February 6, 2020

Mr. Tim Crockett. P.E.
Crockett Engineering
1000 West Nifong Boulevard, Building 1
Columbia, MO 65203

RE: Traffic Impact Study Addendum – Proposed Gas Station
Highway WW and Elk Park Drive
Columbia, Missouri
CBB Job No. 006-20

Dear Mr. Crockett:

As requested, CBB has completed a traffic impact study pertaining to the proposed convenience store and gas station in Columbia, Missouri. The proposed development is located in the southeast quadrant of the intersection of Highway WW and Elk Park Drive. The location of the site in relation to the surrounding road system is depicted in **Figure 1**.

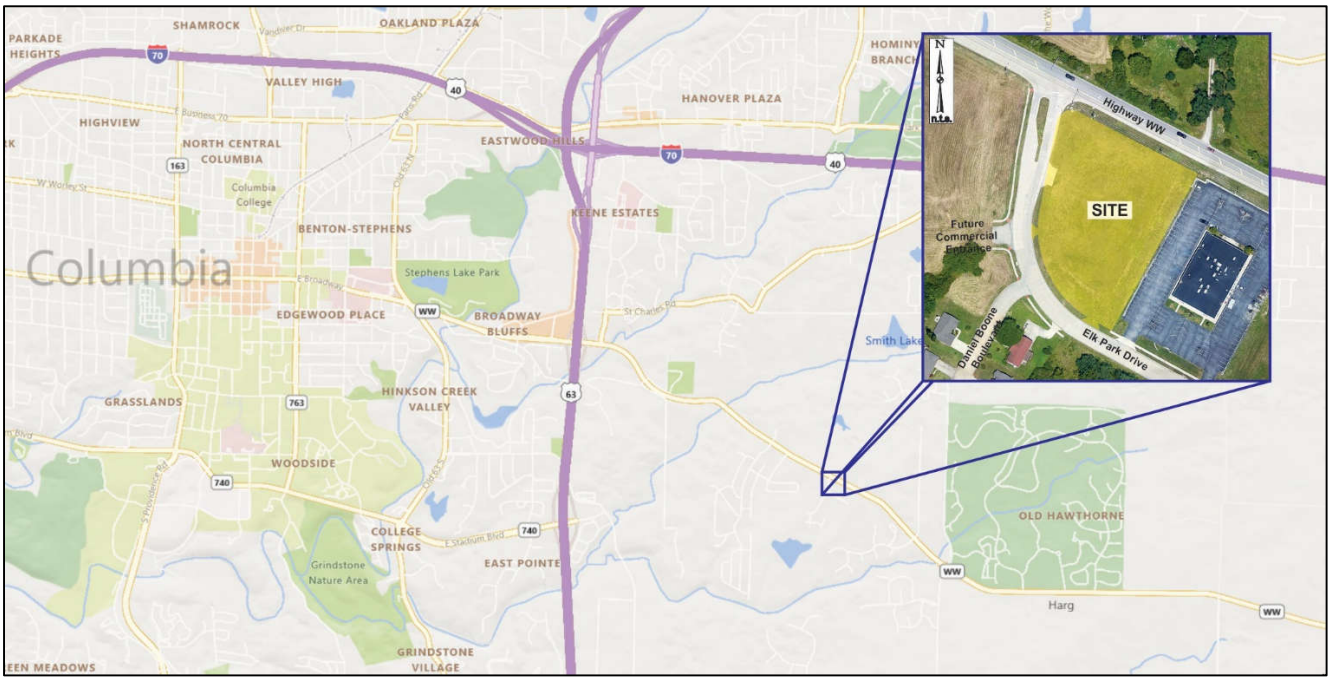

Figure 1: Project Location Map

Based on the site plan provided at the commencement of the study, the proposed development would consist of a 4,800-square-foot convenience store with 16 vehicle fueling positions (vfp) and a 900 square foot bank with ATM as an endcap on the west end of the convenience store building. Access is proposed via the existing curb cut on Elk Park Drive, as well as two new curb cuts on Elk Park Drive. A schematic of the concept plan provided is shown in **Figure 2**.

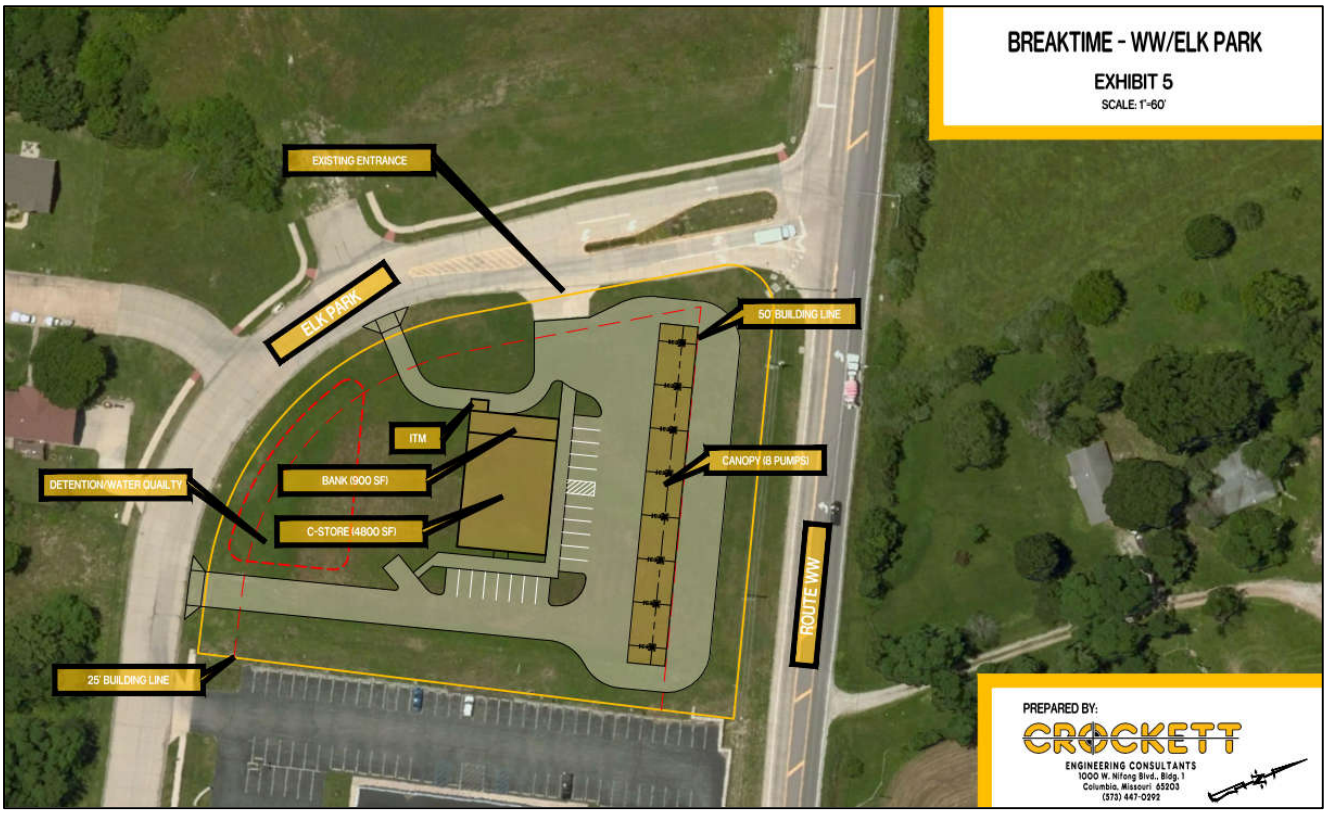

Figure 2: Proposed Site Plan (Provided by Crockett Engineering)

The purpose of this study was to determine the number of additional trips that would be generated by the proposed development, evaluate the impact on the operating conditions for the adjacent roadways, and determine the ability of motorists to safely enter and exit the site. If necessary, roadway improvements (lane additions and/or traffic control modifications) are recommended to mitigate the impact of the development and to accommodate the additional traffic. The focus of this study was the AM and PM peak hours of a typical weekday.

CBB discussed the scope of work for this traffic study with the City of Columbia at the commencement of the traffic study process. As requested by the City, the following report presents the methodology and findings relative to the 2036 Build conditions.

2036 BASE CONDITIONS

CBB previously conducted a Traffic Impact Study in January 2017 for The Brooks Phase 2 residential development subdivision located north of the Highway WW and Elk Park Drive intersection. The Brook Phase 2 development consists of approximately 390 single family homes and is currently under construction.

The 2036 Design Year scenario of The Brooks Phase 2 Study considered the build-out of the vacant tracts to the north (referred to as the North Tract), west (referred to as the El Chaparral Tract) and south (referred to as the Elk Park Residential and Commercial Tracts) of The Brooks site. For reference, these tracts are depicted in **Figure 3**.

Figure 3: Adjacent Tracts Assumed to Develop by 2036

Baseline Traffic Volumes: Based on discussions with City staff, it was decided that the 2036 Build Traffic Volumes from The Brooks Phase 2 Study, which included these future development areas along with the build-out of the approved Brooks Phase 1 development and the proposed Brooks Phase 2 development, would be used as the Base Traffic Volumes in this analysis.

Based on the prior counts, the weekday AM peak hour occurred from 7:15 to 8:15 a.m. while the weekday PM peak hour occurred from 4:45 to 5:45 p.m. The 2036 Base weekday AM and PM peak hour traffic volumes are summarized in **Figure 4**.

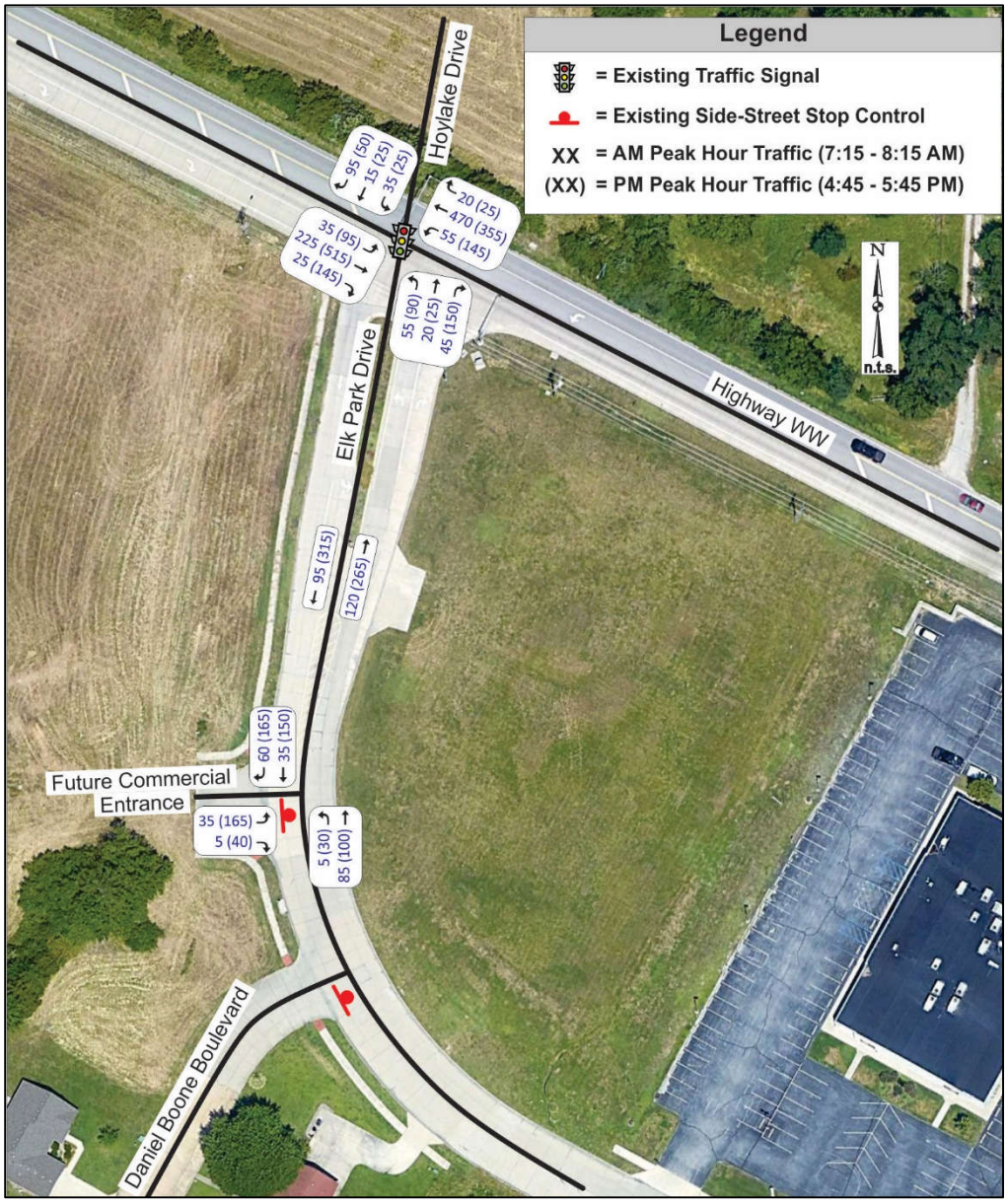

Figure 4: 2036 Base Traffic Volumes (2036 Build Traffic Volumes from Brooks Phase 2 Traffic Study)

PROPOSED SITE

While the Brooks Phase 2 Study did include potential future commercial development in the southwest quadrant of the intersection of Highway WW and Elk Park Drive, it did not specifically include future development on the proposed development site in the southeast quadrant.

Proposed Land Use: Based upon the concept plan provided by Crockett Engineering Consultants, previously shown in Figure 2, the proposed development would consist of a 4,800-square-foot convenience store with 16 vehicle fueling positions (vfp) and a 900 square foot bank with ATM as an endcap on the west end of the convenience store building.

Site Access: As shown on the concept plan, access is proposed via the existing curb cut on Elk Park Drive approximately 170 feet south of Highway WW (measured from the northbound stop bar to the center of the site drive). An exit only driveway serving the bank ATM drive-through is proposed on Elk Park Drive opposite the future commercial drive. Additionally, an access drive is proposed on the east edge of the property on Elk Park Drive.

Intersection Sight Distance – Site Drive on Elk Park Drive: 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.

The sight distance for the existing site drive on Elk Park Drive was based on the guidelines found in *A Policy on Geometric Design of Highways and Streets* published by the American Association of State Highway and Transportation Officials (AASHTO), commonly referred to as the Green Book. The Green Book's guidelines for minimum safe sight distance for entrances reflect the design speed of the major road and the gap time required for a vehicle on the minor road to enter or cross the major road. The intersection sight distance is computed according to the following formula:

*ISD = 1.47*Design Speed (mph)*Design Gap (sec)*

A design speed of 35 mph (30 mph posted + 5 mph) was used for Elk Park Drive. The minimum design gap time for a passenger car is typically assumed to be 7.5 seconds plus 0.5 seconds for each additional lane crossing. Based on these criteria, the recommended Intersection Sight Distance (ISD) for the site drive at Elk Park Drive is 390 feet for a passenger vehicle.

Figure 5 depicts the approximate sight triangle area that should be clear from any obstructions to obtain 390 feet of sight distance. Note that CBB did not measure the sight distance in the field.

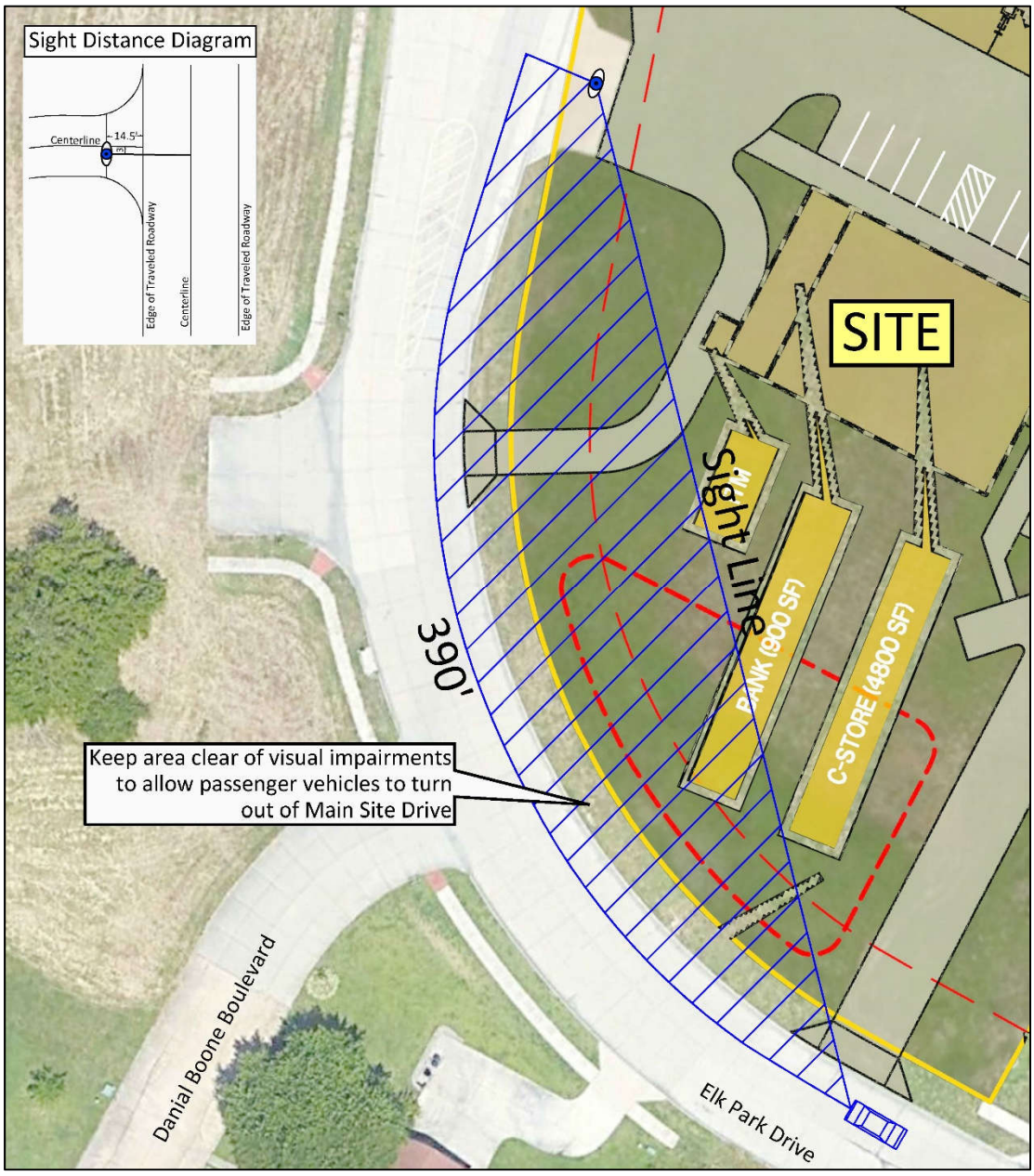

Figure 5: Site Drive and Elk Park Drive Intersection Sight Distance Sketch

Careful consideration should be given to sight distance obstructions when planning future aesthetics enhancements, such as signs, berms, fencing and landscaping, to ensure that these improvements do not obstruct the view of entering and exiting traffic at the intersection of all drives with the public roadways. It is generally recommended that all improvements higher than 3 ½ feet above the elevation of the nearest pavement edge be held back at least 20 feet from the traveled roadway and in this particular case the entire area shaded in blue in **Figure 5**.

Trip Generation: Forecasts were prepared to estimate the amount of traffic that the proposed development would generate during the weekday AM and PM peak periods. These forecasts were based upon information provided in the 10th Edition of the *Trip Generation Manual*, published by the Institute of Transportation Engineers (ITE). This manual, which is a standard resource for transportation engineers, is based on a compilation of nationwide studies documenting the characteristics of various land uses. Estimates for proposed development were based upon the following land uses:

- Land Use: 912 – Drive-In Bank
- Land Use: 960 –Super Convenience Store/Gas Station

Not all of these trips would represent *new* traffic on the adjacent roadways. Nationwide studies have found that a large percentage of convenience-oriented trips, such as gas stations and banks, would already be present on the adjacent roads and would be attracted to the development on their way to or from home, work or another destination (i.e., pass-by trips). The statistical information provided in the *Trip Generation Handbook, A Recommended Practice*, supports a pass-by percentage of 62% in the AM peak hour and 56% in the PM peak hour for convenience store/gas station. No pass-by trips were assumed for the small bank. The pass-by trips will add turning movements at the site access drives but will not increase total traffic levels on the adjacent roadways.

The resulting trip generation estimate, including both new trips and pass-by trips, for the proposed convenience store with gas station is summarized in **Table 1**. As shown in the table, the proposed development is estimated to generate 160 new trips during the weekday AM and PM peak hours with another 250 and 190 pass-by trips respectively during the AM and PM peak hours.

Table 1: Trip Estimate – Super Convenience Store with and Gas Pumps and Bank

Land Use	Size	Weekday AM Peak Hour			Weekday PM Peak Hour		
		In	Out	Total	In	Out	Total
Super Convenience Store with Gas Pumps	4,800 ft²	200	200	400	165	165	330
Bank	900 ft²	5	5	10	10	10	20
Gas Station Pass-by Trips [1,2]		125	125	250	95	95	190
Gas Station New Trips [2]		75	75	150	70	70	140
Bank New Trips [2]		5	5	10	10	10	20

[1] Pass by Trips: Gas Station = 62% AM & 56% PM
[2] Trips rounded to nearest 5

Trip Distribution*:* The new site-generated trips for the proposed development were then assigned into and out of the site based upon an estimated directional distribution. Based upon the existing travel patterns in the area and a fairly uniform distribution to the surrounding subdivision, it is anticipated that the distribution of new site-generated trips for the proposed development would be as follows:

- To/from the east on Highway WW 35%
- To/from the west on Highway WW 30%
- To/from the north on Hoylake Drive..... 20%
- To/from the south on Elk Park Drive..... 15%

The pass-by trips were assigned according to the base traffic volumes on the adjacent roadways.

The site-generated traffic volumes for the weekday AM and PM peak hour are shown in **Figure 6.**

2036 Build Traffic Volumes (2036 Base plus Site Trips): The assigned traffic volumes resulting from the trip distribution for the proposed gas station development (Figure 6) were added to the 2036 Baseline traffic volumes (Figure 4) to determine the total volumes in the forecasted scenario. The 2036 Build traffic volumes for the AM and PM peak hours are shown in **Figure 7.**

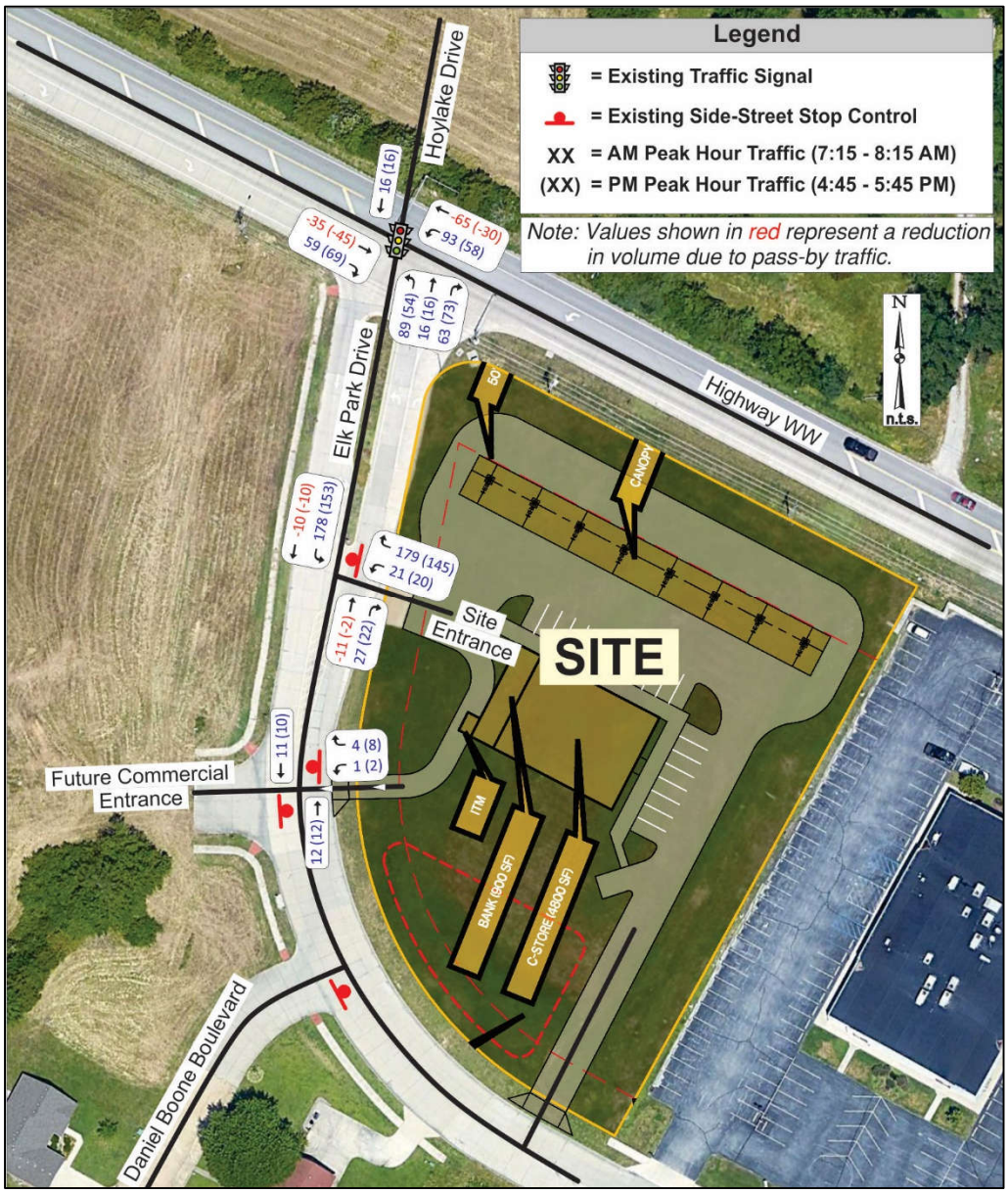

Figure 6: Site-Generated Traffic Volumes

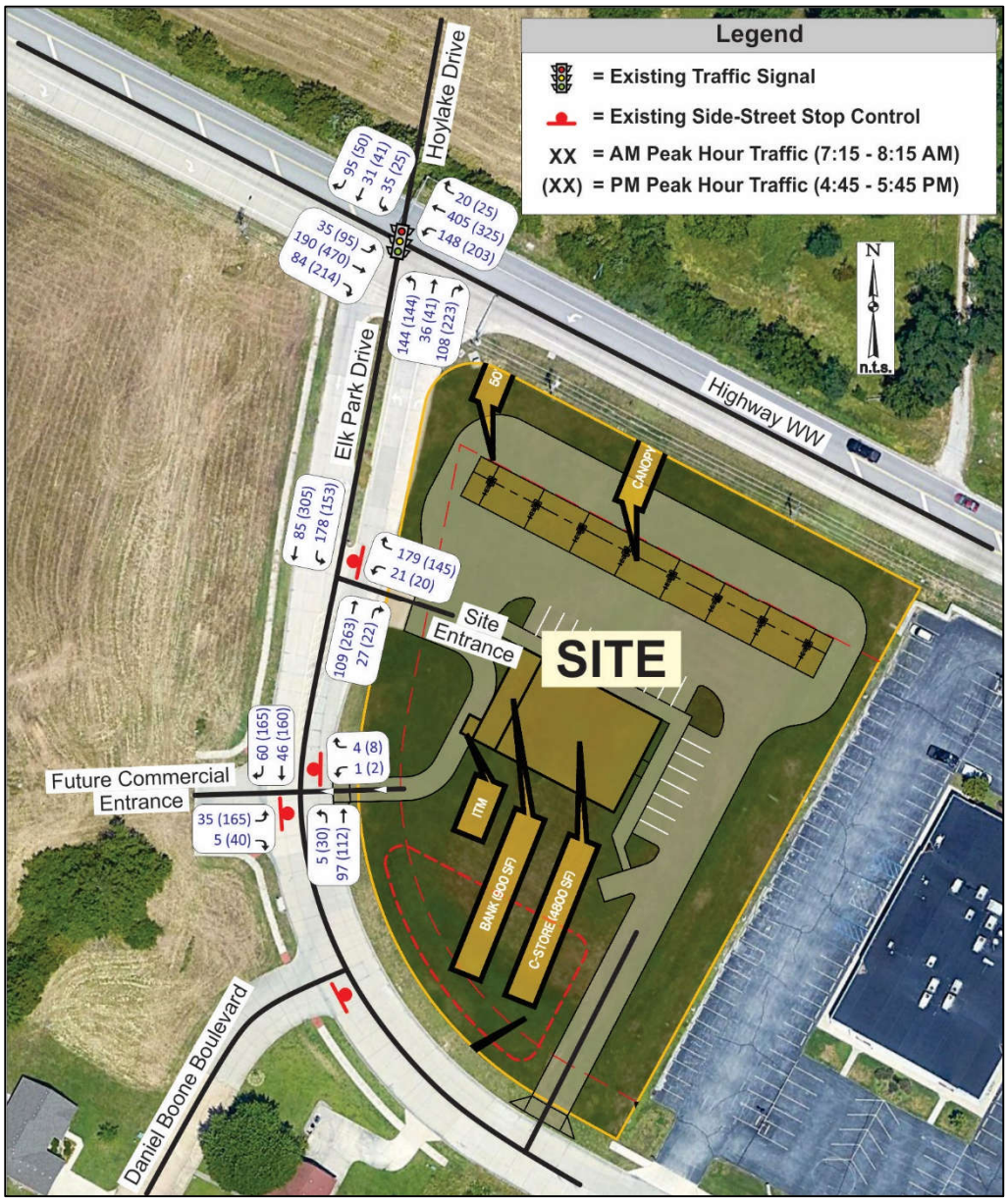

Figure 7: 2036 Build Traffic Volumes (2036 Base plus Convenience Store with Gas Pumps and Bank)

2036 TRAFFIC ANALYSIS

Study Procedures: The 2036 Base and Build operating conditions were analyzed using SYNCHRO 10, a macro-level analytical traffic flow model. SYNCHRO is based on study procedures outlined in the *Highway Capacity Manual*, published 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. However, Level D is considered acceptable for peak period conditions in urban and suburban areas.

The thresholds that define level of service at an intersection are based upon the type of control used (i.e., whether it is signalized or unsignalized) and the calculated delay. For signalized and all-way stop intersections, the average control delay per vehicle is estimated for each movement and aggregated for each approach and then the intersection as a whole. At intersections with partial (side-street) stop control, delay is calculated for the minor movements only since motorists on the main road are not required to stop.

Level of service is directly related to control delay. At signalized intersections, the level of service criteria differ from that at unsignalized intersections primarily because different transportation facilities create different driver expectations. The expectation is that a signalized intersection is designed to carry higher traffic volumes, and consequently may experience greater delay than an unsignalized intersection. **Table 2** summarizes the thresholds used in the analysis for signalized and unsignalized intersections.

Table 2: 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

2036 Operating Conditions: The study intersections were evaluated using the methodologies described above. **Table 3** summarizes the results of this analysis, which reflects the 2036 Base and 2036 Build operating conditions and average delays during the AM and PM peak hours. The same signal timings parameters (i.e., free) were used for both the Base and Build scenarios.

The 95th percentile queue for the northbound Elk Park Drive approach at Highway WW is shown in the table to assess the potential for the site driveway to be blocked during the peak hours. The 95th percentile queue for the southbound Elk Park Drive left-turn movement at the site drive is shown to assess the adequacy of the existing southbound left-turn lane storage.

Table 3: Capacity Analysis Summary – 2036 Conditions

Intersection / Approach	Weekday AM Peak Hour		Weekday PM Peak Hour	
	2036 Base	2036 Build	2036 Base	2036 Build
Highway WW and Elk Park Drive/Hoylake Drive (Traffic Signal Control)				
Eastbound Highway WW Approach	B (13.7)	B (12.4)	B (18.5)	B (17.5)
Westbound Highway WW Approach	C (20.1)	B (17.3)	B (16.9)	B (17.5)
Northbound Elk Park Drive Approach	B (14.6) 95th Queue: 45' LT	B (14.7) 95th Queue: 95' LT	B (14.8) 95th Queue: 75' LT	B (16.4) 95th Queue: 115' LT
Southbound Hoylake Drive Approach	B (12.3)	B (13.7)	B (17.9)	B (19.9)
Overall	**B (16.8)**	**B (15.1)**	**B (17.4)**	**B (17.4)**
Elk Park Drive and Site Drive (Side-Street STOP Control)				
Westbound Site Drive Approach		B (13.0)		C (16.6)
Northbound Elk Park Drive Approach		Free Flow		Free Flow
Southbound Elk Park Drive Left-Turn		A (8.4) 95th Queue: 25' LT		A (8.9) 95th Queue: 25' LT

X (XX.X) - Level of Service (Vehicular delay in seconds per vehicle)

As shown in **Table 3**, all approaches at the study intersections are forecasted to operate at desirable levels of service (i.e., LOS C or better) during the peak hours in the 2036 Base conditions. Adding the trips associated with the proposed development, the study intersections are forecasted to continue to operate at overall acceptable levels of service with only minor differences in delay.

Based on the 2036 Base conditions, the 95th percentile queue for the northbound Elk Park Drive approach at the traffic signal is estimated at 45 feet in the AM peak hour and 75 feet in the PM peak hour. The 95th percentile queue for the northbound Elk Park Drive approach is expected to increase to approximately 95 feet in the AM peak hour and 115 feet in the PM peak hour with

the proposed development. There is approximately 150 feet of storage available for the northbound Elk Park Drive approach before the existing site drive would be blocked. As such, the 2036 forecasted northbound Elk Park Drive queues are not expected to block the existing site drive during the peak hours.

Based on the 2036 Build conditions, the 95th percentile queue for the southbound Elk Park Drive left-turn lane at the site drive is estimated at 25 feet, or one vehicle, in the AM and PM peak hours. There is approximately 35 feet of storage available for the southbound Elk Park Drive left-turn lane which is technically sufficient. However, it is recommended that 50 feet of storage be provided in the southbound left-turn lane to accommodate two vehicles to minimize the potential of vehicles to block southbound Elk Park Drive.

SUMMARY

In summary, the following findings and improvements should be considered in conjunction with the proposed convenience store and gas station in Columbia, Missouri:

- Provide a total of 50 feet of storage for the southbound left-turn lane on Elk Park Drive at the site drive.

We trust that this traffic study adequately describes the forecasted traffic conditions that should be expected in the vicinity of the proposed development. If additional information is desired, please feel free to contact me at 314-449-9572 or swhite@cbbtraffic.com.

Sincerely,

Shawn Lerai White, P.E., PTOE
Associate - Senior Traffic Engineer