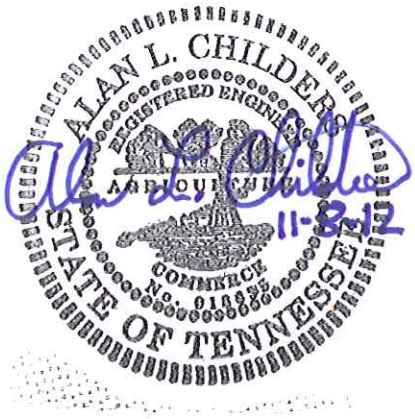
Traffic Impact Study

Copper Trace Development
Copper Ridge Road
Knox County, Tennessee

01048-0000

November 8, 2012



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EXECUTIVE SUMMARY

This report provides a summary of the traffic impact study that was performed for a proposed residential development to be located off Copper Ridge Road in Northwest Knox County. The project site is approximately one-half mile north of Emory Road (State Route 131) on the east side of Copper Ridge Road. The current plans for this proposed development provide for a maximum of 102 single family dwelling units at full build-out. The project entrance will be a new three-leg intersection on Copper Ridge Road located approximately one-half mile north of Emory Road.

A primary conclusion of this study is that the traffic generated by the proposed development will result in short-term impacts on traffic operational conditions in the project area, especially at the intersection of Emory Road and Copper Ridge Road. The resulting recommendation is that consideration should be given to implementing possible improvements to the intersection of Emory Road and Copper Ridge Road, with the following issues being considered in determining improvement scope and responsibility:

1. An eastbound left-turn lane will be justified during both A.M. and P.M. peak hour traffic conditions as a result of this development. Such a lane is currently justified during existing P.M. peak hour conditions.
2. The southbound capacity analyses of unimproved year 2017 conditions identified level-of-service "E" conditions for only one peak hour. With the addition of a second southbound approach lane on Copper Ridge Road at Emory Road, the resulting levels-of-service for the southbound left-turn movement is LOS "E" and LOS "C" for the southbound right turns.
3. Existing roadway right-of-way on both Emory Road and Copper Ridge Road at this intersection appear to be on the order of 50 feet, and are not under the control of the project developer.

Other traffic related issues evaluated for this project included corner sight distance for the proposed subdivision access roadway intersection with Copper Ridge Road, and the general width and condition of Copper Ridge Road between Emory Road and the project site. These evaluations concluded that corner sight distance requirements will be satisfied, and that although Copper Ridge Road is narrow, its width does meet or exceed the eighteen foot minimum required by Knox County.

INTRODUCTION AND PURPOSE OF STUDY

This report provides a summary of the traffic impact study that was performed for a proposed residential development to be located off Copper Ridge Road in Northwest Knox County. The project site is approximately one-half mile north of Emory Road (State Route 131) on the east side of Copper Ridge Road. FIGURE 1 is a location map that identifies the project site in relation to the roadways in the vicinity of the proposed development.

The current plans for this proposed subdivision development provide for a maximum of 102 single family dwelling units at full build-out. FIGURE 2 is a site map showing the proposed site layout with access to Copper Ridge Road. The development entrance will be a new three-leg intersection on Copper Ridge Road located approximately one-half mile north of Emory Road.

The purpose of this study was the evaluation of the traffic operational and safety impact of the proposed development upon the adjacent portion of Copper Ridge Road. Of particular interest was the intersection of the site entrance roadway with Copper Ridge Road, as well as the intersection of Copper Ridge Road and Emory Road. This evaluation was performed assuming full build-out of all units of the subdivision, with existing and background growth conditions also evaluated for purposes of comparison.

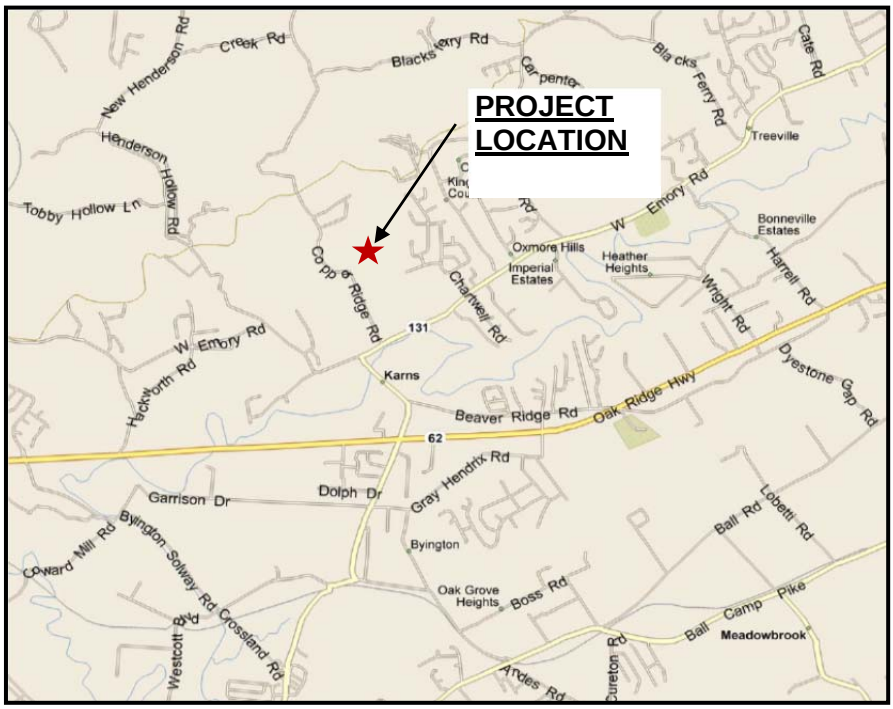

FIGURE 1: LOCATION MAP

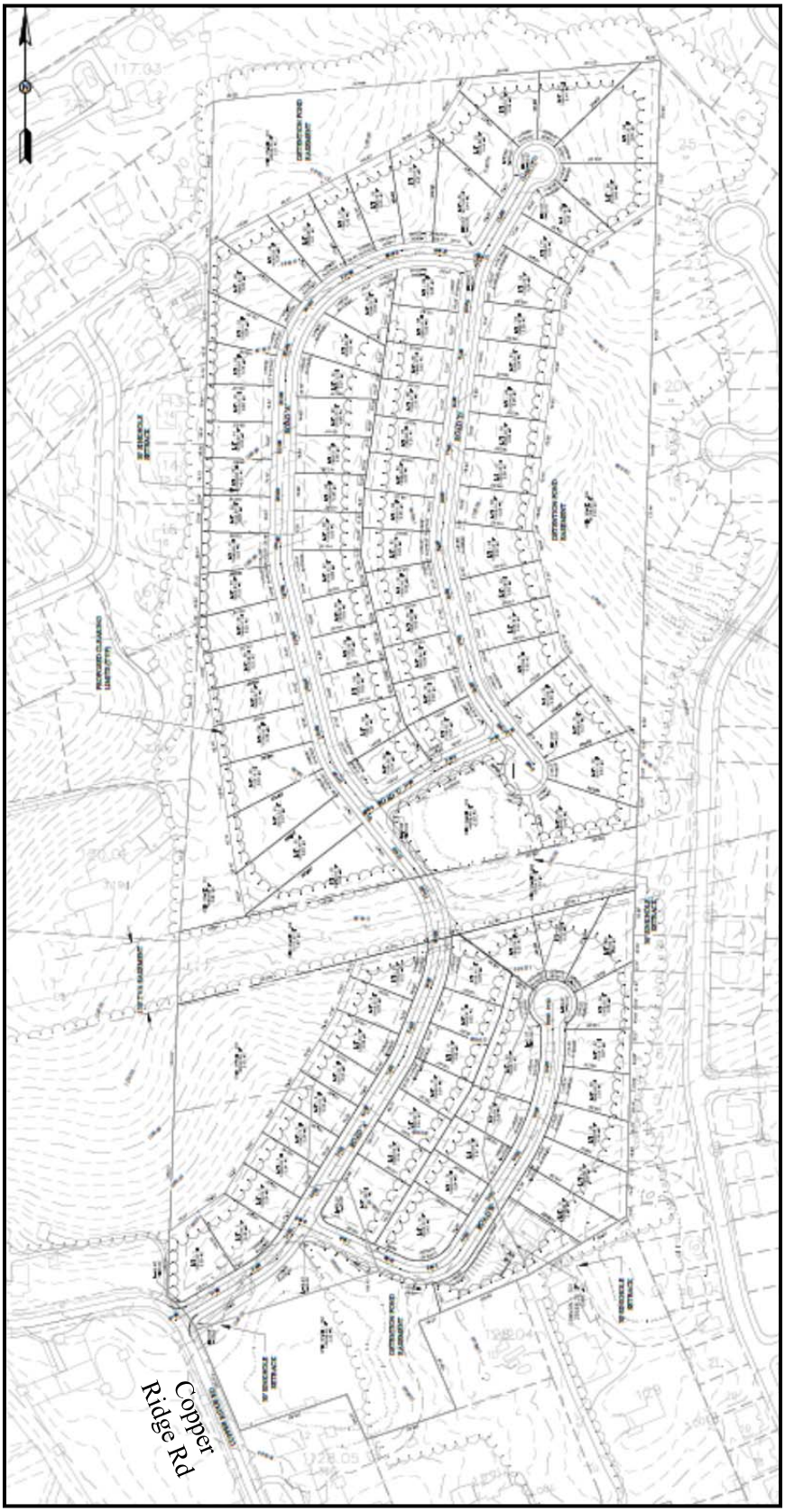

FIGURE 2: PROPOSED SITE LAYOUT

Existing Roadway Conditions

Copper Ridge Road is a Local access roadway that is maintained by Knox County. The roadway pavement is approximately 20 feet in width, and is striped with a center double yellow line delineating two traffic lanes of approximately 8.5 to 9.0 feet. Minimal shoulders are located beyond the white pavement edgelines. The study section of Copper Ridge Road was constructed under older design standards, and thus possesses significant horizontal curvature and non-standard roadside ditches. The posted speed limit on Copper Ridge Road is 30 mph.

Existing Traffic Data

A traffic count station for collecting average daily traffic data (ADT) is located on Emory Road approximately three miles east of Copper Ridge Road. The most recent data from this station was provided by the Tennessee Department of Transportation, with resulting ADTs shown in TABLE 1.

TABLE 1
AVERAGE DAILY TRAFFIC COUNT SUMMARY

Count Year	EMORY ROAD WEST OF CLINTON HIGHWAY (TDOT STA. 047)
2011	9,006
2010	9,512
2009	9,426
2008	8,792
2007	9,077
2006	8,872

In order to collect more refined data, and to establish a basis for trip distribution patterns, turning movement traffic counts were collected at the existing three-leg intersection of Emory Road and Copper Ridge Road. These counts were conducted during the A.M. and P.M. peak traffic hours. Raw data count summaries are contained in the APPENDIX.

In addition to helping establish trip distribution patterns, these turning movement counts were used to establish the existing traffic volumes for this study, as displayed on FIGURE 3.

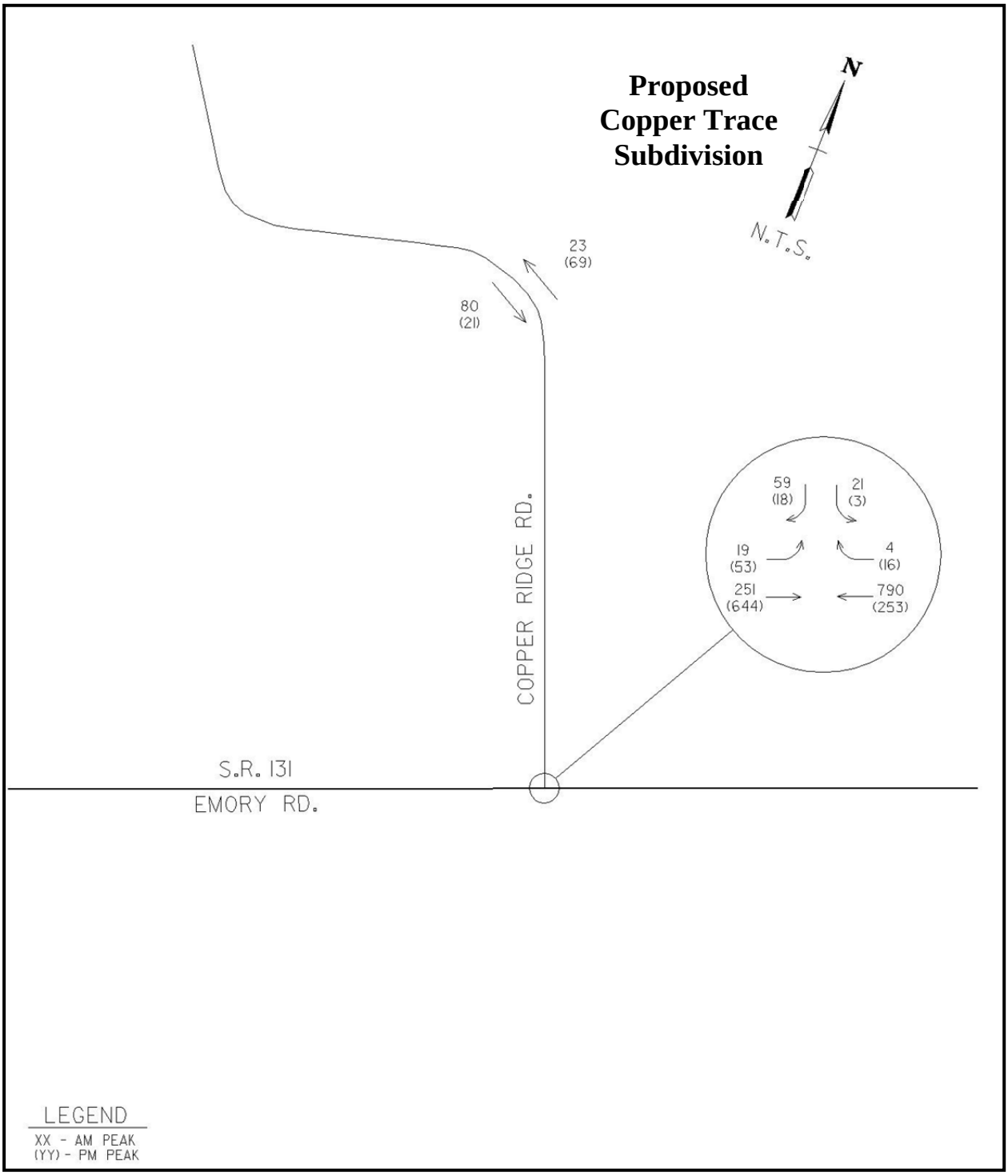

FIGURE 3: 2012 EXISTING TRAFFIC DATA

Existing Level-of-Service Evaluation

Intersection Capacity Analyses employing the methods of the Highway Capacity Manual (HCM 2010) were used to evaluate the intersection of Emory Road and Copper Ridge Road for the existing roadway and traffic conditions. This intersection was chosen as the most critical of the two study intersections from a capacity and level-of-service perspective. The results indicate that Emory Road left-turn traffic movement is currently operating at level-of-service "A" during both the AM and PM peak hours with Copper Ridge Road turning movements operating at a level-of-service "C" during the AM peak and "B" during the PM peak. These results are summarized in detail on the "Two Way Stop Control Summary" printouts contained in the APPENDIX. Also see the APPENDIX for a discussion of Intersection Capacity and Level of Service Concepts.

Background Traffic Growth

The anticipated time for full build-out of the Copper Trace Development is estimated as five years. Therefore, year 2017 was established as the appropriate design/analysis year for this study. In order to determine traffic volumes resulting solely from background traffic growth to year 2017, it was necessary to establish an annual growth rate for existing traffic. The ADT values given previously in TABLE 1, along with engineering judgment, were used to arrive at a rate of 2 percent for this development. FIGURE 4 contains the background traffic volumes that would result from this 2 percent annual growth to year 2017.

Background Level of Service Evaluation

Intersection Capacity Analyses employing the methods of the Highway Capacity Manual (HCM 2010) were used to evaluate the study intersection of Emory Road and Copper Ridge Road for the background (2017) traffic conditions, shown on FIGURE 4. The results indicate that Emory Road left-turn traffic movement would be expected to operate at level-of-service "B" during AM peak hour and "A" during the PM peak hour, and Copper Ridge Road movements would operate at a level-of-service "D" during the AM peak hour and "B" during the PM peak hour, if the proposed development is not constructed. These results are summarized in detail on the "Two-Way Stop Control Summary" printouts contained in the APPENDIX. Also see the APPENDIX for a discussion of intersection capacity and level-of-service concepts.

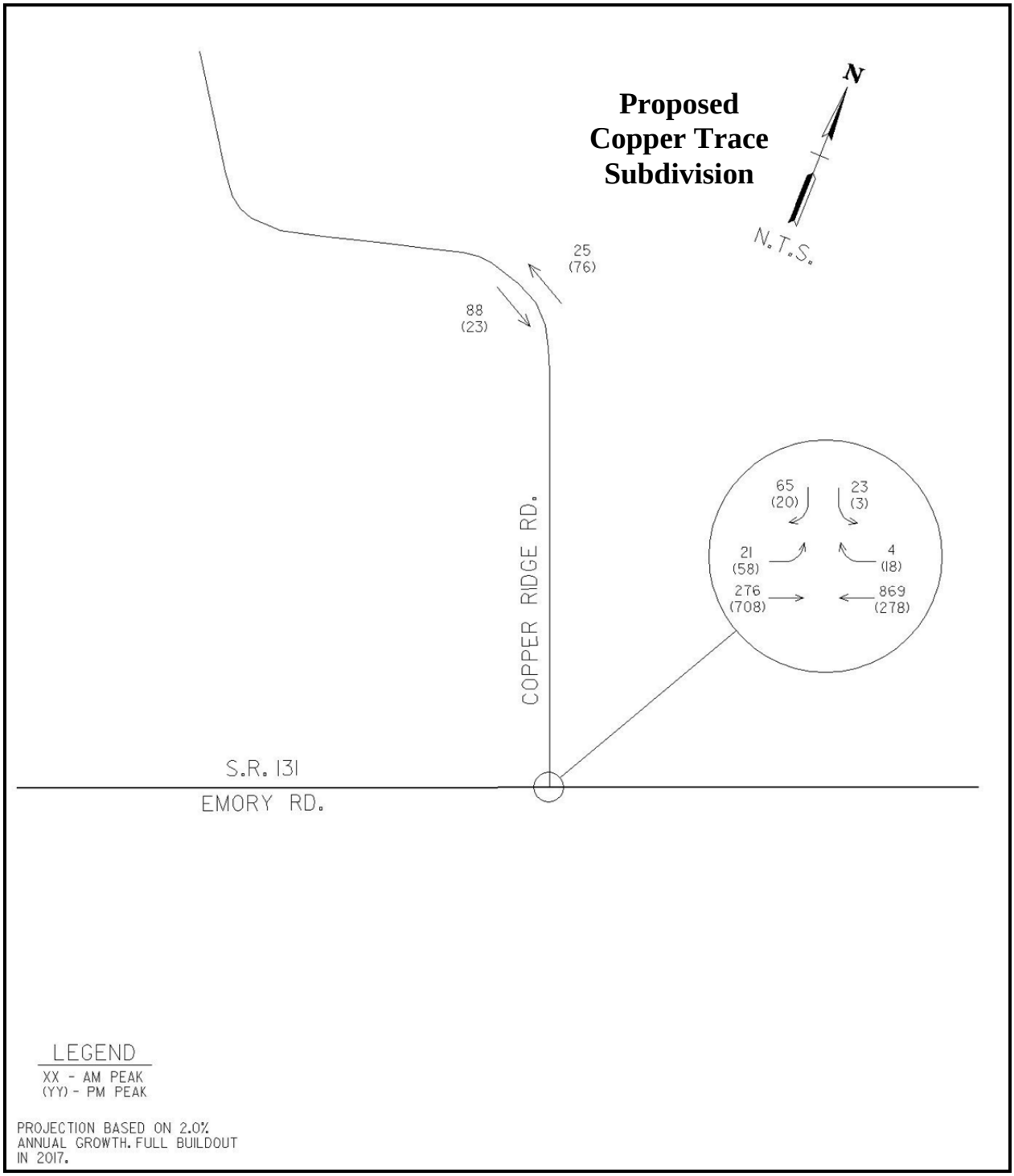

FIGURE 4: 2017 BACKGROUND TRAFFIC DATA

Trip Generation

In order to estimate the expected traffic volumes to be generated by full build-out of the proposed development, the data and procedures of *Trip Generation, Eighth Edition* (Institute of Transportation Engineers, 2008) were utilized. The generated traffic volumes were determined based on the total weekday morning, and evening peak hour of adjacent street traffic trip generation rates for single-family detached housing (Land Use Code 210, Volume 2, pages 290 to 292). As noted earlier in this report, the anticipated maximum number of units upon full build-out is 102, which was used to determine the number of new trips generated. TABLE 2 summarizes the number and directional split of entering and exiting trips for the proposed development.

TABLE 2

TRIP GENERATION SUMMARY

(RATES FOR SINGLE FAMILY DETACHED HOUSING – I.T.E. CODE 210)

SINGLE FAMILY DETACHED HOUSING – 102 UNITS					
	Total New Trips	% Entering	% Exiting	Number Entering	Number Exiting
Weekday	1058	50%	50%	529	529
A.M. Peak	81	25%	75%	20	61
P.M. Peak	107	63%	37%	67	40

Trip Distribution

FIGURE 5 provides a summary of the trip distribution patterns developed for the study intersections, which were derived from the existing traffic patterns. In addition, FIGURE 6 provides the generated traffic volumes as assigned to the local roadway network in accordance with these distribution patterns. FIGURE 7 shows the combined year 2017 volumes reflecting the existing traffic, the background traffic growth, and the newly generated traffic from the Copper Trace Development. These are the volumes used in the analysis of full build-out conditions.

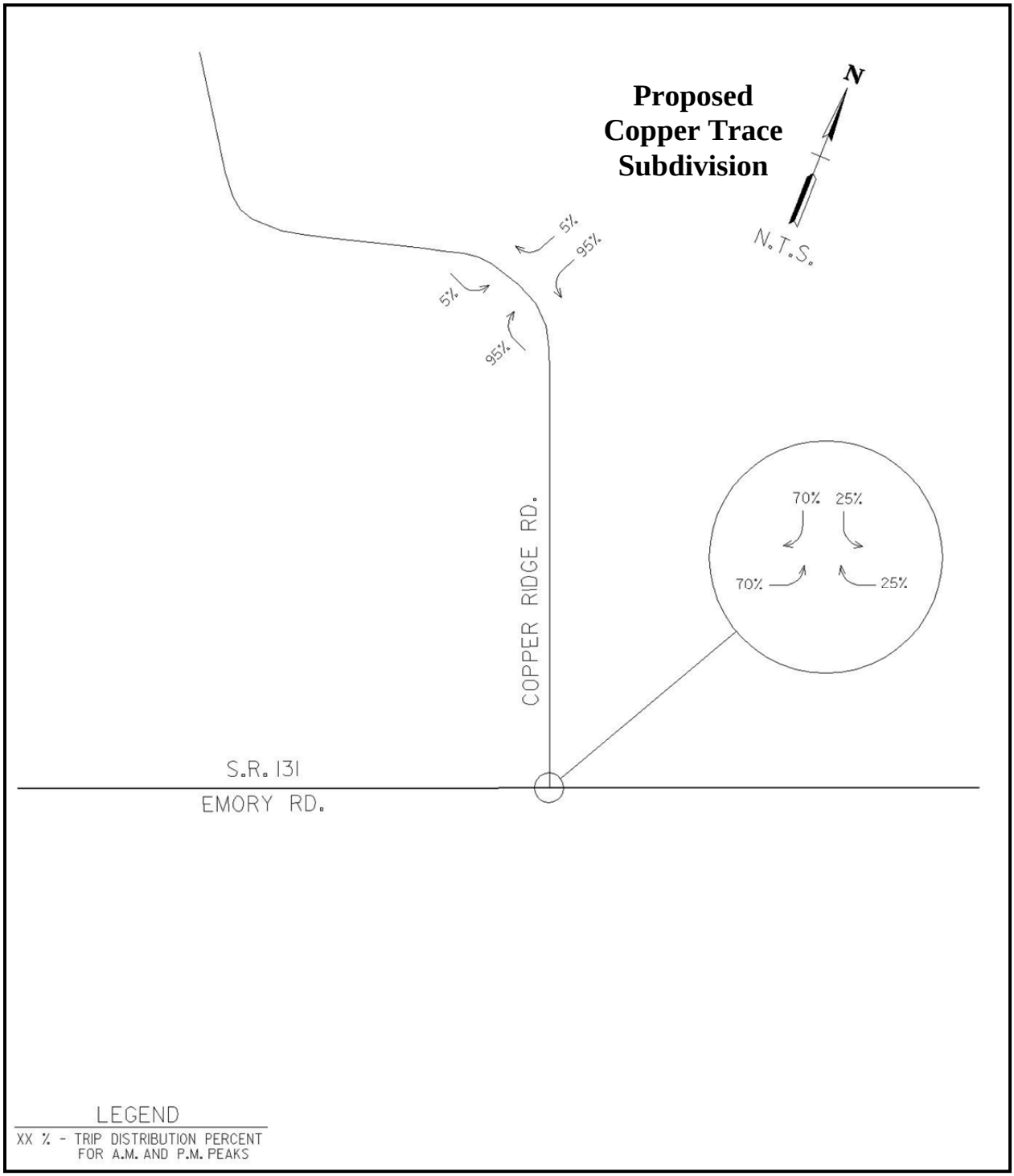

FIGURE 5: TRIP DISTRIBUTION

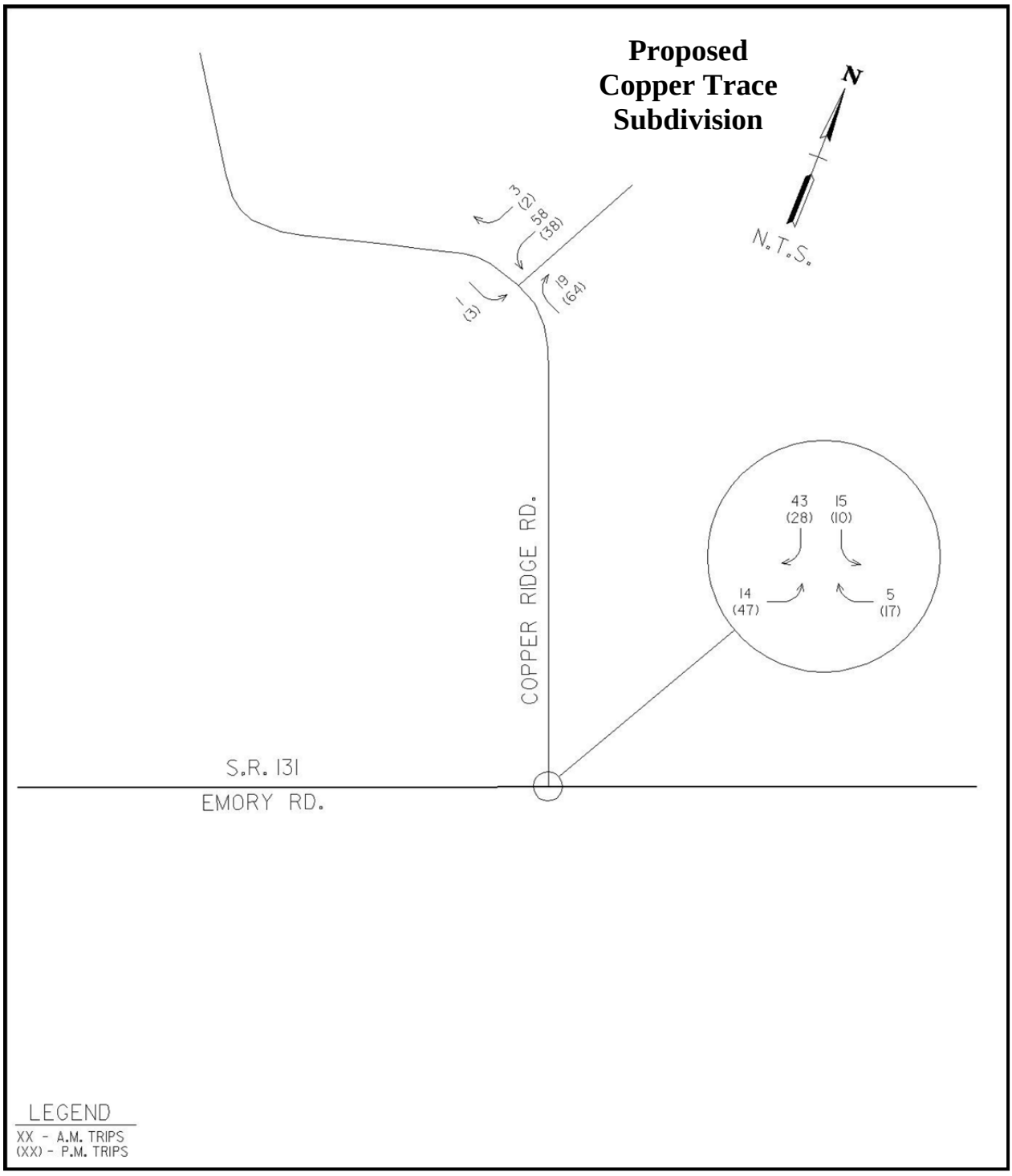

FIGURE 6: GENERATED TRIPS

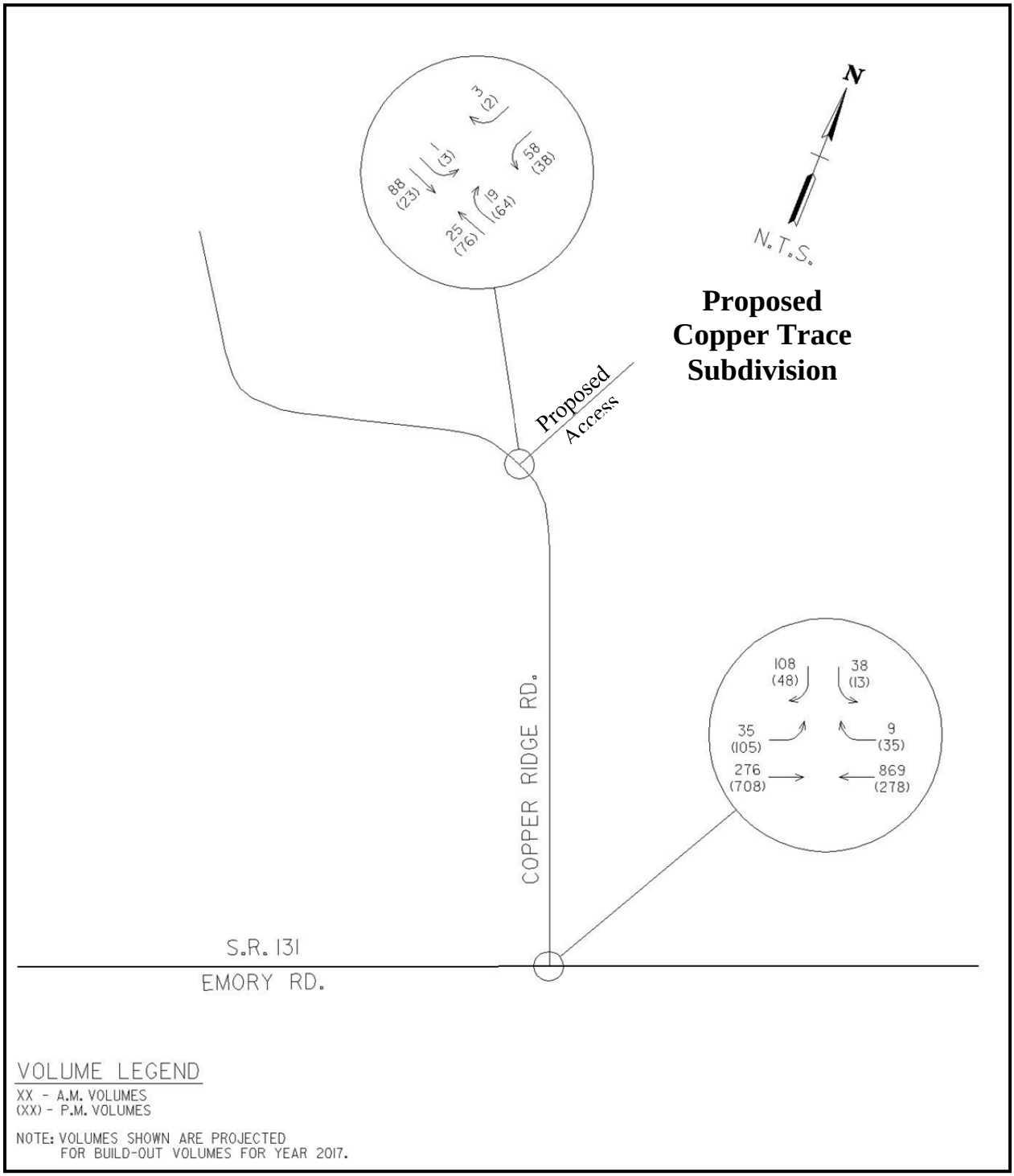

FIGURE 7: 2017 COMBINED TRAFFIC DATA

Proposed Level-of-Service Evaluation

Intersection Capacity Analyses employing the methods of the Highway Capacity Manual were used to evaluate the intersection of Emory Road and Copper Ridge Road, for the year 2017 combined traffic volume conditions (FIGURE 7). The results indicate that with existing intersection turn lane geometry, the Emory Road left-turn traffic movement would be expected to operate at level-of-service "B" during the AM peak hour and "A" during the PM peak hour, and Copper Ridge Road movements would operate at a level-of-service "E" during the AM peak hour and "B" during the PM peak hour. These results are summarized in detail on the "Two-Way Stop Control Summary" printouts contained in the APPENDIX. The APPENDIX may also be referenced for a discussion of intersection capacity and level-of-service concepts.

Intersection Sight Distance and Other Issues

A field review was conducted to identify any sight distance restrictions, geometric deficiencies or other issues of concern that could impact the proposed development. The results of this review are summarized below:

1) Intersection Corner Sight Distance:

   The proposed project development entrance on Copper Ridge Road was evaluated for corner sight distance. Based on the posted 30 mph speed limit, the required minimum sight distance in accordance with Knox County regulations would be 300 feet. Field reviews indicate that this requirement will be met at this intersection, as available sight distance was measured in excess of 450 feet looking south and approximately 385 feet looking north. The sight distance to the north was measured looking through a horizontal curve and chain link fence.

Looking south from intersection along Copper Ridge Road

Looking north from intersection along Copper Ridge Road

2) Auxiliary Lanes for Proposed Development Intersection:

Turn lane warrant analyses were conducted for the intersection of Emory Road and Copper Ridge Road under proposed development conditions. These analyses employed Tables 5A and 5B from the Knox County Access Control and Driveway Design Policy, which are based on turn lane warrants developed by Harmelink. The results were that an eastbound left-turn lane on Emory Road at Copper Ridge Road is expected to be warranted during both peak traffic hours. As a basis of comparison, existing traffic conditions were also analyzed, with the result that the eastbound left-turn lane currently satisfies warranting conditions for the P.M. peak. A westbound right-turn lane on Emory Road was not found to be warranted. Copies of Tables 5A and 5B are located in the APPENDIX for review.

CONCLUSIONS AND RECOMMENDATIONS

A primary conclusion of this study is that the traffic generated by the proposed development will result in short-term impacts on traffic operational conditions in the project area. Of particular concern is the existing intersection of Emory Road and Copper Ridge Road, through which the vast majority of traffic to this development will travel. The issues at this location include the fact that an eastbound left-turn lane will be clearly warranted during both A.M. and P.M. peak traffic hours, and during the A.M. peak hour the southbound traffic will experience level-of-service "E" operation. TABLE 3 summarizes all intersection capacity evaluations conducted for this study, including possible improvement alternative scenarios.

TABLE 3

CAPACITY ANALYSES SUMMARY

EVALUATION CONDITION	LEVEL-OF-SERVICE (AVG. DELAY)	
	Southbound (Copper Ridge Rd)	Eastbound (Emory Rd)
Existing (2012) – AM	C (22.5)	A (9.8)
Existing (2012) – PM	B (11.4)	A (7.9)
Background (2017) – AM	D (27.4)	B (10.2)
Background (2017) – PM	B (11.8)	A (8.0)
Combined w/ Existing Lanes – AM	E (43.3)	B (10.3)
Combined w/ Existing Lanes – PM	B (14.9)	A (8.2)
Combined w/ EBLT & SBRT – AM	D (26.9)*	B (10.3)
Combined w/ EBLT & SBRT – PM	B (14.1)*	A (8.2)

* Southbound Breakdown by Lane:

AM – Left-turn lane – E(35.8), Right-turn lane – C(23.8)

PM – Left-turn lane – D(29.0), Right-turn lane – B(10.3)

The above issues and evaluations indicate that consideration should be given to possible improvements to the intersection of Emory Road and Copper Ridge Road. This study indicated that some justification exists for both an eastbound left-turn lane and a southbound second approach lane. It is recommended that the following factors be considered when determining the scope of actual improvements to be required and how responsibility for the improvements is to be assigned:

1. Although an eastbound left-turn lane is anticipated to be justified under full project build-out traffic conditions, it is noteworthy that such a lane is currently justified during existing P.M. peak hour conditions.
2. The southbound capacity analyses of unimproved full build-out conditions identified level-of-service "E" operation for only one peak hour.
3. Existing roadway right-of-way on both Emory Road and Copper Ridge Road at this intersection appear to be on the order of 50 feet, and are not under the control of the project developer.

Other traffic related issues evaluated for this project included corner sight distance for the proposed subdivision access roadway intersection with Copper Ridge Road, and the general width and condition of Copper Ridge Road between Emory Road and the project site. These evaluations concluded that corner sight distance requirements will be exceeded, and that although Copper Ridge Road is narrow, its width does meet or exceed the eighteen feet minimum required by Knox County.

APPENDIX

Intersection Capacity and Level of Service Concepts

In a general sense, a roadway is similar to a pipeline or other material-carrying conduit in that it has a certain capacity for the amount of material (vehicles) that it can efficiently carry. As the number of vehicles in a given time period gradually increases, the quality of traffic flow gradually decreases. On roadway sections this results in increasing turbulence in the traffic stream, and at intersections it results in increasing stops and delay. As the volumes begin to approach the capacity of the facility, these problems rapidly magnify, with resulting serious levels of congestions, stops, delay, excess fuel consumption, pollutant emissions, etc.

The Federal Highway Administration has published the Year 2010 Highway Capacity Manual (HCM2010), which establishes theoretical techniques to quantify the capacity conditions on all types of roadways, intersections, ramps, pedestrian facilities, etc. A basic concept that is applicable to most of these techniques is the idea of level of service (LOS). This concept establishes a rating system that quantifies the quality of traffic flow, as perceived by motorists and/or passengers. The general system is similar to a school grade scale, and is outlined as follows:

Level of Service(LOS)	General Quality of Traffic Flow	Description of Corresponding Conditions
A	Excellent	Roadways – Free flow, high maneuverability Intersections – Very few stops, very low delay
B	Very Good	Roadways – Free flow, slightly lower maneuverability Intersections – Minor stops, low delay
C	Good	Roadways – Stable flow, restricted maneuverability Intersections – Significant stops, significant delay
D	Fair	Roadways – Marginally stable flow, congestion seriously restricts maneuverability Intersections – High stops, long but tolerable delay
E	Poor	Roadways – Unstable flow*, lower operating speeds, congestion severely restricts maneuverability Intersections – All vehicles stop, very long queues and very long intolerable delay
F	Very Poor	Roadways – Forced flow, stoppages may be lengthy, congestion severely restricts maneuverability Intersections – All vehicles stop, extensive queues and extremely long intolerable delay

*Unstable flow is such that minor fluctuations or disruptions can result in rapid degradation to LOS F.

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8550 Kingston Pike
Knoxville, TN 37919

CCI Project Name: Copper Trace TIS
CCI Project Number: 1048-0000
Intersection: Emory @ Copper Ridge
Counted By: CCI

File Name : Emory_Copper Ridge_10-25-12
Site Code : 00000001
Start Date : 10/25/2012
Page No : 1

Groups Printed- 1 - Unshifted

	Copper Ridge Road Southbound					Emory Road Westbound					Northbound					Emory Road Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
07:00 AM	3	0	6	0	9	0	162	0	0	162	0	0	0	0	0	2	33	0	0	35	206
07:15 AM	5	0	18	0	23	0	206	0	0	206	0	0	0	0	0	3	49	0	0	52	281
07:30 AM	7	0	9	0	16	0	245	1	0	246	0	0	0	0	0	7	74	0	0	81	343
07:45 AM	4	0	22	0	26	0	161	0	0	161	0	0	0	0	0	3	82	0	0	85	272
Total	19	0	55	0	74	0	774	1	0	775	0	0	0	0	0	15	238	0	0	253	1102
08:00 AM	5	0	10	0	15	0	178	3	0	181	0	0	0	0	0	6	46	0	0	52	248
08:15 AM	5	0	9	0	14	0	110	1	0	111	0	0	0	0	0	2	61	0	0	63	188
08:30 AM	2	0	3	0	5	0	116	2	0	118	0	0	0	0	0	2	43	0	0	45	168
08:45 AM	3	0	6	0	9	0	107	2	0	109	0	0	0	0	0	4	39	0	0	43	161
Total	15	0	28	0	43	0	511	8	0	519	0	0	0	0	0	14	189	0	0	203	765
*** BREAK ***																					
04:00 PM	2	0	7	0	9	0	56	2	0	58	0	0	0	0	0	6	117	0	0	123	190
04:15 PM	0	0	3	0	3	0	62	1	0	63	0	0	0	0	0	8	105	0	0	113	179
04:30 PM	3	0	10	0	13	0	54	1	0	55	0	0	0	0	0	13	142	0	0	155	223
04:45 PM	1	0	1	0	2	0	56	3	0	59	0	0	0	0	0	15	152	0	0	167	228
Total	6	0	21	0	27	0	228	7	0	235	0	0	0	0	0	42	516	0	0	558	820
05:00 PM	1	0	5	0	6	0	59	3	0	62	0	0	0	0	0	11	156	0	0	167	235
05:15 PM	1	0	8	0	9	0	62	4	0	66	0	0	0	0	0	10	174	0	0	184	259
05:30 PM	0	0	4	0	4	0	76	6	0	82	0	0	0	0	0	17	162	0	0	179	265
05:45 PM	1	0	8	0	9	0	74	0	0	74	0	0	0	0	0	16	118	0	0	134	217
Total	3	0	25	0	28	0	271	13	0	284	0	0	0	0	0	54	610	0	0	664	976
Grand Total	43	0	129	0	172	0	1784	29	0	1813	0	0	0	0	0	125	1553	0	0	1678	3663
Apprch %	25.0	0.0	75.0	0.0		0.0	98.4	1.6	0.0		0.0	0.0	0.0	0.0		7.4	92.6	0.0	0.0		
Total %	1.2	0.0	3.5	0.0	4.7	0.0	48.7	0.8	0.0	49.5	0.0	0.0	0.0	0.0	0.0	3.4	42.4	0.0	0.0	45.8	

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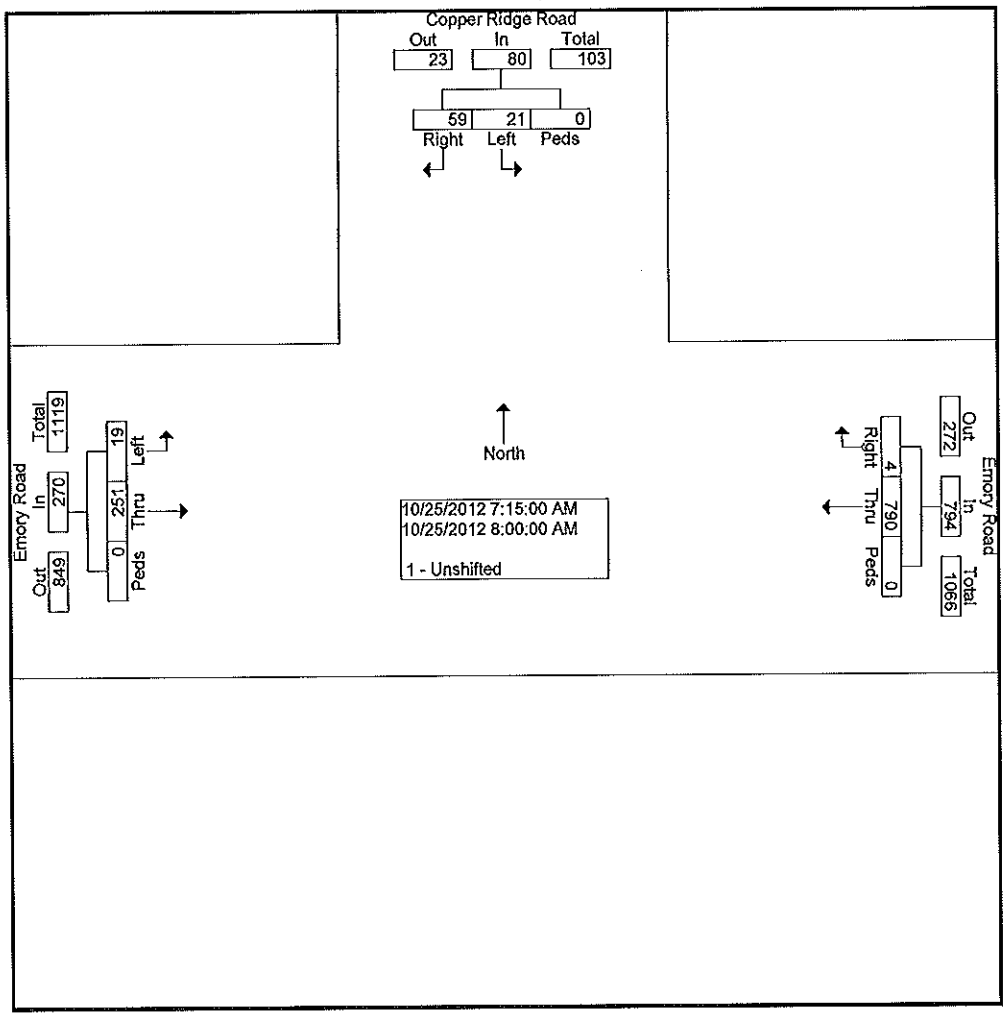
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour From 07:00 AM to 08:45 AM - Peak 1 of 1																					
Intersection	07:15 AM																				
Volume	21	0	59	0	80	0	790	4	0	794	0	0	0	0	0	19	251	0	0	270	1144
Percent	26.3	0.0	73.8	0.0		0.0	99.5	0.5	0.0		0.0	0.0	0.0	0.0		7.0	93.0	0.0	0.0		
07:30 Volume	7	0	9	0	16	0	245	1	0	246	0	0	0	0	0	7	74	0	0	81	343
Peak Factor																					0.834
High Int.	07:45 AM					07:30 AM					6:45:00 AM					07:45 AM					
Volume	4	0	22	0	26	0	245	1	0	246	0	0	0	0	0	3	82	0	0	85	
Peak Factor					0.769					0.807										0.794	



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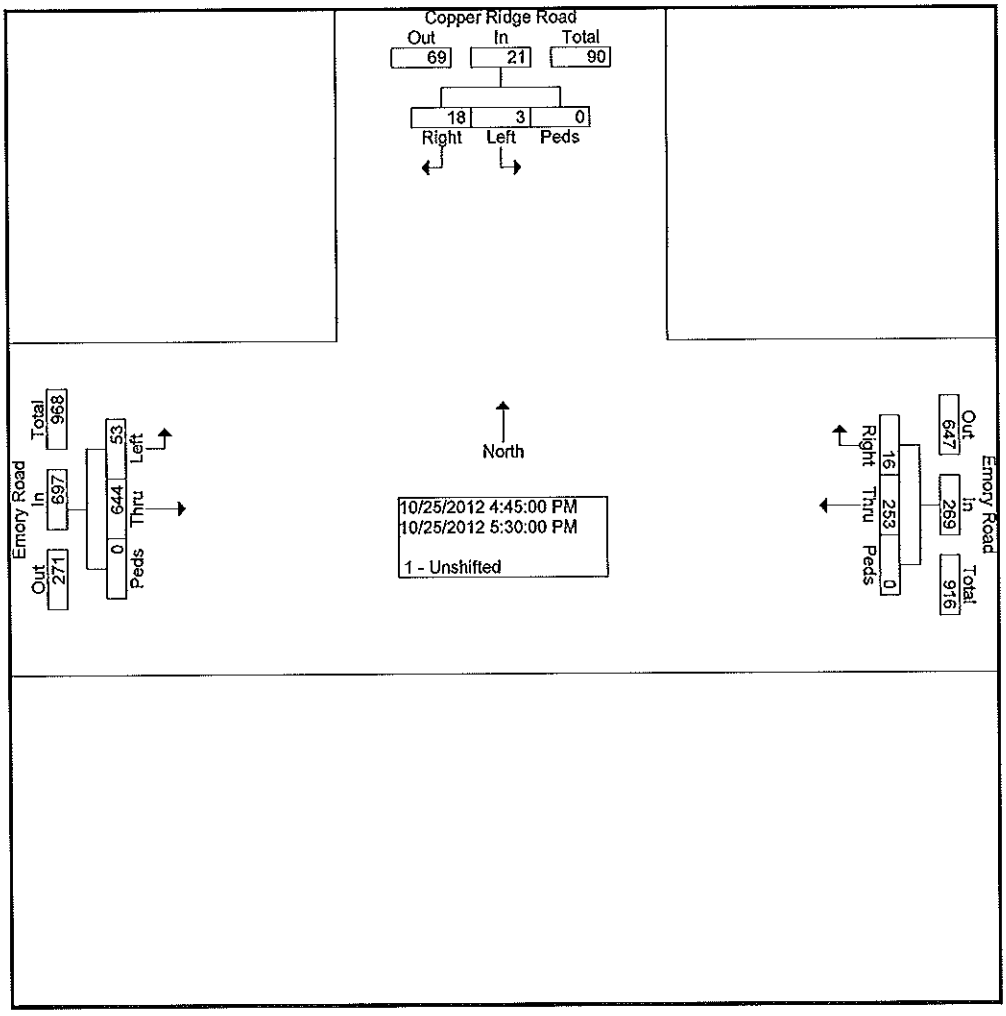
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour From 04:00 PM to 05:45 PM - Peak 1 of 1																					
Intersection	04:45 PM																				
Volume	3	0	18	0	21	0	253	16	0	269	0	0	0	0	0	53	644	0	0	697	987
Percent	14.3	0.0	85.7	0.0		0.0	94.1	5.9	0.0		0.0	0.0	0.0	0.0		7.6	92.4	0.0	0.0		
05:30 Volume	0	0	4	0	4	0	76	6	0	82	0	0	0	0	0	17	162	0	0	179	265
Peak Factor																					0.931
High Int.	05:15 PM					05:30 PM										05:15 PM					
Volume	1	0	8	0	9	0	76	6	0	82	0	0	0	0	0	10	174	0	0	184	
Peak Factor					0.583					0.820										0.947	



Station #	County	Location	Route #
000047	Knox	NEAR ANDERSON CO LINE	SR131

Record	Year	AADT
1	2011	9006
2	2010	9512
3	2009	9426
4	2008	8792
5	2007	9077
6	2006	8872
7	2005	9140
8	2004	8467
9	2003	8368
10	2002	7948
11	2001	7419
12	2000	7819
13	1999	7541
14	1998	6908
15	1997	6865
16	1996	6427
17	1995	5941
18	1994	5995
19	1993	5993
20	1992	5370
21	1991	5283
22	1990	4554
23	1989	4910
24	1988	4542
25	1987	4514
26	1986	4261
27	1985	3919

5-Year growth: $9006 = 8872(1+x)^5$ $x = 0.3\%$

10-Year growth: $9006 = 7419(1+x)^{10}$ $x = 2.0\%$

Use 2.0% Annual Growth @ 5-year buildout

Factor: Mod 1.10

Single-Family Detached Housing
(210)

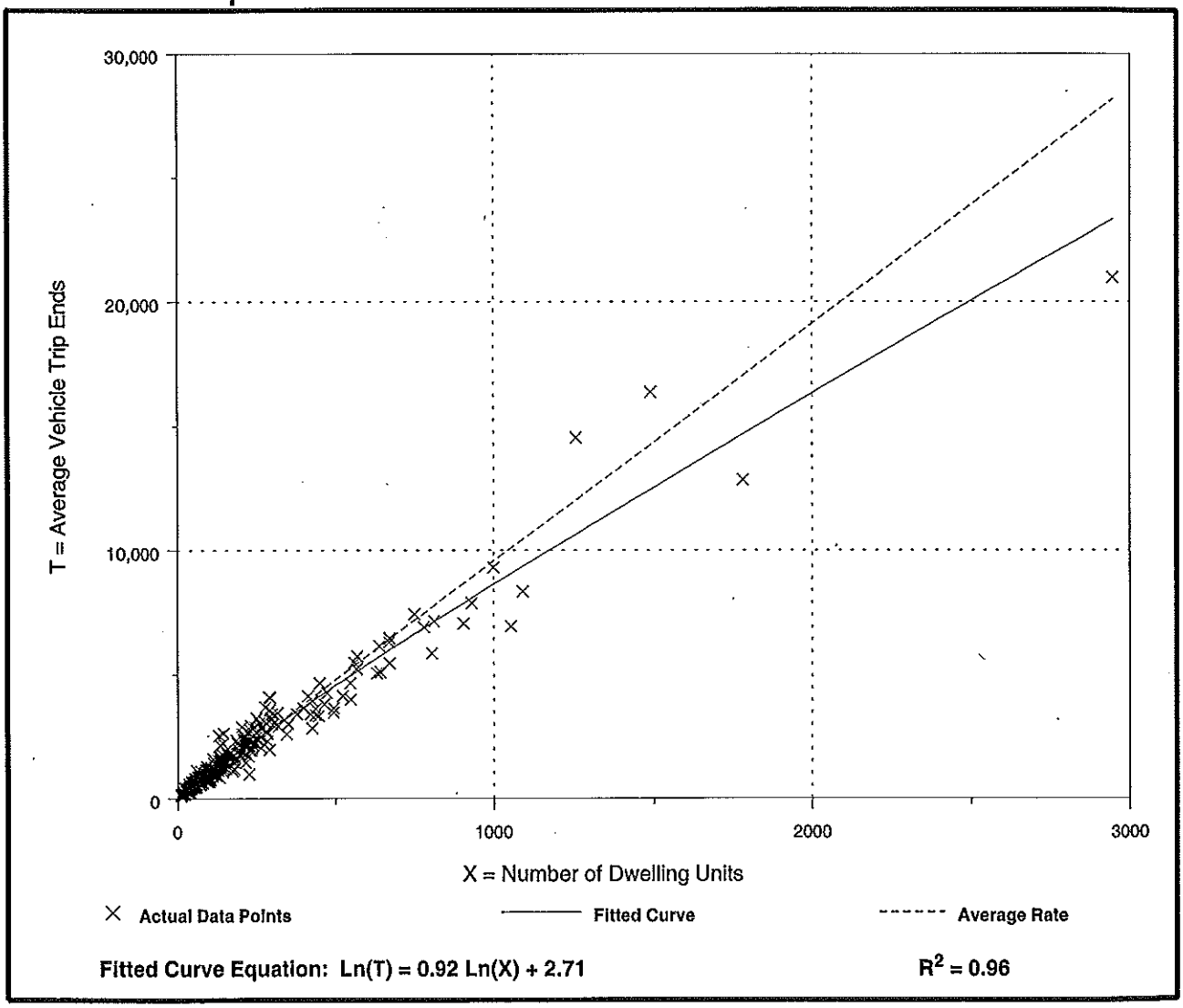
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Number of Studies: 351
Avg. Number of Dwelling Units: 197
Directional Distribution: 50% entering, 50% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
9.57	4.31 - 21.85	3.69

Data Plot and Equation



Fitted Curve Equation: Ln(T) = 0.92 Ln(X) + 2.71

R^2 = 0.96

Single-Family Detached Housing
(210)

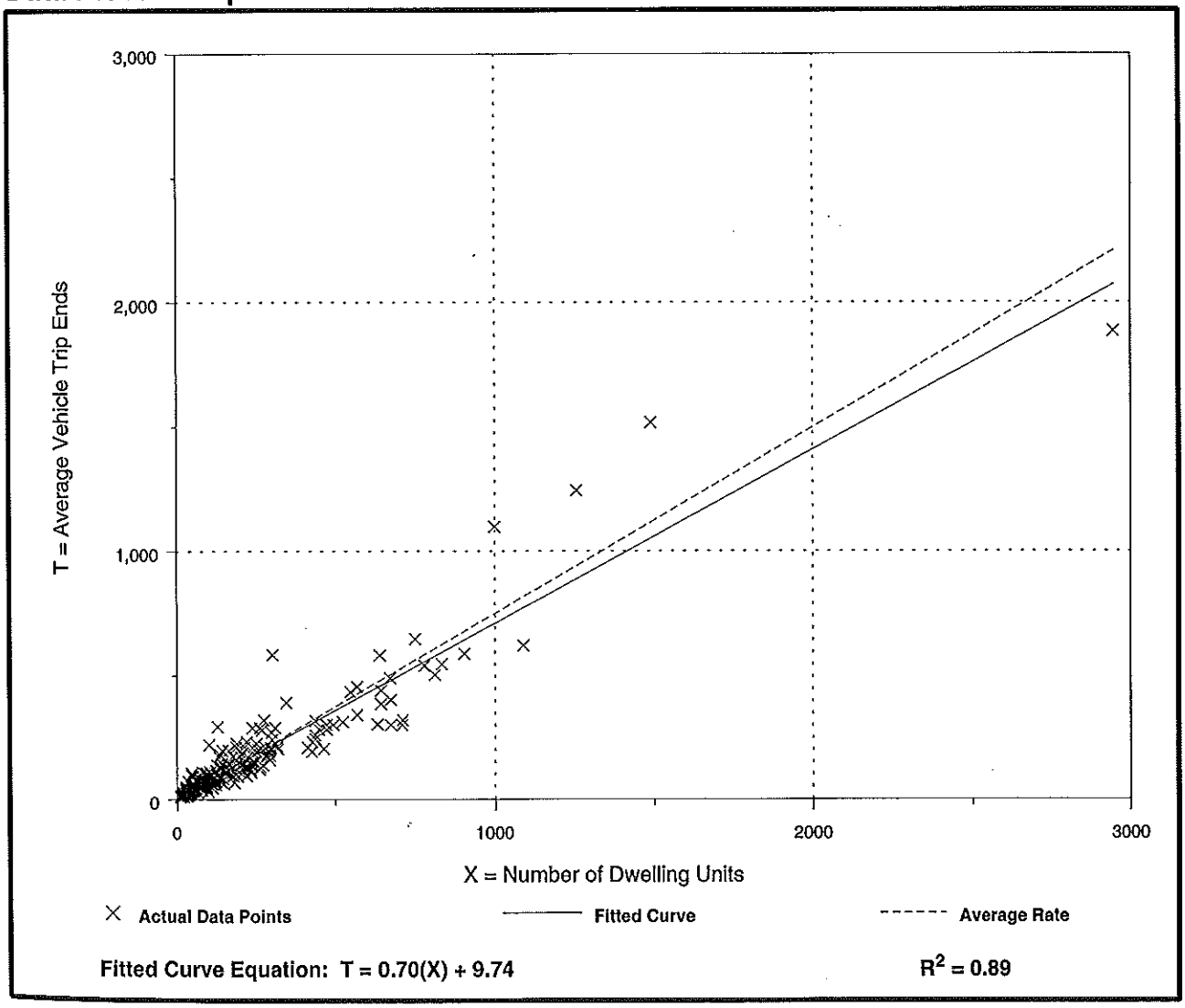
Average Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday,**
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.

Number of Studies: 286
Avg. Number of Dwelling Units: 194
Directional Distribution: 25% entering, 75% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.75	0.33 - 2.27	0.90

Data Plot and Equation



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

R^2 = 0.89

Single-Family Detached Housing
(210)

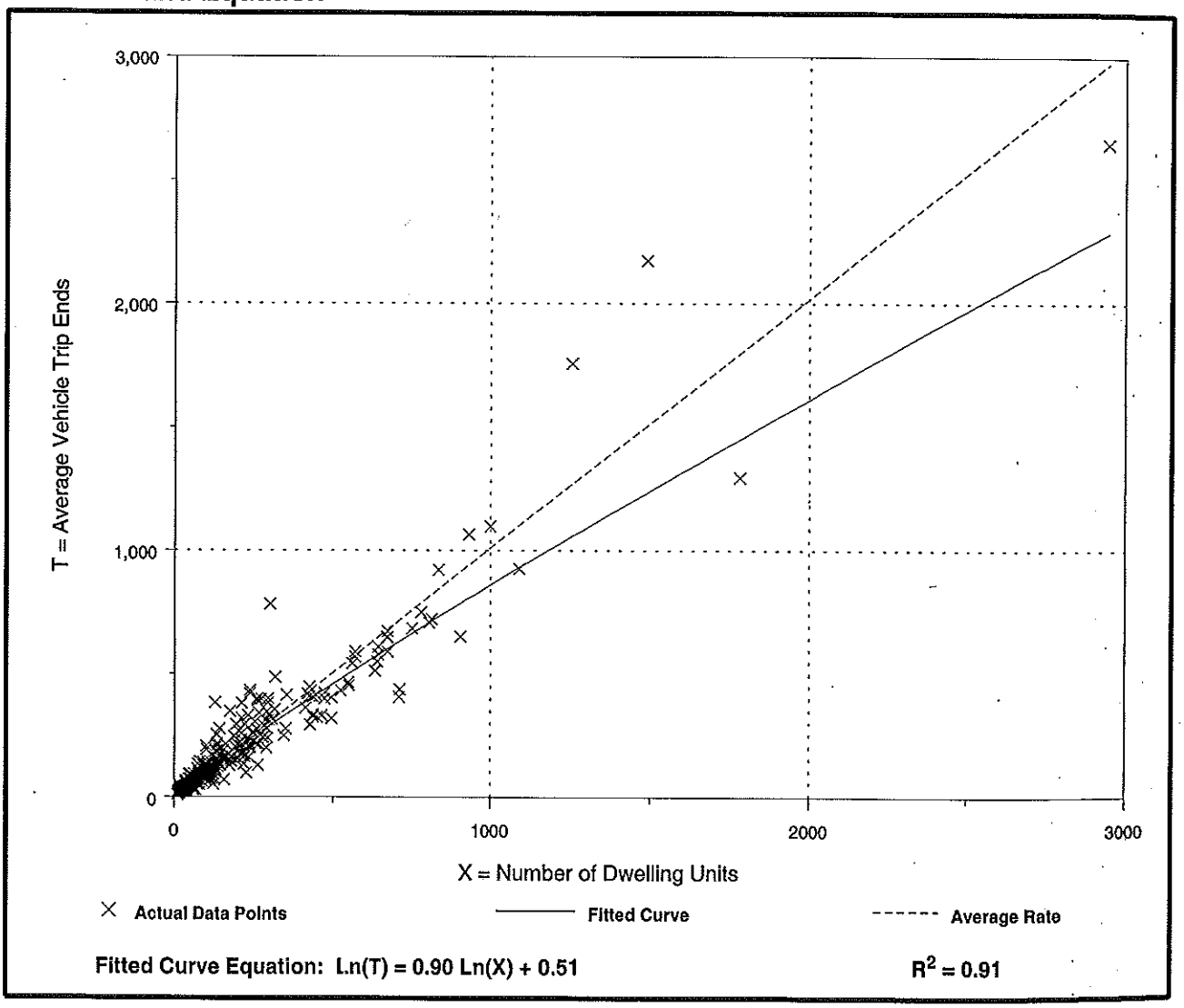
Average Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday,**
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.

Number of Studies: 314
Avg. Number of Dwelling Units: 208
Directional Distribution: 63% entering, 37% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
1.01	0.42 - 2.98	1.05

Data Plot and Equation



Fitted Curve Equation: Ln(T) = 0.90 Ln(X) + 0.51

R^2 = 0.91

TRIP GENERATION

COPPER TRACE DEVELOPMENT

ITE TRIP GENERATION (210) - SINGLE FAMILY DETACHED HOUSING

102 DWELLING UNITS

WEEKDAY

LN(T) = 0.92*LN(X) + 2.71
T = 1058

50%	ENTERING =	529
50%	EXITING =	529

AM PEAK

T = 0.70*(X) + 9.74
T = 81

25%	ENTERING =	20
75%	EXITING =	61

PM PEAK

LN(T) = 0.90*LN(X) + 0.51
T = 107

63%	ENTERING =	67
37%	EXITING =	40

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	BJH	Intersection	Emory @ Copper Ridge
Agency/Co.	Cannon & Cannon, Inc.	Jurisdiction	Knox County
Date Performed	10/31/2012	Analysis Year	Existing 2012
Analysis Time Period	AM Peak		

Project Description: Copper Trace TIS

East/West Street: Emory Road | North/South Street: Copper Ridge Road

Intersection Orientation: East-West | Study Period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	19	251			790	4
Peak-Hour Factor, PHF	0.90	0.90	1.00	1.00	0.90	0.90
Hourly Flow Rate, HFR (veh/h)	21	278	0	0	877	4
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LT					TR
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				21		59
Peak-Hour Factor, PHF	1.00	1.00	1.00	0.90	1.00	0.90
Hourly Flow Rate, HFR (veh/h)	0	0	0	23	0	65
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	0	0	0	0	0
Configuration					LR	

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LT						LR	
v (veh/h)	21						88	
C (m) (veh/h)	776						293	
v/c	0.03						0.30	
95% queue length	0.08						1.23	
Control Delay (s/veh)	9.8						22.5	
LOS	A						C	
Approach Delay (s/veh)	--	--				22.5		
Approach LOS	--	--				C		

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	BJH	Intersection	Emory @ Copper Ridge
Agency/Co.	Cannon & Cannon, Inc.	Jurisdiction	Knox County
Date Performed	10/31/2012	Analysis Year	Existing 2012
Analysis Time Period	PM Peak		

Project Description: Copper Trace TIS

East/West Street: Emory Road | North/South Street: Copper Ridge Road

Intersection Orientation: East-West | Study Period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	53	644			253	16
Peak-Hour Factor, PHF	0.93	0.93	1.00	1.00	0.93	0.93
Hourly Flow Rate, HFR (veh/h)	56	692	0	0	272	17
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LT					TR
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				3		18
Peak-Hour Factor, PHF	1.00	1.00	1.00	0.93	1.00	0.93
Hourly Flow Rate, HFR (veh/h)	0	0	0	3	0	19
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	0	0	0	0	0
Configuration					LR	

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LT						LR	
v (veh/h)	56						22	
C (m) (veh/h)	1284						581	
v/c	0.04						0.04	
95% queue length	0.14						0.12	
Control Delay (s/veh)	7.9						11.4	
LOS	A						B	
Approach Delay (s/veh)	--	--				11.4		
Approach LOS	--	--				B		

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*BJH*
Agency/Co.	*Cannon & Cannon, Inc.*
Date Performed	*10/31/2012*
Analysis Time Period	*AM Peak*

Site Information

Intersection	*Emory @ Copper Ridge*
Jurisdiction	*Knox County*
Analysis Year	*Background 2017*

Project Description *Copper Trace TIS*

East/West Street: *Emory Road* | North/South Street: *Copper Ridge Road*

Intersection Orientation: *East-West* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*21*	*276*			*869*	*4*
Peak-Hour Factor, PHF	*0.90*	*0.90*	*1.00*	*1.00*	*0.90*	*0.90*
Hourly Flow Rate, HFR (veh/h)	*23*	*306*	*0*	*0*	*965*	*4*
Percent Heavy Vehicles	*0*	--	--	*0*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*1*	*0*
Configuration	*LT*					*TR*
Upstream Signal		*0*			*0*	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*23*		*65*
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*0.90*	*1.00*	*0.90*
Hourly Flow Rate, HFR (veh/h)	*0*	*0*	*0*	*25*	*0*	*72*
Percent Heavy Vehicles	*0*	*0*	*0*	*0*	*0*	*0*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*0*	*0*
Configuration					*LR*	

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*LT*						*LR*	
v (veh/h)	*23*						*97*	
C (m) (veh/h)	*719*						*256*	
v/c	*0.03*						*0.38*	
95% queue length	*0.10*						*1.69*	
Control Delay (s/veh)	*10.2*						*27.4*	
LOS	*B*						*D*	
Approach Delay (s/veh)	--	--				*27.4*		
Approach LOS	--	--				*D*		

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	BJH	Intersection	Emory @ Copper Ridge
Agency/Co.	Cannon & Cannon, Inc.	Jurisdiction	Knox County
Date Performed	10/31/2012	Analysis Year	Background 2017
Analysis Time Period	PM Peak		

Project Description: Copper Trace TIS

East/West Street: Emory Road | North/South Street: Copper Ridge Road

Intersection Orientation: East-West | Study Period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	58	708			278	18
Peak-Hour Factor, PHF	0.93	0.93	1.00	1.00	0.93	0.93
Hourly Flow Rate, HFR (veh/h)	62	761	0	0	298	19
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LT					TR
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				3		20
Peak-Hour Factor, PHF	1.00	1.00	1.00	0.93	1.00	0.93
Hourly Flow Rate, HFR (veh/h)	0	0	0	3	0	21
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	0	0	0	0	0
Configuration					LR	

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LT						LR	
v (veh/h)	62						24	
C (m) (veh/h)	1255						550	
v/c	0.05						0.04	
95% queue length	0.16						0.14	
Control Delay (s/veh)	8.0						11.8	
LOS	A						B	
Approach Delay (s/veh)	--	--				11.8		
Approach LOS	--	--				B		

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	BJH	Intersection	Emory @ Copper Ridge
Agency/Co.	Cannon & Cannon, Inc.	Jurisdiction	Knox County
Date Performed	10/31/2012	Analysis Year	Combined 2017
Analysis Time Period	AM Peak		

Project Description: Copper Trace TIS

East/West Street: Emory Road | North/South Street: Copper Ridge Road

Intersection Orientation: East-West | Study Period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	35	276			869	9
Peak-Hour Factor, PHF	0.90	0.90	1.00	1.00	0.90	0.90
Hourly Flow Rate, HFR (veh/h)	38	306	0	0	965	10
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LT					TR
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				38		108
Peak-Hour Factor, PHF	1.00	1.00	1.00	0.90	1.00	0.90
Hourly Flow Rate, HFR (veh/h)	0	0	0	42	0	120
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	0	0	0	0	0
Configuration					LR	

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LT						LR	
v (veh/h)	38						162	
C (m) (veh/h)	716						248	
v/c	0.05						0.65	
95% queue length	0.17						4.09	
Control Delay (s/veh)	10.3						43.3	
LOS	B						E	
Approach Delay (s/veh)	--	--				43.3		
Approach LOS	--	--				E		

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	BJH	Intersection	Emory @ Copper Ridge
Agency/Co.	Cannon & Cannon, Inc.	Jurisdiction	Knox County
Date Performed	10/31/2012	Analysis Year	Combined 2017
Analysis Time Period	PM Peak		

Project Description: Copper Trace TIS

East/West Street: Emory Road | North/South Street: Copper Ridge Road

Intersection Orientation: East-West | Study Period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	105	708			278	35
Peak-Hour Factor, PHF	0.93	0.93	1.00	1.00	0.93	0.93
Hourly Flow Rate, HFR (veh/h)	112	761	0	0	298	37
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LT					TR
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				13		48
Peak-Hour Factor, PHF	1.00	1.00	1.00	0.93	1.00	0.93
Hourly Flow Rate, HFR (veh/h)	0	0	0	13	0	51
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	0	0	0	0	0
Configuration					LR	

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LT						LR	
v (veh/h)	112						64	
C (m) (veh/h)	1236						427	
v/c	0.09						0.15	
95% queue length	0.30						0.52	
Control Delay (s/veh)	8.2						14.9	
LOS	A						B	
Approach Delay (s/veh)	--	--				14.9		
Approach LOS	--	--				B		

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	BJH	Intersection	Emory @ Copper Ridge
Agency/Co.	Cannon & Cannon, Inc.	Jurisdiction	Knox County
Date Performed	10/31/2012	Analysis Year	Combined 2017
Analysis Time Period	AM Peak		

Project Description: Copper Trace TIS - Combined with EB and SB Turn Lanes

East/West Street: Emory Road | North/South Street: Copper Ridge Road

Intersection Orientation: East-West | Study Period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	35	276			869	9
Peak-Hour Factor, PHF	0.90	0.90	1.00	1.00	0.90	0.90
Hourly Flow Rate, HFR (veh/h)	38	306	0	0	965	10
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	1	1	0	0	1	0
Configuration	L	T				TR
Upstream Signal		0			0	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				38		108
Peak-Hour Factor, PHF	1.00	1.00	1.00	0.90	1.00	0.90
Hourly Flow Rate, HFR (veh/h)	0	0	0	42	0	120
Percent Heavy Vehicles	0	0	0	0	0	0
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	0	0	1	0	1
Configuration				L		R

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	L					L		R
v (veh/h)	38					42		120
C (m) (veh/h)	716					158		310
v/c	0.05					0.27		0.39
95% queue length	0.17					1.02		1.76
Control Delay (s/veh)	10.3					35.8		23.8
LOS	B					E		C
Approach Delay (s/veh)	--	--				26.9		
Approach LOS	--	--				D		

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*BJH*	Intersection	*Emory @ Copper Ridge*
Agency/Co.	*Cannon & Cannon, Inc.*	Jurisdiction	*Knox County*
Date Performed	*10/31/2012*	Analysis Year	*Combined 2017*
Analysis Time Period	*PM Peak*		

Project Description *Copper Trace TIS - Combined with EB and SB Turn Lanes*

East/West Street: *Emory Road* | North/South Street: *Copper Ridge Road*

Intersection Orientation: *East-West* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*105*	*708*			*278*	*35*
Peak-Hour Factor, PHF	*0.93*	*0.93*	*1.00*	*1.00*	*0.93*	*0.93*
Hourly Flow Rate, HFR (veh/h)	*112*	*761*	*0*	*0*	*298*	*37*
Percent Heavy Vehicles	*0*	--	--	*0*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*1*	*1*	*0*	*0*	*1*	*0*
Configuration	*L*	*T*				*TR*
Upstream Signal		*0*			*0*	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*13*		*48*
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*0.93*	*1.00*	*0.93*
Hourly Flow Rate, HFR (veh/h)	*0*	*0*	*0*	*13*	*0*	*51*
Percent Heavy Vehicles	*0*	*0*	*0*	*0*	*0*	*0*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*0*	*0*	*1*	*0*	*1*
Configuration				*L*		*R*

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*L*					*L*		*R*
v (veh/h)	*112*					*13*		*51*
C (m) (veh/h)	*1236*					*163*		*729*
v/c	*0.09*					*0.08*		*0.07*
95% queue length	*0.30*					*0.26*		*0.23*
Control Delay (s/veh)	*8.2*					*29.0*		*10.3*
LOS	*A*					*D*		*B*
Approach Delay (s/veh)	--	--				*14.1*		
Approach LOS	--	--				*B*		

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Emory Road (SR 131) at Copper Ridge Road

Eastbound Left-Turn Lane Warrant Assessment

TABLE 5A

LEFT-TURN LANE VOLUME THRESHOLDS
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 36 TO 45 MPH

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

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	100 - 149	150 - 199	200 - 249	250 - 299	300 - 349	350 - 399
100 - 149 150 - 199	250 200	180 140	140 105	110 90	80 70	70 60
200 - 249 250 - 299	160 130	115 100	85 75	75 65	65 60	55 50
300 - 349 350 - 399	110 100	90 80	70 65	60 55	55 50	45 40
400 - 449 450 - 499	90 80	70 65	60 55	50 45	45 40	35 30
500 - 549 550 - 599	70 65	60 55	45 40	35 35	35 30	25 25
600 - 649 650 - 699	60 55	45 35	35 35	30 30	25 25	25 20
700 - 749 750 or More	50 45	35 35	30 25	25 (25) 1,3	20 20	20 20

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 599	=/ > 600
100 - 149 150 - 199	70 60	60 55	50 45	45 40	40 35	35 30
200 - 249 250 - 299	55 50	50 45	40 35	35 30	30 30	30 (30) 2
300 - 349 350 - 399	45 40	40 35	35 30	30 25	25 25	(25) 4 20
400 - 449 450 - 499	35 30	30 25	30 25	25 20	20 20	20 20
500 - 549 550 - 599	25 25	25 20	20 20	20 20	20 20	15 15
600 - 649 650 - 699	25 20	20 20	20 20	20 20	20 20	15 15
700 - 749 750 or More	20 20	20 20	20 20	15 15	15 15	15 15

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

1- Existing (2012) A.M. Peak - Volume: 19, Required: 25 - Not Warranted

2- Existing (2012) P.M. Peak- Volume: 53, Required: 30 - Warranted

3- Combined (2017) A.M. Peak- Volume: 35, Required: 25- Warranted

4- Combined (2017) P.M. Peak- Volume: 105, Required: 25- Warranted

Emory Road (SR 131) at Copper Ridge Road

Westbound Right-Turn Lane Warrant Assessment

TABLE 5B

RIGHT-TURN LANE VOLUME THRESHOLDS
FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 36 TO 45 MPH

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

* The above based on Combined (2017) Traffic

Westbound Right-Turn Lane Not Warranted