

# MEMO



**To:** Chris Krueger, PE

**From:** Kelly Schaefer, PE, PTOE  
Dustin Smith, EIT

**Date:** September 3, 2022

**Subject:** Kirkwood Road Traffic Study

Lochmueller Group has completed a traffic study for assessing the impact of implementing a road diet and supporting intersection upgrades along Kirkwood Road between Adams and Bodley Avenues in Kirkwood, Missouri. Currently, this segment has two vehicle lanes in each direction. The proposed cross-section includes one vehicle lane in each direction and parking on both sides of the street, with left-turn lanes at signalized intersections. The supporting intersection upgrades would consist of hardscaped bumpouts to reinforce the cross-section at intersections, reduce crosswalk lengths, and protect parking.

The proposed configuration is similar to the effective cross-section between Argonne Drive and Adams Avenue, where parking is allowed and typically occupied in the outside lanes. These improvements would continue the cross-section experienced in the central area of Downtown Kirkwood to its northern limit of Bodley Avenue.

Downtown Kirkwood is a very lively area populated with numerous restaurants, store fronts, churches, etc. The planned improvements would provide for a more pedestrian friendly environment with additional on-street parking as the downtown area continues to develop in the future. They would also support the City's Vision Zero Action Plan that was adopted in March 2022.

The purpose of this study is to evaluate traffic related impacts and determine any necessary mitigation measures due to the proposed road diet along Kirkwood Road. It also evaluated how to transition into and out of the road diet at the termini.

## Existing Conditions

### Roadway Conditions

To identify traffic impacts associated with the revised cross-section, it was first necessary to quantify roadway, traffic, and operating conditions as they currently exist. The study area includes the following signalized intersections:

- Kirkwood Road & Essex Avenue
- Kirkwood Road & Washington Avenue
- Kirkwood Road & Adams Avenue

**Kirkwood Road**, within the study area, is a four-lane principal arterial traveling in the north-south directions throughout the Kirkwood area. It has a posted speed limit of 30 miles per hour (mph). Mainline left turns operate with protected/permissive phasing at all signals.

The cross streets of Essex and Washington Avenues are owned and operated by the City of Kirkwood, while Adams Avenue is owned and operated by St. Louis County.

### Pedestrian Accommodations

Downtown Kirkwood is populated with restaurants, store fronts, banks, churches, etc. which creates a dense pedestrian environment throughout the area. Sidewalks are provided throughout the entire downtown area and

are all compliant with Americans with Disabilities Act (ADA) regulations. Traffic signal coordination plans are timed to accommodate all pedestrian movements along the corridor.

### Operating Conditions

The existing traffic operating conditions at the critical study intersections were evaluated based upon the traffic volumes presented in **Figure 1** and **Figure 2**. These volumes are from a 2019 improvement project that upgraded the signals on Kirkwood Road and implemented new coordinated signal timing plans. The analysis was completed using Synchro 11 traffic modeling software, which is based upon the methodologies outlined in the “Highway Capacity Manual” (HCM) published by the Transportation Research Board.

Intersection performance or traffic operations are quantified by six Levels of Service (LOS), which range from LOS A (“Free Flow”) to LOS F (“Fully Saturated”). LOS C is normally used for design purposes and represents a roadway with volumes ranging from 70% to 80% of its capacity. LOS D and E are considered acceptable for peak period conditions in urban and suburban areas and would be an appropriate benchmark of acceptable traffic for the study area road system, and LOS F is not unusual for side-street stop-controlled approaches during peak period conditions, especially along major arterials.

Levels of service for intersections are determined based on the average delay experienced by motorists. Signalized intersections reflect higher delay tolerances as compared to unsignalized and roundabout locations because motorists are accustomed to and accepting of longer delays at signals. For signalized and all-way stop intersections, the average control delay per vehicle is estimated for each movement and then aggregated for each approach and the intersection as a whole. For intersections with partial (side-street) stop control, the delay is calculated for the minor movements only (side-street approaches and major road left-turns) since through traffic on the major road is not required to stop.

**Table 1** summarizes the criterion for both signalized and unsignalized intersections, as defined by the Highway Capacity Manual (HCM) 6th Edition, last updated in 2016 by the Transportation Research Board.

**TABLE 1: INTERSECTION LEVEL OF SERVICE THRESHOLDS**

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

Operating conditions at the study intersections were evaluated using Synchro 11 and are summarized in **Table 2**. The measures of effectiveness reported include LOS, delay, queue, and volume-to-capacity ratio (v/c). The delay is reported in seconds per vehicle. The queue is reported in feet as the 95th percentile queue. The v/c ratio compares vehicle demand to the capacity of an associated lane group. A v/c ratio of 1.0 represents a road segment that is at full capacity.

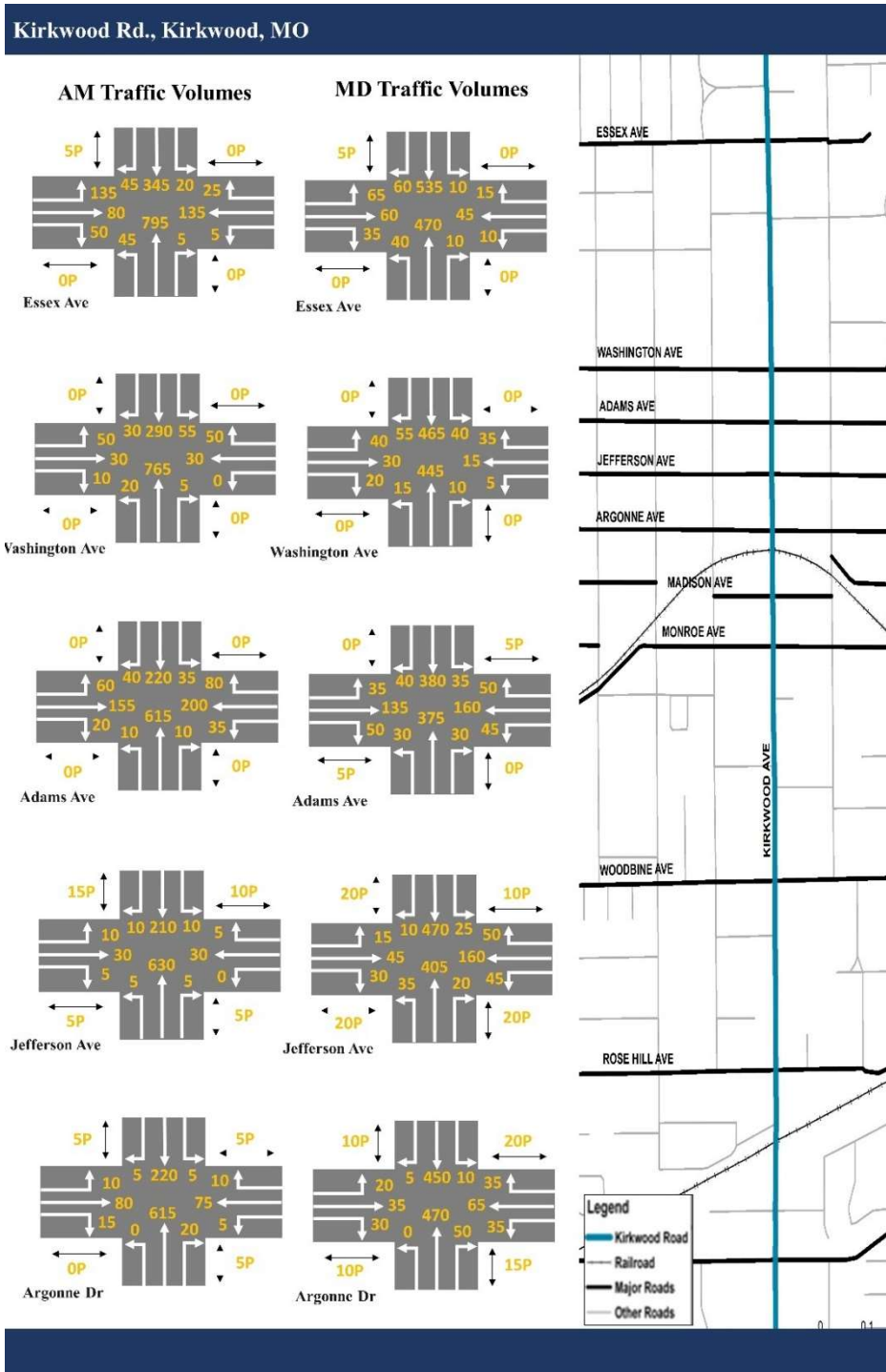


FIGURE 1. EXISTING MORNING AND MIDDAY PEAK HOUR TRAFFIC VOLUMES

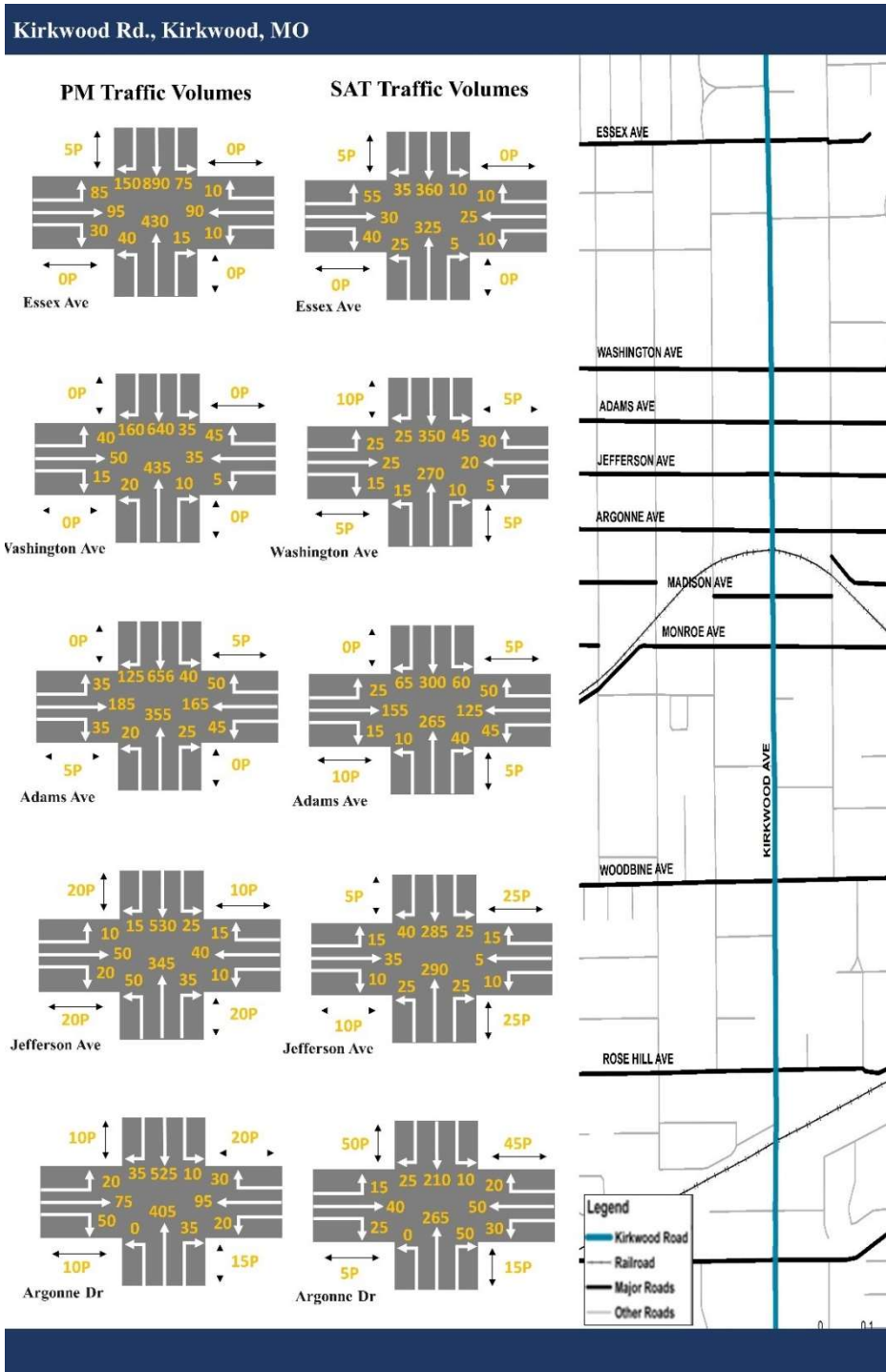


FIGURE 2. EXISTING AFTERNOON AND SATURDAY MIDDAY TRAFFIC VOLUMES

**TABLE 2: EXISTING OPERATING CONDITIONS**

Intersection & Movements	LOS (Delay, sec/vehicle) [Max Queue Length, feet] <Ratio of Volume-to-Capacity >			
	AM Peak Hour	MD Peak Hour	PM Peak Hour	WKND Peak Hour
<b>1. Kirkwood Road &amp; Essex Avenue (signalized)</b>				
<b>Overall Intersection</b>	<b>C (20.1)</b>	<b>B (15.3)</b>	<b>C (21.8)</b>	<b>B (14.4)</b>
Eastbound Approach	C (30.3) [114] <0.58>	B (15.3) [56] <0.16>	C (28.1) [111] <0.32>	B (15.5) [50] <0.15>
Westbound Approach	D (45.5) [158] <0.65>	C (23.5) [63] <0.18>	D (41.6) [123] <0.42>	C (24.8) [46] <0.14>
Northbound Approach	B (10.8) [301] <0.49>	A (8.4) [93] <0.31>	B (13.5) [161] <0.29>	A (9.5) [139] <0.22>
Southbound Approach	B (17.8) [135] <0.27>	C (20.2) [204] <0.44>	C (21.8) [367] <0.62>	B (17.3) [130] <0.27>
<b>2. Kirkwood Road &amp; Washington Avenue (signalized)</b>				
<b>Overall Intersection</b>	<b>A (8.9)</b>	<b>A (5.6)</b>	<b>A (6.6)</b>	<b>A (6.7)</b>
Eastbound Approach	D (39.6) [97] <0.42>	C (27.6) [76] <0.34>	D (40.4) [120] <0.40>	C (26.1) [63] <0.21>
Westbound Approach	B (17.1) [56] <0.24>	B (14.1) [39] <0.15>	C (22.4) [74] <0.25>	B (17.1) [40] <0.17>
Northbound Approach	A (6.1) [76] <0.43>	A (3.9) [28] <0.25>	A (3.9) [41] <0.23>	A (4.1) [21] <0.18>
Southbound Approach	A (3.9) [24] <0.17>	A (1.9) [15] <0.29>	A (2.5) [32] <0.46>	A (4.1) [26] <0.22>
<b>3. Kirkwood Road &amp; Adams Avenue (signalized)</b>				
<b>Overall Intersection</b>	<b>B (18.2)</b>	<b>B (12.6)</b>	<b>B (18.2)</b>	<b>B (13.1)</b>
Eastbound Approach	C (33.0) [158] <0.47>	C (21.0) [122] <0.32>	D (36.8) [202] <0.57>	C (29.6) [145] <0.41>
Westbound Approach	C (31.4) [205] <0.61>	C (22.7) [145] <0.38>	C (30.1) [178] <0.41>	C (21.8) [119] <0.31>
Northbound Approach	B (11.2) [125] <0.36>	A (7.4) [42] <0.29>	B (16.5) [144] <0.21>	A (6.2) [25] <0.24>
Southbound Approach	A (3.2) [18] <0.25>	A (7.8) [56] <0.50>	A (8.5) [584] <0.67>	A (5.6) [243] <0.36>

## Application to Vision Zero

The study evaluated converting the existing four-lane cross-section from two travel lanes in each direction to one travel lane in each direction and parking on each side. This conversion is commonly referred to as a road diet.

This proposal is supported by the City of Kirkwood's Vision Zero Action Plan. Adopted in March 2022, the preceding study identified this segment of Kirkwood Road in its High Injury Network (HIN). A map of the HIN is found on page 25 of the [Vision Zero Action Plan](#). Implementing a road diet is one of the three Design Strategies named in the Action Plan (page 28) to better manage speeds on City roadways.

In addition, the study found that 84% of respondents wanted walking to be made safer in the City. Reinforced by bumpouts, which bring the curb in to the edge of the travel lane, a road diet reduces the crossing distance and the amount of time pedestrians are exposed to vehicular traffic at signalized and mid-block crossings. This is particularly important on this segment of Kirkwood Road as it continues to develop with mixed uses, drawing pedestrians to/from residential and commercial needs on each side of the road.

## Concept Development

An important part of the overall road diet analysis was determining how to transition to and from the existing and proposed cross-sections. Since Kirkwood Road already has this configuration to the south of the study area, a transition is not needed, and only the northern limits were reviewed.

The study also reviewed operations at the included traffic signals to identify any additional improvements needed for them to operate safely and efficiently.

### Road Diet Transitioning at North End

To transition out of the road diet in the northbound direction, the parking lanes on Kirkwood Road would stop at Bodley Avenue and the second travel lane will open for motorists.

To transition into the road diet in the southbound direction, there are three feasible options:

1. Start the road diet at the intersection of Kirkwood Road and Essex Avenue. The southbound approach of the signalized intersection would consist of a left-turn lane, a single through lane, and a dedicated right-turn lane so that only one southbound lane continues south of Essex Avenue.
2. Maintain two southbound lanes until Bodley Avenue. Approaching the intersection, turn the outside lane into a dedicated right-turn lane at Bodley Avenue so that only one lane continues south.
3. Maintain two southbound lanes until just before Bodley Avenue. Merge traffic into a single through lane just before Bodley Avenue.

Synchro 11 was used to model Option 1. This option was deemed infeasible as the southbound through lane operates with a v/c ratio which is at capacity, and 95<sup>th</sup> percentile queue lengths of approximately 1,000 feet. This location is also beyond the extents of Downtown Kirkwood, making it potentially not preferred also.

Option 2 was also found infeasible from a context-sensitivity standpoint. East Bodley Avenue, between Kirkwood Road and North Clay Avenue, is a local roadway with residential housing. Selecting Option 2 would turn the section of Bodley Avenue between Kirkwood Road and Clay Avenue into a major cut through route and substantially increase the traffic along this segment of roadway. This option would cause significant impact to the residents and likely be opposed by the local community.

VISSIM 2021 SP9 was used to analyze Option 3, in particular operations and queuing at the merge point and at the intersection at Essex Avenue, which is approximately 500 feet away. VISSIM is a microsimulation software that accurately replicates individual vehicles and their interactions within complex traffic streams.

The main parameter impacting the merge area under study is the lane change distance, which is distance from which motorists begin to consider making a lane change in advance of a downstream turn or merge. Two distances were chosen for study, 500 feet and 1,500 feet, representing points before and after the Essex Avenue intersection.

The VISSIM microsimulation model was run for only the afternoon peak period as it is the busiest peak period pertaining to southbound traffic. **Table 3** depicts the maximum queue at both the signalized intersection of Kirkwood Road at Essex Avenue and the southbound merge point before Bodley Avenue.

**TABLE 3: VISSIM MICROSIMULATION RESULTS**

Maximum Queue (ft.)	Lane Change Distance	
	500 ft.	1500 ft.
<b>Southbound Approach at Essex Avenue</b>	485	1020
<b>Southbound at Road Diet Merge Point</b>	408	205

As shown, when the lane change distance is higher and more conservative (1,500 feet), the queues at Essex Avenue and the merge point are 1,020 feet and 205 feet, respectively. When modeled at 500 feet, these queues are 485 feet and 408 feet. In both scenarios, the queue from the merge point does not extend to the signal at Essex Avenue which would impact its operation.

Assuming actual results would be between the two scenarios analyzed and presented, then expected queues are acceptable and Option 3 is a feasible approach to implementing the lane reduction in the southbound direction.

### Right-Turn Warrant Analysis

Understanding there are heavy southbound right-turn movements before and at Adams Avenue now, a right-turn lane warrant analysis was conducted at the included signals to determine if dedicated right-turn lanes are warranted and should be included in the design.

The Missouri Department of Transportation’s (MoDOT) Engineering Policy Guidelines (EPG) Section 940.9.7 was referenced for the right-turn lane warrant analysis. The warrant analysis for two-lane roadways is based on right-turn volume, advancing volume in the same direction (through and left-turn), and roadway travel speed.

As shown in **Table 4**, both intersections of Washington Avenue and Adams Avenue at Kirkwood Road warrant dedicated southbound right-turn lanes during the weekday afternoon peak hour. It is recommended that these lanes be constructed to provide better operations and safety at the intersections. Their design, in particular, the length, shall be coordinated with the City, Lochmueller Group, and the roadway designer.

**TABLE 4: SOUTHBOUND RIGHT-TURN LANE WARRANT ANALYSIS**

	Washington Avenue				Adams Avenue			
	AM	MD	PM	SAT	AM	MD	PM	SAT
<b>Right-Turn Volume</b>	30	55	160	25	40	40	125	65
<b>Advancing Volume</b>	345	520	675	395	255	415	696	360
<b>Warrant Justified?</b>	<b>NO</b>	<b>NO</b>	<b>YES</b>	<b>NO</b>	<b>NO</b>	<b>NO</b>	<b>YES</b>	<b>NO</b>

## Operation of Unsignalized Driveways

The proposed cross-section does not include a center turn lane, also called a Two Way Left Turn Lane (TWLTL). This means that all turns into and out of the commercial driveways would happen from the two travel lanes.

Synchro 11 was used to analyze operations on the mainline and turning out of the driveways near Walgreens and Global Foods as an example location. For this analysis, volumes from the 2019 study were used for the mainline and turning movements were estimated by land use and engineering judgment. During the afternoon peak hour, the analysis showed the mainline to operate at LOS A with minimal queuing and the driveways to operate at LOS E.

While the analysis showed acceptable to favorable results, it was decided that observations would be critical to validate these results and the recommendation of the proposed cross-section. Currently, northbound Kirkwood Road is reduced to one lane for construction of the James Development on the previous UMB Bank site. This reduction offers the opportunity to see operations with half of the road diet implemented. Southbound traffic was then observed understanding all traffic would operate out of one lane.

Observations were conducted on the following days:

- Monday, August 21, 2022 from 4:30-5:30 PM
- Wednesday, August 24, 2022 from 4:30-6:00 PM
- Friday, August 26, 2022 from 11:30 AM-1:00 PM

These dates represent times when Kirkwood schools were in session (and one date before, school started on August 23, 2022). They also were conducted during the weekday midday and afternoon peaks, which are the busiest times on Kirkwood Road.

The observations are summarized below:

- Most northbound left turns completed this movement with little to no delay or queueing.
- When northbound lefts could not make an immediate turn, the resulting queue was typically 1 to 5 vehicles in length and dissipated immediately; there were no residual effects from the left turns sharing the lane with the through movement.
- Queues from the driveways was typically 0 to 1 vehicle. Delays for exiting vehicles were minimal.
- The coordinated timing plans on Kirkwood Road are designed to provide time on the mainline where there are no northbound or southbound platoons, therefore exiting vehicles only needed to wait for the platoons to pass to make their turns out. They did not have to wait another cycle to get an acceptable gap.
- Most southbound platoons heavily utilized the left lane due to the downstream lane drop at Adams Avenue. Therefore, the gaps observed in the field would be similar to those after the road diet.
- Motorists use the two driveways near these stores for either use. The proximity of their entrances on the mainline created several observed conflict points on Kirkwood Road as motorists navigate turns into and out of these sites. Internal conflict points were also observed. It is recommended that one of these driveways be closed if the properties redevelop.

From extensive field observations, it was concluded the road diet would allow for acceptable operations at unsignalized driveways during the peak hours, and that non-peak hours would be accommodated well.

## Forecasted Operating Conditions

The forecasted scenario represents future conditions with the implementation of a road diet along Kirkwood Road with the Option 3 transition and the two right-turn lanes are.



Forecasted operating conditions were evaluated using the same methodology applied to existing conditions. Each study intersection will be discussed in detail. The forecasted operating conditions are summarized in **Table 5**.

#### **Kirkwood Road & Essex Avenue**

As shown, the intersection continues to operate with favorable levels of service during all peak periods. It is expected that there will be slightly skewed lane utilization for the southbound approach as drivers who are familiar with the area will merge into the innermost through lane in anticipation for the road diet ahead. The VISSIM model depicted the impacts on southbound queues as a result of driver lane change distance. The two case scenarios depict the most extreme impacts of driver look ahead distance and its relevance to the Essex Avenue signalized intersection.

#### **Kirkwood Road & Washington Avenue**

The intersection of Kirkwood Road and Washington Avenue operates with LOS B or better during all peak periods. The intersection warrants a southbound right-turn lane during the weekday afternoon peak hour. It is recommended that the southbound right-turn lane be approximately 140 feet or greater in order to not be blocked by the through traffic 95<sup>th</sup> percentile queue.

#### **Kirkwood Road & Adams Avenue**

The intersection of Kirkwood Road and Adams Avenue operates with LOS C or better during all peak periods. The southbound approach warrants a dedicated right-turn lane during the afternoon peak hour. It is recommended to leave the southbound approach as is, with a dedicated right-turn lane which extends back to Washington Avenue. A curb bump out should be installed just south of Washington Avenue to prohibit southbound motorists from utilizing the dedicated southbound right-turn lane at Washington Avenue as a through lane.

TABLE 5: FORECASTED OPERATING CONDITIONS

Intersection & Movements	LOS (Delay, sec/vehicle) [Max Queue Length, feet] <Ratio of Volume-to-Capacity >			
	PM Peak Hour	MD Peak Hour	PM Peak Hour	WKND Peak Hour
<b>1. Kirkwood Road &amp; Essex Avenue (signalized)</b>				
<b>Overall Intersection</b>	<b>B (19.2)</b>	<b>B (16.0)</b>	<b>C (21.6)</b>	<b>B (13.8)</b>
Eastbound Approach	C (30.3) [114] <0.58>	B (15.3) [56] <0.16>	C (28.1) [111] <0.32>	B (15.5) [41] <0.14>
Westbound Approach	D (45.5) [158] <.65>	C (23.5) [63] <0.18>	D (41.6) [123] <0.42>	C (24.8) [46] <0.14>
Northbound Approach	A (8.8) [230] <0.49>	B (10.4) [129] <0.31>	B (12.5) [123] <0.29>	A (8.0) [118] <0.22>
Southbound Approach	B (17.8) [135] <0.27>	C (20.2) [204] <0.44>	C (21.8) [367] <0.62>	B (17.3) [130] <0.27>
<b>2. Kirkwood Road &amp; Washington Avenue (signalized)</b>				
<b>Overall Intersection</b>	<b>B (13.8)</b>	<b>A (7.9)</b>	<b>A (9.9)</b>	<b>A (8.5)</b>
Eastbound Approach	D (39.6) [97] <0.42>	C (27.6) [76] <0.34>	D (40.4) [120] <0.40>	C (26.1) [63] <0.21>
Westbound Approach	B (17.1) [56] <0.24>	B (14.1) [39] <0.15>	C 922.4) [74] <0.25>	B (17.1) [40] <0.17>
Northbound Approach	B (13.6) [169] <0.81>	A (5.4) [67] <0.48>	A (5.1) [84] <0.44>	A (5.0) [41] <0.34>
Southbound Approach	A (6.0) [47] <0.29>	A (5.3) [77] <0.49>	A (7.5) [130] <0.71>	A (7.0) [268] <0.38>
<b>3. Kirkwood Road &amp; Adams Avenue (signalized)</b>				
<b>Overall Intersection</b>	<b>C (20.6)</b>	<b>B (14.1)</b>	<b>B (18.8)</b>	<b>B (13.5)</b>
Eastbound Approach	C (33.0) [158] <0.47>	C (21.0) [122] <0.32>	D (36.8) [202] <0.57>	C (29.3) [145] <0.41>
Westbound Approach	C (31.4) [205] <0.61>	C (22.7) [145] <0.38>	C (30.1) [178] <0.41>	C (21.8) [119] <0.31>
Northbound Approach	B (17.5) [#481] <0.69>	B (12.6) [105] <0.55>	B (19.7) [308] <0.41>	A (9.6) [53] <0.46>
Southbound Approach	A (2.9) [15] <0.25>	A (7.4) [84] <0.50>	A (8.2) [361] <0.67>	A (4.2) [34] <0.36>

## Conclusions

Lochmueller Group has completed the preceding traffic analysis regarding the feasibility of a road diet along the Kirkwood Road corridor. The proposed cross-section consists of one travel lane in each direction and parking on both sides. The following conclusions were made:

- Based on macro- and microsimulation traffic analyses and field observations, the road diet is expected to operate at acceptable to favorable levels along Kirkwood Road at the signalized and unsignalized intersections.
- The Missouri Department of Transportation's (MoDOT) Engineering Policy Guidelines (EPG) Section 940.9.7 was referenced for the right-turn warrant analysis. The intersections of Washington Avenue and Adams Avenue at Kirkwood Road warrant dedicated southbound right-turn lanes during the afternoon peak hour.
  - It is recommended that the southbound right-turn lane at Kirkwood Road & Washington Avenue be approximately 140 feet or greater in order to not be blocked by the through traffic 95<sup>th</sup> percentile queue.
  - At Kirkwood Road and Adams Avenue, it is recommended to leave the southbound approach as is, with a dedicated right-turn lane which extends back to Washington Avenue. However, a curb bump out should be installed just south of Washington Avenue to prohibit southbound motorists from utilizing the dedicated southbound right-turn lane at Washington Avenue as a through lane.
- Three options were presented as to how the northbound road diet limits should be integrated with the current roadway. It was determined that traffic should be merged into a single through lane just north of Bodley Avenue.
- It is recommended that one of the driveways serving the Walgreens and Global Foods stores be closed if the properties redevelop. In general, access along Kirkwood Road should be reviewed for safety, operations, and consolidation when opportunities arise.

This study adequately describes the traffic conditions that should be expected if a road diet is implemented along the Kirkwood Road corridor. Please contact our office at (314) 446-3791 if you have any questions or comments concerning this report.

**Completed by Lochmueller Group, Inc**