CANNON & CANNON INC
CONSULTING ENGINEERS · FIELD SURVEYORS

February 9, 2016

Ms. Tarren Barrett
Knoxville Regional TPO
400 Main Street, Suite 403
Knoxville, TN 37902

RE: Traffic Impact Study for Hidden Valley Farms Subdivision
Knox County, Tennessee

Dear Ms. Barrett:

This correspondence provides a summary of a traffic impact study that was performed for the referenced proposed residential development. This study was structured to comply with the relevant requirements of Knox County, the Knoxville-Knox County Metropolitan Planning Commission (MPC) and the Tennessee Department of Transportation (TDOT). This version, dated February 9, 2016, is a revised version of the original report, which was dated December 17, 2015. These revisions are intended to address MPC comments, received on February 7, 2016.

Six figures and three tables were developed as a part of this study. These tables and figures appear throughout this correspondence in the order that they are discussed. In addition, a number of items are contained in the APPENDIX, which is placed at the rear of this document. These are referenced as appropriate in the discussion that follows.

The project site is located in west Knox County on Lovell Road (SR 131), northeast of the interchange of Lovell Road with Pellissippi Parkway (SR 162). The specific location is detailed on the site location map shown on FIGURE 1. The current proposal is to construct a development consisting of 120 single-family detached housing units with a complete new subdivision street system, lying on the southeast side of Lovell Road. The concept layout plan of this development is shown on FIGURE 2. The purpose of this study is to assess the anticipated traffic impacts resulting from the future full build-out of this project.

Existing and Background Conditions

The project site is proposed to take its access directly off of Lovell Road at a location approximately 0.60 mile east of Pellissippi Parkway. The proposed access road into the development will form the fourth leg of the existing intersection of Lovell Road with Thompson Road. This intersection is currently stop controlled, with Thompson Road stopping for Lovell Road, and it is proposed that the new subdivision access road also be stop controlled.

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FIGURE 1 – SITE LOCATION MAP

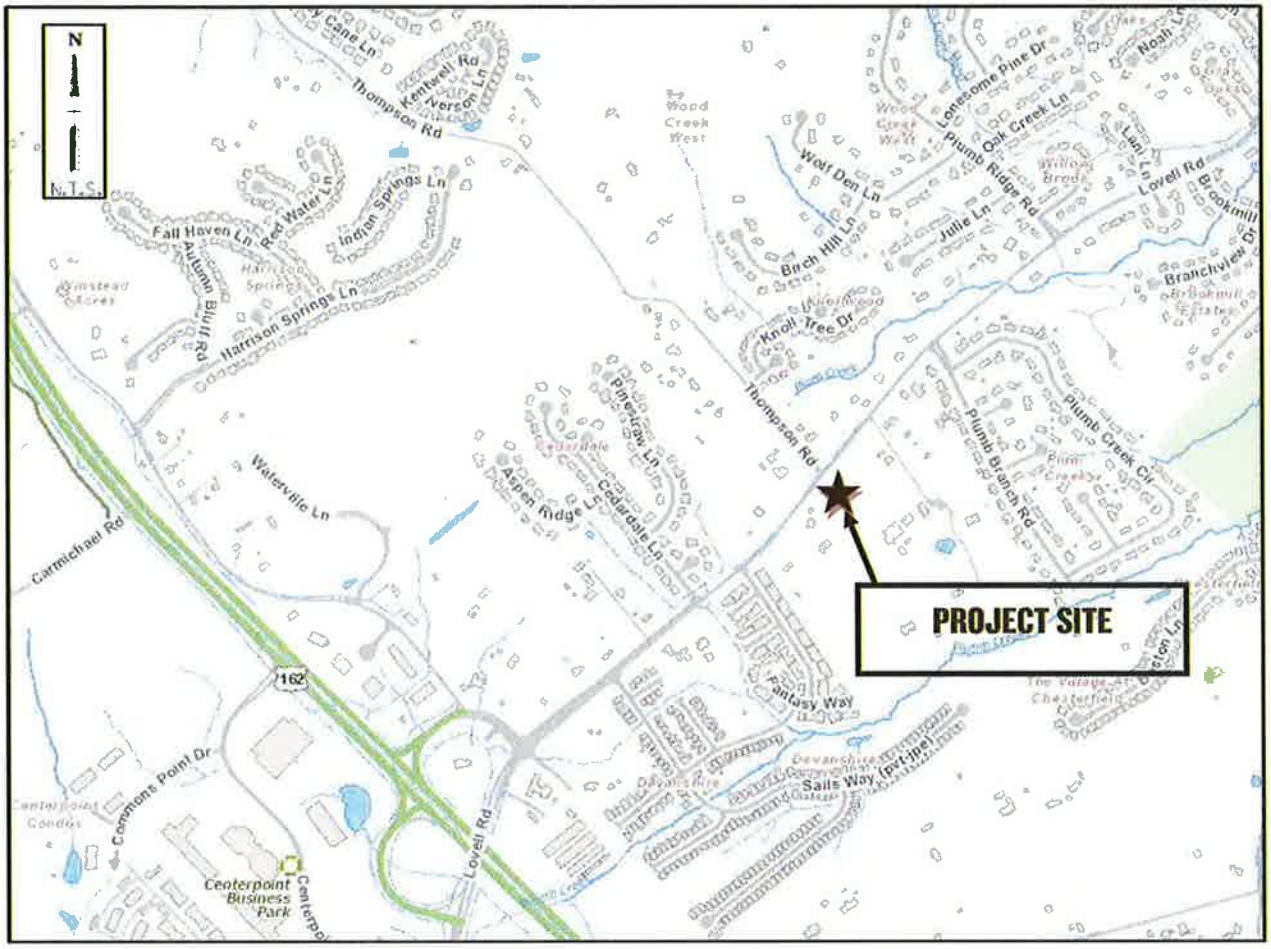

FIGURE 2 – CONCEPT LAYOUT PLAN

Lovell Road is a two lane state highway maintained by TDOT that is classified as a Minor Arterial roadway per the MPC. It is a five mile long roadway that runs primarily north-south, although it is oriented more in an east-west direction at the study location. Its southern terminus is at Kingston Pike and its northern terminus is at Middlebrook Pike. In the vicinity of the project site the roadway pavement is approximately 22 feet with minimal or no shoulders. The roadway traverses through rolling terrain and has a posted speed limit of 35 mph. It is fully striped with a double yellow centerline and white edgelines at both edges of pavement.

Thompson Road is also a two lane roadway, but is classified as a Minor Collector Street. It possesses a narrow pavement that varies in width, typically in the sixteen to eighteen foot range. It is approximately one and one quarter miles in length, forming a direct connection between Lovell Road on the south end and Hardin Valley Road on the north end. The study intersection is the southern terminus and Thompson Road is posted with a 30 mph speed limit.

TABLE 1 provides a summary of several years of recent Annual Average Daily Traffic (AADT) information from a TDOT AADT count station that is located on Lovell Road just to the north of the study intersection. This data will be further discussed in the next paragraph. In addition to the AADT traffic data, A.M. and P.M. peak hour turning movement traffic counts were conducted for the study intersection of Lovell Road and Thompson Road. This data, which is the existing year 2015 traffic data, is summarized in FIGURE 3. Raw traffic count and AADT data summaries are also contained in the APPENDIX.

TABLE 1
ANNUAL AVERAGE DAILY TRAFFIC COUNT SUMMARY

COUNT YEAR	TDOT COUNT STATION 085 LOVELL ROAD (SR 131)- NEAR BALL CAMP EAST OF SR 162
2014	12,325
2013	11,970
2012	12,944
2011	11,685
2010	10,294
2009	11,615
2008	11,854
2007	10,914

A five year time period was assumed for project build-out and full occupancy. In order to arrive at estimates of what traffic would be like after five years if the development were not constructed, a 1.5 percent annual growth rate was assumed for each of these five years. This rate is considered somewhat conservative, as the TABLE 1 AADT data for recent years shows no consistent pattern of growth and in some cases volumes actually dropped from year to year. FIGURE 4 provides estimates of the background year 2020 traffic using the 1.5 percent annual growth rate.

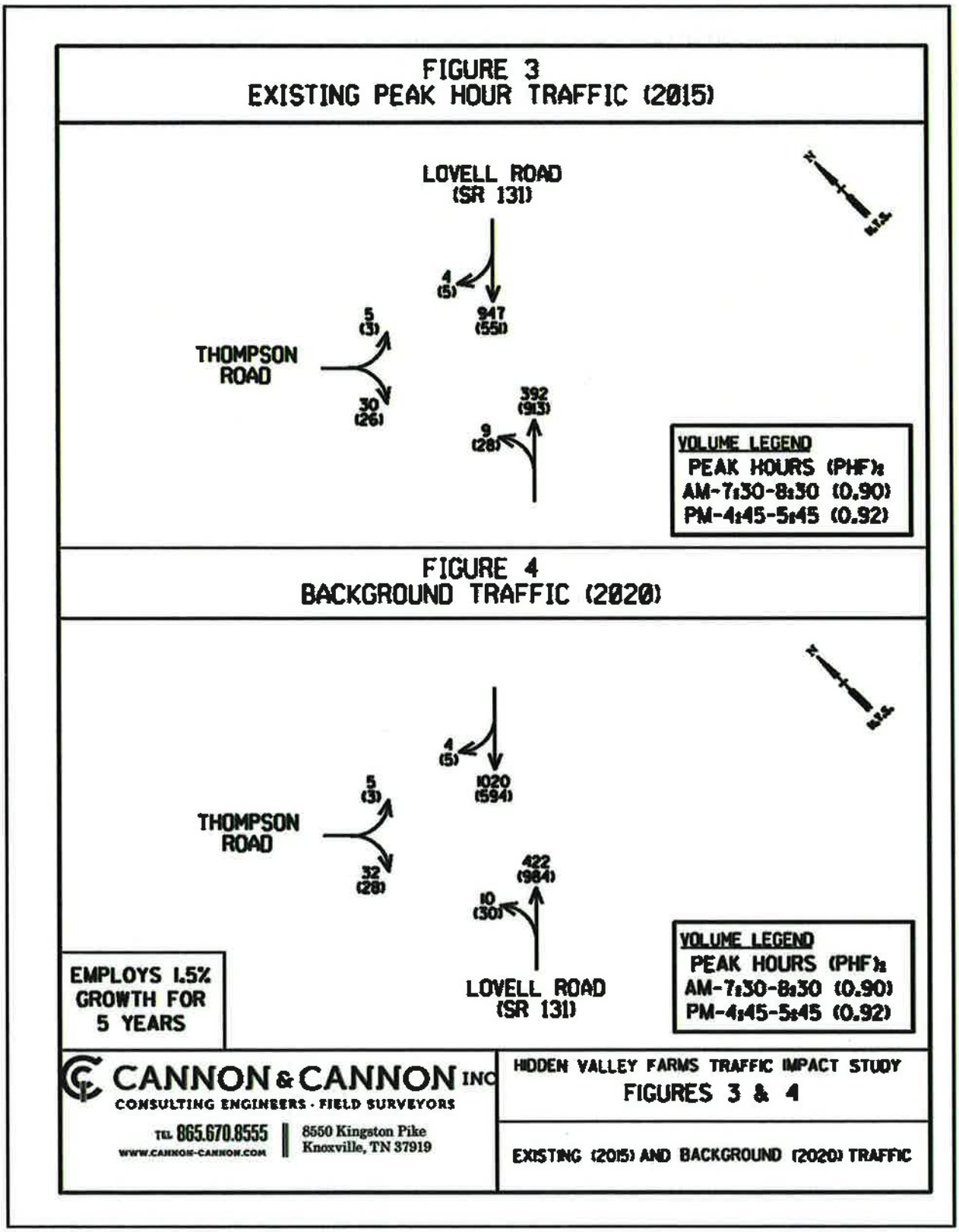
FIGURE 3
EXISTING PEAK HOUR TRAFFIC (2015)
LOVELL ROAD
(SR 131)
4
(5)
947
(550)
5
(3)
THOMPSON
ROAD
30
(26)
392
(913)
9
(28)
VOLUME LEGEND
PEAK HOURS (PHF)
AM-7:30-8:30 (0.90)
PM-4:45-5:45 (0.92)
FIGURE 4
BACKGROUND TRAFFIC (2020)
4
(5)
1020
(594)
5
(3)
THOMPSON
ROAD
32
(28)
422
(984)
10
(30)
LOVELL ROAD
(SR 131)
EMPLOYS 1.5%
GROWTH FOR
5 YEARS
VOLUME LEGEND
PEAK HOURS (PHF)
AM-7:30-8:30 (0.90)
PM-4:45-5:45 (0.92)
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HIDDEN VALLEY FARMS TRAFFIC IMPACT STUDY
FIGURES 3 & 4
EXISTING (2015) AND BACKGROUND (2020) TRAFFIC

Future Conditions

In order to estimate future trips coming from the proposed residential development, trip generation rates developed by the Institute of Transportation Engineers (ITE) were applied. The selected rates were those from the ITE document *Trip Generation, 9th Edition*, and were specifically the rates for Single Family Detached Housing (ITE Code 210). TABLE 2 provides a summary of this trip generation, which was applied to the 120 units that are proposed. A sheet is also contained in the APPENDIX that summarizes the trip generation calculations.

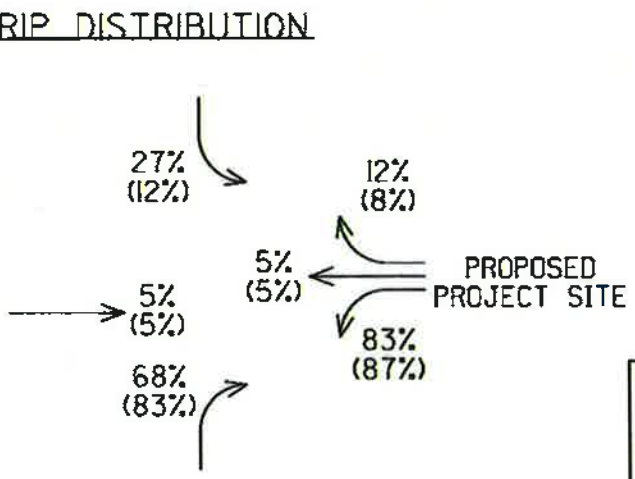
TABLE 2
TRIP GENERATION SUMMARY

LAND USE	SIZE	WEEKDAY (TRIPS/DAY)	AM PEAK HR. (TRIPS/HOUR)	PM PEAK HR. (TRIPS/HOUR)
SINGLE FAMILY DETACHED HOUSING (ITE CODE 210)	120 UNITS	1242	95	124
ENTERING TRIPS (%)	-	621 (50%)	24 (25%)	78 (63%)
EXITING TRIPS (%)	-	621 (50%)	71 (75%)	46 (37%)

The generated trips were applied to the study intersection by developing distribution percentages derived directly from the existing traffic counts that were conducted for the study intersection. These distribution percentages are shown on the top of FIGURE 5, while the remainder of the figure shows how the generated trips were assigned to the study intersection for the AM and PM peak hours using these percentages. FIGURE 6 provides the volumes for the year 2020 combined analysis, which were developed by adding the FIGURE 4 background volumes to the FIGURE 5 generated volumes.

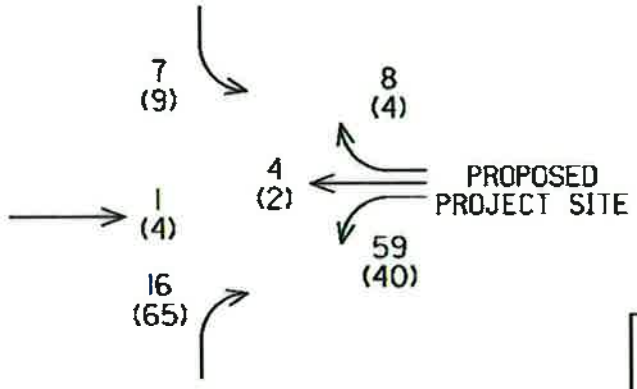
FIGURE 5
TRIP DISTRIBUTION AND ASSIGNMENT

TRIP DISTRIBUTION



PERCENT LEGEND
AM - ENTER/EXIT %
PM - ENTER/EXIT %

TRIP ASSIGNMENT



VOLUME LEGEND
PEAK HOURS (PHF):
AM-7:30-8:30 (0.90)
PM-4:45-5:45 (0.92)

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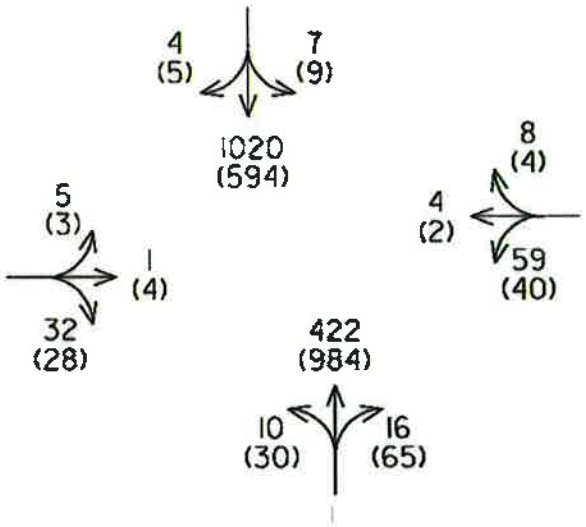
HIDDEN VALLEY FARMS TRAFFIC IMPACT STUDY
FIGURE 5

TRIP DISTRIBUTION AND ASSIGNMENT

FIGURE 6
COMBINED TRAFFIC (2020)



VOLUME LEGEND
PEAK HOURS (PHF):
AM-7:30-8:30 (0.90)
PM-4:45-5:45 (0.92)

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HIDDEN VALLEY FARMS TRAFFIC IMPACT STUDY
FIGURE 6

COMBINED TRAFFIC (2020)

Project Analyses

Capacity Analyses:
The capacity analysis methods of the most recent edition of the *Highway Capacity Manual (HCM2010)* were applied to the existing (FIGURE 3), background (FIGURE 4) and combined (FIGURE 6) traffic volumes at the study intersection. Because Knox County and TDOT are currently working towards a project to widen Lovell Road to five lanes in the study area in the next few years, analyses were conducted for both the existing two lane roadway and for the future five lane roadway. The results are summarized in TABLE 3, with computer print-out summaries contained in the APPENDIX.

TABLE 3
CAPACITY ANALYSIS SUMMARY
LOVELL ROAD AT THOMPSON ROAD

CAPACITY ANALYSES CONDITIONS	PEAK TIME PERIOD	MAIN STREET LEFT TURNS EB LT / WB LT (LOS)	SOUTHBOUND MOVEMENTS (LOS/DELAY)	NORTHBOUND MOVEMENTS (LOS/DELAY)
EXISTING CONDITIONS (2015)	A.M.	B /	C / 23.5s	
	P.M.	A /	C / 15.8s	
BACKGROUND CONDITIONS (2020)	A.M.	B /	D / 26.6s	
	P.M.	A /	C / 17.0s	
COMBINED (2020) TWO LANE LOVELL RD	A.M.	B / A	D / 31.6s	F / 246.5s
	P.M.	A / B	C / 27.5s	F / 258.7s
COMBINED (2020) FIVE LANE LOVELL RD	A.M.	B / A	C / 15.6s	C / 20.1s
	P.M.	A / B	B / 11.0s	D / 32.3s

Analysis methodology is two-way stop control analysis per HCM 2010. Results shown are level-of-service (LOS) and average vehicular delay given for main street left-turns and average of movements on the two side street approaches. See APPENDIX for a sheet explaining capacity and level-of-service concepts.

The capacity analyses summarized in TABLE 3 reveals that the study intersection will operate with acceptable levels-of-service once Lovell Road is widened to five lanes. Until this widening is completed, however, poor levels-of-service are expected on the northbound new subdivision approach. As the number of occupied subdivision units near full build-out, the associated delays will likely be quite severe. It should be noted that even at full build-out, the levels-of-service for the non-northbound traffic movements are expected to remain acceptable. Thus, it is the subdivision traffic itself that will be most significantly affected by these conditions.

Turn Lane Assessment:
The possible need for left and right turn lanes for the Lovell Road approaches to the study intersection were investigated by applying the requirements of the *Knox County Access Control and Driveway Design Policy*. The resulting figures are contained in the APPENDIX. As can be seen, the only justification will be for an eastbound right-turn lane when Lovell Road is two lanes and at least 46 units are constructed. Once Lovell Road is widened to five lanes, it appears that a right-turn lane will no longer be justified, even when the full 120 units are constructed. It should be noted that even thought a left-turn lane is not justified, one will be constructed as part of the Lovell Road widening project.

Intersection Sight Distance:
The intersection corner sight distance was field measured for the study intersection. Because existing brush and terrain issues make these measurements on the south side of Lovell Road difficult and dangerous, the measurements were actually estimated from the south side shoulder, as well as from a location on the north side of Lovell Road. Using accepted criteria for driver eye and approaching vehicle height, the available corner sight distance looking east is well in excess of 600 feet. Looking west, measurements were made on two occasions, with estimated values ranging from 340 to 360 feet. John Sexton form Knox County was present during the second field visit and he estimated the sight distance to be 350 feet. The current speed limit is 35 mph, so in typical circumstances the required sight distance would be 350 feet. However, MPC and Knox County are asking for a minimum sight distance of 400 feet based on observed traffic speeds and a past crash history at this location. The last three sheets in the Appendix should be referenced for a summary of MPC/Knox County comments on sight distance observations and requirements, as well as a crash history summary.

Conclusions and Recommendations

Based on this traffic impact study, it appears that the impact on intersection capacity at the study intersection from the anticipated newly generated site traffic will be significant. However, this impact will have its most serious effect on northbound subdivision traffic exiting the project site. The impact on other intersection movements will be relatively small and within acceptable ranges. Discussions with Knox County have indicated that the Lovell Road widening project could be under construction in a three to four year time frame. Once this project is complete, intersection capacity conditions will be much improved and good levels-of-service are expected for all traffic movements. Therefore, it is recommended that this roadway project be expedited. It is also recommended that the subdivision developer carefully plan the build-out of his development in order to minimize roadway and intersection related concerns. It should be noted that if these concerns become too severe, they will likely affect the attractiveness of this subdivision to potential buyers.

The only additional turn lane that appears justified for this project is an eastbound right-turn lane, which will likely only be justified as long as Lovell Road remains two lanes and only when 46 or more units will be occupied. Given the time frame noted above for the widening, and given the fact that it will take several years for this subdivision to develop, it is not recommended that this lane be constructed at this time, especially since it would likely be torn out during construction. Consideration might be given to a larger than normal right-turn radius or a tapered entrance to assist the right-turn movement. The construction of a right-turn lane could be considered as part of the Lovell Road widening project.

Based on the MPC/Knox County 400 foot sight distance requirement discussed above, the intersection corner sight distance is not adequate at the study intersection. It is therefore recommended that the developer and his site engineer work with Knox County to identify an appropriate intersection location to meet this requirement and the access and layout requirements of the development. It should be noted that MPC/Knox County also require a 125 foot separation between the subdivision entrance and Thompson Road (see MPC letter at rear of

Appendix). In addition, existing trees and brush along the south side of Lovell Road, west of the study intersection, be completely removed, and all site signage and landscaping be very carefully placed to avoid any impact on lines of sight. In addition, the sight limiting hillcrest located west of the study intersection should be improved when Lovell Road is widened in order to improve the corner sight distance to well beyond minimum requirements.

Please do not hesitate to contact us with any questions or if you require additional information.

Sincerely,

Alan L. Childers

Alan L. Childers, P.E.
Vice President

Attachments

cc: Project File 00773-0006

APPENDIX

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 congestion, stops, delay, excess fuel consumption, pollutant emissions, etc.

The Transportation Research Board 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.

Another measure of intersection capacity that is often used in the evaluation of intersection operations is the volume to capacity (V/C) ratio. This ratio is defined as "the ratio of flow rate to capacity", and is a good measure of how much of an intersection's available capacity has been used up by the analysis volumes. Conversely, it also provides an indication of the reserve capacity available for future growth in traffic volumes.

The Intersection Capacity Utilization (ICU) is another measure that expresses a value similar to the V/C ratio. Specifically, the ICU method "sums the amount of the time required to serve all movements at saturation for a given cycle length and divides by that reference cycle length." The ICU is considered a more accurate measure of volume to capacity conditions for a signalized intersection, primarily because it accounts for the effects of the signal timing on intersection capacity.

HCS 2010 Two-Way Stop Control Summary Report

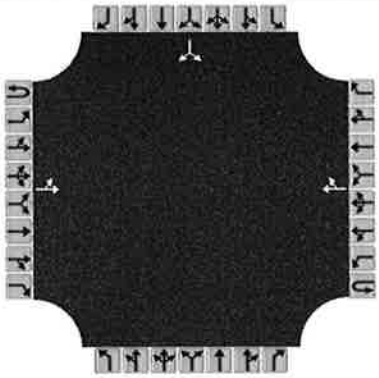
General Information

Analyst	ALC
Agency/Co.	CCI
Date Performed	12/15/2015
Analysis Year	2015
Time Analyzed	AM Peak (7:30-8:30)
Intersection Orientation	East-West
Project Description	Hidden Valley Farms - Existing

Site Information

Intersection	Lovell / Thompson
Jurisdiction	Knox County
East/West Street	Lovell Road
North/South Street	Thompson Road
Peak Hour Factor	0.90
Analysis Time Period (hrs)	0.25

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	0	0
Configuration		LT						TR							LR	
Volume (veh/h)		09	0392				0947	04						05		030
Percent Heavy Vehicles		3												3		3
Proportion Time Blocked																
Right Turn Channelized	No				No				No				No			
Median Type	Undivided															
Median Storage																

Delay, Queue Length, and Level of Service

Flow Rate (veh/h)		446													39	
Capacity		655													233	
v/c Ratio		0.68													0.17	
95% Queue Length		0.0													0.6	
Control Delay (s/veh)		10.6													23.5	
Level of Service (LOS)		B													C	
Approach Delay (s/veh)	0.4												23.5			
Approach LOS	A												C			

HCS 2010 Two-Way Stop Control Summary Report

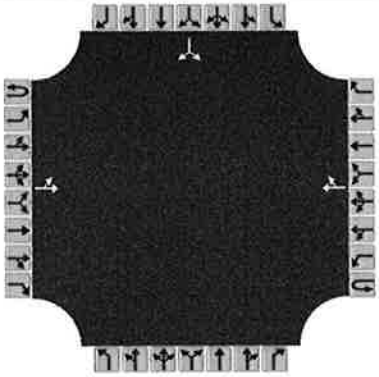
General Information

Analyst	ALC
Agency/Co.	CCI
Date Performed	12/15/2015
Analysis Year	2015
Time Analyzed	PM Peak (4:45-5:45)
Intersection Orientation	East-West
Project Description	Hidden Valley Farms - Existing

Site Information

Intersection	Lovell / Thompson
Jurisdiction	Knox County
East/West Street	Lovell Road
North/South Street	Thompson Road
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	0	0
Configuration		LT						TR							LR	
Volume (veh/h)		28	913				551	5						3		26
Percent Heavy Vehicles		3												3		3
Proportion Time Blocked																
Right Turn Channelized	No				No				No				No			
Median Type	Undivided															
Median Storage																

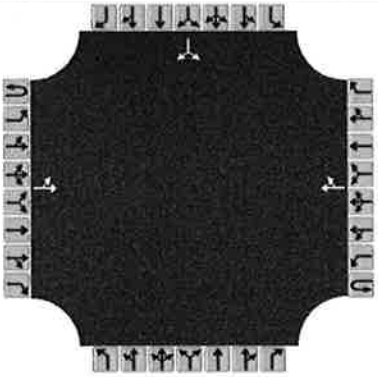
Delay, Queue Length, and Level of Service

Flow Rate (veh/h)		1022													31	
Capacity		968													364	
v/c Ratio		1.06													0.09	
95% Queue Length		0.1													0.3	
Control Delay (s/veh)		8.8													15.8	
Level of Service (LOS)		A													C	
Approach Delay (s/veh)	0.9												15.8			
Approach LOS	A												C			

HCS 2010 Two-Way Stop Control Summary Report

General Information		Site Information	
Analyst	ALC	Intersection	Lovell / Thompson
Agency/Co.	CCI	Jurisdiction	Knox County
Date Performed	12/15/2015	East/West Street	Lovell Road
Analysis Year	2020	North/South Street	Thompson Road
Time Analyzed	AM Peak (7:30-8:30)	Peak Hour Factor	0.90
Intersection Orientation	East-West	Analysis Time Period (hrs)	0.25
Project Description	Hidden Valley Farms - Background		

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	0	0
Configuration		LT						TR							LR	
Volume (veh/h)		10	0422				1020	4						S		032
Percent Heavy Vehicles		3												3		3
Proportion Time Blocked																
Right Turn Channelized	No				No				No				No			
Median Type	Undivided															
Median Storage																

Delay, Queue Length, and Level of Service

Flow Rate (veh/h)		480													42	
Capacity		610													208	
v/c Ratio		0.79													0.20	
95% Queue Length		0.1													0.7	
Control Delay (s/veh)		11.0													26.6	
Level of Service (LOS)		B													D	
Approach Delay (s/veh)	0.5												26.6			
Approach LOS	A												D			

HCS 2010 Two-Way Stop Control Summary Report

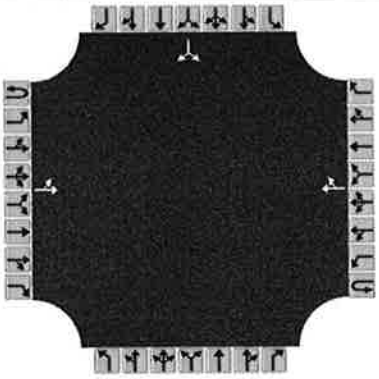
General Information

Analyst	ALC
Agency/Co.	CCI
Date Performed	12/15/2015
Analysis Year	2020
Time Analyzed	PM Peak (4:45-5:45)
Intersection Orientation	East-West
Project Description	Hidden Valley Farms - Background

Site Information

Intersection	Lovell / Thompson
Jurisdiction	Knox County
East/West Street	Lovell Road
North/South Street	Thompson Road
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	0	0		0	0	0
Configuration		LT						TR							LR	
Volume (veh/h)		030	0984				0594	05						03		028
Percent Heavy Vehicles		3												3		3
Proportion Time Blocked																
Right Turn Channelized	No				No				No				No			
Median Type	Undivided															
Median Storage																

Delay, Queue Length, and Level of Service

Flow Rate (veh/h)		1103													33	
Capacity		930													334	
v/c Ratio		1.19													0.10	
95% Queue Length		0.1													0.3	
Control Delay (s/veh)		9.0													17.0	
Level of Service (LOS)		A													C	
Approach Delay (s/veh)	1.0												17.0			
Approach LOS	A												C			

HCS 2010 Two-Way Stop Control Summary Report

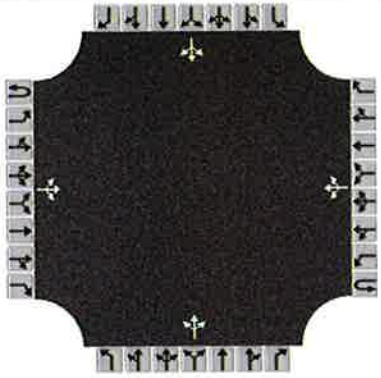
General Information

Analyst	ALC
Agency/Co.	CCI
Date Performed	12/15/2015
Analysis Year	2020
Time Analyzed	AM Peak (7:30-8:30)
Intersection Orientation	East-West
Project Description	Hidden Valley Farms - Combined (2 Lane Lovell)

Site Information

Intersection	Lovell / Thompson
Jurisdiction	Knox County
East/West Street	Lovell Road
North/South Street	Thompson Road
Peak Hour Factor	0.90
Analysis Time Period (hrs)	0.25

Lanes



Major Street: East West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	1	0		0	1	0
Configuration			LTR				LTR				LTR				LTR	
Volume (veh/h)		10	422	16		7	1020	4		59	4	8		5	1	32
Percent Heavy Vehicles		3				3				3	3	3		3	3	3
Proportion Time Blocked																
Right Turn Channelized	No				No				No				No			
Median Type	Undivided															
Median Storage																

Delay, Queue Length, and Level of Service

Flow Rate (veh/h)		11				8					79				43	
Capacity		610				1070					70				178	
v/c Ratio		0.02				0.01					1.12				0.24	
95% Queue Length		0.1				0.0					6.0				0.9	
Control Delay (s/veh)		11.0				8.4					246.5				31.6	
Level of Service (LOS)		B				A					F				D	
Approach Delay (s/veh)	0.5				0.2				246.5				31.6			
Approach LOS	A				A				F				D			

HCS 2010 Two-Way Stop Control Summary Report

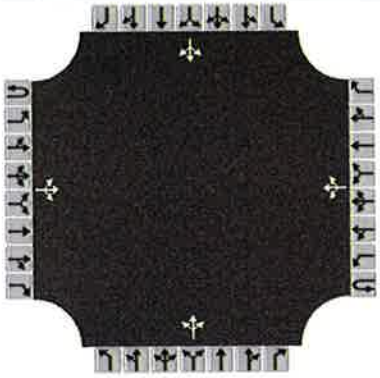
General Information

Analyst	ALC
Agency/Co.	CCI
Date Performed	12/15/2015
Analysis Year	2020
Time Analyzed	PM Peak (4:45-5:45)
Intersection Orientation	East-West
Project Description	Hidden Valley Farms - Combined (2 Lane Lovell)

Site Information

Intersection	Lovell / Thompson
Jurisdiction	Knox County
East/West Street	Lovell Road
North/South Street	Thompson Road
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes



Major Street: East West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	1	0		0	1	0
Configuration			LTR				LTR				LTR				LTR	
Volume (veh/h)		30	984	65		9	594	5		40	2	4		3	4	28
Percent Heavy Vehicles		3				3				3	3	3		3	3	3
Proportion Time Blocked																
Right Turn Channelized	No				No				No				No			
Median Type	Undivided															
Median Storage																

Delay, Queue Length, and Level of Service

Flow Rate (veh/h)		33				10					49				37	
Capacity		930				608					49				197	
v/c Ratio		0.04				0.02					1.00				0.19	
95% Queue Length		0.1				0.1					4.3				0.7	
Control Delay (s/veh)		9.0				11.0					258.7				27.5	
Level of Service (LOS)		A				B					F				D	
Approach Delay (s/veh)	1.1				0.4				258.7				27.5			
Approach LOS	A				A				F				D			

HCS 2010 Two-Way Stop Control Summary Report

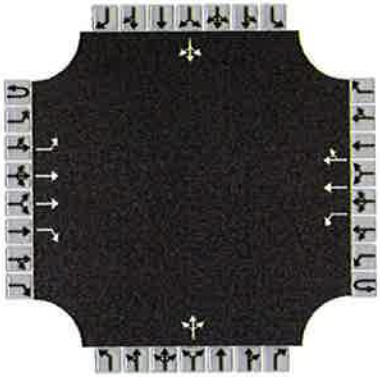
General Information

Analyst	ALC
Agency/Co.	CCI
Date Performed	12/15/2015
Analysis Year	2020
Time Analyzed	AM Peak (7:30-8:30)
Intersection Orientation	East-West
Project Description	Hidden Valley Farms-Combined (5 Lane Lovell)

Site Information

Intersection	Lovell / Thompson
Jurisdiction	Knox County
East/West Street	Lovell Road
North/South Street	Thompson Road
Peak Hour Factor	0.90
Analysis Time Period (hrs)	0.25

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	1	2	1	0	1	2	0		0	1	0		0	1	0
Configuration		L	T	R		L	T	TR			LTR				LTR	
Volume (veh/h)		10	422	16		7	1020	4		59	4	8		5	1	32
Percent Heavy Vehicles		3				3				3	3	3		3	3	3
Proportion Time Blocked																
Right Turn Channelized	No				No				No				No			
Median Type	Left Only															
Median Storage	1															

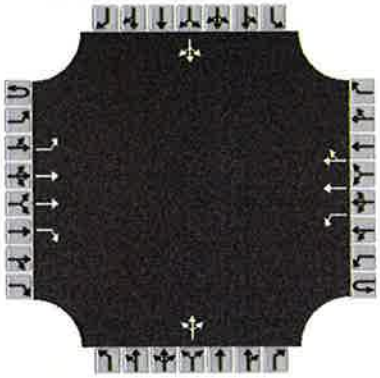
Delay, Queue Length, and Level of Service

Flow Rate (veh/h)		11				8					79				43	
Capacity		605				1065					317				382	
v/c Ratio		0.02				0.01					0.25				0.11	
95% Queue Length		0.1				0.0					1.0				0.4	
Control Delay (s/veh)		11.1				8.4					20.1				15.6	
Level of Service (LOS)		B				A					C				C	
Approach Delay (s/veh)	0.2				0.1				20.1				15.6			
Approach LOS	A				A				C				C			

HCS 2010 Two-Way Stop Control Summary Report

General Information		Site Information	
Analyst	ALC	Intersection	Lovell / Thompson
Agency/Co.	CCI	Jurisdiction	Knox County
Date Performed	12/15/2015	East/West Street	Lovell Road
Analysis Year	2020	North/South Street	Thompson Road
Time Analyzed	PM Peak (4:45-5:45)	Peak Hour Factor	0.92
Intersection Orientation	East-West	Analysis Time Period (hrs)	0.25
Project Description	Hidden Valley Farms-Combined (5 Lane Lovell)		

Lanes



Major Street: East West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	1	2	1	0	1	2	0		0	1	0		0	1	0
Configuration		L	T	R		L	T	TR			LTR				LTR	
Volume (veh/h)		30	984	65		9	594	5		40	2	4		3	4	28
Percent Heavy Vehicles		3				3				3	3	3		3	3	3
Proportion Time Blocked																
Right Turn Channelized	No				No				No				No			
Median Type	Left Only															
Median Storage	1															

Delay, Queue Length, and Level of Service

Flow Rate (veh/h)		33				10					49				37	
Capacity		925				602					180				638	
v/c Ratio		0.04				0.02					0.27				0.06	
95% Queue Length		0.1				0.1					1.1				0.2	
Control Delay (s/veh)		9.0				11.1					32.3				11.0	
Level of Service (LOS)		A				B					D				B	
Approach Delay (s/veh)	0.3				0.2				32.3				11.0			
Approach LOS	A				A				D				B			

Possible Westbound Left-turn Lane

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	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
300 - 349 350 - 399	45 40	40 35	35 30	30 25	25 25	25 20
400 - 449 450 - 499	35 30	30 25	30 25	25 20	20 20	AM (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 PM (15) *	15 15

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

* AM - 20 L.T. needed, Projected = 7 → L.T. lane not warranted

PM - 15 L.T. needed, Projected = 10 → L.T. lane not warranted

Possible Eastbound Right-turn Lane

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			FIVE LANES AM (NO) 16			
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		TWO LANES AM (NO) 16	FIVE LANES PM (NO) 65	Yes	Yes Yes	TWO LANES Yes PM (Yes) 65*
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.

* Right-turn lane justified only in P.M. Peak w/2 Lane Lovell
- Lane warranted when 25 right-turns are present
- 25 ÷ 65 = 38% buildout of units = 46 units occupied is when lane becomes justified

Trip Generation - Single Family Detached Housing
ITE Code 210 from Trip Generation, 9th Edition

1) Weekday (P. 296)
$Ln(T) = 0.92\ Ln(120\ units) + 2.72$
$T = 1242\ trips^{*}$ - 50% Entering = 621
50% Exiting = 621

* Level I study per Knox County (Level I = 750-3000)

2) AM Peak (P. 297)
Peak hour of adjacent street traffic, 1 hr. between 7 & 9 a.m.
$T = 0.70(120\ units) + 9.74$
$T = 94\ (95\uparrow)\ trips$ - 25% Entering = 24 (Rounded both up)
75% Exiting = 71

3) PM Peak (P. 298)
Peak hour of adjacent street traffic, 1 hr. between 4 & 6 p.m.
$Ln(T) = 0.90\ Ln(120\ units) + 0.51$
$T = 124\ trips$ - 63% Entering = 78
37% Exiting = 46

Single-Family Detached Housing
(210)

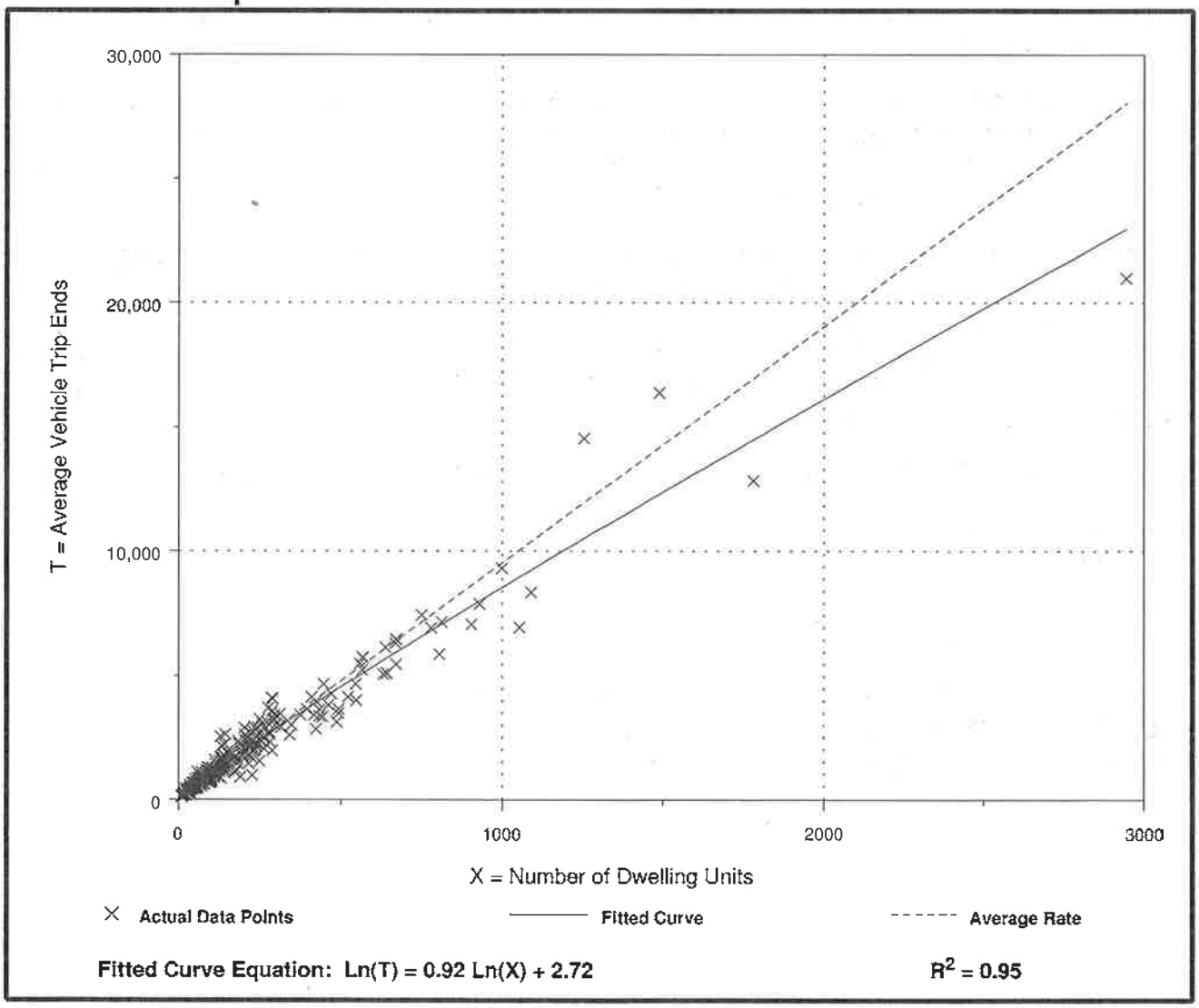
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Number of Studies: 355
Avg. Number of Dwelling Units: 198
Directional Distribution: 50% entering, 50% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
9.52	4.31 - 21.85	3.70

Data Plot and Equation



Fitted Curve Equation: Ln(T) = 0.92 Ln(X) + 2.72

R^2 = 0.95

Single-Family Detached Housing
(210)

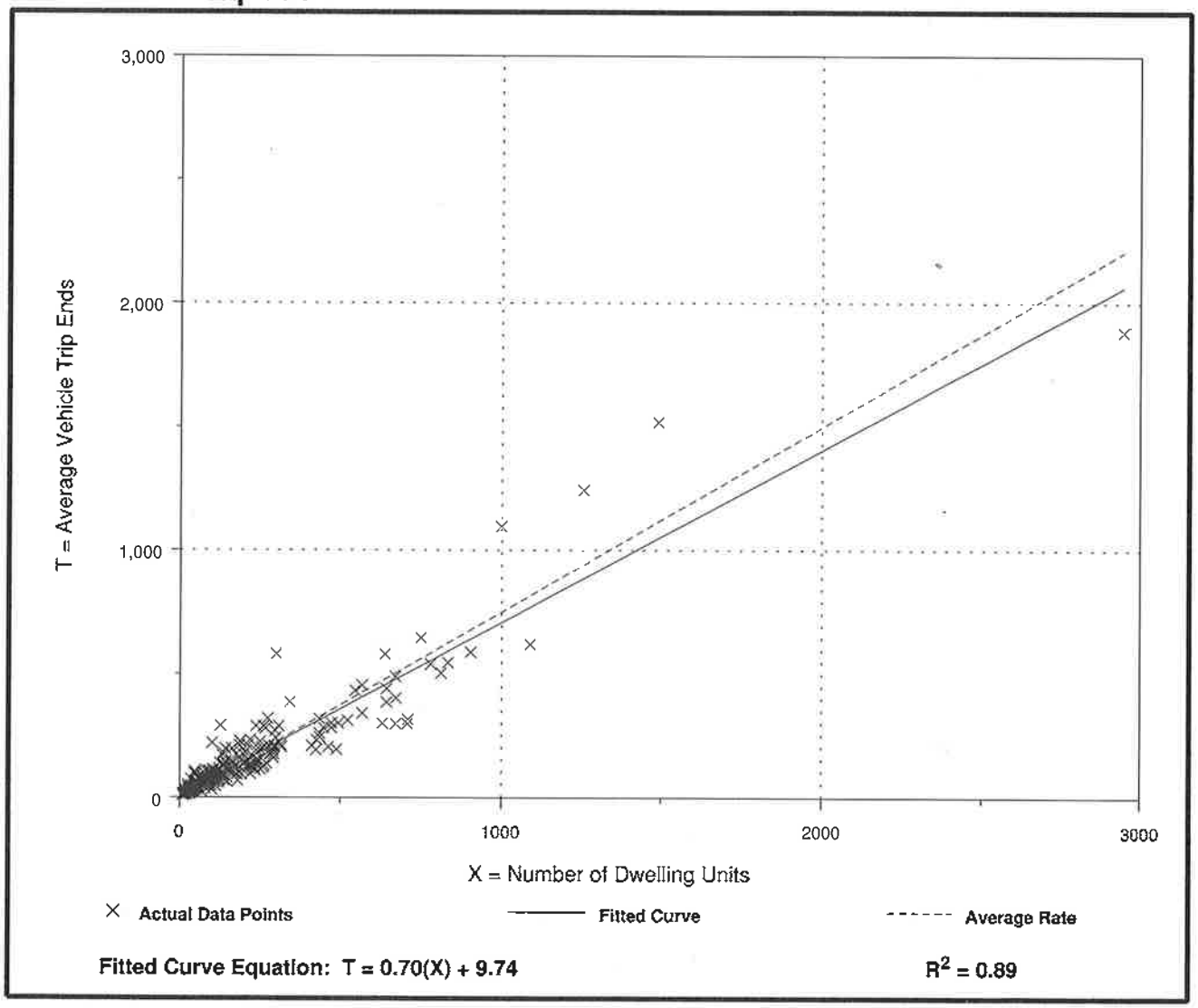
Average Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday,**
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.

Number of Studies: 292
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)

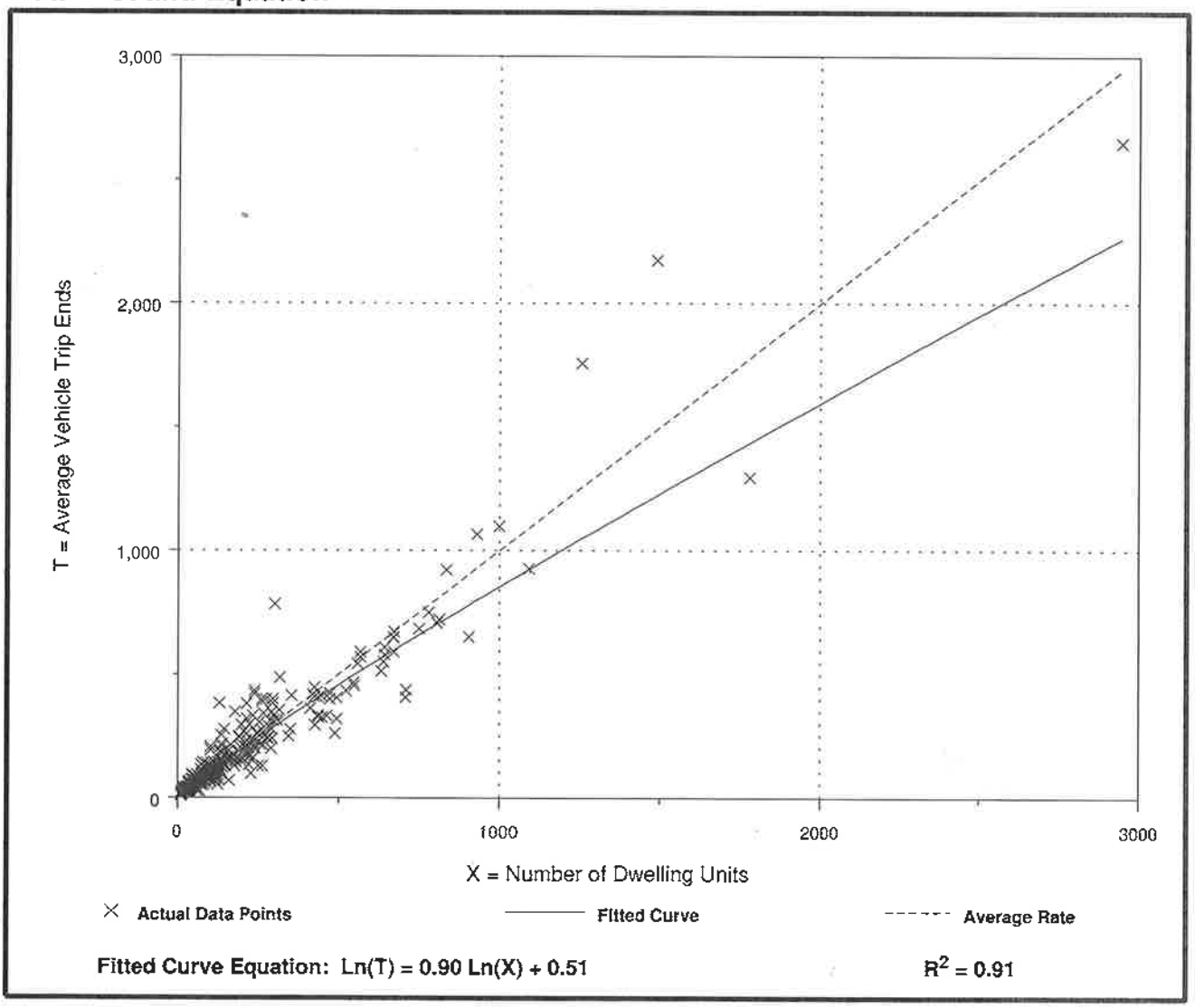
Average Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday,**
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.

Number of Studies: 321
Avg. Number of Dwelling Units: 207
Directional Distribution: 63% entering, 37% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
1.00	0.42 - 2.98	1.05

Data Plot and Equation



Fitted Curve Equation: $Ln(T) = 0.90\ Ln(X) + 0.51$ $R^2 = 0.91$