

June 4, 2014

Mr. Quinn Bellmer
JQB Construction & Development
6209 Upper Bridle Bend Drive
Columbia, MO 65201

RE: Rolling Hills Tract 5 Assessment
Rolling Hills Road south of Richland Road
Columbia, Missouri
CBB Job No. 41-14

Dear Mr. Bellmer:

As requested, CBB has prepared a Traffic Assessment related to a proposed residential development within Tract 5 of the Rolling Hills Road and Richland Road development area in Columbia and Boone County, Missouri. The development tract is located in the southwest quadrant of the intersection of Rolling Hills Road and Richland Road as shown in **Figure 1** below.

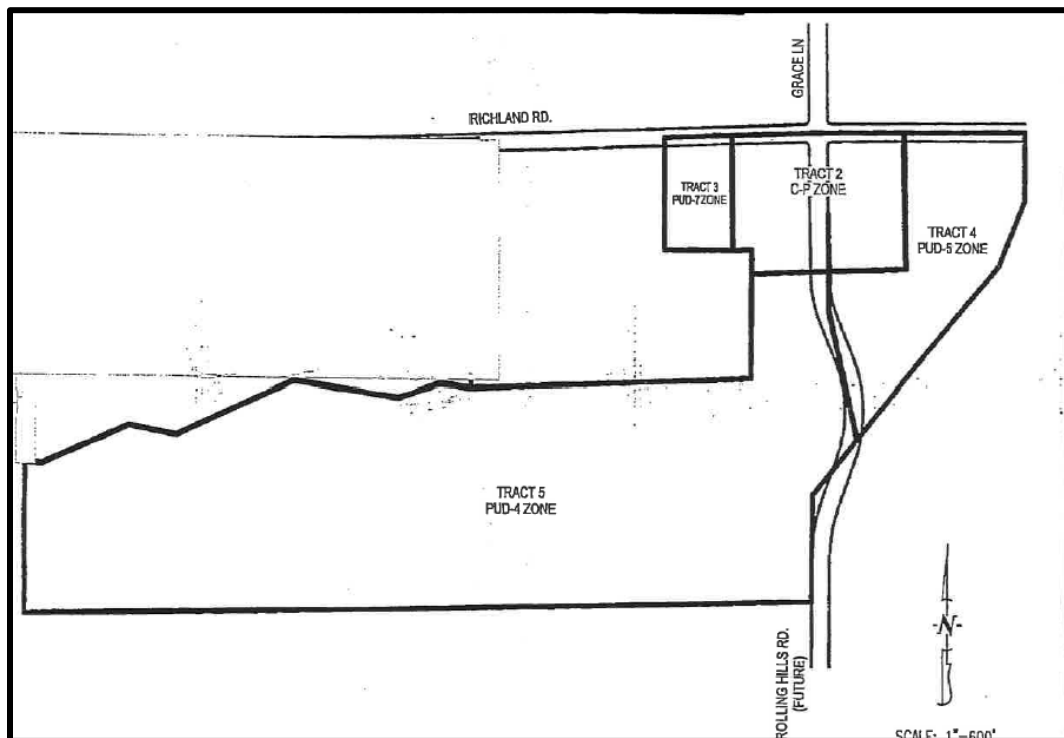


Figure 1: Rolling Hills Development Area (Tract 5)

Based on the preliminary site plan provided by Crockett Engineering, shown in **Figure 2**, the proposed residential tract would consist of approximately 80 homes on 50 acres and would be served via a new roadway off Rolling Hills Road.



Figure 2: Rolling Hills Tract 5 Development – Preliminary Plan

Although the proposed development will only occupy approximately 50 acres of Tract 5, this assessment evaluated the entire Tract 5, which is approximately 150 acres. The entire Tract 5 is currently zoned PUD-4, which would allow up to four homes/units per acre.

The primary purpose of this assessment was to look at the future roadway network in the area, the anticipated traffic volumes on the adjacent roadways, specifically the roadway through Tract 5, and to make recommendations as to the type of roadway that should serve Tract 5, as well as the necessary configuration of the new intersection on Rolling Hills Road.



EXISTING CONDITIONS

Area Roadway System: Rolling Hills Road is two-lane Minor Arterial that runs north/south along the east side of Columbia. Rolling Hills Road has a 30 foot cross section with two striped lanes and curb and gutter. Sidewalk is provided along the east side of the roadway. The posted speed on Rolling Hills Road is 35 miles per hour (mph). **Figure 3** depicts a photo of Rolling Hills Road adjacent to the site. It is our understanding, that, ultimately Rolling Hills Road will consist of four lanes, two lanes in each direction with a center grassy median.



Figure 3: Rolling Hills Road Adjacent to Site – Looking North

The intersection of Rolling Hills Road and Richland Road is currently controlled as an All-Way STOP. Separate left-turn lanes are provided for the northbound Rolling Hills Road and eastbound Richland Road approaches.

Existing Traffic Volumes: In order to establish a base condition for the study area, manual peak period traffic counts were collected in May 2014 at the intersection of Rolling Hills Road and Richland Road during the weekday AM and PM peak periods. The data was collected during normal school operations and was not collected during bad weather days. Based on the counts, the weekday AM peak hour occurred from 7:15 to 8:15 a.m. and the weekday PM peak hour occurred from 4:45 to 5:45 p.m. The existing peak hour traffic volumes are summarized in **Figure 4**.

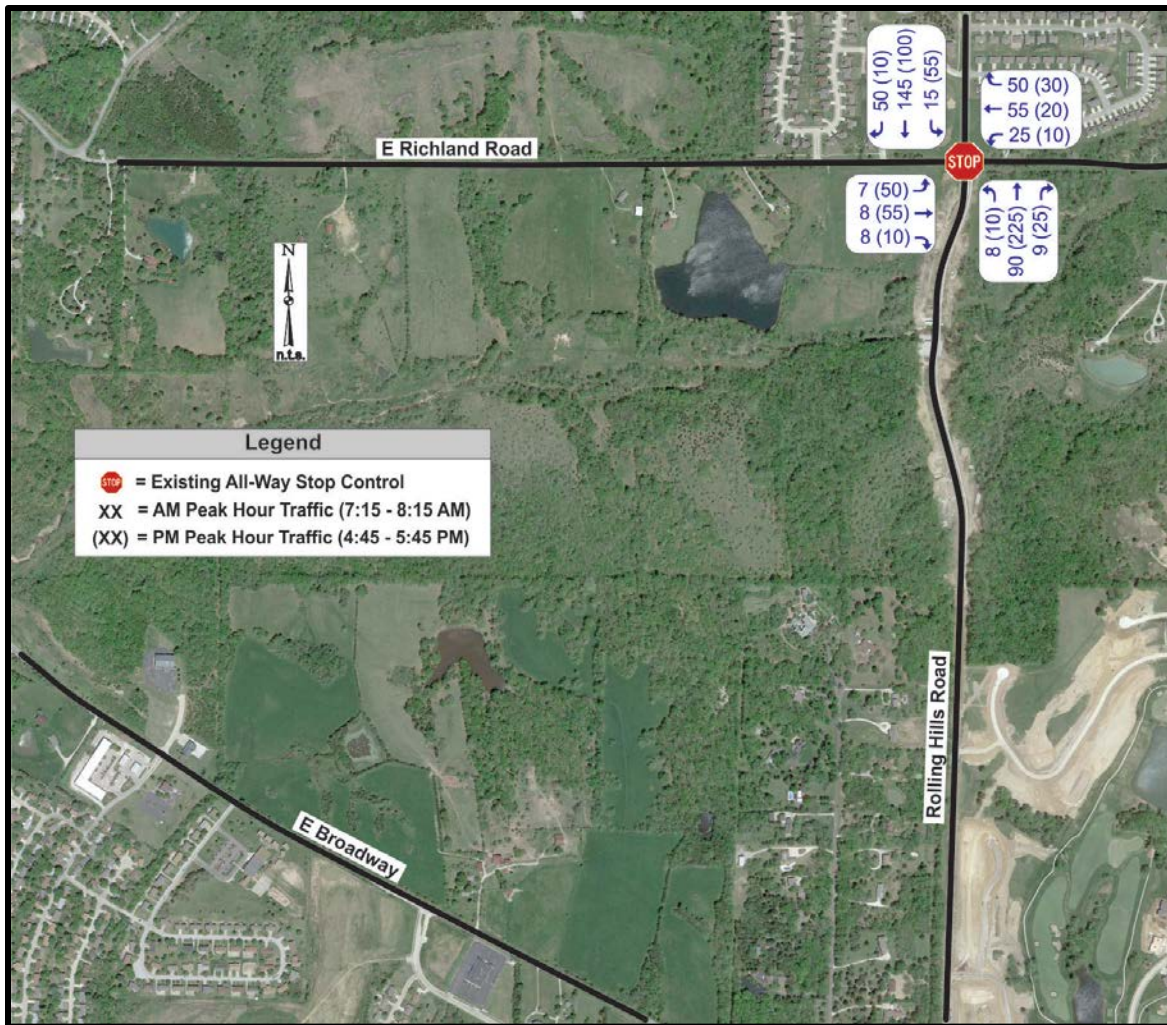


Figure 4: Existing Traffic Volumes

Existing Traffic Analysis: The operating conditions were analyzed using SYNCHRO 8, 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 1** summarizes the thresholds used in the analysis for signalized and unsignalized intersections.

Table 1: Level of Service Thresholds

<i>Level of Service (LOS)</i>	<i>Control Delay per Vehicle (sec/veh)</i>	
	<i>Signalized Intersections</i>	<i>Unsignalized Intersections</i>
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

The study intersection was evaluated using the methodologies described above. **Table 2** summarizes the results of the existing operating conditions and average delays at the intersection of Rolling Hills Road and Richland Road during the morning and evening peak hours. As shown in **Table 2**, the intersection of Rolling Hills Road and Richland Road currently operates at highly desirable levels of service during the peak periods.

Table 2: Existing Operating Conditions

<i>Traffic Movement</i>	<i>AM Peak Hour</i>	<i>PM Peak Hour</i>
Rolling Hills Road and Richland Road (All-Way STOP Control)		
Eastbound Richland Road Approach	A (7.7)	A (8.6)
Westbound Richland Road Approach	B (10.3)	A (9.4)
Northbound Rolling Hills Road Approach	A (8.3)	B (10.5)
Southbound Grace Lane Approach	B (11.4)	B (10.7)
Overall	B (10.2)	B (10.0)

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



FORECASTED CONDITIONS

Trip Generation: As mentioned previously, the proposed development will occupy approximately 50 acres of the total 150 acres within Tract 5. The proposed residential tract would consist of approximately 80 homes on 50 acres, with the remaining 100 acres zoned PUD-4 which would allow up to four homes/units per acre. Given the larger residential lots in the vicinity, it is very possible that the remainder of Tract 5 would not develop to the four units per acre density; however, in an effort to analyze the worst case scenario, it was assumed that the remaining 100 acres would develop to the maximum units allowed.

The trip generation for the proposed and future residential development area was based upon information provided in the *Trip Generation Manual*, 9th Edition, 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. Land Use 210, Single-Family Homes, was used for estimating the trip generation for Tract 5. Based on this data, the number of trips that could be generated by the maximum build-out of Tract 5 is shown in **Table 3**.

Table 3: Tract 5 Trip Generation Estimate

Land Use	Units	ADT	Weekday AM Peak Hour			Weekday PM Peak Hour		
			In	Out	Total	In	Out	Total
Proposed Residential Site – 50 acres								
Single-Family Homes	80 homes	855	15	50	65	55	30	85
Potential Future Residential – 100 acres								
Single-Family Homes	400 homes	3,760	75	215	290	230	135	365
Total Maximum Trips for Tract 5			90	265	355	285	165	450

As shown in **Table 3**, the proposed development is expected to generate a total of approximately 65 trips during the weekday AM peak hour and 85 trips during the weekday PM peak hour. The future build-out of Tract 5 could yield as many as 400 additional homes which would generate an additional 290 trips during the weekday AM peak hour and 365 trips during the weekday PM peak hour.

Trip Distribution: The development trips for the proposed 80 homes were assigned to Rolling Hills Road based upon the estimated directional distribution. Initially, the subdivision would be served solely via Rolling Hills Road, though, it is anticipated that as the adjacent tracts to the south and west of the proposed site develop, the collector road through the site would be extended to Highway WW which would then provide an additional means of access. Based

upon the existing travel patterns in the area, it is anticipated that the distribution of site-generated trips for the initial 80 homes would be as follows:

- To/from the north on Rolling Hills Road 65%
- To/from the south on Rolling Hills Road 35%

The site-generated trips for the proposed 80 home subdivision for the weekday AM and PM peak hours are shown in **Figure 5**.



Figure 5: Site-Generated Trips (Proposed 80 Homes)

It was assumed that the future development of Tract 5 would be contingent on a secondary connection to the Highway WW. Consequently, the potential trips for the full build-out Tract 5 (480 homes) were assigned to the future roadway network as follows:

- To/from the west on new Collector Road 35%
- To/from the north on Rolling Hills Road 45%
- To/from the south on Rolling Hills Road 20%

The site-generated trips for the proposed full build-out Tract 5 (480 homes) for the weekday AM and PM peak hours are shown in **Figure 6**.



Figure 6: Site-Generated Trips (Full Build-out of Tract 5 - 480 Homes)

Forecasted Traffic Volumes: The assigned traffic volumes resulting from the trip distribution for the initially planned development and the potential build-out of Tract 5 were added to the existing traffic volumes to determine the total volumes in the forecasted scenarios. The forecasted traffic volumes for the weekday AM and PM peak hours assuming only the proposed 80 homes are shown in **Figure 7**. The forecasted traffic volumes for the weekday AM and PM peak hours assuming the potential build-out of Tract 5 (480 homes) are shown in **Figure 8**.



Figure 7: Forecasted Traffic Volumes (Proposed 80 Homes)



Figure 8: Forecasted Traffic Volumes (Full Build-out of Tract 5 - 480 Homes)

Forecasted Traffic Analysis – 80 Homes: The study intersections were re-evaluated using the same methodologies as before. **Table 4** summarizes the results of the forecasted operating conditions and average delays during the morning and evening peak hours assuming the development of the proposed 80 homes.

As shown in **Table 4**, the All-Way STOP at the intersection of Rolling Hills Road and Richland Road would continue to operate at highly desirable levels of service during the peak periods. Additionally, the intersection of Rolling Hills Road and the new collector road is forecasted to operate at highly desirable levels of service during the peak periods as a side-street STOP. No auxiliary lanes are needed at the intersection of Rolling Hills Road and the new collector road.



Table 4: Forecasted Operating Conditions – 80 Homes

<i>Traffic Movement</i>	<i>AM Peak Hour</i>	<i>PM Peak Hour</i>
Rolling Hills Road and Richland Road (<i>All-Way STOP Control</i>)		
Eastbound Richland Road Approach	A (7.9)	A (9.4)
Westbound Richland Road Approach	B (10.6)	B (10.4)
Northbound Rolling Hills Road Approach	A (8.8)	B (13.2)
Southbound Grace Lane Approach	B (11.9)	B (12.7)
Overall	B (10.5)	B (12.1)
Rolling Hills Road and New Collector Road (<i>Side-Street STOP Control</i>)		
Eastbound Collector Road Approach	B (10.9)	B (11.9)
Northbound Rolling Hills Road Approach	A (<1.0)	A (<1.0)
Southbound Rolling Hills Road Approach	A (<1.0)	A (<1.0)

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

Forecasted Traffic Analysis – 480 Homes: The study intersections were re-evaluated using the same methodologies as before. **Table 5** summarizes the results of the forecasted operating conditions and average delays during the morning and evening peak hours assuming the full build out of Tract 5 with 480 homes. The analysis assumed the intersection of Rolling Hills Road and Richland Road would remain an All-Way STOP and that the new collector road would be side-street STOP controlled.

Table 5: Forecasted Operating Conditions – 480 Homes

<i>Traffic Movement</i>	<i>AM Peak Hour</i>	<i>PM Peak Hour</i>
Rolling Hills Road and Richland Road (<i>All-Way STOP Control</i>)		
Eastbound Richland Road Approach	B (11.6)	B (10.3)
Westbound Richland Road Approach	B (11.6)	B (11.8)
Northbound Rolling Hills Road Approach	B (10.9)	C (18.9)
Southbound Grace Lane Approach	B (13.5)	C (17.7)
Overall	B (11.9)	C (16.5)
Rolling Hills Road and New Collector Road (<i>Side-Street STOP Control</i>)		
Eastbound Collector Road Approach	B (14.4)	C (16.8)
Northbound Rolling Hills Road Approach	A (1.4)	A (1.9)
Southbound Rolling Hills Road Approach	A (<1.0)	A (<1.0)

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



As shown in **Table 5**, the All-Way STOP at the intersection of Rolling Hills Road and Richland Road would continue to operate at desirable levels of service during the peak periods with the full build-out of Tract 5 (480 homes). Additionally, the intersection of Rolling Hills Road and the new collector road is forecasted to operate at desirable levels of service as a side-street STOP during the peak periods with the full build-out of Tract 5.

Intersection Sight Distance: The intersection sight distance for Rolling Hills Road and the new collector road was measured in the field by Crockett Engineering based on guidelines published in *A Policy on Geometric Design of Highways and Streets* published by the American Association of State Highway and Transportation Officials (AASHTO) often referred to as the *Green Book*. The *Green Book* method incorporates the design speed of the major road and the required gap time for a minor road vehicle to enter or cross the major road to define the minimum safe distance for entrance visibility. The design speed is generally assumed to be the posted speed limit plus five mph, unless detailed speed study data is available.

A traffic gap is the time between successive vehicles along the main roadway required to allow traffic making a stop or yielding movement to enter or exit the minor road. The required gap is dependent on the acceleration characteristics of the design vehicle and the number of lanes to be crossed. According to AASHTO, the required gaps are 7.5 seconds for a passenger car, 9.5 seconds for a single-unit truck and 11.5 seconds for a combination truck. Consequently, the intersection sight distance requirement for the new collector road at Rolling Hills Road is 445 feet (assuming a 35 mph posted speed limit and 40 mph design speed, 7.5 second gap, and wet pavement condition).

The measured sight distance at the new collector road, as currently proposed, looking to the south is approximately 800 feet. The measured sight distance at the new collector road looking to the north was deemed acceptable by visual inspection.

The measured sight distance for the new collector road assuming the roadway is located closer to the southern edge of the property line is approximately 500 feet looking to the south. The sight distance looking to the north was deemed acceptable by visual inspection.

Thus, the currently proposed location for the new collector road would provide better sight distance looking to the south (800 feet versus 500 feet).

CATSO Roadway Plan: The proposed residential development was evaluated to determine if the proposed site plan provides an appropriate internal roadway network considering future developments and the City's CATSO Roadway Plan. Rolling Hills Road is designated as a Minor Arterial in the CATSO Major Roadway Plan Map (August 2010) as depicted in **Figure 9**. Additionally, a Major Collector Road is identified in the vicinity of Tract 5 that would provide access between Rolling Hills Road and Highway WW (Broadway).

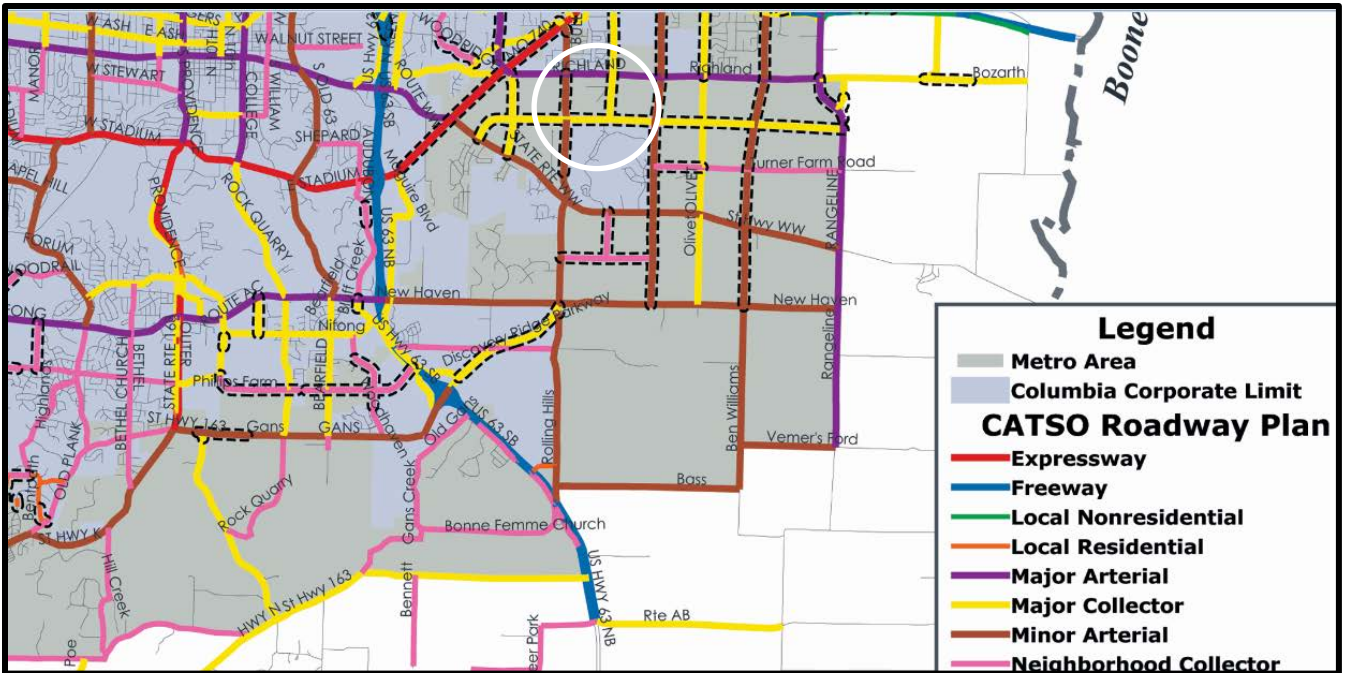
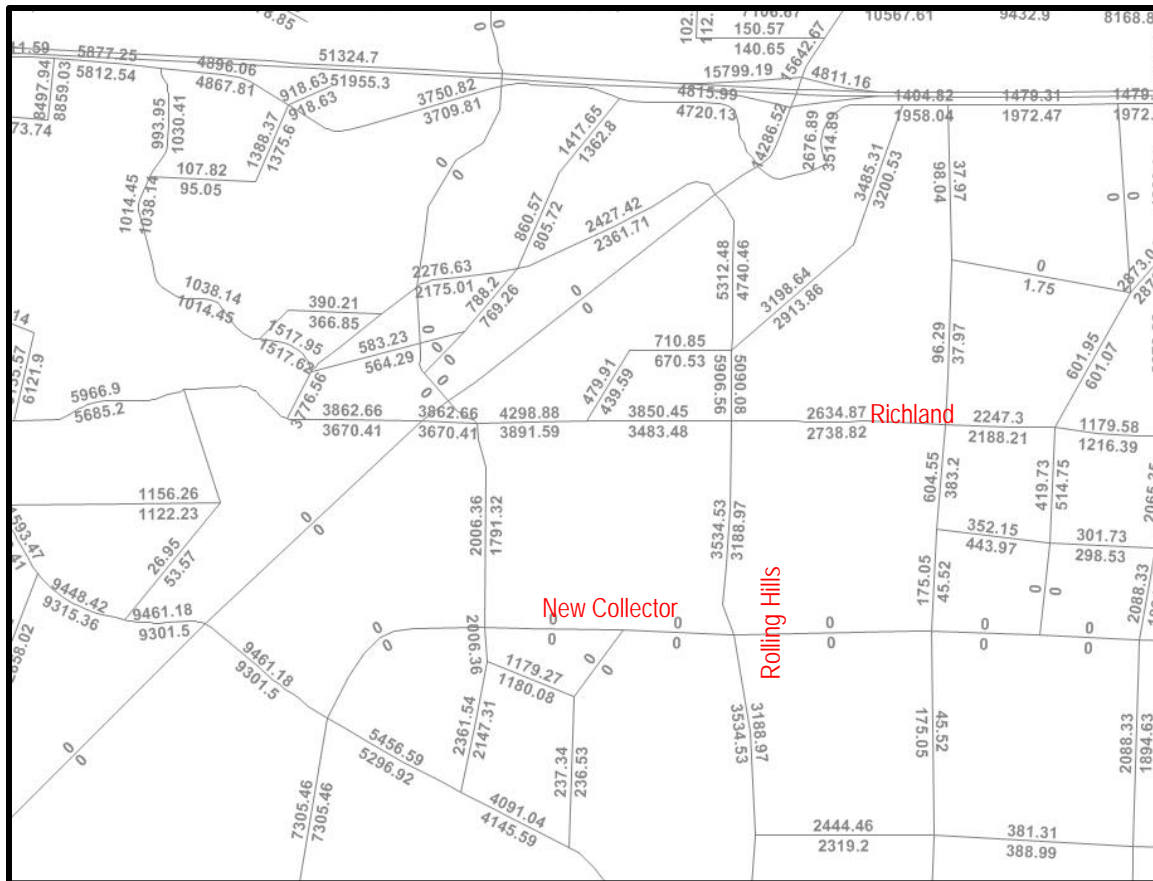
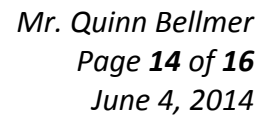


Figure 9: CATSO Major Roadway Plan Map (August 2010)

The City provided Average Daily Traffic (ADT) estimates for the roadways within the study area from the 2030 CATSO Model as depicted in **Figure 10**. As shown in **Figure 10**, the CATSO model does not currently reflect any traffic volumes on the future collector road. The City indicated that the current model is not reliable in this area and is being updated to reflect the anticipated roadway and land use changes in the area. The City further indicated that the expected volumes for a Major Collector are in the range of 3,000 to 5,000 vehicles per day.

Based on data provided in the *ITE Trip Generation Manual*, the average daily traffic generated by the full build-out of Tract 5 (480 homes) would be approximately 4,615 trips per day. Depending upon the distribution of the trips, the average ADT's along the new collector road would range from 1,500 to 3,000 trips per day. However, it is acknowledged that further development in the area would likely add to these estimates likely bringing them closer to the 3,000 to 5,000 vehicles per day referenced by the City.

The collector road through Tract 5 connecting Rolling Hills Road to Highway WW was added by the City to the Major Roadway Plan to provide a future roadway to ensure both access and circulation to support development. Along this new collector there are several large acreage tracts that would be landlocked without the provision of a new collector road. The presence of the North Fork of Grindstone Creek limits future northern connections to and from Richland Road to this area and the existing subdivisions preclude any significant southern connection to and from Highway WW. As such, this new collector road would provide a crucial connection between Rolling Hills Road and Highway WW.



As shown, it is anticipated that this collector road would curve southward and tie into Highway WW at either El Chaparral Avenue or Elk Park Drive, though it appears that a connection to El Chaparral Avenue would be preferred. While the exact alignment of this collector road is not known at this time, and depends of future development in the area, the proposed 80 home development does not preclude the City's plan of providing a collector road between Rolling Hills Road and Highway WW.

The proposed alignment of the collector road as it ties into Rolling Hills Road would allow for a future extension of the collector road further to the east, thereby creating a four-way intersection on Rolling Hills Road.

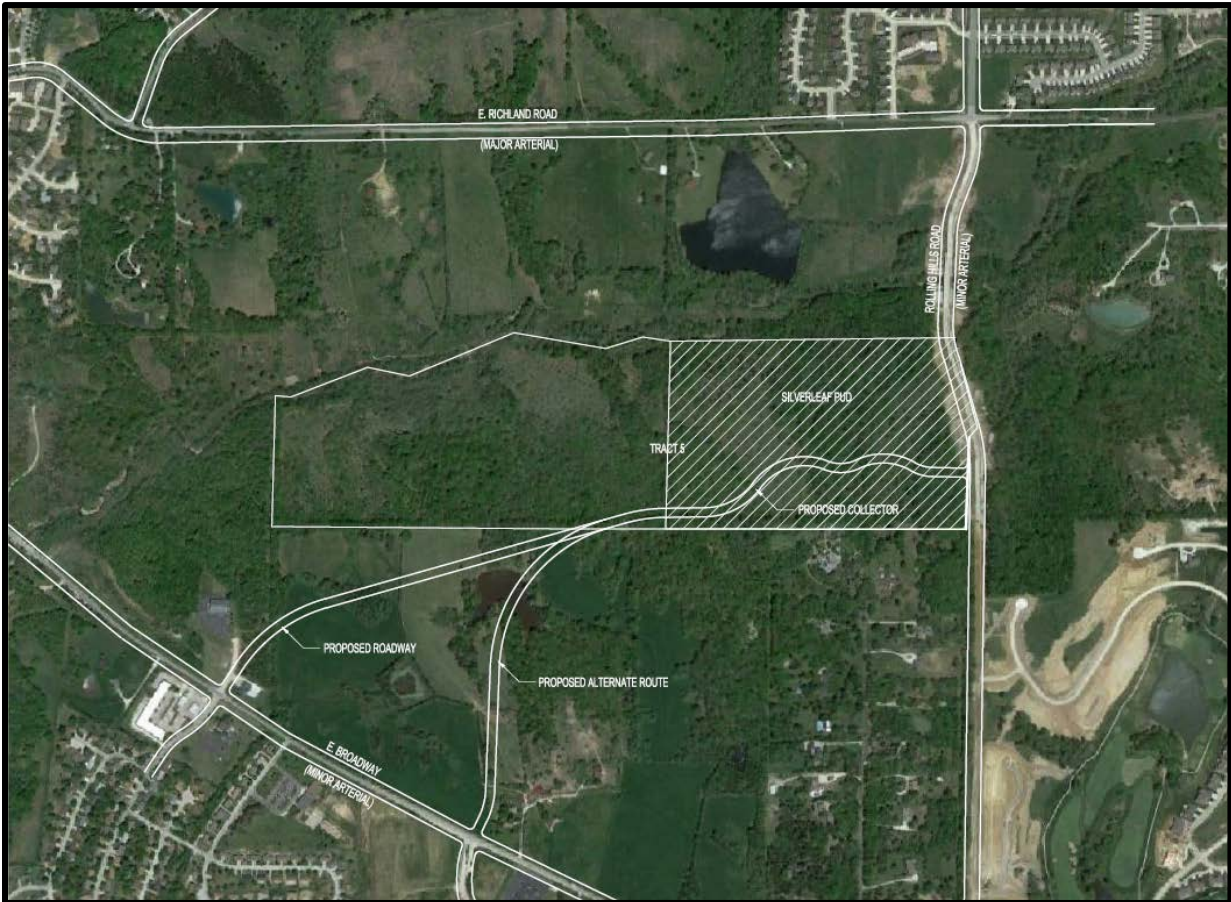


Figure 11: Potential New Collector Road Alignment – Rolling Hills Road to Highway WW

SUMMARY

The proposed development will occupy approximately 50 acres of the total 150 acres within Tract 5 of the Rolling Hills Road and Richland Road development area. Although the tract is zoned PUD-4 which would allow up to four homes/units per acre, the proposed residential tract would only consist of approximately 80 homes on 50 acres. It was assumed that the remaining 100 acres could develop to the maximum units allowed (400 homes), though given the larger residential lots in the vicinity, it is very possible that the remainder of Tract 5 would not develop to the level of density allowed.

The proposed development is expected to generate a total of approximately 65 trips during the weekday AM peak hour and 85 trips during the weekday PM peak hour. The future build-out of Tract 5 could yield as many as 400 additional homes which would generate an additional 290 trips during the weekday AM peak hour and 365 trips during the weekday PM peak hour.



As planned in the City's CATSO Major Roadway Plan Map, the roadway within the proposed subdivision, through Tract 5, would be built to the City's collector standards. Initially, the proposed 80 home subdivision would be served solely via Rolling Hills Road, though, it is anticipated that as the adjacent tracts to the south and west of the proposed site develop, the collector road through the site would be extended to Highway WW which would then provide an additional means of access.

An evaluation of the initial conditions (80 homes), as well as the full build-out of Tract 5 (480 homes), found that the intersection of Rolling Hills Road and Richland Road would continue to operate at desirable levels of service during the peak periods as an All-Way STOP. Additionally, the intersection of Rolling Hills Road and the new collector road is forecasted to operate at desirable levels of service during the peak periods with the full build-out of Tract 5 as a side street STOP. As such, no roadway improvements are necessary to accommodate the proposed development.

We trust that this assessment adequately addresses the traffic concerns associated with the proposed residential development within Tract 5 of the Rolling Hills Road and Richland Road development area in Columbia and Boone County, Missouri. Please contact me should there be any questions regarding this letter.

Sincerely,

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