D

APPENDIX D

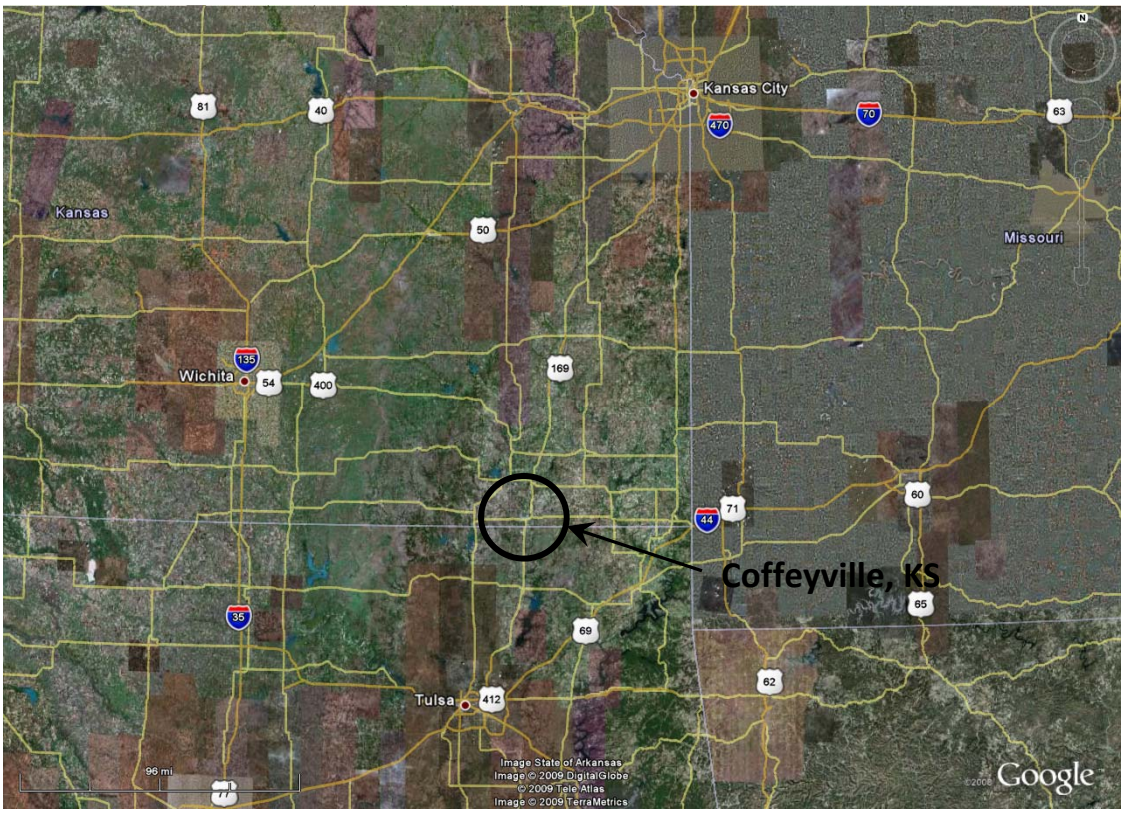
Transportation Analysis- DRG

EXECUTIVE SUMMARY

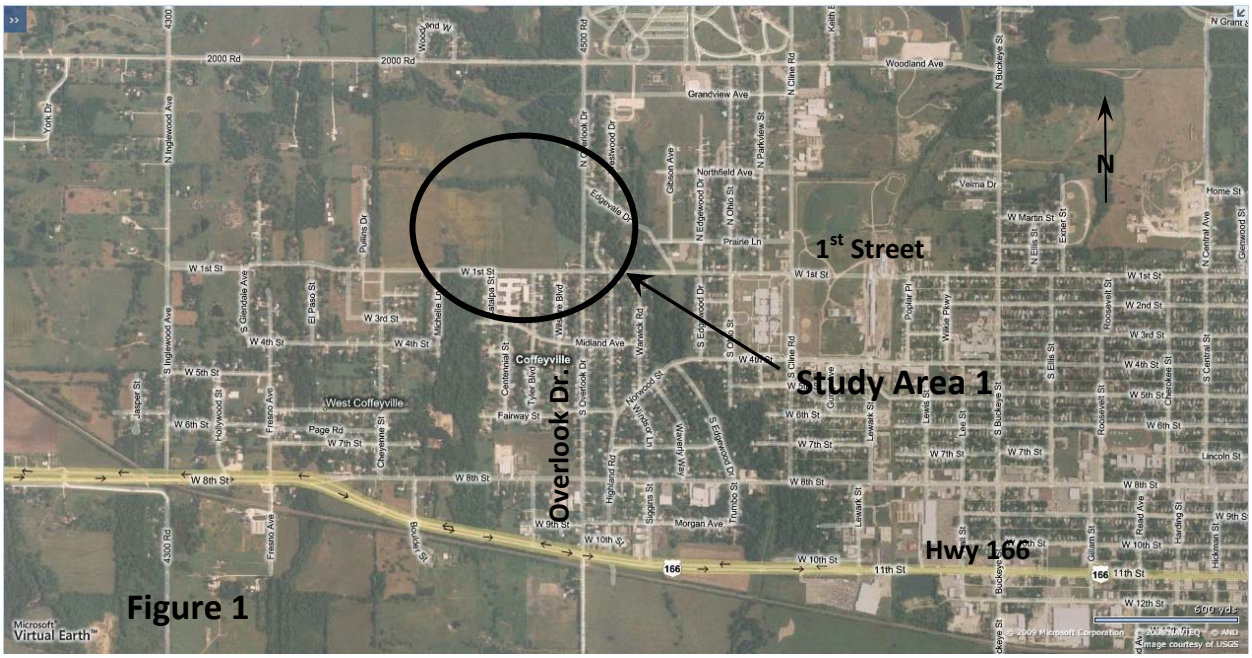
Delich, Roth & Goodwillie was retained by Ochsner, Hare & Hare and the City of Coffeyville to perform a traffic study at various locations throughout the city of Coffeyville, KS. The City is expecting growth and development to take place in certain locations and wants to know how that will affect the existing roadway network and what if any roadway improvements are necessary. This study will also analyze the extension of Cline Road from the old East-West arterial (8th Street) to the new East-West Major Arterial (Hwy. 166, or 11th Street).

GENERAL LOCATION

The City of Coffeyville is a community of about 11,000 people in southeast Kansas, approximately one mile from the Kansas/Oklahoma State Line. Joplin, MO is 73 miles to the east, Wichita is about 130 miles to the west, Tulsa, OK is 70 miles to the south and Kansas City, MO is 150 miles to the north of Coffeyville. The city predominately runs east-west as the Hwy 166 bypass of 8th Street is the new "main drag".



1ST & OVERLOOK – SITE CONDITIONS



Generally speaking, both 1st Street and Overlook Drive serve as residential streets. The configuration of the existing intersection is a 4-way stop sign control with 30 mph posted approaches that are 23 feet in width. According to the 2001 KDOT Traffic Map (see Figure 4), the ADT's are:

- 1140 at 1st Street west of Overlook
- 940 at 1st Street east of Overlook
- 1235 on Overlook south of 1st Street
- 345 on 1st Street at Inglewood Avenue (1 mile west of Overlook).

In the northwest quadrant of 1st Street and Overlook Drive, an 80 acre residential development is expected to be built (see Figure 1 for site location). The proposed development will consist of 110 single family lots, 72 villa units and 72 apartment units. See Figure 5 for the proposed "Wilson Property Master Plan". The City would like to see if any improvements are necessary along 1st Street or its intersection with Overlook Drive to handle the additional vehicle trips from the development.

TRIP GENERATION & SITE TRAFFIC PROJECTIONS

Typically before a new development arises, a traffic study is done to see how the additional traffic from the development will affect the roadway system. First one must have the existing traffic volumes then add the traffic the new development will generate. The Institute of Transportation Engineers (ITE) developed equations from studies of similar sites. The ITE Trip Generation, 7th Edition, an informational report, is widely used by traffic engineers and planners and to estimate the number of trips generated by proposed developments. As part of this study the ITE Trip Generation report was utilized. Equations can be found to estimate the ADT, AM and PM peak hour volumes and what percent is entering and exiting. Results for the proposed residential development in the northwest quadrant of 1st Street and Overlook Drive are shown below.

Single Family, 110 Lots	**Trips**	**% Entering**	**% Exiting**	**# Entering**	**# Exiting**
Weekday Trip Ends	1135	50	50	568	568
A.M. Hour (7-9)	86	25	75	22	65
P.M. Hour (4-6)	117	63	37	74	43

Apartments, 72 Units	**Trips**	**% Entering**	**% Exiting**	**# Entering**	**# Exiting**
Weekday Trip Ends	583	50	50	292	292
A.M. Hour (7-9)	39	20	80	8	31
P.M. Hour (4-6)	57	65	35	37	20

Villas, 72 Units	**Trips**	**% Entering**	**% Exiting**	**# Entering**	**# Exiting**
Weekday Trip Ends	485	50	50	243	243
A.M. Hour (7-9)	40	17	83	7	33
P.M. Hour (4-6)	46	67	33	31	15

Total	**Trips**	**# Entering**	**# Exiting**
Weekday Trip Ends	2203	1102	1102
A.M. Hour (7-9)	165	36	129
P.M. Hour (4-6)	220	142	78

In summary, the 80 acre residential development is expected to add 2203 trips each weekday. 165 trips are added in the AM peak hour with 129 of those exiting, and 220 vehicles are added in the PM peak hour with 142 of those entering the development. In addition to the existing 1140 vehicles on 1st Street west of Overlook Dr., there will be an expected 3343 vehicles on 1st Street a day. The location of the site is in the northwest part of the city, and 1st Street to the west is not a through street and existing traffic drops off sharply. So to give a worst-case scenario for the intersection, all vehicles from the development entrance on 1st Street are assumed to go to and from the east. North of 1st Street, Overlook Drive is mostly rural residential. At the intersection, most of the traffic from the residential development is expected to go to and from the east along 1st Street or south along Overlook Drive to go to and from the city. According to ITE, about 75% of the AM traffic is leaving, and about 67% of the PM traffic is going back home. Assuming a 10% peak hour factor, the existing intersection movements may look like:

1ST ST. & OVERLOOK DR., EST. BASE VOLUMES												
	EB LT	EB TH	EB RT	NB LT	NB TH	NB RT	WB LT	WB TH	WB RT	SB LT	SB TH	SB RT
AM	10	30	60	10	10	10	80	10	10	10	80	10
PM	10	30	30	30	60	30	20	30	30	10	30	10

Adding the site generated trips to the existing intersection in accordance with the ITE percent entering and percent exiting in a reasonable directional distribution, the 1st Street and Overlook Drive intersection with the 80 acre residential development may look like:

1ST ST. & OVERLOOK DR., EST. BASE + DEVELOPMENT VOLUMES												
	EB LT	EB TH	EB RT	NB LT	NB TH	NB RT	WB LT	WB TH	WB RT	SB LT	SB TH	SB RT
AM	10	150	100	30	10	10	80	30	10	10	80	10
PM	10	80	80	110	60	30	20	110	30	10	30	20

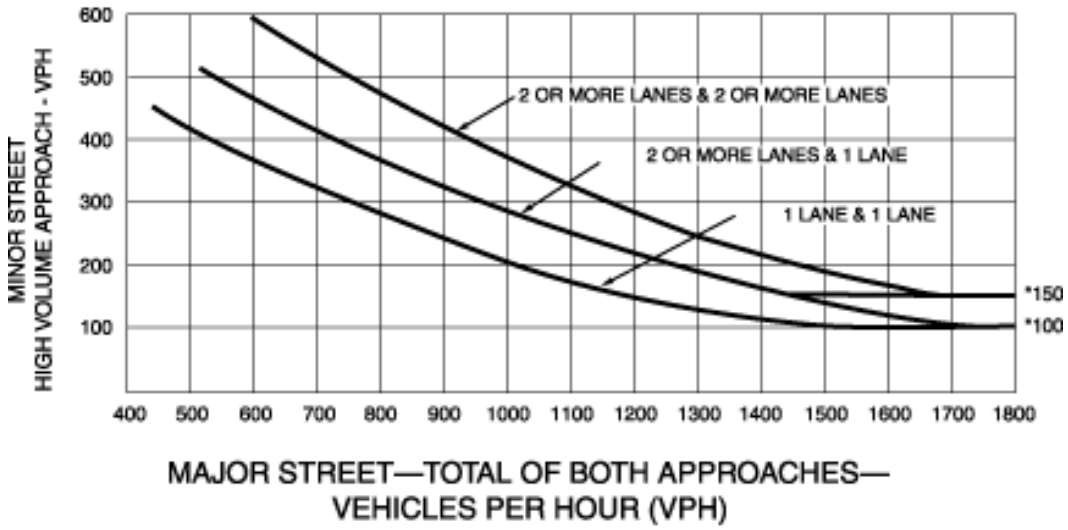
SIGNAL WARRANTS AND TRAFFIC ANALYSIS

The Manual on Uniform Traffic Control Devices (MUTCD) has 8 signal warrants, 1 of which must be met in order to consider installing traffic signals at an intersection. These warrants are:

Warrant 1, Eight-Hour Vehicular Volume
Warrant 2, Four-Hour Vehicular Volume
Warrant 3, Peak Hour
Warrant 4, Pedestrian Volume
Warrant 5, School Crossing
Warrant 6, Coordinated Signal System
Warrant 7, Crash Experience
Warrant 8, Roadway Network

Figure 4C-3 below is for the peak hour warrant. The total of both major street approaches (EB/WB in AM) is 380, and the higher volume minor street approach is 100 (SB). All approaches are one lane, but the volumes don't even reach the minimum depicted on the graph, clearly not warranting signals.

Figure 4C-3. Warrant 3, Peak Hour



*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.

The analysis of traffic at the intersection was performed using Synchro. Synchro is a powerful program that uses Highway Capacity Manual equations to estimate average delay time at intersections and the resultant Level of Service (LOS). Values range from LOS A, a free-flow condition with little or no delay (<= 10 seconds) to LOS F, which is grid lock with very high delays (>50 seconds for unsignalized intersections, or >80 seconds for signalized intersections). Typically, roadways and intersections are designed for LOS D, a balance between excessive delays for the drivers and costly over-building for the municipalities or states. AM and PM models were ran for the "Base" volumes and "Base + Development" volumes for the four-way stop controlled intersection. The turning movements at the intersection were based on reasonable assumptions and not hard count data, thus several scenarios were ran with varying directional distributions and higher volumes for a factor of safety, and all the results were similar. All approaches and movements were calculated to have a LOS A. Therefore, more development will have to take place before it approaches LOS D and beyond. The tables below summarize the LOS at the 1st Street and Overlook Drive intersection. Detailed Synchro reports are in the Appendix.

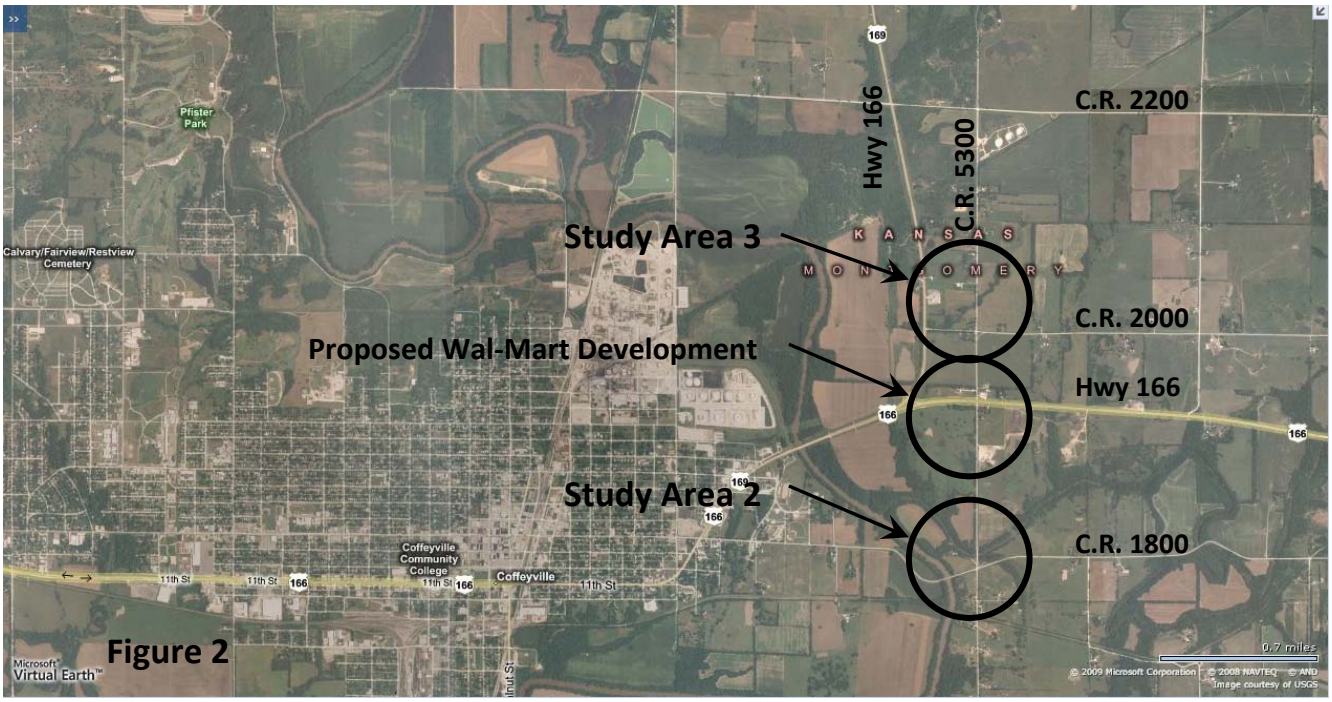
1ST ST. & OVERLOOK DR., BASE LOS				
	EB Approach	NB Approach	WB Approach	SB Approach
AM	A	A	A	A
PM	A	A	A	A

1ST ST. & OVERLOOK DR., BASE + DEVELOPMENT LOS				
	EB Approach	NB Approach	WB Approach	SB Approach
AM	A	A	A	A
PM	A	A	A	A

FINDINGS AND RECOMMENDATIONS

Based on the findings from the Synchro analysis and the low post-development volumes, no improvements at the 1st Street and Overlook Drive intersection are recommended. The LOS A's don't necessarily reflect an over-designed intersection, but rather an intersection with low volumes and room for some growth. Given the low volumes on 1st Street, specifically the very low conflicting traffic from the west, no widening or other improvements are recommended along 1st Street. It is recommended to align the proposed development entrances opposite an existing entrance where possible. This access management technique will drastically improve the operation of 1st Street after the development is in place. At the east development entrance, it may be advised to add a short right turn lane into the development for the westbound traffic to separate them from the traffic that continues westward.

C.R. 5300 AT C.R. 1800 & C.R. 2000 – SITE CONDITIONS



The purpose for analyzing traffic in the location of study areas 2 & 3 is the fact that a Wal-Mart is planned to be constructed in the southwest quadrant of Hwy 166 and County Road 5300 east of the city. C.R. 5300 runs north-south and is about 1600' east of Hwy 169. Along with the Wal-Mart and outlots in the southwest quadrant of Hwy 166 and C.R. 5300, further development of retail and restaurants is expected to follow in the other quadrants. See Figure 8-B for the proposed Wal-Mart development site plan and projected PM peak hour volumes. A Traffic Impact Study (TIS) has been completed by Peters & Associates to analyze the impacts of the 64 acre development on the existing roadway network and to recommend any improvements to the C.R. 5300/Hwy 166 intersection, the Hwy 166/Hwy 169 intersection, and the intersections of C.R. 5300 with the development entrances. The two study areas (2 and 3 on Figure 2) in this report are grouped together because they will be directly impacted by the increased traffic using the Wal-Mart and other commercial development.

Study Area 2 is at the intersection of C.R. 5300 and C.R. 1800 (which becomes 8th Street to the west in the City of Coffeyville). This intersection is ¾ mile south of Hwy 166 and 2900' south of the proposed Wal-Mart Drive C along C.R. 5300. C.R. 1800 is a 22' wide roadway with no shoulders and a 45 mph posted speed limit. C.R. 5300 is a 24' wide roadway with no shoulders and intersects C.R. 1800 about 1000' east of the Verdigris River. The intersection is two-way stop controlled, with the C.R. 5300 approaches having to stop. 8th Street used to be the main drag in Coffeyville but it has since been bypassed by Hwy 166. There are concerns that the elderly population will take 8th street to C.R. 5300 to access the new Wal-Mart and development and avoid taking Hwy 166 and the new interchange with Hwy 169. Study Area 2 will address the need for improvements at the C.R. 5300/C.R. 1800 intersection due to the increase in traffic.

Study Area 3 is at the intersection of C.R. 5300 and C.R. 2000 and north along C.R. 5300 to C.R. 2200. C.R. 2000 is 1700' north of Hwy 166, and 1000' north of the proposed Wal-Mart development Drive E. C.R. 5300 is 1250' east of Hwy 169 at its intersection with C.R. 2000, and C.R. 2200 is 1 mile north of C.R. 2000. The entire Wal-Mart and surrounding development will be built south of the C.R. 5300/C.R. 2000 intersection and is included in the Wal-Mart TIS. North of the intersection along C.R. 5300, a 200-unit multi-family residential development is expected to be built. C.R. 2000 and C.R. 5300 south of the intersection are currently 20' wide asphalt roadways with ditches. North of the intersection, C.R. 5300 is a 19' wide gravel roadway with ditches. Study Area 3 will address the need for improvements at the C.R. 5300/C.R. 2000 intersection or along C.R. 5300 due to the expected residential and Wal-Mart developments.

SITE TRAFFIC PROJECTIONS & ANALYSIS

Study Area 2 – C.R. 1800/C.R. 5300

According to the 2001 KDOT Traffic Map (see Figure 4), the ADT on 8th Street (C.R. 1800) east of Hwy 169 is 1000, and the ADT's on C.R. 5300 north and south of C.R. 1800 are 245 and 600, respectively. Based on the traffic volumes plus some to be conservative, the existing PM intersection turning movements may look like:

C.R. 1800 & C.R. 5300, EST. BASE PM VOLUMES											
EB LT	EB TH	EB RT	NB LT	NB TH	NB RT	WB LT	WB TH	WB RT	SB LT	SB TH	SB RT
20	40	20	25	10	10	20	30	20	10	20	20

According to the Wal-Mart TIS on Figure 8-B, 201 vehicles were expected to approach the development from the south in the PM peak hour. Since the majority of the development is retail, and far more retail trips occur in the PM than the AM, just the PM peak hour was analyzed. C.R. 1800 (8th Street) is an arterial that runs through Coffeyville to the west, so the majority of the 201 vehicles approaching the development from the south are making an Eastbound left at the C.R. 1800/C.R. 5300 intersection. The other volumes are minor. The "Base + Development" volumes used are:

C.R. 1800 & C.R. 5300, EST. BASE + DEVELOPMENT PM VOLUMES											
EB LT	EB TH	EB RT	NB LT	NB TH	NB RT	WB LT	WB TH	WB RT	SB LT	SB TH	SB RT
201	40	20	25	20	10	20	30	30	20	30	201

Since it was a concern of the City that more drivers would take 8th Street to C.R. 5300 to avoid the Hwy 166/Hwy 169 interchange, additional trips were added for the analysis as a factor of safety. Instead of adding 201 trips, 300 trips were added – 280 from the west and 10 each from the south and east. The volumes used for the "Base + Development Plus" intersection analyses are:

C.R. 1800 & C.R. 5300, EST. BASE + DEVELOPMENT PLUS PM VOLUMES											
EB LT	EB TH	EB RT	NB LT	NB TH	NB RT	WB LT	WB TH	WB RT	SB LT	SB TH	SB RT
300	40	20	25	20	10	20	30	30	20	30	300

Synchro was used to perform the traffic analysis for the intersection. The existing roadway configuration and intersection control (two-way stop) was used for the analysis of each of the alternates. The level of service summary is below:

C.R. 1800 & C.R. 5300, BASE PM LOS				
EB Approach	NB Approach	WB Approach	SB Approach	Intersection
A	B	A	A	A

C.R. 1800 & C.R. 5300, BASE + DEVELOPMENT PM LOS				
EB Approach	NB Approach	WB Approach	SB Approach	Intersection
A	C	A	B	A

C.R. 1800 & C.R. 5300, BASE + DEVELOPMENT PLUS PM LOS				
EB Approach	NB Approach	WB Approach	SB Approach	Intersection
A	E	A	C	B

According to the Synchro analysis, the “Base + Development” scenario (201 vehicles added, per the Wal-Mart TIS) doesn’t increase the overall delay that much from the “Base” scenario. As more cars use 8th street to get to the Wal-Mart development and back, the northbound approach experiences higher delays (as seen in the “Base + Development Plus” scenario, with 300 vehicles added to the base). Not many more vehicles are needed on top of that to push the NB level of service to an F. However, since the northbound approach to the intersection is so minor, its weighted average doesn’t affect the overall intersection level of service very much, still having an overall intersection level of service B.

Adding an eastbound left turn lane may help separate turning vehicles from through vehicles which could make it safer, and adding a southbound right turn lane may help reduce queues for that approach. But unfortunately neither of these or even adding turn lanes for the northbound approach will help create more gaps, thus resulting in the same levels of service.

If more cars use 8th street to access the development, and if one were concerned about the increase in delays on the northbound approach, a low cost solution is to make the intersection a 4-way stop. The level of service summary is below:

C.R. 1800 & C.R. 5300, BASE + DEVELOPMENT PLUS PM, 4-WAY STOP LOS				
EB Approach	NB Approach	WB Approach	SB Approach	Intersection
C	A	A	B	B

The 4-way stop intersection provides more gaps for the northbound approach to go through, increasing its level of service to an A. However, it happens at the expense of the eastbound and westbound traffic not having free movements through the intersection. As a result, the EB approach drops to a level of service C and there is no noticeable decrease in overall intersection delay. One point of concern could be acclimating the drivers who have been driving the road for years to the new stop signs on C.R. 1800. Another less than desirable situation about converting it to a 4-way stop is it only helps the northbound approach with very small volumes anyway for an hour or two out of the day, at the expense of the other approaches as explained above. Detailed Synchro reports are in the Appendix.

Based on current and proposed traffic volumes, geometric configuration, and existing site conditions the intersection does not meet signal warrants.

Study Area 3 – C.R. 2000/C.R. 5300

Traffic projections developed for the Wal-Mart development in the Traffic Impact Study have been made for the C.R. 5300/C.R. 2000 intersection as shown in Figure 8-B. This report will assume that this has been built and these volumes will be considered the "Base" volumes. The directional distributions from the Wal-Mart development are shown in Figure 6. To the north of this intersection along C.R. 5300, a 200-unit multi-family residential development is expected to be built. In accordance with the ITE Trip Generation Manual, 7th Edition, the housing development is expected to generate the following trips:

Multi-Family, 200 Units	Trips	% Entering	% Exiting	# Entering	# Exiting
Weekday Trip Ends	1157	50	50	579	579
A.M. Hour (7-9)	90	17	83	15	75
P.M. Hour (4-6)	106	67	33	71	35

These trips added from the housing development were applied at the directional distributions rates shown in Figure 6. Since the Wal-Mart development has the biggest impact on the PM peak hour, and the Wal-Mart TIS just analyzed the PM peak hour, just the PM peak hour will be used in this report. The turning movements in the PM peak hour generated by the housing development at the C.R. 5300/C.R. 2000 intersection are shown in Figure 7. These turning movements generated by the housing development are superimposed on the turning movements after the Wal-Mart development to create the Fully Developed PM peak hour turning movements, as shown in Figure 8.

Synchro was used to analyze the intersection. The “Base” PM peak hour (with the Wal-Mart full build-out development) was analyzed first with the existing roadway geometrics and configuration to act as a base line. The level of service summary is below.

C.R. 2000 & C.R. 5300, BASE PM LOS				
EB Approach	NB Approach	WB Approach	SB Approach	Intersection
A	B	A	B	A

C.R. 2000, which does not have to stop at the intersection, has a level of service A for both the east and west approaches. C.R. 5300, which does have to stop at the intersection, has slightly higher delays for a level of service B for both the north and south approaches. The overall intersection level of service is an A.

The intersection was also analyzed with the trips generated from the housing development north on C.R. 5300. This development added 106 vehicles to the PM peak hour with the assumption that all vehicles are going to and coming from the south for a conservative analysis at the C.R. 5300/C.R. 2000 intersection. The level of service summary for the full Wal-Mart build out plus the residential housing development at the C.R. 5300/C.R. 2000 intersection is below.

C.R. 2000 & C.R. 5300, BASE + HOUSING DEVELOPMENT PM LOS				
EB Approach	NB Approach	WB Approach	SB Approach	Intersection
A	B	A	B	A

Comparing the “Base” to the “Base + Housing Development” level of service summary, there is no appreciable decrease in the operation of the intersection in its current configuration. Detailed Synchro reports for both scenarios are in the Appendix.

FINDINGS AND RECOMMENDATIONS

Study Area 2 – C.R. 1800/C.R. 5300

If the traffic projections provided in the Wal-Mart TIS are in the ballpark with 201 vehicles approaching the full build-out development from the south, the C.R. 1800/C.R. 5300 intersection will operate effectively in its existing configuration. It should be noted, however, that care should be taken when interpreting ITE Trip Generations. Although they are widely used and accepted among traffic engineers and planners, wide ranges can and do take place. The equations used are a best fit equation for multiple sites, so real world values may come back higher or lower depending on many factors, including population. That said, there is a margin of error allowed at this intersection. Most of the movements at this intersection after the full build-out will be non-conflicting movements, an eastbound left and a southbound right. If 300 vehicles use this route in addition to the existing traffic, the northbound approach will begin to have a hard time finding gaps big enough to enter. Since this volume is relatively low, the intersection delay isn't affected much. As noted above, adding turn lanes may make the eastbound approach safer by separating the turning traffic from the through traffic, or may help reduce the queues for the southbound approach, but won't help to create gaps for the northbound approach. Signals or a 4-way stop at this point may help the northbound approach for an hour or two out of the day, but at the expense of the eastbound and westbound approaches for the remainder of the day. If 400-500 vehicles use this route, the intersection as a whole will begin to experience significant delays. At this point, a signalized intersection may be recommended.

In the short term (a couple years after the development is built), no geometric improvements are recommended. It is recommended to monitor the intersection for an increase in accidents. Specifically, rear-ends for eastbound traffic, and right angle and sideswipes for northbound and southbound traffic trying to enter the intersection. Advance warning signs or rumble strips are low-cost improvements to consider should there be an increase in accidents or implemented immediately as a preventative measure.

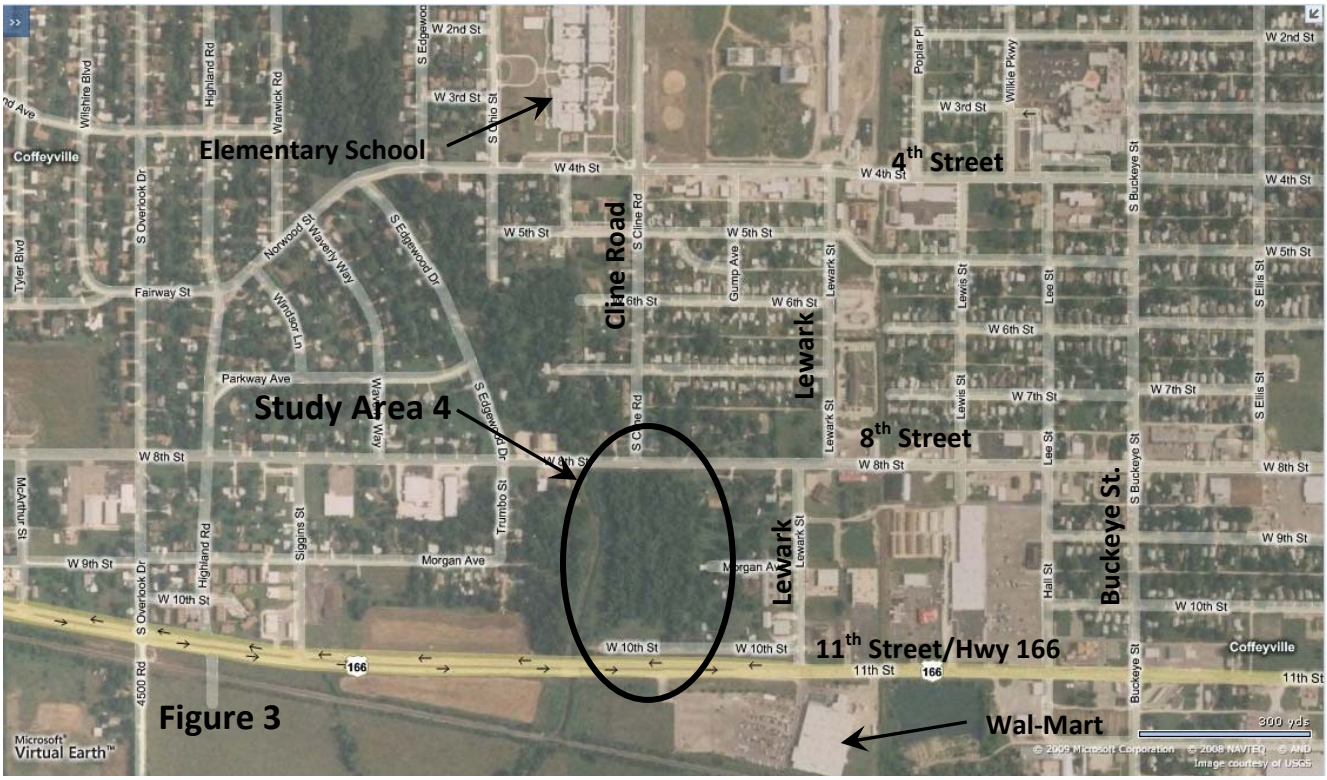
Study Area 3 – C.R. 2000/C.R. 5300

At the C.R. 2000/C.R. 5300 intersection, no geometric improvements are recommended. The intersection provides a level of service A for the anticipated Wal-Mart full build-out PM peak hour. The 200-unit multi-family residential development is expected to add 106 trips in the PM peak hour, having a minimal affect on the overall level of service.

DRG recommends that there should be roadway improvements constructed north of the intersection along C.R. 5300, roadway improvements are recommended. C.R. 5300 is currently a 19' gravel roadway with no shoulders or sidewalks and a drainage ditch. The ADT after the Wal-Mart full development will be about 800, and the residential development will add about 1157 trips, so the total ADT can be expected to be around 2000 vehicles/day. It is recommended to build a roadway to "Residential Collector Streets" standards as shown in Figures 9-12 from C.R. 2000 to C.R. 2200 to accommodate the future residential development.

Total project cost is expected to be approximately $1,250,000 - $1,500,000 in 2009 dollars.

CLINE ROAD EXTENSION – SITE CONDITIONS



In the southwest part of Coffeyville, Cline road currently goes as far south as 8th Street (see Figure 3). Since Cline Road has been built, Hwy 166 (11th Street) has been built to bypass 8th street and is currently the main east-west travelway in Coffeyville. From 8th street to 4th street, Cline is a 34', 2 lane residential street with curb and gutters. In the northwest quadrant of 4th and Cline is an 1100 student elementary school. From 4th Street to Woodland, Cline is a 35', 3 lane roadway with curb and gutter and signed at a 30 mph speed limit (except in the school zone which is 20 mph) serving a mix of businesses. North of Woodland, Cline is a 24', 2 lane roadway with ditches and a 40 mph speed limit. Although it is more rural in this stretch, it does serve a golf course and Veterans Memorial Stadium further to the north. The problem is getting people from the main east-west corridor 11th street to these locations. Lewark Street, just east of Cline, is one option. At Lewark and 11th street is a signalized intersection opposite the main Wal-Mart entrance. But to get from 11th street to 4th street one actually has to travel east on 8th street. Buckeye is a north-south arterial but is getting congested since it is an alternate for the disconnection of Cline to 11th Street. An extension of Cline will

provide more direct access from 11th Street to the destinations on Cline and relieve some traffic from Buckeye.

SITE ALTERNATES

If Cline were to be extended straight, it would be offset about 135' from the west Wal-Mart entrance. Since it would be preferable to have the Wal-Mart entrance line up directly opposite of Cline, three alternates have been developed. Alternate 1, as shown in Figure 13, is a straight extension of Cline. The west Wal-Mart entrance is realigned 135' to the west to line up with Cline. Alternate 2, as shown in Figure 14, realigns Cline eastward 135' to line up with the existing west Wal-Mart entrance.

Assuming this Wal-Mart vacates and moves to the new location at C.R. 5300/Hwy 166 prior to the Cline extension, Alternate 3 is an option. As shown in Figure 15, Cline Road is extended straight to 11th Street and the west Wal-Mart entrance is removed, turning it into a "T" intersection. If the Wal-Mart is demolished and a new development goes in, they can continue to use Lewark as the main entrance and either not have an entrance at Cline or line up a new entrance opposite Cline. However, this may be a good opportunity to provide the main entrance to the new development at Cline, making the signals at Lewark easier to remove.

Hwy 166 is a 4 lane divided roadway with curb and gutter and a 14' grass median. All alternates show removing the median to provide left turn bays for eastbound and westbound traffic.

There are large drainage ditches running along the south side of 8th street and the north side of 11th street in the vicinity of the Cline extension. The ditches are running west towards Sycamore creek about 300' to the west. The area of the Cline extension is a wooded undeveloped tract adjacent to the creek. Wetlands have been identified in the vicinity of the proposed improvements and in the project area according to the National Wetlands Inventory (NWI) internet site as shown in Figure 16. Thus, the area between 8th street and 11th street should be walked by an environmentalist at the local level to see if any wetlands are impacted and determine what if any mitigation is required.

SITE TRAFFIC PROJECTIONS AND SIGNAL WARRANTS

Traffic counts were taken at the intersections of 4th/Cline and 11th/Lewark to find the PM peak hour volumes. The total 2 ½ hour counts from 3-5:30 and the PM peak hour counts for both intersections can be found in the Appendix. The PM peak hour next to the elementary school at 4th and Cline was from 3-4. At the intersection, 221 vehicles went southbound to 8th Street and 190 went eastbound. If Cline were extended, some of the eastbound traffic is expected to take Cline to 11th Street. At 11th and Lewark, the PM peak hour was from 4:30-5:30, which is logical considering this is the intersection for Wal-Mart's main entrance, which would lag the peak hour some. To justify a signal warrant at the 11th and Cline intersection, peak hour volumes have to be used from the same one-hour time frame. The spike in volumes from the elementary school has a greater affect on the signal warrants, giving it higher minor street traffic approach volumes. From 3-4 PM at 11th/Lewark, there were 234 EB Th's, 12 EB Lt's and 4 EB Rt's. The westbound volumes were 320 WB Th's, 125 WB Lt's and 98 WB Rt's. After the Cline extension is built, all the WB Lt's are expected to remain, and 75% of the northbound traffic on Lewark is expected to take Cline instead. The new projected volumes on 11th street at Cline from 3-4 PM is 641. Not included in the counts are all the vehicles that made the EB Rt at the west Wal-Mart entrance prior to the main entrance at Lewark.

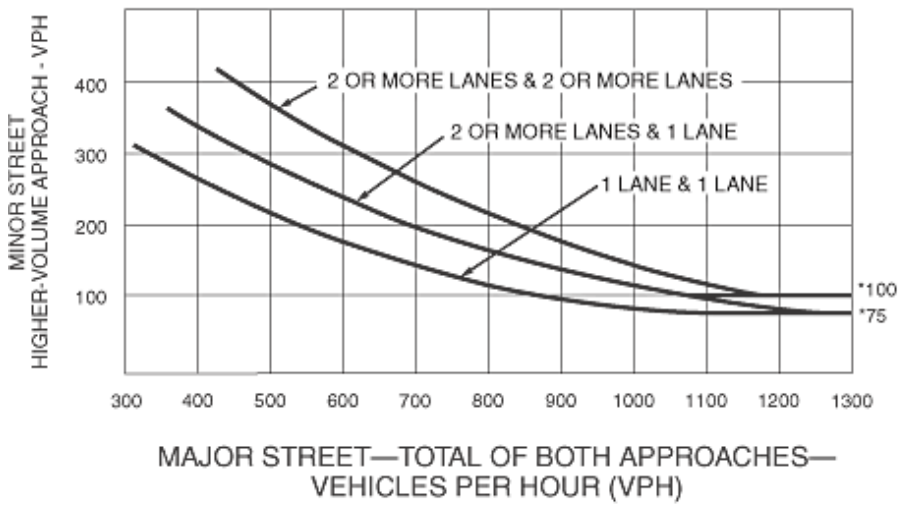
According to the MUTCD Signal Warrant 3, Peak Hour warrant, this intersection applies for the 70% factor. It states that if the posted or statutory speed limit on the major street exceeds 40 mph or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, 70% of the volumes for Signal Warrant 3 are required to warrant signals at the intersection. The MUTCD Signal Warrant 3, Peak Hour with the 70% factor, graph and table are shown in Figure 4C-4. While the city population is close at about 11,000, the posted speed limit on 11th street is 45 mph in the vicinity of the intersection. Using this factor and the 2 lane major approach and 1 lane minor approach graph and tables, with 600 vehicles on both major approaches, 245 vehicles are required on the higher minor street to warrant signals. Of the 411 vehicles going southbound and eastbound at 4th and Cline, 60% need to go

south on Cline to 11th street to warrant a signal. While some traffic from Lewark at 11th may use Cline instead, they were not added in this scenario because it is assumed that the majority of the traffic here originated at the elementary school and may be counted twice. If 59 vehicles make the eastbound right into the west Wal-Mart entrance, bringing the total for both approaches on 11th street to 700, only 200 vehicles are required on Cline to warrant signals, which is less than half of the southbound and eastbound traffic at 4th and Cline.

The current signalized intersection at 11th and Lewark should also be analyzed to see if it still warrants signals after the extension of Cline has been built. It is important to note that the south approach, the main Wal-Mart entrance, has the higher volumes of the minor street approaches especially after the Cline extension is expected to take traffic off of Lewark. Even with signals and complete access to the west Wal-Mart entrance, the entrance opposite Lewark will be the main entrance and this approach should be used in determining signal warrants. All vehicles exiting Wal-Mart at this intersection are expected to continue to do so. The peak hour at this approach was 4-5 PM, with 230 vehicles. Considering Cline is expected to take vehicles off of Lewark, more vehicles can be expected on the major approaches (11th street) at the Lewark intersection. Even without moving traffic from Lewark to Cline to access 11th street, there are 780 vehicles on the 11th street approaches. This total major approach volume in addition to the 230 on the Wal-Mart approach warrants signals based upon the peak hour, 70% factor warrant. Although a Wal-Mart will be built at Hwy 166/C.R. 5300, and this Wal-Mart is expected to be sold and be a different store, it is not advisable to remove the signals at 11th/Lewark until it has happened and new data suggest that the existing signal is not warranted any more.

Figure 4C-4. Warrant 3, Peak Hour (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 70 km/h OR ABOVE 40 mph ON MAJOR STREET)



*Note: 100 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 75 vph applies as the lower threshold volume for a minor-street approach with one lane.

The table below shows the approximate VPH on the major street and corresponding VPH on the minor street for each combination of approach lanes.

Table for Figure 4C-4					
One lane and one lane		**Two or more lanes and one lane**		**Two or more lanes and two or more lanes**	
VPH on the major street (Total of both approaches)	**VPH on the minor street (Higher volume approach)**	**VPH on the major street (Total of both approaches)**	**VPH on the minor street (Higher volume approach)**	**VPH on the major street (Total of both approaches)**	**VPH on the minor street (Higher volume approach)**
1300	75	1300	75 or 100*	1300	100
1200	75	1200	80 or 100*	1200	100
1100	75	1100	100	1100	120
1000	80	1000	120	1000	150
900	100	900	140	900	175
800	120	800	160	800	225
700	145	700	200	700	260
600	170	600	245	600	315
500	220	500	280	500	370
400	260	400	340	400	Not available

FINDINGS AND RECOMMENDATIONS

A major factor in determining whether Cline shall be extended as Alternate 1 or Alternate 2 is whether or not the land around it can be developed. The surrounding land is currently in a 100-year floodplain making the land around it undevelopable. There may be a reservoir built upstream of the Sycamore Creek that would make the land developable. If it can be developed, Alternate 1 may be the preferred alternate. Although this will require some modifications to the west Wal-Mart entrance, it allows for a straight extension of Cline. This alternate also provides more signal spacing between this intersection and the 11th/Lewark intersection. Assuming Cline cannot be developed, Alternate 2 may be the preferred alternate. Although it would put horizontal curves on Cline, it would line up directly with the existing Wal-Mart entrance requiring little work to be done to it, giving it a slightly cheaper overall project cost. If the Wal-Mart site is vacant at the time of the Cline extension, Alternate 3 may be the preferred alternate with provisions to allow an entrance to line up opposite of Cline and be used as the site's main entrance.

More than 3,000 ADT are expected to use Cline from 8th to 11th, which is more than a residential collector allows. It is recommended the Cline extension be a 3 lane, 36' roadway with curb and gutter and be built to the Minor Arterial standards as shown in KCMO APWA Figures 9-12. Sidewalks on both sides of Cline are recommended with the elementary school a couple blocks away. It is anticipated that signals will be warranted at 11th street upon the completion of the Cline extension. Semi-actuated signals are recommended, with actuation on the Cline/Wal-Mart extension, and 11th street with Green priority. Given the close proximity to the Lewark signals, coordination with this intersection is also recommended. It is NOT recommended to remove the signals at the Lewark intersection upon completion of the Cline intersection until it can be proven with new data that the intersection does not warrant or need signals.

Total project cost is expected to be approximately $750,000-$1,000,000 in 2009 dollars.