APPENDIX D

Traffic Accident and Safety Data

The National Environmental Policy Act (NEPA), 42 U.S.C. §§ 4321-4370f, requires that this analysis of the proposed project must consider and discuss its effects and impacts on mankind, and its effects and impacts on plants, animals, resources, and the natural world in general. One of the key elements to be discussed in any NEPA analysis of a proposed highway project is its effects and impacts on the safety of those who use those highways. However, Congress has recognized that even while this document summarizes and presents traffic accident and safety information for the general benefit of the public, pursuant to federal law, some people may attempt to use the information to establish federal, state or local liability in lawsuits arising from highway accidents. Congress has enacted a law, 23 USC Section 409, Section 409, which prohibits the discovery or use, in litigation, of highway accident and safety data, developed under federal law to make highway safety improvements. Congress's rationale is obvious: the safety data was compiled and collected at their request, to help prevent future accidents, injuries and death on our nation's highways. If that information can be used in expensive damage suits, then the millions of dollars that litigation may cost MoDOT and local governments will not be available for their use to make Missouri's highways safer. The collection of this safety data should be encouraged, not discouraged.

Traffic accident statistics and safety data are compiled, presented and summarized in portions of this NEPA document. Where noted in an introductory footnote to a segment of this document, the discussions, reports, lists, tables, diagrams and data presented throughout that chapter, unit, section or subsection were compiled or collected for the purpose of identifying, evaluating or planning the safety enhancement of potential accident sites or hazardous roadway conditions pursuant to federal law. Thus, that information and its supporting reports, schedules, lists, tables, diagrams and data are not subject to discovery, and they are prohibited by federal law (23 USC § 409) from being admitted into evidence in a federal or state court proceeding, or from being considered for other purposes, in any action for damages arising from an occurrence on the highways, intersections or interchanges discussed in this document.

Rex Whitton Expressway Traffic Analysis: Design Year (2035) Conditions for Initial Concepts Considered

PREPARED FOR: HNTB

PREPARED BY: CH2M HILL

COPIES: Project File

DATE: December 3, 2007

Overview

The Missouri Department of Transportation (MoDOT) is investigating the need for adding capacity to the Rex Whitton Expressway (US 50) in Jefferson City, Missouri. The Whitton corridor extends from Bolivar Street on the west end to Eastland Drive on the east end. Within the study area, the Whitton Expressway cuts through the heart of Jefferson City. As part of this study, traffic operations have been analyzed on the existing Whitton Expressway and the initial concepts that were consideration.

This memo is a brief summary of the results obtained for the traffic analyses conducted on the range of initial alternatives (including the no-build alternative) discussed in the project's Draft Environmental Impact Statement (DEIS). The initial concepts considered include a variety of solutions to address the purpose and need for the project.

For the purposes of this summary, the initial concepts have been organized into two geographic sections: West of Jackson Street and East of Jackson Street.

- The West of Jackson Street section extends from the western terminus at Bolivar Street through Jefferson, Madison, and Monroe (the "triplets").
- The East of Jackson Street section extends from Lafayette to the eastern terminus at Eastland Drive.

Level of Service (LOS) analyses were performed on the range of build alternatives along with the no-build alternative, in order to evaluate and compare their operational performance. The remainder of this memo summarizes the results of these analyses.

Level of Service Analysis for Rex Whitton Concepts

Utilizing projected traffic volumes provided by MoDOT and the Problem Definition Study, operational analyses were conducted for each of the alternatives. Highway Capacity Software (HCS), Synchro, and SimTraffic were utilized to evaluate and model the various locations for each alternative. In all cases, the PM peak hour represents the design hour LOS. The results for each alternative are discussed in the following sections.

Concepts West of Jackson Street

A variety of alternatives were considered at the Missouri Boulevard intersection, including both grade separated interchange configurations and at-grade signalized intersection configurations. Table 1 below depicts the results for each concept at Missouri Boulevard.

TABLE 1: CONCEPTS AT MISSOURI BOULEVARD

Alternative	**Design Hour LOS (2035)**	**Remarks**
No-build	F	
Max Lanes – At-grade intersection	E	The NB left from Missouri Boulevard is at LOS F. There is also excessive queueing for the WB direction on Whitton Expressway. Assumes 4 through lanes in each direction on RWE.
Single Point Urban Interchange (SPUI)	C	Requires viaduct fly-overs to provide movements from RWE to US 63 and vice versa. Assumes Broadway closure.
Modified Diamond Interchange	C,B (south, north)	Requires a slip ramp connection from McCarty to the tri-level (no WB entrance ramp provided at MO Blvd). This connection causes significant queueing on McCarty due in part to its close proximity to existing US 63 ramp termini intersections located on McCarty.
Modified Diamond Interchange	Same as above	Same as above
Diverging Diamond	B,B (south, north)	Some queueing between termini develops during the design hour. Requires the same slip ramp connection and resulting operational problems on McCarty that are described for the Modified Diamond Interchange described above.
Minor Improvements—At-grade intersection	F	This option is not intended to be the long-term solution for Missouri Blvd. It fails under approximately 85% of the 2035 traffic volume. Depending on the rate of traffic growth, it crosses from LOS E to LOS F somewhere between 2025 and 2030.

"The Triplets" include the signalized intersections at Jefferson, Madison, and Monroe. These three closely spaced signals tend to operate as one system. One of the biggest challenges within the system is the short storage lengths available for turning vehicles on the Whitton Expressway. A variety of alternatives were developed in an attempt to improve the existing condition. The design year operational results for each are shown in Table 2 below.

TABLE 2: CONCEPTS AT "THE TRIPLETS"

Note: the LOS's shown are in the order of Jefferson/Madison/Monroe		
Alternative	**Design LOS (2035)**	**Remarks**
No-build	F/F/F	
Max Lanes (At-grade Intersections)	C/B/D	Assumes 4 through lanes in each direction on RWE.
Viaduct (Viaduct Over the Triples)	D/C/C	Assumes 2 lanes in each direction on RWE, with 1 lane in each direction plus turn lanes on the crossroads.
Parkway - Interim (Extended Left Turn System)	F /E/F	Proposes 3 lanes and dual lefts on Whitton Expressway, with 2 lanes in each direction plus shared turn lanes on crossroads. This option is not intended to be the long-term solution. Depending on the rate of growth, it could operate at LOS E for all intersections until roughly 2025.
Parkway - Future (Viaduct Over Triplets)	D/B/C	Assumes 2 lanes in each direction on RWE, with 2 lanes in each direction (no exclusive turn lanes) on the crossroads.
Madison Overpass (1-way couplet for Jefferson/Monroe)	B/-/D	Proposes 3 lanes and dual lefts on Whitton Expressway, with 2 lanes plus turn lanes on crossroads
Madison Overpass (Jefferson and Monroe remain 2-way)	E-/-/E- (both Jefferson and Monroe are very close to LOS F)	Proposes 3 lanes and dual lefts on Whitton Expressway, with 2 lanes in each direction plus shared turn lanes on crossroads. Both crossroads fail in the design year. Several movements on mainline fail in the design year. Slight increase in volume from this level will send both intersections to LOS F. The LOS E noted here requires 150 second cycle lengths. A 10% reduction in volume provides LOS D and E at Jefferson and Monroe, respectively, indicating that this concept could provide adequate operations up to 2025 and possibly even 2030. Consideration of 1-way conversion at that time would be appropriate.

For the alternatives that would include a viaduct concept over the triplets, there could be a short weaving section created between Missouri Boulevard and Jefferson (Figure 1) as well as at Monroe and a new interchange at Lafayette (Figure 2). For the peak hour (PM controlling), the westbound direction experiences significantly heavier volumes on mainline Rex Whitton Expressway and on both ramps, resulting in operational performance of LOS F for the design year at both locations. The eastbound direction is less traveled in the design hour, and would therefore not perform as poorly as the westbound section (LOS D and E). Weaving lengths in this location would be approximately 1,200 and 1,300 feet for westbound and eatbound, respectively, in Figure 1. In Figure 2, the weaving lengths would be approximately 750 and 650 feet for westbound and eastbound, respectively.

FIGURE 1: REX WHITTON EXPRESSWAY AT MISSOURI BOULEVARD AND JEFFERSON W/ VIADUCT

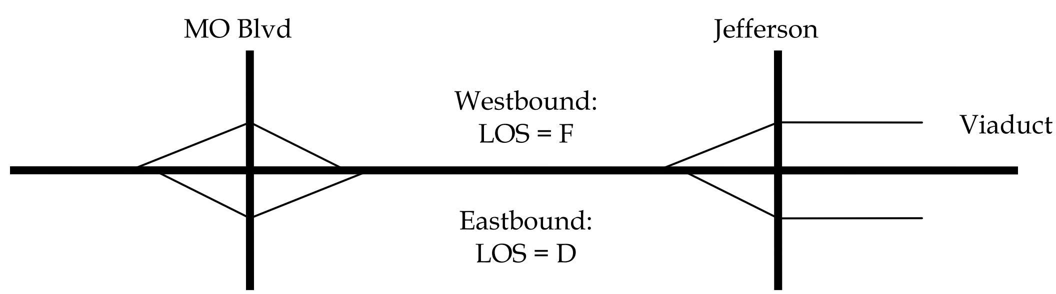
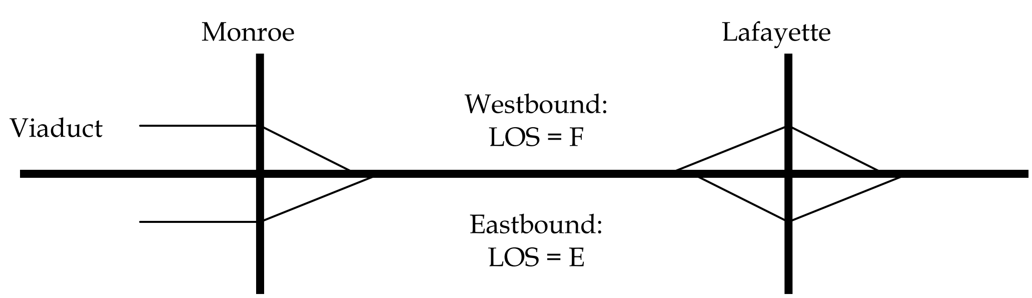


FIGURE 2: REX WHITTON EXPRESSWAY AT MONROE AND LAFAYETTE W/ VIADUCT



Concepts East of Jackson Street

The East of Jackson Street section of the corridor consists of 2 primary locations: Lafayette Street and Clark Avenue. Lafayette in the existing condition is grade-separated from the Whitton Expressway, providing no access to or from the facility. Clark in the existing condition is configured as a standard diamond interchange. There is a desire from both a capacity perspective and an access perspective to provide an interchange at Lafayette in the future. Tables 3 and 4 below provide a summary of operational results at Lafayette.

TABLE 3: CONCEPTS AT LAFAYETTE STREET

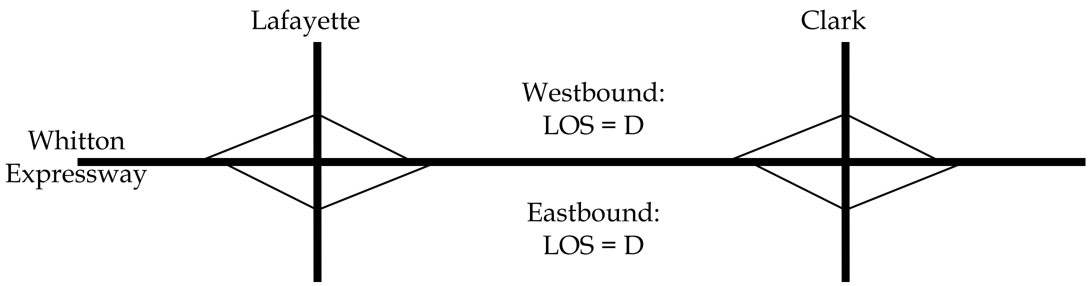
Concepts at Lafayette Street Note: the LOS's shown are for the ramp termini and are in the order of south terminus/north terminus		
Alternative	**Design LOS (2035)**	**Remarks**
No-build	---	Does not exist currently
Diamond Interchange	B/B	Assumes 4 lanes on Lafayette
Half-diamond Interchange	C/C	Assumes 2 lanes on Lafayette. Ramps to and from the west only.

TABLE 4: CONCEPTS AT CLARK AVENUE

Concepts at Clark Avenue Note: the LOS's shown are for the ramp termini and are in the order of south terminus/north terminus		
Alternative	**Design LOS (2035)**	**Remarks**
No-build	B/B	Assumes intersections have been upgraded to signalized.
Diamond Interchange w/ roundabouts	A/B	The conversion to roundabouts is not driven by capacity needs, as evidenced by the sufficient performance of the no-build in the design year. It is driven by the close proximity of adjacent frontage roads and the desire to tie them together at one single intersection.

An additional issue in this section is the operational performance of the Rex Whitton Expressway. In this area, the expressway takes on freeway characteristics. As such, examining some of the basic freeway measures of effectiveness, particularly between the closely spaced interchanges of Lafayette and Clark, will be an important consideration. In closely spaced systems like this, the worst performing element will generally control the overall performance of the broader section. For this particular configuration, the overall LOS can therefore be simply described as LOS D. Weaving lengths in this location would be approximately 500′.

FIGURE 3: REX WHITTON EXPRESSWAY AT LAFAYETTE AND CLARK



A variation of this configuration was considered as a possible future improvement at this location. That configuration was a C-D system that would pull the weaving off of mainline Rex Whitton Expressway and onto a C-D road parallel to the existing mainline expressway. From a mainline traffic perspective, the operations would improve by virtue of removing the weaving movements, but it is not necessary to do so since the basic configuration shown above will perform at LOS D in 2035. From a local road network, perspective, however, the C-D system would provide additional continuity and connectivity between Lafayette and Clark. For that reason it may have merit as a component of the future solution in this location.

Missouri State Penitentiary (MSP) Site Access

One of the key drivers for an interchange at Lafayette Street and improvements at the existing Clark Avenue interchange is a proposed development north of the Whitton Expressway on the existing Missouri State Penitentiary MSP development site. The proposed development is projected to increase the travel demand on the Whitton Expressway and consequently on Lafayette and Clark as well. While it is unclear how quickly volumes will grow to the projected levels suggested in previous studies, the numbers do provide a framework in which future capacity needs can be assessed.

In order to maximize efficiency and to avoid duplicate efforts from the Problem Definition Study, detailed travel demand forecasts were not developed as part of the current Whitton EIS study. The data from the Problem Definition Study, combined with engineering judgment, has been used to conservatively project future demand and subsequent capacity requirements. In order to understand basic capacity requirements for the new access road, the general forecasts from the previous study were used. Table 5 below depicts several scenarios and the estimated demand for each:

TABLE 5

Access Road Design Hour Volumes Note: the design hour is the PM peak in 2035		
Access Scenario	**Design Hour Volume**	**Remarks**
Access via Lafayette	3,000 vph	Assumes some volume still would trickle over to Clark interchange, even though Clark not extended all the way to the MSP development site.
Access via Clark realignment	3,600 vph	Assumes no access to/from Whitton Expressway at Lafayette.
Access via Lafayette ***and*** Clark realignment	1,800 vph Lafayette 1,800 vph Clark	Assumes that the total volume would roughly split 50/50 between the two, and that the 3,600 for the “Clark-only” scenario represents the most conservative projection.

To determine basic capacity requirements given the estimates of future volumes described in Table 5, Chapter 10 of the Highway Capacity Manual (HCM) was consulted. This section of the HCM deals with urban street capacity methodology and provides guidance on a variety of urban street capacity issues, including basic sizing of “typical” facilities. Exhibit 10-7 provides volume/LOS thresholds for various “classes” of urban streets. A variety of assumptions are built into the Exhibit and it is not a prescription for the exact condition of the access road alternatives, but it does provide a good estimate of future capacity requirements. The exhibit is depicted in Table 6 on the following page.

Table 6: Exhibit 10-7 from HCM

Lanes	Service Volumes (veh/h)				
	A	B	C	D	E
			Class I		
1	N/A	860	930	1020	1140
2	N/A	1720	1860	2030	2280
3	N/A	2580	2780	3050	3430
4	N/A	3450	3710	4060	4570
			Class II		
1	N/A	N/A	670	850	890
2	N/A	N/A	1470	1700	1780
3	N/A	N/A	2280	2550	2670
4	N/A	N/A	3090	3400	3560
			Class III		
1	N/A	N/A	480	780	850
2	N/A	N/A	1030	1600	1690
3	N/A	N/A	1560	2410	2540
4	N/A	N/A	2140	3220	3390
			Class IV		
1	N/A	N/A	540	780	800
2	N/A	N/A	1200	1570	1620
3	N/A	N/A	1900	2370	2430
4	N/A	N/A	2610	3160	3250

It is assumed that the access road will be either Class III or Class IV – lower speed roads with greater frequency of traffic signals (Class III is assumed to have a free-flow speed of 35 mph; Class IV = 30 mph). Given this, there are some basic conclusions that can be drawn:

- Lafayette without a Clark realignment will require 4 lanes in the design year 2035
- Clark realignment without a Lafayette interchange will require 4 lanes in the design year 2035 (both a single 4-lane facility and a 1-way couplet [2+2] were considered for this function)
- The combination of Lafayette and Clark realignment will require somewhere in the range of 2-3 lanes for both Lafayette and Clark.

With those general capacity targets in mind, three basic alternatives were considered to provide the MSP access road function:

- Expanding Lafayette to 4 lanes
- Extending a realigned Clark north to the new site as a 4-lane facility with no new interchange at Lafayette
- Keeping Lafayette as a 2-lane facility and extending a realigned Clark, but only as a 2-lane facility

In terms of traffic operations, the first two would operate in very similar fashion. Both would be 4-lane roads carrying comparable volumes. The third option would not require widening of the existing facilities. Over time, if volume under the third scenario were to increase faster than anticipated, the two roads could be converted to a 1-way couplet with two lanes on each. Such a conversion would have more than sufficient capacity for future volumes and would improve traffic signal efficiency along the local road network.

Rex Whitton Expressway Lafayette Interchange Analysis

PREPARED FOR: HNTB

PREPARED BY: CH2M HILL

COPIES: File

DATE: May 23, 2008

Introduction

The purpose of the memorandum is to document the findings and recommendations regarding roundabout treatments at the future Lafayette interchange along the Rex Whitton Expressway in Jefferson City, MO. This analysis included looking at three alternatives. The first alternative is considered the baseline and would provide signalized intersections at the two ramp terminals. The second alternative provides a series of single lane roundabouts, and the third alternative is the same as the second alternative; however, it would provide peak period signalization at each of the roundabouts. A brief discussion about the analysis and our findings for each alternative are presented below.

Alternative 1: Signalized Ramp Terminals

The signalized ramp terminals are currently part of the preferred alternative for the project and are considered to be a baseline for comparison. The baseline alternative was previously analyzed using the VISSIM software package and the detailed findings of that analysis were presented in a technical memorandum dated May 21th, 2008. That memorandum states that both the eastbound Rex Whitton Expressway Ramps/Lafayette Street and the westbound Rex Whitton Ramps/Lafayette Street will operate at LOS D in 2035. Of note, however, is that the Westbound Rex Whitton/Lafayette Street intersection does not provide enough storage on the southbound approach during the peak hour in the design year.

Results from a previous Synchro analysis also indicated that the westbound ramps would operate at with acceptable delay, but also showed that the southbound approach would operate with a v/c ratio greater than 1.00. In addition, Queuing from the SBR movement at this intersection blocks the SBT movement, further worsening operations. Consideration for lengthening the SBR turn lane should be taken.

Alternative 2: Single Lane Roundabouts

The traffic operations team also analyzed a single-lane roundabout alternative. This alternative would construct a single-lane roundabout at each of the Rex Whitton Expressway/Lafayette Street ramp terminals. The traffic analysis team used SIDRA Version 3.2 to conduct this analysis. This analysis had the following assumptions:

- Single internal circulating lane at each ramp terminal
- A 100′ island diameter with a 15′ circulating width (for a total diameter of 130′)
- The Westbound Rex Whitton Ramps/Lafayette Street intersection would have a southbound right turn bypass lane onto Westbound Rex Whitton Expressway

This analysis also assumed the same traffic volumes and vehicle compositions that were used in the signalized ramp terminal analysis.

The SIDRA analysis indicated that neither roundabout would operate at an acceptable level during the PM peak hour in 2035. At the Eastbound Rex Whitton Expressway/Lafayette Street ramps, the analysis showed this intersection would operate at LOS F with an average of 150.9 seconds of delay per vehicle. Major queuing is expected on the eastbound and northbound approaches of this intersection, with eastbound queues spilling back from the intersection onto the expressway. The eastbound and northbound approaches do not receive enough gaps because of the high southbound through movement (demand greater than 1,100 vph).

A similar situation is expected at the westbound Rex Whitton Expressway/Lafayette Street intersection. This intersection is expected to operate at LOS D with an average delay of 41.3 seconds/vehicle. At the southbound approach, vehicle queues are expected to be approximately 2,200 feet long. This analysis also shows the southbound right-turn bypass lane would be operate near capacity with a v/c ratio of 0.8 and density of 44 passenger cars-per mile-per lane (pcpmpl.)

Alternative 3: Single Lane Roundabouts with Peak Period Signalization

A qualitative analysis was conducted for the final alternative, providing a series of single-lane roundabouts with peak period signalization. Signalizing roundabouts is a relatively atypical concept, and is normally done after traffic volumes get too high for the available capacity. At the Westbound Rex Whitton ramp/Lafayette Street intersection, the southbound movement is still expected to be overcapacity even with after adding signals. Providing signalization to the northbound and westbound approaches at this intersection may provide a little operational benefit, but still would not likely allow all the southbound demand to be served. At the Eastbound Rex Whitton Ramp/Lafayette Street intersection, adding a signal to the southbound movement may open some gaps for both the eastbound and northbound ramps; however, two additional issues may arise.

1. The red time that we could provide to the southbound movement would be minimal because of the short spillback storage that exists between the eastbound and westbound ramp terminal intersections.
2. If gaps are provided by signalizing the southbound approach, the eastbound approach volumes have the potential to limit the gaps for vehicles from the northbound approach.

In general, signalizing roundabouts is not a common practice. Typically, roundabouts are recommended and constructed to keep vehicle moving and signals are only installed as a last resort prior to building a new intersection. The other difficultly with installing signals at roundabouts is the circulating traffic always has the right-of-way. Because the circulating traffic will not stop, approaching motorists may still have to yield, even under a green signal. This would be similar to permissive lefts at a standard intersection.

Conclusions

Based on the analysis results, Alternative 1 (Signals) is expected to operate the best out of the 3 alternatives in 2035 with the preferred alternative design configuration. Alternative 2 (Roundabouts) is expected to result in higher delays than Alternative 1 on the southbound movement at the westbound ramps and at the eastbound and northbound movements on the eastbound ramps. From a qualitative analysis perspective, Alternative 3 (Roundabouts with Signals) will likely not provide enough gaps to the high volume movements to cause any significant reduction in overall average vehicle delay. A further detailed quantitative analysis with VISSIM would be required to verify that results from the Alternative 3 qualitative analysis.

The analysis results also show that all of the alternatives fail to provide enough capacity to the southbound movement at westbound ramps. Regardless of which alternative is chosen, queue spillback and oversaturated conditions are expected to occur at the Lafayette westbound ramps and potentially will occur at the Lafayette eastbound ramps.

Rex Whitton Expressway(US 50/US 63) - Existing and Preferred Alternative VISSIM Model Development and Findings

PREPARED FOR: HNTB

PREPARED BY: CH2M HILL

COPIES: File

DATE: May 21, 2008

Introduction

The purpose of this memorandum is to document the findings for the traffic operations analysis of the Rex Whitton Expressway Corridor in Jefferson City, MO. The primary analysis tool that was used is the VISSIM microsimulation package. It was used to simulate arterial and freeway operations within the project study area. Two models were developed for this analysis; an existing conditions model, used to calibrate to field conditions, and a preferred alternative model.

A discussion of the model assumptions and characteristics, calibration methods, analysis measures of effectiveness (MOEs), evaluation criteria and model outputs will be presented in this memorandum.

VISSIM Model Development

Overview of VISSIM Software

VISSIM is a microscopic simulation software program that can be used to model traffic and transit systems. VISSIM uses a stochastic time step based model to implement and track the inputs to the network. Inputs to the model include roadway geometry, traffic decision systems, vehicle demand and routing, and traffic control devices (stop signs, signal controls, yield conditions). Several measures of effectiveness (MOEs) can be collected from the model for use in the evaluation of multiple transportation design and operational alternatives. Some of the common MOEs that can be collected from the model include queuing, vehicular delay, travel times, vehicle density, volumes, and average vehicle speeds.

Simulation Study Area

The project study area includes major intersections along the existing and proposed future Rex Whitton Expressway corridor. The following intersections were included in the VISSIM model:

- Rex Whitton Expressway/Missouri Blvd
- Rex Whitton Expressway/Broadway Street

- Rex Whitton Expressway/Jefferson Street
- Rex Whitton Expressway/Madison Street (Existing Conditions Only)
- Rex Whitton Expressway/Monroe Street
- Eastbound Rex Whitton Expressway Ramp/ Lafayette Street (Preferred Alternative Only)
- Westbound Rex Whitton Expressway Ramp/ Lafayette Street (Preferred Alternative Only)

In addition to the above intersections, the weaving sections between the proposed Lafayette Interchange and the existing Clark Interchanges were also included in the Preferred Alternative VISSIM model. The existing conditions model assumed average speeds of 40 mph on the expressway and an average of 30 mph on cross-streets. Under the preferred alternative, speeds were assumed to be an average of 45 mph on the expressway and an average of 30 mph on cross streets.

Figure 1 shows the VISSIM existing conditions network and the study area.

Peak Period Analysis

The VISSIM analysis was conducted for a one-hour, PM peak period.

Network Geometry & Vehicle Types

The network geometry of the existing conditions VISSIM model was developed through the use of online mapping programs such as *Live Maps.* Aerial images from the online programs were then created and imported into VISSIM as a base map for the creation of the links and connectors that represent the roadway characteristics. An existing conditions Synchro file provided by MoDOT was used to verify intersection geometrics and turn pocket lengths.

Two vehicles types were included in the VISSIM model, cars and trucks. The 'Car' vehicle type represented a vehicle with average length and acceleration and deceleration curves. The 'Truck' vehicles type was composed of a combination of heavy vehicle types including, delivery vans, dump trucks, and semi-trucks and trailers. The acceleration and deceleration rates of the 'Truck' vehicle type were based on the VISSIM default values for heavy vehicles. The VISSIM model assumed 2 percent of the vehicle composition would be trucks while the remaining 98 percent is comprised of cars.

Vehicle Volume and Routing Inputs

The VISSIM model vehicle inputs and turning movements along the arterial roadways were obtained from the existing conditions Synchro model. Peak hour volumes and turning movements were utilized in the VISSIM model. Vehicle routing decisions in VISSIM – the origin-destination pairs, were based on existing turning movement splits.

Future volume inputs and turning movement volumes for the Preferred Alternative were determined from a Year 2035 Synchro network and from a ramp volume plot provided from George Butler Associates, Inc. (*Figure E15-1 – Lafayette Street Interchange 2035 Volumes & Level of Service).* Traffic volume assumptions for the existing conditions and preferred alternative are provided in Appendix A of this technical memorandum.

FIGURE 1. REX WHITTON EXPRESSWAY STUDY AREA

Signal Timings

Existing signal timings, offsets, and phasing for the PM peak hour were obtained from the MoDOT existing conditions Synchro model. All of the signalized intersections in the study area were modeled as fully actuated - coordinated signals within the VISSIM model.

Future signal timings were based on future turning movements and roadway volumes. The future signal timing splits, cycle length, and offsets were developed and optimized using the Synchro software package. These were used as input to VISSIM to establish the basis for signal timings in the future year simulation.

Performance Measures

In order to evaluate the effectiveness of the proposed improvements, VISSIM performance data was collected and reported on segments and at individual data points along the corridor. The following output data was extracted from the VISSIM model and is shown in Tables 1 and 2.

- Average Intersection Vehicle Delay
- Queuing Impacts
- Model Volume vs. Expected Volume

The measures of effectiveness (MOEs) were used to evaluate both the existing conditions and Preferred Alternative operational performance.

Model Calibration and Validation

Calibration Overview

Model calibration and validation is a necessary step in a traffic simulation analysis. Calibration involves the modification of simulation operational parameters to reflect the prevailing conditions of the study area. Validation is the process of comparing quantitative and qualitative model output against existing field data to verify that the existing model is operating similar to the actual field conditions.

The PM peak hour Rex Whitton VISSIM model was calibrated using both qualitative and quantitative methods. The calibration effort focused on comparing model turning movement volumes to the traffic field counts collected and comparing model queuing and congestion patterns to the provided existing conditions Synchro network.

The Federal Highway Administration's *Traffic Analysis Toolbox III: Guidelines for Applying Traffic Microsimulation Modeling Software* was used to as a starting point to determine the calibration targets for the VISSIM model. The following target criteria were set as quantitative calibration goals for the PM peak hour models.

1) 85% or more of all model volume cases should be within 15% of the observed volumes for simulated volumes greater than 700 vehicles per hour

2) 85% or more of all model volume cases should be within 100 vehicles per hour for simulated volumes less than 700 vehicles per hour

The qualitative calibration involved visually inspecting the queue and congestion locations of the model in comparison to actual queues and congestion points. Based on the existing conditions Synchro network, areas where recurring congestion was present in the PM peak were replicated in the VISSIM model.

Calibration Parameter Adjustments

Two levels of calibration were conducted, a system calibration, which looks at network speeds, geometry, traffic volumes, and route choice, as well as an operational calibration, which focuses on car following and lane changing characteristics of vehicles.

System Calibration Parameters

Network speeds, geometry, traffic volumes and route choice were all examined during the base model development and error checking stages. There were no major modifications made to the system calibration parameters PM peak hour models.

Operational Calibration Parameters

In order to replicate the existing driver behavior along the Rex Whitton corridor, the VISSIM model was calibrated to the ideal saturation flow rate of 1,800 vehicles per hour per lane (vphpl) as shown in the existing conditions Synchro network. The VISSIM arterial car following operational parameters (based on Wiedemann 74) for the additive part of safety distance were modified to accurate account for the ideal vehicle saturation flow rate expected along the corridor.

Model Validation Results

VISSIM model data was compared quantitatively to the Synchro network at key turning movement locations in the VISSIM networks. Table 1 shows a comparison of the field (Synchro) turning movement volumes and the VISSIM model turning movement volumes for PM peak hour. Operational findings for the existing conditions analysis are shown in Table 2. VISSIM results were based on an average of ten simulation runs.

TABLE 1. PM PEAK HOUR VALIDATION RESULTS

Name	Movement/Approach	VISSIM Volumes	Synchro Volumes	Difference	Percent Difference
Rex Whitton and Missouri Blvd	Entire Intersection	5681	5761	-81	-1%
Missouri Blvd	Westbound	1302	1346	-45	-3%
Missouri Blvd	WBR	582	591	-9	-1%
Missouri Blvd	WBT	637	672	-35	-6%
Missouri Blvd	WBL	82	83	-1	-1%
Rex Whitton	Northbound	2162	2149	13	1%
Rex Whitton	NBR	41	42	-1	-2%
Rex Whitton	NBT	1616	1601	15	1%
Rex Whitton	NBL	505	506	-1	0%
Missouri Blvd	Eastbound	944	956	-12	-1%
Missouri Blvd	EBR	470	470	0	0%
Missouri Blvd	EBT	220	222	-2	-1%
Missouri Blvd	EBL	253	264	-11	-4%
Rex Whitton	Southbound	635	675	-40	-6%
Rex Whitton	SBR	0	0	0	n/a
Rex Whitton	SBT	520	555	-36	-7%

Name	Movement/Approach	VISSIM Volumes	Synchro Volumes	Difference	Percent Difference
Rex Whitton	SBL	115	120	-5	-4%
US 54	Southbound	639	635	4	1%
US 54	SBR	80	80	0	0%
US 54	SBT	558	555	3	1%
US 54	SBL	0	0	0	n/a
Rex Whitton and Broadway	Entire Intersection	4310	4251	59	1%
Rex Whitton	Westbound	2036	2050	-14	-1%
Rex Whitton	WBR	64	67	-3	-4%
Rex Whitton	WBT	1931	1916	15	1%
Rex Whitton	WBL	41	67	-26	-63%
Broadway	Northbound	179	182	-3	-2%
Broadway	NBR	29	31	-2	-6%
Broadway	NBT	85	84	1	1%
Broadway	NBL	64	67	-3	-4%
Rex Whitton	Eastbound	1646	1555	91	6%
Rex Whitton	EBR	102	98	4	4%
Rex Whitton	EBT	1458	1375	83	6%
Rex Whitton	EBL	86	82	4	4%
Broadway	Southbound	449	464	-15	-3%
Broadway	SBR	147	148	-1	-1%
Broadway	SBT	152	162	-10	-6%
Broadway	SBL	150	154	-4	-2%
Rex Whitton and Jefferson	Entire Intersection	4216	4248	-32	-1%
Rex Whitton	Westbound	1955	1788	167	9%
Rex Whitton	WBR	30	26	4	13%
Rex Whitton	WBT	1853	1693	160	9%
Rex Whitton	WBL	73	69	4	5%
Jefferson	Northbound	230	243	-13	-6%
Jefferson	NBR	72	78	-6	-8%
Jefferson	NBT	111	112	-1	-1%
Jefferson	NBL	47	53	-6	-13%
Rex Whitton	Eastbound	1641	1809	-168	-10%
Rex Whitton	EBR	20	25	-5	-27%
Rex Whitton	EBT	1582	1741	-159	-10%
Rex Whitton	EBL	39	43	-4	-9%
Jefferson	Southbound	390	408	-18	-5%
Jefferson	SBR	158	164	-6	-4%
Jefferson	SBT	176	188	-12	-7%
Jefferson	SBL	56	56	0	0%
Rex Whitton and Madison	Entire Intersection	4320	4041	279	6%
Rex Whitton	Westbound	1960	1721	239	12%
Rex Whitton	WBR	28	22	6	20%
Rex Whitton	WBT	1781	1556	225	13%
Rex Whitton	WBL	151	143	8	5%
Madison	Northbound	285	305	-20	-7%

Name	Movement/Approach	VISSIM Volumes	Synchro Volumes	Difference	Percent Difference
Madison	NBR	105	116	-11	-10%
Madison	NBT	129	132	-3	-2%
Madison	NBL	51	57	-6	-12%
Rex Whitton	Eastbound	1708	1632	76	4%
Rex Whitton	EBR	20	20	0	-1%
Rex Whitton	EBT	1653	1580	73	4%
Rex Whitton	EBL	35	32	3	9%
Madison	Southbound	367	383	-16	-4%
Madison	SBR	126	132	-6	-5%
Madison	SBT	208	219	-11	-5%
Madison	SBL	33	32	1	3%
Rex Whitton and Monroe	Entire Intersection	4145	3959	186	4%
Rex Whitton	Westbound	1667	1543	124	7%
Rex Whitton	WBR	22	18	4	18%
Rex Whitton	WBT	1587	1472	115	7%
Rex Whitton	WBL	58	53	5	8%
Monroe	Northbound	147	145	2	1%
Monroe	NBR	40	39	1	1%
Monroe	NBT	30	29	1	3%
Monroe	NBL	78	77	1	1%
Rex Whitton	Eastbound	1790	1682	108	6%
Rex Whitton	EBR	35	33	2	5%
Rex Whitton	EBT	1639	1541	98	6%
Rex Whitton	EBL	117	108	9	7%
Monroe	Southbound	541	589	-48	-9%
Monroe	SBR	272	292	-20	-7%
Monroe	SBT	83	92	-9	-10%
Monroe	SBL	186	205	-19	-10%

Future Alternative Analysis

Preferred Alternative Analysis Assumptions

As part of the Rex Whitton study, the preferred alternative was analyzed using VISSIM to gauge its effectiveness against existing conditions. The base year for the preferred alternative was assumed to be 2035.

The following major network changes were assumed under the Year 2035 preferred alternative.

- Construct a full diamond interchange at Lafayette Street
- Provide an additional through lane on the Rex Whitton Expressway between Broadway Street and the west ramps of the Lafayette Interchange
- Convert Jefferson Street and Monroe Street into a one-way couplet
- Remove access to Madison Street from the Rex Whitton Expressway
- Provide additional intersection improvements, such as lengthening, removing and/or adding turn pockets at study intersections.

Figure 2 illustrates the preferred alternative VISSIM network in context with the existing conditions aerial background and design drawings.

Preferred Alternative Modeling Assumptions

Under the preferred alternative model, intersection turning movement volumes were based on the year 2035 preferred alternative Synchro model and interchange volume plots. This modeling effort also assumed ramp-to-ramp traffic between the Clark interchange and the proposed Lafayette interchange would be negligible. Moreover, the VISSIM model assumes 50 percent of the approach volume at the Rex Whitton Expressway/Missouri Blvd intersection from US 54 and the remaining 50 percent arrives from US 50.

Other model inputs, such as truck percentages, vehicle speeds and driver behavior parameters, remained the same as existing conditions unless if it is specifically mentioned previously in this memorandum.

Preferred Alternative Results and Findings

Table 2 shows the findings for the Year 2035 preferred alternative and the existing conditions analyses. A brief discussion describing the operations for each intersection is also provided below Table 2.

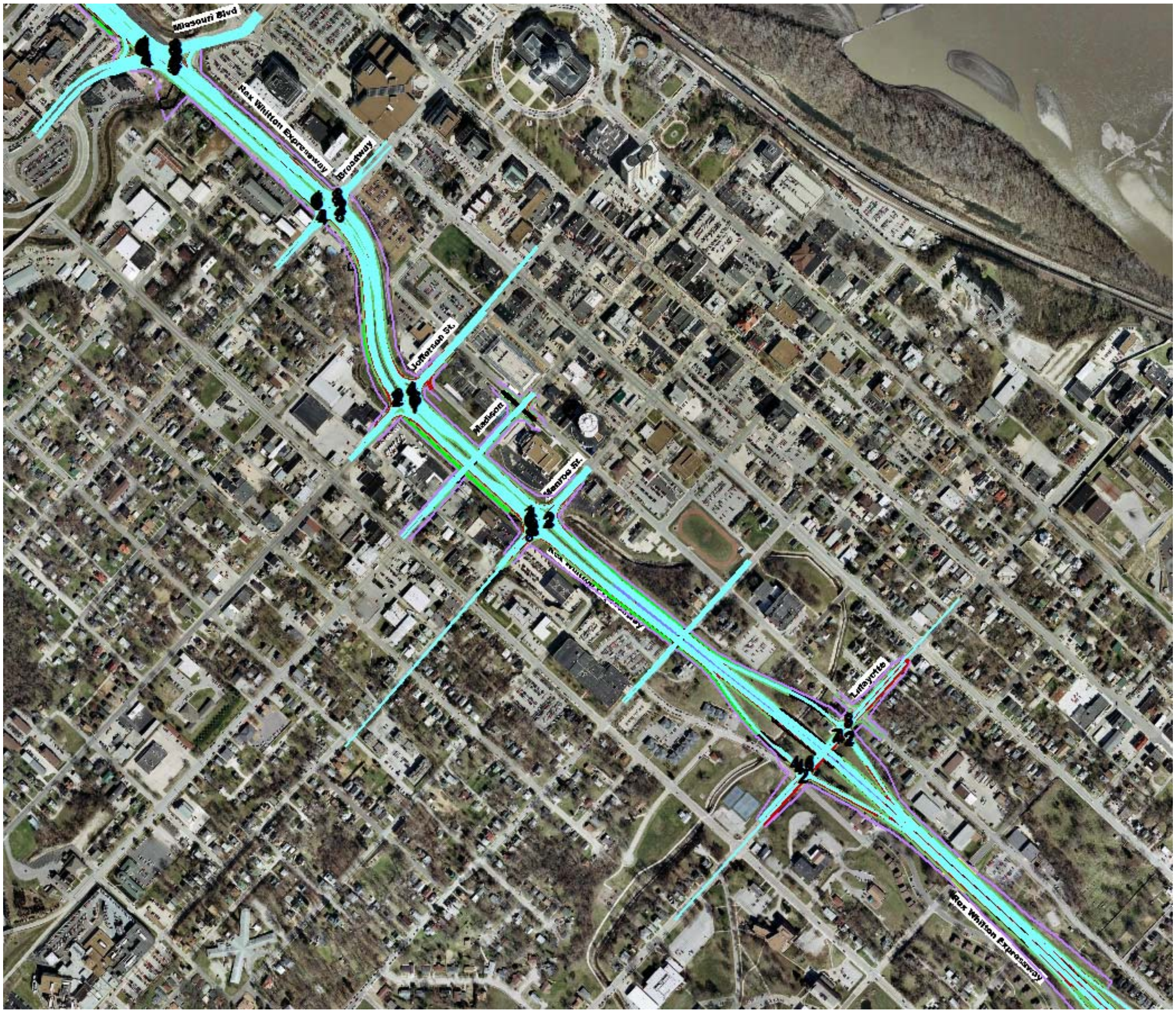


FIGURE 2. REX WHITTON EXPRESSWAY PREFERRED ALTERNATIVE

TABLE 2. EXISTING AND 2035 PREFERRED ALTERNATIVE OPERATIONAL ANALYSIS RESULTS

Intersection	Approach	Existing			2035 Build		
		LOS	Average Delay (sec/veh)	95th % Queue (feet)	LOS	Average Delay (sec/veh)	95th % Queue (feet)
Rex Whitton Expressway and Missouri Blvd	All	C	34	n/a	E	61	n/a
	North		18	267		32	1200
	South		31	223		51	1239[1]
	East		24	317		84	789
	West		73	811		80	555
Rex Whitton Expressway and Broadway Street	All	B	17	n/a	C	28	n/a
	North		32	111		72	396
	South		26	179		136	463
	East		7	151		16	418
	West		22	485		19	570
Rex Whitton Expressway and Jefferson Street	All	B	12	n/a	C	27	n/a
	North		40	241		1	n/a
	South		54	598		61	670
	East		24	173		36	1226[1]
	West		5	165		11	257
Rex Whitton Expressway and Madison Street	All	B	13	n/a	n/a	n/a	n/a
	North		56	328		n/a	n/a
	South		31	257		n/a	n/a
	East		10	225		n/a	n/a
	West		6	152		n/a	n/a
Rex Whitton Expressway and Monroe Street	All	C	26	n/a	B	21	n/a
	North		33	94		125	1534[1]
	South		108	2008		6	n/a
	East		11	229		7	174
	West		15	362		12	396
Rex Whitton Expressway Eastbound Ramps and Lafayette Street	All	n/a	n/a	n/a	D	52	n/a
	North	n/a	n/a	n/a		114	1084[1]
	South	n/a	n/a	n/a		14	402
	East	n/a	n/a	n/a		29	157
	West	n/a	n/a	n/a		n/a	n/a
Rex Whitton Expressway Westbound Ramps and Lafayette Street	All	n/a	n/a	n/a	D	36	n/a
	North	n/a	n/a	n/a		4	78
	South	n/a	n/a	n/a		63	932[1]
	East	n/a	n/a	n/a		n/a	n/a
	West	n/a	n/a	n/a		32	75

[1]Queue extends outside modeled network. Queue length and approach delay are higher than reported.

Rex Whitton Expressway/Missouri Blvd

This intersection is expected to operate at LOS E with the preferred alternative in 2035. The eastbound and westbound Rex Whitton Blvd approaches are expected to operate with delays greater than 80 seconds per vehicle during the evening peak hour. The VISSIM model indicates the left turn from westbound Rex Whitton onto Missouri Blvd may be over capacity, and some model runs indicate queues will spill out of the left turn pocket. Furthermore, queues from the Rex Whitton eastbound approach occasionally spill back onto the ramp from US 54, from weaving that occurs prior to the intersection, as shown in Figure 3.

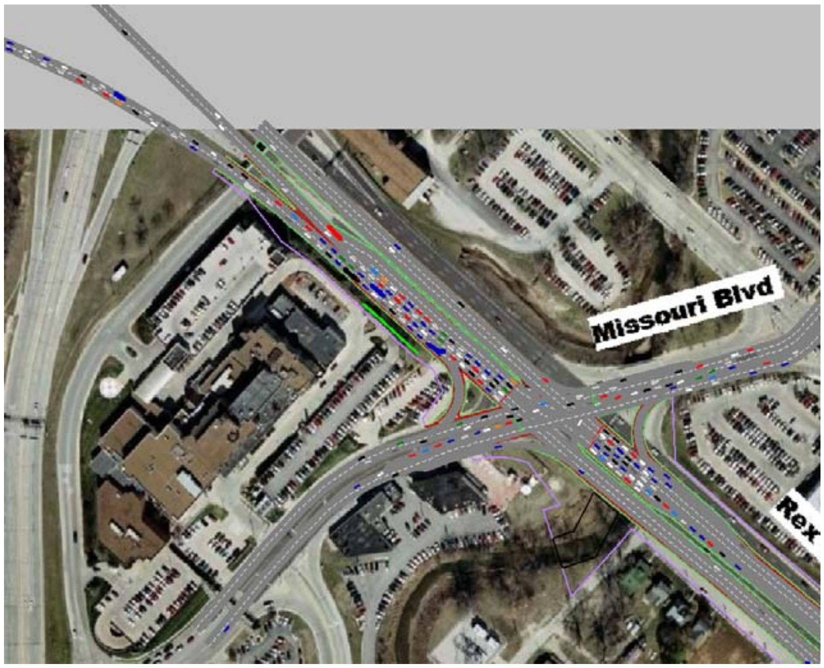


FIGURE 3. QUEUING AT REX WHITTON AND MISSOURI BLVD.

Some operational improvements at this intersection may include:

- Extend Rex Witton westbound dual left turn pockets to provide additional queue storage.
- Provide dual left-turn pockets for the northbound and southbound Missouri Blvd approaches.

Rex Whitton Expressway/Broadway Street

The intersection of Rex Whitton and Broadway Street is expected to operate at LOS C with 28 seconds of delay per vehicle under the preferred alternative. Minor street approaches are expected to operate poorly; however, overall the intersection will operate at an acceptable level. Queuing from both the right turn and left turn pockets on the Broadway street southbound approach occasionally spill back and impede other movements. The northbound approach does not have any significant queuing concerns; however, vehicles may wait up to two signal cycles to clear the intersection.

Operational improvements at this intersection may include:

- Extend southbound right turn pocket on Broadway Street.
- Provide protected phasing for the northbound/southbound left turns to minimize minor street queuing. This improvement would result in overall intersection delay worse than indicated in Table 2.

Rex Whitton Expressway/Jefferson Street

This intersection operates fairly well with an overall delay of 27 seconds per vehicle (LOS C). Queues occasionally form on the Jefferson Street southbound approach that block the channelized right turn pocket. No other significant operational issues occur at this intersection

The only operational improvement recommended at this intersection is:

- Extend the southbound right-turn pocket by approximately 100 feet.

Rex Whitton Expressway/Monroe Street

The VISSIM model indicates this intersection will operate at an acceptable level with an average delay of 21 seconds per vehicle and operate at LOS C. Similar to the Rex Whitton Expressway/Jefferson Street intersection, vehicle queues are occasionally expected to block the northbound right turn pocket, as indicated by the high northbound approach delay shown in Table 2.

Operation improvements at this intersection may include:

- Extend the northbound right-turn pocket by approximately 100 feet or,
- Provide a left, a shared through/left, and extend the right turn pocket.

Eastbound Rex Whitton Expressway Ramps/ Lafayette Street

The intersection is expected to operate at LOS D with 52 seconds of average delay per vehicle. Queues form in several models runs on the northbound Lafayette Street approach, resulting in a high approach delay. These queues do occasionally spill back outside of the VISSIM model, so overall queue length and intersection delay may be higher than reported. Other intersection approaches operate at an acceptable level, and off-ramp queues do not spill back onto the expressway.

The only operation improvement recommended at this intersection is:

- Lengthen the northbound right-turn pocket

Westbound Rex Whitton Expressway Ramps/ Lafayette Street

As shown in Table 2, this intersection is expected to operate at LOS D with an average of 36 seconds of delay per vehicle. However, operations at this intersection are expected to be much worse than indicated. Long queues form on the southbound Lafayette Street approach. Based on traffic volume forecasts for the southbound approach, approximately 1,175 vehicles are expected to turn right onto westbound Rex Whitton while another 960 are expected to travel through the intersection. As currently designed, the one lane approach with a channelized right turn **will not** provide enough capacity to serve this demand. Other approaches are expected to operate at an acceptable level, and off-ramp queues should remain off the expressway. Figure 4 shows the northbound and southbound queues through this interchange.

FIGURE 4. LAFAYETTE STREET INTERCHANGE OPERATIONS.

In order to mitigate the southbound approach at this intersection the following improvements should be considered. Additional analysis or volume forecast refinement may be required to determine the overall benefit of these improvements:

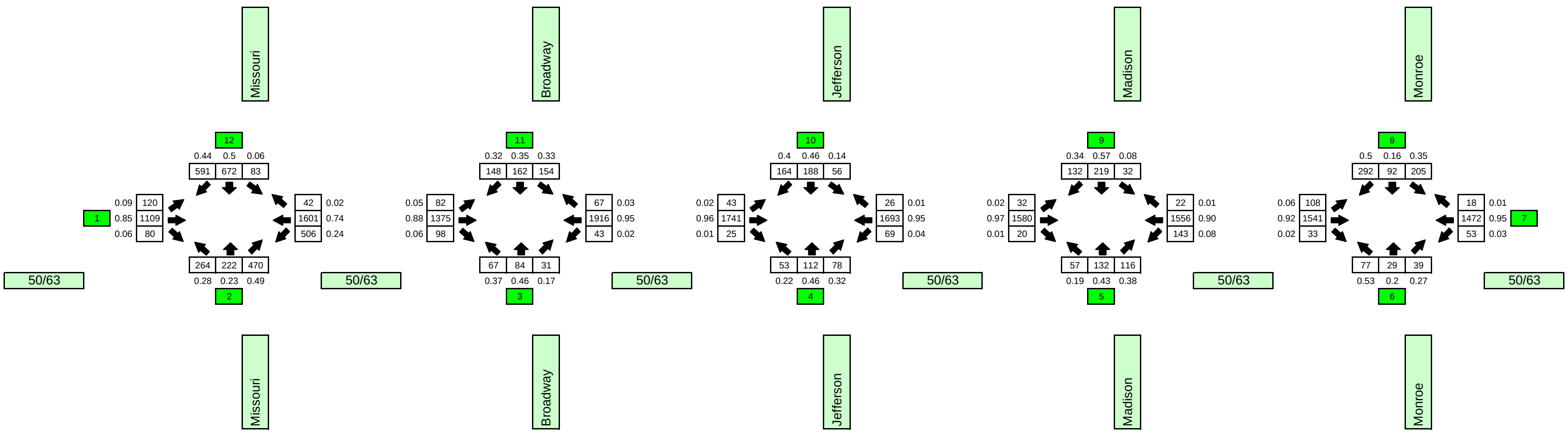
- Provide a two-lane southbound approach with a drop lane onto the westbound Rex Whitton Expressway on-ramp.
- Consider widening between the ramps to four lanes on Lafayette. Provide one through lane and one left turn lane; therefore providing adequate left turn storage.

Appendix A: Traffic Volume Assumptions

Rex Whitton Corridor

Existing Conditions: VISSIM Routing and Volumes

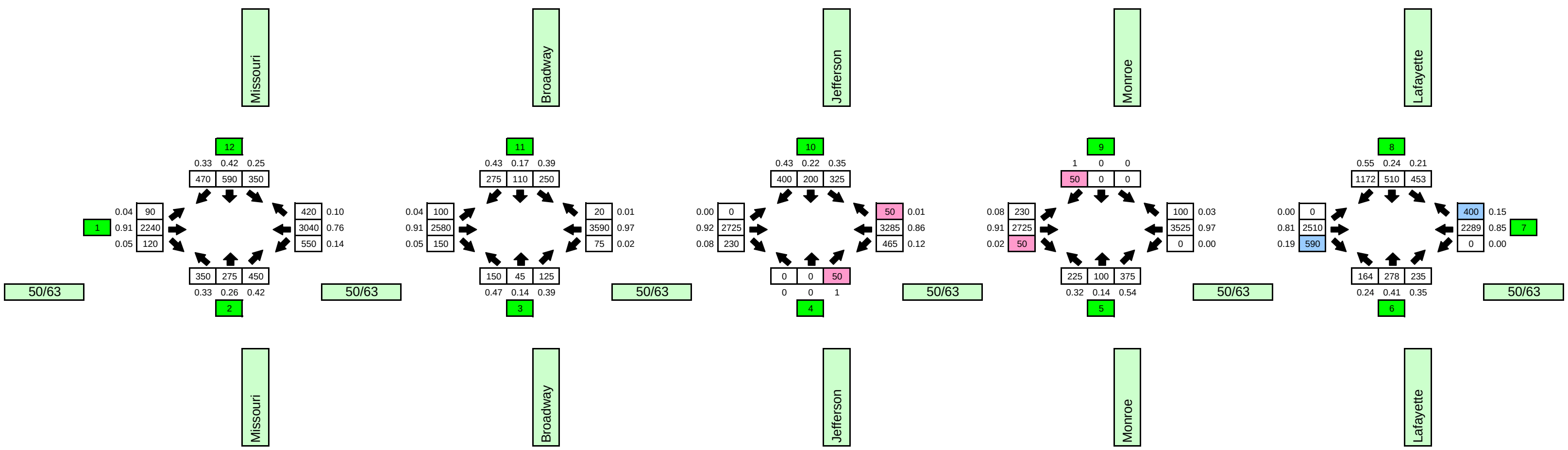
CH2M Hill



JDJ
5/20/2008

Rex Whitton Corridor

2035 Preferred Alternative: VISSIM Routing and Volumes



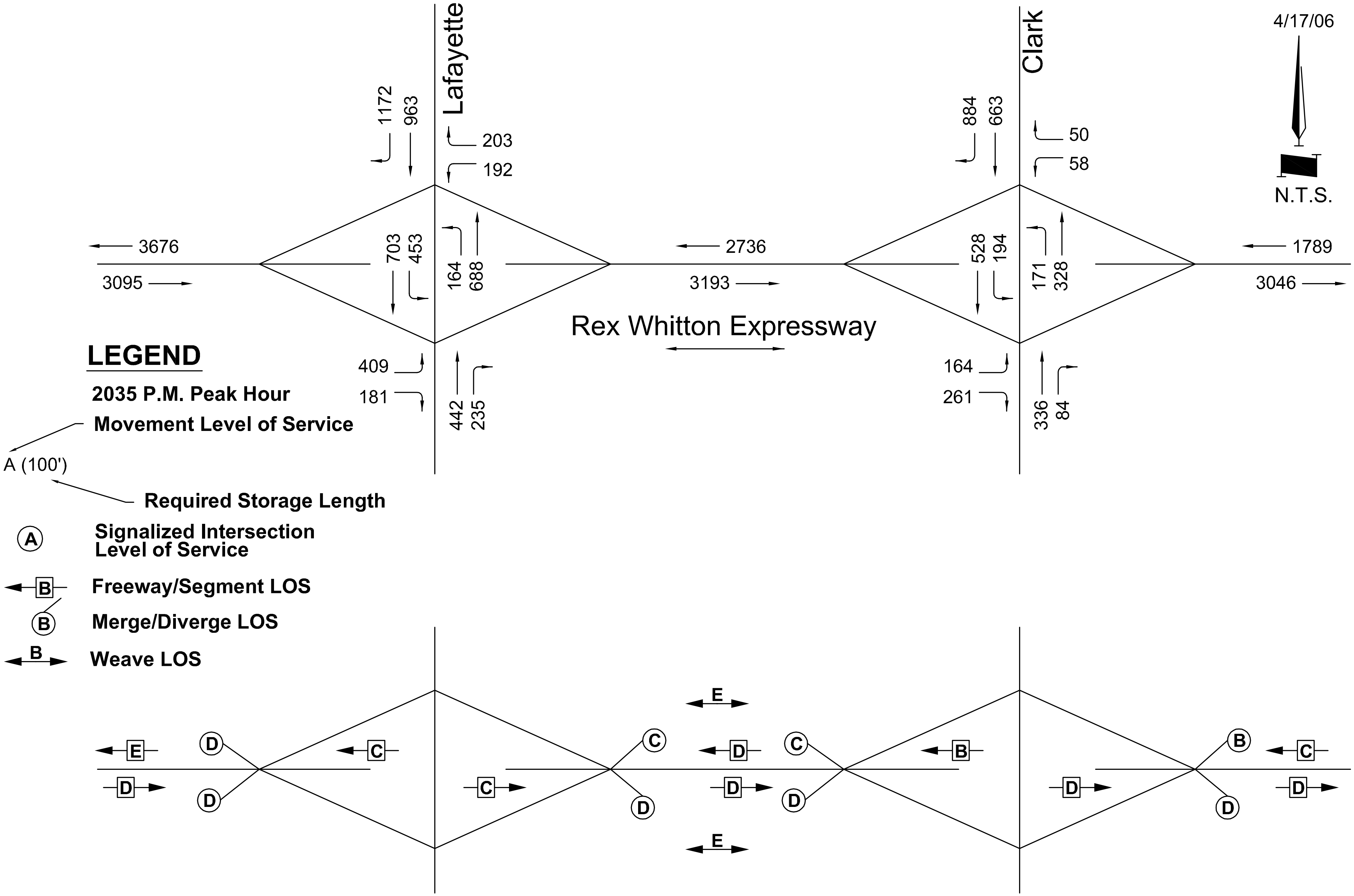


FIGURE E15-1
Lafayette Street Interchange
2035 Volumes & Levels of Service

GEORGE BUTLER ASSOCIATES, INC.
Engineers · Architects

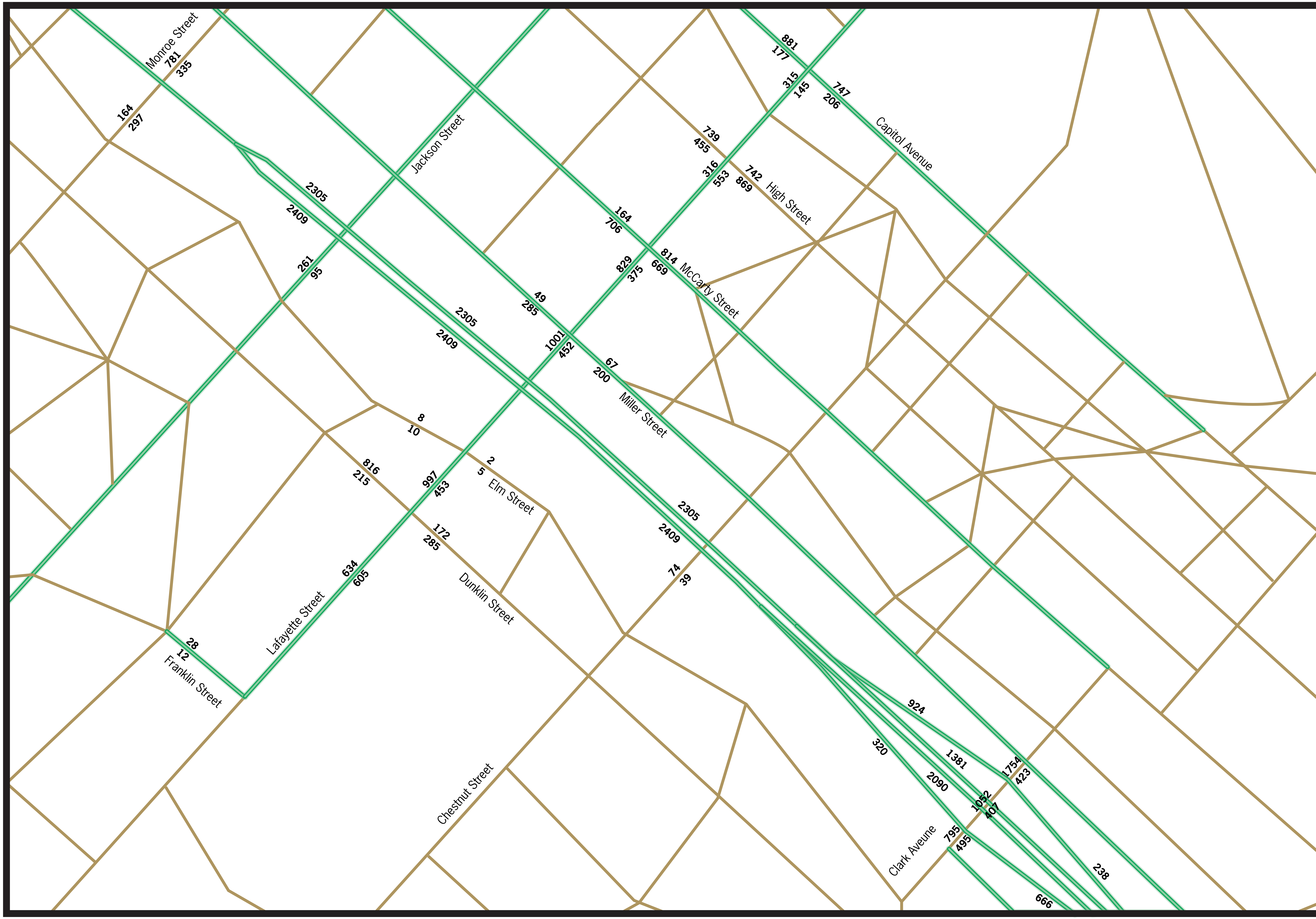


EXHIBIT D-1

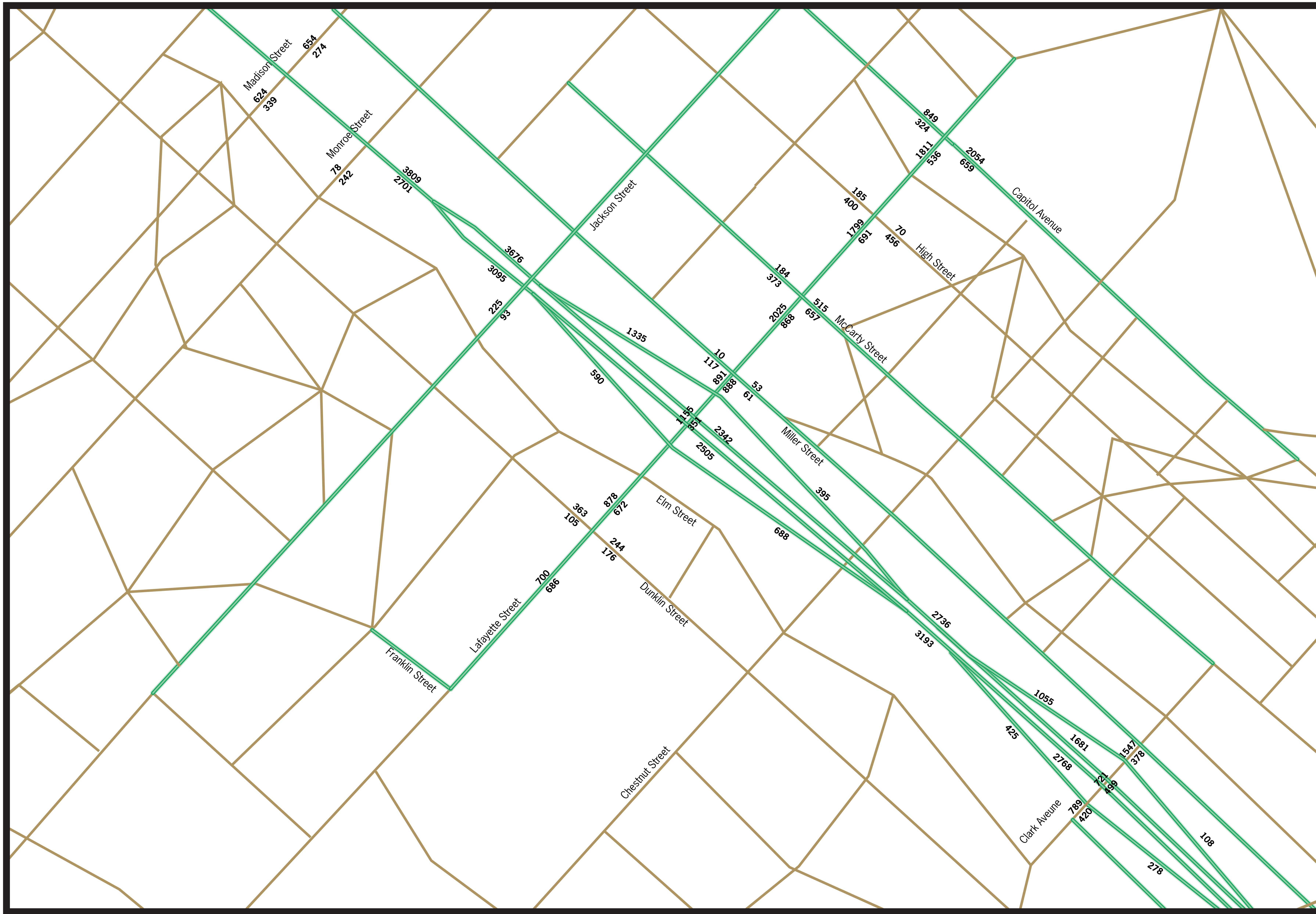
Whitton Expressway EIS

Future 2035 without Lafayette Interchange PM Peak Hours

HNTB

EXHIBIT D-2

Whitton Expressway EIS



Future 2035 with Lafayette Interchange
PM Peak Hours

HNTB