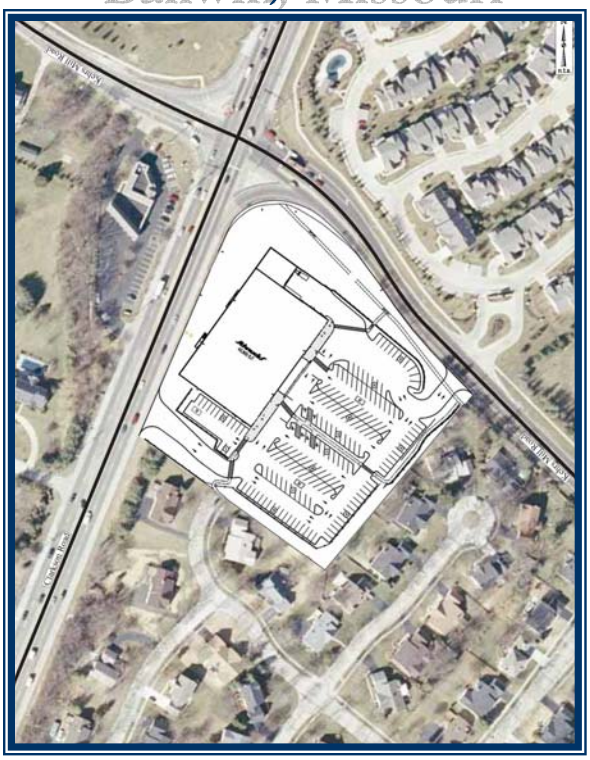
Traffic Impact Study
For The
Proposed Ballwin
Schnucks
Ballwin, Missouri



Prepared for:
Schnucks Market
11420 Lackland Road
St. Louis, Missouri 63146

Prepared by:
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April 2009

CBB Crawford, Bunte, Brammeier
Traffic and Transportation Engineers

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CBB Job No. 28-09

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Executive Summary

Crawford, Bunte, Brammeier has completed a study in an effort to evaluate the traffic impacts associated with the proposed Schnucks grocery store in Ballwin, Missouri. The development site is located in the southeast quadrant of Clarkson Road and Kehrs Mill Road. It is our understanding that a 40,900 square foot (SF) store is proposed with right-in/right-out access to Clarkson Road and full access to Kehrs Mill Road opposite Picardy Hill Drive. The focus of our analysis was the a.m., school dismissal and p.m. peak hours of a typical weekday as well as the Saturday midday peak hour during a Saturday.

Base traffic conditions were evaluated and revealed that some constraints currently exist at the intersection of Clarkson Road with Kehrs Mill Road during the a.m. peak hour (northbound and westbound approaches) and the p.m. peak hour (the southbound left-turn) as well as the eastbound and westbound approaches of Country Ridge Drive/Marquette High School during the a.m., school dismissal and p.m. peak hours of weekdays.

Year 2010 No-Build conditions, which considers traffic shifts based on a new access drive to Marquette High School along Kehrs Mill Road, were also evaluated. Even if signal optimizations are made, constraints are still expected at the intersection of Clarkson Road with Kehrs Mill Road (northbound and westbound approaches) during the a.m. peak hour, but the conditions at the Marquette High School/Country Ridge Drive intersection are expected to improve slightly.

The analysis of the Year 2010 Build conditions determined that the following improvements would be beneficial in conjunction with the development of the proposed Schnucks:

- A dedicated northbound right-turn lane (deceleration lane) on Clarkson Road in advance of the proposed right-turn only drive;

- Construct a raised median within Clarkson Road to restrict the driveway to right-turns only and still allow left-turns into and out of the exiting National City Bank driveway;

- Provision of dual southbound left-turn lanes on Clarkson Road at Kehrs Mill Road and the widening of Kehrs Mill Road to West Par Drive to provide two eastbound lanes[1];

- Extend the northbound right-turn lane on Clarkson Road at the Kehrs Mill Road signal;

[1] If dual southbound left-turn lanes are not provided on Clarkson Road and Kehrs Mill Road is not widened to provide two eastbound lanes, then it is recommended that a separate eastbound right-turn lane (deceleration lane) in advance of the proposed full access driveway on Kehrs Mill Road be provided.

- Modify the signal timing at the intersection of Clarkson and Kehrs Mill Road so as to increase the northbound left-turn split during the a.m., school dismissal and p.m. peak hours;

- Modify the signal timing at the intersection of Clarkson and Country Ridge Drive/Marquette High School so as to decrease the northbound left-turn split during the a.m. peak hour;

- Modify the signal timing at the intersection of Clarkson and Country Ridge Drive/Marquette High School so as to increase the east and west splits during the a.m., school dismissal and p.m. peak hours;

- Modify the offsets for the traffic signals along Clarkson Road during the a.m., school dismissal and p.m. peak hours so as to improve upon traffic progression;

- Modify the signal timing at the intersection of Clarkson and Kehrs Mill Road so as to provide additional green time to the southbound left-turn during the p.m. peak hour;

- Increase the Saturday signal cycle lengths to 100 seconds at Kehrs Mill Road and Country Ridge/Marquette High School (as well as at Wilson Avenue although that intersection was not explicitly included in this analysis). The coordinated signal system to the north (Baxter to Lea Oak) currently operates a 100 second cycle on a Saturday, so connectivity to the system to the north could be considered; and

- Provide a crosswalk and pedestrian signal on the east leg of the intersection of Clarkson and Kehrs Mill Road so as to accommodate pedestrians between Marquette High School and the proposed store.

Assuming the above physical improvements and signal operation modifications are implemented, it is feasible to maintain operating conditions along Clarkson Road comparable to the No-Build scenario for the Year 2010. The service levels of most approaches at either signalized intersection either do not change, or at a minimum degrade more than one letter grade (example: LOS C to LOS D). The provision of dual southbound left turn lanes would actually improve conditions for that movement as compared to the No-Build scenario. Therefore, it can be concluded the impact of the development's traffic could be mitigated with above recommendations.

A more detailed explanation is provided in the following report.

Introduction

As you requested, Crawford, Bunte, Brammeier has completed a traffic impact study for a proposed grocery store in the southeast quadrant of Clarkson and Kehrs Mill Roads. The proposed site is located within the municipality of Ballwin; with Clarkson Road under MoDOT control and Kehrs Mill Road controlled by St. Louis County. The site location, as well as existing lane configuration on the adjacent roadways, is depicted in **Exhibit 1**.

The proposed store would be more of a "neighborhood" grocery, serving the surrounding subdivisions within western Ballwin, Chesterfield and Clarkson Valley. Consequently, the grocery store would only be approximately 40,900 SF, which is smaller than the typical suburban grocery store. Access to the site would be provided via a right-in/right-out directly onto Clarkson Road (approximately 500 feet south of Kehrs Mill Road) and a full access drive onto Kehrs Mill Road, directly opposite Picardy Hill Drive. **Exhibit 2** illustrates the proposed development plan.

A scoping meeting was held on March 11th 2009 at MoDOT's offices and was attended by representatives the Missouri Department of Transportation (MoDOT), St. Louis County Department of Highways & Traffic (STLCDHT), the City of Ballwin and Schnucks Markets. The scope of work for a traffic impact study of the proposed grocery store was agreed to at this meeting, which includes the analysis of the following intersections:

- Clarkson Road & Kehrs Mill Road
- Clarkson Road & Country Ridge/Marquette HS Drive
- Clarkson Road & National City Bank Drive
- Kehrs Mill Road & Picardy Hills Drive
- Kehrs Mill Road & West Par/Stonebriar Ridge Drive

The study would analysis traffic conditions during the weekday morning (7:00 to 9:00 a.m.), school dismissal peak period (2:45 p.m. to 4:00 p.m.) and the weekday p.m. peak period (4:00 to 6:00 p.m.) as well as the midday peak (11:00 a.m. to 2:00 p.m.) of a Saturday.

The purpose of this traffic impact study is to identify the number of trips that would be generated by the proposed grocery store, the ability of motorists to safely enter and exit the site at each access point, and the impact that the additional trips would have on operating conditions along both roadways. If necessary, roadway improvements (lane additions and/or intersection modifications) would be recommended to mitigate the impact of the development and to accommodate the additional traffic.

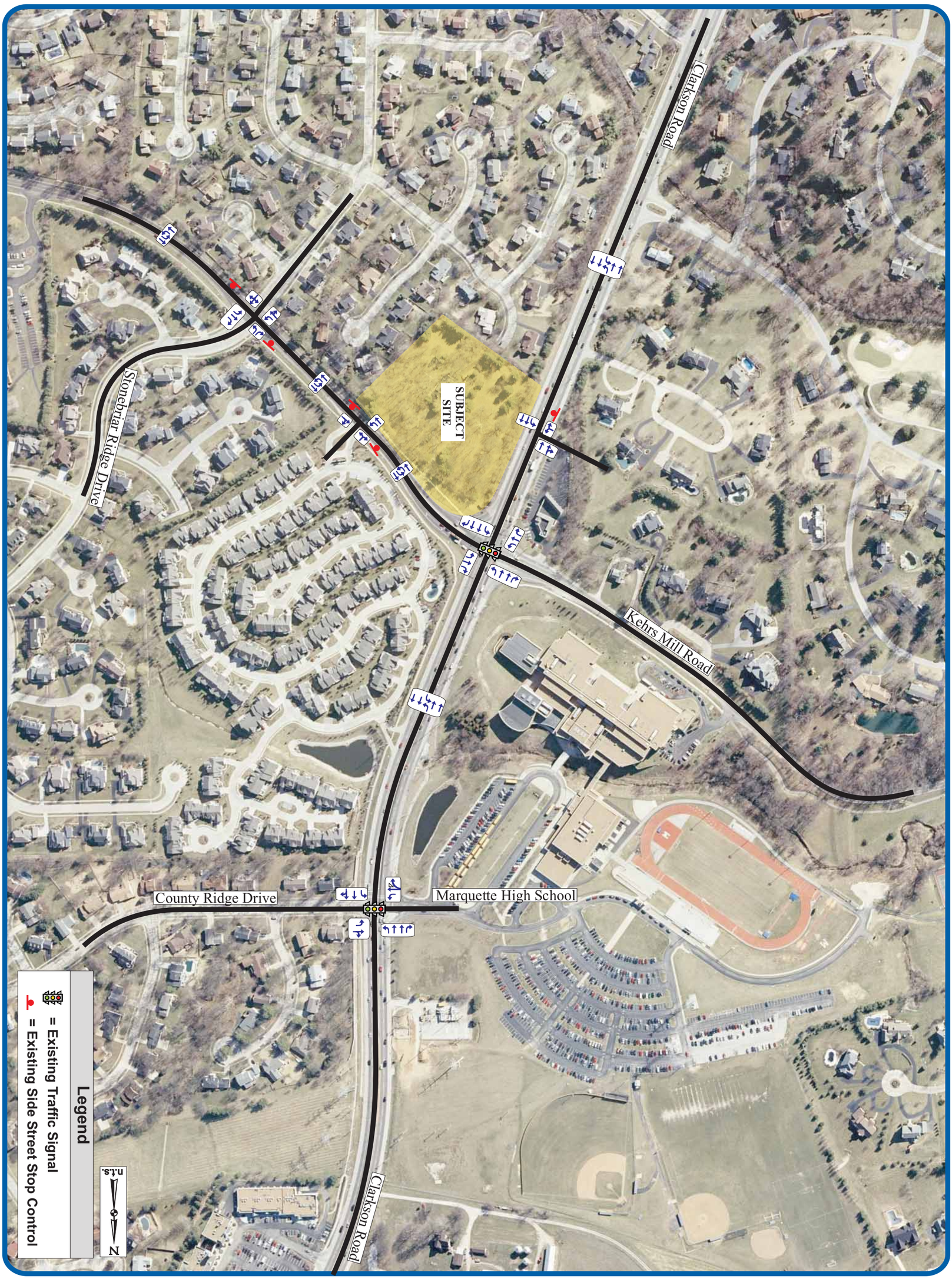

Exhibit 1: Site Location and Existing Lane Configurations

Traffic Impact Study
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Exhibit 2: Proposed Development Plan

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Based upon discussions during the meeting with agency representatives, the following scenarios were established as critical analysis timeframes:

- **Base Conditions** scenario reflects conditions within the study area as they currently exist, with the influence of the ongoing construction on the west leg of Kehrs Mill Road removed. Data collected in March 2009 was adjusted based upon a 2005 historical count provided by MoDOT.

- **No-Build Conditions for the Years 2010 and 2030** scenarios reflect traffic conditions representative of background growth and the introduction of a secondary access drive to Marquette High School further to the west on Kehrs Mill Road. 20-year traffic volumes were projected for Clarkson Road based on an annual growth rate of 1% for the first 10 years, tapering to 0.5% for the next 10 years. Similarly, 20-year traffic volumes were projected for Kehrs Mill Road based on an annual growth rate of 0.75%.

- **Build Conditions for the Years 2010 and 2030** scenarios reflect the build out of the subject site with a 40,900 SF grocery store in addition to secondary access drive to Marquette High School further to the west on Kehrs Mill Road. 20-year traffic volumes were projected for Clarkson Road based on an annual growth rate of 1% for the first 10 years, tapering to 0.5% for the next 10 years. Similarly, 20-year traffic volumes were projected for Kehrs Mill Road based on an annual growth rate of 0.75%.

The following report presents the findings of the analysis described above for the Base, No-Build and Build conditions in accordance with the scope of work agreed upon by the various reviewing agencies.

Existing Roadway Conditions

Area Roadway System

The study evaluates conditions along Clarkson Road (Missouri Route 340) with the limits of Country Ridge Drive to the north and the proposed Schnucks right-in/right-out driveway to the south, thereby including its intersection with Kehrs Mill Road. Clarkson Road is a primary, arterial serving west St. Louis County that is owned and maintained by MoDOT and is generally a five lane roadway (two lanes in each direction with a center left-turn lane) with shoulders. Auxiliary northbound and southbound right-turn lanes are present at Kehrs Mill Road as well as a separate southbound right-turn lane at Country Ridge Drive. Clarkson Road has a posted speed limit of 45 miles per hour (mph), north of Kehrs Mill Road and 40 mph south of Kehrs Mill Road. The intersections of Clarkson Road with Kehrs Mill Road and Country Ridge Drive/Marquette High School are both signalized.

Kehrs Mill Road between Clarkson Road and Stonebriar Ridge Drive is also evaluated in the study. Kehrs Mill Road is a minor arterial that is owned and maintained by SLCDHT. East of Clarkson Road and adjacent to the site, Kehrs Mill Road is a three-lane roadway (one lane in each direction with a center left-turn lane) with minimal shoulders on both sides of the road and a posted speed limit of 35 mph. Within the study area, a short westbound right-turn lane (50-foot) is provided at the intersection with Stonebriar Ridge Drive and a longer westbound right-turn lane is provided at the signalized intersection with Clarkson Road. Sidewalks are also located along both sides of the road.

Kehrs Mill Road, west of Clarkson Road, is currently under construction. A three lane section is planned between Clarkson Road and Marquette High School's proposed southern access drive with a transition back to a two lane section to the west. The project will also eliminate substandard vertical and horizontal grades, enclose roadway drainage system with curbing, and install/improve sidewalks to meet ADA requirements. Kehrs Mill Road, west of Clarkson Road, has a posted speed limit of 30 mph.

Country Ridge Drive is a residential collector with a posted speed limit of 25 mph. Country Ridge Drive is a two lane road with on-street parking permitted on both sides, except within approximately 150 feet of Clarkson Road. At the approach to Clarkson Road, a separate left-turn lane and a shared though/right-turn lane is provided.

The west side of the signalized intersection of Clarkson Road with Country Ridge Drive serves Marquette High School. The eastbound approach of the signal has a separate left-turn lane and a shared through/right-turn lane separated by a channelized island.

Picardy Hills Drive, Stonebriar Ridge Drive and Westpar Drive are two-lane local roads that serve residential subdivisions. The posted speed limits on each of the streets is 25 mph with on-street parking allowed.

Existing Traffic Volumes

In order to quantify the existing traffic conditions adjoining the site, manual traffic counts were performed in March 2009 at the intersections of: Clarkson Road with National City Bank, Kehrs Mill Road, and Country Ridge Drive as well as Kehrs Mill Road with Stonebriar Ridge Drive/Westpar Drive and Picardy Hills Drive during the morning (7:00-9:00 a.m.) and afternoon (2:45-6:00 p.m.) peak periods of a typical weekday and during the midday peak period during a Saturday (11:00 a.m.-2:00 p.m.). Based on those counts, four peak hours were identified for analysis, the a.m. (7:15-8:15 a.m.), afternoon school dismissal (2:45-3:45 p.m.), p.m. (5:00-6:00 p.m.) and Saturday (12:00 p.m.-1:00 p.m.) peak hours.

Since the west leg of Kehrs Mill Road was under construction during the March 2009 traffic counts, MoDOT provided historical traffic count data at the intersection of Clarkson Road at Kehrs Mill Road from early June 2005 and count data at the intersection of Clarkson Road at Country Ridge Drive from early September 2005. This data was utilized to develop base traffic volumes that removed the influence of the ongoing construction along Kehrs Mill Road. Generally, the traffic volumes from the 2009 data collection were similar to the 2005 historical count data. However in order to be conservative, the higher volume was assumed if significant discrepancies were found. **Exhibit 3** graphically summarizes the Base Traffic Volumes on the surrounding roadways.

Clarkson Road

Kehrs Mill Road

Marquette High School

Clarkson Road

County Ridge Drive

Stonebriar Ridge Drive

Picardy Hill Drive

National City Bank Drive

0 (2) [3] <5>
2 (2) [1] <8>
5 (6) [2] <2>
1,165 (1,704) [2,238] <1,453>
2 (5) [3] <2>
2,178 (1,368) [1,434] <1,452>

220 (380) [515] <390>
5 (10) [10] <10>
5 (5) [5] <10>
5 (5) [5] <5>
630 (325) [385] <410>
0 (5) [5] <5>

95 (140) [200] <120>
55 (85) [135] <90>
145 (80) [75] <75>
130 (90) [115] <100>
2,025 (1,240) [1,275] <1,310>
25 (40) [45] <50>
55 (95) [100] <90>
1,035 (1,525) [1,995] <1,290>
145 (265) [345] <260>
40 (45) [45] <45>
130 (75) [95] <95>
465 (210) [250] <280>

170 (365) [175] <15>
30 (25) [10] <5>
140 (140) [65] <10>
285 (35) [50] <10>
1,015 (1,440) [2,205] <1,595>
10 (30) [15] <30>
455 (80) [125] <15>
2,145 (1,390) [1,430] <1,610>
30 (55) [40] <35>
50 (80) [60] <30>
95 (5) [10] <5>
10 (30) [15] <10>

10 (15) [25] <15>
200 (335) [445] <350>
15 (35) [50] <30>
35 (20) [30] <20>
0 (0) [1] <5>
10 (15) [10] <10>
5 (15) [20] <5>
545 (270) [320] <365>
5 (10) [20] <10>
50 (40) [40] <30>
0 (0) [1] <1>
15 (15) [10] <10>

N

Legend

= Existing Traffic Signal

= Existing Side Street Stop Control

XX = AM Peak Hour Traffic (7:15 - 8:15 AM)

(XX) = School Peak Hour Traffic (2:45 - 3:45 PM)

[XX] = PM Peak Hour Traffic (5:00 - 6:00 PM)

<XX> = Saturday Peak Hour Traffic (12:00 - 1:00 PM)

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Exhibit 3: Base Traffic Volumes

** Influence of ongoing construction on west leg of Kehrs Mill Road removed.*

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No-Build Conditions

Background Growth Rate

Growth rate percentages were identified by the respective agencies as a means of projecting future increases in background traffic volumes along the public roadways adjacent to the development site. The percentages reflect future development opportunities in the surrounding area, anticipated capacity constraints in the existing roadway system and the impacts of those constraints upon local traffic flows, as well as general population and traffic growth trends in the region. Regional traffic growth is slowing due to economic conditions, and the population in western St. Louis County has stabilized following several decades of growth.

Considering each of these factors, traffic growth trends along Clarkson Road are expected to taper downward in the future. Specifically, the area surrounding Clarkson Road is predominantly built-out with minimal opportunities for new development. Consequently, 20-year traffic volumes are projected for Clarkson Road based on an annual growth rate of 1% for the first ten years, tapering to 0.5% for the later ten years. Similarly, 20-year traffic volumes are projected for Kehrs Mill Road based on an annual growth rate of 0.75%.

Year 2010 No-Build Traffic Volumes

Based upon an anticipated construction year of 2010 for the proposed development, the only adjustments to the base traffic volumes presented in Exhibit 3 that were contemplated were those associated with the addition of a secondary access drive to Marquette High School to the west on Kehrs Mill Road. A traffic impact study prepared by CBB for the Rockwood School District in 2004 was utilized to quantify the diversion of traffic to the new driveway.

During the morning peak hour, a total of 340 vehicles would be diverted away from the signalized intersection of Clarkson Road and Country Ridge Drive to the new driveway on Kehrs Mill Road. In particular, nearly 250 vehicles would be expected to shift from the northbound left turn into the high school. Similarly, during the afternoon school dismissal peak hour, 245 vehicles would be diverted from the access drive on Clarkson Road to the new drive on Kehrs Mill Road. The impact of the new school drive is realized even during the p.m. peak hour, when a total of 165 vehicles are diverted away from the Clarkson Road access.

Exhibit 4 illustrates the No-Build traffic volumes for the study area, which reflects the above presented diversion for Marquette High School's new access drive.

Year 2030 No-Build Traffic Volumes

In order to assist MoDOT with long term traffic planning, twenty year traffic forecast were also developed. The 20-Year No-Build Traffic Volumes, as presented in **Exhibit 5**, are reflective of an annual growth rate along Clarkson Road of 1% for the first ten years, tapering to 0.5% for the next ten years as well as an annual growth rate of 0.75% on Kehrs Mill Road. Overall, this results in an increase of 16.1% as compared to the Year 2010 No-Build Traffic Volumes (Exhibit 4).

IMPROVED ACCESS TO MARQUETTE H.S. VIA KEHRS MILL ROAD

Clarkson Road

Kehrs Mill Road

Marquette High School

County Ridge Drive

Stonebriar Ridge Drive

Picardy Hill Drive

National City Bank Drive

0 (2) [3] <5>
2 (2) [1] <8>
5 (6) [2] <2>
1,165 (1,704) [2,238] <1,453>
2 (5) [3] <2>
2,178 (1,368) [1,434] <1,452>

220 (380) [515] <390>
5 (10) [10] <10>
5 (5) [5] <10>
5 (5) [5] <5>
630 (325) [385] <410>
0 (5) [5] <5>

275 (115) [155] <105>
1,880 (1,215) [1,235] <1,305>
25 (40) [45] <50>
150 (255) [255] <120>
75 (135) [160] <95>
100 (70) [60] <70>
40 (60) [85] <85>
980 (1,410) [1,940] <1,290>
125 (215) [320] <255>
40 (45) [45] <45>
190 (85) [110] <95>
405 (200) [235] <280>

80 (165) [80] <5>
30 (25) [10] <5>
140 (140) [65] <10>
285 (35) [50] <10>
1,015 (1,440) [2,205] <1,595>
10 (30) [15] <30>
205 (35) [55] <5>
2,150 (1,395) [1,435] <1,615>
30 (55) [40] <35>
50 (80) [60] <30>
95 (5) [10] <5>
10 (30) [15] <10>

10 (15) [25] <15>
200 (335) [445] <350>
15 (35) [50] <30>
35 (20) [30] <20>
0 (0) [1] <5>
10 (15) [10] <10>
5 (15) [20] <5>
545 (270) [320] <365>
5 (10) [20] <10>
50 (40) [40] <30>
0 (0) [1] <1>
15 (15) [10] <10>

n.t.s.

N

Legend

= Existing Traffic Signal

= Existing Side Street Stop Control

XX = AM Peak Hour Traffic (7:15 - 8:15 AM)

(XX) = School Peak Hour Traffic (2:45 - 3:45 PM)

[XX] = PM Peak Hour Traffic (5:00 - 6:00 PM)

<XX> = Saturday Peak Hour Traffic (12:00 - 1:00 PM)

Exhibit 4: Year 2010 No-Build Traffic Volumes

** Secondary access to Marquette High School is reflected in volumes.*

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IMPROVED ACCESS TO MARQUETTE H.S. VIA KEHRS MILL ROAD

Clarkson Road

Kehrs Mill Road

Marquette High School

County Ridge Drive

Stonebriar Ridge Drive

National City Bank Drive

Picardy Hill Drive

0 (2) [3] <5>
2 (2) [1] <8>
5 (6) [2] <2>
1,355 (1,974) [2,598] <1,688>
2 (5) [3] <2>
2,533 (1,588) [1,664] <1,687>

255 (440) [595] <455>
5 (10) [10] <10>
5 (5) [5] <10>
5 (5) [5] <5>
730 (380) [450] <475>
0 (5) [5] <5>

175 (295) [295] <140>
85 (155) [185] <110>
115 (80) [70] <80>
320 (135) [180] <120>
2,185 (1,410) [1,435] <1,515>
30 (45) [50] <60>
45 (70) [100] <100>
1,140 (1,635) [2,255] <1,500>
145 (250) [370] <295>
45 (50) [50] <50>
220 (100) [130] <110>
470 (235) [275] <325>
80 (165) [80] <5>
30 (25) [10] <5>
140 (140) [65] <10>
285 (35) [50] <10>
1,200 (1,710) [2,585] <1,860>
10 (30) [15] <30>
205 (35) [55] <5>
2,535 (1,635) [1,685] <1,880>
30 (55) [40] <35>
50 (80) [60] <30>
95 (5) [10] <5>
10 (30) [15] <10>
10 (15) [25] <15>
235 (395) [525] <415>
15 (35) [50] <30>
35 (20) [30] <20>
0 (0) [1] <5>
10 (15) [10] <10>
5 (15) [20] <5>
645 (325) [385] <430>
5 (10) [20] <10>
50 (40) [40] <30>
0 (0) [1] <1>
15 (15) [10] <10>

n.t.s.

Legend

= Existing Traffic Signal
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<XX> = Saturday Peak Hour Traffic (12:00 - 1:00 PM)

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Exhibit 5: Year 2030 No-Build Traffic Volumes

** Secondary access to Marquette High School is reflected in volumes.*

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Site-Generated Traffic

The proposed store would be more of a "neighborhood" grocery, serving the surrounding subdivisions within western Ballwin, Chesterfield and Clarkson Valley. Consequently, the grocery store would only be approximately 40,900 SF, which is smaller than the typical suburban grocery store. Therefore, for the purposes of determining traffic generation for the smaller store, trip generation counts were conducted at the Schnuck's Market at Clayton and Lindbergh in the City of Ladue and the Schnuck's Market at Olive Boulevard and Spoede Road in the City of Creve Coeur.

Traffic Generation

Manual counts were conducted at both the Ladue and Creve Coeur Schnucks during the weekday morning, midday and p.m. peak hours as well as the midday peak of a Saturday. **Table 1** presents the results of the data collection at each of the stores, as well as the average of both stores results. It should be noted that the level of traffic generation for both stores was determined to be reasonable when compared to the nationwide traffic generation rates provided by the Institute of Transportation Engineers.

Table 1 – Collected Traffic Data at Existing Schnucks Stores

Store Location	*Weekday AM Peak Hour*			*Weekday School Dismissal Hour*			*Weekday PM Peak Hour*			*Saturday Midday Peak Hour*		
	In	Out	Total	In	Out	Total	In	Out	Total	In	Out	Total
Creve Coeur	111	91	202	142	142	284	224	225	449	150	150	300
Ladue	104	62	166	198	190	388	181	201	382	177	205	382
Average	108	77	185	170	166	336	203	213	416	164	178	342

Creve Coeur Store located in southeast quadrant of Olive & Spoede (37,000 SF)
Ladue Store located in the northeast quadrant of Lindbergh & Clayton (35,097 SF)

Based upon a review of this data, as well as the comparable store sizes, it was determined that the average traffic generation as presented in Table 1 was appropriate for the proposed store. In fact, Schnucks Markets, Inc. research indicates that these traffic projections could be considered likely conservative and that the actual traffic generation of the proposed store in Ballwin could actually be less, perhaps as much as 25% less. **Table 2** presents the resulting site generated traffic for the proposed Ballwin store.

Table 2 – Estimated Traffic Generation – Proposed Schnuck's Market

	Weekday AM Peak Hour			***Weekday School Dismissal Peak Hour***			***Weekday PM Peak Hour***			***Saturday Midday Peak Hour***		
	In	Out	Total	In	Out	Total	In	Out	Total	In	Out	Total
Ballwin Store	*110*	*75*	*185*	*170*	*165*	*335*	*205*	*215*	*420*	*165*	*180*	*345*
Pass-by Trips (10% in AM; 28% remaining time periods)	10	10	20	45	45	90	60	60	120	50	50	100
Captured Trips (16%)	20	10	30	30	25	55	30	35	65	25	30	55
New Trips	80	55	135	95	95	190	115	120	235	90	100	190

Ballwin West Store trip generation is based upon the average of the Creve Coeur and Ladue West stores, rounded to the nearest 5 vph.

The forecasts presented in Table 2 were adjusted to account for the fact that not all of the trips generated by the proposed grocery store would be new to the adjoining road system. Studies show that a portion of the traffic generated by grocery stores with high-visibility from major transportation corridors are already present on the adjacent roads and would be attracted to the development on their way to or from another destination. Based upon information provided in the Institute of Transportation Engineers (ITE), it was estimated that pass-by trips would account for 28% of grocery store's trip generation during the weekday afternoon and p.m. peak periods as well as on a Saturday. A lower, more conservative, 10% rate was applied to the weekday morning peak hour.

In addition, given the proximity of the proposed grocery store to existing grocers in the area, it is highly likely that a portion of the proposed store's patrons would be "captured" from other existing stores in the area. For example, there are four existing stores within a two mile radius of the proposed site and an additional seven grocery stores within a four mile radius. Therefore, using information provided by Schnucks Markets, Inc. it was determined that approximately 16% of its anticipated patrons are already traveling thru the intersection of Clarkson and Kehrs Mill Road on their way to or from another grocery store in the immediate area. As a consequence of the proposed store being built, these patrons would divert their trip away from the existing store to the new store. Therefore, the trip generation presented in Table 2 was adjusted accordingly.

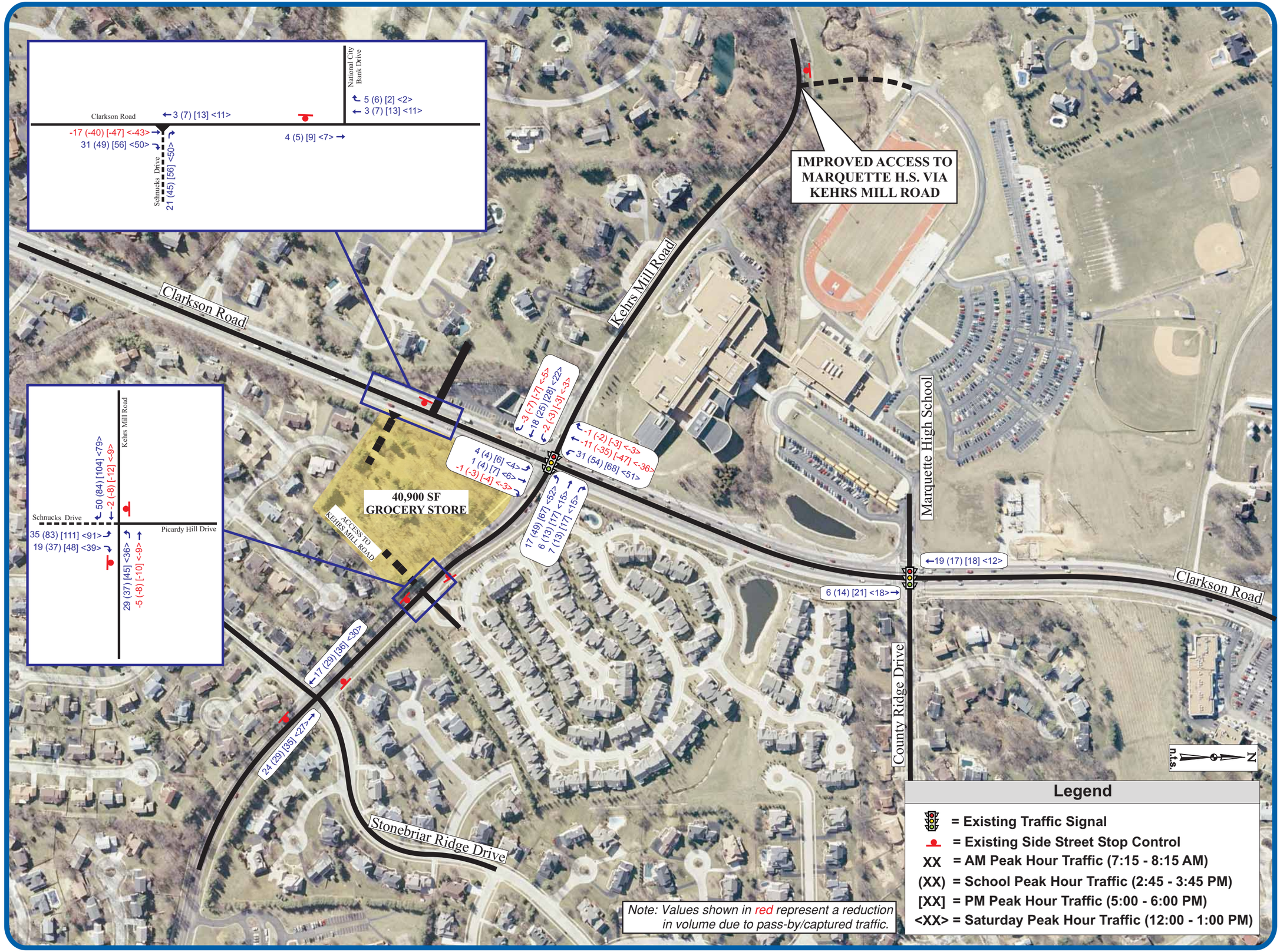
Consequently, the grocery store is expected to generate approximately 185, 335, and 420 trips during the weekday a.m., afternoon and p.m. peak hours, respectively and 345 trips during the Saturday midday peak hour. However, a portion of these trips would be pass-by or captured in nature, so only 135, 190 and 235 "new" trips would be added to the adjoining road system during the weekday peak hours and 190 "new" trips during the Saturday midday peak hour.

Site-Generated Traffic Assignment

Access to the site would be provided via a right-in/right-out directly onto Clarkson Road (approximately 500 feet south of Kehrs Mill Road) and a full access drive onto Kehrs Mill Road, directly opposite Picardy Hill Drive. In subsequent steps of the traffic study, the site-generated trips will be assigned into and out of the development site based upon the anticipated directional distribution of the grocer's patrons. The distribution of the store's *new* trips would be as follows:

- 30% to and from the east on Kehr's Mill Road;
- 30% to and from the north on Clarkson Road;
- 22% to and from the south on Clarkson Road; and
- 18% to and from west on Kehr's Mill Road.

The Schnucks site-generated traffic volumes were assigned to the roadways as shown in **Exhibit 6**. Please note that the values shown in red on the exhibit are due to the diversion of traffic as a result of pass-by and captured trips.



Note: Values shown in red represent a reduction in volume due to pass-by/captured traffic.

Legend

- = Existing Traffic Signal
- = Existing Side Street Stop Control
- XX = AM Peak Hour Traffic (7:15 - 8:15 AM)
- (XX) = School Peak Hour Traffic (2:45 - 3:45 PM)
- [XX] = PM Peak Hour Traffic (5:00 - 6:00 PM)
- <XX> = Saturday Peak Hour Traffic (12:00 - 1:00 PM)

Exhibit 6: Site-Generated Traffic Volumes

Traffic Impact Study
Proposed Schnucks: Clarkson Road at Kehrs Mill Road
Ballwin, Missouri

Job# 28-09
4/9/09

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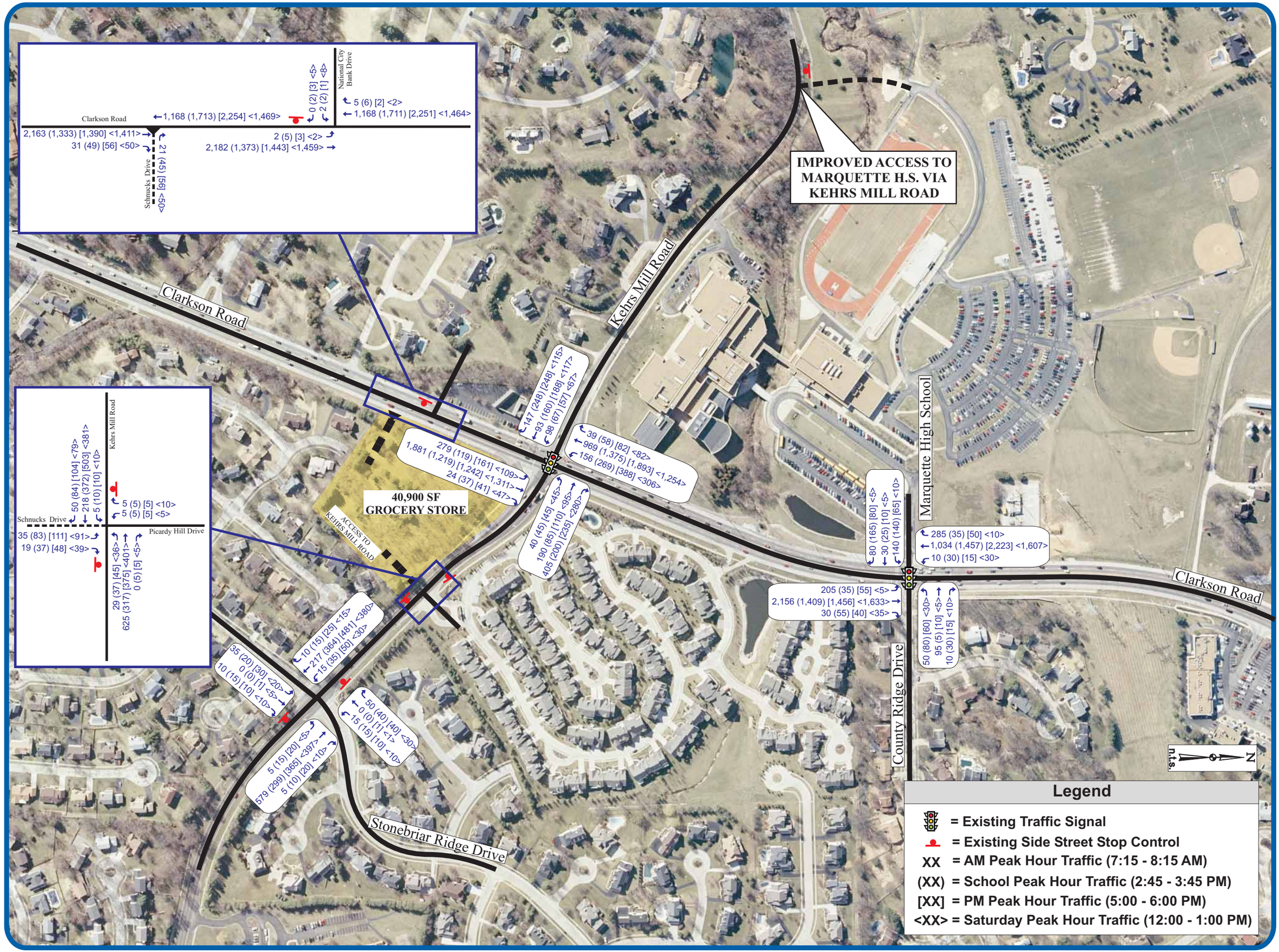
Year 2010 Build Traffic Volumes

The Schnucks site-generated traffic volumes (Exhibit 6) were aggregated with the Year 2010 No-Build Traffic Volumes (Exhibit 4) in order to determine the total volumes in the Year 2010 Build scenario. The Year 2010 Build Traffic Volumes for the four critical peak hours are shown in **Exhibit 7.**

Year 2030 Build Traffic Volumes

The Schnucks site-generated traffic volumes (Exhibit 6) were also aggregated with the Year 2030 No-Build traffic volumes. The resulting Year 2030 Build Traffic Volumes are depicted in **Exhibit 8**.



Legend

= Existing Traffic Signal

= Existing Side Street Stop Control

XX = AM Peak Hour Traffic (7:15 - 8:15 AM)

(XX) = School Peak Hour Traffic (2:45 - 3:45 PM)

[XX] = PM Peak Hour Traffic (5:00 - 6:00 PM)

<XX> = Saturday Peak Hour Traffic (12:00 - 1:00 PM)

Exhibit 7: Year 2010 Build Traffic Volumes

** Secondary access to Marquette High School is reflected in volumes.*

Traffic Impact Study
Proposed Schnucks: Clarkson Road at Kehrs Mill Road
Ballwin, Missouri

Job# 28-09
4/9/09

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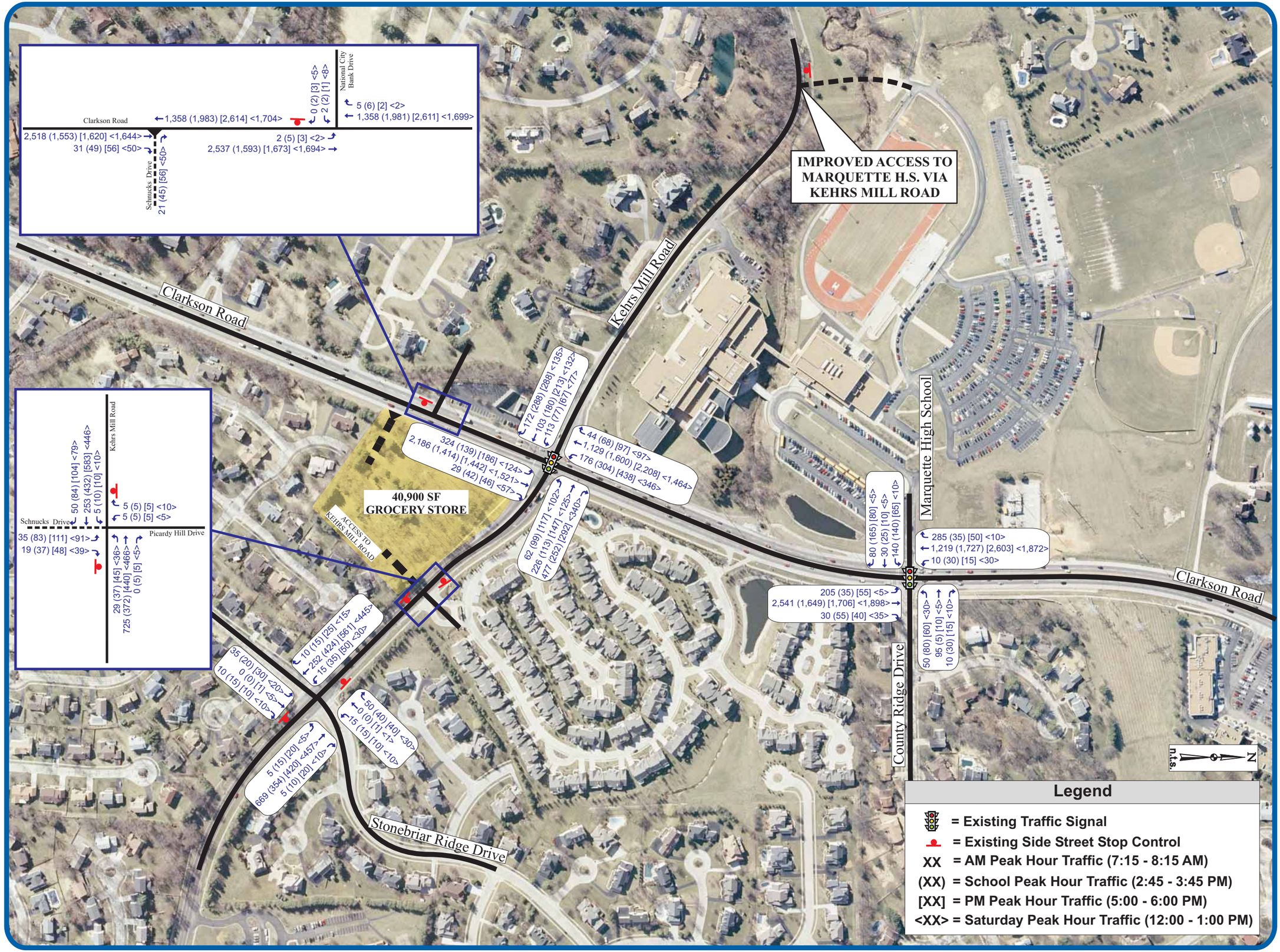

Legend

= Existing Traffic Signal

= Existing Side Street Stop Control

XX = AM Peak Hour Traffic (7:15 - 8:15 AM)

(XX) = School Peak Hour Traffic (2:45 - 3:45 PM)

[XX] = PM Peak Hour Traffic (5:00 - 6:00 PM)

<XX> = Saturday Peak Hour Traffic (12:00 - 1:00 PM)

Exhibit 8: Year 2030 Build Volumes

* *Secondary access to Marquette High School is reflected in volumes.*

Traffic Impact Study
Proposed Schnucks: Clarkson Road at Kehrs Mill Road
Ballwin, Missouri

Job# 28-09
4/9/09

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Operational Analysis

The following sections of the report discuss in detail the operational aspects of the traffic conditions within the study area. Included in this analysis is a review of the driveway locations, need for auxiliary turn lanes per the respective agency's criteria, sight distance, and capacity analysis.

Auxiliary Turn Lane Analysis

The need for a dedicated right turn lane on Clarkson Road at the proposed right-turn only drive was evaluated using MoDOT's "Access Managements Guidelines", while the need for a dedicated right turn lane on Kehrs Mill Road was compared to criteria set forth by SLCDHT. These guidelines consider auxiliary lanes an asset in promoting safety and improved traffic flow. Separate turn lanes are intended to remove turning vehicles from the through lanes to reduce the potential number of rear-end collisions at intersections.

The proposed access on Clarkson Road would be limited to right turns only. Furthermore, Kehrs Mill Road currently has a center left-turn lane, which can accommodate the left-turn movement into the proposed driveway. Therefore, it is not necessary to evaluate the need for dedicated left turn lanes on either Clarkson or Kehrs Mill Road.

Right-Turn Lane Warrants

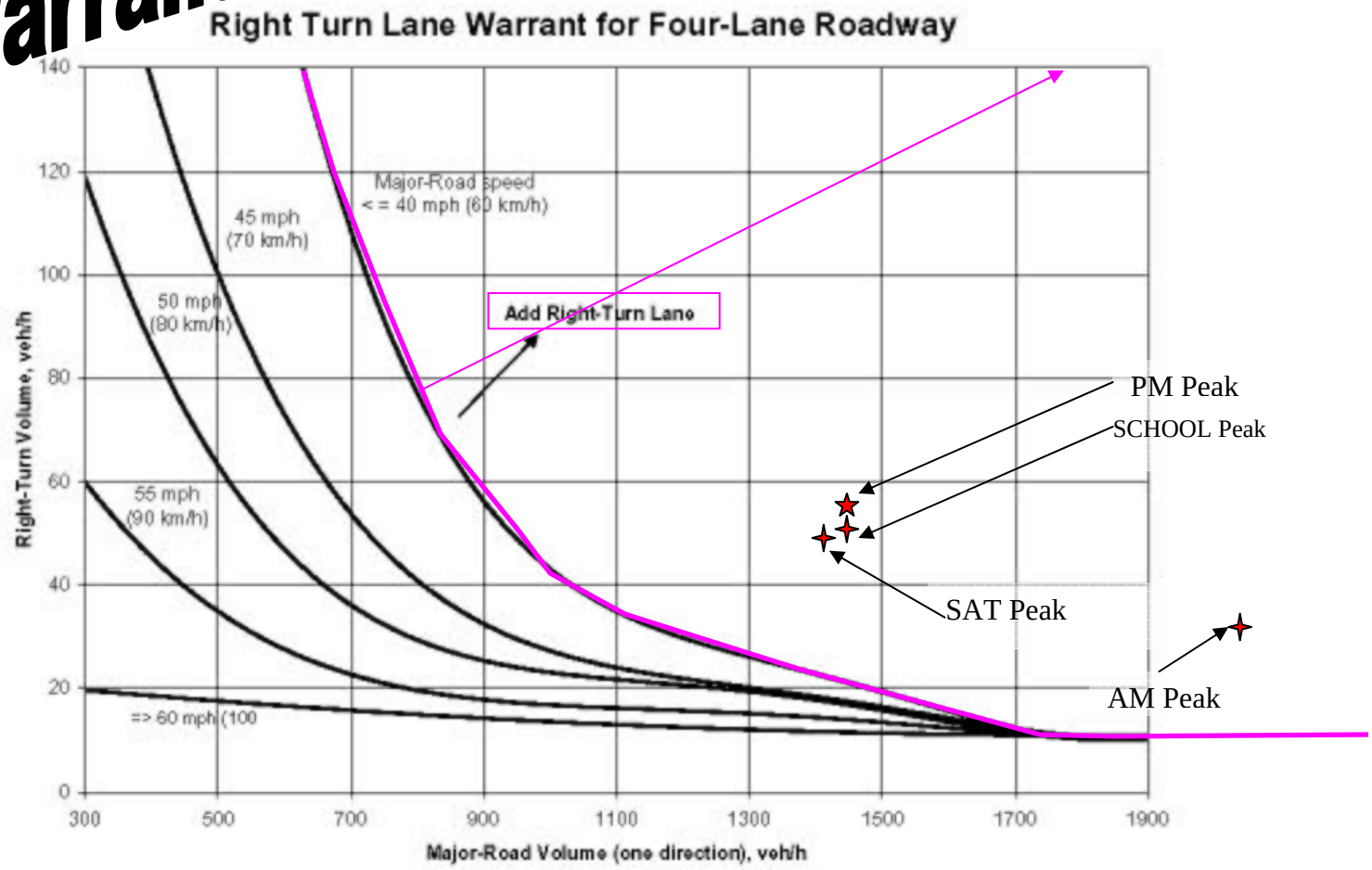
The MoDOT figure, *Right Turn Lane Warrant for a Four-Lane Roadway*, was utilized to compare traffic volumes from Clarkson Road to the proposed Schnucks driveway. **Exhibit 9** illustrates the Year 2010 Build traffic volumes as plotted on the MoDOT figure. Based on the minimal number of right-turns needed to satisfy the criteria coupled with the existing high traffic volume along Clarkson Road, a separate northbound right-turn lane is warranted on Clarkson Road at the proposed Schnucks right-in/right-out driveway. The existing shoulder near the proposed entrance could presumably be re-striped to accommodate a separate right-turn lane.

STLCDHT's draft Access Management Guidelines utilizes MoDOT's figure *Right Turn Lane Warrant for a Two-Lane Roadway* as a means of determining if an auxiliary lane is warranted. **Exhibit 10** illustrates the Year 2010 Build traffic volumes as plotted on the figure. As can be seen, 104 right-turns are expected in conjunction with 617 vph advancing during the p.m. peak hour. As a result, the forecasted volumes would warrant a separate right-turn lane on Kehrs Mill Road at the Schnucks Driveway.

However, should dual southbound left-turn lanes be provided on Clarkson Road (as discussed later in the report), Kehrs Mill Road would need to be widened to accommodate two eastbound lanes for a distance east of the intersection (preferably to West Par Drive). Under this scenario, MoDOT's figure *Right Turn Lane Warrant for a Four-Lane Roadway* would be more applicable. A review of the forecasted volumes reveals that, if two eastbound lanes are provided on Kehrs Mill Road as a result of the provision of dual southbound left-turn lanes from Clarkson Road, a separate right-turn lane on Kehrs Mill Road at the Schnucks driveway would not be warranted.

Exhibit 9 - Right-Turn Lane Needs Evaluation
Northbound Clarkson Road at Proposed Schnucks Driveway
Year 2010 Build Conditions

Warranted



The following data are required:

1. Advancing Volume (veh/hr) - The advancing volume should include the right-turn, left-turn and through movements in the same direction as the right turning vehicle.
2. Right Turning Volume (veh/hr) - The right turning volume is the number of advancing vehicles turning right.
3. Operating Speed (mph) - The greater of design or posted speed.

Note: Right turn lane not warranted for right turn volume less than 10 vph

If the combination of major-road approach volume and right-turn volume intersects above or to the right of the speed trend line corresponding the major road operating speed, then a right-turn lane is warranted.

Roadway Speed
40 mph

AM Peak Hour
V_A = 2,194 vph
Right-Turns = 31

School Peak Hour
V_A = 1,382 vph
Right-Turns = 49

PM Peak Hour
V_A = 1,446 vph
Right-Turns = 56

Saturday Peak Hour
V_A = 1,461 vph
Right-Turns = 50

Source: MoDOT "Access Management"

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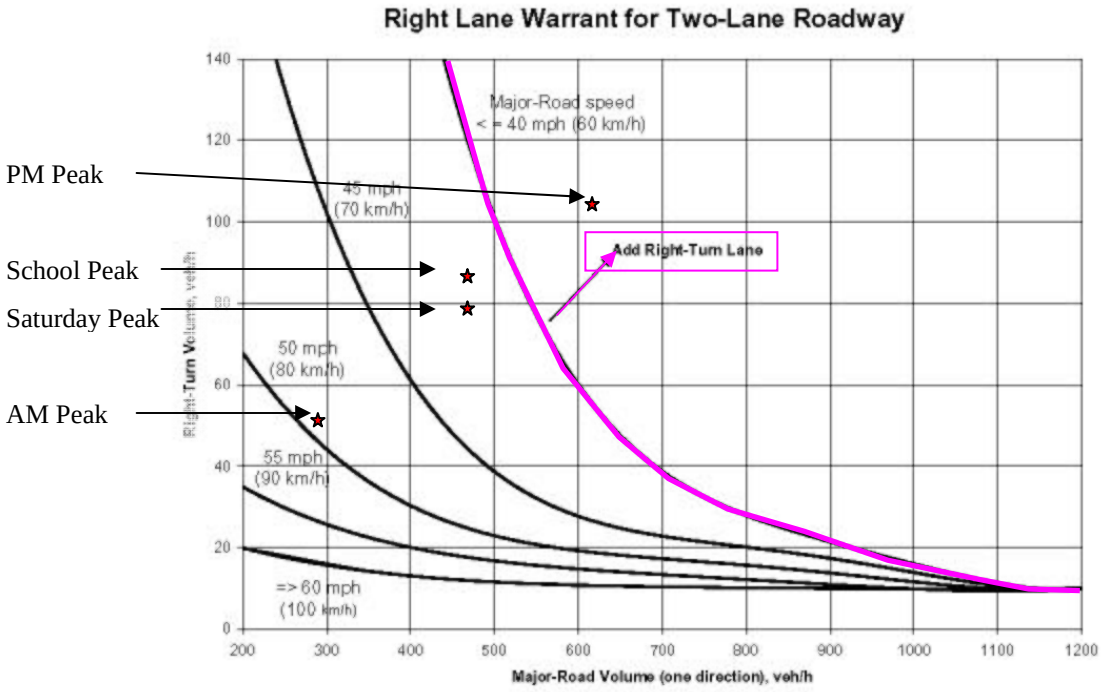
Exhibit 10 - Right-Turn Lane Needs Evaluation
Eastbound Kehrs Mill Road at Schnucks/Picardy Hill Drive
Year 2010 Build Conditions

Warranted

Posted Speed = 35 mph

AM Peak Hour	School Peak Hour	PM Peak Hour	Sat Peak Hour
Va = 273 vph	Va = 466 vph	Va = 617 vph	Va = 470 vph
Right-Turns = 50 vph	Right-Turns = 84 vph	Right-Turns =104 vph	Right-Turns = 79 vph



The following data are required:

1. Advancing Volume (veh/hr) - The advancing volume should include the right-turn, left-turn and through movements in the same direction as the right turning vehicle.
2. Right Turning Volume (veh/hr) - The right turning volume is the number of advancing vehicles turning right.
3. Operating Speed (mph) - The greater of design or posted speed.

Note: Right turn lane is not warranted for right turn volume less than 10 vph

If the combination of major-road approach volume and right-turn volume intersects above or to the right of the speed trend line corresponding the major road operating speed, then a right-turn lane is warranted.

Source: SLCDHT Access Management Guidelines, which refers to MoDOT Access Management

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Driveway Location

MoDOT's Access Management Guidelines specify a minimum spacing/corner clearance for right-in/right-out driveways of 220 to 330 feet. As shown, the proposed right turn only drive on Clarkson Road would provide approximately 450 feet of corner clearance south of Kehrs Mill Road and therefore exceeds MoDOT's requirements.

A full access drive onto Kehrs Mill Road, directly opposite Picardy Hill Drive, is also proposed. STLCDHT's draft Access Management Guidelines state that "driveways should be aligned across the public roadway from each other whenever possible." Furthermore, STLCDHT recommends 510 feet of corner clearance/separation between a commercial drive and Clarkson Road. As proposed, the drive is approximately 540 feet east of the extended curbline of Clarkson Road. Therefore, it is evident that the proposed full access drive on Kehrs mill Road would meet and/or exceed STLCDHT requirements.

Currently, the queue in the westbound right-turn from Clarkson Road occasionally blocks the location of the proposed Schnucks entrance along Kehrs Mill Road (opposite Picardy Hill) during the morning peak hour. However, the anticipated shift in the school traffic shift resulting from the provision of secondary access to the west on Kehrs Mill Road would divert traffic away from the westbound right turn. Consequently, it is expected that the queues observed in the field would be reduced and that the proposed Schnucks driveway (as well as Picardy Hill) would only infrequently, if at all, be obstructed during the morning peak hour.

Furthermore, during the peak hours, the 95th percentile queue length for the northbound through movement on Clarkson Road is expected to frequently obstruct the proposed right-turn only drive to Schnucks. However, this driveway is located as far south on the subject site as possible and there is no viable alternative for its placement along Clarkson Road.

Driveway Sight Distance

The proposed Schnucks driveways onto Clarkson Road and Kehrs Mill Road were compared to MoDOT and SLCDHT sight distance requirements, respectively. Adequate sight distance is necessary at intersections to allow drivers to perceive potentially conflicting vehicles and allow those motorists sufficient time to adjust their speed to avoid a collision or make a choice of when to cross or enter the mainline traffic flow. All drivers approaching or stopped at the intersection should have an unobstructed view of the entire intersection so that potential collisions can be avoided.

It should be noted that MoDOT utilizes a tiered approach in their requirements based upon Table III-1 and Figure IX-41 of the AASHTO Green Book 1994 Edition. The three "levels" of sight distance compliance are: minimum entrance stopping sight distance, minimum entering sight distance and design entering sight distance. The design entering sight distance is the largest, most conservative requirement and is preferred for optimal sight distance. The design entering sight distance for the proposed right-turn only drive on Clarkson Road would be 575 feet.

As verified in the field, the proposed right-turn only driveway has more than adequate sight distance (in excess of 1,000 foot) available. Thus, the sight distance for the proposed commercial driveway exceeds the design entering sight distance recommended by MoDOT.

SLCDHT has sight distance guidelines for vehicles entering roadway from a stopped position. According to those guidelines, which incorporates the cross-section and the design speed (35 mph design + 5 mph = 40 mph design) of Kehrs Mill Road, the minimum sight distance for left-turns from the minor road is 355 feet and the minimum sight distance for vehicles exiting from the minor road is 500 feet, assuming the eastbound right-turn lane is constructed. The proposed Schnucks driveway is approximately 560 feet east of Clarkson Mill Road (centerline to centerline). Since Clarkson Road is visible from the proposed driveway and there is adequate visibility to the east on Kehrs Mill Road, it was determined that STLCDHT sight distance requirements would be satisfied.

However, careful consideration should be given to sight distance obstructions when planning any future aesthetics enhancements, such as berms, fencing and landscaping, to ensure that these improvements do not obstruct the view of entering and exiting traffic at the site intersections with the public roads. It is generally recommended that all improvements higher than 3.5 feet above the elevation of the nearest pavement edge be held back at least 20 feet from the traveled roadway.

Capacity Analysis

In addition to the above aspects, it is also necessary to evaluate the traffic operations within the study area.

Methodology

The operating conditions at the study intersections were evaluated using SYNCHRO 7, which is based on study procedures outlined in the *Highway Capacity Manual*, last updated in 2000 by the Transportation Research Board. This manual, which is used universally by traffic engineers to measure roadway capacity, establishes six levels of traffic service: Level A ("Free Flow), to Level F ("Fully Saturated"). Levels of service (LOS) are measures of traffic flow which consider such factors as speed, delay, traffic interruptions, safety, driver comfort, and convenience. Level C, which is normally used for highway design, represents a roadway with volumes ranging from 70% to 80% of its capacity. Level D is considered acceptable for peak period conditions in urban areas, while LOS C is preferred in rural areas.

LOS thresholds and criteria vary depending upon the type of traffic control used at an intersection (i.e. whether it is signalized or unsignalized). At signalized intersections, average control delay per vehicle is estimated for each movement and aggregated for each approach and the intersection as a whole. At intersections with partial (side-street) stop control, delay is only calculated for the minor movements - but not for the intersection as a whole - since motorists on the main road are not required to stop. In addition, signalized intersections are designed to carry higher traffic volumes, so longer delays are tolerated than at unsignalized intersections. **Table 3** summarizes the thresholds for each LOS.

Table 3 – Level of Service Thresholds

Level of Service (LOS)	Control Delay per Vehicle (sec/veh)	
	Signalized Intersections	***Unsignalized Intersections***
A	≤ 10	0-10
B	> 10-20	> 10-15
C	> 20-35	> 15-25
D	> 35-55	> 25-35
E	> 55-80	> 35-50
F	> 80	> 50

Capacity Analysis Results

The traffic signals along Clarkson Road within the study area are part of a coordinated traffic system (Wilson to Froesel) which runs a 130-second cycle during the weekday morning, school and p.m. peak hours, while the Saturday peak hour cycle is 85 seconds. The traffic signal at Clarkson Road and Kehrs Mill Road operates with protected-only north-south left-turns, while the east-west left-turns operate under protected plus permitted phasing as well as right-turn overlaps phases for both the east and west approaches. The traffic signal at Clarkson Road at Country Ridge Drive/Marquette High School operates with protected plus permitted left-turns for the northbound, southbound, and eastbound approaches, while the westbound approach has a permitted phase only.

The critical intersections within the study area, including the unsignalized intersections, were evaluated using the traffic volumes for each scenario and design horizon presented earlier in the report. The Base Traffic, Year 2010 No-Build , Year 2030 No-Build, Year 2010 Build and Year 2030 Build operational evaluations are summarized in **Tables 4, 5, 6,** and **7** for the morning, school dismissal, p.m. and Saturday peak hours, respectively. These tables identify the levels of service, average delays and the 95th percentile queues for comparison during each peak hour.

Base Traffic Conditions

Based upon field observations, as well as analysis of the base traffic volumes, the following constraints were identified within the study area:

- The westbound approach of Country Ridge Drive to Clarkson Road operates at less than desirable conditions during all three weekday peak hours. During the weekday school dismissal peak hour, the eastbound approach exiting Marquette High School also operates at an unacceptable level of service. Both of these conditions are a result of the combination of a coordinated system along Clarkson Road and heavy school traffic with concentrated peaking characteristics, which limit the ability to serve Country Ridge Drive and Marquette High School during the weekday peak hours. Despite the lengthy delays, the queue lengths are generally short (under 200 feet) for both approaches.

Table 4 – Morning Peak Hour Operating Conditions

Intersection/Movement	*Morning Peak Hour (7:15 – 8:15 AM)*									
	Base Conditions		*2010 No Build* [1]		*2030 No-Build Condition* [1]		*2010 Build Condition* [2]		*2030 Build Condition* [2]	
	LOS (Delay)	*95Th Queues*	*LOS (Delay)*	*95Th Queues*	*LOS (Delay)*	*95Th Queues*	*LOS (Delay)*	*95Th Queues*	*LOS (Delay)*	*95Th Queues*
Clarkson Road at Country Ridge Drive/Marquette High School (signalized)										
Eastbound Marquette HS Exit	D (49.0)	187 (lt)	D (50.8)	200 (lt)	D (50.8)	200 (lt)	D (50.8)	200 (lt)	D (50.8)	200 (lt)
Westbound Country Ridge	F (95.6)	149 (th/rt)	E (76.6)	145 (th/rt)	E (76.6)	145 (th/rt)	E (76.6)	145 (th/rt)	E (76.6)	145 (th/rt)
Northbound Clarkson	B (19.1)	538 (th)	C (23.5)	m1047 (th)	F (95.6)	m1097 (th)	B (17.0)	m1047 (th)	F (90.8)	m1052 (th)
Southbound Clarkson	D (40.0)	558 (th)	C (21.3)	425 (th)	C (25.1)	542 (th)	C (21.6)	425 (th)	C (25.6)	555 (th)
Overall Intersection	C (31.7)		C (27.0)		E (67.2)		C (23.6)		E (64.5)	
Clarkson Road at Kehrs Mill Road (signalized)										
Eastbound Kehrs Mill	D (50.3)	176 (lt)	C (31.3)	126 (lt)	C (35.0)	154 (lt)	C (34.0)	125 (lt)	D (36.6)	149 (th)
Westbound Kehrs Mill	F (123.2)	#635 (rt)	E (69.0)	#450 (rt)	F (110.7)	#652 (rt)	E (76.5)	#505 (rt)	F (105.3)	#654 (rt)
Northbound Clarkson	F (111.4)	#1347 (th)	F (94.5)	#1227 (th)	F (154.9)	#1494 (th)	F (87.2)	#1204 (th)	F (163.8)	#1506 (th)
Southbound Clarkson	D (39.5)	549 (th)	D (50.8)	558 (th)	E (73.1)	660 (th)	E (63.7)	568 (th)	F (85.5)	655 (th)
Overall Intersection	F (86.3)		E (72.8)		F (114.8)		E (74.5)		F (121.5)	
Clarkson Road at National City Bank Driveway (Side-Street Stop Controlled)										
Northbound Left-Turn from Clarkson	B (12.4)	1 (lt)	B (11.8)	1 (lt)	B (13.9)	1 (lt)	B (11.9)	1 (lt)	B (13.9)	1 (lt)
Eastbound National City Exit	D (28.4)	17 (lt/th/rt)	D (26.8)	1 (lt/th/rt)	D (34.4)	2 (lt/th/rt)	D (27.1)	1 (lt/th/rt)	D (34.6)	2 (lt/th/rt)
Clarkson Road at Proposed Schnucks right-in/right-out Driveway (Side-Street Stop Controlled)										
Westbound Schnucks Exit							D (27.3)	10 (rt)	E (36.6)	14 (rt)
Kehrs Mill Road at Picardy Hill Drive/Proposed Schnucks Driveway (Side-Street Stop Controlled)										
Eastbound Left-Turn from Kehrs Mill	A (9.4)	1 (lt)	A (9.4)	1 (lt)	A (9.9)	1 (lt)	A (9.4)	1 (lt)	A (9.8)	1 (lt)
Westbound Left-Turn from Kehrs Mill							A (8.0)	2 (lt)	A (8.2)	2 (lt)
Northbound Schnucks Exit							C (15.9)	13 (lt/th/rt)	C (18.0)	13 (lt/th/rt)
Southbound Picardy Hill Drive	B (14.4)	4 (lt/rt)	B (14.4)	4 (lt/rt)	C (16.0)	5 (lt/rt)	C (15.8)	5 (lt/th/rt)	C (17.8)	5 (lt/rt)
Kehrs Mill Road at Stonebriar Ridge Drive/Westpar Drive (Side-Street Stop Controlled)										
Eastbound Left-Turn from Kehrs Mill	A (9.1)	2 (lt)	A (9.1)	2 (lt)	A (9.5)	2 (lt)	A (9.2)	2 (lt)	A (9.7)	2 (lt)
Westbound Left-Turn from Kehrs Mill	A (7.8)	1 (lt)	A (7.8)	1 (lt)	A (7.9)	1 (lt)	A (7.9)	1 (lt)	A (8.0)	1 (lt)
Northbound Westpar Drive	C (18.0)	20 (lt/th/rt)	C (18.0)	20 (lt/th/rt)	C (21.5)	25 (lt/th/rt)	C (18.9)	22 (lt/th/rt)	C (22.7)	27 (lt/th/rt)
Southbound Stonebriar Ridge Drive	B (14.4)	12 (th/rt)	B (14.4)	12 (th/rt)	C (16.3)	14 (th/rt)	B (14.9)	13 (th/rt)	C (16.8)	15 (th/rt)

X (XX.X) - Level of Service (Vehicular delay in seconds per vehicle) [1] Signal timings optimized to accommodate school traffic shift [2] Signal timings optimized to accommodate school and site traffic

95th % queue notes: m = 95th % queues may not be experienced due to upstream signal metering, # = 95th % queue exceeds capacity, (lt) = 95th % queue experienced in left-turn lane, (th) = 95th % queue experienced in through lane, (rt) = 95th % queue experienced in right-turn lane

Table 5 – School Dismissal Peak Hour Operating Conditions

Intersection/Movement	*School Peak Hour (2:45 – 3:45 AM)*									
	Base Conditions		*2010 No Build* [1]		*2030 No-Build Condition* [1]		*2010 Build Condition* [2]		*2030 Build Condition* [2]	
	LOS (Delay)	*95Th Queues*	*LOS (Delay)*	*95Th Queues*	*LOS (Delay)*	*95Th Queues*	*LOS (Delay)*	*95Th Queues*	*LOS (Delay)*	*95Th Queues*
Clarkson Road at Country Ridge Drive/Marquette High School (signalized)										
Eastbound Marquette HS Exit	F (173.3)	#495 (lt)	D (35.9)	155 (lt)	D (36.6)	155 (lt)	D (35.9)	155 (lt)	D (36.6)	155 (lt)
Westbound Country Ridge	F (456.7)	200 (lt)	E (72.4)	118 (lt)	E (72.4)	118 (lt)	E (72.4)	118 (lt)	E (72.4)	118 (lt)
Northbound Clarkson	A (5.8)	120 (th/rt)	A (7.7)	180 (th/rt)	B (12.0)	283 (th/rt)	A (6.2)	133 (th/rt)	A (9.9)	m175 (th/rt)
Southbound Clarkson	B (19.9)	555 (th)	B (24.2)	628 (th)	C (34.0)	873 (th)	B (24.6)	643 (th)	D (35.1)	#909 (th)
Overall Intersection	E (60.0)		C (21.3)		C (27.0)		C (20.8)		C (26.6)	
Clarkson Road at Kehrs Mill Road (signalized)										
Eastbound Kehrs Mill	D (40.1)	128 (th)	D (41.9)	185 (rt)	D (44.8)	236 (rt)	D (52.7)	233 (rt)	E (56.3)	286 (rt)
Westbound Kehrs Mill	C (32.6)	116 (th)	C (28.6)	124 (th)	C (31.5)	141 (th)	C (32.3)	141 (th)	C (33.9)	159 (th)
Northbound Clarkson	C (31.0)	595 (th)	C (34.7)	616 (th)	D (42.0)	843 (th)	D (37.2)	603 (th)	D (52.4)	840 (th)
Southbound Clarkson	C (20.7)	m383 (th)	B (16.9)	485 (th)	C (25.4)	987 (th)	C (22.6)	404 (lt)	C (33.2)	921 (th)
Overall Intersection	C (26.7)		C (27.0)		C (33.9)		C (32.2)		D (42.5)	
Clarkson Road at National City Bank Driveway (Side-Street Stop Controlled)										
Northbound Left-Turn from Clarkson	C (17.2)	1 (lt)	C (17.2)	1 (lt)	C (23.8)	2 (lt)	C (17.4)	1 (lt)	C (24.3)	2 (lt)
Eastbound National City Exit	C (24.3)	1 (lt/th/rt)	C (24.4)	3 (lt/th/rt)	E (35.6)	5 (lt/th/rt)	C (24.8)	3 (lt/th/rt)	E (36.7)	5 (lt/th/rt)
Clarkson Road at Proposed Schnucks right-in/right-out Driveway (Side-Street Stop Controlled)										
Westbound Schnucks Exit							C (16.3)	11 (rt)	C (19.0)	14 (rt)
Kehrs Mill Road at Picardy Hill Drive/Proposed Schnucks Driveway (Side-Street Stop Controlled)										
Eastbound Left-Turn from Kehrs Mill	A (8.0)	1 (lt)	A (8.0)	1 (lt)	A (8.2)	1 (lt)	A (8.0)	1 (lt)	A (8.2)	1 (lt)
Westbound Left-Turn from Kehrs Mill							A (9.1)	3(lt)	A (9.5)	4 (lt)
Northbound Schnucks Exit							C (16.6)	31(lt/th/rt)	C (18.9)	37(lt/th/rt)
Southbound Picardy Hill Drive	B (11.5)	2 (lt/rt)	B (11.5)	2 (lt/rt)	B (12.2)	2 (lt/rt)	B (12.9)	2 (lt/th/rt)	B (14.0)	2 (lt/rt)
Kehrs Mill Road at Stonebriar Ridge Drive/Westpar Drive (Side-Street Stop Controlled)										
Eastbound Left-Turn from Kehrs Mill	A (8.1)	2 (lt)	A (8.1)	2 (lt)	A (8.2)	3 (lt)	A (8.2)	2 (lt)	A (8.4)	3 (lt)
Westbound Left-Turn from Kehrs Mill	A (8.1)	1 (lt)	A (8.1)	1 (lt)	A (8.3)	1 (lt)	A (8.2)	1 (lt)	A (8.4)	1 (lt)
Northbound Westpar Drive	B (13.8)	17 (lt/th/rt)	B (13.8)	17 (lt/th/rt)	B (15.0)	19 (lt/th/rt)	B (14.3)	17 (lt/th/rt)	B (15.7)	20 (lt/th/rt)
Southbound Stonebriar Ridge Drive	B (11.4)	7 (th/rt)	B (11.4)	7 (th/rt)	B (12.1)	8 (th/rt)	B (11.8)	7 (th/rt)	B (12.5)	9 (th/rt)

X (XX.X) - Level of Service (Vehicular delay in seconds per vehicle) [1] Signal timings optimized to accommodate school traffic shift [2] Signal timings optimized to accommodate school and site traffic

95th % queue notes: m = 95th % queues may not be experienced due to upstream signal metering, # = 95th % queue exceeds capacity, (lt) = 95th % queue experienced in left-turn lane, (th) = 95th % queue experienced in through lane, (rt) = 95th % queue experienced in right-turn lane

Table 6 – PM Peak Hour Operating Conditions

Intersection/Movement	*PM Peak Hour (5:00 – 6:00 PM)*									
	Base Conditions		*2010 No Build [1]*		*2030 No-Build Condition [1]*		*2010 Build Condition [2]*		*2030 Build Condition [2]*	
	LOS (Delay)	*95Th Queues*	*LOS (Delay)*	*95Th Queues*	*LOS (Delay)*	*95Th Queues*	*LOS (Delay)*	*95Th Queues*	*LOS (Delay)*	*95Th Queues*
Clarkson Road at Country Ridge Drive/Marquette High School (signalized)										
Eastbound Marquette HS Exit	D (37.9)	161 (th/rt)	C (26.7)	91 (lt)	C (26.7)	91 (lt)	C (27.6)	92 (lt)	C (28.0)	92 (lt)
Westbound Country Ridge	E (71.3)	101 (lt)	E (63.7)	98 (lt)	E (63.7)	98 (lt)	E (64.9)	99 (lt)	E (64.9)	99 (lt)
Northbound Clarkson	A (7.8)	119 (th/rt)	A (5.4)	114 (th/rt)	A (9.4)	m203 (th/rt)	A (6.1)	m107 (th/rt)	B (11.2)	m113 (th/rt)
Southbound Clarkson	D (39.9)	#1275 (th)	C (31.5)	#1299 (th)	E (79.7)	#1663 (th)	C (32.1)	#1303 (th)	F (81.5)	#1667 (th)
Overall Intersection	C (28.2)		C (22.2)		D (50.5)		C (22.8)		D (52.2)	
Clarkson Road at Kehrs Mill Road (signalized)										
Eastbound Kehrs Mill	D (40.9)	186 (th)	D (46.9)	216 (th)	D (51.1)	274 (rt)	D (54.9)	272 (th)	E (59.6)	330 (th)
Westbound Kehrs Mill	C (31.4)	134 (th)	C (29.7)	151 (th)	C (32.2)	174 (th)	C (33.5)	173 (th)	D (35.7)	197 (th)
Northbound Clarkson	D (37.8)	667 (th)	D (43.2)	711 (th)	E (59.7)	915 (th)	D (54.9)	746 (th)	F (98.1)	#947 (th)
Southbound Clarkson	C (29.4)	m1062(th/rt)	C (23.0)	m1117(th)	E (78.9)	m#1120(th)	C (33.6)	m1047(th)	F (99.6)	m1056 (th)
Overall Intersection	C (33.2)		C (32.4)		E (66.1)		D (42.4)		F (88.7)	
Clarkson Road at National City Bank Driveway (Side-Street Stop Controlled)										
Northbound Left-Turn from Clarkson	D (27.4)	2 (lt)	D (27.7)	2 (lt)	F (58.8)	4 (lt)	D (28.6)	2 (lt)	F (57.4)	4 (lt)
Eastbound National City Exit	D (27.6)	4 (lt/th/rt)	D (27.8)	4 (lt/th/rt)	F (70.5)	10 (lt/th/rt)	D (28.9)	4 (lt/th/rt)	F (70.0)	10 (lt/th/rt)
Clarkson Road at Proposed Schnucks right-in/right-out Driveway (Side-Street Stop Controlled)										
Westbound Schnucks Exit							C (17.4)	15 (rt)	C (20.7)	19 (rt)
Kehrs Mill Road at Picardy Hill Drive/Proposed Schnucks Driveway (Side-Street Stop Controlled)										
Eastbound Left-Turn from Kehrs Mill	A (8.2)	1 (lt)	A (8.2)	1 (lt)	A (8.4)	1 (lt)	A (8.1)	1 (lt)	A (8.3)	1 (lt)
Westbound Left-Turn from Kehrs Mill							A (9.2)	4 (lt)	A (9.6)	5 (lt)
Northbound Schnucks Exit							C (19.2)	49 lt/th/rt)	C (22.6)	59 lt/th/rt)
Southbound Picardy Hill Drive	B (11.9)	3 (lt/rt)	B (11.9)	3 (lt/rt)	B (12.7)	4 (lt/rt)	B (13.7)	4 lt/th/rt)	B (15.0)	5 (lt/rt)
Kehrs Mill Road at Stonebriar Ridge Drive/Westpar Drive (Side-Street Stop Controlled)										
Eastbound Left-Turn from Kehrs Mill	A (8.1)	4 (lt)	A (8.1)	4 (lt)	A (8.3)	4 (lt)	A (8.2)	4 (lt)	A (8.4)	4 (lt)
Westbound Left-Turn from Kehrs Mill	A (8.5)	2 (lt)	A (8.5)	2 (lt)	A (8.8)	2 (lt)	A (8.6)	2 (lt)	A (9.0)	2 (lt)
Northbound Westpar Drive	C (15.4)	12 (lt/th/rt)	C (15.3)	12 (lt/th/rt)	C (17.1)	14 (lt/th/rt)	C (16.2)	13 (lt/th/rt)	C (18.1)	15 (lt/th/rt)
Southbound Stonebriar Ridge Drive	B (11.4)	7 (th/rt)	B (11.4)	7 (th/rt)	B (12.2)	7 (th/rt)	B (11.8)	7 (th/rt)	B (12.6)	8 (th/rt)

X (XX.X) - Level of Service (Vehicular delay in seconds per vehicle) [1] Signal timings optimized to accommodate school traffic shift [2] Signal timings optimized to accommodate school and site traffic

95th % queue notes: m = 95th % queues may not be experienced due to upstream signal metering, # = 95th % queue exceeds capacity, (lt) = 95th % queue experienced in left-turn lane, (th) = 95th % queue experienced in through lane, (rt) = 95th % queue experienced in right-turn lane

Table 7 – Saturday Peak Hour Operating Conditions

Intersection/Movement	*Saturday Peak Hour (12:00 – 1:00 PM)*									
	Base Conditions		*2010 No Build* [1]		*2030 No-Build Condition* [1]		*2010 Build Condition* [2]		*2030 Build Condition* [2]	
	LOS (Delay)	*95Th Queues*	*LOS (Delay)*	*95Th Queues*	*LOS (Delay)*	*95Th Queues*	*LOS (Delay)*	*95Th Queues*	*LOS (Delay)*	*95Th Queues*
Clarkson Road at Country Ridge Drive/Marquette High School (signalized)										
Eastbound Marquette HS Exit	C (20.6)	16 (lt)	C (24.8)	16 (lt)	C (24.8)	16 (lt)	C (28.5)	18 (lt)	C (28.5)	18 (lt)
Westbound Country Ridge	D (35.5)	44 (lt)	D (35.5)	44 (lt)	D (35.5)	44 (lt)	D (42.9)	50 (lt)	D (42.9)	50 (lt)
Northbound Clarkson	A (6.5)	#636 (th/rt)	A (6.4)	#637 (th/rt)	B (10.5)	#670 (th/rt)	A (6.0)	m143 (th/rt)	A (9.4)	m152 (th/rt)
Southbound Clarkson	A (7.4)	496 (th)	A (7.3)	491 (th)	A (9.0)	719 (th)	A (8.0)	511 (th)	A (9.8)	722 (th)
Overall Intersection	A (7.5)		A (7.4)		B (10.2)		A (7.7)		B (10.2)	
Clarkson Road at Kehrs Mill Road (signalized)										
Eastbound Kehrs Mill	C (28.6)	98 (th)	C (29.9)	112 (th)	C (34.9)	136 (th)	D (39.7)	139 (th)	D (50.5)	185 (th)
Westbound Kehrs Mill	C (29.0)	160 (rt)	C (28.7)	158 (rt)	C (33.1)	206 (rt)	C (28.4)	144 (rt)	C (33.6)	176 (rt)
Northbound Clarkson	C (29.3)	#545 (th)	C (32.7)	#536 (th)	E (63.0)	#687 (th)	D (43.2)	#642 (th)	F (82.3)	#788 (th)
Southbound Clarkson	C (21.5)	273 (lt)	C (21.6)	267 (lt)	C (29.0)	552 (th)	C (26.0)	371 (lt)	C (27.2)	414 (lt)
Overall Intersection	C (26.0)		C (27.5)		D (43.3)		C (34.1)		D (55.0)	
Clarkson Road at National City Bank Driveway (Side-Street Stop Controlled)										
Northbound Left-Turn from Clarkson	B (12.4)	1 (lt)	B (12.3)	1 (lt)	B (14.2)	1 (lt)	B (12.5)	1 (lt)	B (14.7)	1 (lt)
Eastbound National City Exit	C (19.6)	6 (lt/th/rt)	C (19.4)	6 (lt/th/rt)	C (23.8)	8 (lt/th/rt)	C (19.9)	6 (lt/th/rt)	C (25.0)	8 (lt/th/rt)
Clarkson Road at Proposed Schnucks right-in/right-out Driveway (Side-Street Stop Controlled)										
Westbound Schnucks Exit							C (17.4)	14 (rt)	C (20.6)	17 (rt)
Kehrs Mill Road at Picardy Hill Drive/Proposed Schnucks Driveway (Side-Street Stop Controlled)										
Eastbound Left-Turn from Kehrs Mill	A (8.5)	1 (lt)	A (8.5)	1 (lt)	A (8.8)	1 (lt)	A (8.5)	1 (lt)	A (8.8)	1 (lt)
Westbound Left-Turn from Kehrs Mill							A (8.8)	3 (lt)	A (9.1)	3 (lt)
Northbound Schnucks Exit							C (18.3)	38 lt/th/rt)	C (21.3)	46 lt/th/rt)
Southbound Picardy Hill Drive	B (12.4)	4 (lt/rt)	B (12.4)	4 (lt/rt)	B (13.3)	4 (lt/rt)	B (13.3)	4 (lt/rt)	B (14.5)	5 (lt/rt)
Kehrs Mill Road at Stonebriar Ridge Drive/Westpar Drive (Side-Street Stop Controlled)										
Eastbound Left-Turn from Kehrs Mill	A (8.5)	3 (lt)	A (8.5)	3 (lt)	A (8.7)	3 (lt)	A (8.6)	3 (lt)	A (8.9)	3 (lt)
Westbound Left-Turn from Kehrs Mill	A (8.3)	1 (lt)	A (8.3)	1 (lt)	A (8.5)	1 (lt)	A (8.4)	1 (lt)	A (8.7)	1 (lt)
Northbound Westpar Drive	B (14.7)	11 (lt/th/rt)	B (14.7)	11 (lt/th/rt)	C (16.2)	12 (lt/th/rt)	B (15.3)	11 (lt/th/rt)	C (17.0)	13 (lt/th/rt)
Southbound Stonebriar Ridge Drive	B (12.3)	5 (th/rt)	B (12.3)	5 (th/rt)	C (13.2)	6 (th/rt)	B (12.7)	6 (th/rt)	C (13.7)	6 (th/rt)

X (XX.X) - Level of Service (Vehicular delay in seconds per vehicle) [1] Signal timings optimized to accommodate school traffic shift [2] Signal timings optimized to accommodate school and site traffic

95th % queue notes: m = 95th % queues may not be experienced due to upstream signal metering, # = 95th % queue exceeds capacity, (lt) = 95th % queue experienced in left-turn lane, (th) = 95th % queue experienced in through lane, (rt) = 95th % queue experienced in right-turn lane

- The northbound left-turn vehicular queues along Clarkson Road at the entrance to Marquette High School routinely extend back towards Kehrs Mill during the morning peak hour when arrivals at the school are at their peak. However, these queues are generally short in duration. Occasionally, arrivals in advance of the school's dismissal and/or evening activities can also create lengthy northbound left-turn at the Marquette High School entrance.

- The northbound approach of Clarkson Road at Kehrs Mill Road, specifically the through and left-turn movements, operates at a poor level of service during the morning peak hour. This is a direct result of the heavy northbound through volume (2,025 vph), which is approaching the capacity of the two available lanes. The northbound left-turn volumes are relatively light during each peak hour and therefore a minimal amount of the signal's green time is allocated to that movement. Consequently, the northbound left-turn movement operates poorly during the a.m., school and p.m. peak hours. Due to safety concerns, MoDOT has indicated that modifying the north-south left-turns phase from protected-only to a protected-plus-permitted left-turn phase was not feasible.

- The southbound left-turn movement from Clarkson Road onto Kehrs Mill Road operates at less than desirable levels of service during the school dismissal and p.m. peak hours and was routinely observed to spill out of the dedicated turn bay and into the two-way left-turn lane. In fact, a peak queue length of 23 vehicles was observed during the data collection efforts (p.m. peak hour). The southbound left-turn volume is relatively heavy throughout the day, with as many as 300 vph during the p.m. peak hour and 250 vph during the Saturday midday peak hour.

- The westbound approach of Kehrs Mill Road at the signalized intersection with Clarkson Road operates poorly during the morning peak hour. Specifically, the demand for the westbound right-turn is significant during the a.m. peak due to the influence of both commuter traffic and those destined to Marquette High School[2]. Furthermore, the east-west through movements on Kehrs Mill Road receive a minimal amount of the signal's green time, despite the relatively long cycle length (130 seconds).

It should be noted that all of the unsignalized intersections (Stonebriar Ridge Drive/Westpar Drive, Picardy Hill Drive, and National City Bank Drive) operate at acceptable levels of service during each of the peak hours analyzed.

[2] It should be noted that Synchro 7 overestimated the existing queues compared to field observations. The software estimates a 95th percentile queue length of 635 feet (25 to 32 vehicles) while field observations made during the data collection indicate a 95th percentile queue length of only 18 vehicles (360 to 450 feet, assuming a typical 20 to 25 foot per vehicle).

No-Build Traffic Conditions

Year 2010 No-Build Conditions were also analyzed. As the reader may recall, the traffic forecasts for the Year 2010 No-Build accounted for the anticipated shifts in traffic due to the provision of secondary access to Marquette High School via Kehrs Mill Road to the west of Clarkson Road. The analysis quickly revealed the need to optimize the signal timing at the signalized intersections along Clarkson Road in order to accommodate the anticipated shifts in traffic destined to and from Marquette High School. However, despite the modifications in the signal's timing, traffic progression along Clarkson Road was maintained and the "greenband" for the predominant direction of traffic (time of day dependent) remained relatively constant (no more than a few seconds deviation).

In particular, the following signal timing modifications were implemented:

- The northbound left-turn split at Kehrs Mill Road was increased during the a.m., school dismissal and p.m. peak hours;
- The northbound left-turn split was decreased at Country Ridge Drive during the a.m. peak hour;
- The east and west splits at Country Ridge Drive were increased during the a.m., school dismissal and p.m. peak hours; and
- The offsets were changed during the a.m., school dismissal and p.m. peak hours.

In general, the northbound left-turns at Marquette High School are expected to be reduced due to the provision of the new drive on Kehrs Mill Road, which in turn reduces the delays and vehicular queues at the signal at Country Ridge Drive/Marquette High School. However, the diversion of the school's traffic did result in the need to allocate additional time to the northbound left-turn at Kehrs Mill due to the increased volume. In general, the modifications to the signal timing resulted in minor decreases in vehicular delay thereby providing improved traffic operations.

Year 2030 No-Build Conditions were also evaluated in an effort to assist MoDOT and STLCDHT with long term planning. Given the more than 16% increase in traffic that is anticipated over the next twenty years, it is a foregone conclusion that conditions along an already congested Clarkson Road would worsen. In particular, the analysis of the Year 2030 No-Build scenario revealed:

- Northbound Clarkson Road at Country Ridge Drive is anticipated to degrade to a LOS F during the morning peak hour and similarly, southbound Clarkson Road at Country Ridge Drive would degrade to a LOS E during the p.m. peak hour.
- At the intersection with Kehrs Mill Road, southbound Clarkson is anticipated to degrade to a LOS E during the a.m. peak, northbound and southbound Clarkson to LOS E during the p.m. peak and northbound Clarkson Road degrades to LOS E during the Saturday midday peak.

- The eastbound approach exiting National City Bank Drive onto Clarkson Road is expected to operate at less than desirable levels due to the increase in background traffic along Clarkson Road during the school dismissal and p.m. peak hours. The northbound left-turn into National City Bank is expected to operate poorly during the p.m. peak hour due to a lack of adequate gaps in the traffic flow. Considering the bank driveway generates a minimal amount of traffic it can be reasoned that nearly all unsignalized intersections along Clarkson Road would operate poorly due to the extremely heavy mainline traffic volumes, especially the left-turns.

Build Traffic Conditions

Year 2010 Build Conditions aggregated the anticipated traffic attributable to the proposed Schnuck's grocery store with the Year 2010 No-Build traffic volumes, which accounts for the shifts in traffic due to the secondary access to Marquette High School. The forecasted volumes were analyzed using the same methodology applied to the No-Build scenarios in an attempt to quantify the impacts associated with the proposed development.

As previously mentioned, a dedicated northbound right-turn lane (deceleration lane) would be justified on Clarkson Road in advance of the proposed right-turn only drive. In addition, a separate eastbound right-turn lane (deceleration lane) would be warranted in advance of the proposed full access driveway on Kehrs Mill Road. Therefore, both of these auxiliary lanes were included in the analysis of the Build Conditions.

Furthermore, field observations revealed that numerous vehicles traveling north on Clarkson Road destined to the east on Kehrs Mill Road would utilize the shoulder as an extension of the northbound right turn lane as a means of decelerating in advance of their turn as well as bypassing the lengthy northbound queues waiting to travel through the intersection, particularly during the morning peak hour. The existing northbound right turn lane is extremely short, measuring only 75 feet in length. Therefore, it is recommended that the northbound right-turn lane be lengthened to 215 feet, exclusive of taper, so as to comply with MoDOT's guidelines and more effectively accommodate right-turning traffic. Consequently, this longer right-turn lane was also considered in the analysis of the Build Conditions.

Lastly, it is also recommended that the restriction of the access drive on Clarkson Road, which would be limited to right-turns only, be achieved via the installation of a raised median on Clarkson Road rather than a "porkchop" island within the drive itself. This has been found to be a more effective, and safe, means of limiting turning movements at a driveway and is the preference of MoDOT. This raised island would not prohibit turning movements into and out National City Bank's drive further to the north.

It was necessary to again consider minor signal timing modifications as a means of accommodating the increased traffic volumes at the intersection. As with the No-Build analysis, traffic progression along Clarkson Road was maintained and the "greenband" for the

predominant direction of traffic (time of day dependent) remained relatively constant (no more than a few seconds deviation) despite the following modifications in the coordinated signal system timing:

- All of the changes previously outlined in the Year 2010 No-Build Scenario (see page 31);
- Allocated additional time to the southbound left-turn at Kehrs Mill Road during the p.m. peak hour;
- Slight reallocation of the splits at Clarkson and Kehrs Mill Road amongst the various signal phases in an effort to more evenly distribute the delay; and
- Increased the Saturday cycle lengths to 100 seconds at Kehrs Mill Road and Country Ridge/Marquette High School (as well as at Wilson Avenue although that intersection was not explicitly included in this analysis). The coordinated signal system to the north (Baxter to Lea Oak) currently operates a 100 second cycle on a Saturday, so connectivity to the system to the north could be considered.

Assuming the above physical improvements and signal operation modifications, it was feasible to maintain operating conditions along Clarkson Road comparable to the No-Build scenario for the Year 2010. The service levels of most approaches at either signalized intersection did not change, or at a minimum degrade more than one letter grade (example: LOS C to LOS D). Therefore, it can be concluded the impact of the development's traffic could be mitigated with above recommendations.

With respect to the intersection of Clarkson and Kehrs Mill Road, as can be seen from Exhibit 6 *Site Generated Trips*, the proposed development would have the most significant impact to the southbound left-turn and the eastbound left-turn. Nearly 70 vph would be added to each of these movements during the p.m. peak, less during the other time periods. The remainder of the movements would be impacted by less than 30 vph in any given time period. Furthermore, due to the influence of pass-by and captured trips, some movements at the intersection would actual decrease as compared to the No-Build Scenario; i.e., southbound through or the northbound right. The impact at the signalized intersection with Country Ridge/Marquette High School is considerably less (less than 40 vph total at any given time) and is limited to the through movements on Clarkson Road only.

Lastly, it should be noted that all of the unsignalized intersections within the study area, including the proposed access drives serving the development, were determined to operate at acceptable service levels in the Year 2010. Therefore, no further improvements beyond the dedicated right turn lanes at each of the access drives was deemed necessary. It is suggested that consideration be given to providing separate left and right turn lanes exiting the site be provided on the drive along Kehrs Mill Road. To do so would minimize queuing into the site as motorists await a gap to turn onto Kehrs Mill Road, which would be for the convenience of Schnucks patrons rather than capacity.

Year 2030 Build Conditions were also evaluated in an effort to assist MoDOT and STLCDHT with long term planning. As previously mentioned, with more than a 16% increase in traffic over the next twenty years, it can be concluded that conditions along an already congested Clarkson Road would worsen. The resulting operating conditions were similar to those presented for the Year 2030 No-Build Conditions.

Assuming the physical improvements and signal operation modifications recommended in the 2010 Build Conditions, it is feasible to maintain operating conditions along Clarkson Road comparable to the No-Build scenario for the Year 2030. The service levels of most approaches at either signalized intersection would with not change or degrade more than one letter grade (example: LOS C to LOS D). Therefore, it can be concluded the impact of the development's traffic could be mitigated with above recommendations.

Benefits of Providing Dual Southbound Left-Turn Lanes on Clarkson Road at Kehrs Mill Road

Given the demand for the southbound left turn at the intersection of Clarkson and Kehrs Mill, even without consideration of the proposed development, the provision of dual southbound left turn lanes was considered. As previously mentioned, No-Build traffic volumes for this movement exceed 250 vph during the Saturday peak hour and 300 vph during the weekday p.m. peak hour. Once the development's traffic is included, the southbound left-turn volume would increase to nearly 390 vph during the weekday p.m. peak hour and exceed 300 vph during the Saturday peak hour.

The analyses for the years 2010 and 2030 Build Conditions were repeated assuming dual southbound left turn lanes were provided on Clarkson Road and Kehrs Mill Road. **Table 8** compares the results to those previously presented in Tables 4 thru 7. As can be seen, the provision of dual southbound left-turn lanes does not have a significant impact upon the intersection's overall level of service, which in fact does not change for any of the time periods considered in 2010 or 2030. However, a closer examination of the operations for the southbound approach, and the southbound left-turn movement in particular (shown in Table 8), does show the impact of providing the second turn lane. For example, during the morning peak hour, the introduction of a second left-turn lane reduces the average vehicular delay in 2010 for this movement by nearly 30 seconds per vehicle. By the year 2030, this reduction in delay is expected to be approaching 50 seconds per vehicle. Although the reductions in delay for the other time periods are not as much, it should be noted that in all scenarios except for the year 2010 PM peak hour, the level of service for the southbound left-turn improves one letter grade.

Table 8 – Comparison of Operating Conditions Assuming Dual Southbound Left-Turns (Clarkson Road at Kehrs Mill Road)

Intersection/Movement	*Clarkson Road at Kerhs Mill Road (signalized)*							
	2010 Build Condition [2]		*2010 Build Condition (Dual SB Left-Turns)* [2]		*2030 Build Condition* [2]		*2030 Build Condition (Dual SB Left-Turns)* [2]	
	LOS (Delay)	*95Th Queues*	*LOS (Delay)*	*95Th Queues*	*LOS (Delay)*	*95Th Queues*	*LOS (Delay)*	*95Th Queues*
Clarkson Road at Kehrs Mill Road (signalized) - Morning Peak Hour (7:15 – 8:15 AM)								
Eastbound Kehrs Mill	C (34.0)	125 (lt)	C (33.3)	135 (th)	D (36.6)	149 (th)	D (36.3)	149 (th)
Westbound Kehrs Mill	E (76.5)	#505 (rt)	E (81.9)	#516 (rt)	F (105.3)	#654 (rt)	F (118.6)	#676 (rt)
Northbound Clarkson	F (87.2)	#1204 (th)	E (78.2)	#1192 (th)	F (163.8)	#1506 (th)	F (149.0)	#1482 (th)
Southbound Clarkson	E (63.7)	568 (th)	E (60.6)	568 (th)	F (85.5)	655 (th)	F (79.3)	655 (th)
Southbound LEFT-TURN	*F (97.7)*	*250*	*E (68.3)*	*158*	*F (121.5)*	*#299*	*E (73.4)*	*180*
Overall Intersection	E (74.5)		E (70.2)		F (121.5)		F (114.9)	
Clarkson Road at Kehrs Mill Road (signalized) - School Dismissal Hour (2:45 – 3:45 AM)								
Eastbound Kehrs Mill	D (52.7)	233 (rt)	D (53.1)	236 (rt)	E (56.3)	286 (rt)	E (56.3)	286 (rt)
Westbound Kehrs Mill	C (32.3)	141 (th)	C (33.6)	139 (th)	C (33.9)	159 (th)	D (35.9)	159 (th)
Northbound Clarkson	D (37.2)	603 (th)	D (32.4)	557 (th)	D (52.4)	840 (th)	D (39.6)	840 (th)
Southbound Clarkson	C (22.6)	404 (lt)	C (20.1)	357 (th)	C (33.2)	921 (th)	C (30.7)	921 (th)
Southbound LEFT-TURN	*E (70.7)*	*404*	*D (54.9)*	*260*	*E (71.0)*	*m#368*	*D (54.8)*	*m227*
Overall Intersection	C (32.2)		C (29.7)		D (42.5)		D (37.4)	
Clarkson Road at Kehrs Mill Road (signalized) - PM Peak Hour (5:00 – 6:00 PM)								
Eastbound Kehrs Mill	D (54.9)	272 (th)	D (54.9)	272 (th)	E (59.6)	330 (th)	E (59.6)	330 (th)
Westbound Kehrs Mill	C (33.5)	173 (th)	D (35.3)	173 (th)	D (35.7)	197 (th)	D (38.1)	197 (th)
Northbound Clarkson	D (54.9)	746 (th)	D (41.9)	622 (th)	F (98.1)	#947 (th)	F (57.6)	#847 (th)
Southbound Clarkson	C (33.6)	m1047(th)	C (33.6)	m1047(th)	F (99.6)	m1056 (th)	F (97.3)	M1056 (th)
Southbound LEFT-TURN	*D (49.8)*	*m354*	*D (44.9)*	*m245*	*E (68.9)*	*m333*	*D (49.7)*	*m236*
Overall Intersection	D (42.4)		D (38.5)		F (88.7)		F (88.7)	
Clarkson Road at Kehrs Mill Road (signalized) - Saturday Peak Hour (12:00 – 1:00 PM)								
Eastbound Kehrs Mill	D (39.7)	139 (th)	D (39.6)	139 (th)	D (50.5)	185 (th)	D (45.5)	172 (th)
Westbound Kehrs Mill	C (28.4)	144 (rt)	C (29.9)	155 (rt)	C (33.6)	176 (rt)	D (35.2)	208 (rt)
Northbound Clarkson	D (43.2)	#642 (th)	D (34.1)	#558 (th)	F (82.3)	#788 (th)	E (63.3)	#752 (th)
Southbound Clarkson	C (26.0)	371 (lt)	C (22.0)	233 (lt)	C (27.2)	414 (lt)	C (23.8)	269 (lt)
Southbound LEFT-TURN	*E (71.5)*	*371*	*D (50.0)*	*#233*	*E (76.3)*	*414*	*D (52.9)*	*269*
Overall Intersection	C (34.1)		C (29.2)		D (55.0)		D (42.3)	

X (XX.X) - Level of Service (Vehicular delay in seconds per vehicle) [2] Signal timings optimized to accommodate school and site traffic

95th % queue notes: m = 95th % queues may not be experienced due to upstream signal metering, # = 95th % queue exceeds capacity, (lt) = 95th % queue experienced in left-turn lane, (th) = 95th % queue experienced in through lane,
(rt) = 95th % queue experienced in right-turn lane

This benefit was weighed against the estimated cost of providing dual southbound left turn lanes, which would be in excess of $1,000,000, not including the possible acquisition of right-of way along the east side of Clarkson Road. Furthermore, given that Kehrs Mill Road is currently only capable of receiving one left turn lane and the nature of the road is that of a primarily residential two lane roadway, there may be concern regarding the need to carry two eastbound lanes on Kehrs Mill an effective distance east of the intersection (perhaps to West Par) in order to get decent lane utilization for both turn lanes. Nevertheless, it was concluded that the long-term benefits associated with the provision of dual southbound left turn lanes appear to be outweighed by the costs.

Pedestrian Accommodations between Marquette High School & Proposed Schnucks

Pedestrian accommodations across Clarkson Road are currently provided at the signalized intersection with Country Ridge/Marquette High School. Additional accommodations (crosswalks with pedestrian signals) were contemplated at the signalized intersection with Kehrs Mill Road given the proximity of the proposed Schnucks store. However, in order to provide adequate pedestrian time across Clarkson Road, approximately 9 sec of mainline green time (7%) would need to be reallocated from mainline Clarkson Road and given to Kehrs Mill Road. The reallocation of these nine seconds of green time would have degrade operating conditions for both northbound and southbound Clarkson Road. Therefore, it was determined that the provision of a crossing of Clarkson Road at Kehrs Mill Road would not be desirable.

However, pedestrian accommodations across Kehrs Mill Road, on the east side of Clarkson Road were assumed. The provision of this crossing would allow a pedestrian from Marquette High School, oriented to the grocery store, to cross Clarkson Road at the Country Ridge signal, utilize the sidewalk along the east side of Clarkson Road and cross Kehrs Mill Road to the proposed Schnucks via the east leg of the intersection. Therefore, it is recommended that Schnucks incorporate into the site development plan pedestrian accommodations that would allow a pedestrian to access the site from the southeast corner of the intersection.

Conclusion

Crawford, Bunte, Brammeier has completed a study to evaluate the traffic impacts associated with the proposed Schnucks grocery store in Ballwin, Missouri. The development site is located in the southeast quadrant of Clarkson Road and Kehrs Mill Road. It is our understanding that a 40,900 square foot (SF) store is proposed with right-in/right-out access to Clarkson Road and full access to Kehrs Mill Road opposite Picardy Hill Drive. The focus of our analysis was the a.m., school dismissal and p.m. peak hours of a typical weekday as well as the Saturday midday peak hour during a Saturday.

Base traffic conditions were evaluated and revealed that some constraints currently exist at the intersection of Clarkson Road with Kehrs Mill Road (northbound and westbound approaches) during the a.m. peak hour as well as the eastbound and westbound approaches of Country Ridge Drive/Marquette High School during the a.m., school dismissal and p.m. peak hours of weekdays.

Year 2010 No-Build conditions, which considers traffic shifts based on a new access drive to Marquette High School along Kehrs Mill Road, were also evaluated. Even if signal optimizations are made, constraints are still expected at the intersection of Clarkson Road with Kehrs Mill Road (northbound and westbound approaches) during the a.m. peak hour, but the conditions at the Marquette High School/Country Ridge Drive intersection are expected to improve slightly.

The analysis of the Year 2010 Build conditions determined that the following improvements (as depicted in **Exhibit 11**) would be beneficial in conjunction with the development of the proposed Schnucks:

- A dedicated northbound right-turn lane (deceleration lane) on Clarkson Road in advance of the proposed right-turn only drive;

- Construct a raised median within Clarkson Road to restrict the driveway to right-turns only and still allow left-turns into and out of the exiting National City Bank driveway;

- Provision of dual southbound left-turn lanes on Clarkson Road at Kehrs Mill Road and the widening of Kehrs Mill Road to West Par Drive to provide two eastbound lanes[3];

[3] If dual southbound left-turn lanes are not provided on Clarkson Road and Kehrs Mill Road is not widened to provide two eastbound lanes, then it is recommended that a separate eastbound right-turn lane (deceleration lane) in advance of the proposed full access driveway on Kehrs Mill Road be provided.

Exhibit 11: Proposed Roadway Improvements

Traffic Impact Study
Proposed Schnucks: Clarkson Road at Kehrs Mill Road
Ballwin, Missouri

CBB Crawford, Bunte, Brammeier
Traffic and Transportation Engineers

Job # 28-09
4/9/09

- Extend the northbound right-turn lane on Clarkson Road at the Kehrs Mill Road signal;

- Modify the signal timing at the intersection of Clarkson and Kehrs Mill Road so as to increase the northbound left-turn split during the a.m., school dismissal and p.m. peak hours;

- Modify the signal timing at the intersection of Clarkson and Country Ridge Drive/Marquette High School so as to decrease the northbound left-turn split during the a.m. peak hour;

- Modify the signal timing at the intersection of Clarkson and Country Ridge Drive/Marquette High School so as to increase the east and west splits during the a.m., school dismissal and p.m. peak hours;

- Modify the offsets for the traffic signals along Clarkson Road during the a.m., school dismissal and p.m. peak hours so as to improve upon traffic progression;

- Modify the signal timing at the intersection of Clarkson and Kehrs Mill Road so as to provide additional green time to the southbound left-turn during the p.m. peak hour;

- Increase the Saturday signal cycle lengths to 100 seconds at Kehrs Mill Road and Country Ridge/Marquette High School (as well as at Wilson Avenue although that intersection was not explicitly included in this analysis). The coordinated signal system to the north (Baxter to Lea Oak) currently operates a 100 second cycle on a Saturday, so connectivity to the system to the north could be considered; and

- Provide a crosswalk and pedestrian signal on the east leg of the intersection of Clarkson and Kehrs Mill Road so as to accommodate pedestrians between Marquette High School and the proposed store.

Assuming the above physical improvements and signal operation modifications are implemented, it is feasible to maintain operating conditions along Clarkson Road comparable to the No-Build scenario for the Year 2010. The service levels of most approaches at either signalized intersection either do not change, or at a minimum degrade more than one letter grade (example: LOS C to LOS D). The provision of dual southbound left turn lanes would actually improve conditions for that movement as compared to the No-Build scenario. Therefore, it can be concluded the impact of the development's traffic could be mitigated with above recommendations.

Appendix

Trip Generation Memo
Revised Trip Generation Table & Email

Synchro 7 Outputs
- Base Conditions
- Year 2010 No-Build Conditions
- Year 2010 Build Conditions
- Year 2030 No-Build Conditions
- Year 2030 Build Conditions

Alternative Right-Turn Lane Analysis – *Right Turn Lane Warrant for a Four-Lane Roadway*
Dual Southbound left-turn lanes from Clarkson
- Figure 1 - 2010 Build Conditions
- Figure 1 - 2030 Build Conditions

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