County Engineering and Public Works.

The proposed site layout is shown in Figure 2.



Figure 1: Location Map



Figure 2: Site Plan

1.2 Study Area

The purpose of this study is to evaluate the impacts to the traffic conditions caused by the proposed development. Ebenezer Road is considered a north-south orientate roadway and Kingston Pike (US 11/US 70) is considered an east-west oriented roadway. The existing intersections and existing traffic control are summarized in Table 1.2-1 Study Area.

Table 1.2-1	
Ebenezer Road Subdivision	
Study Area	

Intersection	Existing Traffic Control
Kingston Pike (US 11/US 70) at Ebenezer Road	Signalized

1.3 Existing Site Conditions

Roadway geometry and posted speed limits were obtained by field observations. The Knoxville-Knox County Planning "2018 Major Road Plan" was used to determine road classification. This information is summarized in Table 1.3-1 Existing Site Conditions.

Table 1.3-1Ebenezer Road SubdivisionExisting Site Conditions										
Roadway	Speed Limit	Lanes	Road Width	Major Road Plan						
Kingston Pike (US 11/US 70)	45 mph	5	~58 feet	Major Arterial						
Ebenezer Road	30 mph	2	∼21 feet	Minor Collector						

The intersection of Kingston Pike (US 11/US 70) at Ebenezer Road is located within the City of Knoxville limits and the signal is maintained by the City of Knoxville Department of Engineering.

At the signalized intersection of Kingston Pike (US 11/US 70) at Ebenezer Road the eastbound approach (Kingston Pike) has a left turn lane with an approximate storage length of 140 feet and a right turn lane with an approximate storage length of 140 feet. The westbound approach (Kingston Pike) has a left turn lane with an approximate storage length of 90 feet and a right turn lane with an approximate

storage length of 100 feet. The southbound approach (Driveway) has a separate right turn lane with an approximate storage length of 50 feet. The northbound approach (Ebenezer Road) has a separate right turn lane with an approximate storage length of 50 feet.

The measured width of Ebenezer Road south of the signalized intersection is 30 feet and tapers to 24 feet south of the existing commercial driveway connections. The measured width of Ebenezer Road at the proposed subdivision roadway connection is approximately 21 feet.

An aerial photo of the signalized intersection of Kingston Pike (US 11/US 70) at Ebenezer Road is included in Attachment 1.

Guardrails are located on both sides of Ebenezer Road south of Kingston Pike (US 11/US 70) at the Ten Mile Creek crossing. Pictures of the existing conditions of the guardrails are included in Attachment 1.

There are no sidewalks or bike infrastructure in the vicinity of the proposed development.

The Knoxville Area Transit (KAT) operates in the vicinity of the proposed development. Route 16 (Cedar Bluff Connector) stops include Parkwest Hospital, Cedar Bluff at Fox Lonas and Walmart Walbrook Drive. The nearest KAT stop to the development along Route 16 is currently located on Cedar Bluff Road near the Kroger Development which is approximately 1.1 miles walk to the Ebenezer Road Subdivision.

2 Existing Traffic Volumes

Ardurra conducted a peak hour turning movement count at the signalized intersection of Kingston Pike (US 11/US 70) at Ebenezer Road on Tuesday March 19, 2024. The AM peak hour occurred between 7:45 a.m. and 8:45 a.m. with an AM PHF of 0.97. The PM peak hour occurred between 5:00 p.m. and 6:00 p.m. with a PM PHF of 0.94.

The existing volumes including the AM and PM peak hour traffic volumes at the count locations are shown in Figure 3, and the count data collected is included in Attachment 2.



— 5 (16) TURNING MOVEMENT VOLUME AM (PM)

Figure 3: 2024 Existing Peak Hour Traffic

3 Background Growth

The Tennessee Department of Transportation (TDOT) maintains count stations in the vicinity of the proposed development.

TDOT count station ID 47000466 is located on Ebenezer Road between Kingston Pike (US 11/US 70) and George Williams Road in Knoxville, TN. The annual growth rate for this station over the last ten years is approximately -3.80%. The 2023 ADT was 4,581 vehicles per day.

TDOT count station ID 47000128 is located on Kingston Pike (US 11/US 70) west of the signalized intersection with Cedar Bluff Road. The annual growth rate for this station over the last ten years is approximately 0.59%. The 2022 ADT was 27,645 vehicles per day.

For the purpose of this study, an annual growth rate of 1.0% was assumed for traffic at the studied intersections until full occupancy is reached in 2027. Attachment 3 shows the trend line growth charts for the TDOT count stations.

Figure 4 demonstrates the projected background peak hour volumes at the studied intersections after applying the background growth rate to the existing conditions.



— 5 (16) TURNING MOVEMENT VOLUME AM (PM)

Figure 4: 2027 Background Peak Hour Traffic

3.1 Future Development Area

In addition to the background growth, the trips from the Future Development Area were calculated and included in the projected background peak hour traffic. The future development area is expected to be a proposed apartment complex with 278 garden style apartment units. A roadway connection between the two developments is under consideration for the purpose of emergency access.

The Knoxville-Knox County Planning Commission published a memorandum ("Local Trip Generation Rates for Multi-Family Residential Uses", August 14, 2000) for the purpose of providing locally collected data for all multi-family residential developments. The fitted curve equations from the local study were used to calculate site trips for the future development area.

The land use worksheets are included in the attachments and a trip generation summary is shown in Table 3.1.

Table 3.1-1 Future Development Area Trip Generation Summary										
Land Use	Density	Daily Trips	AM Pea Enter	k Hour Exit	PM Peak Hour Enter Exit					
Apartments (Local Trip Gen Study)	278 Units	2,392	30	107	108	88				

The total combined new trips generated by the Future Development Area were estimated to be 2,392 daily trips. The estimated trips are 137 trips during the AM peak hour and 196 trips during the PM peak hour.

The directional distribution of the traffic generated by the Ebenezer Road Subdivision was determined using the existing traffic volumes in combination with the site plan layout. The entering/exiting traffic was assumed to be 70% Ebenezer Road northbound to/from Kingston Pike (US 11/US 70) and 30% Ebenezer Road southbound to/from Gleason Drive/Westland Drive.

Figures 5 and 6 show the Future Development Area – apartment peak hour trip distribution and site trips.



— 50% (50%) TRIP DISTRIBUTION ENTERING (EXITING)

Figure 5: Apartment Peak Hour Trip Distribution



Figure 6: Apartment Peak Hour Site Trips

Trip Generation and Trip Distribution 4

The Ebenezer Road Subdivision proposes 113 single-family residential lots. A roadway connection between the two developments is under consideration for the purpose of emergency access. Single-Family Detached Housing or Land Use 210 was used to calculate site trips for the development using the fitted curve equations from the Trip Generation, 11th Edition, published by the Institute of Transportation Engineers.

The land use worksheets are included in Attachment 4. A trip generation summary is shown in Table 4-1.

Ebenezer Road Subdivision Trip Generation Summary										
Land Use	Density	Daily Trips	AM Pe Enter	ak Hour Exit	PM Pea Enter	ak Hour Exit				
Single Family Detached Housing (LUC	113 Lots	1,129	21	62	71	41				

Table 4-1

The total combined new trips generated by the Ebenezer Road Subdivision were estimated to be 1,129 daily trips. The estimated trips are 83 trips during the AM peak hour and 112 trips during the PM peak hour.

Ebenezer Road at the intersection with Kingston Pike (US 11 / US 70) has an existing trip distribution of 70% northbound and 30% southbound during the AM peak hour and 45% northbound and 55% southbound during the PM peak hour.

The directional distribution of the traffic generated by the Ebenezer Road Subdivision was determined using the existing traffic volumes in combination with the site plan layout. The entering/exiting traffic was assumed to be 70% Ebenezer Road northbound to/from Kingston Pike (US 11 / US 70) and 30% Ebenezer Road southbound to/from Gleason Drive/Westland Drive.

Figures 7 and 8 show the subdivision peak hour trip distribution and site trips. Figure 9 shows the 2027 full buildout peak hour traffic including the background growth and the peak hour site trips from both the future development area and the Ebenezer Road Subdivision.



Figure 7: Subdivision Peak Hour Trip Distribution



Figure 8: Subdivision Peak Hour Site Trips



Figure 9: 2027 Full Buildout Peak Hour Traffic

5 **Projected Capacity and Level of Service**

Intersection capacity analyses were performed using the Synchro 11 Software at signalized intersection and the Highway Capacity Software 2023 at the two-way stop-controlled intersections in order to evaluate the AM and PM peak hours for existing, background and full buildout conditions. The existing signal timing at the signalized intersection was provided by City of Knoxville Department of Engineering and is included in Attachment 5.

Level of Service

The results from the analyses are expressed with a term "level of service" (LOS), which is based on the amount of delay experienced at the intersection. The LOS index ranges from LOS A, indicating excellent traffic conditions with minimal delay, to LOS F indicating very congested conditions with excessive delay. LOS D generally is considered the minimum acceptable condition in urban areas. Table 5-1 shows the LOS index range for signalized and unsignalized intersections as defined by the Highway Capacity Manual (HCM).

Level of Service	Signalized Intersection	Unsignalized Intersection							
LOS A	\leq 10 sec	$\leq 10 \text{ sec}$							
LOS B	10 – 20 sec	10 – 15 sec							
LOS C	20 – 35 sec	15 – 25 sec							
LOS D	35 – 55 sec	25 – 35 sec							
LOS E	55 – 80 sec	35 – 50 sec							
LOS F	> 80 sec	> 50 sec							

Table 5-1 Level of Service (LOS) Index

The Synchro 11 worksheets are included in Attachments 6, 7, and 8. Table 5-2 shows the results of the capacity analyses.

Intersection	Time Period	Year 2024 Existing (Delay/LOS)	Year 2027 Background (Delay/LOS)	Year 2027 Full Buildout (Delay/LOS)
Kingston Pike (US 11/US 70) @ Ebenezer Road	AM Peak Intersection PM Peak Intersection	18.0 / B 27.3 / C	18.3 / B 28.1 / C	22.9 / C 38.0 / D
Ebenezer Road @ Apartment Driveway	AM Peak WB Approach SB Approach PM Peak WB Approach SB Approach			12.5 / B 1.2 / A 14.1 / B 1.7 / A
Ebenezer Road @ Driveway	AM Peak WB Approach SB Approach PM Peak WB Approach SB Approach			11.5 / B 0.8 / A 12.5 / B 1.4 / A

Table 5-2 Level of Service (LOS) Summary

Notes:

1.Whole intersection weighted average control delay expressed in second per vehicle for signalized intersections and all-way stop controlled intersections.

6 Queue Analysis

Table 6-1 presents the Synchro traffic queueing summary for the 95th percentile queue at the signalized intersection of Kingston Pike (US 11/US 70) at Ebenezer Road for both the AM and PM peak hour.

Intersection	Movement	Storage Capacity	Exist Cond	ing itions	Backa Conc	ground litions	Full Buildout Conditions		
		(ft)	AM	PM	AM	PM	AM	PM	
	EBL	140	14	26	14	27	16	29	
	EBT	585	264	604	274	#650	304	#725	
Kingston Pk	EBR	140	0	21	0	23	0	54	
(US 70/US 11)	WBL	90	42	119	43	135	59	216	
@ Ebenezer Rd	WBT	1,000+	148	277	154	288	171	288	
	WBR	100	0	1	0	1	0	1	
	NBT	1,000+	125	#169	127	#180	162	#259	
	NBR	50	57	61	58	68	101	131	
	SBT	240	31	#257	31	#268	33	#281	
	SBR	50	0	0	0	0	0	0	

Table 6-1 Synchro Queue Summary

Notes:

The # footnote indicates that the volume for the 95th percentile cycle exceeds capacity. Bold indicates queue length exceeds available storage capacity.

Bold cells indicate that the queue lengths are more than the available storage. The 95th percentile queue length is defined as the queue length that has only a 5-percent probability of being exceeded during the analysis time period. The 95th percentile queue length is typically used to determine the length of turning lanes in order to minimize the risk of blockage. Synchro assumes a vehicle length of 25 feet.

The northbound right turn lane has an existing storage length of 50 feet and an additional 30 feet of taper length before the queue from the signalized intersection would block the driveway to the retail strip center. The signalized intersection capacity analysis shows the full buildout 95% queue length for the northbound right turn lane of approximately 101 feet (4 vehicles) during the AM peak hour and 131 feet (6 vehicles) during the PM peak hour and the full buildout 50% queue length for the northbound right turn lane of approximately 31 feet (2 vehicles) during the AM peak hour and 47 feet (2 vehicles) during the PM peak hour.

Therefore; the existing northbound right turn lane storage will exceed capacity and cause spillback into the thru lane less than 50% of time after the completion of the Ebenezer Road Subdivision.

7 Turn Lane Warrant Analysis

The intersection of Ebenezer Road at the proposed apartment roadway connection and the proposed subdivision roadway connection was evaluated to determine if a northbound right turn lane or a southbound left turn lane are warranted. The Knox County Department of Engineering and Public Works handbook, "Access Control and Driveway Design Policy," was used to analyze the information.

At the intersection of Ebenezer Road at the proposed roadway connection to the Future Development Area a southbound left turn is warranted during the PM peak hour and a northbound right turn lane is not warranted during either the AM and or PM peak hours after the full buildout of the Ebenezer Road Subdivision and Future Development Area.

At the intersection of Ebenezer Road at the proposed roadway connection to the Ebenezer Road Subdivision neither a southbound left turn lane nor a northbound right turn lane are warranted during the AM or PM peak hours.

The turn lane warrant worksheets and analysis are included in Attachment 9.

8 Conclusions and Recommendations

8.1 Kingston Pike (US 11/US 70) at Ebenezer Road

The existing intersection of Kingston Pike (US 11/US 70) at Ebenezer Road is a signalized four-legged intersection. The southbound approach is an existing shopping center driveway connection. The existing signal timing was provided by the City of Knoxville.

Under the existing and 2027 background conditions the signalized intersection of Kingston Pike (US 11/US 70) at Ebenezer Road operates at an acceptable LOS B during the AM peak hour and LOS C during the PM peak hour.

After the completion of the Ebenezer Road Subdivision including the future development area the traffic conditions for the signalized intersection of Kingston Pike (US 11/US 70) at Ebenezer Road will operate at an acceptable LOS C during the AM peak hour and a LOS D during the PM peak hour.

The 95% queue length is defined as the queue length that has only a 5-percent probability of being exceeded during the analysis time period. The 95% queue length is typically used to determine the length of turning lanes in order to minimize the risk of blockage.

The northbound right turn lane has an existing storage length of 50 feet and an additional 30 feet of taper length before the queue from the signalized intersection would block the driveway to the retail strip center. The signalized intersection capacity analysis shows the full buildout 95% queue length for the northbound right turn lane of approximately 101 feet (4 vehicles) during the AM peak hour and 131 feet (6 vehicles) during the PM peak hour and the full buildout 50% queue length for the northbound right turn lane of approximately 31 feet (2 vehicles) during the AM peak hour and 47 feet (2 vehicles) during the PM peak hour.

The northbound right turn lane (Ebenezer Road) will exceed the available queue storage length of 50 feet less than 50% of the time after the completion of the Ebenezer Road Subdivision and Future Development Area.

There are several existing constraints including the location of guard rails and power poles and the proximity to Ten Mile Creek that would make extending the storage length of the right turn lane difficult to construct.

The existing geometry of the northbound right turn lane is a 50-foot storage length and a 30-foot taper ending at the start of the existing commercial driveway. In order to maximum storage capacity Ardurra recommends relocating the communication pole and widening the 80-foot length of Ebenezer Road between the stop bar and the commercial driveway to match the existing width of 20 feet to allow additional vehicle stacking.

Ardurra recommends that any future intersection improvements be reviewed, coordinated and approved by both the City of Knoxville Department of Engineering and Knox County Engineering and Public Works.

8.2 Ebenezer Road at Future Development Area

The proposed full buildout conditions at the unsignalized intersection of Ebenezer Road at the Future Development Area Roadway were analyzed using the Highway Capacity Software (HCS2023).

A southbound left turn lane is warranted during the PM peak hour and a northbound right turn lane is not warranted at the intersection of Ebenezer Road at Future Development Area Roadway per the Knox County Department of Engineering and Public Works handbook, "Access Control and Driveway Design Policy." The southbound left turn lane has a recommended minimum storage length of 50 feet per the AASHTO Greenbook "A Policy on Geometric Design of Highways and Streets."

After the completion of the full buildout of the Ebenezer Road Subdivision including the proposed roadway improvements the intersection of Ebenezer Road at Future Development Area Roadway will operate as follows. The westbound approach (Apartment Roadway) will operate at a LOS B during both the AM and PM peak hours and the southbound approach (Ebenezer Road) will operate at a LOS A during both the AM and PM peak hours.

Ebenezer Road is classified as Minor Collector per the Major Road Plan. The minimum intersection spacing required on a collector road is 300 feet per the "Knoxville-Knox County Subdivision Regulations" amended through October 6, 2022.

The minimum required sight distance for a road with a posted speed limit of 30 mph is 300 feet in each direction in accordance with the "Knoxville-Knox County Subdivision Regulations" amended through October 6, 2022.

The location of the proposed apartment roadway for the Future Development Area is still under consideration.

Ardurra recommends that the intersection sight distance be certified by a land surveyor prior to construction in order to verify that Ebenezer Road has adequate intersection sight distance at the proposed apartment roadway connection to comply with Knox County Engineering and Public Works guidelines.

Ardurra recommends that the signs and pavement markings be installed in accordance with the standards provided in the *Manual on Uniform Traffic Control Devices* (MUTCD).

Any future improvements to the intersection or the various traffic management infrastructure, would need to be reviewed, coordinated, and approved by Knox County Engineering and Public Works.

8.3 Ebenezer Road at Ebenezer Subdivision

The proposed full buildout conditions at the unsignalized intersection of Ebenezer Road at the Ebenezer Subdivision Roadway were analyzed using the Highway Capacity Software (HCS2023).

Neither a southbound left turn lane nor a northbound right turn lane is warranted at the intersection of Ebenezer Road at Ebenezer Subdivision Roadway per the Knox County Department of Engineering and Public Works handbook, "Access Control and Driveway Design Policy."

After the completion of the full buildout of the Ebenezer Road Subdivision the intersection of Ebenezer Road at Subdivision Roadway will operate as follows. The westbound approach (Subdivision Roadway) will operate at a LOS B during both the AM and PM peak hours and the southbound approach (Ebenezer Road) will operate at a LOS A during both the AM and PM peak hours.

Ebenezer Road is classified as Minor Collector per the Major Road Plan. The minimum intersection spacing required on a collector road is 300 feet per the "Knoxville-Knox County Subdivision Regulations" amended through October 6, 2022. The Ebenezer Subdivision Roadway is located approximately 535 feet north of Rosemont Boulevard; therefore, the minimum separation on a collector is met and no change is necessary.

The minimum required sight distance for a road with a posted speed limit of 30 mph is 300 feet in each direction in accordance with the "Knoxville-Knox County Subdivision Regulations" amended through October 6, 2022.

At 15 feet from the edge of pavement the intersection sight distance is greater than 300 feet looking both northbound and southbound. Attachment 10 includes pictures of the intersection sight distance at the intersection of Ebenezer Road at Ebenezer Subdivision Roadway.

Ardurra recommends that the intersection sight distance be certified by a land surveyor prior to construction in order to verify that Ebenezer Road has adequate intersection sight distance at the proposed apartment roadway connection to comply with Knox County Engineering and Public Works guidelines.

Ardurra recommends that the signs and pavement markings be installed in accordance with the standards provided in the *Manual on Uniform Traffic Control Devices* (MUTCD).

Any future improvements to the intersection or the various traffic management infrastructure, would need to be reviewed, coordinated, and approved by Knox County Engineering and Public Works.

Attachment 1	
Aerial Photos	



Kingston Pike (SR 70) at Ebenezer Road - Signalized



Ebenezer Road Guardrail - Northbound



Ebenezer Road Guardrail – Southbound

Attachment 2 Traffic Counts

Project: 330.029 Ebenezer Rd Subdivision Intersection: Kingston Pike at Ebenezer Road Date Conducted: Tuesday March 19,2024

		Drive	way			Kingsto	ngston Pike		E	beneze	er Road			Kingsto	n Pike		
		Southb	ound			Westb	ound			Northb	ound			Eastbo	ound		
Start	Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	Int. Total
7:00 AM	0	0	0	0	7	81	3	91	13	0	18	31	0	65 120	3	68 120	190
7:13 AM	2	4	2	28	14	98	4	116	27	1	52 45	50 73	0	150	0 9	150	360
7:45 AM	1	0	2	3	17	158	4	179	31	4	48	83	4	209	13	226	491
Total	3	4	6	13	44	441	12	497	88	6	143	237	4	558	33	595	1342
8:00 AM	4	3	3	10	15	141	3	159	29	2	49	80	3	217	15	235	484
8:15 AM	1	3	1	5	21	160	8	189	20	2	46	68	1	213	10	224	486
0:30 AM 8:45 AM	4	7	2 2	9 14	20	170	13	203	25	3	30	61	2	134	12	103	436
Total	14	13	11	38	70	621	28	719	96	13	161	270	9	766	44	819	1846
9:00 AM	4	3	0	7	15	115	9	139	20	2	26	48	0	139	14	153	347
9:15 AM	7	4	1	12	6	171	6	183	20	2	21	43	2	158	19	179	417
9:30 AM	4	1	0	5	13	129	8	150	22	0	26	48	1	142	11	154	357
9:45 AM	<u> </u>	0	1	3	21	588	32	203	15	0	28	43	3	602	55	662	426
TOLAT	10	0	1	27		300	52	0/3	//	4	101	102	0	002	55	005	1347
10:00 AM	9	6	2	17	11	158	10	179	18	5	10	33	1	133	8	142	371
10:15 AM	4	6	3	13	7	175	11	193	13	4	17	34	3	196	10	209	449
10:30 AM	9	4	3	16	13	193	13	219	16	6	22	44	2	147	8	157	436
10:45 AM	6	4	3	13	13	194	15	222	17	3	16	36	1	191	12	204	475
Total	28	20	11	59	44	720	49	813	64	18	65	147	7	667	38	712	1731
11.00 444	14	6	4	24	1.4	100	14	227	21	0	15	44	6	100	14	200	504
11:15 AM	14	4	4	17	14	220	14	246	21	0 4	15	44	2	207	14	209	529
11:30 AM	12	6	4	22	21	191	14	226	23	6	15	44	6	185	22	213	505
11:45 AM	7	7	6	20	19	259	12	290	17	5	25	47	5	265	18	288	645
Total	38	23	22	83	68	869	52	989	87	23	71	181	19	846	65	930	2183
		_	_	1				1		_		1					
12:00 PM	11	3	7	21	25	226	12	263	24	7	22	53	6	231	9	246	583
12:15 PM 12:30 PM	15	10	2	23	20 13	259	10	295	20	2	27	49 54	4	200	17	270	632
12:45 PM	6	5	4	15	24	269	10	303	19	7	19	45	7	256	15	278	641
Total	46	19	21	86	82	1018	50	1150	86	19	96	201	20	973	69	1062	2499
1:00 PM	19	4	6	29	16	197	14	227	26	1	18	45	6	207	15	228	529
1:15 PM	12	3	5	20	15	268	18	301	24	5	18	47	2	262	25	289	657
1:30 PM	12	7	4	23	14	261	15	290	29	2	16	47	5	221	23	249	609
Total	51	16	19	86	64	1033	66	345	108	12	69	20 189	2 18	936	81	209	2473
Total	51	10	15	001	04	1055	00	1105	100	12	05	105	10	550	01	1055	2475
2:00 PM	17	6	8	31	17	243	18	278	16	4	22	42	3	213	29	245	596
2:15 PM	13	7	6	26	23	261	14	298	19	3	16	38	2	251	22	275	637
2:30 PM	4	7	3	14	16	269	11	296	20	5	15	40	4	217	20	241	591
2:45 PM	42	4	3	16	19	251	19	289	28	4	22	174	10	244	13	260	619
TOLAT	43	24	20	0/	75	1024	62	1101	03	16	75	1/4	12	925	04	1021	2443
3:00 PM	9	8	6	23	22	231	12	265	32	2	23	57	3	237	22	262	607
3:15 PM	9	8	1	18	21	270	15	306	20	4	17	41	5	269	29	303	668
3:30 PM	11	7	4	22	26	257	15	298	33	8	30	71	1	221	20	242	633
3:45 PM	11	8	5	24	37	304	14	355	26	2	18	46	5	266	20	291	716
Total	40	31	16	87	106	1062	56	1224	111	16	88	215	14	993	91	1098	2624
4.00 PM	12	7	5	2 ⊿	26	218	11	255	20	1	20	621	10	261	27	201	642
4.00 PM	6	7	2	15	20	210	11	233	28	3	29	54	4	320	27	351	709
4:30 PM	21	9	1	31	32	226	12	270	28	7	29	64	3	303	23	329	694
4:45 PM	12	11	2	25	28	261	14	303	18	4	28	50	4	328	25	357	735
Total	51	34	10	95	113	956	48	1117	106	15	109	230	21	1215	102	1338	2780
E 00 BL/			~	1		a 	_	2001	25	2		= c l	-	200	0.5	226	761
5:00 PM	28	15	2	45	44	247	7	298	35	3	41	79 75	5	309	25	339	/6] 769
5:15 PM	30	13	4	4/ 1/	30 22	∠53 221	0 1 2	299	29 18	6 5	40 24	/5 /7	6 1	313 200	20 22	34/ 222	/00 701
5:45 PM	19	15	5	39	32	280	13	325	22	5	31	-+/ 58	7	356	21	384	806
Total	104	54	17	175	147	1011	41	1199	104	19	136	259	19	1277	107	1403	3036
Grand Total	436	246	154	836	868	9343	496	10707	1010	161	1114	2285	149	9758	769	10676	24504
Approach %	52.2	29.4	18.4		8.1	87.3	4.6	42 -	44.2	7.0	48.8	0.2	1.4	91.4	7.2	42.6	
iotal %	1.8	1.0	0.6	3.4	3.5	38.1	2.0	43.7	4.1	0.7	4.5	9.3	0.6	39.8	3.1	43.6	

Project: 330.029 Ebenezer Rd Subdivision Intersection: Kingston Pike at Ebenezer Road Date Conducted: Tuesday March 19,2024

AM Peak Hour	7:45 AM - 8:45 AM	1897
PM Peak Hour	5:00 PM - 6:00 PM	3036

		Drive	eway			Kingsto	on Pike		E	benez	er Roac			Kingsto	on Pike		
		South	oound			Westk	ound			North	bound		Eastbound				
Start	Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	Left	Thru	Right	Total	Int. Total
Peak Hour Analysis from	7:00 AN	1 to 9:0	0 AM														
AM Peak Hour begins at	7:45 AM																
7:45 AM	1	0	2	3	17	158	4	179	31	4	48	83	4	209	13	226	491
8:00 AM	4	3	3	10	15	141	3	159	29	2	49	80	3	217	15	235	484
8:15 AM	1	3	1	5	21	160	8	189	20	2	46	68	1	213	10	224	486
8:30 AM	4	0	5	9	20	170	13	203	25	6	30	61	2	154	7	163	436
Total Volume	10	6	11	27	73	629	28	730	105	14	173	292	10	793	45	848	1897
Future (1.0% over 3 yrs)	10	6	11		75	648	29		108	14	178		10	817	46		1954
PHF	0.63	0.50	0.55		0.87	0.93	0.54		0.85	0.58	0.88		0.63	0.91	0.75		0.97
Peak Hour Analysis from	3:00 PM	to 6:00) PM														
PM Peak Hour begins at 3	5:00 PM																
5:00 PM	28	15	2	45	44	247	7	298	35	3	41	79	5	309	25	339	761
5:15 PM	30	13	4	47	38	253	8	299	29	6	40	75	6	313	28	347	768
5:30 PM	27	11	6	44	33	231	13	277	18	5	24	47	1	299	33	333	701
5:45 PM	19	15	5	39	32	280	13	325	22	5	31	58	7	356	21	384	806
Total Volume	104	54	17	175	147	1011	41	1199	104	19	136	259	19	1277	107	1403	3036
Future (1.0% over 3 yrs)	107	56	18		151	1042	42		107	20	140		20	1316	110		3128
PHF	0.87	0.90	0.71		0.84	0.90	0.79		0.74	0.79	0.83		0.68	0.90	0.81		0.94

Attac	hment	3
ADT	Trend	S

	Year	Adjusted Average Daily Traffic	
10	2010	6563	
11	2011	5988	ADT Trend - TDOT Station ID: 47000466
2	2012	6391	Ebenezer Rd
3	2013	6321	7000
4	2014	5845	
5	2015	6576	6000
6	2016	5609	5000
7	2017	5866	
8	2018	4111	4000
9	2019	4526	3000
0	2020	5562	2000
1	2021	4240	1000
2	2022	4491	1000
3	2023	4581	0 2008 2010 2012 2014 2016 2018 2020 2022 202

Most Recent Trend Line GrowthYearADT2013632120234581

Annual Percent Growth

-3.80%
	Adjusted Average	
Year	Daily Traffic	
2001	28732	
2002	30319	ADT Trend TDOT STation ID: 47000128
2003	28953	Kingston Pike - SR001 S. of Andrew Jackson Lake
2004	30734	25000
2005	27340	55000
2006	27738	30000
2007	27777	25000
2008	25714	20000
2009	24173	15000
2010	24388	15000
2011	27957	10000
2012	26019	5000
2013	27441	
2014	27306	1995 2000 2005 2010 2015 2020 2025
2015	28450	
2016	28758	
2017	29058	
2018	25708	
2019	27477	
2020	29865	
2021	24832	
2022	27645	
2023	16397	

Most Recent Trend Line Growth Year ADT

rear	ADT
2012	26019
2022	27645

Annual Percent Growth

0.59%

Project: Ebenezer Subdivision - Future Development Area Date Conducted: 4/12/2024

Local Apartment Trip Generation Study 278 Units

Average Daily Traffic

 $T = 15.193(X)^{0.899}$ T = 15.193(278)^0.899 T = 2392

Peak Hour of Adjacent Street Traffic

One Hour Between 7 and 9 a.m. $T = 0.758(X)^{0.924}$ $T = 0.758(278)^{0.924}$

T = 137

Peak Hour of Adjacent Street Traffic

One Hour Between 4 and 6 p.m.

T = 0.669(X) + 10.069T = 0.669(278) + 10.069 T = 196

		Percent		Number	
Time Period	Total Trips	Enter	Exit	Enter	Exit
Weekday (24 hours)	2392	50%	50%	1196	1196
AM Peak Hour	137	22%	78%	30	107
PM Peak Hour	196	55%	45%	108	88

Project: Ebenezer Road Subdivision Date Conducted: 4/12/2024

Single-Family Detached Housing (LUC 210) 113 Lots

Average Daily Traffic

 $\begin{array}{l} Ln(T) \ = \ 0.92 \ Ln(X) \ + \ 2.68 \\ Ln(T) \ = \ 0.92 \ Ln(113) \ + \ 2.68 \\ T \ = \ 1129 \end{array}$

Peak Hour of Adjacent Street Traffic

One Hour Between 7 and 9 a.m. Ln(T) = 0.91 Ln(X) + 0.12 Ln(T) = 0.91 Ln(113) + 0.12T = 83

Peak Hour of Adjacent Street Traffic

One Hour Between 4 and 6 p.m.

Ln(T) = 0.94 Ln(X) + 0.27 Ln(T) = 0.94 Ln(113) + 0.27T = 112

		Percent		Number	
Time Period	Total Trips	Enter	Exit	Enter	Exit
Weekday (24 hours)	1129	50%	50%	565	565
AM Peak Hour	83	25%	75%	21	62
PM Peak Hour	112	63%	37%	71	41



MEMORANDUM

To: Traffic Impact Study Reviewers and Preparers (see attached list)

From: Mike Conger

Date: August 14, 2000

Subject: Local Trip Generation Rates for Multi-Family Residential Uses

Attached please find a summary of the final report with data plots for the Knox County Local Apartment Trip Generation Study. As you will recall, this report was discussed when the traffic impact study group last convened this past February. A consensus was reached at that meeting that the trip generation rates developed in the local study should be used for new apartment complexes <u>and</u> any other "multi-family" residential uses that are being proposed.

The MPC voted at its July 2000 meeting to officially amend the Traffic Impact Study Guidelines with language which reads that "trip generation rates for proposed uses shall be calculated using the latest edition of the ITE Trip Generation Manual, or using local data when it is available". This amendment allows the full implementation of the new rates, and they should be used for future proposed multi-family developments unless it can be demonstrated otherwise.

Thanks for your assistance and cooperation in this matter, if there are any questions or comments, please let me know.

Suite 403 • City County Building 4 0 0 M a i n S t r e e t Knoxville, Tennessee 37902 8 6 5 • 2 1 5 • 2 5 0 0 F A X • 2 1 5 • 2 0 6 8 w w • k n o x m p c • o r g

TRAFFIC IMPACT STUDY REVIEWER & PREPARER GROUP

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KNOX COUNTY LOCAL APARTMENT TRIP GENERATION STUDY

PURPOSE

A Traffic Impact Study (TIS) is currently required in Knox County when a proposed development is projected to generate in excess of 750 trips per day. The determinations of when the threshold is met as well as all subsequent analyses in the TIS are performed using the rates and equations given in the Institute of Transportation Engineers (ITE) Trip Generation Manual. Local governmental agencies rely heavily on the accuracy of these trip generation rates in order to correctly predict the impacts of a proposed development on the transportation system. Therefore, in certain instances, it is logical to verify whether the "national" rates and equations given in the ITE Trip Generation Manual are appropriate for use in a specific local area or region.

The decision was made to study the local trip-making characteristics of apartments because of the discrepancy between the trip generation rates for apartments and single family residential land uses as given in the ITE Trip Generation Manual. While these two land uses are similar in nature, the Trip Generation Manual predicts about three less trips per dwelling unit generated by apartments for the average weekday. Additionally the Trip Generation Manual points out that due to the age of their database, which dates back to the 1960's, "the rates for apartments probably had changed over time". It is also assumed that some of the ITE data had come from larger metropolitan areas with denser development and greater transit use than Knox County, which would contribute to lower trip generation Manual or generate new ones that can be applied to locally proposed apartment developments.

PROCEDURE

The procedures recommended by ITE in conducting local trip generation studies were generally followed for this study, along with some important assumptions that have made. ITE has published a proposed recommended practice entitled "Trip Generation Handbook" which specifically outlines procedures for conducting local trip generation studies and establishing new rates and equations.

The first step in the study was to define the number and location of the sites to be studied, as well as the counting methodology. Initially 14 sites were selected, although one apartment complex – the College Park Apartments – was later omitted due to uncharacteristically high traffic generation numbers. The number of sites used in this study far exceeds the recommended minimum amount suggested by ITE, which is five sites. Traffic counts were taken for week-long periods at 15-minute intervals between July 22, 1996 and August 9, 1996 at the access points to the apartment complexes. A Technical Appendix to this report contains the traffic count data collected at each apartment complex.

RESULTS

The traffic count data was analyzed using spreadsheets in order to determine the weighted average rates and regression equations. In order to be considered valid, the local rates and equations for each time period of analysis that were generated must meet certain statistical criteria. First, the standard deviation of the independent variable (dwelling units) should be no more than 110 percent of the weighted average rate; and secondly, the regression equations require a computed coefficient of determination (\mathbb{R}^2) value of at least 0.75 before good data fit is indicated. This statistical criteria is met by the local data results, and in fact it often exceeds the level of data fit given by their counterparts in the ITE Trip Generation Manual. Finally, in order to simplify the use of the local data, plots were generated that appear identical to the actual ones in the ITE Trip Generation Manual.

The resulting rates and equations calculated from the local data indicate that the average weekday trip generation of apartments in this area is well above the national rates reported in the ITE manual. For example, the locally computed average rate for number of trips generated during a weekday is 35% higher than the rate given by ITE (increase from 6.63 trips per dwelling unit to 9.03 trips per dwelling unit). The trip generation rates do not increase as much for the AM and PM peak hours however. The local rate is roughly 8% higher for the AM peak, and 16% higher for the PM peak. The plots from the ITE Trip Generation Manual are included in the Technical Appendix for comparison purposes.

ASSUMPTIONS MADE

Some important assumptions have been made which may affect the results of the local data that was collected:

- It is important to note that the local trip generation rates were computed for the *total* number of dwelling units in the apartment complex, and <u>not</u> necessarily for the number of *occupied* dwelling units. There are several reasons why this was done, chiefly because of the need for comparability with the rates given in ITE Trip Generation Manual, as it does not specify whether the dwelling units are occupied. According to ITE procedures the selected sites must only be of "reasonably full occupancy (i.e. at least 85%)". The Apartment Association of Greater Knoxville (AAGK) publishes quarterly reports on occupancy levels of apartment complexes, and the report covering the period of the data collection was reviewed to determine occupancy levels. According to the AAGK report from July 1, 1996 September 30, 1996 all of the apartment complexes surveyed in this study met the minimum 85% occupancy level, with an average occupancy rate for all sites studied of 94%.
- The count data that was collected at each apartment complex was used "raw" meaning that it was not factored for possible daily or seasonal variations. Once again, according to an ITE representative it is not known whether the data used in the Trip Generation Manual was factored or not, so therefore in order to be able to compare

local rates to those in the manual you must assume that count data should not be factored. Additionally, it was felt that apartment complexes would generally not be as susceptible to major seasonal fluctuations as other land uses might be. The local rates were also developed using count data that was collected and averaged over an entire week, which should limit some of the daily variations. Finally, reliable local daily and seasonal variation factors do not truly exist.

CONCLUSION

The local apartment study methodology and results were distributed for comment to a group of local transportation professionals who are directly responsible for either preparing or reviewing traffic impact studies. A meeting was held between this group on February 16, 2000 in order to gather comments and discuss the study in greater detail. The following conclusions are based on the discussion and consensus reached at this meeting:

- 1. The trip generation rates and equations meet statistical requirements and resulted from a study that followed accepted procedures; therefore they should be adopted for future use. Furthermore, the rates and equations are recommended for use in reviewing the traffic impact of any development termed as "multi-family", such as townhouse and condominium developments due to their similarity to apartment complexes.
- 2. The Traffic Access and Impact Study Guidelines and Procedures adopted by MPC should be amended with the language that local data should be used when available, which will allow the implementation of these new multi-family trip generation rates.
- 3. The following suggestions were made for future consideration:
 - This study should be updated with data collected from local townhouse and condominium developments in order to further justify the use of the new trip generation rates.
 - A statistical comparison should be made between any newly developed rates and the ITE single family trip generation rates to determine if there is a significant difference. If there is no difference then perhaps ITE single-family rates could be used for any residential development proposed in Knox County.

Local Apartment Trip Generation Study

Average Vehicle Trip Ends vs: On a:

Dwelling Units Weekday

13
193
50% entering, 50% exiting

Trip Generation Per Dwelling Unit

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



Local Apartment Trip Generation Study

Average	Vehicle	Trip	Ends vs:	
			On a:	

Dwelling Units Weekday, Peak Hour of Adjacent Street Traffic, One Hour Between 7 and 9 a.m.

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

Trip Generation Per Dwelling Unit

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



Local Apartment Trip Generation Study

Average Vehicle Trip Ends vs: On a:	Dwelling Units Weekday, Peak Hour of Adjacent Street Traffic, One Hour Between 4 and 6 p.m.
Number of Studies:	13
Average Number of Dwelling Units:	193
Directional Distribution:	55% entering, 45% exiting

Trip Generation Per Dwelling Unit

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



Single-Family Detached Housing (210)

Vehicle Trip Ends vs: Dwelling Units

On a: Weekday

Setting/Location: General Urban/Suburban

Number of Studies: 174

Avg. Num. of Dwelling Units: 246

Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Dwelling Unit

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



Single-Family Detached Housing (210)

Vehicle Trip Ends vs: Dw	velling Units
On a: We	eekday,
Pe	ak Hour of Adjacent Street Traffic,
On	ne Hour Between 7 and 9 a.m.
Setting/Location: Ge	eneral Urban/Suburban
Number of Studies: 19	2
Avg. Num. of Dwelling Units: 22	6
Directional Distribution: 26	% entering, 74% exiting

Vehicle Trip Generation per Dwelling Unit

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





Single-Family Detached Housing (210)

Vehicle Trip Ends vs: Dwelling Units	
On a: Weekday,	
Peak Hour of Adjacent Street Traffic	
One Hour Between 4 and 6 p.m.	
Setting/Location: General Urban/Suburban	
Number of Studies: 208	
Avg. Num. of Dwelling Units: 248	
Directional Distribution: 63% entering, 37% exiting	

Vehicle Trip Generation per Dwelling Unit

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



Attachment 5	
Signal Timing	

Intersection N	ame : Kir	ngston Pi	ke and E	benezer]	Rd		Las	t Update	ed: 4/8/24	4	
Basic Tim	ing (secor	nds)	Phase 1	Phase 2	Phase 3	Phase 4	Image: Phase 5 Phase 6 Phase 7 Phase 7				
Min	Green		6	18	8	8		18			
Gap / 1	Extension		2	3	3	2		3			
Μ	lax 1		20	50	30	15		50			
Μ	lax 2		25	55	25	30		55			
Yellow	Clearanc	e	4	4.5	4	4		4.5			
Red C	learance		1.5	1.5	2	3		1.5			
V	Valk		N/A	N/A	N/A	N/A		N/A			
Pedestria	n Clearai	ice	N/A	N/A	N/A	N/A		N/A			
Max	Recall			X				X			
Active (Er	nable) Pha	ases	X	X	X	X		X			
Flashing Y	ellow Ar	row									
Overl	aps (1-4)			1		1		1		1	
	<u> </u>		Coord	lination '	Fiming/(s	seconds			<u>.</u>		
Split #	Coord.	Phase	Phase 1	Phase 2	Phase 3	Phase 4	4 Phase 5	Phase 6	Phase 7	Phase 8	
Split 1	2		17	36	21	21		53			
Split 2	2		16	38	28	18		54			
Split 3	2		18	60	21	21		78			
Split 4	2		26	54	20	20		80			
Split 5	2		18	63	19	25		81			
Split 6	2		28	63	22	22		91			
<u> </u>	Patter	n Table			Lead /	Lag	Fixed / Fl	oating	Fixed		
Pattern#	Cycle	Offset	Split	Seq. #	Phas	e #	Beginnin	g of	Yellow		
1	95	22	1	1	1		(Green/Ye	ellow) on ID#	252		
2	100	76	2	1	1	_	I/P Add	ross	N/A		
2	120	18	3	1	1	-		lross	N/A N/A		
<u> </u>	120	10 24	<u> </u>	1	1	-	Radio Ad	dress	11/14		
5	120	24	5	1	1	_	Comm 7	Type	N/A		
<u> </u>	125	13	6	1	1	_	Detecti	ion	Inductive Lear		
0	155	15	0	Dov Pla	n Evont	<u> </u>	Dutt		Inductive Loops		
Day Plan	нн	MM	Pat	Day I la torn	In Lvent	s Plan	нн	MM	Patt	orn	
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110103.											



Timings 1: Ebenezer Road/Driveway & Kingston Pike

05/23/2024	ŀ
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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBT	NBR	SBT	SBR	
Lane Configurations	۲	^	1	٦	^	1	र्स	1	ų	1	
Traffic Volume (vph)	10	793	45	73	629	28	14	173	6	11	
Future Volume (vph)	10	793	45	73	629	28	14	173	6	11	
Turn Type	Perm	NA	Perm	pm+pt	NA	Perm	NA	Perm	NA	Perm	
Protected Phases		2		1	6		8		4		
Permitted Phases	2		2	6		6		8		4	
Detector Phase	2	2	2	1	6	6	8	8	4	4	
Switch Phase											
Minimum Initial (s)	18.0	18.0	18.0	6.0	18.0	18.0	8.0	8.0	8.0	8.0	
Minimum Split (s)	24.0	24.0	24.0	11.5	24.0	24.0	14.0	14.0	15.0	15.0	
Total Split (s)	38.0	38.0	38.0	16.0	54.0	54.0	28.0	28.0	18.0	18.0	
Total Split (%)	38.0%	38.0%	38.0%	16.0%	54.0%	54.0%	28.0%	28.0%	18.0%	18.0%	
Yellow Time (s)	4.5	4.5	4.5	4.0	4.5	4.5	4.0	4.0	4.0	4.0	
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5	1.5	2.0	2.0	3.0	3.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Lost Time (s)	6.0	6.0	6.0	5.5	6.0	6.0	6.0	6.0	7.0	7.0	
Lead/Lag	Lag	Lag	Lag	Lead							
Lead-Lag Optimize?	Yes	Yes	Yes	Yes							
Recall Mode	C-Max	C-Max	C-Max	None	Max	Max	None	None	None	None	
Act Effct Green (s)	56.7	56.7	56.7	67.1	66.6	66.6	12.4	12.4	8.0	8.0	
Actuated g/C Ratio	0.57	0.57	0.57	0.67	0.67	0.67	0.12	0.12	0.08	0.08	
v/c Ratio	0.02	0.41	0.05	0.18	0.28	0.03	0.55	0.51	0.11	0.04	
Control Delay	16.3	16.0	0.1	9.3	8.8	0.0	49.9	11.1	44.7	0.3	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	16.3	16.0	0.1	9.3	8.8	0.0	49.9	11.1	44.7	0.3	
LOS	В	В	A	А	A	A	D	В	D	А	
Approach Delay		15.2			8.5		26.9		26.6		
Approach LOS		В			A		С		С		
Intersection Summary											
Cycle Length: 100											
Actuated Cycle Length: 100)										
Offset: 0 (0%), Referenced	to phase 2	:EBTL, St	art of Gre	en							
Natural Cycle: 65											
Control Type: Actuated-Coc	ordinated										
Maximum v/c Ratio: 0.55											
Intersection Signal Delay: 1	4.6			Ir	ntersectio	n LOS: B					
Intersection Capacity Utiliza	ation 60.6%)		10	CU Level	of Service	эB				
Analysis Period (min) 15											
• ··· · •	-										

Splits and Phases: 1: Ebenezer Road/Driveway & Kingston Pike

€ø1	Ø2 (R)	Ø4	√ ø8	
16 s	38 s	2.81	28 📾	
₹ø6				
54 s				

Timings 1: Ebenezer Road/Driveway & Kingston Pike

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBT	NBR	SBT	SBR	
Lane Configurations	٢	44	1	5	**	1	र्भ	1	đ	1	
Traffic Volume (vph)	19	1277	107	147	1011	41	19	136	54	17	
Future Volume (vph)	19	1277	107	147	1011	41	19	136	54	17	
Turn Type	Perm	NA	Perm	pm+pt	NA	Perm	NA	Perm	NA	Perm	
Protected Phases		2		1	6		8		4		
Permitted Phases	2		2	6		6		8		4	
Detector Phase	2	2	2	1	6	6	8	8	4	4	
Switch Phase											
Minimum Initial (s)	18.0	18.0	18.0	6.0	18.0	18.0	8.0	8.0	8.0	8.0	
Minimum Split (s)	24.5	24.5	24.5	11.5	24.0	24.0	14.0	14.0	15.0	15.0	
Total Split (s)	54.0	54.0	54.0	26.0	80.0	80.0	20.0	20.0	20.0	20.0	
Total Split (%)	45.0%	45.0%	45.0%	21.7%	66.7%	66.7%	16.7%	16.7%	16.7%	16.7%	
Yellow Time (s)	4.5	4.5	4.5	4.0	4.5	4.5	4.0	4.0	4.0	4.0	
All-Red Time (s)	2.0	2.0	2.0	1.5	1.5	1.5	2.0	2.0	3.0	3.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Lost Time (s)	6.5	6.5	6.5	5.5	6.0	6.0	6.0	6.0	7.0	7.0	
Lead/Lag	Lag	Lag	Lag	Lead							
Lead-Lag Optimize?	Yes	Yes	Yes	Yes							
Recall Mode	C-Max	C-Max	C-Max	None	Max	Max	None	None	None	None	
Act Effct Green (s)	59.6	59.6	59.6	76.3	75.8	75.8	12.5	12.5	12.6	12.6	
Actuated g/C Ratio	0.50	0.50	0.50	0.64	0.63	0.63	0.10	0.10	0.10	0.10	
v/c Ratio	0.08	0.77	0.13	0.66	0.48	0.04	0.70	0.49	0.89	0.06	
Control Delay	19.8	29.6	2.1	30.2	12.9	0.1	71.9	13.9	94.8	0.4	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	19.8	29.6	2.1	30.2	12.9	0.1	71.9	13.9	94.8	0.4	
LOS	В	С	А	С	В	А	E	В	F	А	
Approach Delay		27.4			14.5		41.4		85.6		
Approach LOS		С			В		D		F		
Intersection Summary											
Cycle Length: 120											
Actuated Cycle Length: 120											
Offset: 0 (0%), Referenced to	phase 2:	EBTL, St	art of Gre	en							
Natural Cycle: 80	Natural Cycle: 80										
Control Type: Actuated-Coordinated											
Maximum v/c Ratio: 0.89											
Intersection Signal Delay: 26.	.9			Ir	ntersectio	n LOS: C					
Intersection Capacity Utilizati	on 74.5%			10	CU Level	of Service	e D				
Analysis Period (min) 15											

Splits and Phases: 1: Ebenezer Road/Driveway & Kingston Pike

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26 s	54 5	20 s	20 s
₹ø6			
80 s			

HCM 6th Signalized Intersection Summary 1: Ebenezer Road/Driveway & Kingston Pike

05/23/2024

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	٦	† †	1	7	^	1		र्स	1		đ	1
Traffic Volume (veh/h)	10	793	45	73	629	28	105	14	173	10	6	11
Future Volume (veh/h)	10	793	45	73	629	28	105	14	173	10	6	11
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	10	818	46	75	648	29	108	14	178	10	6	11
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	470	1858	829	409	2240	999	218	28	218	48	29	67
Arrive On Green	0.52	0.52	0.52	0.05	0.63	0.63	0.14	0.14	0.14	0.04	0.04	0.04
Sat Flow, veh/h	762	3554	1585	1781	3554	1585	1586	206	1585	1134	680	1585
Grp Volume(v), veh/h	10	818	46	75	648	29	122	0	178	16	0	11
Grp Sat Flow(s),veh/h/ln	762	1777	1585	1781	1777	1585	1791	0	1585	1814	0	1585
Q Serve(g_s), s	0.6	14.3	1.4	1.8	8.2	0.7	6.3	0.0	10.9	0.9	0.0	0.7
Cycle Q Clear(g_c), s	0.6	14.3	1.4	1.8	8.2	0.7	6.3	0.0	10.9	0.9	0.0	0.7
Prop In Lane	1.00		1.00	1.00		1.00	0.89		1.00	0.62		1.00
Lane Grp Cap(c), veh/h	470	1858	829	409	2240	999	246	0	218	77	0	67
V/C Ratio(X)	0.02	0.44	0.06	0.18	0.29	0.03	0.50	0.00	0.82	0.21	0.00	0.16
Avail Cap(c_a), veh/h	470	1858	829	502	2240	999	394	0	349	200	0	174
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	11.5	14.8	11.7	10.1	8.4	7.0	39.9	0.0	41.9	46.3	0.0	46.2
Incr Delay (d2), s/veh	0.1	0.8	0.1	0.1	0.3	0.1	1.5	0.0	7.8	0.5	0.0	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/In	0.1	5.4	0.5	0.6	2.7	0.2	2.9	0.0	4.7	0.4	0.0	0.3
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	11.6	15.6	11.9	10.1	8.7	7.0	41.4	0.0	49.7	46.8	0.0	46.6
LnGrp LOS	В	В	В	В	A	A	D	A	D	D	A	D
Approach Vol, veh/h		874			752			300			27	
Approach Delay, s/veh		15.3			8.8			46.3			46.7	
Approach LOS		В			А			D			D	
Timer - Assigned Phs	1	2		4		6		8				
Phs Duration (G+Y+Rc), s	10.8	58.3		11.2		69.0		19.8				
Change Period (Y+Rc), s	5.5	6.0		7.0		6.0		6.0				
Max Green Setting (Gmax), s	10.5	32.0		11.0		48.0		22.0				
Max Q Clear Time (g_c+I1), s	3.8	16.3		2.9		10.2		12.9				
Green Ext Time (p_c), s	0.0	4.9		0.0		4.5		0.8				
Intersection Summary												
HCM 6th Ctrl Delay			18.0									
HCM 6th LOS			В									

Queues 1: Ebenezer Road/Driveway & Kingston Pike

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBT	NBR	SBT	SBR	
Lane Group Flow (vph)	10	818	46	75	648	29	122	178	16	11	
v/c Ratio	0.02	0.41	0.05	0.18	0.28	0.03	0.55	0.51	0.11	0.04	
Control Delay	16.3	16.0	0.1	9.3	8.8	0.0	49.9	11.1	44.7	0.3	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	16.3	16.0	0.1	9.3	8.8	0.0	49.9	11.1	44.7	0.3	
Queue Length 50th (ft)	3	174	0	18	96	0	75	0	10	0	
Queue Length 95th (ft)	14	264	0	42	148	0	125	57	31	0	
Internal Link Dist (ft)		551			715		608		380		
Turn Bay Length (ft)			140			100		50		50	
Base Capacity (vph)	428	2006	970	458	2356	1090	392	487	198	314	
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	
Reduced v/c Ratio	0.02	0.41	0.05	0.16	0.28	0.03	0.31	0.37	0.08	0.04	
Intersection Summary											

HCM 6th Signalized Intersection Summary 1: Ebenezer Road/Driveway & Kingston Pike

05/23/2024

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	7	† †	1	7	† †	1		ŧ	1		ŧ	1
Traffic Volume (veh/h)	19	1277	107	147	1011	41	104	19	136	104	54	17
Future Volume (veh/h)	19	1277	107	147	1011	41	104	19	136	104	54	17
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	20	1359	114	156	1076	44	111	20	145	111	57	18
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	290	1846	823	241	2210	986	164	30	171	129	66	171
Arrive On Green	0.52	0.52	0.52	0.06	0.62	0.62	0.11	0.11	0.11	0.11	0.11	0.11
Sat Flow, veh/h	503	3554	1585	1781	3554	1585	1520	274	1585	1196	614	1585
Grp Volume(v), veh/h	20	1359	114	156	1076	44	131	0	145	168	0	18
Grp Sat Flow(s),veh/h/ln	503	1777	1585	1781	1777	1585	1794	0	1585	1811	0	1585
Q Serve(g_s), s	2.7	35.7	4.5	4.7	19.7	1.3	8.4	0.0	10.8	11.0	0.0	1.2
Cycle Q Clear(g_c), s	10.1	35.7	4.5	4.7	19.7	1.3	8.4	0.0	10.8	11.0	0.0	1.2
Prop In Lane	1.00		1.00	1.00		1.00	0.85		1.00	0.66		1.00
Lane Grp Cap(c), veh/h	290	1846	823	241	2210	986	193	0	171	195	0	171
V/C Ratio(X)	0.07	0.74	0.14	0.65	0.49	0.04	0.68	0.00	0.85	0.86	0.00	0.11
Avail Cap(c_a), veh/h	290	1846	823	444	2210	986	209	0	185	196	0	172
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	18.4	22.4	14.9	21.3	12.3	8.8	51.5	0.0	52.6	52.7	0.0	48.3
Incr Delay (d2), s/veh	0.5	2.7	0.4	1.1	0.8	0.1	7.7	0.0	27.8	28.8	0.0	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/In	0.3	14.4	1.6	2.0	7.2	0.4	4.2	0.0	5.6	6.5	0.0	0.5
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	18.8	25.1	15.3	22.4	13.1	8.9	59.2	0.0	80.4	81.5	0.0	48.4
LnGrp LOS	В	С	В	С	В	А	E	А	F	F	А	D
Approach Vol, veh/h		1493			1276			276			186	
Approach Delay, s/veh		24.3			14.1			70.3			78.3	
Approach LOS		С			В			Е			Е	
Timer - Assigned Phs	1	2		4		6		8				
Phs Duration (G+Y+Rc), s	12.3	68.8		19.9		81.1		18.9				
Change Period (Y+Rc), s	5.5	6.5		7.0		* 6.5		6.0				
Max Green Setting (Gmax), s	20.5	47.5		13.0		* 74		14.0				
Max Q Clear Time (g_c+I1), s	6.7	37.7		13.0		21.7		12.8				
Green Ext Time (p_c), s	0.2	6.3		0.0		9.2		0.2				
Intersection Summary												
HCM 6th Ctrl Delay			27.3									
HCM 6th LOS			С									

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

Queues 1: Ebenezer Road/Driveway & Kingston Pike

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBT	NBR	SBT	SBR	
Lane Group Flow (vph)	20	1359	114	156	1076	44	131	145	168	18	
v/c Ratio	0.08	0.77	0.13	0.66	0.48	0.04	0.70	0.49	0.89	0.06	
Control Delay	19.8	29.6	2.1	30.2	12.9	0.1	71.9	13.9	94.8	0.4	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	19.8	29.6	2.1	30.2	12.9	0.1	71.9	13.9	94.8	0.4	
Queue Length 50th (ft)	8	447	0	48	225	0	98	0	130	0	
Queue Length 95th (ft)	26	604	21	119	277	1	#169	61	#257	0	
Internal Link Dist (ft)		551			715		608		380		
Turn Bay Length (ft)			140			100		50		50	
Base Capacity (vph)	245	1758	857	373	2236	1034	208	312	195	292	
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	
Reduced v/c Ratio	0.08	0.77	0.13	0.42	0.48	0.04	0.63	0.46	0.86	0.06	

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Attachment 7 Intersection Worksheets – Background AM/PM Peaks

HCM 6th Signalized Intersection Summary 1: Ebenezer Road/Driveway & Kingston Pike

05/23/2024

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	۲	^	1	7	^	1		र्स	1		र्स	1
Traffic Volume (veh/h)	10	817	46	75	648	29	108	14	178	10	6	11
Future Volume (veh/h)	10	817	46	75	648	29	108	14	178	10	6	11
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	10	842	47	77	668	30	111	14	184	10	6	11
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	460	1843	822	397	2226	993	225	28	224	48	29	67
Arrive On Green	0.52	0.52	0.52	0.05	0.63	0.63	0.14	0.14	0.14	0.04	0.04	0.04
Sat Flow, veh/h	748	3554	1585	1781	3554	1585	1590	201	1585	1134	680	1585
Grp Volume(v), veh/h	10	842	47	77	668	30	125	0	184	16	0	11
Grp Sat Flow(s),veh/h/ln	748	1777	1585	1781	1777	1585	1791	0	1585	1814	0	1585
Q Serve(g_s), s	0.7	14.9	1.5	1.8	8.6	0.7	6.4	0.0	11.3	0.9	0.0	0.7
Cycle Q Clear(g_c), s	0.7	14.9	1.5	1.8	8.6	0.7	6.4	0.0	11.3	0.9	0.0	0.7
Prop In Lane	1.00		1.00	1.00		1.00	0.89		1.00	0.62		1.00
Lane Grp Cap(c), veh/h	460	1843	822	397	2226	993	253	0	224	77	0	67
V/C Ratio(X)	0.02	0.46	0.06	0.19	0.30	0.03	0.49	0.00	0.82	0.21	0.00	0.16
Avail Cap(c_a), veh/h	460	1843	822	490	2226	993	394	0	349	200	0	174
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	11.7	15.2	11.9	10.4	8.6	7.1	39.6	0.0	41.7	46.3	0.0	46.2
Incr Delay (d2), s/veh	0.1	0.8	0.1	0.1	0.3	0.1	1.5	0.0	8.7	0.5	0.0	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/In	0.1	5.6	0.5	0.6	2.9	0.2	2.9	0.0	4.9	0.4	0.0	0.3
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	11.8	16.0	12.1	10.4	8.9	7.2	41.1	0.0	50.4	46.8	0.0	46.6
LnGrp LOS	В	В	В	В	Α	Α	D	Α	D	D	Α	<u> </u>
Approach Vol, veh/h		899			775			309			27	
Approach Delay, s/veh		15.8			9.0			46.6			46.7	
Approach LOS		В			А			D			D	
Timer - Assigned Phs	1	2		4		6		8				
Phs Duration (G+Y+Rc), s	10.8	57.9		11.2		68.6		20.1				
Change Period (Y+Rc), s	5.5	6.0		7.0		6.0		6.0				
Max Green Setting (Gmax), s	10.5	32.0		11.0		48.0		22.0				
Max Q Clear Time (g_c+I1), s	3.8	16.9		2.9		10.6		13.3				
Green Ext Time (p_c), s	0.0	4.9		0.0		4.7		0.9				
Intersection Summary												
HCM 6th Ctrl Delay			18.3									
HCM 6th LOS			В									

Queues 1: Ebenezer Road/Driveway & Kingston Pike

05/23/2	2024
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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBT	NBR	SBT	SBR	
Lane Group Flow (vph)	10	842	47	77	668	30	125	184	16	11	
v/c Ratio	0.02	0.42	0.05	0.19	0.28	0.03	0.56	0.51	0.11	0.04	
Control Delay	16.4	16.3	0.1	9.4	8.9	0.0	50.0	11.0	44.7	0.3	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	16.4	16.3	0.1	9.4	8.9	0.0	50.0	11.0	44.7	0.3	
Queue Length 50th (ft)	3	181	0	18	100	0	76	0	10	0	
Queue Length 95th (ft)	14	274	0	43	154	0	127	58	31	0	
Internal Link Dist (ft)		551			715		608		380		
Turn Bay Length (ft)			140			100		50		50	
Base Capacity (vph)	418	2000	968	447	2351	1088	392	491	198	314	
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	
Reduced v/c Ratio	0.02	0.42	0.05	0.17	0.28	0.03	0.32	0.37	0.08	0.04	
Intersection Summary											

HCM 6th Signalized Intersection Summary 1: Ebenezer Road/Driveway & Kingston Pike

05/23/2024

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	٦	^	1	7	^	1		र्स	1		đ	1
Traffic Volume (veh/h)	20	1316	110	151	1042	42	107	20	140	107	56	18
Future Volume (veh/h)	20	1316	110	151	1042	42	107	20	140	107	56	18
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	21	1400	117	161	1109	45	114	21	149	114	60	19
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	280	1846	823	235	2215	988	167	31	174	129	68	172
Arrive On Green	0.52	0.52	0.52	0.06	0.62	0.62	0.11	0.11	0.11	0.11	0.11	0.11
Sat Flow, veh/h	487	3554	1585	1781	3554	1585	1515	279	1585	1187	624	1585
Grp Volume(v), veh/h	21	1400	117	161	1109	45	135	0	149	174	0	19
Grp Sat Flow(s),veh/h/ln	487	1777	1585	1781	1777	1585	1795	0	1585	1811	0	1585
Q Serve(g_s), s	3.0	37.5	4.6	4.8	20.5	1.3	8.7	0.0	11.1	11.4	0.0	1.3
Cycle Q Clear(g_c), s	11.0	37.5	4.6	4.8	20.5	1.3	8.7	0.0	11.1	11.4	0.0	1.3
Prop In Lane	1.00		1.00	1.00		1.00	0.84		1.00	0.66		1.00
Lane Grp Cap(c), veh/h	280	1846	823	235	2215	988	197	0	174	196	0	172
V/C Ratio(X)	0.07	0.76	0.14	0.69	0.50	0.05	0.68	0.00	0.85	0.89	0.00	0.11
Avail Cap(c_a), veh/h	280	1846	823	436	2215	988	209	0	185	196	0	172
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	18.8	22.9	15.0	22.6	12.4	8.8	51.4	0.0	52.5	52.8	0.0	48.3
Incr Delay (d2), s/veh	0.5	3.0	0.4	1.3	0.8	0.1	8.3	0.0	29.2	34.1	0.0	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	15.1	1.7	2.3	7.5	0.4	4.4	0.0	5.8	7.0	0.0	0.5
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	19.3	25.8	15.3	23.9	13.2	8.8	59.7	0.0	81.6	86.9	0.0	48.4
LnGrp LOS	В	С	В	С	В	A	E	A	F	F	A	D
Approach Vol, veh/h		1538			1315			284			193	
Approach Delay, s/veh		25.0			14.4			71.2			83.1	
Approach LOS		С			В			E			F	
Timer - Assigned Phs	1	2		4		6		8				
Phs Duration (G+Y+Rc), s	12.5	68.3		20.0		80.8		19.2				
Change Period (Y+Rc), s	5.5	6.0		7.0		6.0		6.0				
Max Green Setting (Gmax), s	20.5	48.0		13.0		74.0		14.0				
Max Q Clear Time (g_c+l1), s	6.8	39.5		13.4		22.5		13.1				
Green Ext Time (p_c), s	0.2	5.8		0.0		9.6		0.1				
Intersection Summary												
HCM 6th Ctrl Delay			28.1									
HCM 6th LOS			С									

Queues 1: Ebenezer Road/Driveway & Kingston Pike

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBT	NBR	SBT	SBR	
Lane Group Flow (vph)	21	1400	117	161	1109	45	135	149	174	19	
v/c Ratio	0.09	0.80	0.14	0.71	0.50	0.04	0.72	0.51	0.91	0.07	
Control Delay	19.9	30.7	2.3	38.2	13.2	0.1	72.8	15.8	97.7	0.4	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	19.9	30.7	2.3	38.2	13.2	0.1	72.8	15.8	97.7	0.4	
Queue Length 50th (ft)	8	468	0	64	236	0	101	6	135	0	
Queue Length 95th (ft)	27	#650	23	135	288	1	#180	68	#268	0	
Internal Link Dist (ft)		551			715		608		380		
Turn Bay Length (ft)			140			100		50		50	
Base Capacity (vph)	237	1754	855	362	2227	1030	208	309	195	289	
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	
Reduced v/c Ratio	0.09	0.80	0.14	0.44	0.50	0.04	0.65	0.48	0.89	0.07	

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Attachment 8 Intersection Worksheets – Full Buildout AM/PM Peaks

HCM 6th Signalized Intersection Summary 1: Ebenezer Road/Driveway & Kingston Pike

05/23/2024

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	٦	^	1	7	^	1		र्स	1		đ	1
Traffic Volume (veh/h)	10	817	58	97	648	29	149	20	249	10	8	11
Future Volume (veh/h)	10	817	58	97	648	29	149	20	249	10	8	11
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	10	842	60	100	668	30	154	21	257	10	8	11
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	423	1667	743	360	2062	920	292	40	294	45	36	70
Arrive On Green	0.47	0.47	0.47	0.06	0.58	0.58	0.19	0.19	0.19	0.04	0.04	0.04
Sat Flow, veh/h	748	3554	1585	1781	3554	1585	1577	215	1585	1011	809	1585
Grp Volume(v), veh/h	10	842	60	100	668	30	175	0	257	18	0	11
Grp Sat Flow(s),veh/h/ln	748	1777	1585	1781	1777	1585	1792	0	1585	1820	0	1585
Q Serve(g_s), s	0.7	16.5	2.1	2.7	9.7	0.8	8.8	0.0	15.8	1.0	0.0	0.7
Cycle Q Clear(g_c), s	0.7	16.5	2.1	2.7	9.7	0.8	8.8	0.0	15.8	1.0	0.0	0.7
Prop In Lane	1.00		1.00	1.00		1.00	0.88		1.00	0.56		1.00
Lane Grp Cap(c), veh/h	423	1667	743	360	2062	920	332	0	294	81	0	70
V/C Ratio(X)	0.02	0.51	0.08	0.28	0.32	0.03	0.53	0.00	0.87	0.22	0.00	0.16
Avail Cap(c_a), veh/h	423	1667	743	447	2062	920	394	0	349	200	0	174
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	14.3	18.5	14.7	13.0	10.8	9.0	36.8	0.0	39.6	46.1	0.0	46.0
Incr Delay (d2), s/veh	0.1	1.1	0.2	0.2	0.4	0.1	1.3	0.0	18.8	0.5	0.0	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/In	0.1	6.4	0.7	1.0	3.4	0.3	3.9	0.0	7.6	0.4	0.0	0.3
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	14.4	19.6	14.9	13.1	11.3	9.0	38.1	0.0	58.4	46.6	0.0	46.4
LnGrp LOS	В	В	В	В	В	A	D	A	E	D	A	D
Approach Vol, veh/h		912			798			432			29	
Approach Delay, s/veh		19.2			11.4			50.1			46.5	
Approach LOS		В			В			D			D	
Timer - Assigned Phs	1	2		4		6		8				
Phs Duration (G+Y+Rc), s	11.1	52.9		11.4		64.0		24.5				
Change Period (Y+Rc), s	5.5	6.0		7.0		6.0		6.0				
Max Green Setting (Gmax), s	10.5	32.0		11.0		48.0		22.0				
Max Q Clear Time (g_c+I1), s	4.7	18.5		3.0		11.7		17.8				
Green Ext Time (p_c), s	0.0	4.7		0.0		4.7		0.8				
Intersection Summary												
HCM 6th Ctrl Delay			22.9									
HCM 6th LOS			С									

Queues 1: Ebenezer Road/Driveway & Kingston Pike

05/23/2	2024
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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBT	NBR	SBT	SBR	
Lane Group Flow (vph)	10	842	60	100	668	30	175	257	18	11	
v/c Ratio	0.03	0.45	0.07	0.26	0.30	0.03	0.63	0.62	0.12	0.04	
Control Delay	19.6	19.3	0.1	11.5	10.6	0.0	49.2	16.1	44.9	0.3	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	19.6	19.3	0.1	11.5	10.6	0.0	49.2	16.1	44.9	0.3	
Queue Length 50th (ft)	3	195	0	26	108	0	107	31	11	0	
Queue Length 95th (ft)	16	304	0	59	171	0	162	101	33	0	
Internal Link Dist (ft)		551			715		608		380		
Turn Bay Length (ft)			140			100		50		50	
Base Capacity (vph)	392	1873	917	421	2247	1044	393	507	199	314	
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	
Reduced v/c Ratio	0.03	0.45	0.07	0.24	0.30	0.03	0.45	0.51	0.09	0.04	
Intersection Summary											

	HCS Two-Way Stop	-Control Report	
General Information		Site Information	
Analyst	Addie Kirkham	Intersection	Ebenezer Road at Apartment Driveway
Agency/Co.	Ardurra	Jurisdiction	Knox County
Date Performed	4/13/2024	East/West Street	Apartment Driveway
Analysis Year	2027	North/South Street	Ebenezer Road
Time Analyzed	Full Buildout AM Peak	Peak Hour Factor	0.92
Intersection Orientation	North-South	Analysis Time Period (hrs)	0.25
Project Description	330.029 - Ebenezer Subdivision		
Lanes			
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Vehicle Volumes and Adju	istme	nts															
Approach		Eastb	ound			West	oound			North	bound			South	bound		
Movement	U	L	Т	R	U	L	Т	R	U	L	Т	R	U	L	Т	R	
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6	
Number of Lanes		0	0	0		0	1	0	0	0	1	0	0	1	1	0	
Configuration							LR					TR		L	Т		
Volume (veh/h)						32		75			343	9		21	142		
Percent Heavy Vehicles (%)						2		2						2			
Proportion Time Blocked																	
Percent Grade (%)						(C										
Right Turn Channelized																	
Median Type Storage		Undivided															
Critical and Follow-up He	adwa	ys															
Base Critical Headway (sec)						7.1		6.2						4.1			
Critical Headway (sec)						6.42		6.22						4.12			
Base Follow-Up Headway (sec)						3.5		3.3						2.2			
Follow-Up Headway (sec)						3.52		3.32						2.22			
Delay, Queue Length, and	Leve	l of Se	ervice														
Flow Rate, v (veh/h)							116							23			
Capacity, c (veh/h)							593							1176			
v/c Ratio							0.20							0.02			
95% Queue Length, Q ₉₅ (veh)							0.7							0.1			
Control Delay (s/veh)							12.5							8.1	0.1		
Level of Service (LOS)							В							А	А		
Approach Delay (s/veh)						12	2.5							1	.2		
Approach LOS						I	3							1	4		

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HCS 100 TWSC Version 2023 Full Buildout AM Peak_Apartment Driveway_LT.xtw

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	HCS Two-Way Stop	-Control Report	
General Information		Site Information	
Analyst	Addie Kirkham	Intersection	Ebenezer Road at Driveway
Agency/Co.	Ardurra	Jurisdiction	Knox County
Date Performed	4/13/2024	East/West Street	Subdivision Driveway
Analysis Year	2027	North/South Street	Ebenezer Road
Time Analyzed	Full Buildout AM Peak	Peak Hour Factor	0.92
Intersection Orientation	North-South	Analysis Time Period (hrs)	0.25
Project Description	330.029 - Ebenezer Subdivision		
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Major Street: North-South	

Northbound

Vehicle Volumes and Adju	istme	nts					
Approach		Eastb	ound			bound	
Movement	U	L	Т	R	U	L	Т

Movement	U	L	T	R	U	L	T	R	U	L	Т	R	U	L	Т	R		
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6		
Number of Lanes		0	0	0		0	1	0	0	0	1	0	0	0	1	0		
Configuration							LR					TR		LT				
Volume (veh/h)						19		43			309	7		15	159			
Percent Heavy Vehicles (%)						2		2						2				
Proportion Time Blocked																		
Percent Grade (%)							0											
Right Turn Channelized																		
Median Type Storage				Undi	vided													
Critical and Follow-up He	adwa	ys																
Base Critical Headway (sec)						7.1		6.2						4.1				
Critical Headway (sec)						6.42		6.22						4.12				
Base Follow-Up Headway (sec)						3.5		3.3						2.2				
Follow-Up Headway (sec)						3.52		3.32						2.22				
Delay, Queue Length, and	l Leve	l of Se	ervice															
Flow Rate, v (veh/h)							67							16				
Capacity, c (veh/h)							621							1216				
v/c Ratio							0.11							0.01				
95% Queue Length, Q ₉₅ (veh)							0.4							0.0				
Control Delay (s/veh)							11.5							8.0	0.1			
Level of Service (LOS)							В							А	А			
Approach Delay (s/veh)						1'	1.5							0	.8			
Approach LOS							В								4			

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HCS TW TWSC Version 2023 Full Buildout AM Peak_Ebenezer SD Driveway.xtw

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Southbound

HCM 6th Signalized Intersection Summary 1: Ebenezer Road/Driveway & Kingston Pike

05/23/2024

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	۲	^	1	5	^	1		र्स	1		र्स	1
Traffic Volume (veh/h)	20	1316	153	226	1042	42	138	26	194	107	63	18
Future Volume (veh/h)	20	1316	153	226	1042	42	138	26	194	107	63	18
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	21	1400	163	240	1109	45	147	28	206	114	67	19
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	276	1706	761	269	2191	977	176	34	185	124	73	172
Arrive On Green	0.48	0.48	0.48	0.09	0.62	0.62	0.12	0.12	0.12	0.11	0.11	0.11
Sat Flow, veh/h	487	3554	1585	1781	3554	1585	1508	287	1585	1142	671	1585
Grp Volume(v), veh/h	21	1400	163	240	1109	45	175	0	206	181	0	19
Grp Sat Flow(s),veh/h/ln	487	1777	1585	1781	1777	1585	1795	0	1585	1813	0	1585
Q Serve(g_s), s	3.0	40.6	7.2	8.7	20.9	1.3	11.5	0.0	14.0	11.9	0.0	1.3
Cycle Q Clear(g_c), s	7.5	40.6	7.2	8.7	20.9	1.3	11.5	0.0	14.0	11.9	0.0	1.3
Prop In Lane	1.00		1.00	1.00		1.00	0.84		1.00	0.63		1.00
Lane Grp Cap(c), veh/h	276	1706	761	269	2191	977	209	0	185	196	0	172
V/C Ratio(X)	0.08	0.82	0.21	0.89	0.51	0.05	0.84	0.00	1.11	0.92	0.00	0.11
Avail Cap(c_a), veh/h	276	1706	761	411	2191	977	209	0	185	196	0	172
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	19.5	26.8	18.1	27.9	12.8	9.1	51.9	0.0	53.0	53.0	0.0	48.3
Incr Delay (d2), s/veh	0.5	4.6	0.6	10.8	0.8	0.1	24.4	0.0	100.1	42.0	0.0	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/In	0.4	17.0	2.6	4.1	7.7	0.5	6.6	0.0	10.7	7.7	0.0	0.5
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	20.0	31.3	18.7	38.7	13.7	9.2	76.3	0.0	153.1	95.0	0.0	48.4
LnGrp LOS	С	С	В	D	В	Α	E	Α	F	F	Α	<u>D</u>
Approach Vol, veh/h		1584			1394			381			200	
Approach Delay, s/veh		29.9			17.8			117.8			90.6	
Approach LOS		С			В			F			F	
Timer - Assigned Phs	1	2		4		6		8				
Phs Duration (G+Y+Rc), s	16.4	63.6		20.0		80.0		20.0				
Change Period (Y+Rc), s	5.5	6.0		7.0		6.0		6.0				
Max Green Setting (Gmax), s	20.5	48.0		13.0		74.0		14.0				
Max Q Clear Time (g_c+l1), s	10.7	42.6		13.9		22.9		16.0				
Green Ext Time (p_c), s	0.2	4.0		0.0		9.6		0.0				
Intersection Summary												
HCM 6th Ctrl Delay			38.0									
HCM 6th LOS			D									
Queues 1: Ebenezer Road/Driveway & Kingston Pike

Lane GroupEBLEBTEBRWBLWBTWBRNBTNBRSBTSBTLane Group Flow (vph)211400163240110945175206181175v/c Ratio0.100.880.210.840.510.040.860.680.930.0Control Delay23.239.15.954.013.70.188.029.3101.50Queue Delay0.00.00.00.00.00.00.00.00.00.0Total Delay23.239.15.954.013.70.188.029.3101.50Queue Length 50th (ft)951710130236013547141Queue Length 95th (ft)29#725542162881#259131#281Internal Link Dist (ft)551715608380550 </th <th></th> <th>٨</th> <th>+</th> <th>1</th> <th>4</th> <th>Ļ</th> <th>•</th> <th>t</th> <th>1</th> <th>ţ</th> <th>~</th>		٨	+	1	4	Ļ	•	t	1	ţ	~
Lane Group Flow (vph)2114001632401109451752061811v/c Ratio0.100.880.210.840.510.040.860.680.930.0Control Delay23.239.15.954.013.70.188.029.3101.50Queue Delay0.00.00.00.00.00.00.00.00.00.0Total Delay23.239.15.954.013.70.188.029.3101.50Queue Length S0th (ft)951710130236013547141Queue Length 95th (ft)29#725542162881#259131#281Internal Link Dist (ft)5517156083805055	Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBT	NBR	SBT	SBR
v/c Ratio 0.10 0.88 0.21 0.84 0.51 0.04 0.86 0.68 0.93 0.0 Control Delay 23.2 39.1 5.9 54.0 13.7 0.1 88.0 29.3 101.5 0 Queue Delay 0.0	Lane Group Flow (vph)	21	1400	163	240	1109	45	175	206	181	19
Control Delay 23.2 39.1 5.9 54.0 13.7 0.1 88.0 29.3 101.5 0 Queue Delay 0.0 <td>v/c Ratio</td> <td>0.10</td> <td>0.88</td> <td>0.21</td> <td>0.84</td> <td>0.51</td> <td>0.04</td> <td>0.86</td> <td>0.68</td> <td>0.93</td> <td>0.07</td>	v/c Ratio	0.10	0.88	0.21	0.84	0.51	0.04	0.86	0.68	0.93	0.07
Queue Delay 0.0 <th< td=""><td>Control Delay</td><td>23.2</td><td>39.1</td><td>5.9</td><td>54.0</td><td>13.7</td><td>0.1</td><td>88.0</td><td>29.3</td><td>101.5</td><td>0.4</td></th<>	Control Delay	23.2	39.1	5.9	54.0	13.7	0.1	88.0	29.3	101.5	0.4
Total Delay 23.2 39.1 5.9 54.0 13.7 0.1 88.0 29.3 101.5 0 Queue Length 50th (ft) 9 517 10 130 236 0 135 47 141	Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Queue Length 50th (ft) 9 517 10 130 236 0 135 47 141 Queue Length 95th (ft) 29 #725 54 216 288 1 #259 131 #281 Internal Link Dist (ft) 551 715 608 380 Turn Bay Length (ft) 140 100 50 55 Base Capacity (vph) 214 1586 787 359 2192 1015 208 309 195 28 Starvation Cap Reductn 0	Total Delay	23.2	39.1	5.9	54.0	13.7	0.1	88.0	29.3	101.5	0.4
Queue Length 95th (ft) 29 #725 54 216 288 1 #259 131 #281 Internal Link Dist (ft) 551 715 608 380	Queue Length 50th (ft)	9	517	10	130	236	0	135	47	141	0
Internal Link Dist (ft) 551 715 608 380 Turn Bay Length (ft) 140 100 50 5 Base Capacity (vph) 214 1586 787 359 2192 1015 208 309 195 28 Starvation Cap Reductn 0	Queue Length 95th (ft)	29	#725	54	216	288	1	#259	131	#281	0
Turn Bay Length (ft)1401005050Base Capacity (vph)21415867873592192101520830919528Starvation Cap Reductn0000000000Spillback Cap Reductn0000000000Storage Cap Reductn000000000	Internal Link Dist (ft)		551			715		608		380	
Base Capacity (vph)21415867873592192101520830919528Starvation Cap Reductn000000000Spillback Cap Reductn000000000Storage Cap Reductn000000000	Turn Bay Length (ft)			140			100		50		50
Starvation Cap Reductn 0	Base Capacity (vph)	214	1586	787	359	2192	1015	208	309	195	289
Spillback Cap Reductn 0	Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn 0	Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
	Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio 0.10 0.88 0.21 0.67 0.51 0.04 0.84 0.67 0.93 0.0	Reduced v/c Ratio	0.10	0.88	0.21	0.67	0.51	0.04	0.84	0.67	0.93	0.07

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

	HCS Two-Way Stop	-Control Report	
General Information		Site Information	
Analyst	Addie Kirkham	Intersection	Ebenezer Road at Apartment Driveway
Agency/Co.	Ardurra	Jurisdiction	Knox County
Date Performed	4/13/2024	East/West Street	Apartment Driveway
Analysis Year	2027	North/South Street	Ebenezer Road
Time Analyzed	Full Buildout PM Peak	Peak Hour Factor	0.92
Intersection Orientation	North-South	Analysis Time Period (hrs)	0.25
Project Description	330.029 - Ebenezer Subdivision		
Lanes			



Vehicle Volumes and Adjustments																
Approach		Eastb	ound			West	ound			North	bound			South	oound	
Movement	U	L	Т	R	U	L	Т	R	U	L	Т	R	U	L	Т	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		0	1	0	0	0	1	0	0	1	1	0
Configuration							LR					TR		L	Т	
Volume (veh/h)						26		62			296	32		76	367	
Percent Heavy Vehicles (%)						2		2						2		
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized																
Median Type Storage		Undivided														
Critical and Follow-up Headways																
Base Critical Headway (sec)						7.1		6.2						4.1		
Critical Headway (sec)						6.42		6.22						4.12		
Base Follow-Up Headway (sec)						3.5		3.3						2.2		
Follow-Up Headway (sec)						3.52		3.32						2.22		
Delay, Queue Length, and	Leve	l of Se	ervice													
Flow Rate, v (veh/h)							96							83		
Capacity, c (veh/h)							492							1202		
v/c Ratio							0.19							0.07		
95% Queue Length, Q_{95} (veh)							0.7							0.2		
Control Delay (s/veh)							14.1							8.2	0.4	
Level of Service (LOS)							В							А	А	
Approach Delay (s/veh)						14	l.1					1.7				
Approach LOS						E	3						A			

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HCS TW TWSC Version 2023 Full Buildout PM Peak_Apartment Driveway_LT.xtw

	HCS Two-Way Stop	-Control Report	
General Information		Site Information	
Analyst	Addie Kirkham	Intersection	Ebenezer Road at Driveway
Agency/Co.	Ardurra	Jurisdiction	Knox County
Date Performed	4/13/2024	East/West Street	Subdivision Driveway
Analysis Year	2027	North/South Street	Ebenezer Road
Time Analyzed	Full Buildout PM Peak	Peak Hour Factor	0.92
Intersection Orientation	North-South	Analysis Time Period (hrs)	0.25
Project Description	330.029 - Ebenezer Subdivision		
Lanes			

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	Major Street: North-South	

Vehicle Volumes and Adjustments

Approach		Eastb	ound			West	ound			North	bound			South	bound	
Movement	U	L	Т	R	U	L	Т	R	U	L	Т	R	U	L	Т	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		0	1	0	0	0	1	0	0	0	1	0
Configuration							LR					TR		LT		
Volume (veh/h)						12		29			299	21		50	343	
Percent Heavy Vehicles (%)						2		2						2		
Proportion Time Blocked																
Percent Grade (%)						()									
Right Turn Channelized																
Median Type Storage				Undi	vided											
Critical and Follow-up He	adwa	ys														
Base Critical Headway (sec)						7.1		6.2						4.1		
Critical Headway (sec)						6.42		6.22						4.12		
Base Follow-Up Headway (sec)						3.5		3.3						2.2		
Follow-Up Headway (sec)						3.52		3.32						2.22		
Delay, Queue Length, and	Leve	l of Se	ervice													
Flow Rate, v (veh/h)							45							54		
Capacity, c (veh/h)							526							1211		
v/c Ratio							0.08							0.04		
95% Queue Length, Q ₉₅ (veh)							0.3							0.1		
Control Delay (s/veh)							12.5							8.1	0.5	
Level of Service (LOS)							В							А	А	
Approach Delay (s/veh)						12	.5							1.	.4	
Approach LOS						E	3							A	4	

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HCS TM TWSC Version 2023 Full Buildout PM Peak_Ebenezer SD Driveway.xtw

Attachment 9 Turn Lane Warrants

Project: Ebenezer Road Subdivision

Ebenezer Road at Apartment Roadway

Ebenezer Road	VOLUMES				
at Apartment Roadway					
LEFT TURN	Opposing	Thru	LT	LT MAX	Warrant Met
AM	352	142	21	135	NO
PM	328	367	76	65	YES
Ebenezer Road	VOLUMES				
at Apartment Roadway					
RIGHT TURN	_	Thru	RT	RT MAX	Warrant Met
AM		343	9	299	NO
PM		296	32	349	NO

Ebenezer Road at Subdivision Roadway

Ebenezer Road	VOLUMES				
at Subdivision Roadway					
LEFT TURN	Opposing	Thru	LT	LT MAX	Warrant Met
AM	316	159	15	135	NO
PM	320	343	50	80	NO
Ebenezer Road	VOLUMES				
at Subdivision Roadway					
RIGHT TURN		Thru	RT	RT MAX	Warrant Met
AM	_	309	7	299	NO
PM		299	21	349	NO

TABLE 4A

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

OPPOSING	THROUG	HVOLUME	PLUS RIGH	T-TURN	VOLUME	*
VOLUME	100 - 149	150 - 199	200 - 249	250 - 299	300 - 349	350 - 399
100 - 149	300	235 200	185 160)45 130	120 110	100 90
200 - 249	205	170 150	140 125	115 105	100 90	80 70
300 - 349 350 - 399	155 135 AM P	135 Peak 120	110 100	95 85	PM Peak 76 LT	65 60
400 - 419	120 105	105	90 80	75 71)	65 60	55 50
500 - 549 550 - 599	95 83	\$0 70	70 65	65 60	55 50	50 45
600 - 649 650 - 699	75 70	65 60	60 55	55 50	45 40	40 35
700 - 749 750 or Marc	65 60	55 50	50 45	45 40	35 35	30 30

(If the left-turn volume exceeds the table value a left -turn lane is needed)

OPPOSING	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *										
VOLUME	350 - 399	400 - 449	450 - 499	500 - 549	550 - 599	= 1 > 600					
100 - 149	100	80 75	70 65	60 55	55 50	50 45					
200 - 249 250 - 299	80 70	72 65	460 55	55 50	50 45	45 40					
300 - 349	65 60	60 55	50 50	50 45	45 40	40 40					
400 - 449	55 50	50 45	45	45 40	40 35	35 35					
500 - 549	50 45		40 40	40 35	35 35	35 35					
600 - 649 650 - 699	40	35	35 35	35 30	35 30	30 30					
700 - 749 750 or More	30	30	30 30	30 30	30 30	30 30					

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

TABLE 4B

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

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RIGHT-TURN	THRO	THROUGH VOLUME PLUS LEFT-TURN VOLUME *										
VOLUME	<100	100 - 199	200 - 249	250 - 299	300 - 349	350 - 399						
Fewer Than 25 25 - 49 50 - 99			PM P	eak		M Peak RT						
109 - 149 150 - 199			32 R1									
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 ar Marc	Yes	Yes	Yes	Yes	Yes	Yes						

RIGHT-TURN	THROUGH VOLUME PLUS LEFT-TURN VOLUME *											
VOLUME	350 - 399	400 - 449	450 - 499	500 - 549	550 - 600	+ / > 600						
Fewer Than 25 25 - 49 50 - 99	· · · · · · · · · · · · · · · · · · ·				Yes	Yes Yes						
100 - 149 150 - 199			Yes	Yes Yes	Yes Yes	Yes Yes						
200 - 249 250 - 299	Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes						
300 - 349 350 - 399	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes						
400 - 449 450 - 499	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes						
500 - 549 550 - 599	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes . Yes						
600 or More	Yes	Yes	Yes	Yes	Yes	Yes						

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

TABLE 4A

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

OPPOSING	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
VOLUME	100 - 149	150 - 199	200 - 249	250 - 299	300 - 349	350 - 399
100 - 149	300	235	185)45	120	100
	245	200	160	130	110	90
200 - 249	205	170 150	140 125	115 105	100 90	80 70
300 - 349	155	(135)	Peak 110	95	S0	M Peal
350 - 399	135	120) AM	T 100	85	70	
409 - 4-19 450 - 499	120	105 90	90 80	75 70	65 60	50
500 - 549	95	Síi	70	65	55	50
550 - 599	85	70	65	60	50	45
600 - 649	75	65	60	55	45	40
	70	60	55	50	40	35
700 - 749	65	55	50	45	35	30
750 or 210rt	60	50	45	40	35	30

(If the left-turn volume exceeds the table value a left -turn lane is needed)

OPPOSING	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
VOLUME	350 - 399	400 - 449	450 - 499	500 - 549	550 - 599	= 1 > 600
100 - 149	100	80	70	60	55	50
150 - 199		75	65	55	50	45
200 - 249	80	72	460	55	50	45
250 - 299	70	65	55	50	45	40
300 - 349	65	60	50	50	45	40
	60	55	50	45	40	40
400 - 449	55 50	50 45	45	45 40	40 35	35 35
500 - 549	50	45 40	40 40	40 35	35 35	35 35
600 - 649	40	35	35	35	35	30
650 - 699		35	35	30	30	30
700 - 749	30	30	30	30	30	30
750 or Mure		30	30	30	30	30

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

TABLE 4B

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

RIGHT-TURN VOLUME	THROUGH VOLUME PLUS LEFT-TURN VOLUME *						
	<100	100 - 199	200 - 249	250 - 299	300 - 349	350 - 399	
Fewer Than 25 25 - 49 50 - 99			PM Pea 21 RT			M Peak LT	
108 - 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	

RIGHT-TURN VOLUME	THROUGH VOLUME PLUS LEFT-TURN VOLUME *						
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 600	+ / > 600	
Fewer Than 25 25 - 49 50 - 99					Yes	Yes Yes	
100 - 149 150 - 199			Yes	Yes Yes	Yes Yes	Yes Yes	
200 - 249 250 - 299	Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	
300 - 349 350 - 399	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	
400 - 449 450 - 499	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	
500 - 549 550 - 599	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes . Yes	
600 or More	Yes	Yes	Yes	Yes	Yes	Yes	

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

Attachment 10 Sight Distance



Ebenezer Road at Subdivision Roadway – Looking Left (Southbound)



Ebenezer Road at Subdivision Roadway – Looking Right (Northbound)



Date: May 28, 2024

To: Knoxville-Knox County Planning

Subject: Ebenezer Road Subdivision TIS Comments (6-SD-24-C/6-H-24-DP)

Dear Knoxville-Knox County Planning staff,

The following comment response document is submitted to address comments dated May 22, 2024:

1. Reviewer Comment: The TIS notes the northbound right turn (NB RT) lane of Ebenezer Road at Kingston Pike will exceed capacity after the development but does not recommend specific improvements to address this deficiency, citing constraints including guard rails, utility poles, and Ten Mile Creek. The reviewing agencies understand the constraints that were cited however the TIS should still provide a recommendation for both the desirable and a "reasonably achievable" storage length for the NB RT at this intersection. In this case, reasonably achievable would mean the maximum distance that could be provided by widening the approach on the east side that would only involve movement of the utility pole(s), and some minor access work and without affecting the stream crossing. Please revise the recommendations section with this information.

<u>Response</u>: Added the following recommendation for the northbound right turn lane to the report. "The existing geometry of the northbound right turn lane is a 50-foot storage length and a 30-foot taper ending at the start of the existing commercial driveway. In order to maximum storage capacity Ardurra recommends relocating the communication pole and widening the 80-foot length of Ebenezer Road between the stop bar and the commercial driveway to match the existing width of 20 feet to allow additional vehicle stacking."

- **2. Reviewer Comment:** There were multiple items related to the Synchro outputs in Appendix that require additional information or clarification:
 - a. Please provide the Synchro Timings sheet so that staff can verify if the signal timing splits are correctly assigned.

Mr. Conger May 28, 2024 Page 2 of 3

<u>Response:</u> Added Synchro Timing sheets to Attachment 5 Signal Timing for Existing Conditions AM and PM peak hours to verify signal timing splits.

b. Vehicle extensions did not match for Phase 1 & Phase 4 for any of the AM/PM analyses for Existing, Background or Build-out conditions. Please revise or provide adequate justification for the values that were used.

<u>Response:</u> Updated the Vehicle Extension for Phase 1 & Phase 4 to match the provided signal timing sheet.

c. It is preferred to report the intersection delay and LOS using the latest HCM (7th Edition) methodology as opposed to HCM 2000 which is what is indicated on the Synchro outputs. Please revise the analysis or provide adequate justification, e.g. if there is negligible difference in results between the two methodologies.

<u>Response:</u> Renamed Phase 3 NB to Phase 8 NB in order to print the Synchro 11 HCM (6th Edition) Reports.

- **3. Reviewer Comments:** Other minor comments and typos that need to be corrected are as follows:
 - a. On page 9, it discusses the measured width of Ebenezer being 24 feet but other sections reference 21 feet. Please revise to provide consistent dimensions throughout the report.

<u>Response</u>: Revised to clarify that the measured width of 24 feet is south of the signalized intersection with Kingston Pike and the measured width of 21 feet width is at the proposed subdivision roadway connection.

b. On page 10, it should state the PHF is 0.97 instead of 97.

Response: Revised the AM PHF to 0.97.

c. On page 14, paragraph 1 it states there are 275 apartment units but the trip generation summary on the same page shows 278, please revise.

<u>Response:</u> Revised to state 278 apartment units to match the trip generation summary.

d. On the left turn lane warrant sheet in the appendix (page 78 of the PDF) it indicates that the PM peak LT amount is 80 whereas it appears as though this should instead be 50 per the volume shown on Figure 9, please revise as appropriate.

<u>Response:</u> Updated the LT Warrant for the intersection of Ebenezer Road at Subdivision to show 50 left turns.

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Sincerely,

