LAKE ST. LOUIS BOULEVARD, VETERAN'S MEMORIAL PARKWAY, I-70 RAMPS

ROUNDABOUT STUDY

Prepared for:

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APPENDICES

1. EXECUTIVE SUMMARY

The City of Lake St. Louis has experienced increasing traffic congestion and delays on the south side of the Lake St. Louis Boulevard interchange with Interstate 70, specifically at the two closely spaced signalized intersections on Lake St. Louis Boulevard, the eastbound I-70 ramps and Veterans Memorial Parkway.

The emphasis of this report was to study two potential roundabout configurations that would help alleviate the traffic flow issues being experienced. Alternative 1 consists of two closely spaced 4-legged smaller diameter roundabouts, one at each intersection operating in tandem. Alternative 2 is a larger diameter 6-legged roundabout configuration that incorporates all entries (legs) of the two existing intersections into one roundabout. Based on our investigation, both roundabout options are feasible and each would provide significant operational improvements to the intersections, with a significant reduction in delay and improvement in Level of Service. Each alternate can be feasibly constructed within the project constraints, with minimal impacts to the adjacent topography.

However, based on the benefits and impacts outlined in this study, Alternate 2, the 6-legged roundabout, is the preferred option for further study. The key items for selection of this alternate are the ability to extend the life span of the existing signalized intersection for the westbound I-70 off ramp, lower implementation costs, and less impact to the commercial entrance on the south leg of the intersection (Hardee's entrance).

2. INTRODUCTION

Oates Associates, in association with MTJ Roundabout Engineering, contracted with the City of Lake St. Louis to provide engineering services for the study of intersection improvements at the Lake St. Louis Boulevard interchange near I-70 (see Exhibit 2-1). The study is being performed to assess intersection improvements, specifically roundabout configurations, for two existing closely spaced signalized intersections on the south side of I-70. The City has experienced continued traffic queuing and backups issues over the past several years.

The goal of the study is to identify conflicts, constraints, impacts (utility and right of way), and cost of improving the intersections and determine the feasibility of the two proposed roundabout configurations. The study will establish design criteria, analyze traffic data, develop conceptual geometry, provide analysis of traffic operations for each alternate, and provide estimates of cost for each alternate.

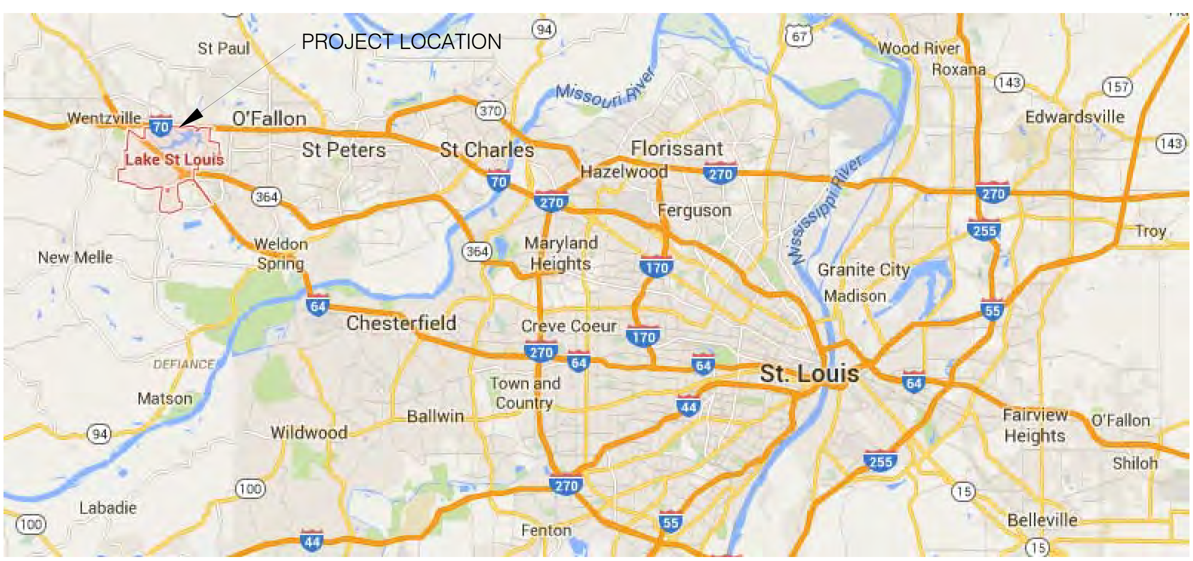

Exhibit 2-1 - Location Map

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3. EXISTING CONDITIONS

The City of Lake St. Louis is located approximately 35 miles northwest of downtown St. Louis and about 15 miles west of downtown St. Charles on I-70 in St. Charles County. The population as of the 2010 census is about 14,800 people.

The topography of the surrounding area consists of mainly rolling/hilly land with agriculture and sparse industry to the north of I-70 with business/ light commercial and residential to the south. Land use immediately adjacent to the study area is made up of service oriented business such as convenience stores, restaurants, and banking facilities (see Exhibit 3-1). Larger traffic generators nearby include SSM Medical/St. Joseph Hospital, which is located approximately 750' west of the Lake St. Louis Boulevard/Veterans Memorial Parkway Intersection and the General Motors Wentzville Assembly plant, which is located about 2.5 miles west of the study area. The majority of the area north of I-70 bound by Highway P to the north, Highway M to the east, I-70 to the south and Josephville Road/Wortman Road/ Highway A to the west is mostly open and has potential for future development. Development further south of study area is predominately single family residential with little or no room for expansion or growth.

Lake St. Louis Boulevard runs north south through the study area (see Exhibits 3-2 and 3-3). It is functionally classified as a minor arterial (see Exhibit 3-4). Between Veterans Memorial Parkway (south outer road) and W. Terra Lane (Old US 40 – north outer road) the roadway consists of two through lanes in each direction with turn lanes at the intersections. Veterans Memorial Parkway runs east west and is functionally classified a major collector route and mainly consists of single through lanes in each direction with a two-way left turn lane. There are two signalized intersections north of I-70, at W. Terra Lane and the westbound I-70 ramps.

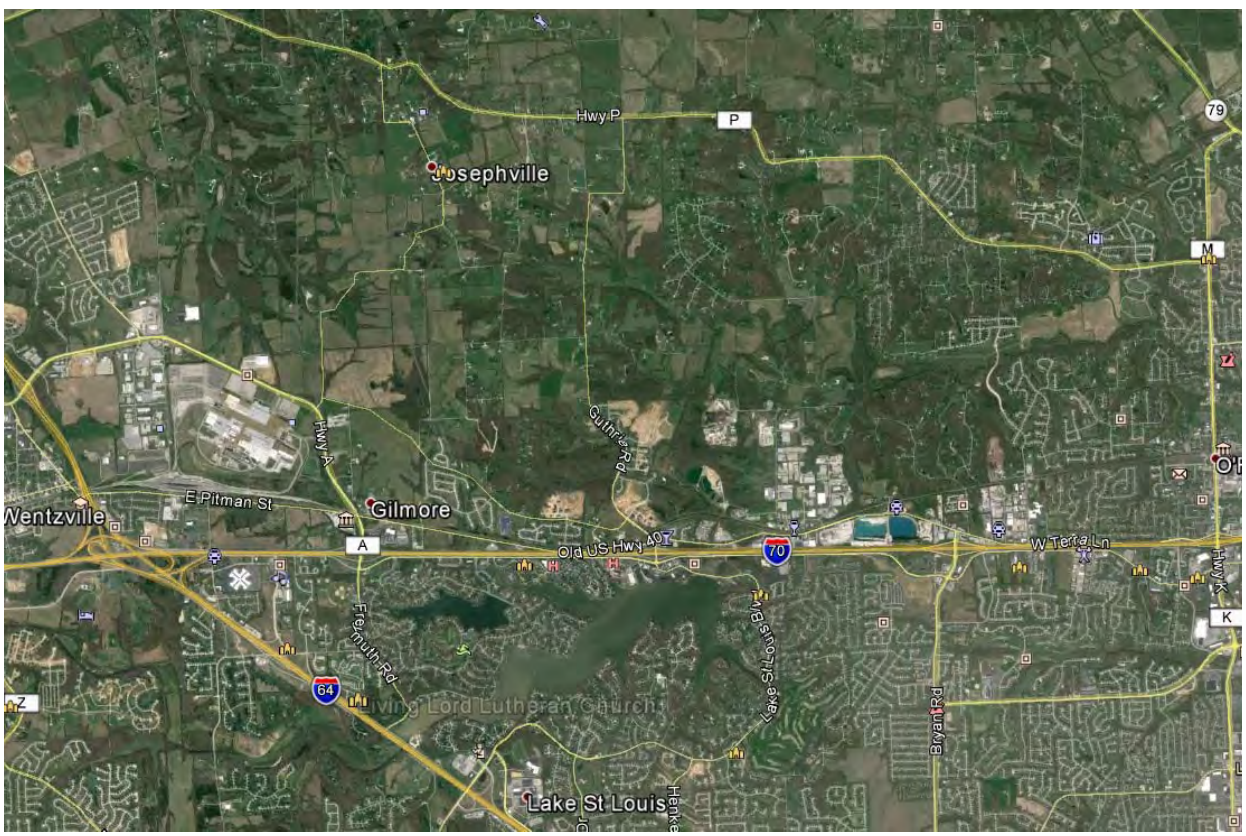

Exhibit 3-1 - Aerial Image of the Study Area

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The study area is bound by W. Terra Lane to the north, Veterans Memorial Parkway (south outer road), and the limits of the Lake St. Louis Boulevard interchange. More specifically, the intersections being directly studied are the eastbound on and off ramps and Veterans Memorial Parkway with Lake St. Louis Boulevard (see Exhibit 3-2).

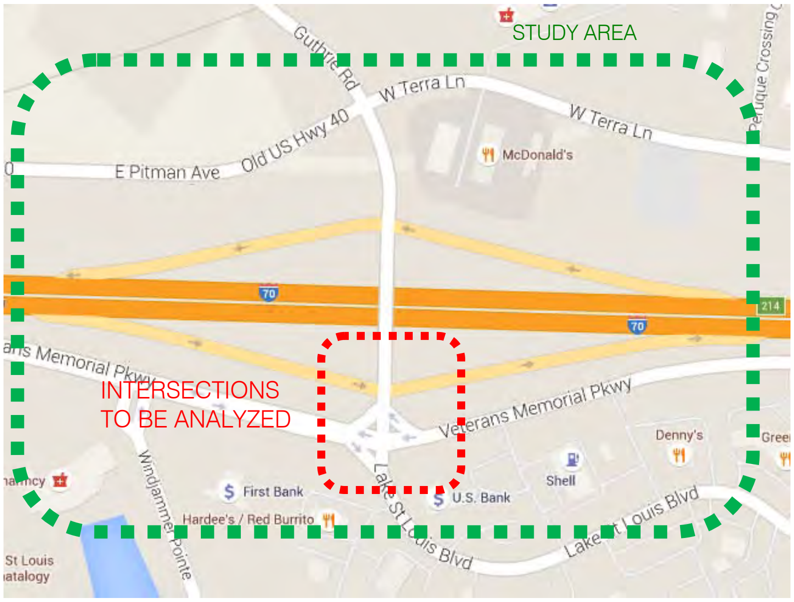

Exhibit 3-2 - Study Area

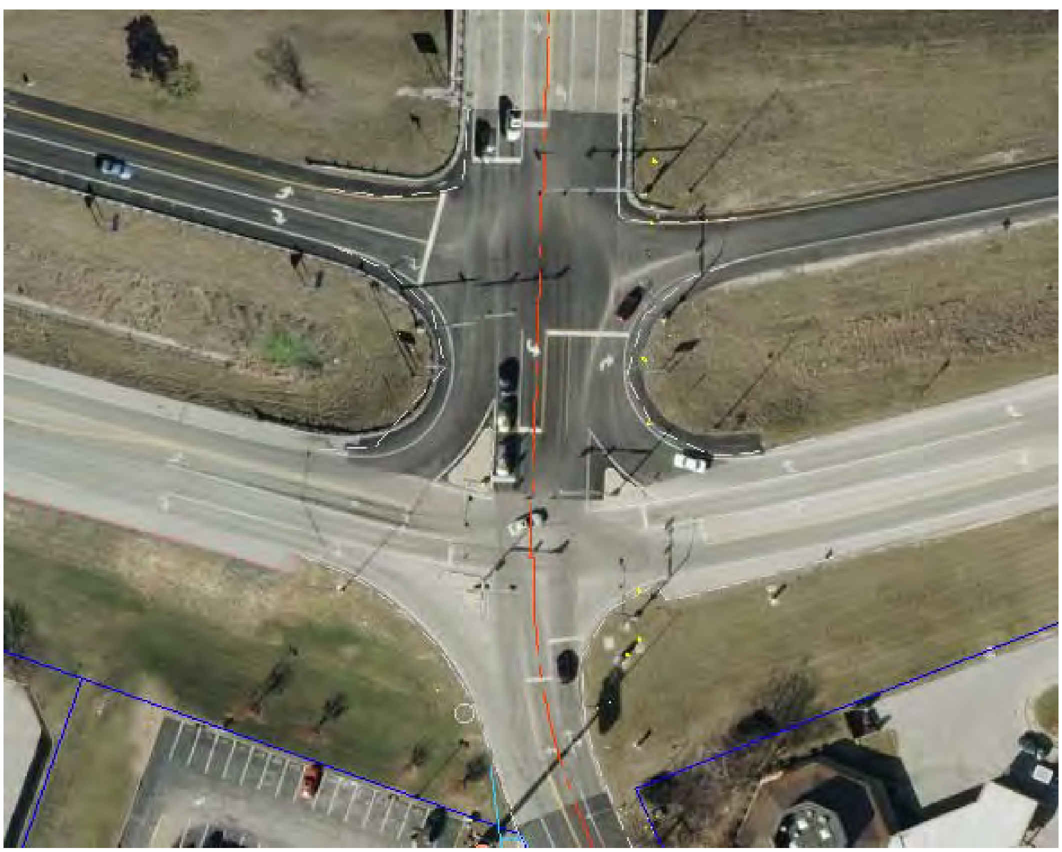

Exhibit 3-3 - Subject Intersections

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The close proximity of the Lake St. Louis Boulevard intersections with the eastbound ramps to I-70 and Veterans Memorial Parkway cause traffic backups and delays. According to the Gateway Green Light Phase II Signal Coordination Report and the study application provided by the City, the intersections are currently functioning at a Level of Service (LOS) of D.

Two sets of traffic counts were analyzed for this study. MoDOT completed a set of counts in August, 2015, and the City of Lake St. Louis completed updated traffic counts in April, 2016. The counts completed by the City were found to be 5%-10% lower than the MoDOT counts, and this discrepancy was attributed to normal fluctuations in traffic volumes observed. In order to be more conservative in our analysis, it was determined that the MoDOT counts from August, 2015 would be used for the study. Truck traffic was taken from the City counts and found to generally be 5% or less of the observed traffic volumes.

There currently are no bicycle or pedestrian facilities in the immediate study area. There are intermittent sidewalks that were constructed specifically as part of a particular development approximately 700' south of the intersections. Also, a multiuse path exists along the south side of Lake St. Louis Boulevard, but terminates approximately 1,300 feet south east. Expansion of the bicycle and pedestrian network is anticipated to be developed over the next several years to include access to the Veteran's Memorial Parkway intersection and along Veteran's Memorial Parkway. Expansion to the north side of the study area, across the existing bridge over I-70, is not anticipated. There are no bus or mass transit facilities in the area.

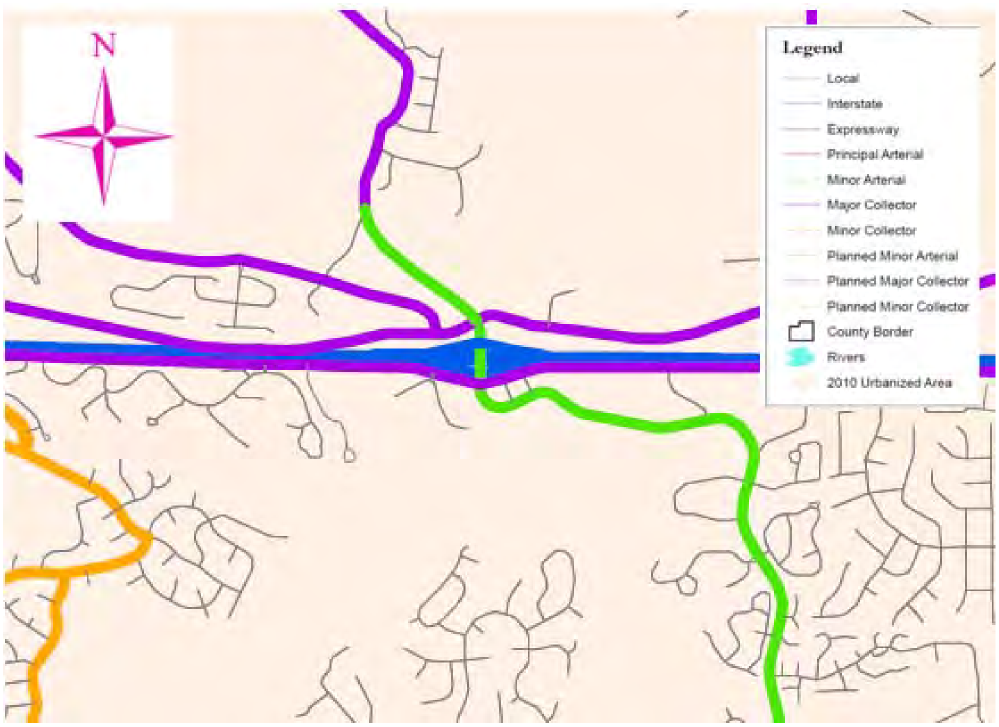

Exhibit 3-4 - Roadway Classifications in the Study Area

Limited field work was done for the study. Most of the information shown in this report was derived from record sources. Photogrammetry came from E-W Gateway Council of Governments and the surface data came from LiDAR data obtained through the Missouri Spatial Data Information Service (MSDIS). Existing right of way was developed from record information. Utility companies in the area were obtained via Missouri One Call. Traffic counts provided by MoDOT, completed in August 2015, were used as a basis for the analysis. Projected growth rates were derived from adjacent land use and projected future developments within the study area. Ground level photographs of the study area are shown in Appendix C.

4. PROPOSED ALTERNATIVES

Two roundabout configurations were considered for this study. One option was the use to two closely spaced, smaller diameter roundabouts operating in tandem. The other was one larger 6-legged roundabout.

Projected traffic growth was developed by analyzing existing and projected land use in and around the study area, and the potential impacts to the intersection and the proposed layouts. The areas to the east, south, and west of the intersections are fully developed and any redevelopment will likely be infill. It is anticipated that this future redevelopment will generate an annual nominal growth rate of approximately 1% for these three legs of the project, or 20% growth over the 20-year design period. The portion of the study area north of I-70 is currently undeveloped and will likely experience significant residential growth over the next several years. It is anticipated that the overall ADT from this area will increase 50%-75% over the design period, approximately 2.5% annually. However, in order to allow for additional potential development, the study used a more aggressive 1.5% annual growth rate, or 35% increase, for the east, south, and west legs, and a 3.5% growth rate, or 100% increase, for the north leg.

The conceptual layout and detailed operational analysis for each alternate was completed by MTJ Roundabout Engineering. The analysis was completed with the roundabout-specific analysis program Rodel (v.1.88). For a more detailed explanation of the Rodel analysis software see the Roundabout Analysis Software section included in Appendix A. The two signalized intersections north of I-70 were analyzed using Synchro (v. 9.1) to determine if the operation of these intersections would have an impact on either proposed alternate or if the anticipated traffic growth would affect their operation and negatively impact the proposed roundabout. See Appendix B for more detail on the Synchro Analysis.

A summary of each alternate is outlined as below:

Alternative 1 – two closely spaced roundabouts (see Exhibit 4-1)

This alternate will consist of two closely spaced, small diameter roundabouts, each with 4 legs. It was assumed that the existing bridge over I-70 will remain in place and that any modifications to the structure would be cosmetic in nature (adjust pavement marking / lane configurations, possible addition of raised median). See Exhibit 4.1 for the conceptual layout of this alternate.

Exhibit 4-1 - Alternative 1 - Two Closely Spaced Roundabouts

The north intersection, the eastbound I-70 exit and entrance ramps, would shift slightly to the south, with minor realignment of the ramps to the south to provide the proper approach angles.

The south intersection, Veteran's Memorial Parkway, would shift farther south, nominally 50 feet, to provide a minimum amount of separation between the two roundabouts. This will require the widening and realignment of each approach of Veteran's Memorial Parkway to provide splitter islands and introduce proper approach angles.

This option is feasible and can be designed to fit the parameters of the project. See Appendix A – Operational Analysis, completed by MTJ Roundabout Engineering, for a detailed description of this alternate and the output of the RODEL analysis.

Benefits of this option include a simpler design and analysis, as the two roundabouts can be can be conceptualized independently, and simpler navigation by motorists due to the single lane nature of each roundabout. The circulating volumes in each roundabout will be lower since some of the traffic will not need to traverse both roundabouts. Additionally, the tighter radii will result in lower circulating speeds through the intersections creating a safer environment for all users, including motorists, bicyclists, and pedestrians.

Potential issues to resolve include reconfiguring the pavement marking to provide lane continuity across the I-70 bridge, possible ROW acquisition, and utility coordination. Currently there are dual left turn lanes from the westbound I-70 off ramp which lead to two southbound through lanes, in addition to a southbound left turn lane, for a total of three southbound lanes across I-70. The proposed roundabout configuration only requires two entry lanes, one to circulate left turns around the north roundabout to the eastbound I-70 on ramp and one to direct traffic to the south roundabout. The distance between the westbound and eastbound off ramps is approximately 300 feet.

Transitioning from the three existing lanes down to two can be accomplished by converting the thru-right lane at the westbound I-70 on ramp into a right only lane, and restriping the bridge for two lanes. The dual left turn lanes from the off ramp will be impacted as well, since drivers will likely favor the outside lane entering the roundabout as the inside lane would be directing them back onto eastbound I-70.

In this scenario the dual left turn lanes from the westbound I-70 ramp would tend to act as a single lane, potentially causing queuing issues on the off ramp. To mitigate this issue, a weaving analysis could be completed to determine if the 300-foot spacing allows enough room for traffic to merge into one lane, or an additional entry lane could be added to the north roundabout to provide a bypass for traffic heading to westbound Veteran's Memorial Parkway.

Another issue of concern is the commercial entrance on the west side of Lake St. Louis Boulevard just south of the intersection (Hardee's entrance). The existing entrance is approximately 100 feet south of the intersection with Veteran's Memorial Parkway. Shifting the intersection to the south as shown in the proposed roundabout layout reduces the gap to the entrance to approximately 50 feet. While this reduced distance is a concern, the improved traffic flow through the intersection and relatively slow circulating speeds of the vehicles exiting the roundabout should mitigate any impacts to the function of the entrance.

Lastly, if projected traffic growth develops as anticipated over the design period, traffic could begin to queue into the roundabouts from the signalized intersections north of I-70, potentially reducing the level of service of the roundabouts. Future intersection improvements north of I-70 may be required to mitigate this issue as future development occurs and traffic volumes increase.

In summary, the advantages and disadvantages for this alternate are summarized below:

Advantages
- Better traffic flow and increased Level of Service
- Less circulating volume
- Tighter radii produce lower circulating speeds
- Reduced speeds aids in future bicycle and pedestrian accommodations
- Simple concept, usability for drivers

Disadvantages
- Higher implementation costs
- Impacts to the commercial entrance on the south leg (Hardee's entrance)
- May require adding median pavement to the existing bridge deck
- Dual left turn lanes from westbound I-70 off ramp may experience reduced level of service

Alternative 2 – larger 6-legged roundabout (See Exhibit 4-2)

This alternate will consist of a single, larger diameter, 6-legged roundabout. It was again assumed that the existing bridge over I-70 will remain in place and that any modifications to the structure would be cosmetic in nature (adjust pavement marking / lane configurations, possible addition of raised median). See Exhibit 4.2 for the conceptual layout of this alternate.

Exhibit 4-2 - Alternative 2 - Larger 6-Legged Roundabout

The north south location of each intersection will not change significantly, and the larger diameter of the roundabout will require additional grading and pavement on the east and west side of Lake St. Louis Boulevard. Minor realignment of the ramps to the south will provide the proper approach angles, while Veteran's Memorial Parkway will be shifted slightly south to provide splitter islands and introduce proper approach angles.

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This option is feasible and can be designed to fit the parameters of the project. See Appendix A – Operational Analysis, completed by MTJ Roundabout Engineering, for a detailed description of this alternate and the output of the RODEL analysis.

Benefits of this option include a more compact overall footprint and lower implementation costs. Additionally, the Veteran's Memorial Parkway intersection will generally be in the same location, eliminating any impacts to the commercial entrance on the west side of Lake St. Louis Boulevard (Hardee's entrance).

This option will not impact the dual left turn lanes at the signalized intersection for the westbound I-70 ramps as both entry lanes to the roundabout provide multiple options for motorists will be less likely to favor the outside lane. This would effectively extend the life span of the existing signal and lane configuration at the westbound I-70 ramp intersection.

Potential issues to resolve again include reconfiguring the three lanes across the I-70 bridge, additional signage and striping requirements for vehicular navigation, and potential impacts to Haddock Lane, the local street on the east side of Veteran's Memorial Parkway. Also, the larger radius used for this alternate will allow for higher circulating speeds around and through the intersection.

In summary, the advantages and disadvantages for this alternate are summarized below:

Advantages

- Lower implementation costs
- Less impact to the commercial entrance on the south leg (Hardee's entrance)
- Less right of way and utility impacts
- No impact to existing dual left turn lanes from westbound I-70 off ramp
- Extends life span of the signalized intersection for westbound I-70 off ramp

Disadvantages

- Larger radius would allow for greater speeds
- Potential negative impact on future expansion of bicycle and pedestrian network
- More circulating volume compared to the dual roundabout option
- Will require additional striping and signage, possible driver confusion
- Potential impacts to Haddock Lane (east side on Veteran's Memorial Parkway)

5. ANALYSIS OF ALTERNATIVES

Design Criteria

The design criteria for the project will follow the AASHTO Geometric Design of Highways and Streets, the MoDOT Engineering Policy Guide, FHWA Publication Number: FHWA-RD-00-068 "Roundabouts, An Informational Guide", and the Lake St. Louis Engineering and Plan Preparation Manual for Public Facilities. The design vehicle was assumed to be a WB-67 truck.

Traffic Analysis

MTJ Roundabout Engineering performed an operational analysis of the proposed roundabout alternatives using Rodel (v.1.88) software (roundabout analysis specific). This analysis is included as Appendix A. The Lake St. Louis Boulevard intersections with the westbound I-70 off ramps and W. Terra Lane were analyzed using Synchro (v. 9.1). This analysis is included as Appendix B.

Crash Data

Crash reports were obtained for the intersections over a 3-year period, 2012 to 2014. A crash analysis was conducted using crash data provided by the City of Lake St. Louis. The summary crash data showed a total of 20 crashes resulting in 3 injuries. Each crash location was similar in the type of crashes and time of day/weather condition by percentage, with the overall totals as follows:

A. TYPE OF CRASH
- 40% rear end crashes
- 40% turning crashes
- 20% sideswipe / merging crashes

B. TIME OF DAY/WEATHER CONDITION
- 75% of the crashes occurred during daylight
- 100% occurred in dry conditions

C. INJURY CRASHES
15% of the crashes resulted in injuries, 2 in rear end crashes and 1 in a turning crash

D. FATALITIES
There were no fatalities in the study area.

Each alternate considered would eliminate the existing conflicts resulting in the turning crashes, and greatly reduce the occurrences of rear end crashes due to the reduced delays and continuous flow of the roundabouts. Sideswipe / merging crashes will likely see a slight reduction due to the reduced speeds of the vehicles traversing the intersections.

Safety Analysis

The 20 documented crashes over a 3-year period yields an intersection crash rate of R = 0.64. Implementation of either roundabout option will lower this crash rate significantly and provide a safer intersection. Table 14-3 of the Highway Safety Manual shows a potential 0.40 crash modification factor (CMF) for Injury crashes and a 033 CMF by converting a signalized intersection into a modern roundabout.

Public Transportation, Pedestrian, and Bicycle Networks

a. Public Transportation: No public transportation exists.
b. Pedestrian Facilities: There is little pedestrian traffic on the existing routes within the study area. Expansion up to and along the south side of Veteran's Memorial Parkway is anticipated in the near future.
c. Bicycle Facilities: The nearest bike path ends approximately 1,300 feet from the intersections, and expansion up to and along the south side of Veteran's Memorial Parkway is anticipated in the near future.

Right of Way Considerations

The study area includes a combination of MoDOT and the City of Lake St. Louis right of way that can be used for the implementation of either alternate. The existing right of way on the south side of Veteran's Memorial Parkway if fairly wide, approximately 90 feet wide at the intersection, which will minimize any right of way acquisition required for the proposed improvements. Each alternate is likely to require minimal ROW or easement acquisition from the two adjacent parcels, anticipated to be less than 0.25 acres from each parcel. See Exhibit 5-1 for the location of the apparent ROW line along the south side of Veteran's Memorial Parkway.

Exhibit 5-1 - Apparent Existing ROW

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Utility Coordination

Both alternates will likely require some minor utility relocations. There is an underground gas main, communications line, and electrical pedestal along the south right of way line that may be impacted by the widening and realignment of Veteran's Memorial Parkway to provide the proper approach angles. See Exhibit 5-2 for the approximate location of the known utilities along the south side of Veteran's Memorial Parkway. The following utility companies were reported to have facilities within the study area:

- Ameren — Electric
- AT&T — Communications
- CenturyLink — Communications
- Charter Communications — Communications
- Cuivre River Electric Coop — Electric
- MoDOT STL District — Electric / Communications
- Laclede Gas Company — Gas
- City of Lake St. Louis — Storm
- City of O'Fallon — Water / Sewer
- St. Charles County PWSD 2 — Water / Sewer

Exhibit 5-2 - Known Existing Utility Facilities along the South Apparent ROW Line

Air Quality

The entire study area is located in a portion of the State classified by the USEPA as a nonattainment or maintenance area. An air quality analysis would need to be completed to evaluate specific air quality impacts. Each alternate would produce an approximate 50% reduction is vehicular delay which will provide a positive impact. While detailed analysis was not completed in this study, several areas of potential air quality impact were identified:

- Alternate 1:
  - HC Reduction: 0.00002 metric tons/day
  - PM 2.5 Reduction: 0.0000011 metric tons/day
  - NOx Reduction: 0.0000102 metric tons/day

- Alternate 2:
  - HC Reduction: 0.0000227 metric tons/day
  - PM 2.5 Reduction: 0.0000013 metric tons/day
  - NOx Reduction: 0.0000115 metric tons/day

**emission information provided by East West Gateway*

Cost Estimates

This section provides a summary of methodology used to prepare the approximate costs for each of the alternatives. The costs presented are conceptual level planning estimates and intended to provide a cost comparison between alternatives. For this report, cost estimates were derived from the conceptual layouts shown in the Appendices.

Construction costs for each of the alternatives were estimated on gross quantities for major items of work; including earthwork, pavement structure, curb and gutters, and storm sewer/drainage improvements, with a contingency factor included for miscellaneous minor or unforeseen items. Engineering costs are nominally estimated at 20% of construction costs. Right of way and utility costs are anticipated to be minimal, including minor acquisitions from two parcels and minor adjustments of existing utility facilities along the south limits of the proposed improvements.

All costs are current (2016) costs, and should be inflated when programming for future years. A detailed cost estimate for each alternate is included in Appendix B.

Alternative 1 – Two Closely Spaced Roundabouts

Construction:	$ 1.56 million
Engineering:	$ 0.30 million
Right-of-way:	$ 0.05 million
Utilities:	$ 0.05 million
Project Total:	$ 1.87 million

Alternative 2 – Single 6-Legged Roundabout

Construction:	$ 1.42 million
Engineering:	$ 0.30 million
Right-of-way:	$ 0.05 million
Utilities:	$ 0.05 million
Project Total:	$ 1.73 million

6. RESULTS AND RECOMMENDATIONS

Both alternates were found to be feasible and provide significant operational improvements to the existing signalized intersections. Each can be feasibly constructed within the project constraints, with minimal impacts to the adjacent topography.

Based on the benefits and impacts outlined in this study, Alternate 2, the 6-legged roundabout, is the preferred option for further study. The key items for selection of this alternate are the ability to extend the life span of the existing signalized intersection for the westbound I-70 off ramp, lower implementation costs, and less impact to the commercial entrance on the south leg of the intersection (Hardee's entrance).

Should further development of Alternate 2 discover an unexpected impact that affects the viability of the proposed improvements, Alternate 1 is feasible and could also be developed further in order to provide improvements to the existing intersections.

7. FUNDING OPTIONS

- **Surface Transportation Program (STP)**

  Routes under Local Agency jurisdiction that are functionally classified as arterial, urban collector, or major collector routes are eligible for STP funding through the STP-Urban program. Projects under this program are funded with up to 80% of funds coming from Federal participation with the remaining 20% coming from local funds. This program is administered by East West Gateway, with calls for projects annually in early January and project applications due in late February / early March.

- **Congestion Mitigation Air Quality (CMAQ)**

  CMAQ funds are available for projects in areas that do not meet Federal air quality standards as set forth in the Clean Air Act. The program funds are used to make infrastructure improvements help reduce congestion and improve air quality such as intersection upgrades, signalization upgrades, and mass transit. Projects under this program are generally funded with up to 80% of the funds coming from Federal assistance with the remaining 20% coming from a local agency match. This program is administered by East West Gateway, with calls for projects annually in early January and project applications due in late February / early March.

- **Highway Safety Grants**
  (Highway Safety Improvement Program (HSIP) Funded Through MAP-21)

  HSIP funding can be used if severe injuries or fatalities have occurred. The purpose of HSIP is to reduce traffic fatalities and serious injuries. Projects that qualify must have had an incapacitating injury or fatality. Qualifying projects will have 90% Federal assistance with the remaining 10% coming from a local agency. From the available crash reports, it doesn't appear that the project would qualify for HSIP funds. If more current reports indicate otherwise, we would suggest pursuing HSIP funds based on the federal participation. This program is administered by the MoDOT Traffic and Highway Safety Division.

- **County Road Board Funds (CRB)**

  In 1985, St. Charles county voters approved a ½-cent sales tax specifically used for transportation improvements that enhance the mobility and safety of the local road system. The sales tax generates roughly $20 million per year. This program is administered by St. Charles County with calls for projects annually in early Spring and project applications due in late May.

APPENDIX A

Operational Analysis of Roundabout Alternates (by MTJ Engineering)

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Technical Memorandum

TO: Mike Busch, PE, PTOE, Oates Associates

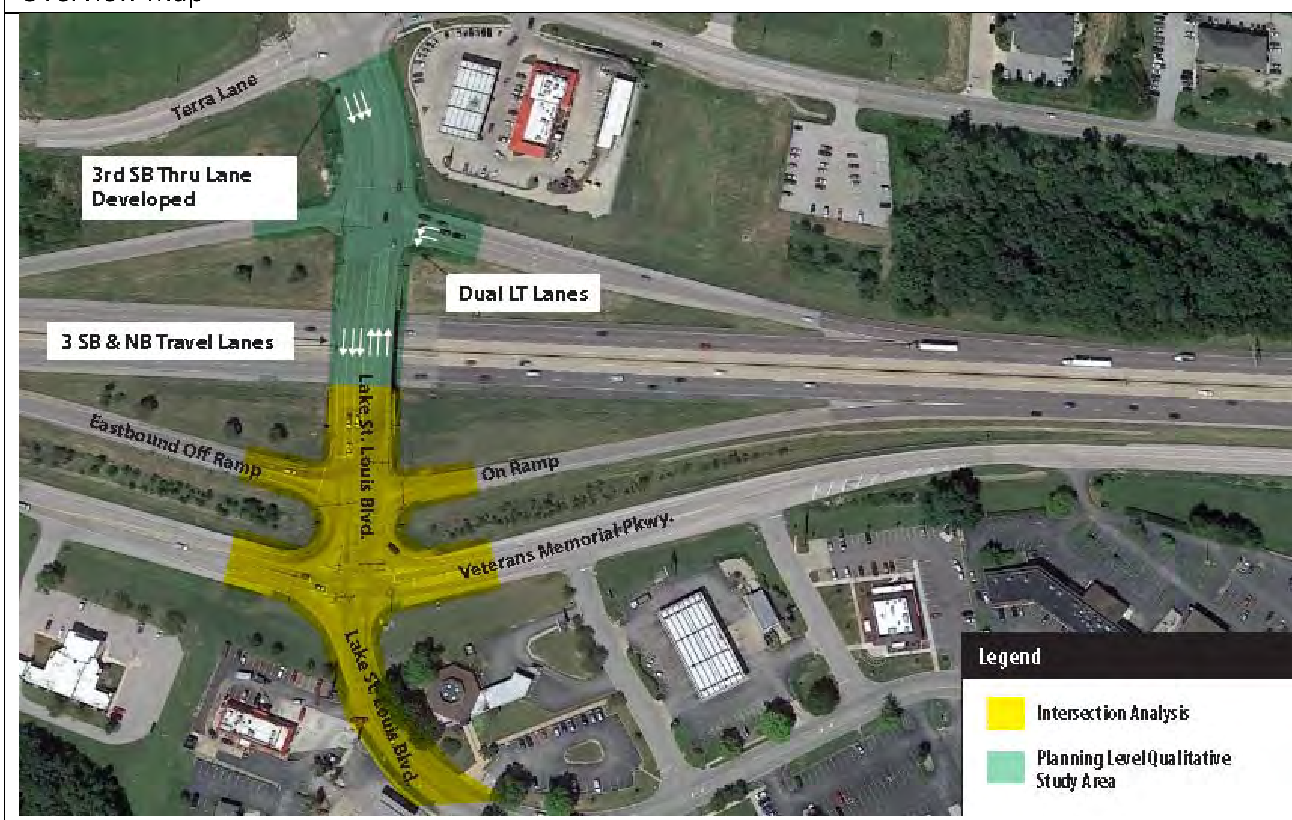
FR: Mark T. Johnson, PE (MO), MTJ Engineering, LLC

RE: Roundabout Analysis Summary – Lake St. Louis Blvd./VMP/I-70, Lake St. Louis, MO

DT: October 6, 2016

As requested, MTJ Roundabout Engineering has analyzed the two intersections on the south side of the I-70 ramp interchange at Lake St. Louis Boulevard. This analysis includes the two intersections that include the EB Off-Ramp Terminal and the closely spaced frontage road intersection of Veterans Memorial Parkway. We've developed two alternatives for the south system of two intersections which allows for maintaining the lane continuity from the existing up-stream signalized intersections at the WB off ramp and previous signalized intersection –Terra Lane.

Overview Map



Overview of Analysis and Sketch Level Design

For this project we've developed two roundabout concepts to address the close spacing of the two existing intersections and they are described below.

- **Alternative 1:** Application of two closely spaced, smaller diameter, 4-legged roundabouts:
    a. Two closely spaced roundabouts will allow for the segregation of traffic streams and reduce circulating flow past downstream entries and may reduce the number of entry lanes. This reduction of lanes and the smaller ICD's can in some conditions provide advantages in application.

- **Alternative 2:** Application of a larger ICD 6-legged roundabout that forms one intersection out of the two:
    a. Multi-leg roundabouts (5-6 common in these situations) with additional entry lanes can in some situations create more impacts.
    b. Provide increased challenges to directional signing and marking given the 5-6 legs.
    c. Also larger ICD's may create higher circulating speeds reduce pedestrian and cycling safety and comfort.

Either alternative can have pros and cons and can be used effectively in these situations. Therefore its important to conduct a comparison of operational analysis performance and design leading to a determination of which layout best meets the project objectives while considering the constraints and context of the site in question.

As per our scope of work, we have completed an operational analysis and developed sketch level design alternatives for each of the two configurations (Alt 1 and Alt 2) to address the existing 2015 traffic and future projected 20-year design traffic.

Based on this analysis we've developed sketch level designs for both Alt 1 and 2 for comparison of fit within existing context and constraints of this site. And Alt 2 was selected and forwarded to a higher level of concept design refinement to more closely reflect expected horizontal design and associated impacts of the roundabout design. Consistent with our scope of services for this project this "highly developed concept horizontal" design adheres to roundabout design principles including speed criteria (aka fast path analysis) and reflects the geometrics necessary to accommodate the design vehicle for this intersection. This highly developed roundabout design can form the basis for further preliminary engineering work as deemed necessary.

OPERATIONAL ANALYSIS

Two analysis scenarios were conducted: 1) inflation of existing traffic to determine how much traffic growth the roundabouts could reasonably accommodate, 2) then selection of a design year traffic growth based on historical traffic growth in this area, this then formed the basis for the 20-year design year traffic and the subsequent analysis and design refinements of the selected preferred alternative.

The operational analysis is a foundational element of roundabout design and we have conducted an analysis with the roundabout-specific analysis program Rodel (v.1.88). Rodel is well suited to provide an understanding of the performance of this roundabout given its high flows and geometrics (please see Rodel summary below).

INITIAL ANALYSIS

The initial analysis scenario established the expected operations based upon the provided 2015-year traffic flows + an inflation factor used to reflect a long-range design year traffic volumes. In order to provide a basis of understanding of available capacity with these two primary concepts (double vs 6-leg), we have utilized the provided 2015 traffic movements for each alternative and inflated this traffic by increments of 5% to understand probable break down period.

This analysis output summaries from Rodel for Delay, Queuing, and LOS for the 2015 Traffic + inflated amount for each viable alternative. Are shown below, there is a variation for each primary alternative that includes an option for two NB entry lanes for the Lake St. Louis entry. Based on this effort we identified two alternatives for each scenario Alt A-1 (double roundabout) and A-2 which the expanded capacity at the southerly leg (NB entry) and the associated geometrics necessary to allow for this increased traffic capacity. We developed same for Alt B-1 (6 Leg) and B-2 with expanded capacity. A summary of this analysis is provided below; the full Rodel output can be provided separately.

SUBSEQUENT ANALYSIS

Subsequent to this initial effort we were implemented (as directed) to utilize a traffic growth factor of 100% for SB traffic and a 35% inflation factor for all other entries. This subsequent analysis determined that the expandable Alternatives A-2 and B-2 previously developed that allowed for increased traffic growth were un-necessary. Other findings of the subsequent analysis determined that in each alternative (Alt A or Alt B) the EB off ramp may only requires a single-lane entry to provide acceptable/good level of service.

Please see brief description of the roundabout specific analysis program Rodel, and the analysis summaries for both the initial and the subsequent more refined analysis below.

Roundabout Analysis Software – Accurate for U.S. Capacity Predictions
Rodel v. 1.88

Rodel is a high definition, robust and accurate roundabout analysis program that utilizes the U.K. Empirical Capacity Model and included the HCM capacity model. Rodel v1.88 extends the application of the U.K. capacity equations to U.S./North American design practices and principles to include lane-based analysis and explicit and robust analysis of right turn lanes to include flared entry and closely spaced roundabouts.

It has been reported that the U.K.-derived capacity predictions may over-predict capacity on U.S. roundabouts since U.K. drivers are more accustomed to roundabouts. However, review of U.S. field-measured capacity data collected by FHWA in 2012 as compared to the U.K. data upon which Rodel is predicated demonstrates that there is, in fact, a very strong correlation of U.S. capacity to Rodel's capacity predictions.

HCM and Rodel both utilize 'Time Dependent Queuing Theory' (developed by U.S. researcher P.M. Morse in the 1960's), and because delay is derived from queuing theory equations, nothing in this respect is different from HCM to Rodel. However, there is an important analysis methodology that differentiates Rodel v.1.88 from other analysis programs and that is:

Rodel incorporates 'High Definition' queuing theory equations (vs. low definition). 'High definition' queuing theory equations provided is that at high v/c ratios Rodel provides accurate and stable predictions for Q and Delay. This is in sharp contrast to HCS and other programs that use 'low definition' queuing theory equations, as the low definition equations become unstable at v/c ratios above 0.90. This can then result in additional laneage to maintain acceptable LOS that is often not necessary.

INITIAL ANALYSIS

Alternative A: Two Closely Spaced Roundabouts Configuration

Alt A-1: Single- lane NB Lake St Louis Entry (controlling entry)

Rndbt #1 Rodel Analysis Output (15 min results): AM 2015 Traffic + 100 %

	Peak 15min Results	Bypass Type	Flow Rate (veh/hr)		Opp Rate (veh/hr)		Capacity (veh/hr)		Ave VCR		Ave Del (sec/veh)			Max Q (veh)		Max Q95% (veh)		LOS A-F		
			Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Entry	Byp	Leg
1	SB	None	1367		0		1926		0.7215		8.33		8.33	3.47		8.35		A		A
2	Off Ramp	Yield	460	420	1362	1362	579	539	0.8218	0.8107	18.51	22.35	20.34	2.84	3.13	6.92	7.58	C	C	C
3	NB	Free	487	753	1023	0	564	1264	0.9000	0.5961	23.30	0.00	9.15	3.97	0.00	9.42	0.00	C	A	A
4	On Ramp	None	0		0		0		0.0000		0.00		0.00	0.00		0.00		A		A
All	Intersection												11.65							B

Results 60 | Results 15 | Int / Slope - 60 | Int / Slope - 15 | Economics | Global Results

Rndbt #1 Rodel Analysis Output (15 min results): PM 2015 Traffic + 100 %

Peak 15min Results	Bypass Type	Flow Rate (veh/hr) Entry	Flow Rate (veh/hr) Bypass	Opp Rate (veh/hr) Entry	Opp Rate (veh/hr) Bypass	Capacity (veh/hr) Entry	Capacity (veh/hr) Bypass	Ave VCR Entry	Ave VCR Bypass	Ave Del (sec/veh) Entry	Ave Del (sec/veh) Bypass	Ave Del (sec/veh) Leg	Max Q (veh) Entry	Max Q (veh) Bypass	Max Q95% (veh) Entry	Max Q95% (veh) Bypass	LOS A-F Entry	LOS A-F Byp	LOS A-F Leg
1 SB	None	1438		0		1926		0.7577		7.50		7.50	3.32		8.00		A		A
2 Off Ramp	Yield	222	391	1434	1434	542	510	0.4173	0.7994	9.25	22.61	17.77	0.63	2.95	1.64	7.17	A	C	C
3 NB	Free	647	920	625	0	772	1264	0.8646	0.7280	16.78	0.00	6.93	3.58	0.00	8.59	0.00	C	A	A
4 On Ramp	None	0		0		0		0.0000		0.00		0.00	0.00		0.00		A		A
All Intersection												8.99							A

Results 60 | Results 15 | Int / Slope - 60 | Int / Slope - 15 | $ Economics | Global Results

Rndbt #2 Rodel Analysis Output (15 min results): AM 2015 Traffic + 60 %

Peak 15min Results	Bypass Type	Flow Rate (veh/hr) Entry	Flow Rate (veh/hr) Bypass	Opp Rate (veh/hr) Entry	Opp Rate (veh/hr) Bypass	Capacity (veh/hr) Entry	Capacity (veh/hr) Bypass	Ave VCR Entry	Ave VCR Bypass	Ave Del (sec/veh) Entry	Ave Del (sec/veh) Bypass	Ave Del (sec/veh) Leg	Max Q (veh) Entry	Max Q (veh) Bypass	Max Q95% (veh) Entry	Max Q95% (veh) Bypass	LOS A-F Entry	LOS A-F Byp	LOS A-F Leg
1 SB	Merge	837	138	265	252	992	1176	0.8691	0.1183	14.79	3.38	13.17	3.78	0.13	9.02	0.35	B	A	B
2 EB vet Mem Pkwy	Yield	411	145	847	847	656	610	0.6419	0.2413	11.72	7.37	10.58	1.44	0.31	3.64	0.81	B	A	B
3 NB Lake St Louis	None	532		811		733		0.7463		13.32		13.32	2.15		5.33		B		B
4 WB vet mem pkwy	None	315		831		785		0.4071		6.72		6.72	0.61		1.59		A		A
All Intersection												11.74							B

Results 60 | Results 15 | Int / Slope - 60 | Int / Slope - 15 | $ Economics | Global Results

Rndbt #2 Rodel Analysis Output (15 min results): PM 2015 Traffic + 60 %

Peak 15min Results	Bypass Type	Flow Rate (veh/hr) Entry	Flow Rate (veh/hr) Bypass	Opp Rate (veh/hr) Entry	Opp Rate (veh/hr) Bypass	Capacity (veh/hr) Entry	Capacity (veh/hr) Bypass	Ave VCR Entry	Ave VCR Bypass	Ave Del (sec/veh) Entry	Ave Del (sec/veh) Bypass	Ave Del (sec/veh) Leg	Max Q (veh) Entry	Max Q (veh) Bypass	Max Q95% (veh) Entry	Max Q95% (veh) Bypass	LOS A-F Entry	LOS A-F Byp	LOS A-F Leg
1 SB	Merge	742	353	358	353	942	1141	0.8066	0.3121	12.40	4.37	9.81	2.83	0.44	6.92	1.16	B	A	A
2 EB vet Mem Pkwy	Yield	568	224	743	743	710	664	0.8259	0.3420	16.47	7.64	13.97	2.96	0.50	7.21	1.31	C	A	B
3 NB Lake St Louis	None	776		735		774		1.0686		36.23		36.23	10.34		22.16		E		E
4 WB vet mem pkwy	None	413		1132		671		0.6290		11.00		11.00	1.38		3.50		B		B
All Intersection												17.71							C

Results 60 | Results 15 | Int / Slope - 60 | Int / Slope - 15 | $ Economics | Global Results

Alt A-2: Flared Two-Lane NB Lake St Louis Entry at Roundabout #2 (South) (controlling entry)

Rndbt #1 Rodel Analysis Output (15 min results): AM Build-Year Traffic + X %

NO CHANGE

Rndbt #1 Rodel Analysis Output (15 min results): PM Build-Year Traffic + X %

NO CHANGE

Rndbt #2 Rodel Analysis Output (15 min results): AM Build-Year Traffic + 80 %

	Peak 15min Results	Bypass Type	Flow Rate (veh/hr)		Opp Rate (veh/hr)		Capacity (veh/hr)		Ave VCR		Ave Del (sec/veh)			Max Q (veh)		Max Q95% (veh)		LOS A-F		
			Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Entry	Byp	Leg
1	SB	Merge	942	155	299	284	1016	1189	0.9703	0.1316	23.53	3.39	20.68	7.17	0.15	16.02	0.39	C	A	C
2	EB vet Mem Pkwy	Yield	462	163	946	946	637	578	0.7490	0.2870	15.91	8.21	13.90	2.26	0.39	5.59	1.02	C	A	B
3	NB Lake St Louis	None	599		908		1001		0.6117		10.62		10.62	1.91		4.77		B		B
4	WB vet mem pkwy	None	354		934		782		0.4603		7.52		7.52	0.77		2.00		A		A
All	Intersection												15.10							C

Results 60 | Results 15 | Int / Slope - 60 | Int / Slope - 15 | $ Economics | Global Results

Rndbt #2 Rodel Analysis Output (15 min results): PM Build-Year Traffic + 80 %

	Peak 15min Results	Bypass Type	Flow Rate (veh/hr)		Opp Rate (veh/hr)		Capacity (veh/hr)		Ave VCR		Ave Del (sec/veh)			Max Q (veh)		Max Q95% (veh)		LOS A-F		
			Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Entry	Byp	Leg
1	SB	Merge	834	397	407	401	916	1124	0.9463	0.3566	20.20	4.71	15.21	5.54	0.54	12.74	1.41	C	A	C
2	EB vet Mem Pkwy	Yield	639	252	831	831	664	618	1.0186	0.4146	32.23	9.06	25.68	7.32	0.68	16.33	1.76	D	A	D
3	NB Lake St Louis	None	873		815		1036		0.8712		17.37		17.37	4.99		11.60		C		C
4	WB vet mem pkwy	None	465		1283		614		0.7808		16.43		16.43	2.42		5.98		C		C
All	Intersection												18.61							C

Results 60 | Results 15 | Int / Slope - 60 | Int / Slope - 15 | $ Economics | Global Results

Alternative A-1 Two Closely Spaced Roundabouts

Alternative A-2 Two Closely Spaced Roundabouts

Alternative B: 6-Leg Configuration

Alt B-1: Leg 4 - Single lane" NB Lake St Louis (controlling entry)

AM Rodel Analysis Output (15 min results): AM 2015 Traffic + 70%

	Peak 15min Results	Bypass Type	Flow Rate (veh/hr)		Opp Rate (veh/hr)		Capacity (veh/hr)		Ave VCR		Ave Del (sec/veh)			Max Q (veh)		Max Q95% (veh)		LOS A-F		
			Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Entry	Byp	Leg
1	SB	None	1201		291		1932		0.6304		6.59		6.59	2.40		5.92		A		A
2	EB Off	None	769		1490		1219		0.6454		11.86		11.86	2.86		6.98		B		B
3	EB Vet Mem Pkwy	Yield	483	170	1824	1824	623	623	0.7988	0.2772	16.38	7.27	14.00	2.62	0.37	6.42	0.97	C	A	B
4	NB Lake St Louis	None	599		1800		609		1.0411		34.99		34.99	8.09		17.84		D		D
5	WB VEt Mem Pk...	None	355		1801		609		0.5957		10.92		10.92	1.22		3.12		B		B
6	EB on ramp	None	0		0		0		0.0000		0.00		0.00	0.00		0.00		A		A
All	Intersection												14.26							B

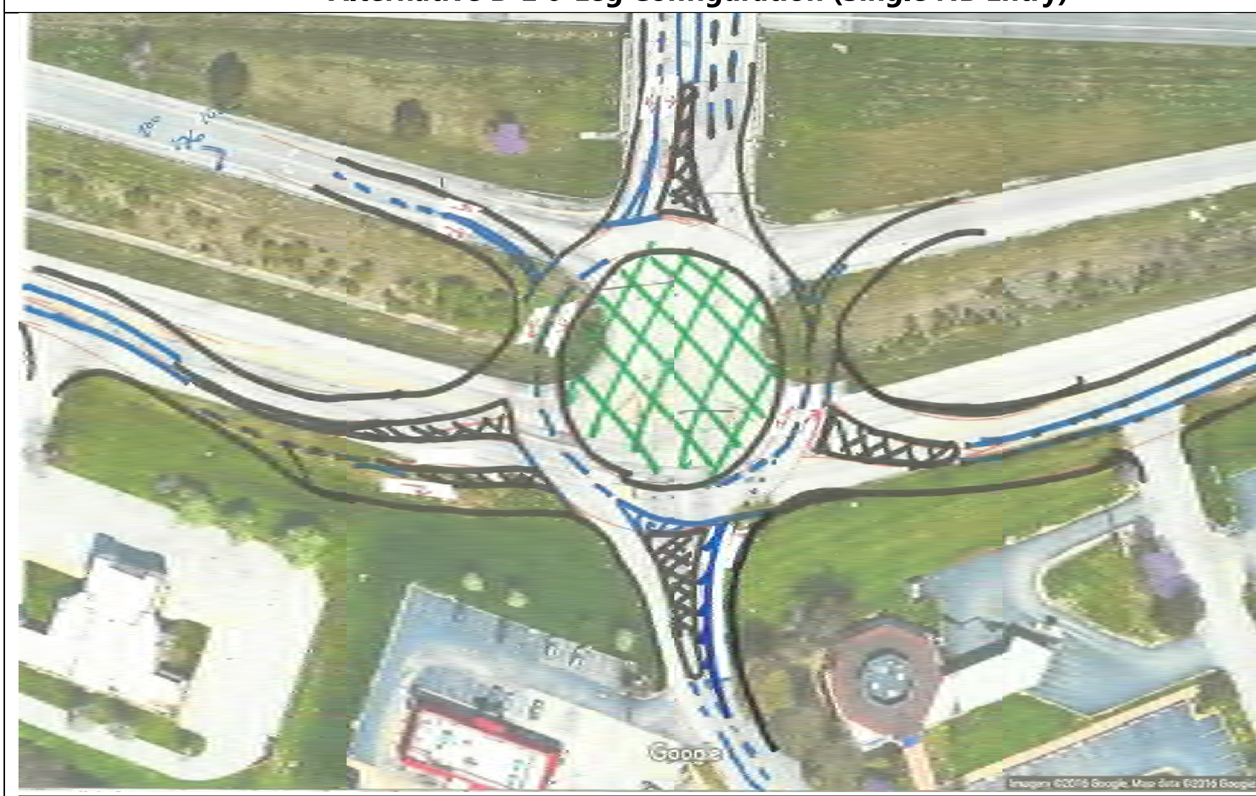
Results 60 | Results 15 | Int / Slope - 60 | Int / Slope - 15 | $ Economics | Global Results

PM Rodel Analysis Output (15 min results): PM Inflated Design (Build Year + 55%)

	Peak 15min Results	Bypass Type	Flow Rate (veh/hr)		Opp Rate (veh/hr)		Capacity (veh/hr)		Ave VCR		Ave Del (sec/veh)			Max Q (veh)		Max Q95% (veh)		LOS A-F		
			Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Entry	Byp	Leg
1	SB	None	1067		372		1865		0.5795		6.23		6.23	1.95		4.86		A		A
2	EB Off	None	455		1437		1250		0.3697		7.35		7.35	0.98		2.52		A		A
3	EB Vet Mem Pkwy	Yield	556	214	1184	1186	770	829	0.7401	0.2616	12.46	5.58	10.55	2.10	0.35	5.23	0.91	B	A	B
4	NB Lake St Louis	None	610		1182		609		1.0802		42.74		42.74	9.49		20.53		E		E
5	WB VEt Mem Pk...	None	396		1429		507		0.8132		20.98		20.98	2.67		6.54		C		C
6	EB on ramp	None	0		0		0		0.0000		0.00		0.00	0.00		0.00		A		A
All	Intersection												15.92							C

Results 60 | Results 15 | Int / Slope - 60 | Int / Slope - 15 | $ Economics | Global Results

Alternative B-1 6-Leg Configuration (Single NB Entry)



Alt B-2 Leg 4- Flare Two-Lane NB Lake St Louis

Rodel Analysis Output (15 min results): AM 2015 Traffic + 70%

	Peak 15min Results	Bypass Type	Flow Rate (veh/hr)		Opp Rate (veh/hr)		Capacity (veh/hr)		Ave VCR		Ave Del (sec/veh)			Max Q (veh)		Max Q95% (veh)		LOS A-F		
			Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Entry	Byp	Leg
1	SB	None	1201		295		1929		0.6312		6.61		6.61	2.41		5.94		A		A
2	EB Off	None	769		1493		1217		0.6464		11.89		11.89	2.87		7.00		B		B
3	EB Vet Mem Pkwy	Yield	461	162	1824	1824	623	623	0.7611	0.2647	14.95	7.16	12.92	2.25	0.35	5.58	0.92	B	A	B
4	NB Lake St Louis	None	599		1779		732		0.8537		23.74		23.74	4.91		11.43		C		C
5	WB VEt Mem Pk...	None	355		1796		611		0.5941		10.86		10.86	1.21		3.10		B		B
6	EB on ramp	None	0		0		0		0.0000		0.00		0.00	0.00		0.00		A		A
All	Intersection												12.18							B

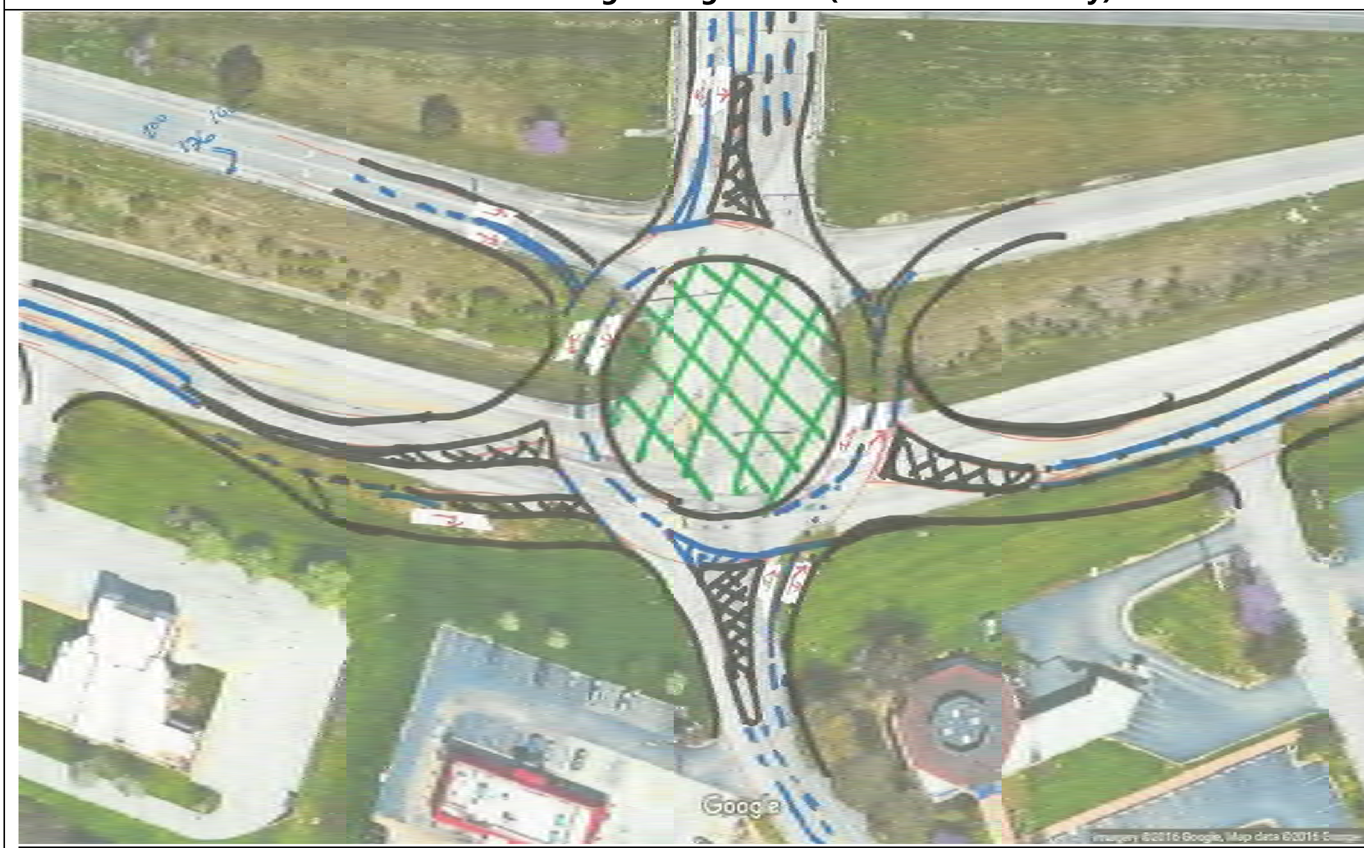
Results 60 | Results 15 | Int / Slope - 60 | Int / Slope - 15 | $ Economics | Global Results

Rodel Analysis Output (15 min results): PM 2015 + 70%

	Peak 15min Results	Bypass Type	Flow Rate (veh/hr)		Opp Rate (veh/hr)		Capacity (veh/hr)		Ave VCR		Ave Del (sec/veh)			Max Q (veh)		Max Q95% (veh)		LOS A-F		
			Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Entry	Byp	Leg
1	SB	None	1170		416		1829		0.6496		7.30		7.30	2.52		6.21		A		A
2	EB Off	None	499		1584		1164		0.4367		8.62		8.62	1.27		3.24		A		A
3	EB Vet Mem Pkwy	Yield	609	235	1298	1300	792	792	0.7916	0.3007	13.82	6.13	11.68	2.60	0.42	6.38	1.09	B	A	B
4	NB Lake St Louis	None	669		1296		974		0.7064		13.94		13.94	2.84		6.94		B		B
5	WB VEt Mem Pk...	None	434		1586		676		0.6577		11.61		11.61	1.53		3.86		B		B
6	EB on ramp	None	0		0		0		0.0000		0.00		0.00	0.00		0.00		A		A
All	Intersection												10.25							B

Results 60 | Results 15 | Int / Slope - 60 | Int / Slope - 15 | $ Economics | Global Results

Alternative B-2 6-Leg Configuration (Two-Lane NB Entry)



SUMMARY OF INITIAL ANALYSIS

Alt A (two closely spaced roundabouts)

- North roundabout
    - Provides sufficient capacity for 2015 + 100% increase of traffic for both AM and PM
- South roundabout
    - Alt A-1:
        - Single NB entry lane and Single EB Entry provides sufficient capacity for 2015 + 60% increase of traffic

    - Alt A-2:
        - Flared two-lane NB entry allows 2015 + 80%
        - Additional EB Yield RT Lane allows for 2015 + 80%

Alt B (6-Leg single roundabout)

- B-1: Single NB entry lane provides sufficient capacity for 2015 + 55% increase of traffic on the afternoon PM analysis hour. Up to 70% for AM
- B-2: Flared two-lane NB entry provides sufficient capacity for 2015 + 70% increase of traffic for both AM and PM.

SUBSEQUENT ANALYSIS (Design Year Traffic):

Alternative A: Two Closely Spaced Roundabouts - Analysis on #1 Ramp Terminal Roundabout

AM Rodel Analysis Output (15 min results): AM 2015 Traffic + 100% SB 35% others

	Peak 15min Results	Bypass Type	Flow Rate (veh/hr)		Opp Rate (veh/hr)		Capacity (veh/hr)		Ave VCR		Ave Del (sec/veh)			Max Q (veh)		Max Q95% (veh)		LOS A-F		
			Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Entry	Byp	Leg
1	SB	None	1323		0		2002		0.6713		7.65		7.65	3.00		7.30		A		A
2	Off Ramp	Yield	575	1	1320	1591	656	480	0.9172	0.0031	24.48	0.00	24.41	4.74	0.00	11.08	0.00	C	A	C
3	NB	Free	318	492	848	0	690	1288	0.4689	0.3820	8.42	0.00	3.30	0.80	0.00	2.06	0.00	A	A	A
4	On Ramp	None	0		0		0		0.0000		0.00		0.00	0.00		0.00		A		A
All	Intersection												9.92							A

Results 60 | Results 15 | Int / Slope - 60 | Int / Slope - 15 | $ Economics | Global Results

PM Rodel Analysis Output (15 min results): PM Traffic + 100% SB 35% others

	Peak 15min Results	Bypass Type	Flow Rate (veh/hr)		Opp Rate (veh/hr)		Capacity (veh/hr)		Ave VCR		Ave Del (sec/veh)			Max Q (veh)		Max Q95% (veh)		LOS A-F		
			Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Entry	Byp	Leg
1	SB	None	1391		0		2002		0.7049		6.80		6.80	2.82		6.89		A		A
2	Off Ramp	Yield	401	1	1389	1643	629	461	0.6538	0.0032	12.68	0.00	12.64	1.57	0.00	3.95	0.00	B	A	B
3	NB	Free	422	601	535	0	856	1288	0.5010	0.4665	7.27	0.00	3.00	0.91	0.00	2.33	0.00	A	A	A
4	On Ramp	None	0		0		0		0.0000		0.00		0.00	0.00		0.00		A		A
All	Intersection												6.26							A

Results 60 | Results 15 | Int / Slope - 60 | Int / Slope - 15 | $ Economics | Global Results

Alternative A-1 Double Roundabout - Analysis on #1 Ramp Terminal Roundabout

Notes:

Q distance is key between the two roundabouts.

- Q for NB entry at roundabout #1:
  - AM 15 min Ave Q = 0.80 vehicles
  - PM 15 min Ave Q = 0.91 vehicles
- Off Ramp operates acceptably with a single entry

Analysis on #2 South Roundabout (frontage road roundabout)

AM Rodel Analysis Output (15 min results): 2015 AM Traffic + 35%

	Peak 15min Results	Bypass Type	Flow Rate (veh/hr)		Opp Rate (veh/hr)		Capacity (veh/hr)		Ave VCR		Ave Del (sec/veh)			Max Q (veh)		Max Q95% (veh)		LOS A-F		
			Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Entry	Byp	Leg
1	SB	Merge	721	119	229	217	1054	1212	0.6970	0.0989	8.89	3.19	8.08	1.92	0.11	4.81	0.29	A	A	A
2	EB vet Mem Pkwy	Yield	354	125	732	732	751	691	0.4792	0.1830	7.92	6.04	7.43	0.83	0.22	2.14	0.58	A	A	A
3	NB Lake St Louis	None	459		700		768		0.6091		9.75		9.75	1.34		3.42		A		A
4	WB vet mem pkwy	None	271		718		759		0.3626		6.61		6.61	0.53		1.37		A		A
All	Intersection												8.11							A

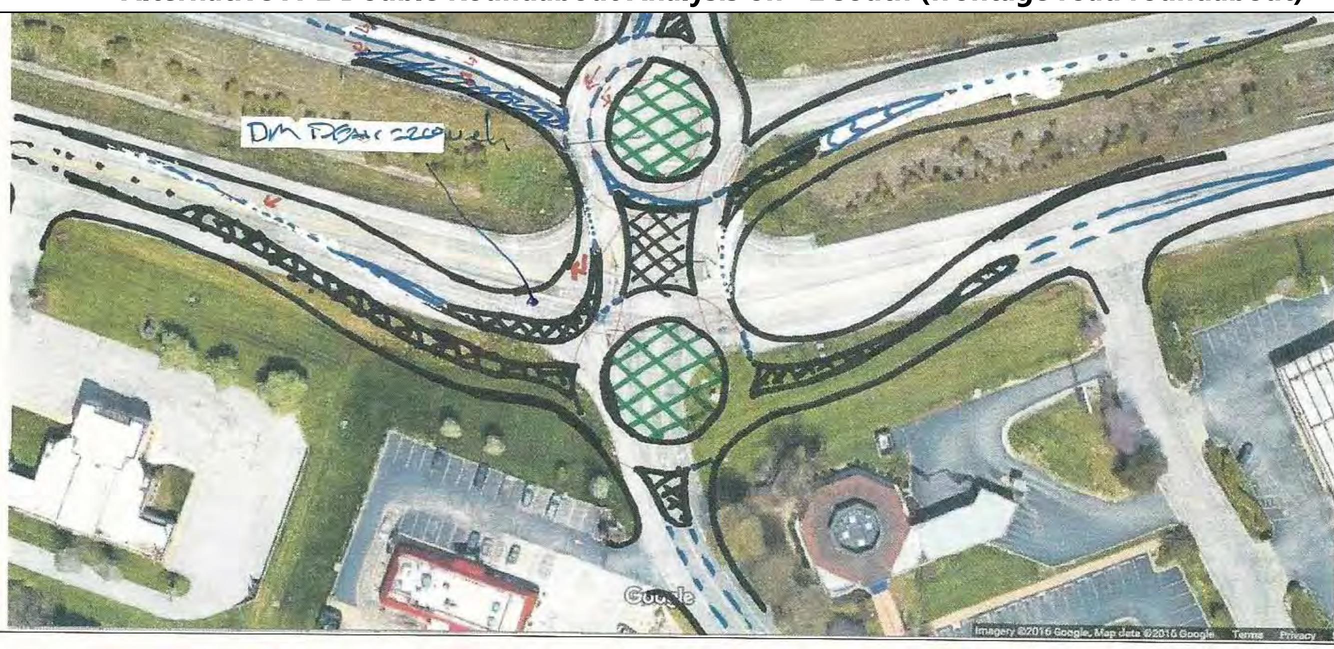
Results 60 | Results 15 | Int / Slope - 60 | Int / Slope - 15 | $ Economics | Global Results

PM Rodel Analysis Output (15 min results): 2015 PM Traffic + 35%

	Peak 15min Results	Bypass Type	Flow Rate (veh/hr)		Opp Rate (veh/hr)		Capacity (veh/hr)		Ave VCR		Ave Del (sec/veh)			Max Q (veh)		Max Q95% (veh)		LOS A-F		
			Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Entry	Byp	Leg
1	SB	Merge	626	298	306	302	1012	1183	0.6285	0.2536	7.90	3.90	6.61	1.47	0.33	3.72	0.88	A	A	A
2	EB vet Mem Pkwy	Yield	479	1	629	629	806	745	0.6055	0.0020	9.27	0.00	9.24	1.33	0.00	3.38	0.00	A	A	A
3	NB Lake St Louis	None	655		623		810		0.8347		16.20		16.20	3.36		8.10		C		C
4	WB vet mem pkwy	None	348		972		624		0.5708		10.91		10.91	1.16		2.96		B		B
All	Intersection												10.37							B

Results 60 | Results 15 | Int / Slope - 60 | Int / Slope - 15 | $ Economics | Global Results

Alternative A-1 Double Roundabout Analysis on #2 south (frontage road roundabout)



Notes:

Q distance is key between the two roundabouts.

- Q for SB entry at roundabout #2:
  - AM 15 min Ave Q = 1.92 vehicles
  - PM 15 min Ave Q = 1.47 vehicles
- Off Ramp operates acceptably with a single entry

Alternative B: 6 Leg Roundabout

AM Rodel Analysis Output (15 min results): AM 2015 Traffic + 100% SB, 35% others

	Peak 15min Results	Bypass Type	Flow Rate (veh/hr)		Opp Rate (veh/hr)		Capacity (veh/hr)		Ave VCR		Ave Del (sec/veh)			Max Q (veh)		Max Q95% (veh)		LOS A-F		
			Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Entry	Byp	Leg
1	SB	None	1413		236		2059		0.6970		7.55		7.55	3.27		7.89		A		A
2	EB Off	None	611		1645		720		0.8790		19.55		19.55	4.09		9.69		C		C
3	EB Vet Mem Pkwy	Yield	495	2	1861	1989	647	593	0.7893	0.0026	16.34	0.00	16.29	2.70	0.00	6.60	0.00	C	A	C
4	NB Lake St Louis	None	476		1705		688		0.7087		12.80		12.80	1.96		4.90		B		B
5	WB VEt Mem Pk...	None	282		1613		703		0.4069		7.36		7.36	0.63		1.64		A		A
6	EB on ramp	None	0		0		0		0.0000		0.00		0.00	0.00		0.00		A		A
All	Intersection												11.85							B

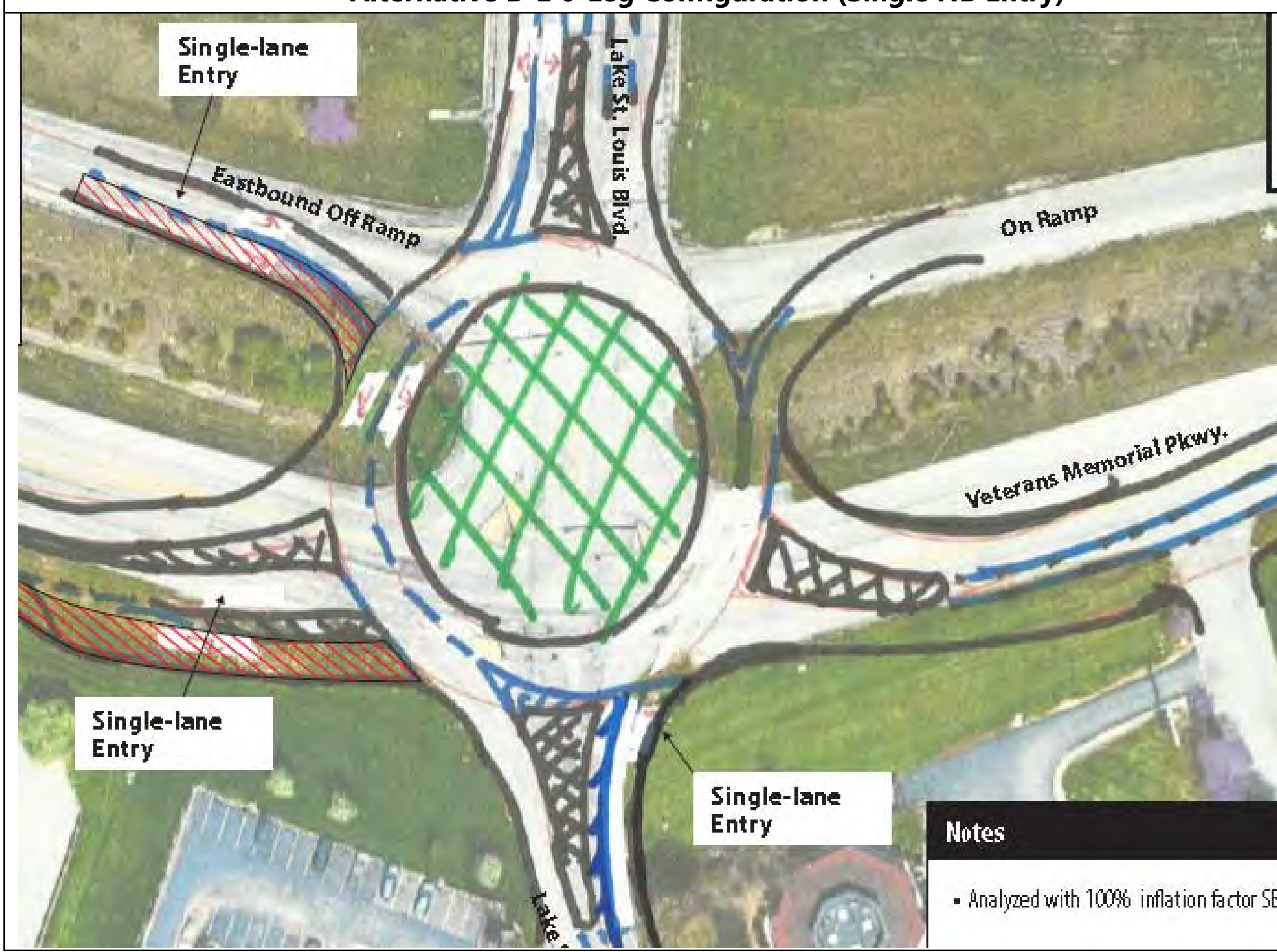
Results 60 | Results 15 | Int / Slope - 60 | Int / Slope - 15 | $ Economics | Global Results

PM Rodel Analysis Output (15 min results): PM 2015 Traffic + 100% SB, 35% others

	Peak 15min Results	Bypass Type	Flow Rate (veh/hr)		Opp Rate (veh/hr)		Capacity (veh/hr)		Ave VCR		Ave Del (sec/veh)			Max Q (veh)		Max Q95% (veh)		LOS A-F		
			Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Entry	Byp	Leg
1	SB	None	1377		331		1899		0.7381		8.68		8.68	3.57		8.56		A		A
2	EB Off	None	396		1704		663		0.6110		10.77		10.77	1.29		3.28		B		B
3	EB Vet Mem Pkwy	Yield	669	1	1373	1558	767	709	0.9062	0.0020	19.94	0.00	19.90	4.31	0.00	10.17	0.00	C	A	C
4	NB Lake St Louis	None	531		1203		812		0.6685		10.09		10.09	1.61		4.07		B		B
5	WB VEt Mem Pk...	None	345		1384		738		0.4744		7.77		7.77	0.79		2.04		A		A
6	EB on ramp	None	0		0		0		0.0000		0.00		0.00	0.00		0.00		A		A
All	Intersection												11.33							B

Results 60 | Results 15 | Int / Slope - 60 | Int / Slope - 15 | $ Economics | Global Results

Alternative B-1 6-Leg Configuration (Single NB Entry)



SUMMARY OF SUBSEQUENT OPERATIONAL ANALYSIS

The subsequent analysis with revised traffic projections indicates each of these two alternatives are viable alternatives and can likely be designed to fit this context. Alternative A (two smaller closely spaced double roundabout) provides modestly higher levels of service in comparison Alternative B (large ICD 6 leg) as the two smaller closely spaced roundabouts reducing the circulating flow past the downstream entries of EB Veterans, and NB Lake St Louise.

However, the dual left turns of the existing signalized intersection for the WB I-70 off ramp creates lane continuity issues for Alt A relative to the WB dual left turners heading SB as lane #1 SB into the first roundabout serves EB I 70 on-ramp. Whereas Alt B allows for other movements besides just EB I-70, and therefore allows the existing signal to perform better and create less weaving and lane balance issues for the WB dual left turn lanes.

Due this operational reason and the fact that the 6 leg compares favorably in terms of costs and fit into existing site Alt B was selected as the preferred design alternative and was advanced to a more refined “highly developed concept design”.

SUMMARY OF HORIZONTAL DESIGN

Based on this analysis we’ve developed sketch level designs for both Alt 1 and 2 for comparison of fit within existing context and constraints of this site. And Alt 2 was selected and forwarded to a higher level of concept design refinement to more closely reflect final horizontal design. This “highly developed concept horizontal” design adheres to state of the art roundabout design principles including; speed criteria (aka fast path analysis), proper alignment of entry to circulating lanes, entry and view angles, and accommodates the design vehicle for this intersection.

This “highly developed” concept roundabout design can form the basis for further preliminary engineering work as deemed necessary.

The design development of this project from initial sketch level of both Alt A and Alt B and the subsequent development of Alt B to “highly developed concept design” are attached to this memo.

Sincerely,

M.T. Johnson

Mark T. Johnson, PE (MO)

Attachments

Appendix A

- Overview Analysis Map
- Original Analysis and Graphics
- Alt A: 1-2
  - Traffic Analysis
  - Sketch Level Design Exhibits
- Alt B: 1-2
  - Traffic Analysis
  - Sketch Level Design Exhibits

Appendix B

- Subsequent Analysis and Graphics (with updated traffic)
  - Alt A-1
  - Alt B-1

Appendix C

- Highly Developed Concept Design of Alt B
  - Fast Path Analysis
  - Truck Turn Templates (WB 62)

APPENDICES A

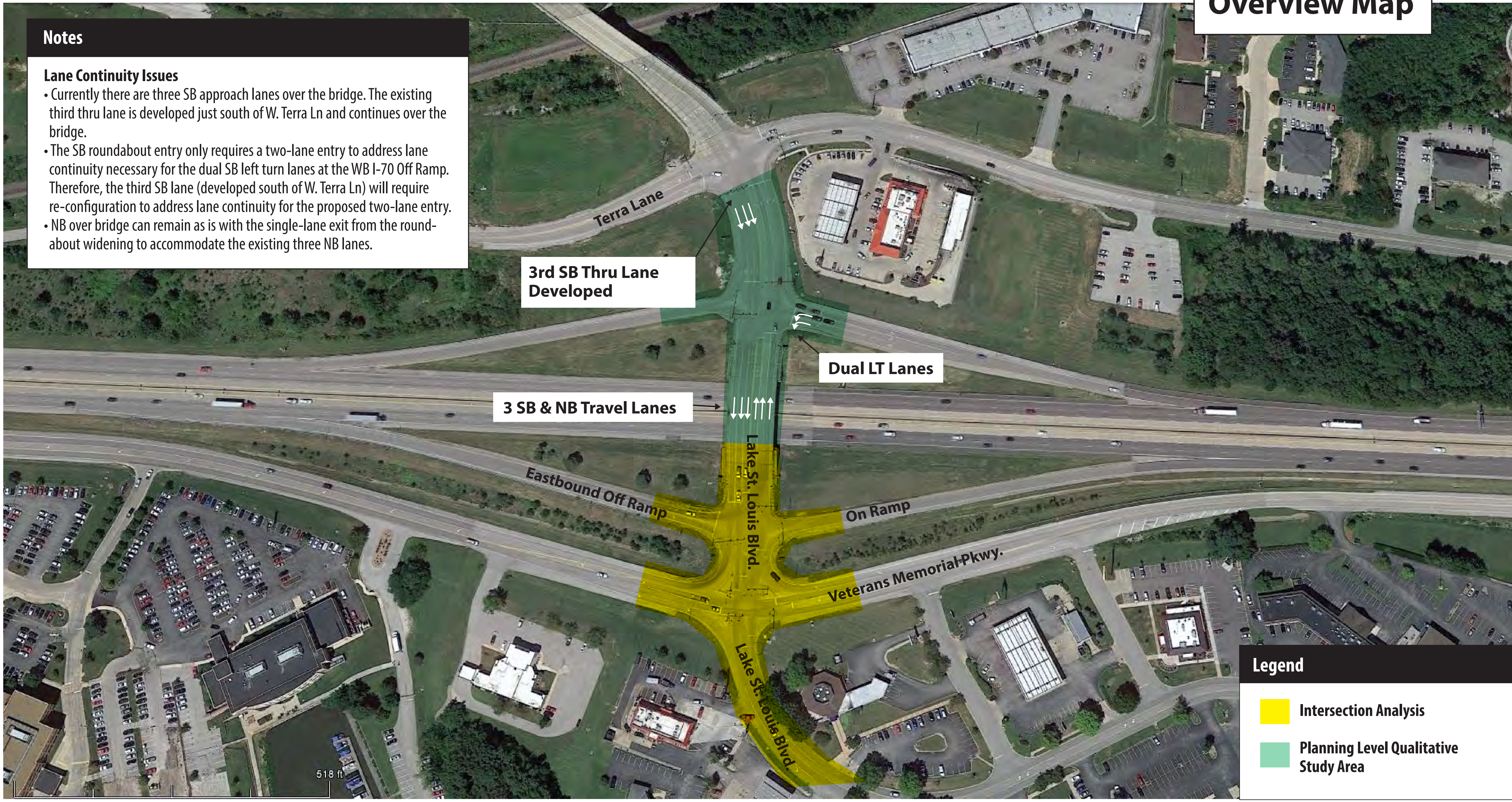
INITIAL ANALYSIS

Overview Map

Notes

Lane Continuity Issues

- Currently there are three SB approach lanes over the bridge. The existing third thru lane is developed just south of W. Terra Ln and continues over the bridge.
- The SB roundabout entry only requires a two-lane entry to address lane continuity necessary for the dual SB left turn lanes at the WB I-70 Off Ramp. Therefore, the third SB lane (developed south of W. Terra Ln) will require re-configuration to address lane continuity for the proposed two-lane entry.
- NB over bridge can remain as is with the single-lane exit from the roundabout widening to accommodate the existing three NB lanes.



LAKE ST. LOUIS BLVD./VETERANS MEMORIAL PKWY/I-70

LAKE ST. LOUIS, MO

PLANNING LEVEL LANE CONTINUITY MAP

6.23.2016

Scale: NTS

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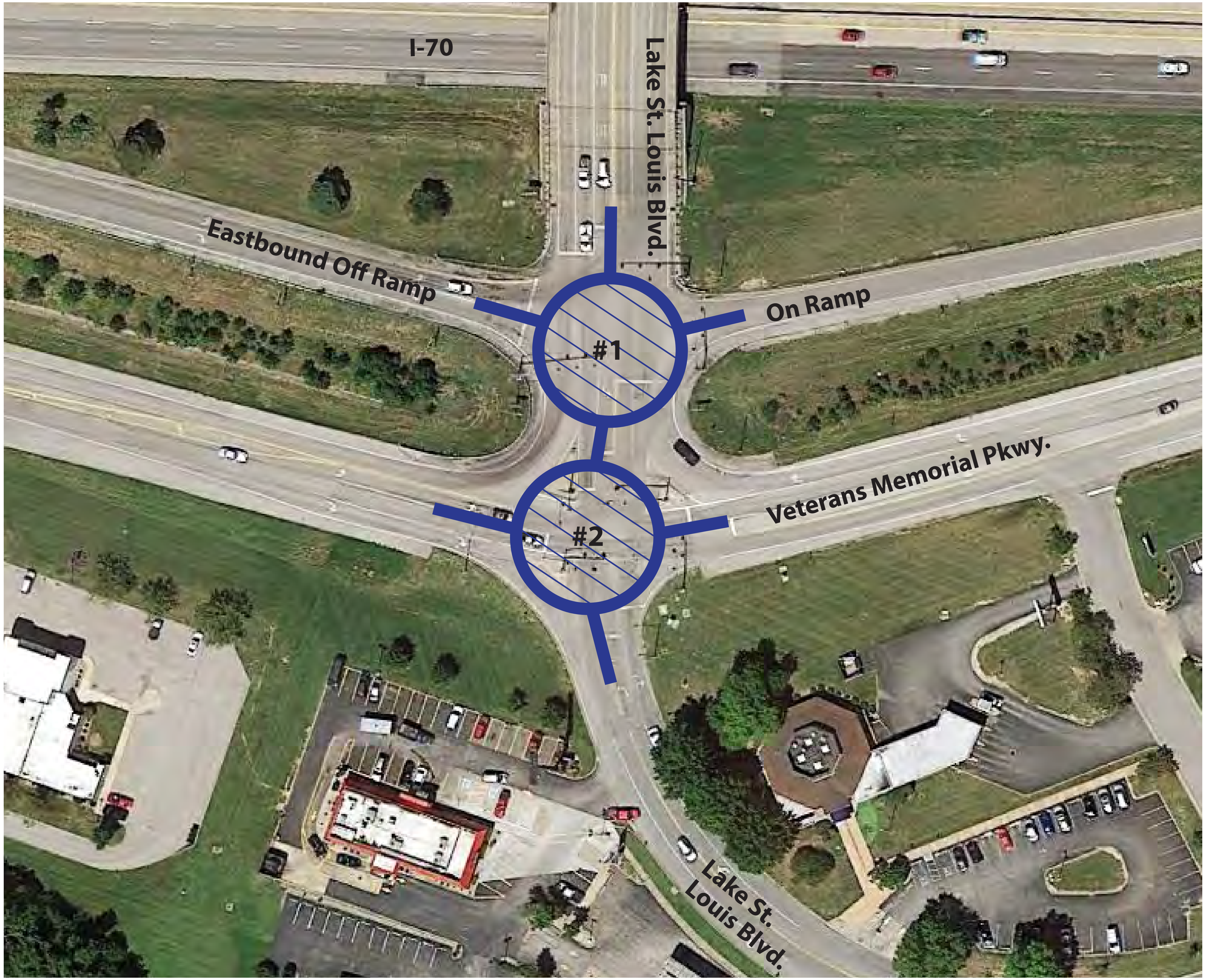
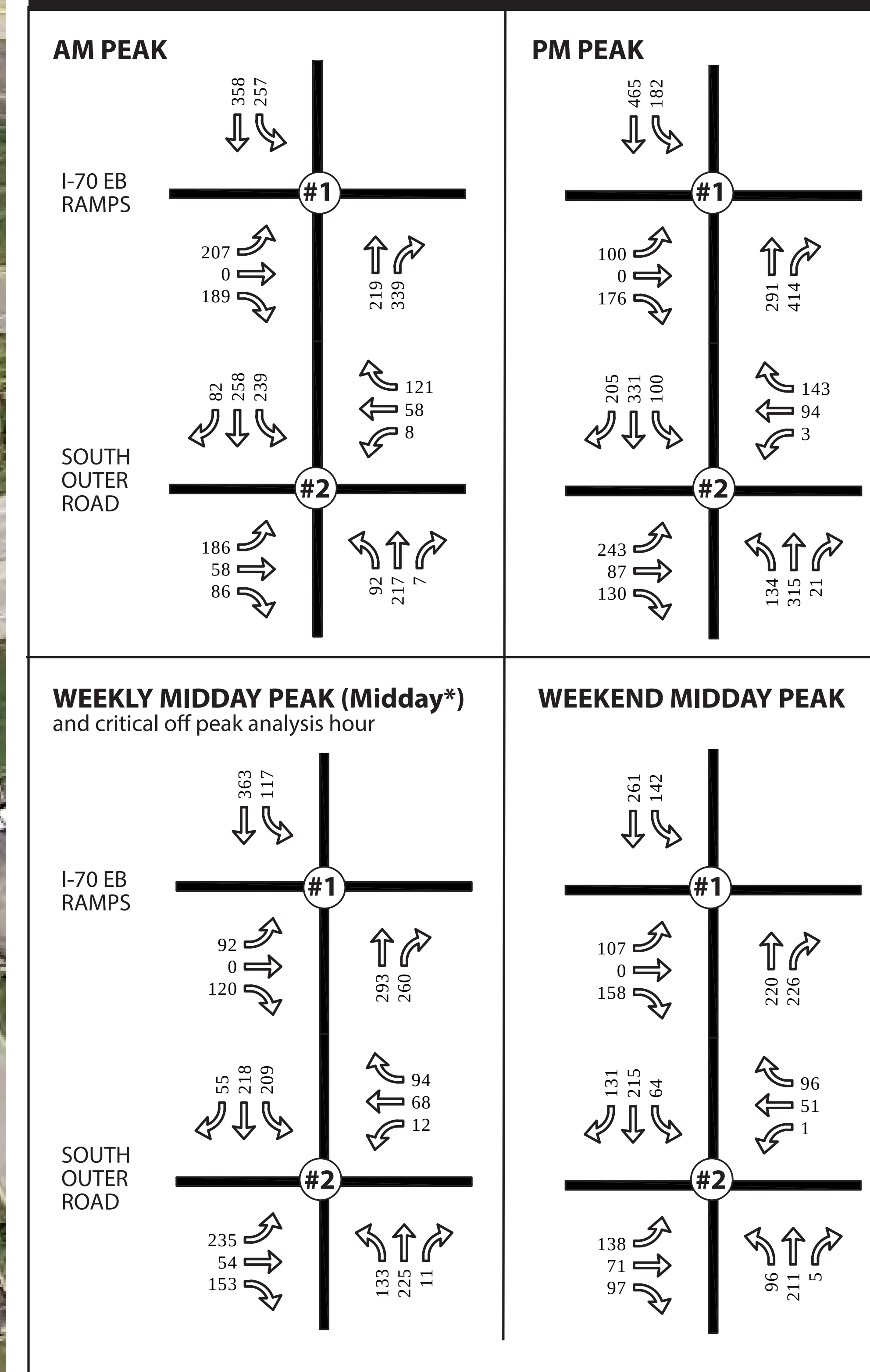


EXISTING 2015 TRAFFIC VOLUMES



LAKE ST. LOUIS BLVD./VETERANS MEMORIAL PKWY/I-70
LAKE ST. LOUIS, MO

TRAFFIC ANALYSIS ALT A
5.24.2016

Scale: NTS

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ALT A-1 Sketch Design

Two Closely Spaced Roundabouts

#1 Operational Results

2015 x 100%

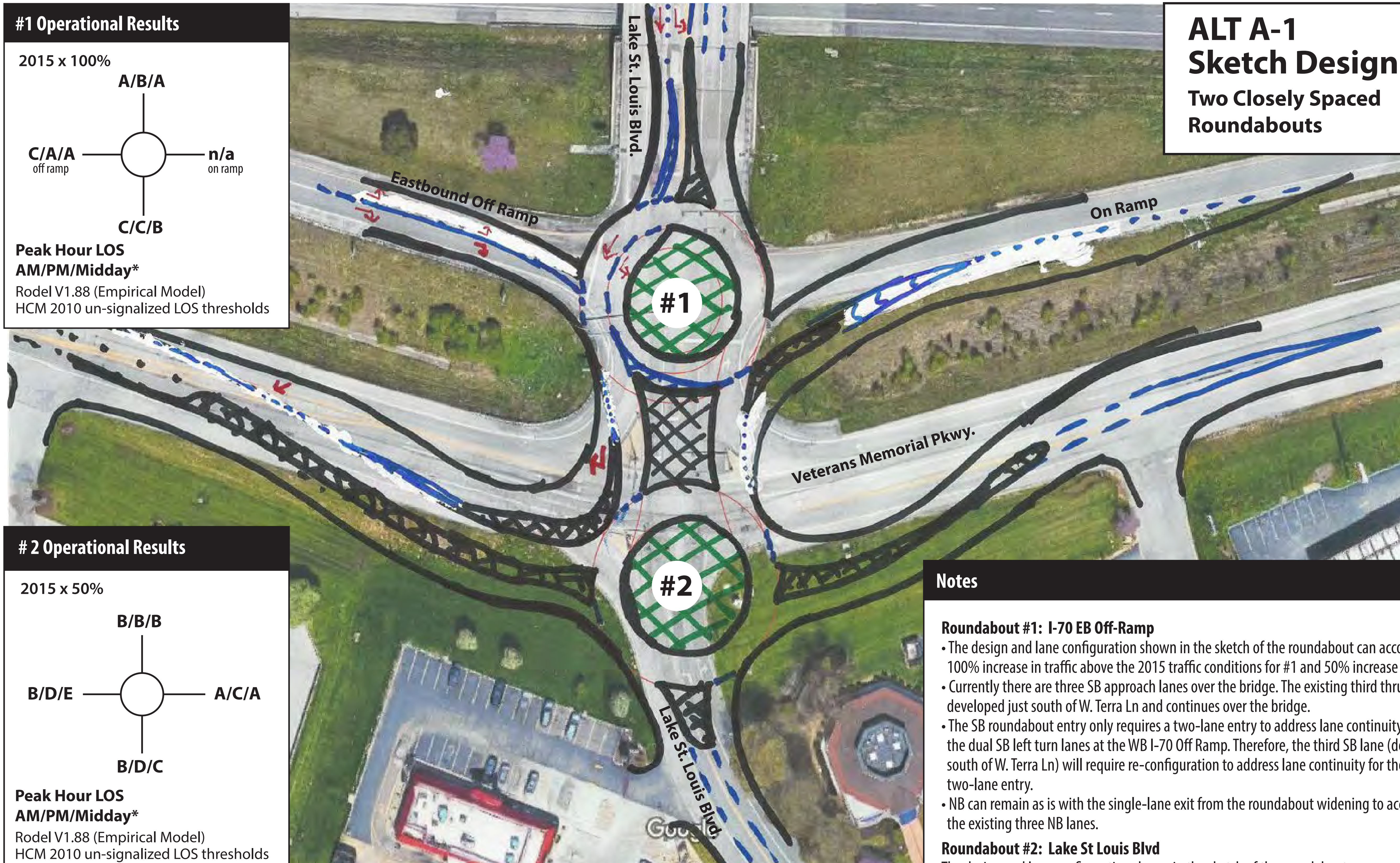
A/B/A

C/A/A (off ramp) — n/a (on ramp)

C/C/B

Peak Hour LOS AM/PM/Midday*

Rodel V1.88 (Empirical Model)
HCM 2010 un-signalized LOS thresholds



2 Operational Results

2015 x 50%

B/B/B

B/D/E — A/C/A

B/D/C

Peak Hour LOS AM/PM/Midday*

Rodel V1.88 (Empirical Model)
HCM 2010 un-signalized LOS thresholds

Notes

Roundabout #1: I-70 EB Off-Ramp

- The design and lane configuration shown in the sketch of the roundabout can accommodate a 100% increase in traffic above the 2015 traffic conditions for #1 and 50% increase for #2.
- Currently there are three SB approach lanes over the bridge. The existing third thru lane is developed just south of W. Terra Ln and continues over the bridge.
- The SB roundabout entry only requires a two-lane entry to address lane continuity necessary for the dual SB left turn lanes at the WB I-70 Off Ramp. Therefore, the third SB lane (developed south of W. Terra Ln) will require re-configuration to address lane continuity for the proposed two-lane entry.
- NB can remain as is with the single-lane exit from the roundabout widening to accommodate the existing three NB lanes.

Roundabout #2: Lake St Louis Blvd

The design and lane configuration shown in the sketch of the roundabout can accommodate a 50% increase in traffic above the 2015 traffic conditions (See Alt A-2 for 80%).

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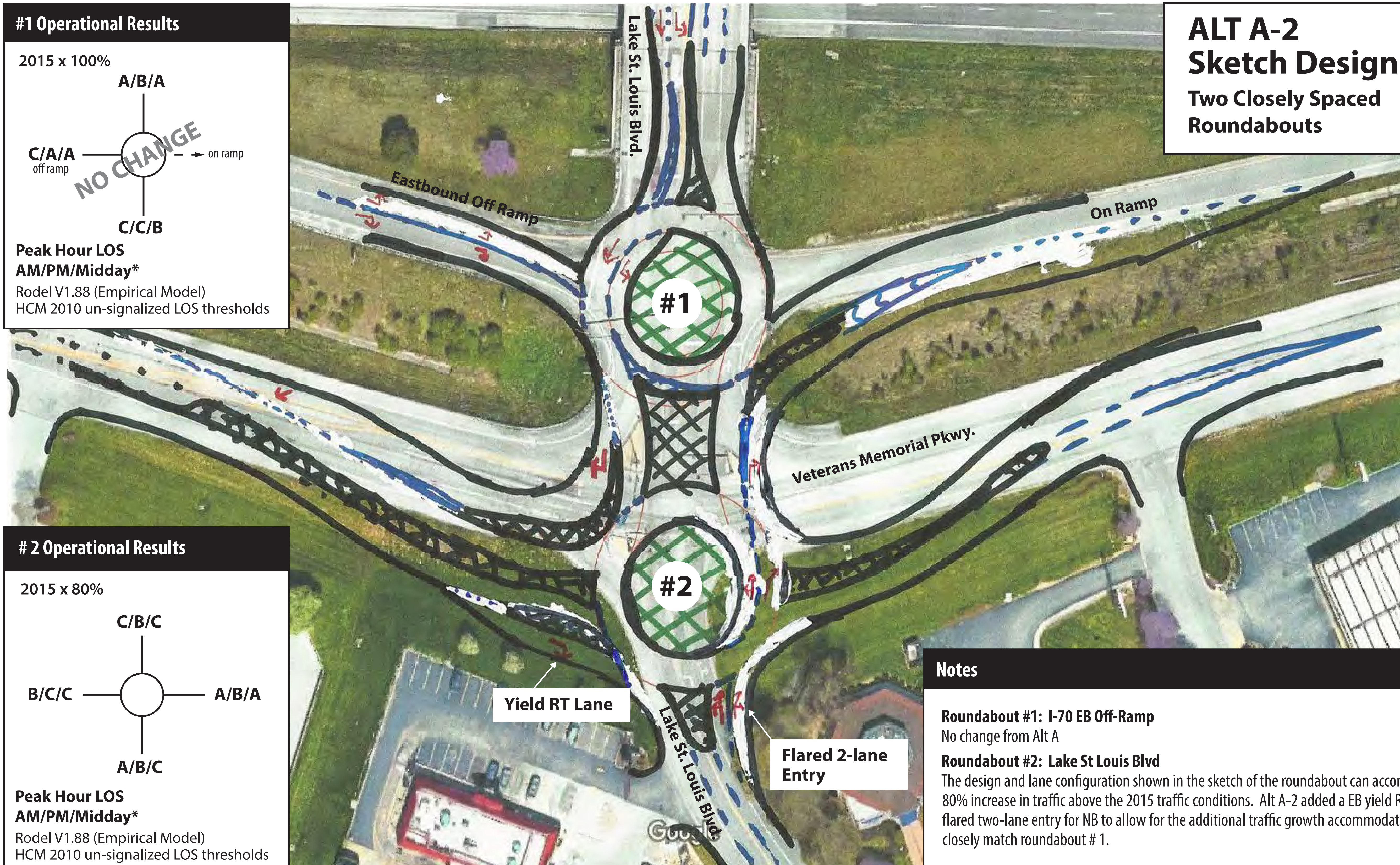
ALT A-2 Sketch Design

Two Closely Spaced Roundabouts



#1 Operational Results

2015 x 100%

A/B/A
C/A/A
off ramp
NO CHANGE
on ramp
C/C/B

Peak Hour LOS
AM/PM/Midday*

Rodel V1.88 (Empirical Model)
HCM 2010 un-signalized LOS thresholds

2 Operational Results

2015 x 80%

C/B/C
B/C/C
A/B/A
A/B/C

Peak Hour LOS
AM/PM/Midday*

Rodel V1.88 (Empirical Model)
HCM 2010 un-signalized LOS thresholds

Notes

Roundabout #1: I-70 EB Off-Ramp
No change from Alt A

Roundabout #2: Lake St Louis Blvd
The design and lane configuration shown in the sketch of the roundabout can accommodate a 80% increase in traffic above the 2015 traffic conditions. Alt A-2 added a EB yield RT lane, and a flared two-lane entry for NB to allow for the additional traffic growth accommodation to more closely match roundabout # 1.

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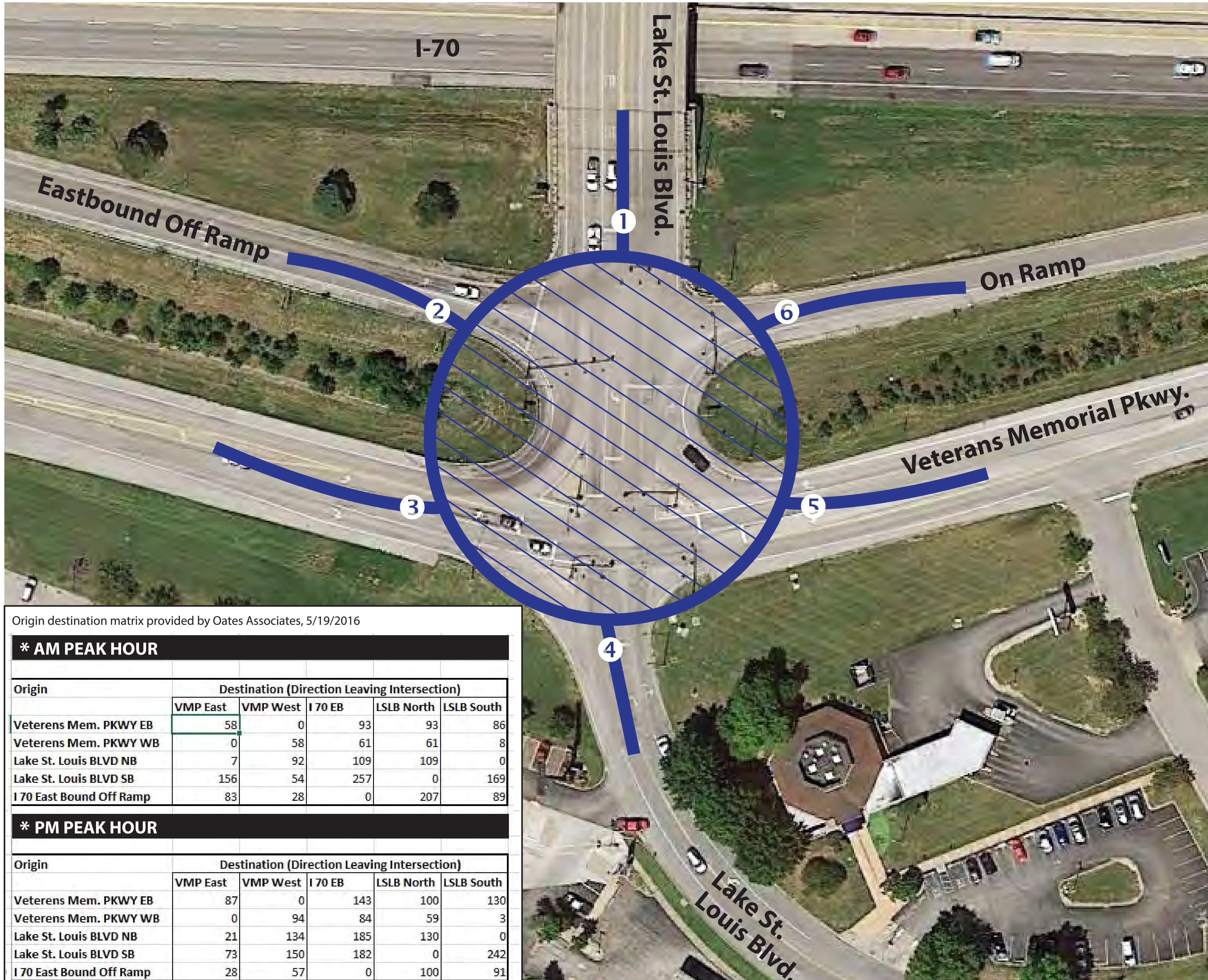
EXISTING 2015 TRAFFIC VOLUMES



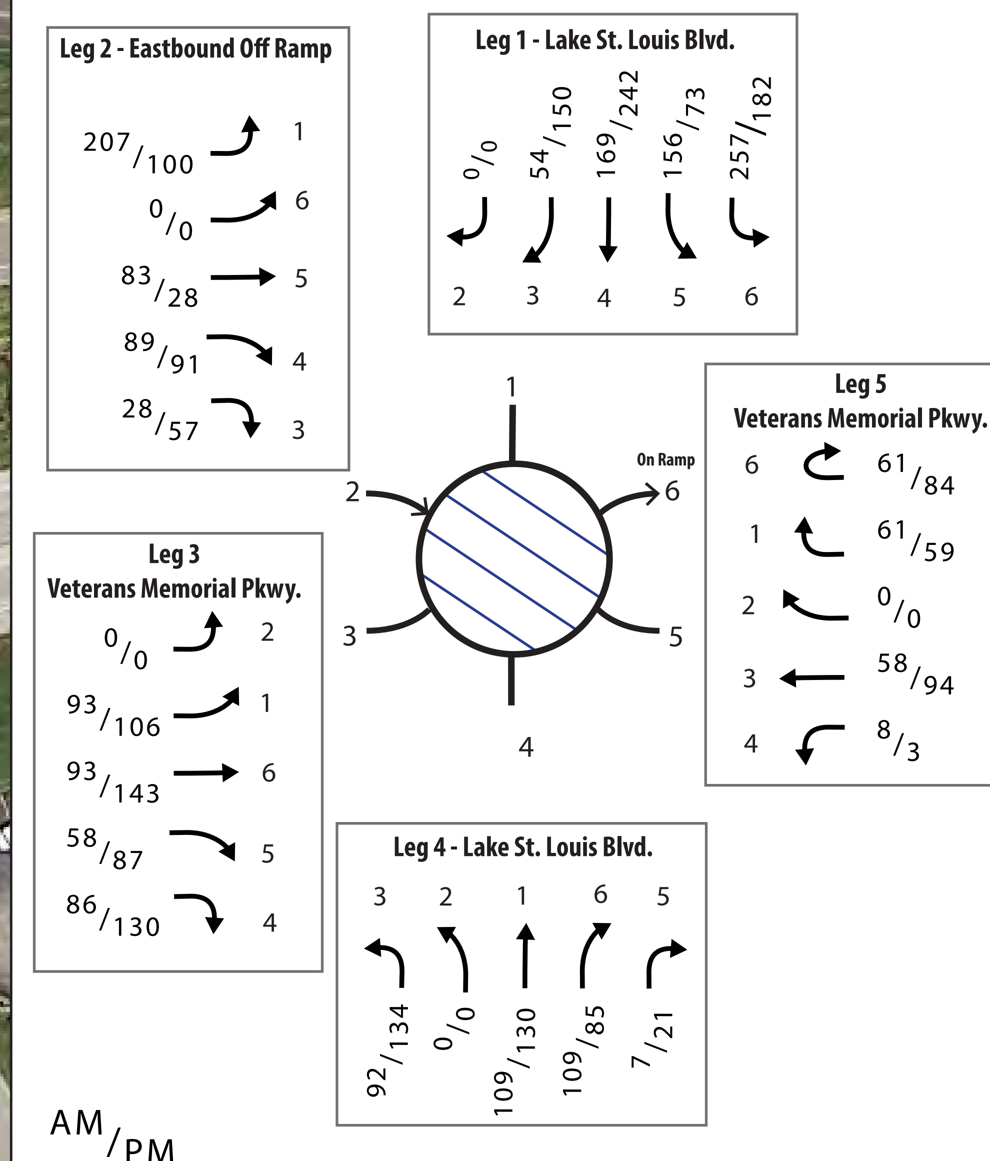
Origin destination matrix provided by Oates Associates, 5/19/2016

* AM PEAK HOUR

Origin	Destination (Direction Leaving Intersection)				
	VMP East	VMP West	I 70 EB	LSLB North	LSLB South
Veterens Mem. PKWY EB	58	0	93	93	86
Veterens Mem. PKWY WB	0	58	61	61	8
Lake St. Louis BLVD NB	7	92	109	109	0
Lake St. Louis BLVD SB	156	54	257	0	169
I 70 East Bound Off Ramp	83	28	0	207	89

* PM PEAK HOUR

Origin	Destination (Direction Leaving Intersection)				
	VMP East	VMP West	I 70 EB	LSLB North	LSLB South
Veterens Mem. PKWY EB	87	0	143	100	130
Veterens Mem. PKWY WB	0	94	84	59	3
Lake St. Louis BLVD NB	21	134	185	130	0
Lake St. Louis BLVD SB	73	150	182	0	242
I 70 East Bound Off Ramp	28	57	0	100	91



* Turning movements diagram developed by MTJ Roundabout Engineering.
Based on origin destination matrix provided by Oates Associates, 5/19/2016.

LAKE ST. LOUIS BLVD./VETERANS MEMORIAL PKWY/I-70
LAKE ST. LOUIS, MO

TRAFFIC ANALYSIS ALT B
5.24.2016

Scale: NTS

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ALT B-1 Sketch Design

Single Six-Leg Roundabout

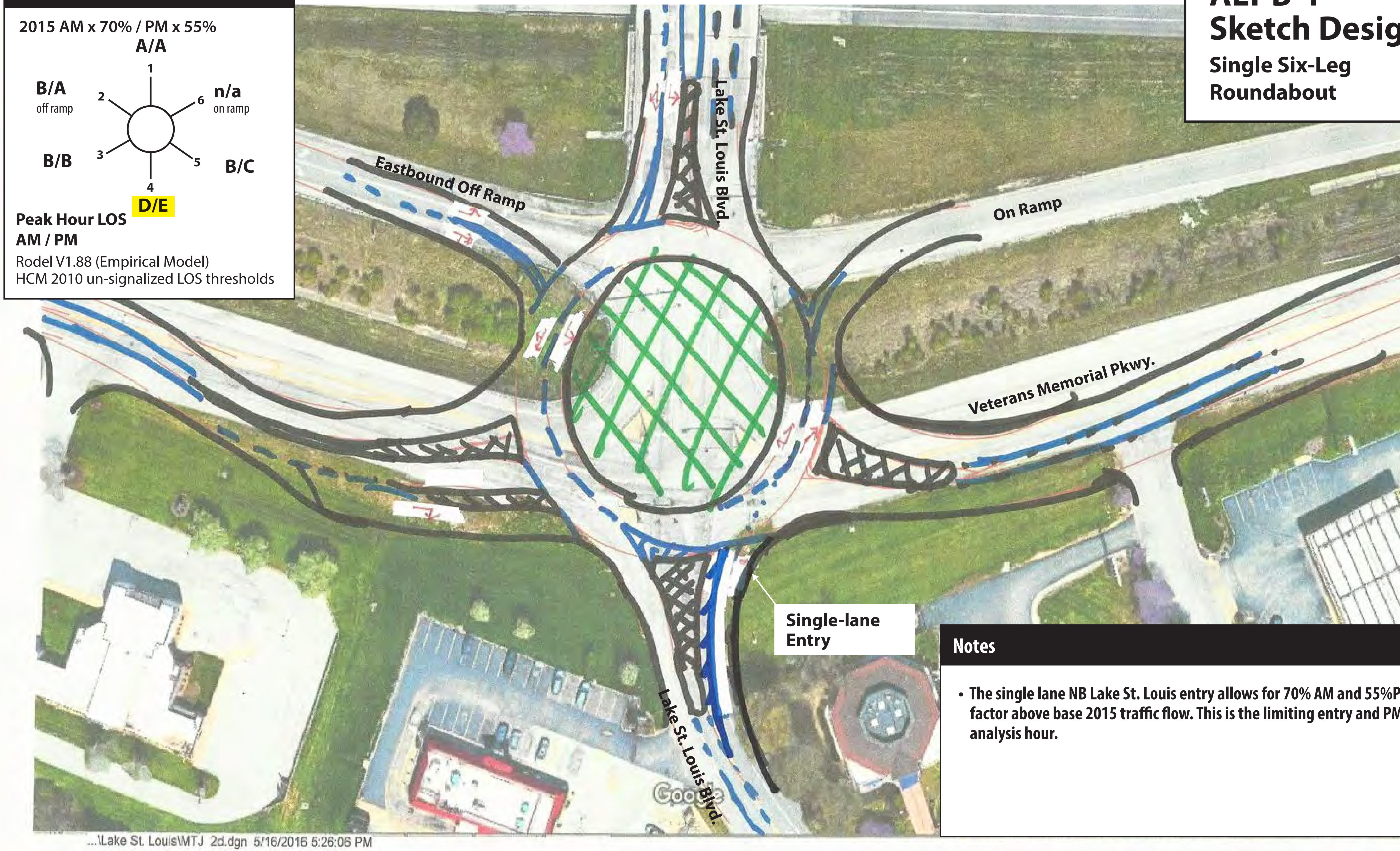
Operational Results

2015 AM x 70% / PM x 55%

Leg	Peak Hour LOS AM / PM
1	A/A
2 (off ramp)	B/A
3	B/B
4	D/E
5	B/C
6 (on ramp)	n/a

Peak Hour LOS
AM / PM

Rodel V1.88 (Empirical Model)
HCM 2010 un-signalized LOS thresholds



Notes

- The single lane NB Lake St. Louis entry allows for 70% AM and 55%PM inflation factor above base 2015 traffic flow. This is the limiting entry and PM peak is critical analysis hour.

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ALT B-2
Sketch Design
Single Six-Leg Roundabout

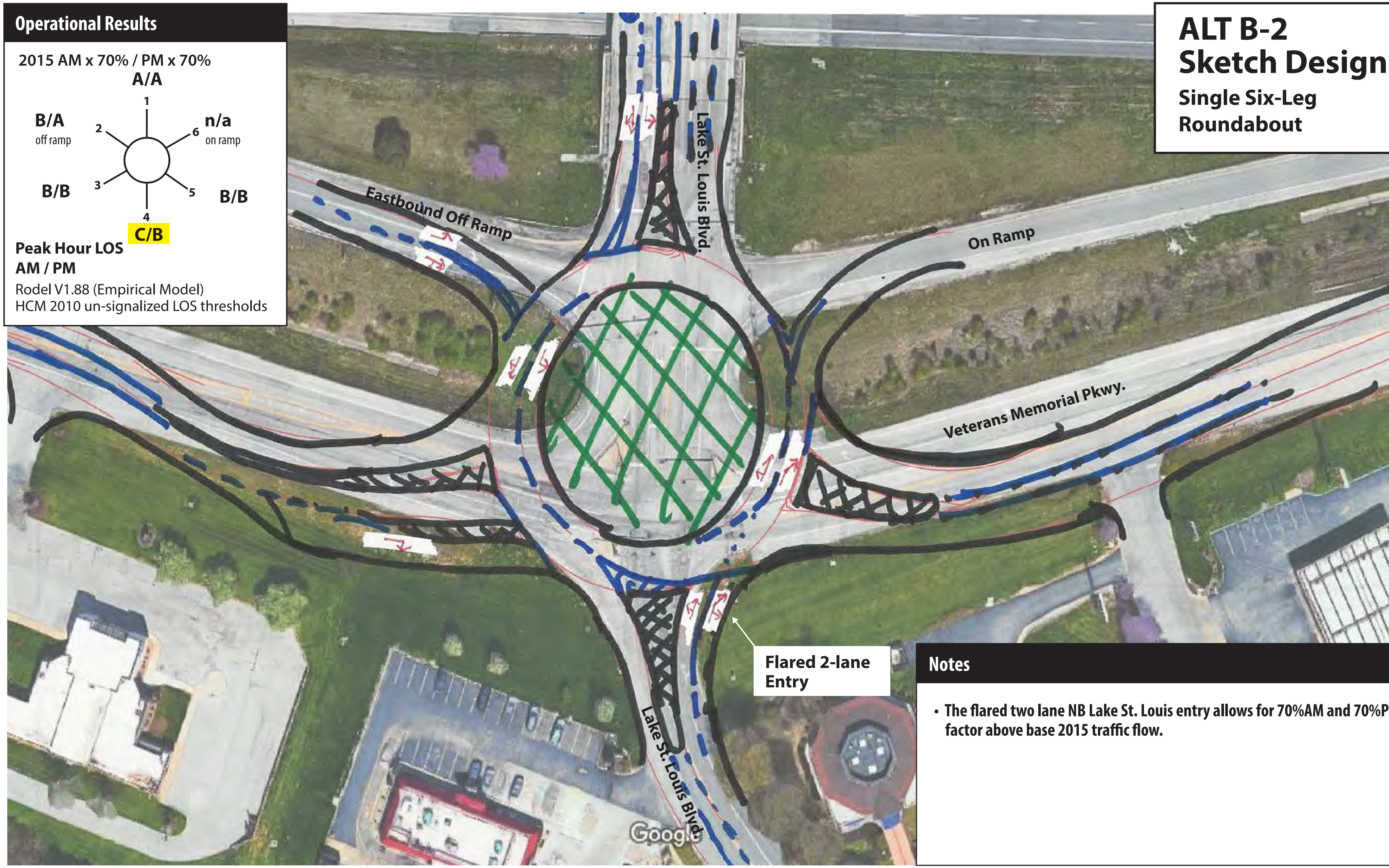
Operational Results

2015 AM x 70% / PM x 70%

Leg	Peak Hour LOS AM / PM
1	A/A
2 (off ramp)	B/A
3	B/B
4	C/B
5	B/B
6 (on ramp)	n/a

Peak Hour LOS
AM / PM

Rodel V1.88 (Empirical Model)
HCM 2010 un-signalized LOS thresholds



Notes

- **The flared two lane NB Lake St. Louis entry allows for 70%AM and 70%PM inflation factor above base 2015 traffic flow.**

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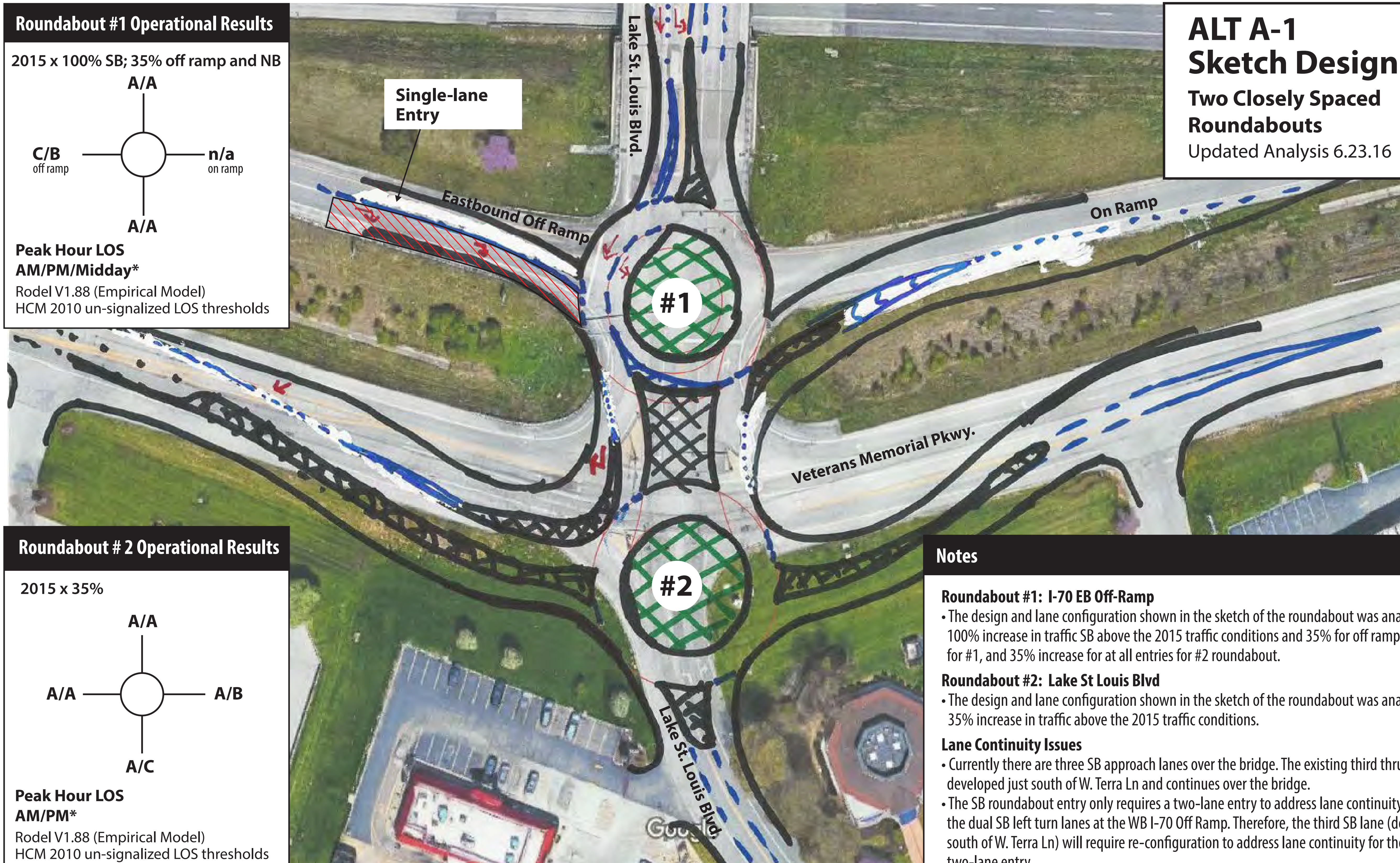
APPENDICES B

SUBSEQUENT ANALYSIS

ALT A-1 Sketch Design

Two Closely Spaced Roundabouts

Updated Analysis 6.23.16



Roundabout #1 Operational Results

2015 x 100% SB; 35% off ramp and NB

	A/A	
C/B (off ramp)		n/a (on ramp)
	A/A	

Peak Hour LOS AM/PM/Midday*

Rodel V1.88 (Empirical Model)
HCM 2010 un-signalized LOS thresholds

Roundabout # 2 Operational Results

2015 x 35%

	A/A	
A/A		A/B
	A/C	

Peak Hour LOS AM/PM*

Rodel V1.88 (Empirical Model)
HCM 2010 un-signalized LOS thresholds

Notes

Roundabout #1: I-70 EB Off-Ramp

- The design and lane configuration shown in the sketch of the roundabout was analyzed with a 100% increase in traffic SB above the 2015 traffic conditions and 35% for off ramp and NB entry for #1, and 35% increase for at all entries for #2 roundabout.

Roundabout #2: Lake St Louis Blvd

- The design and lane configuration shown in the sketch of the roundabout was analyzed with a 35% increase in traffic above the 2015 traffic conditions.

Lane Continuity Issues

- Currently there are three SB approach lanes over the bridge. The existing third thru lane is developed just south of W. Terra Ln and continues over the bridge.
- The SB roundabout entry only requires a two-lane entry to address lane continuity necessary for the dual SB left turn lanes at the WB I-70 Off Ramp. Therefore, the third SB lane (developed south of W. Terra Ln) will require re-configuration to address lane continuity for the proposed two-lane entry.
- NB over bridge can remain as is with the single-lane exit from the roundabout widening to accommodate the existing three NB lanes.

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ALT B-1 Sketch Design

Single Six-Leg Roundabout - Updated Analysis

Updated Analysis 6.23.16

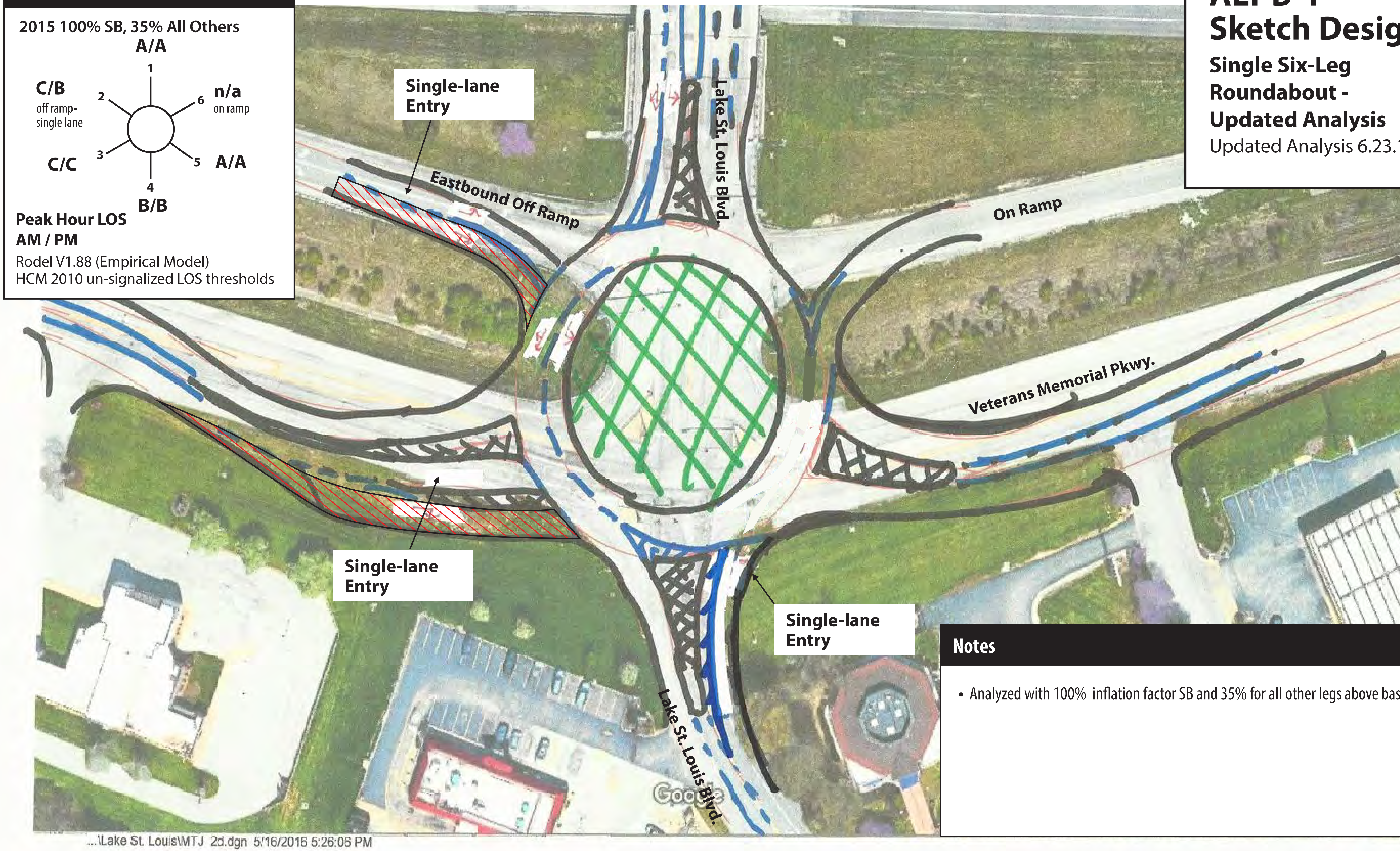
Operational Results

2015 100% SB, 35% All Others

- 1: A/A
- 2: C/B (off ramp-single lane)
- 3: C/C
- 4: B/B
- 5: A/A
- 6: n/a (on ramp)

Peak Hour LOS AM / PM

Rodel V1.88 (Empirical Model)
HCM 2010 un-signalized LOS thresholds



Notes

- Analyzed with 100% inflation factor SB and 35% for all other legs above base 2015 traffic flow.

LAKE ST. LOUIS BLVD./VETERANS MEMORIAL PKWY/I-70
LAKE ST. LOUIS, MO

UPDATED TRAFFIC ANALYSIS ALT B-1 SKETCH DESIGN
6.23.2016

Scale: NTS

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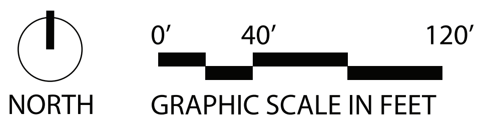
APPENDICES C
"Highly Developed Concept Design"
Alternative B
6 Legged Roundabout

- Fast Path Analysis
- Truck Turn Templates (WB 62)



ROUNDABOUT LAYOUT

LAKE ST. LOUIS BLVD & VETERANS MEMORIAL HWY_LAKE ST. LOUIS, MISSOURI

09.28.16

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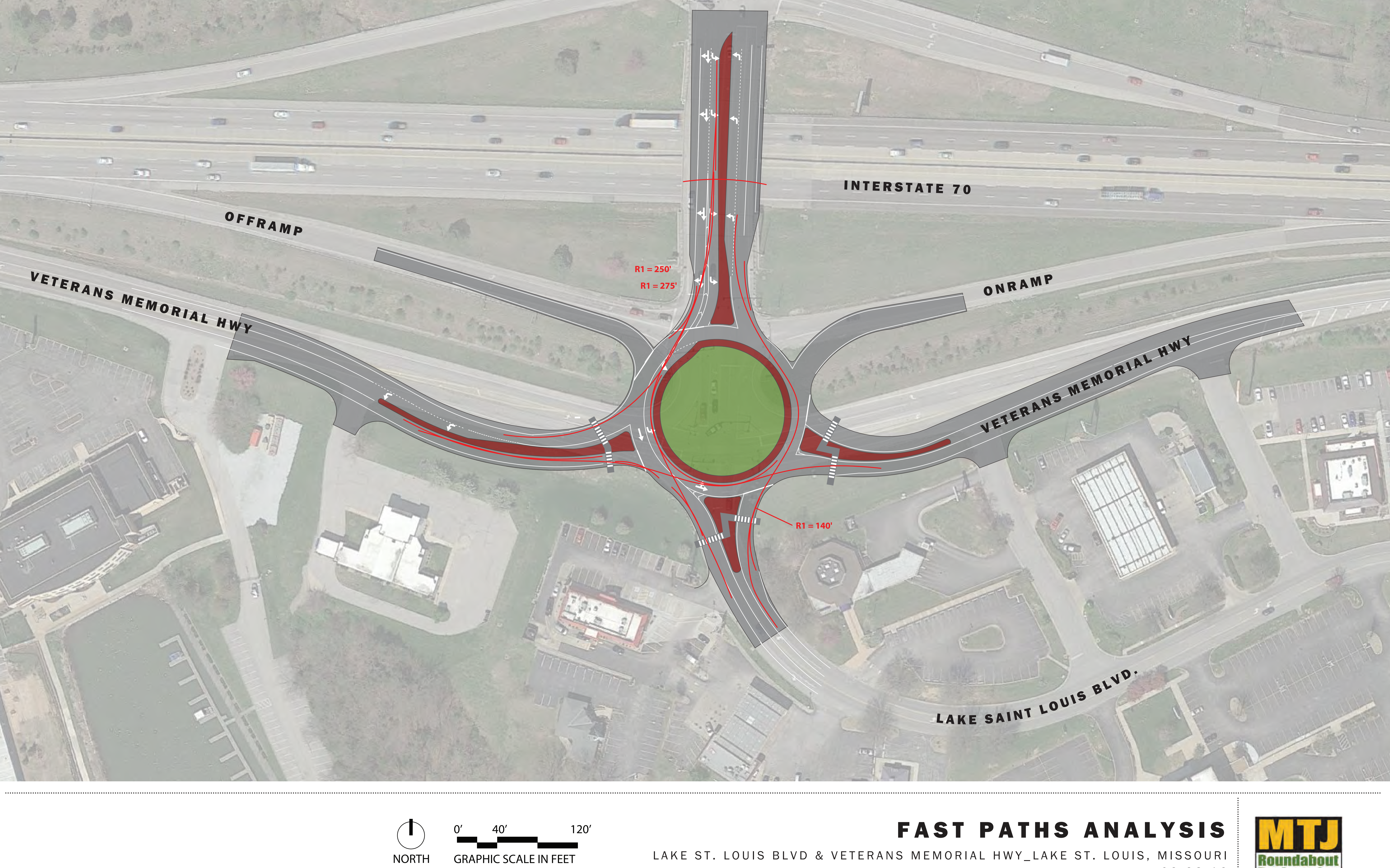

FAST PATHS ANALYSIS

LAKE ST. LOUIS BLVD & VETERANS MEMORIAL HWY_LAKE ST. LOUIS, MISSOURI

09.28.16

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TRUCK ANALYSIS_WB 62

LAKE ST. LOUIS BLVD & VETERANS MEMORIAL HWY_LAKE ST. LOUIS, MISSOURI

09.28.16

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APPENDIX B

Synchro Analysis of Signalized Intersection North of I-70

Overview of Synchro Analysis
Lake St. Louis Boulevard Intersection with Westbound I-70 Ramps & W. Terra Lane

A Synchro Analysis was completed for the signalized intersections immediately north of the study area to determine the impacts of the anticipated traffic growth and whether this would impact either roundabout alternative being considered on Lake St. Louis Boulevard south of I-70. The program used to model the impacts was Synchro (v. 9.1).

For comparison purposes two models were created, one for each roundabout alternative, to get an overview of potential impacts on each alternative. While the roundabouts were included in this analysis, it is important to note that Synchro uses the Highway Capacity Manual (HCM) model, which is a low definition model. For the detailed operational analysis of the roundabout alternative, see the Rodel analysis in Appendix A. The Rodel analysis completed for this study used a lane based geometric model, which is a high definition model.

The intersections that were modeled include: Lake St. Louis Boulevard and W. Terra Lane; Lake St. Louis Boulevard and the westbound I-70 ramps; eastbound I-70 ramps; and Lake St. Louis Boulevard and Veterans Memorial Parkway. The primary objectives for this analysis were to determine how the dual left turn lanes from the westbound I-70 off ramp were impacted by each alternate and whether there was potential for northbound and southbound queueing across the I-70 bridge.

When analyzing the network certain assumptions were made to simplify the model. The signal timings were optimized to reduce total network delay. They were also modeled as two coordinated and fully actuated signals. The traffic entering the study area was assumed to be fully random without any platooning because there are no signals in the vicinity of the network that affect traffic arrival. For comparison purposes, the northern signals were set to the same timing for both the 6-legged and double roundabout alternatives.

Alternate 1 – Two Closely Spaced Roundabouts

The first model looked at the impacts on the existing signals for the two closely spaced roundabouts alternate, see figure B-1. The dual left turn lanes off of the westbound I-70 off ramp tended to operate as a single left turn lane. The inside left turn lane appears to be undesirable to motorists since this would route them to the inside entry lane of the north roundabout, which is the access to the eastbound I-70 on ramp, unless they merged lanes while crossing over I-70. There is approximately 300 feet between the signal and the entry to the roundabout, a weaving study was not completed to determine whether it is reasonable to expect traffic to consider merging within this area.

Figure B-1: Screenshot of the signalized intersections – Synchro model

The dual left turn lanes functioning as a single lane causes the signal to perform poorly and increases delay. The 95th percentile queue length prediction for the westbound left was 382 feet. At this length, cars will begin to block the other lane options. This potential queueing issue is shown in Figure B-2.

For this scenario, the 95th percentile queue length prediction for northbound traffic approaching the signal was 119 feet. This queue length will not cause an impact to the roundabout operation. Figure B-3 shows the expected delay at the intersection.

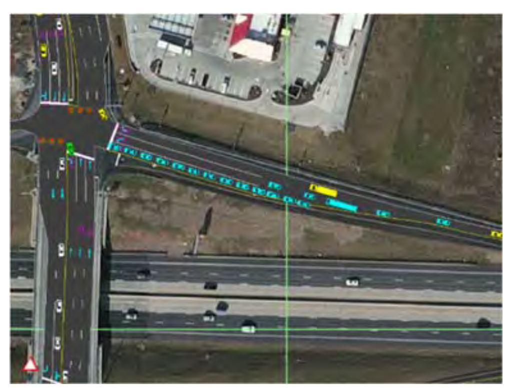
Figure B-2: Westbound I-70 Off Ramp Left Turn Lane Potential Queueing

10: WB I 70 Interchange/WB I 70 Interchange Performance by movement

Movement	WBL	WBR	NBL	NBT	SBT	SBR	All
Denied Del/Veh (s)	3.2	1.1	0.0	0.0	0.0	0.0	0.9
Total Del/Veh (s)	53.5	7.6	17.6	7.0	24.3	12.4	24.0

14: Performance by movement

Movement	EBL	EBR	NBL	NBR	SEL	SER	SER2	SWL	SWR	SWR2	All
Denied Del/Veh (s)	0.1	4.2	0.0	0.0	5.1	4.7	1.4	116.0	130.9	90.4	38.2
Total Del/Veh (s)	512.4	205.3	51.3	22.8	123.3	163.5	2.7	225.2	87.9	48.4	143.7

Total Network Performance

Denied Del/Veh (s)	20.8
Total Del/Veh (s)	95.3

Figure B-3: Two Closely Spaced Roundabouts – Model Delays

Alternate 2: 6-Legged Roundabout

The second model looked at the impacts on the existing signals for the 6-legged roundabout alternate. This analysis showed that the larger diameter roundabout better accounts for the distribution of traffic from the westbound I-70 off ramp, since the inside lane allows for traffic to access eastbound Veteran's Memorial Parkway in addition to the eastbound on ramp, or to merge and continue southbound.

At the westbound I-70 exit ramp, both dual left turn lanes are desirable because the 6-legged design offers desirable options for both southbound lanes over the bridge. The 95th percentile queue for the left turn lane prediction is 230 feet, a reduction of approximately 150 feet from the double roundabout model. All lanes on the ramp are still accessible at that length of queue.

For this scenario, the 95th percentile queue length prediction for northbound traffic approaching the signal was 94 feet, a reduction of 25 feet compared to the dual roundabout option. Neither of these queue lengths will not cause an impact to the roundabout operation. Figure B-4 shows the expected delay at the intersection.

10: WB I 70 Interchange/WB I 70 Interchange Performance by movement

Movement	WBL	WBR	NBL	NBT	SBT	SBR	All
Denied Del/Veh (s)	3.3	1.0	0.0	0.0	0.0	0.0	0.6
Total Del/Veh (s)	26.3	7.7	18.2	6.0	9.2	6.7	11.0

14: Performance by movement

Movement	EBL	EBR	NBL2	NBL	NBR	SEL	SER	SER2	SWL	SWR	SWR2	All
Denied Del/Veh (s)	0.6	3.9	0.0	0.0	0.0	0.2	0.3	0.1	34.6	42.1	40.3	9.3
Total Del/Veh (s)	243.7	23.9	53.0	51.6	11.5	162.3	112.9	3.8	156.3	60.7	42.4	101.6

Total Network Performance

Denied Del/Veh (s)	12.4
Total Del/Veh (s)	93.1

Figure B-4: 6-Legged Roundabout – Model Delays

Conclusions

After analyzing the results for both alternates, it appears the 6-legged roundabout will have less impact on the signalized intersection at Lake St. Louis Boulevard and the westbound I-70 off ramp. The model for the two closely spaced roundabouts predicted a queueing length of 382 feet on the westbound I-70 off ramp due to vehicles favoring the outside lane, compared to a predicted queueing length of 230 feet for the 6-legged roundabout alternate. Also, Figures B-2 and B-5 show that the 6-legged roundabout had a predicted delay for the westbound left at the I-70 exit ramp of 26.3 seconds compared to the 53.5 seconds for the two closely spaced roundabouts alternate.

APPENDIX C

Cost Estimates

PROJECT	**LAKE ST. LOUIS**	**OATES ASSOCIATES, INC.**	
	ALTERNATE 1 -	**PROJECT NO.**	**15182**
	TWO ROUNDABOUTS	**DATE**	**8/5/2016**

DESCRIPTION: **INTERSECTION IMPROVEMENTS - ROUNDABOUT**

ESTIMATE OF PROBABLE CONSTRUCTION COST **2016 DOLLARS**

ELIGIBLE ITEMS

QTY.	UNIT	ITEM	UNIT PRICE		COST
1	L SUM	REMOVAL OF IMPROVEMENTS	$160,000	$	160,000
6,500	CU YD	EARTH/FURNISHED EXCAVATION	$10	$	65,000
2.0	ACRE	SEEDING	$10,000	$	20,000
6,500	SQ YD	TYPE 5 AGGREGATE BASE,12"	$10	$	65,000
6,500	SQ YD	FULL DEPTH PAVEMENT (ASPHALT), 12"	$75	$	487,500
1,350	SQ YD	ASPHALT SHOULDERS	$45	$	60,750
15	EACH	INLETS	$1,250	$	18,750
760	FOOT	STORM SEWERS	$50	$	38,000
1,000	FOOT	BARRIER CURB & GUTTER	$30	$	30,000
1,000	FOOT	MOUNTABLE CURB & GUTTER	$25	$	25,000
4,500	SQ FT	RAISED CONC MEDIAN W/ CURB & GUTTER	$10	$	45,000
1,300	SQ YD	CONCRETE PAVEMENT 8" (STAMPED)	$80	$	104,000
1	L SUM	MOBILIZATION	5%	$	66,600
1	L SUM	TRAFFIC CONTROL AND PROTECTION	$100,000	$	100,000
600	SQ FT	SIGN PANEL	$50	$	30,000
100	SQ FT	PAVEMENT MARKING - LETTERS & SYMBOLS	$25	$	2,500
3,500	FOOT	PAVEMENT MARKING - LINE 4"	$5	$	17,500
	L SUM	MISCELLANEOUS CONSTRUCTION	20%	$	222,000
SUBTOTAL ESTIMATED CONSTRUCTION COST				**$**	**1,560,000**

PROJECT	**LAKE ST. LOUIS**	**OATES ASSOCIATES, INC.**	
	ALTERNATE 2 -	**PROJECT NO.**	**15182**
	6 LEG ROUNDABOUT	**DATE**	**8/5/2016**

DESCRIPTION: **INTERSECTION IMPROVEMENTS - ROUNDABOUT**

ESTIMATE OF PROBABLE CONSTRUCTION COST **2016 DOLLARS**

ELIGIBLE ITEMS

QTY.	UNIT	ITEM	UNIT PRICE		COST
1	L SUM	REMOVAL OF IMPROVEMENTS	$160,000	$	160,000
5,000	CU YD	FURNISHED EXCAVATION	$10	$	50,000
2.0	ACRE	SEEDING	$10,000	$	20,000
5,600	SQ YD	TYPE 5 AGGREGATE BASE,12"	$10	$	56,000
5,600	SQ YD	FULL DEPTH PAVEMENT (ASPHALT), 12"	$75	$	420,000
1,200	SQ YD	ASPHALT SHOULDERS	$45	$	54,000
15	EACH	INLETS	$1,250	$	18,750
780	FOOT	STORM SEWERS	$50	$	39,000
1,000	FOOT	BARRIER CURB & GUTTER	$30	$	30,000
530	FOOT	MOUNTABLE CURB & GUTTER	$25	$	13,250
5,000	SQ FT	RAISED CONC MEDIAN W/ CURB & GUTTER	$10	$	50,000
1,050	SQ YD	CONCRETE PAVEMENT 8" (STAMPED)	$80	$	84,000
1	L SUM	MOBILIZATION	5%	$	60,100
1	L SUM	TRAFFIC CONTROL AND PROTECTION	$100,000	$	100,000
900	SQ FT	SIGN PANEL	$50	$	45,000
150	SQ FT	PAVEMENT MARKING - LETTERS & SYMBOLS	$25	$	3,750
3,500	FOOT	PAVEMENT MARKING	$5	$	17,500
	L SUM	MISCELLANEOUS CONSTRUCTION	20%	$	200,000
SUBTOTAL ESTIMATED CONSTRUCTION COST				**$**	**1,420,000**

APPENDIX D

Existing Ground Level Photographs

Lake St. Louis Boulevard at Veterans Memorial Parkway looking north

Lake St. Louis Boulevard at Veterans Memorial Parkway looking south

Lake St. Louis Boulevard north of the I-70 interchange looking north

Lake St. Louis Boulevard north of the I-70 interchange looking south

Lake St. Louis Boulevard at the I-70 interchange looking west

Lake St. Louis Boulevard at the I-70 interchange looking east

Lake St. Louis Boulevard south of the study area looking north

Westbound Veterans Memorial Parkway queuing at Lake St. Louis Boulevard

Veterans Memorial Parkway at Lake St. Louis Boulevard looking west

Veterans Memorial Parkway at Lake St. Louis Boulevard looking east

Existing utilities in the southeast quadrant of the study area

Existing traffic signal utilities to be removed