INDIANA DEPARTMENT OF TRANSPORTATION
Driving Indiana's Economic Growth

Traffic Management Center
8620 East 21st Street
Indianapolis, Indiana 46219

PHONE: (317) 899-8626
FAX: (317) 898-0897

Eric Holcomb, Governor
Joe McGuinness, Commissioner

May 22, 2020

TO: Jim Poturalski, Senior Director
Engineering and Research

THRU: Rebecca Packer, Director
District Technical Services

FROM: Jeremeih Shaw, Traffic Investigations Engineer
District Technical Services

SUBJECT: Interstate Highway Congestion Policy Exception Request
Sherman Minton Renewal Project (SMRP) I-64 in the Eastbound/Westbound direction(s) from I-265 to I-264 (MM 122.0 (IN) to MM 1.2 (KY)) in Floyd County (IN), Jefferson County (KY)
Contract No. B-40719, Des. No. 1702255

We have reviewed the attached policy exception request and concur with the analyses presented.

IHCP Allowable Closure:	Single Lane – Executive Approval
Requested Closures:	One-lane closure Eastbound and Westbound I-64, 24 hours, 7 days a week Two-lane closure Eastbound I-64, 9:00 PM to 4:00 AM, 7 days a week Two-lane closure Westbound I-64, 10:00 PM to 5:00 AM, 7 days a week Ramp closure Eastbound I-64 to Eastbound I-265, 9:00 PM Friday to 6:00 AM Monday, 1 weekend closure (required as part of mitigation strategy) Ramp closure Westbound I-265 to Westbound I-64, 9:00 PM Friday to 6:00 AM Monday, 1 weekend closure (required as part of mitigation strategy) Ramp closure Eastbound I-265 to Southbound I-65, 9:00 PM Friday to 6:00 AM Monday, 1 weekend closure (required as part of mitigation strategy)
Minimum Open Lanes:	2 lanes in each direction will remain open during the one-lane closure period. 1 lane in each direction will remain open during the nighttime two-lane closure periods.
Anticipated Start of Closures:	Spring 2021
Expected Duration of Closure:	Summer 2023
Lane Width:	11 ft. Min.
Shoulder Width:	1 ft. Min.
Type of barrier used:	Temporary Concrete Barrier

The analyses indicate that **queuing outside policy limits** is anticipated from this closure.

Policy Exception Approved:

James Poturalski Digitally signed by James Poturalski
Date: 2020.05.22 12:35:33 -04'00'

Jim Poturalski, Senior Director
Engineering and Research

Date

Enclosures: Policy Exception Request, Queue Analysis, Attachment A

cc: John McGregor, Manager, Traffic Support Section, Indianapolis Traffic Management Center
Mischa Kachler, Supervisor, Work Zone Safety Section, Indianapolis Traffic Management Center
Gary Kreutzjans, Director, Construction Division, Seymour District
Rebecca Packer, Director, Technical Services Division, Seymour District
Justin Berger, Director, Highway Maintenance Division, Seymour District
Jane Waddle, Manager, Design, Production Division, Seymour District
Damon Brown, Manager, Traffic, Technical Services Division, Seymour District
Annie Walker, District Public Information Officer, Seymour District
Abby Mantsch, Scoping Manager, Technical Services Division, Seymour District
Robert Tally, Bridge Asset Engineer, Technical Services Division, Seymour District
Ron Heustis, Project Manager, Major Project Delivery
Eryn Fletcher, FHWA Design/Construction for the Seymour District
Stephanie Caros, Public Information Officer, Kentucky Transportation Cabinet
Tom Wright, Branch Manager PD&P, Kentucky Transportation Cabinet

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PHONE: (317) 899-8610
FAX: (317) 898-0897

Eric Holcomb, Governor
Joe McGuinness, Commissioner

INTERSTATE HIGHWAYS CONGESTION POLICY
EXCEPTION REQUEST ANALYSIS AND JUSTIFICATION

RE: Sherman Minton Renewal Project (SMRP) I-64 in the Eastbound/Westbound direction(s) from I-265 to I-264 (MM 122.0 (IN) to MM 1.2 (KY)) in Floyd County (IN), Jefferson County (KY)
Contract No. B-40719, Des. No. 1702255
Prime Contractor: TBD

NEED FOR WORK

One-lane and two-lane closures are required to complete necessary rehabilitation work on the I-64 crossing of the Ohio River on the Sherman Minton Bridge (SMB). I-64 is a three-lane (per direction) facility. The anticipated scope of work for the repairs that will be completed during lane closures includes, but is not limited to, bridge deck replacement, bridge structural repairs and component replacements (including cable hangers), bridge painting, and material delivery.

The work is planned for approximately two and a half years of construction during the 2021-2023 seasons. Construction is anticipated to begin in the spring of 2021 with a goal of completion by mid-2023.

PLANNED CLOSURES/RESTRICTIONS

The following closures are anticipated for this project:

- One-lane closure Eastbound and Westbound I-64, 24 hours, 7 days a week
- Two-lane closure Eastbound I-64, 9:00 PM to 4:00 AM, 7 days a week
- Two-lane closure Westbound I-64, 10:00 PM to 5:00 AM, 7 days a week
- Ramp closure Eastbound I-64 to Eastbound I-265, 9:00 PM Friday to 6:00 AM Monday, 1 weekend closure (required as part of mitigation strategy)
- Ramp closure Westbound I-265 to Westbound I-64, 9:00 PM Friday to 6:00 AM Monday, 1 weekend closure (required as part of mitigation strategy)
- Ramp closure Eastbound I-265 to Southbound I-65, 9:00 PM Friday to 6:00 AM Monday, 1 weekend closure (required as part of mitigation strategy)

In order to minimize impacts, the Design-Build Contractor (DBC) will be allowed two-lane closures, limited to nighttime hours. The timing and frequency of these overnight lane restrictions is currently unknown. However, the DBC would be limited to 360 days of two-lane

nighttime closures over the course of the project. Both one-lane and two-lane closures are anticipated to begin Spring 2021 and last through mid-2023.

This IHCP exception approval supplements the Interstate Closure request approved by FHWA. Lane closures on interstate highways outside of the project area to allow for overhead sign modifications associated with detours and other informational signage will be allowed between the hours of 10 PM to 5 AM any night of the week. A minimum of one lane shall remain open during these hours and only lanes required to be closed for this overhead work shall be closed. Twenty-minute short term closures in the project limits for overhead work are allowed under this IHCP exception approval (in lieu of rolling closures).

ANALYSIS

Traffic impacts due to the closures were analyzed using INDOT's Queue Analysis Spreadsheet v. 1.29. The traffic volumes used in the analysis were obtained from travel demand forecasting that was part of the SMRP. A travel demand model (TDM) was developed for the project. The daily TDM used by the Kentuckiana Planning and Development Agency (KIPDA) – the regional metropolitan planning organization (MPO) for the Louisville area – provided the base for the SMRP TDM. The project team added model components to specifically account for trucks, tolls, and specific periods of the day that were critical to the project and its development of the National Environmental Policy Act (NEPA) documentation. The SMRP TDM was validated using recent traffic counts from INDOT, KYTC, and the *Final Louisville-Southern Indiana Ohio River Bridges Project Post-Construction Traffic Monitoring Study.*

The project team coded maintenance of traffic (MOT) options in the SMRP TDM to reflect various lane closure scenarios and forecast changes in travel patterns. The model was used to predict how much traffic would be diverted from the I-64 SMB corridor under each MOT option. The traffic predicted to use the I-64 SMB corridor under each MOT option was used as input to the INDOT Queue Analysis Spreadsheet. The queuing analysis summary reports are included in **Attachment A**.

The capacities used in the analysis are the Highway Capacity Manual's typical values adjusted for the proximity of the work to the travel lane. Capacities varied depending on the location of the lane drop analyzed. Some of the lane drops analyzed occurred on the mainline lanes, while other drops occurred on ramps. The capacities utilized for each scenario are noted below and reported in **Attachment A**. The capacities correspond to a 11 ft. lane width provided in each of the MOT options. Current speed limits are 55 mph. The construction zone speed limits will be reduced to 45 mph.

- 3 to 2 lane drop: 1600 PCE/hr/ln capacity
- 2 to 1 lane drop: 1550 PCE/hr/ln capacity

The SMB is a double-deck structure carrying I-64 with three eastbound lanes on the bottom deck and three westbound lanes on the top deck. The Baseline MOT plan for the SMRP was designed to utilize one deck for traffic while allowing the contractor to utilize most of the opposite deck for rehabilitation and construction. The Baseline MOT scenario provides two lanes of traffic in each direction. One deck will provide two lanes of travel in one direction and one lane of travel in the opposite direction. The other deck will provide one additional lane of travel for the opposite direction. **Figure 1** shows a schematic of the work zone phasing under the Baseline MOT scenario. The contractor will also have the option of providing fewer lanes during certain periods of time for limited durations. **Attachment A** also includes exhibits of the work zone transition areas eastbound and westbound approaching the bridge.

Under the Baseline MOT, no ramps within the construction area will be closed. However, during Phase 2, traffic from Westbound I-264 to I-64 Westbound will not be able to access the exit ramp to Elm Street in New Albany. Additionally, the Baseline MOT includes system-to-system ramp widening mitigation plans along alternative detour routes. This includes the conversion of 1 lane ramps to two with shoulder strengthening and restriping on three ramps: Eastbound I-64 to Eastbound I-265, Westbound I-265 to Westbound I-64, and Eastbound I-265 to Southbound I-65. To facilitate these ramp mitigation improvements, the closure of these ramps is required. The *SMRP Traffic Analysis Report* (included as **Attachment B**) documents the analysis conducted to measure the roadway systems ability to accommodate changes in travel patterns due to capacity limitations in the work zone during the SMB construction. The analysis identified potential bottleneck locations and the ramp improvements were included as part of the mitigation plan.

At times during construction the DBC will be allowed to temporarily close the SMB. These closures will be limited on a per calendar year basis to one nine consecutive day closure and up to three weekend closures. These temporary closures were requested separately in the Interstate Closure request.

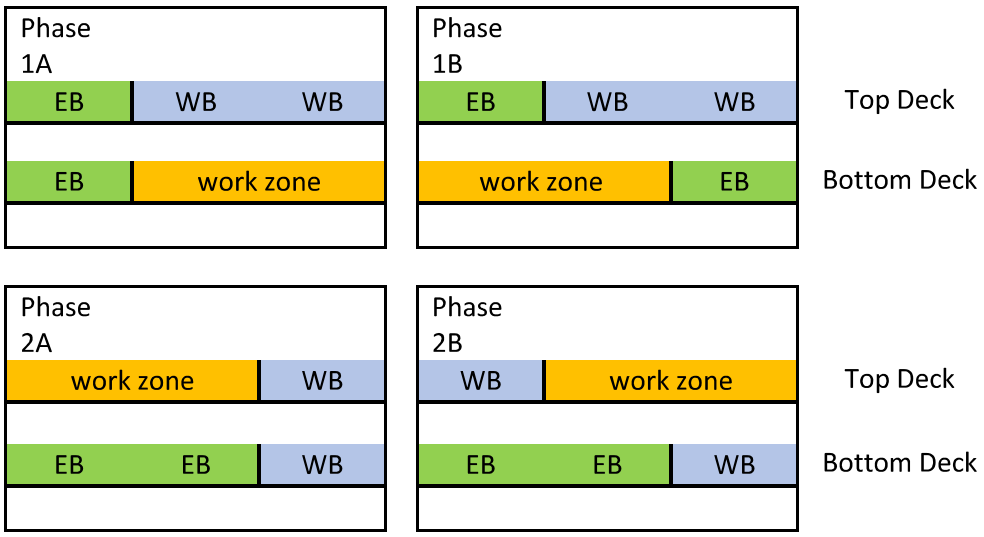


Figure 1 - BASELINE MOT SCENARIO (LOOKING WEST)

Under Phases 1A and 1B the eastbound queuing analysis focused on the single lane to the top deck and the single lane to the bottom deck, treating each as a 2 to 1 lane drop. In the westbound direction the analysis focused on a 2 to 1 lane drop for I-64. The ramp from I-264 was not analyzed as it is currently a single lane with its own receiving lane onto the bridge top deck. Limited overnight closures to a single eastbound lane are reflected in the analysis.

Under Phases 2A and 2B the eastbound queuing analysis focused on a 3 to 2 lane drop for I-64. Like Phases 1A and 1B, the westbound analysis focused on a 2 to1 lane drop for I-64. Limited overnight closures to a single westbound lane are reflected in the analysis.

The traffic volumes developed using the SMRP TDM represent a typical weekday. INDOT's Queue Analysis Spreadsheet includes volume adjustment factors applied to the weekday volumes to approximate Friday, Saturday and Sunday volumes based on statewide data. The Friday adjustment factors effectively increase the westbound PM afternoon and evening volumes by 20 percent. The queueing results for Friday reflect using these factors resulting in longer queues compared to weekdays. However, count data along I-64 northwest of the bridge suggests this increase may not be appropriate for this specific location. The projected maximum queue lengths for an average weekday and Friday are shown in **Table 1**. No queueing was indicated for Saturday or Sunday. The duration of queue lengths as they pertain to the policy limit criteria (listed below) are reported in Table 1. The maximum queue length and queue durations that are outside policy limits have been shaded red.

- Queues greater than 1.5 miles in length should not be permitted.
- Queues greater than 1.0 mile in length should not be permitted to exceed two continuous hours.
- Queues greater than 0.5 miles in length should not be permitted to exceed 4 continuous hours.
- No queues of any length should be permitted to exceed 6 continuous hours duration.
- No queues of any length should be permitted to exceed 12 total hours in any calendar day.

Table 1 – Projected Maximum Queue Length and Policy Limits

Scenario	Miles/Hours	Maximum Queues			
		Eastbound		Westbound	
		M-Th	Fri.	M-Th	Fri.
Phases 1A & 1B	Maximum Queue (miles)	0.7	0.5	2.1	4.4
	Hours above 1.5 miles	0	0	2	5
	Above 1.0 miles > 2 continuous hours	0	0	3	5
	Above 0.5 miles > 4 continuous hours	1	0	4	7
	Any length > 6 continuous hours	1	1	5	8

	Any length > 12 hours in a day*	1	1	5	8
Phases 2A & 2B	**Maximum Queue (miles)**	0.8	0.6	1.2	5.1
	Hours above 1.5 miles	0	0	0	8
	Above 1.0 miles > 2 continuous hours	0	0	2	10
	Above 0.5 miles > 4 continuous hours	1	1	3	11
	Any length > 6 continuous hours	2	1	5	13
	Any length > 12 hours in a day*	2	1	8	13

* A calendar day

SUMMARY

Typical Weekday (Monday – Thursday)

On a typical weekday during Phases 1A and 1B, the analyses indicate that a **queue outside policy limits** should be anticipated as a result of this work. In the westbound direction the results indicate a maximum queue length of approximately 2.1 miles may be experienced at 5:00 p.m. with a maximum queue duration of 5 hours between 3:00 p.m. and 8:00 p.m. In the eastbound direction the results indicate a maximum queue length of approximately 0.7 miles may be experienced at 7:00 a.m. with a maximum queue duration of 1 hour between 7:00 a.m. and 8:00 a.m. Please see the attached analyses and charts for further details on the queue modeling.

On a typical weekday during Phases 2A and 2B, the analyses indicate that a **queue outside policy limits** should be anticipated as a result of this work. In the westbound direction the results indicate that a maximum queue length of approximately 1.2 miles may be experienced at 6:00 p.m. with a maximum queue duration of 5 hours between 3:00 p.m. and 8:00 p.m. In the eastbound direction the results indicate that a maximum queue length of approximately 0.8 miles may be experienced at 7:00 a.m. with a maximum duration of 2 hours between 7:00 a.m. and 9:00 a.m. Please see the attached analyses and charts for further details on the queue modeling.

Friday

On a Friday during Phases 1A and 1B, the analyses indicate that a **queue outside policy limits** should be anticipated as a result of this work. In the westbound direction the results indicate that a maximum queue length of approximately 4.4 miles may be experienced at 6:00 p.m. with a maximum queue duration of 8 hours between 2:00 p.m. and 10:00 p.m. In the eastbound direction the results indicate that a maximum queue length of approximately 0.5 miles may be experienced at 7:00 a.m. with a maximum queue duration of 1 hour between 7:00 a.m. and 8:00 a.m. Please see the attached analyses and charts for further details on the queue modeling.

On Friday during Phases 2A and 2B, the analyses indicate that a **queue outside policy limits** should be anticipated as a result of this work. In the westbound direction the results indicate that

a maximum queue length of approximately 5.1 miles may be experienced at 7:00 p.m. with a maximum duration of 13 hours between 10:00 a.m. and 11:00 p.m. In the eastbound direction the results indicate that a maximum queue length of approximately 0.6 miles may be experienced at 7:00 a.m. with a maximum queue duration of 1 hour between 7:00 a.m. and 8:00 a.m. Please see the attached analyses and charts for further details on the queue modeling.

INDOT's construction staff has completed several closures like this and will be working closely with the TMC to assure that minimal congestion in the work zone is achieved.

SELECTED WORK SCHEDULE

The permitted lane reduction hours were derived by adjusting the number of lanes open to minimize noncompliance with policy limits. Whereas the project schedule is not known at this time, it is necessary to provide permitted lane reduction times to allow the contractor to complete the required work as efficiently as possible.

ABBREVIATED TRANSPORTATION MANAGEMENT PLAN (TMP)

The following Abbreviated TMP will be followed throughout the construction of this project:

Traffic Control Plan (TCP)

The following is an outline of the TCP:

- The PE/PS (or the Contractor if so designated by the PE/PS) will notify the TMC at least 3-days ahead of any MOT change so that the appropriate ATIS messages (if available) can be displayed to inform motorists of the upcoming closure and for general information concerning the status of traffic operations on the Interstate Highways. The E-mail addresses for these notifications are: indpc@isp.IN.gov and indytmc@indot.IN.gov. The PE/PS (or the Contractor if so designed by the PE/PS) shall call the TMC (317-899-8690x1) immediately prior to implementing any lane or shoulder restriction as a final notification and to provide project contacts / phone numbers that will be available for the duration of the restriction.
- All lane or shoulder restrictions will be closed and/or shifted in accordance with the IMUTCD and INDOT Specifications 105, 107 and 801.
- Unless explicitly stated otherwise in this Approval, Recurring Special Provision 108-C-585, which concerns holiday closures, will be followed.
- The speed reduction will be in accordance with INDOT Construction Memorandum 14-06 unless a Temporary Official Action has been issued. This includes approval by the District Traffic Engineer and recordkeeping by both District Traffic and District Construction.
- Unless determined otherwise by the PE/PS based on site conditions, Portable Changeable Message Signs (PCMS's) will be placed approximately 2 miles ahead of the

construction signing to alert drivers that they should expect stopped or slowed traffic. If queuing is observed, extending within a ¼ mile of the PCMS's, the Contractor will adjust the PCMS placement to a position where they are at least ½ mile (but not more than 2 miles) in advance of the maximum observed queue.

- PCMS's shall be installed, in series, 2-minimum in each direction for each lane restriction, to fully advise motorists of the excessive queues in accordance with the *INDOT Guidelines for Portable Changeable Message Signs (PCMS)*. The guidelines can be found at: http://www.in.gov/dot/div/contracts/design/PCMS.pdf. Great care should be used to monitor the excessive queues and place the PCMS's in advance of the observed queues to mitigate the risk to all stakeholders.
- 'Watch for Stopped Traffic' signs shall be placed in advance of the queue.
- The Federal Highway Administration (FHWA) must grant approval of this closure before work can commence. (Interstate to interstate ramp or complete mainline closure.)
- The superintendent and one other responsible employee will be on call during all non-working periods to oversee the repair or replacement of all traffic control devices which may become damaged or inoperative.
- The inside and outside shoulders may be utilized for maintaining traffic in accordance with the plans.
- The PE/PS is strongly encouraged to request ISP support for the work zone, as soon as restriction dates are known – at least 3-days in advance of the lane restrictions. Contact Kim Peters (317-899-8619 / kpeters@indot.IN.gov) or Guy Boruff (317-899-8605 / gboruff@insot.IN.gov) to make these requests.

Traffic Operations Plan (TOP)

Lane restriction information will be transmitted by TMC to ITS boards in advance of this area and will notify motorists of the work, well in advance of the closure, as ITS boards are available.

Public Information

Simultaneous to the TMC notification noted above, the PE/PS (or the Contractor if so, designated by the PE/PS) shall notify the INDOT District Media Contact responsible for the area of the restriction at least 3-days in advance of the closure. The Media Contacts can be found at www.media.indot.in.gov which redirects to www.in.gov/indot/2364.htm. They will ensure that local television news channels, radio stations and newspapers will be notified of this construction. Local commuters will be advised to avoid this area and use alternative local routes if possible. They will also ensure that the Indiana Motor Trucking Association is notified to minimize the number of trucks that will use these detour routes.

Prepared by:

Toby Randolph, PE, PTOE
Senior Engineering Manager
Phone Number: 317-616-4676
Email: tobias.randolph@parsons.com

Reviewed by:

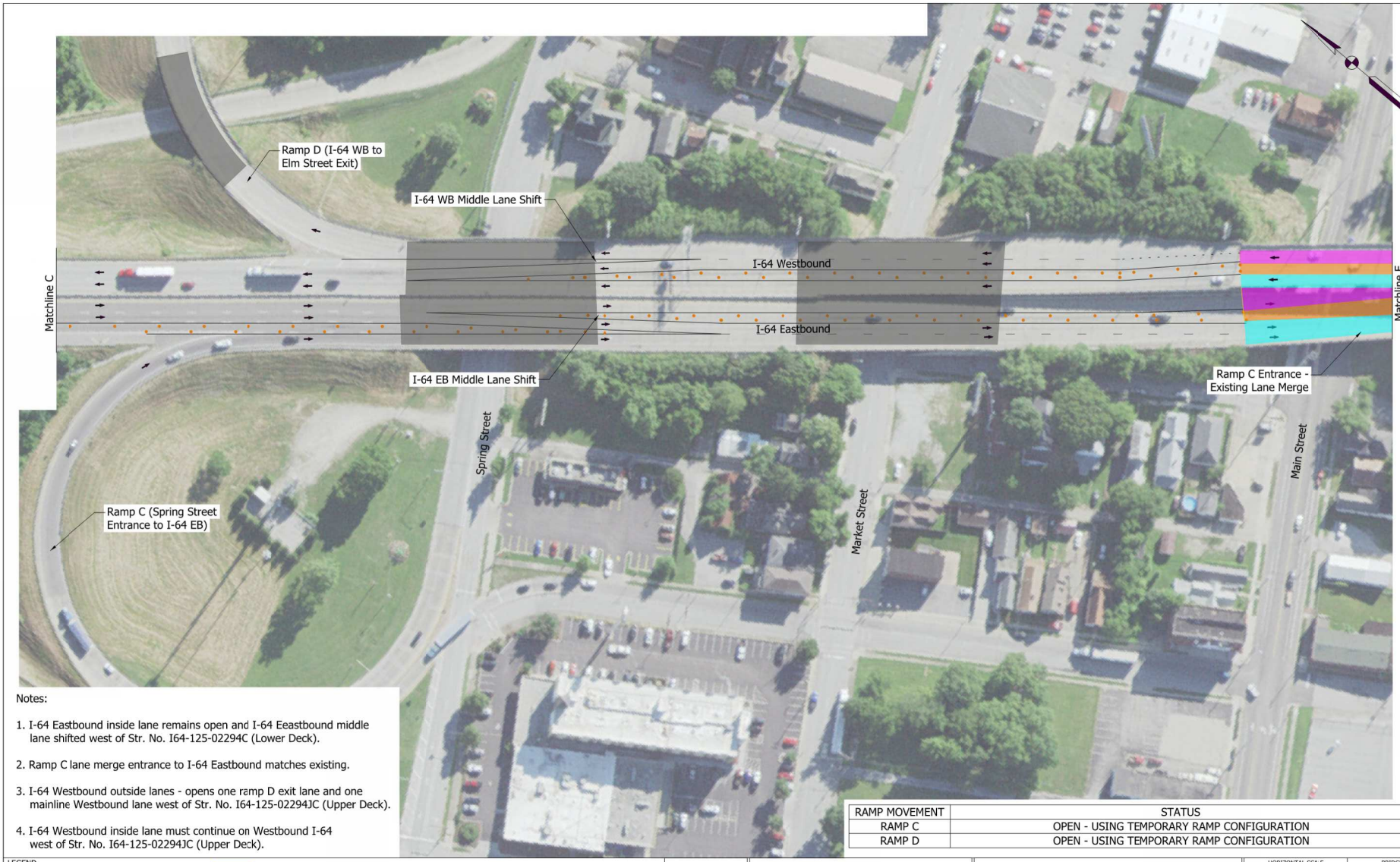
Jeremeih Shaw, Traffic Investigations Engineer
Seymour District Traffic
Phone Number: 812-524-3756
Email: jeshaw@indot.in.gov

Department Comments:

Attachment A

1. MOT Phases 1 and 2 Exhibit
    a. Eastbound Approach
    b. Westbound Approach
    c. Queuing Analysis Summary Report
2. MOT Phases 3 and 4 Exhibit
    a. Eastbound Approach
    b. Westbound Approach
    c. Queuing Analysis Summary Report

Attachment A-1a: MOT Phases 1 and 2 Eastbound Approach



Notes:

1. I-64 Eastbound inside lane remains open and I-64 Eeastbound middle lane shifted west of Str. No. I64-125-02294C (Lower Deck).
2. Ramp C lane merge entrance to I-64 Eastbound matches existing.
3. I-64 Westbound outside lanes - opens one ramp D exit lane and one mainline Westbound lane west of Str. No. I64-125-02294JC (Upper Deck).
4. I-64 Westbound inside lane must continue on Westbound I-64 west of Str. No. I64-125-02294JC (Upper Deck).

RAMP MOVEMENT	STATUS
RAMP C	OPEN - USING TEMPORARY RAMP CONFIGURATION
RAMP D	OPEN - USING TEMPORARY RAMP CONFIGURATION

LEGEND

- Construction
- Existing
- Completed Construction
- Temporary Pavement
- Temporary Traffic Drums
- Temporary Pavement Markings
- Temporary Moveable Concrete Barrier
- Temporary Concrete Barrier
- Existing Bridge Limits
- Temporary Shoring

$FILE$

RECOMMENDED FOR APPROVAL _____ DESIGN ENGINEER DATE

DESIGNED: _____ DRAWN: DH

CHECKED: _____ CHECKED: _____

INDIANA
DEPARTMENT OF TRANSPORTATION

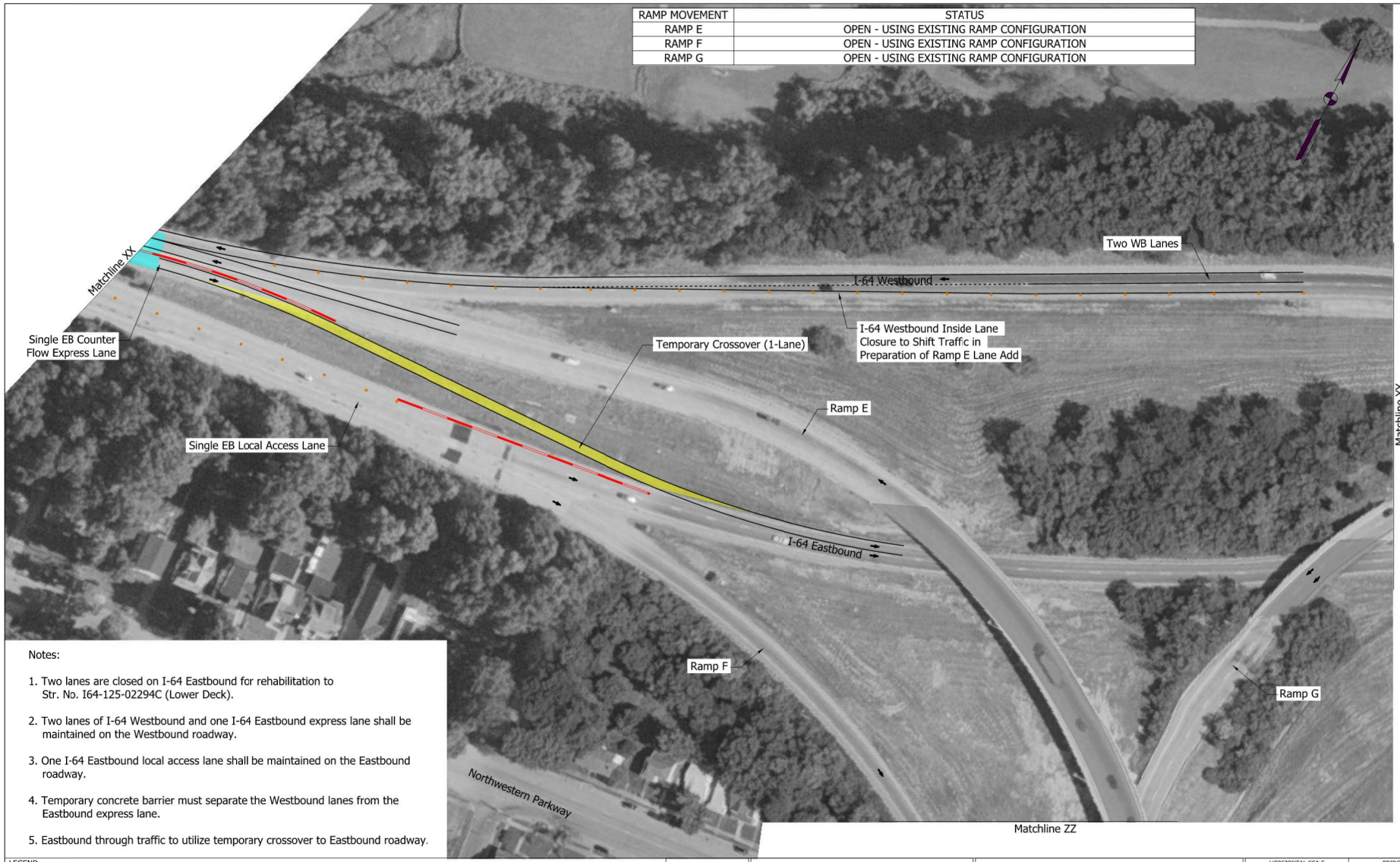
MAINTENANCE OF TRAFFIC
OPTION 1 - PHASE 2
ONE LANE CLOSURE

HORIZONTAL SCALE	BRIDGE FILE
1" = 50'	
VERTICAL SCALE	DESIGNATION
N/A	1702255
SURVEY BOOK	SHEETS
ELECTRONIC	1 of 1
CONTRACT	PROJECT

Attachment 12-5 IHCP Exception Request

Attachment A-1b: MOT Phases 1 and 2 Westbound Approach

RAMP MOVEMENT	STATUS
RAMP E	OPEN - USING EXISTING RAMP CONFIGURATION
RAMP F	OPEN - USING EXISTING RAMP CONFIGURATION
RAMP G	OPEN - USING EXISTING RAMP CONFIGURATION



Notes:

1. Two lanes are closed on I-64 Eastbound for rehabilitation to Str. No. I64-125-02294C (Lower Deck).
2. Two lanes of I-64 Westbound and one I-64 Eastbound express lane shall be maintained on the Westbound roadway.
3. One I-64 Eastbound local access lane shall be maintained on the Eastbound roadway.
4. Temporary concrete barrier must separate the Westbound lanes from the Eastbound express lane.
5. Eastbound through traffic to utilize temporary crossover to Eastbound roadway.

LEGEND

- Construction
- Existing
- Completed Construction
- Temporary Pavement
- Temporary Traffic Drums
- Temporary Pavement Markings
- Temporary Moveable Concrete Barrier
- Temporary Concrete Barrier
- Existing Bridge Limits
- Temporary Shoring

RECOMMENDED FOR APPROVAL _____ DESIGN ENGINEER DATE

DESIGNED: _____ DRAWN: DH

CHECKED: _____ CHECKED: _____

INDIANA
DEPARTMENT OF TRANSPORTATION

MAINTENANCE OF TRAFFIC
MOT BASELINE OPTION - PHASE 1A
TOP DECK OPTION A

HORIZONTAL SCALE	BRIDGE FILE
1" = 50'	
VERTICAL SCALE	DESIGNATION
N/A	1702255
SURVEY BOOK	SHEETS
ELECTRONIC	1 of 1
CONTRACT	PROJECT

pw://VANVA01PWINT01.parsons.com:Indiana State/Documents/I64 Sherman Minton Bridges/50 - Design/CAD/MOT/Exhibits/Hybrid Lane Configurations/I64 Sherman Minton Top Deck A.dgn

Attachment A-1c: MOT Phases 1 and 2 Queuing Analysis Summary Report

INDIANA DEPARTMENT OF TRANSPORTATION

Report for IHCP Queuing Analysis

Prepared by:	**PARSONS**	Position:	**PARSONS**
Prepared for:	**INDOT**	Position:	**INDOT**

Work Zone Information

Route:	I-64 SMB
Mile marker:	MM 000.50
Positive Direction:	East
Contract:	B-40719
Work Year:	2022
Work Month:	JUN
Work Type:	Maintenance
Work Description:	Bridge Renewal - Baseline MOT Phases 1 & 2, Construction on lower deck - I-64 EB 2-1 Lane Drop, I-64 WB 2-1 Lane Drop
Permanent Speed Limit:	55 mph
Work Zone Speed Limit:	45 mph
Workzone Lane Width:	11 ft
Channelizing Devices:	Mixture of Construction Drums, Cones or Barrier Wall.
Additional Information:	SMB Renewal Project. Baseline MOT option. Maintaining 2 lanes EB and WB. Phases 1 & 2 Construction on Lower deck: lower deck - one EB lane open, upper deck - one EB lane and two WB lanes. Phases 3 & 4 Construction on Upper deck: lower deck - two EB lanes and one WB lane, upper deck - one WB lane open.

Queuing Formula

$$L = L_0 + \frac{(V - C) * 1\,hr}{(k * N)}$$

Where:

- L= Length of Queue for Specified Hour (mi)
- L_0= Length of Queue in the Hour Prior to Specified Hour (mi)
- V= Hourly Volume (PCE/hr)
- C= Hourly Capacity (PCE/hr)
- k= Jam Density (PCE/mi/lane)
- N= Number of Storage Lanes Upstream of Restriction (lanes)

Jam Density (k)=	190 PCE/mi/ln
N for WB=	2 ln
N for EB=	1 ln

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Traffic Information

Count Information	Count Station Number:	970210
	Month, Year of Count:	FEB, 2018
	Rural/Urban:	Urban

Weekend Adjustment Factors

Values from "Hourly Day of the Week Conversion Factors.xlsx" Urban Center tab
downloaded on 3/13/2020

Factors to Adjust Counts to Annual Value in Current Year

Annual Adj. Factor:	1.000
Monthly Adj. Factor:	1.000

Factors to Project Annual Value in Current Year to Work Month and Year

Annual Adj. Factor:	1.000
Monthly Adj. Factor:	1.000

Assumed Percent Reduction of Traffic Due to Detouring **

Westbound

Monday-Thursday:	0%
Friday:	0%
Saturday-Sunday:	0%

Eastbound

Monday-Thursday:	0%
Friday:	0%
Saturday-Sunday:	0%

**Traffic diversions determined by travel demand model. Rates of diversion varied by time of day.

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Traffic Volumes **

I-64 WB lane drop 2-1 | I-64 EB lane drop 2-1

Time	Westbound Volumes (PCE/hr)				Eastbound Volumes (PCE/hr)			
	Weekday	Friday	Saturday	Sunday	Weekday	Friday	Saturday	Sunday
Midnight to 1 am	248	308	368	294	375	466	557	445
1 am to 2 am	194	238	236	196	267	328	325	270
2 am to 3 am	135	153	138	110	316	359	324	259
3 am to 4 am	166	191	145	103	353	406	308	219
4 am to 5 am	266	260	178	89	330	323	220	111
5 am to 6 am	498	475	252	128	1009	962	510	259
6 am to 7 am	547	524	207	103	1117	1069	423	210
7 am to 8 am	996	968	357	163	1687	1640	604	277
8 am to 9 am	1071	1059	621	269	1258	1243	730	316
9 am to 10 am	969	1011	821	437	1139	1188	965	514
10 am to 11 am	1175	1235	1094	828	907	953	844	639
11 am to Noon	1164	1300	1138	941	882	985	862	713
Noon to 1 pm	1263	1425	1201	1119	894	1008	850	792
1 pm to 2 pm	1328	1505	1222	1145	838	950	771	722
2 pm to 3 pm	1414	1633	1201	1116	951	1098	808	751
3 pm to 4 pm	1564	1744	1088	1053	1047	1168	728	705
4 pm to 5 pm	1833	2053	1172	1130	959	1074	613	591
5 pm to 6 pm	1881	1990	1193	1168	911	964	578	566
6 pm to 7 pm	1702	1991	1438	1318	823	963	695	637
7 pm to 8 pm	1151	1400	1161	1096	582	708	587	554
8 pm to 9 pm	813	978	898	744	492	592	543	450
9 pm to 10 pm	732	844	811	596	1131	1304	1254	921
10 pm to 11 pm	464	598	565	368	803	1035	978	637
11 pm to Midnight	349	488	425	285	523	732	637	427

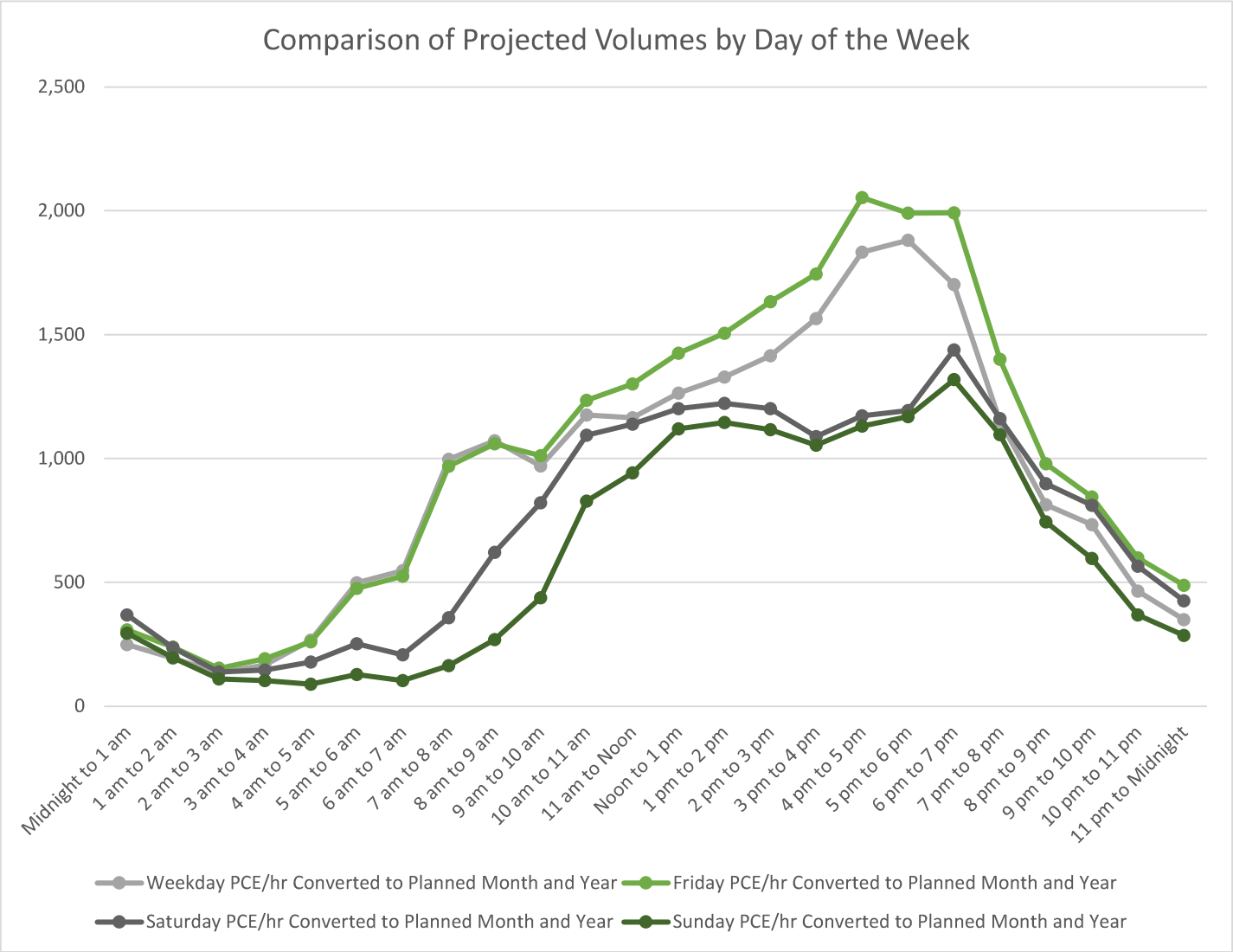
Note: All Traffic Volumes are in PCEs/hr as defined in the IHCP.

**Eastbound traffic volumes from 9 PM until 4 AM reflect all volume on a single lane of traffic

INDIANA DEPARTMENT OF TRANSPORTATION

Traffic Volumes

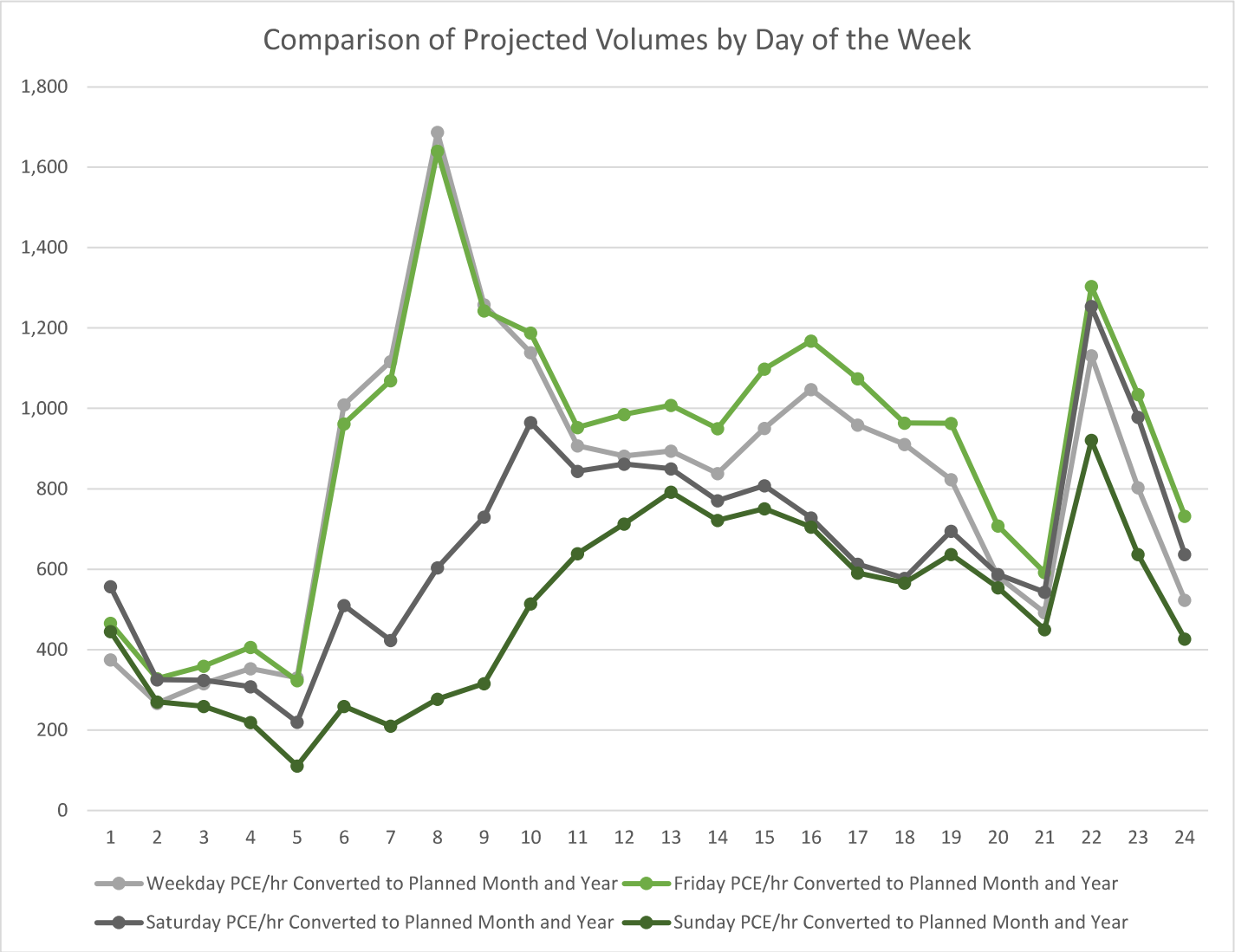
Westbound Volumes I-64 WB lane drop 2-1



INDIANA DEPARTMENT OF TRANSPORTATION

Traffic Volumes

Eastbound Volumes I-64 EB lane drop 2-1



**Eastbound traffic volumes from 9 PM until 4 AM reflect all volume on a single lane of traffic

INDIANA DEPARTMENT OF TRANSPORTATION

Summary of Alternatives

Westbound

Alternative 1 (I-64 WB lane drop 2-1): Fails Criteria i, ii, iii, iv

Eastbound

Alternative 1 (I-64 EB lane drop 2-1): Within Policy Limits

Policy Limits Criteria:

i) No queues of any length for > 6 continuous hours or 12 hours in a calendar day
ii) No queues >0.5 mi for > 4 continuous hours
iii) No queues >1.0 mi for > 2 continuous hours
iv) No queues >1.5 mi

INDIANA DEPARTMENT OF TRANSPORTATION

Alternative 1

I-64 WB lane drop 2-1

Capacities for Westbound Traffic (PCE/hr)

Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Midnight to 1 am	1550	1550	1550	1550	1550	1550	1550
1 am to 2 am	1550	1550	1550	1550	1550	1550	1550
2 am to 3 am	1550	1550	1550	1550	1550	1550	1550
3 am to 4 am	1550	1550	1550	1550	1550	1550	1550
4 am to 5 am	1550	1550	1550	1550	1550	1550	1550
5 am to 6 am	1550	1550	1550	1550	1550	1550	1550
6 am to 7 am	1550	1550	1550	1550	1550	1550	1550
7 am to 8 am	1550	1550	1550	1550	1550	1550	1550
8 am to 9 am	1550	1550	1550	1550	1550	1550	1550
9 am to 10 am	1550	1550	1550	1550	1550	1550	1550
10 am to 11 am	1550	1550	1550	1550	1550	1550	1550
11 am to Noon	1550	1550	1550	1550	1550	1550	1550
Noon to 1 pm	1550	1550	1550	1550	1550	1550	1550
1 pm to 2 pm	1550	1550	1550	1550	1550	1550	1550
2 pm to 3 pm	1550	1550	1550	1550	1550	1550	1550
3 pm to 4 pm	1550	1550	1550	1550	1550	1550	1550
4 pm to 5 pm	1550	1550	1550	1550	1550	1550	1550
5 pm to 6 pm	1550	1550	1550	1550	1550	1550	1550
6 pm to 7 pm	1550	1550	1550	1550	1550	1550	1550
7 pm to 8 pm	1550	1550	1550	1550	1550	1550	1550
8 pm to 9 pm	1550	1550	1550	1550	1550	1550	1550
9 pm to 10 pm	1550	1550	1550	1550	1550	1550	1550
10 pm to 11 pm	1550	1550	1550	1550	1550	1550	1550
11 pm to Midnight	1550	1550	1550	1550	1550	1550	1550

Legend:

Values that are less than the Recommended Non-work Capacity

Summary:

Recommended Non-work Capacity = 4950

Number of Hours per week of restrictions = 168 hr(s)

INDIANA DEPARTMENT OF TRANSPORTATION

Alternative 1

I-64 WB lane drop 2-1

Queuing for Westbound Traffic (mi)

Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Midnight to 1 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 am to 2 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 am to 3 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 am to 4 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 am to 5 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 am to 6 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 am to 7 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 am to 8 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8 am to 9 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 am to 10 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 am to 11 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11 am to Noon	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Noon to 1 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 pm to 2 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 pm to 3 pm	0.0	0.0	0.0	0.0	0.2	0.0	0.0
3 pm to 4 pm	0.0	0.0	0.0	0.0	0.7	0.0	0.0
4 pm to 5 pm	0.8	0.8	0.8	0.8	2.1	0.0	0.0
5 pm to 6 pm	1.7	1.7	1.7	1.7	3.2	0.0	0.0
6 pm to 7 pm	2.1	2.1	2.1	2.1	4.4	0.0	0.0
7 pm to 8 pm	1.0	1.0	1.0	1.0	4.0	0.0	0.0
8 pm to 9 pm	0.0	0.0	0.0	0.0	2.5	0.0	0.0
9 pm to 10 pm	0.0	0.0	0.0	0.0	0.6	0.0	0.0
10 pm to 11 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11 pm to Midnight	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Legend:

Queues greater than zero, but less than 1.5 miles

Queues greater than or equal to 1.5 miles

Summary:

Maximum Queue Length =	4.4 mi
Total queue length-hours =	40 mi-hrs
Total hours with queue =	28 hrs

INDIANA DEPARTMENT OF TRANSPORTATION

Alternative 1

I-64 EB lane drop 2-1

Capacities for Eastbound Traffic (PCE/hr)

Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Midnight to 1 am	1550	1550	1550	1550	1550	1550	1550
1 am to 2 am	1550	1550	1550	1550	1550	1550	1550
2 am to 3 am	1550	1550	1550	1550	1550	1550	1550
3 am to 4 am	1550	1550	1550	1550	1550	1550	1550
4 am to 5 am	1550	1550	1550	1550	1550	1550	1550
5 am to 6 am	1550	1550	1550	1550	1550	1550	1550
6 am to 7 am	1550	1550	1550	1550	1550	1550	1550
7 am to 8 am	1550	1550	1550	1550	1550	1550	1550
8 am to 9 am	1550	1550	1550	1550	1550	1550	1550
9 am to 10 am	1550	1550	1550	1550	1550	1550	1550
10 am to 11 am	1550	1550	1550	1550	1550	1550	1550
11 am to Noon	1550	1550	1550	1550	1550	1550	1550
Noon to 1 pm	1550	1550	1550	1550	1550	1550	1550
1 pm to 2 pm	1550	1550	1550	1550	1550	1550	1550
2 pm to 3 pm	1550	1550	1550	1550	1550	1550	1550
3 pm to 4 pm	1550	1550	1550	1550	1550	1550	1550
4 pm to 5 pm	1550	1550	1550	1550	1550	1550	1550
5 pm to 6 pm	1550	1550	1550	1550	1550	1550	1550
6 pm to 7 pm	1550	1550	1550	1550	1550	1550	1550
7 pm to 8 pm	1550	1550	1550	1550	1550	1550	1550
8 pm to 9 pm	1550	1550	1550	1550	1550	1550	1550
9 pm to 10 pm	1550	1550	1550	1550	1550	1550	1550
10 pm to 11 pm	1550	1550	1550	1550	1550	1550	1550
11 pm to Midnight	1550	1550	1550	1550	1550	1550	1550

Legend:

Values that are less than the Recommended Non-work Capacity

Summary:

Recommended Non-work Capacity = 2475

Number of Hours per week of restrictions = 168 hr(s)

INDIANA DEPARTMENT OF TRANSPORTATION

Alternative 1

I-64 EB lane drop 2-1

Queuing for Eastbound Traffic (mi)

Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Midnight to 1 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 am to 2 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 am to 3 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 am to 4 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 am to 5 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 am to 6 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 am to 7 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 am to 8 am	0.7	0.7	0.7	0.7	0.5	0.0	0.0
8 am to 9 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 am to 10 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 am to 11 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11 am to Noon	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Noon to 1 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 pm to 2 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 pm to 3 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 pm to 4 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 pm to 5 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 pm to 6 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 pm to 7 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 pm to 8 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8 pm to 9 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 pm to 10 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 pm to 11 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11 pm to Midnight	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Legend:

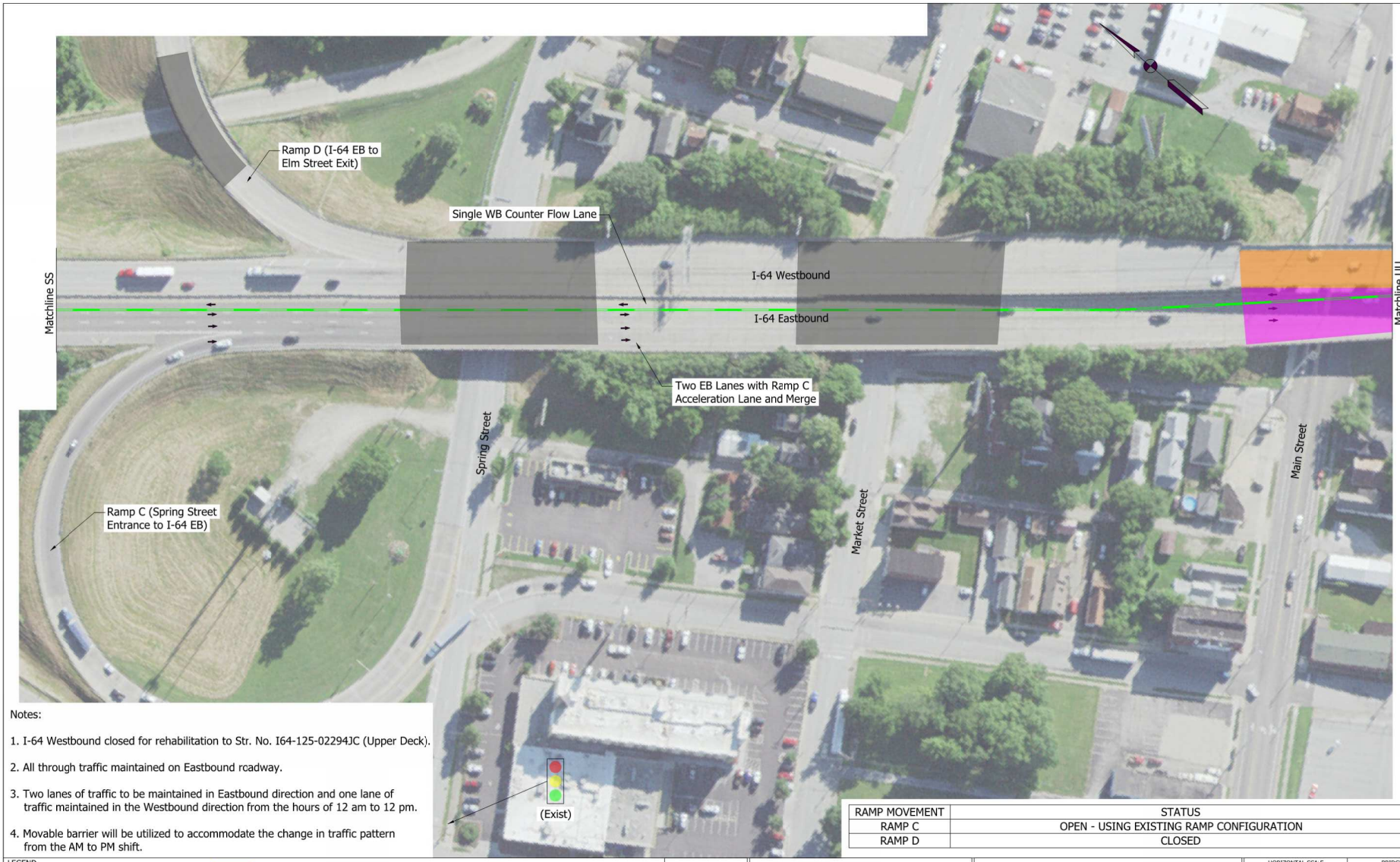
Queues greater than zero, but less than 1.5 miles

Queues greater than or equal to 1.5 miles

Summary:

Maximum Queue Length =	0.7 mi
Total queue length-hours =	3 mi-hrs
Total hours with queue =	5 hrs

Attachment A-2a: MOT Phases 3 and 4 Eastbound Approach



Notes:

1. I-64 Westbound closed for rehabilitation to Str. No. I64-125-02294JC (Upper Deck).
2. All through traffic maintained on Eastbound roadway.
3. Two lanes of traffic to be maintained in Eastbound direction and one lane of traffic maintained in the Westbound direction from the hours of 12 am to 12 pm.
4. Movable barrier will be utilized to accommodate the change in traffic pattern from the AM to PM shift.

RAMP MOVEMENT	STATUS
RAMP C	OPEN - USING EXISTING RAMP CONFIGURATION
RAMP D	CLOSED

LEGEND

- Construction
- Existing
- Completed Construction
- Temporary Pavement
- Temporary Traffic Drums
- Temporary Pavement Markings
- Temporary Moveable Concrete Barrier
- Temporary Concrete Barrier
- Existing Bridge Limits
- Temporary Shoring

$FILE$

RECOMMENDED FOR APPROVAL _____ DESIGN ENGINEER DATE

DESIGNED: _____ DRAWN: DH

CHECKED: _____ CHECKED: _____

INDIANA
DEPARTMENT OF TRANSPORTATION

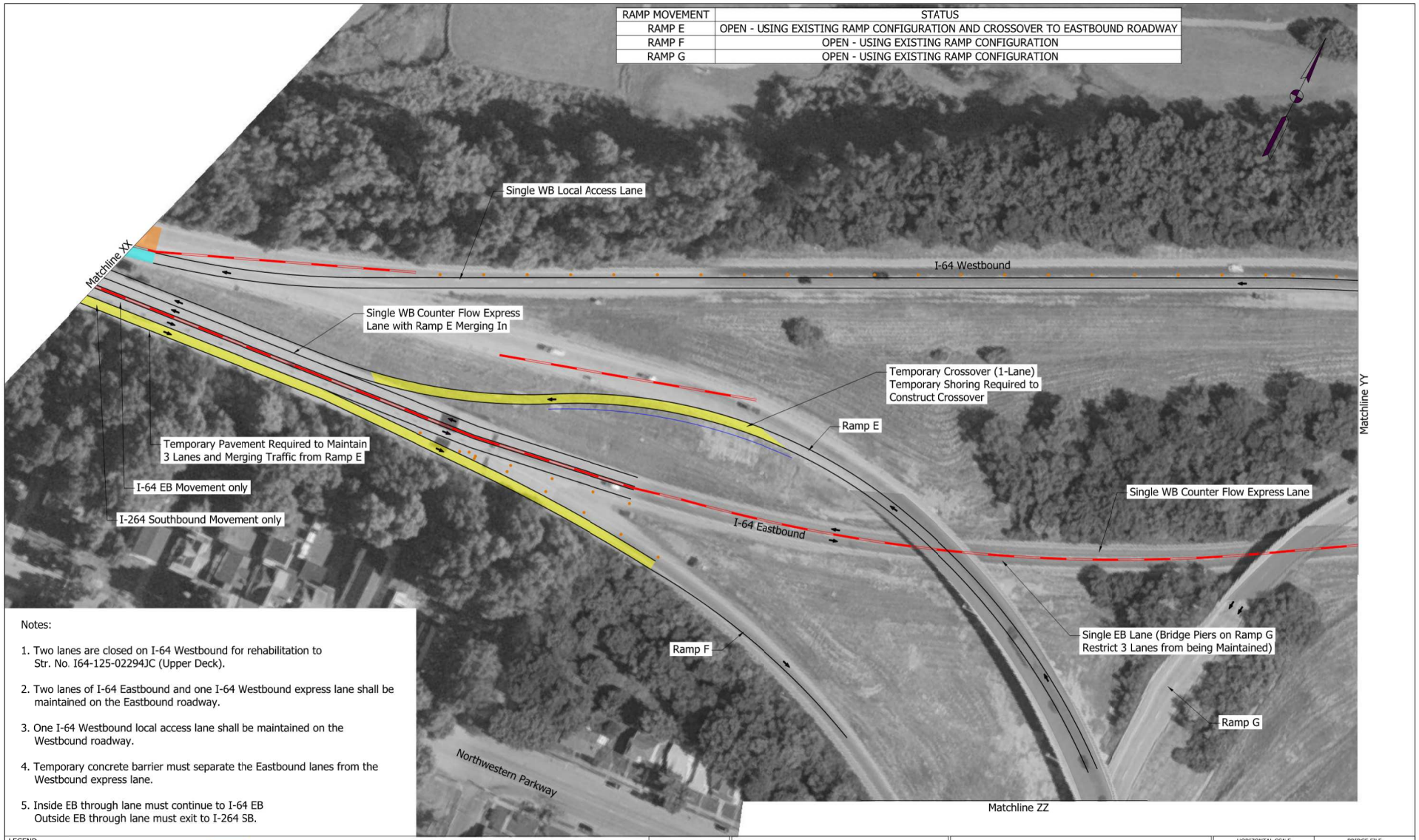
MAINTENANCE OF TRAFFIC
OPTION 4 - PHASE 2 AM
MOVABLE BARRIER OPTION

HORIZONTAL SCALE	BRIDGE FILE
1" = 50'	
VERTICAL SCALE	DESIGNATION
N/A	1702255
SURVEY BOOK	SHEETS
ELECTRONIC	| of |
CONTRACT	PROJECT

Attachment 12-5 IHCP Exception Request

Attachment A-2b: MOT Phases 3 and 4 Westbound Approach

RAMP MOVEMENT	STATUS
RAMP E	OPEN - USING EXISTING RAMP CONFIGURATION AND CROSSOVER TO EASTBOUND ROADWAY
RAMP F	OPEN - USING EXISTING RAMP CONFIGURATION
RAMP G	OPEN - USING EXISTING RAMP CONFIGURATION



Notes:

1. Two lanes are closed on I-64 Westbound for rehabilitation to Str. No. I64-125-02294JC (Upper Deck).
2. Two lanes of I-64 Eastbound and one I-64 Westbound express lane shall be maintained on the Eastbound roadway.
3. One I-64 Westbound local access lane shall be maintained on the Westbound roadway.
4. Temporary concrete barrier must separate the Eastbound lanes from the Westbound express lane.
5. Inside EB through lane must continue to I-64 EB Outside EB through lane must exit to I-264 SB.

LEGEND

- Construction
- Existing
- Completed Construction
- Temporary Pavement
- Temporary Traffic Drums
- Temporary Pavement Markings
- Temporary Moveable Concrete Barrier
- Temporary Concrete Barrier
- Existing Bridge Limits
- Temporary Shoring

RECOMMENDED FOR APPROVAL _____ DESIGN ENGINEER DATE

DESIGNED: _____ DRAWN: DH

CHECKED: _____ CHECKED: _____

INDIANA
DEPARTMENT OF TRANSPORTATION

MAINTENANCE OF TRAFFIC
MOT BASELINE OPTION - PHASE 2A
BOTTOM DECK OPTION B

HORIZONTAL SCALE	BRIDGE FILE
1" = 50'	
VERTICAL SCALE	DESIGNATION
N/A	1702255
SURVEY BOOK	SHEETS
ELECTRONIC	| of |
CONTRACT	PROJECT

pw://VANVA01PWINT01.parsons.com:Indiana State/Documents/I64 Sherman Minton Bridges/50 - Design/CAD/MOT/Exhibits/Hybrid Lane Configurations/I64 Sherman Minton Bottom Deck B.dgn

Attachment A-2c: MOT Phases 3 and 4 Queuing Analysis Summary Report

INDIANA DEPARTMENT OF TRANSPORTATION

Report for IHCP Queuing Analysis

Prepared by:	**PARSONS**	Position:	**PARSONS**
Prepared for:	**INDOT**	Position:	**INDOT**

Work Zone Information

Route:	I-64 SMB
Mile marker:	MM 000.50
Positive Direction:	East
Contract:	B-40719
Work Year:	2022
Work Month:	JUN
Work Type:	Maintenance
Work Description:	Bridge Renewal - Baseline MOT Phases 3 & 4, Construction on Upper deck - I-64 EB 3-2 Lane Drop, I-64 WB 2-1 Lane Drop
Permanent Speed Limit:	55 mph
Work Zone Speed Limit:	45 mph
Workzone Lane Width:	11 ft
Channelizing Devices:	Mixture of Construction Drums, Cones or Barrier Wall.
Additional Information:	SMB Renewal Project. Baseline MOT option. Maintaining 2 lanes EB and WB. Phases 1 & 2 Construction on Lower deck: lower deck - one EB lane open, upper deck - one EB lane and two WB lanes. Phases 3 & 4 Construction on Upper deck: lower deck - two EB lanes and one WB lane, upper deck - one WB lane open.

Queuing Formula

$$L = L_0 + \frac{(V - C) * 1\,hr}{(k * N)}$$

Where:

- L= Length of Queue for Specified Hour (mi)
- L_0= Length of Queue in the Hour Prior to Specified Hour (mi)
- V= Hourly Volume (PCE/hr)
- C= Hourly Capacity (PCE/hr)
- k= Jam Density (PCE/mi/lane)
- N= Number of Storage Lanes Upstream of Restriction (lanes)

Jam Density (k)=	190 PCE/mi/ln
N for WB=	2 ln
N for EB=	3 ln

INDIANA DEPARTMENT OF TRANSPORTATION

Traffic Information

Count Information	Count Station Number:	970210
	Month, Year of Count:	FEB, 2018
	Rural/Urban:	Urban

Weekend Adjustment Factors

Values from "Hourly Day of the Week Conversion Factors.xlsx" Urban Center tab
downloaded on 3/13/2020

Factors to Adjust Counts to Annual Value in Current Year

Annual Adj. Factor:	1.000
Monthly Adj. Factor:	1.000

Factors to Project Annual Value in Current Year to Work Month and Year

Annual Adj. Factor:	1.000
Monthly Adj. Factor:	1.000

Assumed Percent Reduction of Traffic Due to Detouring **

Westbound

Monday-Thursday:	0%
Friday:	0%
Saturday-Sunday:	0%

Eastbound

Monday-Thursday:	0%
Friday:	0%
Saturday-Sunday:	0%

**Traffic diversions determined by travel demand model. Rates of diversion varied by time of day.

INDIANA DEPARTMENT OF TRANSPORTATION

Traffic Volumes **

	I-64 WB lane drop 2-1				I-64 EB lane drop 3-2			
	Westbound Volumes (PCE/hr)				Eastbound Volumes (PCE/hr)			
Time	Weekday	Friday	Saturday	Sunday	Weekday	Friday	Saturday	Sunday
Midnight to 1 am	432	537	642	512	368	457	547	437
1 am to 2 am	350	430	426	354	261	321	318	264
2 am to 3 am	255	290	261	209	310	352	317	254
3 am to 4 am	302	347	263	187	346	398	302	215
4 am to 5 am	520	509	347	174	766	750	511	257
5 am to 6 am	813	775	411	208	2333	2224	1180	598
6 am to 7 am	899	861	340	169	2578	2468	976	485
7 am to 8 am	1556	1513	557	255	3647	3546	1306	598
8 am to 9 am	1560	1542	905	392	2838	2805	1646	713
9 am to 10 am	1415	1476	1199	638	2567	2678	2175	1157
10 am to 11 am	1503	1579	1399	1059	2120	2227	1974	1494
11 am to Noon	1481	1654	1448	1197	2053	2293	2007	1660
Noon to 1 pm	1527	1722	1452	1353	2074	2339	1972	1838
1 pm to 2 pm	1570	1779	1444	1353	1971	2233	1813	1699
2 pm to 3 pm	1414	1633	1201	1116	2282	2635	1938	1801
3 pm to 4 pm	1562	1742	1087	1052	2524	2814	1756	1700
4 pm to 5 pm	1712	1917	1094	1056	2551	2857	1631	1573
5 pm to 6 pm	1778	1881	1128	1104	2307	2440	1463	1432
6 pm to 7 pm	1608	1881	1359	1245	2086	2440	1762	1615
7 pm to 8 pm	1345	1636	1357	1281	1417	1724	1430	1349
8 pm to 9 pm	985	1185	1088	902	1183	1423	1307	1083
9 pm to 10 pm	862	993	956	702	1114	1284	1235	907
10 pm to 11 pm	851	1096	1037	675	791	1019	964	628
11 pm to Midnight	640	896	779	523	514	719	626	420

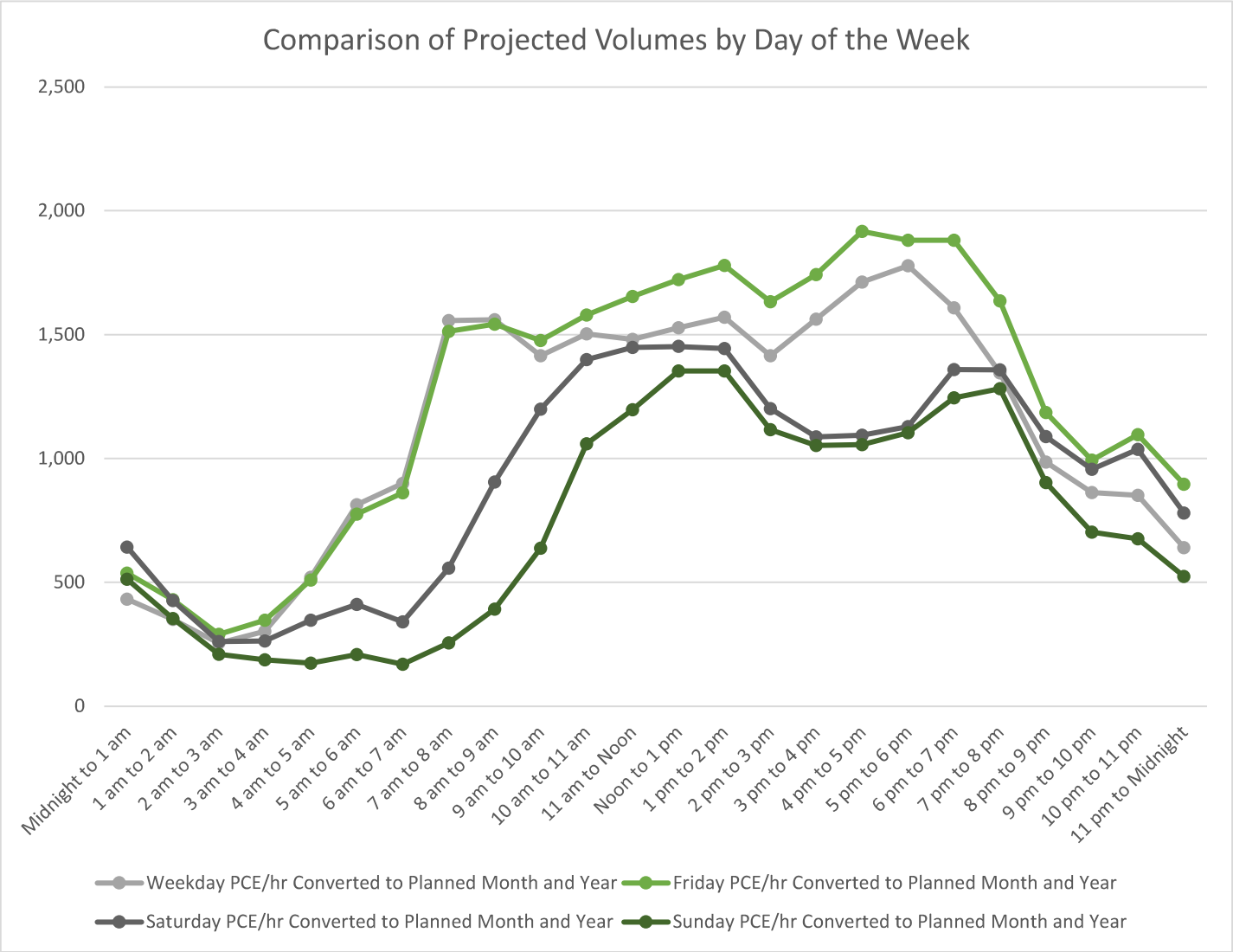
Note: All Traffic Volumes are in PCEs/hr as defined in the IHCP.

**Westbound traffic volumes from 10 PM until 5 AM reflect all volume on a single lane of traffic

INDIANA DEPARTMENT OF TRANSPORTATION

Traffic Volumes

Westbound Volumes I-64 WB lane drop 2-1

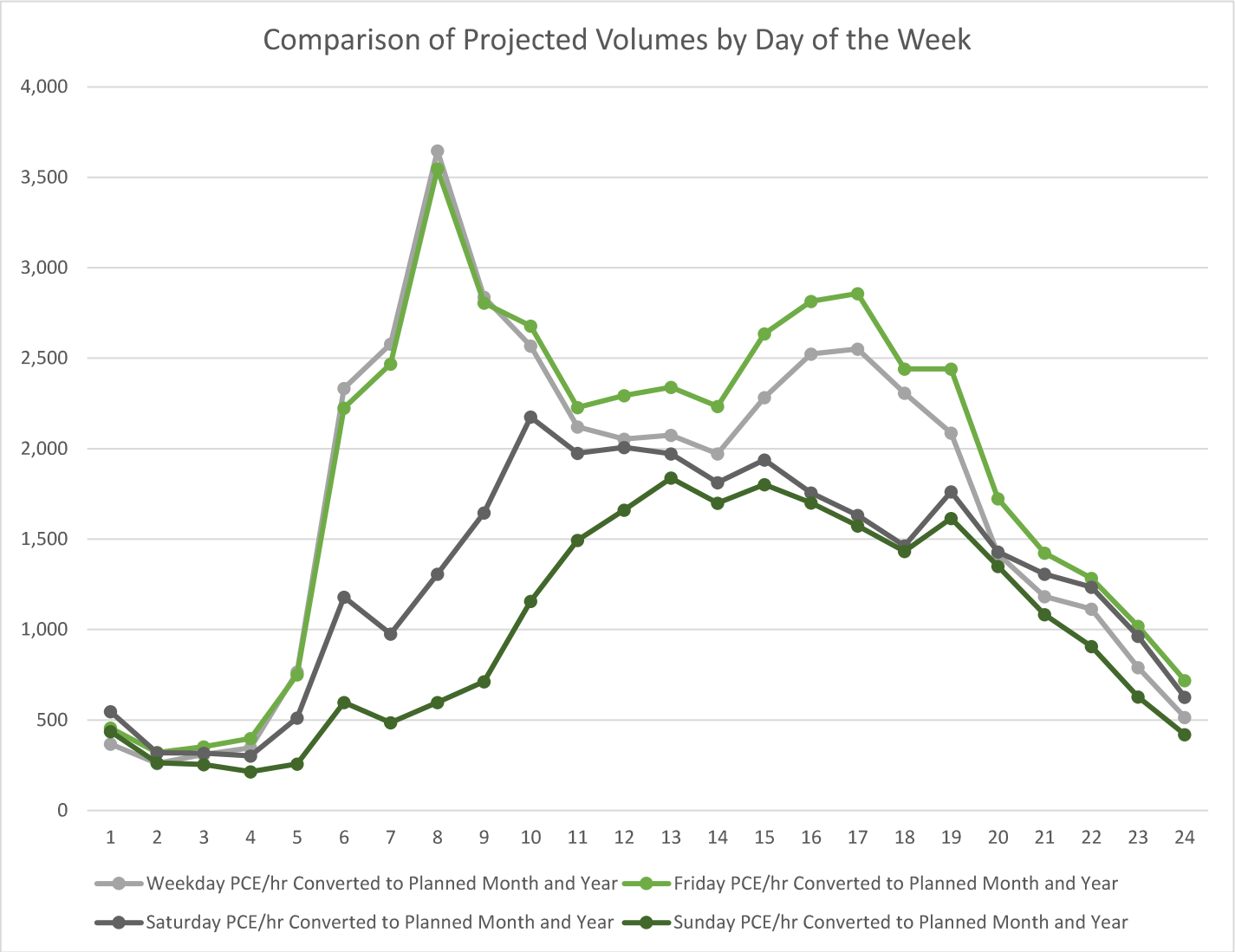


**Westbound traffic volumes from 10 PM until 5 AM reflect all volume on a single lane of traffic

INDIANA DEPARTMENT OF TRANSPORTATION

Traffic Volumes

Eastbound Volumes I-64 EB lane drop 3-2



INDIANA DEPARTMENT OF TRANSPORTATION

Summary of Alternatives

Westbound

Alternative 1 (I-64 WB lane drop 2-1): Fails Criteria i, ii, iii, iv

Eastbound

Alternative 1 (I-64 EB lane drop 3-2): Within Policy Limits

Policy Limits Criteria:

i) No queues of any length for > 6 continuous hours or 12 hours in a calendar day
ii) No queues >0.5 mi for > 4 continuous hours
iii) No queues >1.0 mi for > 2 continuous hours
iv) No queues >1.5 mi

INDIANA DEPARTMENT OF TRANSPORTATION

Alternative 1

I-64 WB lane drop 2-1

Capacities for Westbound Traffic (PCE/hr)

Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Midnight to 1 am	1550	1550	1550	1550	1550	1550	1550
1 am to 2 am	1550	1550	1550	1550	1550	1550	1550
2 am to 3 am	1550	1550	1550	1550	1550	1550	1550
3 am to 4 am	1550	1550	1550	1550	1550	1550	1550
4 am to 5 am	1550	1550	1550	1550	1550	1550	1550
5 am to 6 am	1550	1550	1550	1550	1550	1550	1550
6 am to 7 am	1550	1550	1550	1550	1550	1550	1550
7 am to 8 am	1550	1550	1550	1550	1550	1550	1550
8 am to 9 am	1550	1550	1550	1550	1550	1550	1550
9 am to 10 am	1550	1550	1550	1550	1550	1550	1550
10 am to 11 am	1550	1550	1550	1550	1550	1550	1550
11 am to Noon	1550	1550	1550	1550	1550	1550	1550
Noon to 1 pm	1550	1550	1550	1550	1550	1550	1550
1 pm to 2 pm	1550	1550	1550	1550	1550	1550	1550
2 pm to 3 pm	1550	1550	1550	1550	1550	1550	1550
3 pm to 4 pm	1550	1550	1550	1550	1550	1550	1550
4 pm to 5 pm	1550	1550	1550	1550	1550	1550	1550
5 pm to 6 pm	1550	1550	1550	1550	1550	1550	1550
6 pm to 7 pm	1550	1550	1550	1550	1550	1550	1550
7 pm to 8 pm	1550	1550	1550	1550	1550	1550	1550
8 pm to 9 pm	1550	1550	1550	1550	1550	1550	1550
9 pm to 10 pm	1550	1550	1550	1550	1550	1550	1550
10 pm to 11 pm	1550	1550	1550	1550	1550	1550	1550
11 pm to Midnight	1550	1550	1550	1550	1550	1550	1550

Legend:

Values that are less than the Recommended Non-work Capacity

Summary:

Recommended Non-work Capacity = 4950

Number of Hours per week of restrictions = 168 hr(s)

INDIANA DEPARTMENT OF TRANSPORTATION

Alternative 1

I-64 WB lane drop 2-1

Queuing for Westbound Traffic (mi)

Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Midnight to 1 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 am to 2 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 am to 3 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 am to 4 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 am to 5 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 am to 6 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 am to 7 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 am to 8 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8 am to 9 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 am to 10 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 am to 11 am	0.0	0.0	0.0	0.0	0.1	0.0	0.0
11 am to Noon	0.0	0.0	0.0	0.0	0.4	0.0	0.0
Noon to 1 pm	0.0	0.0	0.0	0.0	0.8	0.0	0.0
1 pm to 2 pm	0.1	0.1	0.1	0.1	1.4	0.0	0.0
2 pm to 3 pm	0.0	0.0	0.0	0.0	1.6	0.0	0.0
3 pm to 4 pm	0.0	0.0	0.0	0.0	2.1	0.0	0.0
4 pm to 5 pm	0.5	0.5	0.5	0.5	3.1	0.0	0.0
5 pm to 6 pm	1.1	1.1	1.1	1.1	4.0	0.0	0.0
6 pm to 7 pm	1.2	1.2	1.2	1.2	4.8	0.0	0.0
7 pm to 8 pm	0.7	0.7	0.7	0.7	5.1	0.0	0.0
8 pm to 9 pm	0.0	0.0	0.0	0.0	4.1	0.0	0.0
9 pm to 10 pm	0.0	0.0	0.0	0.0	2.6	0.0	0.0
10 pm to 11 pm	0.0	0.0	0.0	0.0	1.4	0.0	0.0
11 pm to Midnight	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Legend:

Queues greater than zero, but less than 1.5 miles

Queues greater than or equal to 1.5 miles

Summary:

Maximum Queue Length =	5.1 mi
Total queue length-hours =	46 mi-hrs
Total hours with queue =	45 hrs

INDIANA DEPARTMENT OF TRANSPORTATION

Alternative 1

I-64 EB lane drop 3-2

Capacities for Eastbound Traffic (PCE/hr)

Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Midnight to 1 am	3200	3200	3200	3200	3200	3200	3200
1 am to 2 am	3200	3200	3200	3200	3200	3200	3200
2 am to 3 am	3200	3200	3200	3200	3200	3200	3200
3 am to 4 am	3200	3200	3200	3200	3200	3200	3200
4 am to 5 am	3200	3200	3200	3200	3200	3200	3200
5 am to 6 am	3200	3200	3200	3200	3200	3200	3200
6 am to 7 am	3200	3200	3200	3200	3200	3200	3200
7 am to 8 am	3200	3200	3200	3200	3200	3200	3200
8 am to 9 am	3200	3200	3200	3200	3200	3200	3200
9 am to 10 am	3200	3200	3200	3200	3200	3200	3200
10 am to 11 am	3200	3200	3200	3200	3200	3200	3200
11 am to Noon	3200	3200	3200	3200	3200	3200	3200
Noon to 1 pm	3200	3200	3200	3200	3200	3200	3200
1 pm to 2 pm	3200	3200	3200	3200	3200	3200	3200
2 pm to 3 pm	3200	3200	3200	3200	3200	3200	3200
3 pm to 4 pm	3200	3200	3200	3200	3200	3200	3200
4 pm to 5 pm	3200	3200	3200	3200	3200	3200	3200
5 pm to 6 pm	3200	3200	3200	3200	3200	3200	3200
6 pm to 7 pm	3200	3200	3200	3200	3200	3200	3200
7 pm to 8 pm	3200	3200	3200	3200	3200	3200	3200
8 pm to 9 pm	3200	3200	3200	3200	3200	3200	3200
9 pm to 10 pm	3200	3200	3200	3200	3200	3200	3200
10 pm to 11 pm	3200	3200	3200	3200	3200	3200	3200
11 pm to Midnight	3200	3200	3200	3200	3200	3200	3200

Legend:

Values that are less than the Recommended Non-work Capacity

Summary:

Recommended Non-work Capacity = 7425

Number of Hours per week of restrictions = 168 hr(s)

INDIANA DEPARTMENT OF TRANSPORTATION

Alternative 1

I-64 EB lane drop 3-2

Queuing for Eastbound Traffic (mi)

Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Midnight to 1 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 am to 2 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 am to 3 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 am to 4 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 am to 5 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 am to 6 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 am to 7 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 am to 8 am	0.8	0.8	0.8	0.8	0.6	0.0	0.0
8 am to 9 am	0.1	0.1	0.1	0.1	0.0	0.0	0.0
9 am to 10 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 am to 11 am	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11 am to Noon	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Noon to 1 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 pm to 2 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 pm to 3 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 pm to 4 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 pm to 5 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 pm to 6 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 pm to 7 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 pm to 8 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8 pm to 9 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 pm to 10 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 pm to 11 pm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11 pm to Midnight	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Legend:

Queues greater than zero, but less than 1.5 miles

Queues greater than or equal to 1.5 miles

Summary:

Maximum Queue Length =	0.8 mi
Total queue length-hours =	4 mi-hrs
Total hours with queue =	9 hrs

Traffic Analysis Report

Sherman Minton Renewal Project

Indiana Department of Transportation

March 2020

delivering a better world

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Executive Summary

PROJECT DESCRIPTION

The Indiana Department of Transportation (INDOT) and Kentucky Transportation Cabinet (KYTC) propose to rehabilitate the I-64 Sherman Minton Bridge over the Ohio River as well as its associated approaches. It is expected that the rehabilitation for the Sherman Minton Renewal Project (SMRP) may take two- to three-years. Construction is scheduled to begin in 2021 and is intended to refurbish the structure. This project will not add capacity to the bridge; it will simply rehabilitate the structure.

The purpose of this technical report is to document methods, assumptions and results of the project traffic analysis. This analysis was conducted to provide a better understanding of potential traffic impacts due to maintenance of traffic (MOT) plans during the project. Both the environmental documentation and procurement documents require an understanding of potential traffic impacts under each MOT option under consideration. The traffic analyses were conducted at various levels of detail ranging from systemwide to the highway network to local streets in the study area communities.

A project specific Travel Demand Model (TDM) was developed in support of the traffic analysis. This model was based on the model maintained by the Kentuckiana Regional Planning and Development Agency (KIPDA). The SMRP TDM covers the entire KIPDA planning region which includes the project study area (see Figure 1, Section 1.1). For background on the development of the SMRP TDM refer to the *SMRP Travel Demand Model* documentation located in Appendix A.

STUDY AREA AND ROADWAY NETWORK

The project study area for the SMRP is bounded by I-65 on the east and I-64/I-264 on the west and includes areas within Kentucky and within Indiana (see Figure 1, in Section 1.1,). Each side of the river has a distinct roadway network and travel patterns. However, the Sherman Minton Bridge predominantly serves trips originating in Indiana destined for Louisville, the regional economic driver. AM peak-hour volumes are heaviest in the eastbound direction while PM traffic flows are heaviest westbound. For river crossing trips, drivers within the study area have a choice between I-64 to the west and I-65 or US 31 in downtown to the east of the study area.

Peak-hour traffic in the I-64 Sherman Minton Bridge Corridor, under current conditions, experiences some slowdowns. However, these slowdowns do not occur on the bridge itself. Rather, congestion at locations to the west of the Sherman Minton Bridge in the AM (i.e., US-150/I-64 Interchange) and east during the PM (i.e., I-64/I-264 Interchange) meter traffic flow approaching the bridge.

GENERAL TRAVEL PATTERNS FOR THE MOT OPTIONS

The MOT options for the SMRP span closure of a single lane, two lanes, and full closure (See inset Figures in Section 2.1.1 MOT OPTIONS). As the Sherman Minton Bridge capacity is reduced, a greater number of trips divert eastward to utilize the Clark Memorial Bridge (US31) or Kennedy/Lincoln Bridges (I-65). These diverted trips heading to the downtown bridges increase the traffic flows along I-265 and Spring Street/Brown Station Way. The impacts of the MOT options result in increased systemwide vehicles miles and hours traveled and reductions in average travel speeds. The scale of these impacts is directly related to a MOT option's Sherman Minton Bridge capacity reductions.

Underlying a trip's distance and travel time is the driver's user cost. An individual trip's cost or the user's cost of making a trip is determined by monetizing the trip distance and travel time along with any tolls paid. Along with increases in tolled river crossing trips, the overall increases in trip travel times and distances adds to the average cost of regional travel. As the Clark Memorial Bridge is already near capacity, a majority of diverted cross river trips would require using a tolled bridge.

Short of the full closure MOT option, many drivers will remain within the I-64 corridor using the Sherman Minton Bridge for cross river trips. These drivers will experience increased delays as the bridge capacity is reduced. Most notably, in

the peak hours and peak direction of flow a reduced number of lanes would reach capacity. As such, queues would start to form within the corridor, delaying these remaining trips.

Under some of the MOT options, it is likely the local street system within the study area communities will also experience an increase in congestion. The potential for congestion would be brought on by diverted traffic. Under the most restrictive MOT options (full closure, full closure by direction), the Spring Street/Brown Station Way corridor in New Albany and Clarksville showed the highest potential for congestion during peak hours. On the other hand, the local street network in West Louisville did not see a significant increase in traffic. This is likely due to I-64 on the Kentucky side providing a high-capacity east-west connection between the Sherman Minton Bridge and the downtown bridges that is so close to the river.

FINDINGS

Impacts due to the various MOT options were examined at varying levels ranging from systemwide to the highway network to local streets in the study area communities. The effects on traffic lanes of the Sherman Minton bridge under each MOT option are listed below:

- MOT 1 – Single lane closure both directions
- MOT 2 – Two lane closure both directions
- MOT 5 – Full bridge closure both directions
- MOT 3 and MOT 4 – Provide closures with reversible lanes intended to better accommodate peak-hour direction traffic.
- MOT 6 – Fully close one direction of travel while remaining open in the other direction.

Generally, the more the MOT option is restrictive to the capacity on the Sherman Minton Bridge, the greater the impacts on all levels. Across all measures, MOT 1 is the least impactful to regional travel while MOT 5 is the most impactful. While MOT 2, 3, 4 and 6 fall somewhere in between. Details of the analyses are available in body of the report with more general highlights described here.

General Travel Patterns for MOT Options: As the Sherman Minton Bridge capacity is reduced some trips are expected to divert to other bridges. These capacity restrictions tend to be most impactful during the AM and PM peak periods when cross-river travel demand is highest. Cross-river traffic diverted from the Sherman Minton bridge must choose from one of the remaining river crossing options in the Louisville area: US 31 Clark Memorial Bridge, I-65 Kennedy/Lincoln Bridges, and the I-265 Lewis and Clark Bridge. It should be noted that the other non-tolled bridge, Clark Memorial, already operates near or at capacity. As such, it is likely additional demand from diverted trips could displace existing Clark Memorial trips to one of the tolled bridges. The following table shows the estimated number of diverted trips from the Sherman Minton bridge for each MOT Option, with all trips diverting under MOT 5 – full closure.

General Travel Patterns	BASE	MOT 1	MOT 2	MOT 3	MOT 4	MOT 5	MOT 6
Sherman Minton Bridge Volume	90,000	82,600	56,600	49,400	70,300	0	43,400
Total Diverted Traffic	0	7,400	33,400	40,600	19,700	90,000	46,600
To Clark Memorial		9%	13%	18%	17%	13%	14%
To Kennedy/Lincoln		77%	71%	68%	69%	72%	72%
To Lewis & Clark		14%	17%	14%	14%	15%	14%
To Tolled Crossing		6,700	29,200	16,300	78,200	33,100	40,200

Note: From data reported in Table 1, Section 2.2.1

Systemwide Impacts: Study area impacts were measured by comparing changes in Vehicle Hours and Miles Traveled (VHT and VMT) as well as average network speeds. As trips divert from the Sherman Minton bridge, they will often experience longer distances traveled and increases in travel time. Under existing conditions some drivers already choose a longer distance path in order to avoid a tolled bridge crossing or existing congestion. In these cases, diverted trips may actually be shorter. VHT provides the most comprehensive measure of delay as it considers both speed and distance. The following table highlights estimated study area changes in daily VHT for each MOT option.

Study Area Change	BASE	MOT 1	MOT 2	MOT 3	MOT 4	MOT 5	MOT 6
Vehicle Hours Traveled	207,700	209,300	213,700	211,500	211,600	218,700	213,600
Percent Change VHT		0.8%	2.9%	1.8%	1.9%	5.3%	2.8%
Change VHT		1,600	6,000	3,800	3,900	11,000	5,900

Note: From data reported in Table 2, Section 2.2.2

Impacts to Cross-River Trips: Cross-river trips are directly impacted by lane restrictions on the Sherman Minton bridge. Therefore, changes in trip cost were determined for this subset of regional trips. Average trip costs were calculated for all river-crossing trips using assumptions of vehicle operating cost, drivers' value of time, and toll cost. Average trip costs for all river crossing trips during the AM and PM periods are shown in the following table.

Change in User Cost (All river-crossing trips)	BASE	MOT 1	MOT 2	MOT 3	MOT 4	MOT 5	MOT 6
User Cost per Trip	$23.43	$23.97	$24.94	$24.40	$24.30	$26.60	$25.08
Percent Change in User Cost		2%	6%	4%	4%	13%	7%
Change in User Cost		$0.54	$1.51	$0.96	$0.87	$3.16	$1.64

Note: From data reported in Table 4, Section 2.2.3

For comparison, current Sherman Minton car trip user costs are also reported. Average trip costs for current Sherman Minton trips during the AM period are listed in the following table. As expected, a significantly higher financial burden as measured by user costs would fall to current Sherman Minton bridge users compared to all cross-river trips.

Change in User Cost (Current Sherman Minton trips)	BASE	MOT 1	MOT 2	MOT 3	MOT 4	MOT 5	MOT 6
User Cost per Trip	$17.46	$18.74	$21.23	$20.54	$19.64	$25.01	$21.43
Percent Change in User Cost		7%	22%	18%	12%	43%	23%
Change in User Cost		$1.28	$3.78	$3.09	$2.18	$7.56	$3.97

Note: From data reported in Table 15, Section 2.2.4

Bottleneck Locations: There are existing locations that experience bottlenecks on a regular basis, including the non-interstate Clark Memorial bridge (see Figure 4, Section 2.3.1). Each MOT option has the potential to generate additional bottlenecks throughout the system. Locations with the highest potential for diversion-related congestion common to several MOT options include (see Figure 5-10, Section 2.3.1):

- Sherman Minton Bridge (under partial closure scenarios)
- EB I-265 to SB I-65
- NB I-65 to WB I-265
- WB I-265 to WB I-64
- EB I-64 to EB I-265

I-64 Sherman Minton Bridge Corridor: Some queueing within the I-64 Sherman Minton Corridor is expected for any MOT option that reduces the number of lanes across the bridge. If a MOT provides 3 full lanes of travel or fully closes a direction, no queueing is expected under those conditions within the I-64 Sherman Minton Bridge corridor. As such MOTs 3, 5 and 6 are not expected to experience queues within the I-64 corridor. The worst corridor queues would be found under MOT 2, followed by MOT 4 and then MOT 1 (see Table 17, Section 2.3.1).

Travel times within the I-64 Sherman Minton corridor are related to queueing and are expected to increase through the corridor as additional lanes are closed under MOT options. For MOT options providing 3 full travel lanes, travel time increases within the corridor would be limited. The estimated change in travel times for each MOT option are reported in the next table. The travel times were estimated along the I-64 corridor from US-150 in Indiana and 22nd Street in Louisville (see Figure 11, Section 2.3.1) during peak-period/peak-direction of travel. As expected, short of full closure of the Sherman Minton bridge (as in MOT 5), travel times increase through the corridor as additional lanes are closed.

Corridor Travel Time Increases (Minutes)	BASE TRAVEL TIME	TRAVEL TIME INCREASES					
		MOT 1	MOT 2	MOT 3	MOT 4	MOT 5	MOT 6
Eastbound (AM Peak Period)	8	5	14	0	5	FC	0 (FC)
Westbound (PM Peak Period)	8	6	15	0	4	FC	0 (FC)

Note: From data reported in Table 18, Section 2.3.1)

Note: MOT 3 provides 3 full lanes in peak direction of travel and is fully closed (FC) in the off-peak direction. MOT 6 is phased such that the peak-direction of travel is provided 3 full travel lanes or is fully closed.

Local Community/Local Street Impacts: It is desirable that while implementing a MOT, diverted traffic would utilize the official alternative route (I-265 to I-65). However, estimates indicate some of the diverted traffic would rely on more local routes and potentially cause congestion through the local communities. Estimates of traffic volume changes were determined at several locations along plausible local detour routes through New Albany and West Louisville (These locations are identified in Figure 14, Section 2.3.2). The following table highlights the locations where congestion due to changing travel patterns under the analyzed MOT options is most likely. Only locations within New Albany showed potential for congestion related to local detour routing.

Potential Local Route Congestion (None or AM or PM or Both)	MOT 1	MOT 2	MOT 3	MOT 4	MOT 5	MOT 6
New Albany – Downtown	None	None	None	None	PM	PM
New Albany – Eastside	None	PM	None	None	AM/PM	AM/PM
Clarksville	None	None	None	None	None	None
West Louisville	None	None	None	None	None	None

Note: From data reported in Tables 22-29, Section 2.3.3

1 Introduction

1.1 PROJECT OVERVIEW

The Indiana Department of Transportation (INDOT) and Kentucky Transportation Cabinet (KYTC) propose to rehabilitate the I-64 Sherman Minton Bridge over the Ohio River as well as its associated approaches. It is expected that the rehabilitation may take two- to three-years and construction is scheduled to begin in 2021. The rehabilitation is intended to refurbish the structure; it will not add capacity to the bridge. The Sherman Minton Renewal Project (SMRP) includes development of a maintenance of traffic (MOT) plan as well as design of the rehabilitation of the various structural elements of the bridge. The MOT plan will balance the need to accommodate cross-river travel in the area with the need to provide a safe and adequate working space for the bridge maintenance and construction activities.

This report provides an analysis of different MOT scenarios, ranging from peak-hour lane closures to full bridge closure. The traffic analysis was conducted as part of a series of engineering studies for the project used to support the required NEPA and Design/Build/Best Value procurement documents. The analysis identifies changes in travel route choice due to the various MOT options, including possible diversions on the regional highway network and through local communities, as well as potential associated impacts. The SMRP Study Area is shown below in Figure 1. This figure delineates the study area boundary as well as locations subject to special consideration with regard to measuring impacts. A separate "Maintenance of Traffic Options Analysis" report provides an evaluation of the candidate MOT plans. This report supports the MOT options evaluation.

A project-specific travel demand model was developed as the primary tool used to understand how travel patterns could shift in response to a MOT option. The SMRP travel demand model (TDM) was developed based on the recently updated regional travel demand model maintained by the Kentuckiana Regional Planning & Development Agency (KIPDA). Like the KIPDA travel demand model, the SMRP TDM covers the entire KIPDA planning region. The Study Area is contained with the regional model area. The purpose of this report is to document the traffic analyses used to evaluate the MOT scenarios. Details of the SMRP TDM can be found in Appendix A.

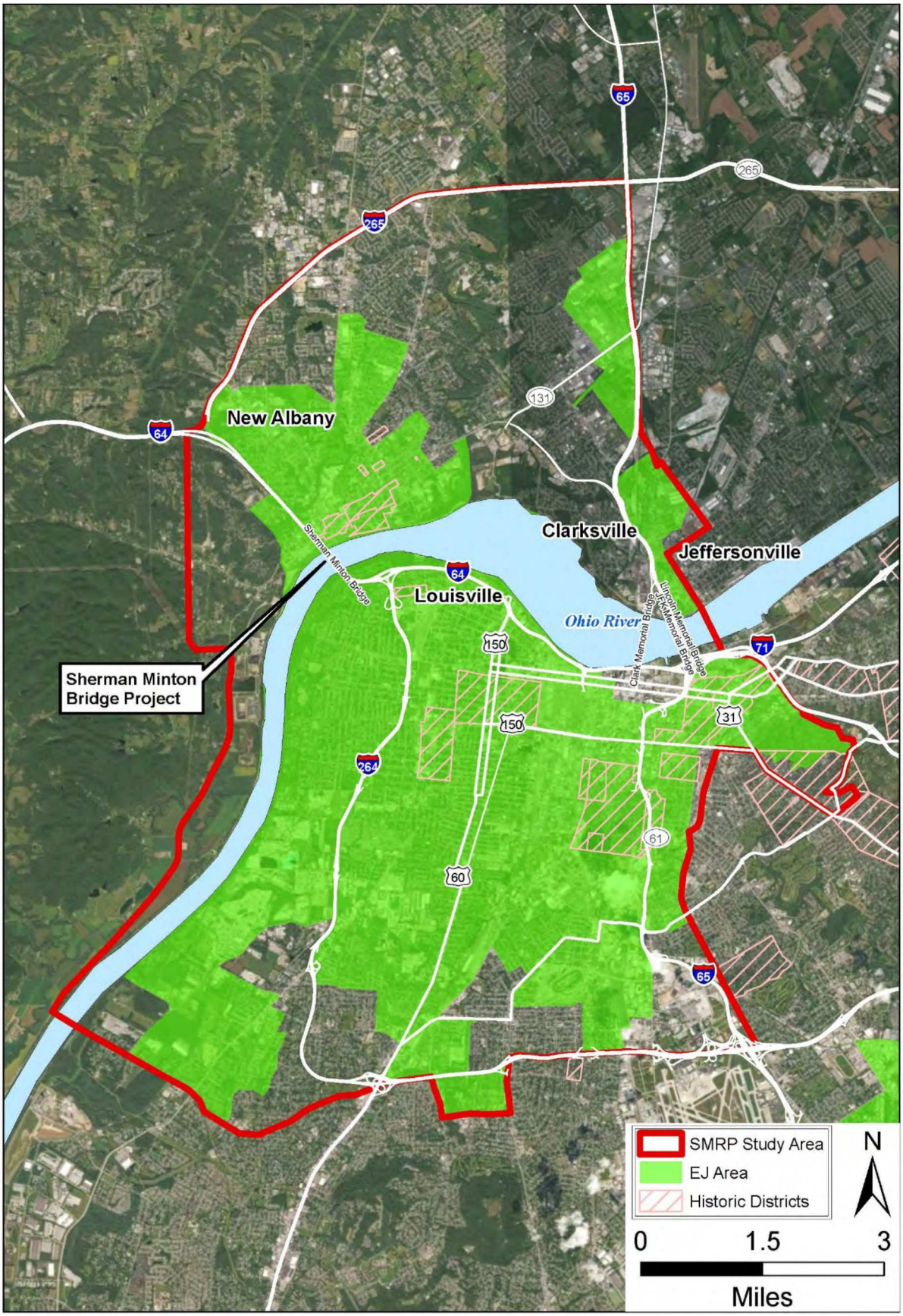


Figure 1 - SMRP Study Area

1.2 TYPES OF IMPACTS

Preparation of the required environmental documentation and Design/Build/Best Value (DBBV) procurement documents both require an understanding of traffic impacts likely to occur during the project. The traffic analysis provides an assessment of each MOT option's impact to the study area, the area roadway network, and more localized communities of interest. The following are the various impacts in each of these specific areas.

Systemwide Impacts

Systemwide impact measures describe the regional and study area impacts as a whole. These measures address different aspects of the effects of each MOT option. For example, hours of delay and average speed give some indication of the overall congestion on the roadways in the area for a given option, while vehicle-miles of travel provides an indication of the magnitude of diversion.

Highway Network Impacts – Bottlenecks

Locations were identified in the study area freeway and ramp roadway network that could potentially become bottlenecks due to diverted traffic in response to a MOT option. MOT impacts were measured relative to existing traffic conditions. The areas of particular interest were roadway segments that do not typically experience recurring bottlenecks but could fail during implementation of a certain MOT option. This analysis also helped identify areas where capacity-related mitigation could be warranted.

Highway Network Impacts – I-64 Corridor

The I-64 Corridor that includes the Sherman Minton Bridge is one of the localized areas examined for impacts due to MOT options. The various MOT options include lane closures that will begin at points upstream of the bridge. This portion of the analysis examined operating conditions for traffic <u>not</u> diverting away from the Sherman Minton Bridge. Travel times and probable queue lengths were estimated to quantify the impacts of a MOT option.

Changes in User Costs

Calculating changes in trip costs experienced under the implementation of MOT options compared to existing traffic conditions is one way of estimating economic impacts to drivers. Average trip costs were determined based on TDM estimated travel distances and times, and vehicle operating costs, travelers' value of time, and roadway tolls. The average trip cost for each MOT option was compared to the average trip cost under existing traffic conditions to determine a percent change.

Local Impacts – Congestion due to Diversion in Communities

Changes in travel patterns in response to the various MOT options were tracked though specific communities. This analysis looked for significant increases in congestion through communities in general but with a specific focus on communities subject to environmental justice (EJ) analysis, and historic areas. Roadways within EJ communities and historic areas where the SMRP TDM estimated a significant increase in congestion over the existing conditions were identified.

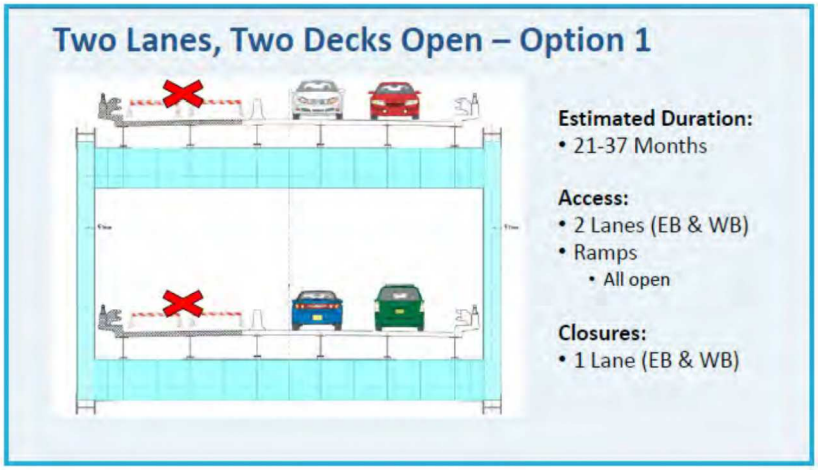
2 Alternatives Analysis

2.1 APPROACH AND APPLICATION

2.1.1 MOT OPTIONS

This section describes the six options considered for maintaining traffic on I-64 during the rehabilitation of the Sherman Minton Bridge. Each of these MOT options and sub-phases were modeled using the TDM by modifying the roadway network to reflect the specified lane closures, ramp closures, directional restrictions, and capacity reductions unique to each option.

Option 1: Single Lane Closure



Two lanes of traffic across the bridge in each direction will be maintained throughout the entire bridge rehabilitation project.

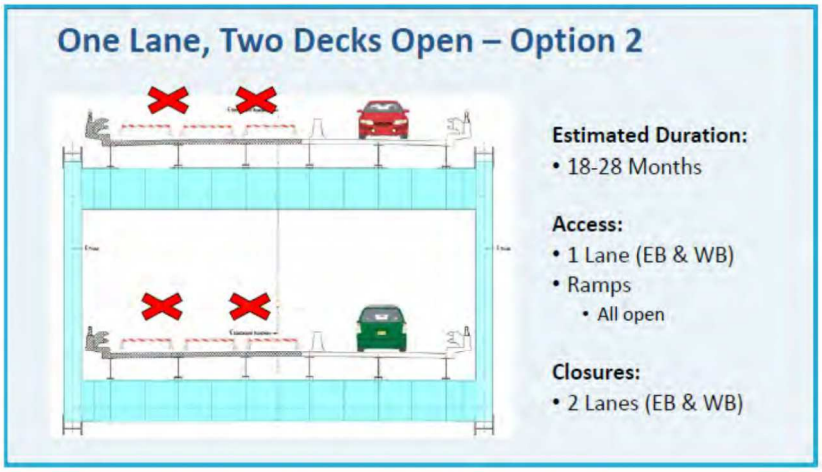
In Phase 1, the inside lane along EB and the outside lane along WB I-64 will be closed and two lanes of traffic will be maintained in the 2 remaining lanes and shoulder. All ramps remain open during this phase.

In Phase 2, EB and WB traffic will be split to the inside and outside lanes along I-64 with the middle portion of the bridge rehabilitation being completed.

In Phase 3, the outside lane along EB and the inside lane along WB I-64 will be closed and two lanes of traffic will be maintained in the 2 remaining lanes and shoulder.

Option 1 allows all ramps throughout the project limits to remain open during construction. The maintenance of traffic scheme does modify some of the ramp entrance/exit configurations, but the scheme allows all ramps to remain open.

Option 2: Two Lane Closure



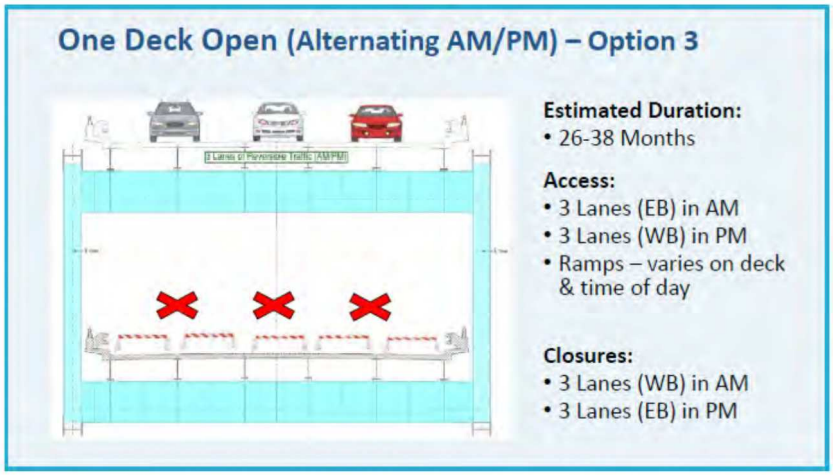
One lane of traffic across the bridge in the EB and WB directions will be maintained throughout the bridge rehabilitation project.

In Phase 1, the inside portion of the EB and the outside portion of the WB bridge rehabilitation will be completed. One 12' lane will be maintained with 2' shoulders.

In Phase 2, the remaining outside portion of the EB and inside portion of the WB bridge rehabilitation will be completed while still providing 1-12' lane and 2' shoulders.

Option 2 allows all ramps throughout the project limits to remain open during construction. The maintenance of traffic scheme does modify some of the ramp entrance/exit configurations, but the scheme allows all ramps to remain open.

Option 3: One Directional Closure (Full Closure of One Deck)



This option maintains three lanes of traffic in the direction of the peak flow during the peak hours. Temporary crossovers will be utilized to shift traffic from one roadway to the other to allow the full closure of either the EB or WB direction of traffic.

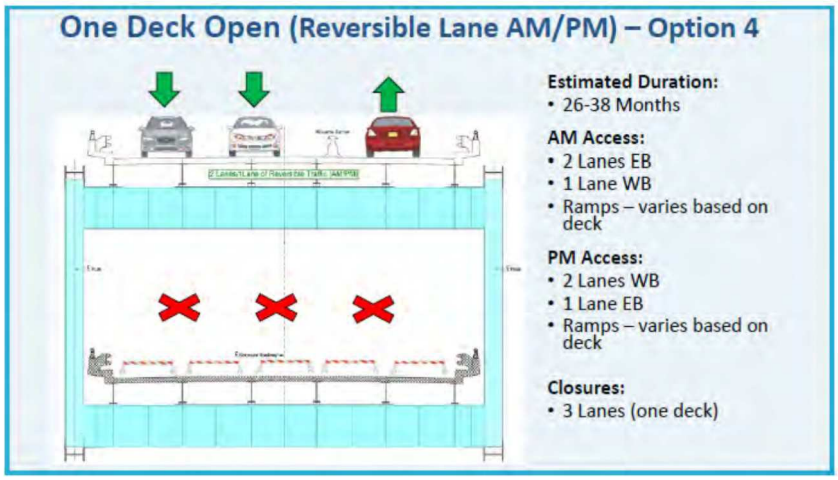
In Phase 1, the I-64 EB lower deck will be closed and all EB bridge rehabilitation completed. All traffic will be maintained on the I-64 WB upper deck. From the hours of 12 am to 12 pm three lanes of traffic will be maintained in the EB direction, with the WB direction being closed during this time. From the hours of 12 pm to 12 am three lanes of traffic will be maintained in the WB direction, with the EB direction being closed during this time. Some ramps will be closed during this phase. The following table shows the ramp closures during Phase 1.

Ramp	Status (AM)	Status (PM)	Remarks
Spring St. to I-64 WB (Entrance)	Closed	Open	Closed from 12 AM to 12 PM, Open from 12 PM to 12 AM using existing ramp configuration
Spring St. to I-64 EB (Entrance)	Closed	Closed	Closed the entire duration of Phase 1
I-64 WB to Elm Street (Exit)	Closed	Open	Closed from 12 AM to 12 PM, Open from 12 PM to 12 AM using existing ramp configuration
I-64 EB to I-264 SB	Closed	Closed	Closed the entire duration of Phase 1
I-64 WB to I-264 SB	Closed	Open	Closed from 12 AM to 12 PM, Open from 12 PM to 12 AM using existing ramp configuration
I-264 SB to Bank Street (Exit)	Closed	Open	Closed from 12 AM to 12 PM, Open from 12 PM to 12 AM using existing ramp configuration

In Phase 2, the I-64 WB upper deck will be closed, and all WB bridge rehabilitation completed. All traffic will be maintained on I-64 EB lower deck. From the hours of 12 AM to 12 PM three lanes of traffic will be maintained in the EB direction, with the WB direction being closed during this time. From the hours of 12 PM to 12 AM three lanes of traffic will be maintained in the WB direction, with the EB direction being closed during this time. Some ramps will be closed during this phase. The following table shows the ramp closures during Phase 2.

Ramp	Status (AM)	Status (PM)	Remarks
Spring St. to I-64 EB (Entrance)	Open	Closed	Open from 12 AM to 12 PM using existing configuration, Closed from 12 PM to 12 AM
I-64 WB to Elm Street (Exit)	Closed	Closed	Closed the entire duration of Phase 2
I-64 EB to I-264 SB	Closed	Closed	Closed the entire duration of Phase 2

Option 4: Movable Barrier Option (Full Closure of One Deck)



This option was developed to provide two lanes of traffic in the peak direction of travel and one counter flow lane in the opposite direction during those peak hours.

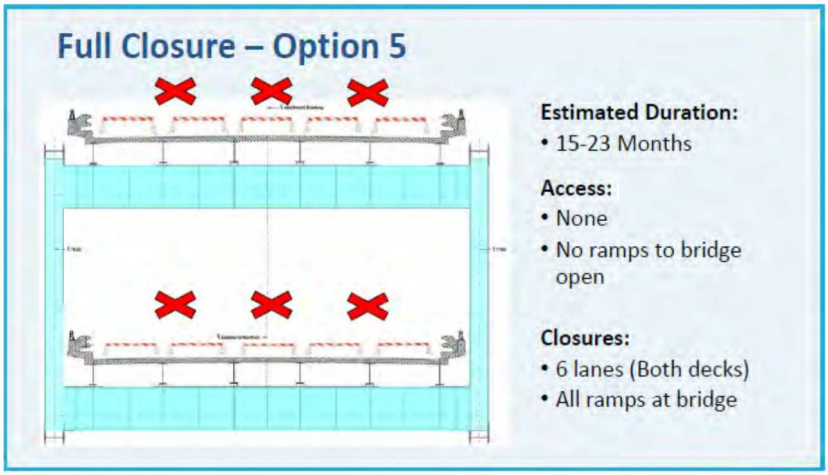
In Phase 1, the I-64 EB lower deck will be closed, and all EB bridge rehabilitation completed. All traffic will be maintained on I-64 WB upper deck. From the hours of 12 AM to 12 PM two lanes of traffic will be maintained in the EB direction and one lane in the WB direction. From the hours of 12 PM to 12 am two lanes of traffic will be maintained in the WB direction and one lane in the EB direction. Some ramps will be closed during this phase. The following table shows the ramp closures during Phase 1.

Ramp	Status (AM)	Status (PM)	Remarks
Spring St. to I-64 EB (Entrance)	Closed	Closed	Closed the entire duration of Phase 1
I-64 EB to I-264 SB	Closed	Closed	Closed the entire duration of Phase 1
I-64 WB to I-264 SB	Closed	Closed	Closed the entire duration of Phase 1
I-264 SB to Bank Street (Exit)	Closed	Closed	Closed the entire duration of Phase 1

In Phase 2, the I-64 WB upper deck will be closed, and all WB bridge rehabilitation completed. All traffic will be maintained on I-64 EB lower deck. From the hours of 12 am to 12 pm two lanes of traffic will be maintained in the EB direction and one lane in the WB direction. From the hours of 12 pm to 12 am two lanes of traffic will be maintained in the WB direction and one lane in the EB direction. Some ramps will be closed during this phase. The following table shows the ramp closures during Phase 2.

Ramp	Status (AM)	Status (PM)	Remarks
I-64 WB to Elm Street (Exit)	Closed	Closed	Closed the entire duration of Phase 2

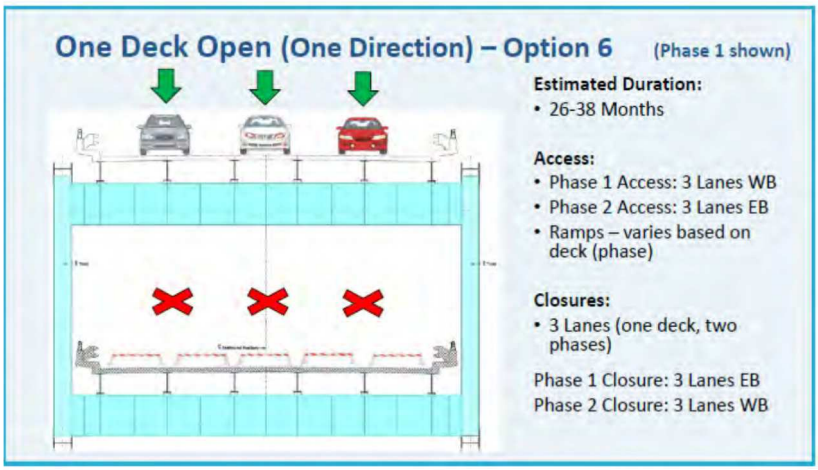
Option 5: Full closure (Both Decks Closed)



This option was developed to eliminate all traffic from the construction work zone which in return would decrease the overall duration of construction. Several ramps will be closed during this phase. The following table shows the ramp closures during this option.

Ramp	Status	Remarks
Spring St. to I-64 EB (Entrance)	Closed	Closed entire duration of Option 5
I-64 WB to Elm Street (Exit)	Closed	Closed entire duration of Option 5
I-264 NB to I-64 WB	Closed	Closed entire duration of Option 5
I-64 EB to I-264 SB	Closed	Closed entire duration of Option 5

Option 6: One Deck Open (One Direction)



This option was developed to eliminate one direction of traffic at a time from the work zone so that each deck can be fully completed within each phase. Some ramps will be closed at adjacent interchanges only to prohibit travel in the direction of the bridge closure. The following tables show the ramp closures during Phases 1 and 2.

In Phase 1, I-64 EB (lower deck) will be closed. Upper deck will remain open for I-64 WB traffic only.

Ramp	Status	Remarks
Spring St. to I-64 EB (Entrance)	Closed	Closed entire duration of Phase 1
I-64 EB to I-264 SB	Closed	Closed entire duration of Phase 1

In Phase 2, I-64 WB (upper deck) will be closed. Lower deck will be open for I-64 EB traffic only.

Ramp	Status	Remarks
I-64 WB to Elm Street (Exit)	Closed	Closed entire duration of Phase 2
I-264 NB to I-64 WB	Closed	Closed entire duration of Phase 2

2.1.2 ASSUMPTIONS

The analysis assumes that the total number of daily bridge crossings is fixed across the options. This allows for an even comparison across options. Therefore, the alternatives analysis examines the redistribution of bridge crossings among the available bridges under capacity reductions on the Sherman Minton Bridge, as prescribed by the various MOT options. The analysis also assumes that the distribution of bridge crossing trips across the four time periods is fixed across the options. In other words, the analysis does not reflect “peak spreading”, in which trips move to other parts of the day to avoid the peak hours.

The effect of these two assumptions is a more conservative estimate of the peak period and peak-hour impacts of each option. During the emergency closure of the Sherman Minton Bridge in 2011 – 2012, there was a reduction in daily bridge crossings. This may occur as well with the Sherman Minton Renewal Project; thus, this analysis assumes more of a worst-case condition with no reduction in daily bridge crossings.

Another caveat pertains to the nature of trip assignment (routing) in travel demand models. The TDM assumes that all drivers have complete information about all travel times on all roadways in the network. Although navigation apps such

as Waze provide travel time information to drivers, most drivers incorporate more simplistic considerations for route choices. Many drivers stick to familiar routes or main highway routes when choosing an alternative route. As a result, the TDM may forecast more drivers using smaller side streets than observed.

2.1.3 STUDY AREA AND ROADWAY NETWORK

Because the Sherman Minton bridge serves the regional transportation corridors, the SMRP will have regional impacts. As such the entire roadway network of the KIPDA planning region is included in the SMRP TDM and includes trip making into, out of, within and through the region. The project study area (highlighted in Figure 1, Section 1.1) falls within the modeled region. Further details about the relationship between the modeled area and the study area can be found in the *SMRP Travel Demand Model* documentation in Appendix A.

The study area for the project, generally bounded by I-65 on the east and I-64/I-264 on the west, includes two distinct areas divided by the Ohio River: the Kentucky side and the Indiana side. Each side of the river has its own unique travel needs and roadway network. The use of the Sherman Minton Bridge is dominated by trips originating on the Indiana side. The AM peak-hour volumes on the bridge are dominated by the EB movement from Indiana to Kentucky by a 2.5:1 margin. The PM peak-hour volumes are dominated by the return trip to Indiana by a 2:1 margin. Louisville is the largest generator in the region as far as employment and commerce, so it is logical that Hoosiers are more likely to cross the river than Kentuckians. This means that, in general, the Indiana side is more dependent on the Sherman Minton Bridge and more affected by capacity limitations on the bridge. This is not to say that there aren't dependencies and effects on Kentucky residents.

Generally, drivers within the study area have a choice for river crossings between I-64 to the west and I-65 or US 31 in downtown in the eastern portion of the study area. For regional through trips, the Lewis and Clark Bridge (East End) is also an option. The roadway networks are unique on either side of the river. On the Kentucky side, I-64 provides a high-capacity interstate connection directly along the river between the Sherman Minton Bridge on the west and the downtown bridges to the east. Secondary to the I-64 connection, West Louisville has a classic arterial grid system that currently has excess traffic capacity.

The Indiana side has a different roadway network. Because Silver Creek bisects the Indiana portion of the study area with limited crossings, there are only two viable routes between the I-64 Sherman Minton Bridge Corridor and the I-65 corridor to the downtown bridges: I-265 and the Spring Street/Brown Station Way. I-265 does provide an interstate connection between the I-64 and I-65 corridors. However, it is at the north end of the study area instead of directly along the river between the bridges like the Kentucky side has. The other option, Spring Street/Brown Station Way is a corridor through downtown New Albany. Brown Station Way is a four-lane arterial from I-65 to Silver Creek. But the Spring Street portion of the corridor from Silver Creek to I-64 is a low-capacity two-lane arterial street with similar parallel options through downtown New Albany. In 2017, New Albany converted several of its east-west streets from one-way operation to two-way operation in the downtown between State Street and Vincennes Street to lower speeds and calm east-west traffic. The relative positioning of these two east-west corridors – I-265 to the north and Spring Street/Brown Station Way closest to the river – means that there is more potential for diverted traffic via local streets through the communities between the bridges in Indiana than in Kentucky.

Existing Traffic Operations

Under current conditions, the peak-hour traffic in the I-64 Sherman Minton Bridge Corridor experiences some slowdowns, but not on the bridge itself. During the AM peak hour, EB I-64 experiences recurring congestion in the area of the on-ramp merge from US 150 outside the study area to the west. There is also some congestion on the SB I-265 ramp to EB I-64. These two recurring bottlenecks, especially the one at US 150, effectively meter the traffic reaching the entering the EB I-64 Sherman Minton Bridge area. Therefore, traffic is heavy, but flowing on the EB I-64 Sherman Minton Bridge. During the PM peak hour, there is heavy traffic and reduced speeds on outbound (WB) I-64 at the I-264 interchange. The ramp from NB I-264 to WB I-64 also experiences congestion. This PM recurring congestion at the I-264 interchange meters the traffic flow approaching the WB I-64 Sherman Minton Bridge. Traffic on the bridge itself is heavy but flowing

during the PM peak hour. The WB I-265 to WB I-64 ramp is also heavy during the PM peak hour. This ramp's one lane carries a volume near capacity and is forced to merge onto the three-lane section of westbound I-64.

2.2 STUDY AREA IMPACTS

Impacts due to MOT options are organized into to two categories: systemwide/study area measures and roadway network/local impacts. The former looks at characteristics of trips in the larger area while the latter progressively zooms in on the roadway network and local streets. The following sections describe these two categories.

2.2.1 GENERAL TRAVEL PATTERNS FOR THE OPTIONS

The MOT options range from closure of only one lane in each direction on the Sherman Minton Bridge (MOT 1) to full closure of the Sherman Minton Bridge (MOT 5). The other options generally fall in between these two in terms of impacts. MOT 2 has two lanes closed in each direction on the Sherman Minton Bridge. To understand the general effects of the MOT options, it is helpful to look at MOT 1, MOT 2, and MOT 5 incrementally.

As discussed above, the Indiana-based trips dominate the cross-river trips on the Sherman Minton Bridge and thus drive most of the change in travel patterns due to limiting capacity on the bridge. This coupled with the limited corridor options between the two bridges and potential for diversion impacts makes it reasonable to focus on the Indiana to Kentucky trips, which are exemplified in the AM period.

During current AM period operations, it is understood that the choice in bridges for Indiana to Kentucky trips comes down to proximity and cost. The model estimates that some trips on the Indiana side will travel slightly farther west to access the toll-free bridge on I-64 instead of using the downtown I-65 tolled bridges. It is important to note that both the KIPDA TDM and, by extension, the SMRP TDM show the Clark Memorial Bridge already at capacity with very little ability to accept additional diverted traffic. This creates a north-south travel shed delineation between I-64 and I-65/US 31 where trip origins on one side generally flow to the west and use I-64 and the other side flow east and use the downtown bridges. Again, this is factor of comparable travel times between the routes with tolls being the deciding factor skewing the boundary between travel sheds slightly toward the east.

As capacity reductions (lane closures) incrementally increase on the Sherman Bridge via MOT Options 1, 2, and 5, the travel shed boundary moves farther and farther west meaning that more and more trips began traveling east to the downtown bridges instead of west to the I-64 bridge. As illustrated in Figure 2, starting with MOT 1, there is some indication of west-to-east traffic diversion due to one lane being closed on the Sherman Minton Bridge – increases in traffic volumes on the eastern ends of the I-265 and Spring Street/Brown Station Way corridors are seen when comparing the base case to MOT 1. Under MOT 2, there is a greater increase in volumes on these two corridors that stretches slightly farther west as more trips go east instead of west. Finally, under the full closure scenario of MOT 5, the largest increases in traffic are seen on the two corridors as all trips from the west must now travel east to access a downtown bridge. The other general pattern to note is that one of the first type of trips to divert from the Sherman Minton Bridge is the trip that goes all the way through the study area: east-west trips via I-64 and I-71. Those trips are seen to be using I-265 all the way around to the north via the East End Bridge. This is indicated by the orange band on Figure 2 showing up just east of I-65 in MOT 1. Table 1 shows the daily estimated number of trips diverted from the Sherman Minton Bridge under each MOT option and how these diversions split to use the other three river bridges.

MOT 3 and MOT 4 provide some combination of closure designed to switch directions midday to better accommodate the peak-hour direction. MOT 6 provides a full closure on one deck of the bridge and three lanes of traffic in the other direction on the opposite deck.

Note: One-Lane Closure (MOT 1), Two-Lane Closure (MOT 2), and All-Lane Closure (MOT 5) (Left to Right)

Figure 2 - General Diversion Patterns

Table 1 – Daily Traffic Diversion from Sherman Minton Bridge

	BASE	MOT 1	MOT 2	MOT 5	MOT 3	MOT 4	MOT 6
Sherman Minton Bridge	90,000	82,600	56,600	0	49,400	70,300	43,400
Total Diverted Traffic	0	7,400	33,400	90,000	40,600	19,700	46,600
To Clark Memorial		9%	13%	13%	18%	17%	14%
To Kennedy/Lincoln		77%	71%	72%	68%	69%	72%
To Lewis & Clark		14%	17%	15%	14%	14%	14%

Note: Percentages may not sum to 100% due to rounding.

2.2.2 IMPACTS TO SYSTEMWIDE MEASURES

Three measures were examined to assess the effect of each MOT option on overall mobility within the study area. These measures are determined by all trips within/originating from/passing through the study area. The measures reported are as follows on a daily basis:

- Daily Vehicular Delay (vehicle hours)
- Daily Vehicle-Miles Traveled (vehicle miles)
- Daily Average Network Speed (miles per hour)

Table 2 below shows each of these three measures for the six MOT options compared to the Existing/Base case. Each of the MOT options show decreases in average speed as capacity is limited or eliminated on the Sherman Minton Bridge.

MOT 2 and MOT 5 show the largest reductions at four percent and three percent, respectively. Daily vehicle miles of travel actually decrease in the scenarios where capacity is limited, but some lanes remain open on the Sherman Minton Bridge (MOT 1, MOT 2, and MOT 4). The vehicle miles traveled increases for the options where the Sherman Minton Bridge has all lanes closed in at least one direction (MOT 3, MOT 5, and MOT 6). This pattern is likely due to a base case where some drivers travel slightly longer distances to utilize the toll-free Sherman Minton Bridge. In the scenarios where one or two lanes are closed on the bridge, the trips that were previously taking a longer route to get to the Sherman Minton Bridge are probably the first users to divert to a bridge crossing that is closer for them. It follows that the full

bridge closure forces all vehicles to divert to another bridge, including the trips that are closest to the Sherman Minton Bridge that would travel now travel a longer distance to another bridge.

Daily vehicle hours traveled provide perhaps the most comprehensive measure of delay, because that measure considers both speed and distance. The magnitude of vehicle hours traveled follows a natural progression from the least restrictive option (MOT 1) increasing delay by one percent to the most restrictive option (MOT 5) increasing delay by five percent over the base case. MOT 2, with one lane available in each direction, forms the midpoint in delay with a three percent increase over the base case. MOT 3 and MOT 4 show increases in delay slightly more than MOT 1, but slightly less than MOT 2. This is because MOT 3 and MOT 4 close more lanes on the bridge than MOT 1 while switching the closures during the day so that the greater number of open lanes is in the peak direction of traffic. MOT 6 shows delay similar to MOT 2 because even though there are three lanes open in one direction, the closure does not switch the open lanes to accommodate the peak direction.

Table 2 - Daily Systemwide Measures (Study Area)

MOT OPTION	AVERAGE SPEED		VEHICLE MILES TRAVELED (VMT)		VEHICLE HOURS TRAVELED (VHT)	
	MPH	CHANGE	MILES	CHANGE	HOURS	CHANGE
Base	27.1		5,629,000		207,700	
MOT 1	26.8	-1.0%	5,613,100	-0.3%	209,300	0.8%
MOT 2	26.1	-3.8%	5,568,700	-1.1%	213,700	2.9%
MOT 3	26.8	-1.0%	5,671,800	0.8%	211,500	1.8%
MOT 4	26.5	-2.2%	5,608,100	-0.4%	211,600	1.9%
MOT 5	26.3	-3.1%	5,742,200	2.0%	218,700	5.3%
MOT 6	26.6	-1.9%	5,677,600	0.9%	213,600	2.8%

2.2.3 IMPACTS TO CROSS-RIVER TRIPS

A concern for the project is the degree to which the average traveler will be affected by MOT options during construction. Calculating changes in trip costs between Base/Existing Conditions and MOT options is one way of calculating these economic impacts. Comparing the change in costs that the average traveler experiences sheds light on whether any of the MOT Options pose a financial burden to the traveling public in general.

Model Output and Analysis

Assumptions of vehicle operation cost, driver's value of time and toll costs are included in the TDM and used in calculating user costs as shown below. Average trip costs are calculated according to the following formula:

Trip Cost = Operating Cost + Time Cost + Tolls

where:

- Operating Cost = vehicle operating cost ($/mile) * <u>trip distance (miles)</u>
- Time Cost = value of time ($/min) * <u>travel time per trip</u> (min)
- Tolls = <u>Cost of Toll for the trip</u> ($)
- (Underlined values come from TDM output)

Within the travel demand model trips are assigned to routes between an origin and destination. These components of travel cost allow the model to estimate trip routes that minimize the overall cost of travel. Values of operating cost, time and tolls vary by trip type. Four trip types are processed within the model: EJ and Non-EJ cars (explained in more detail in Section 2.2.4), light trucks and heavy trucks. Each trip type has individualized values for each cost component. For car trips, operating costs are based on data from the American Automobile Association while values of time are based on a percentage of regional median income census data. The truck operating costs and values of time were selected based within a range of values reported by several research studies. During model validation, values of time were adjusted

within reasonable ranges to better estimate trip routes. The toll costs for each vehicle type are based on a composite of current toll rates that vary by transponder usage and account type. The values of user cost parameters are shown in Table 3.

Table 3 - User Cost Parameter Values

PARAMETER	CARS		TRUCKS	
	EJ	NON-EJ	LIGHT	HEAVY
Operating Cost ($/mile)	$ 0.22	$ 0.22	$ 0.52	$ 0.75
Value of Time ($/minute)	$ 0.3292	$ 0.3873	$ 0.6317	$ 1.1026
% of Median Income	72%	85%	NA	NA
Toll Cost ($)	$ 2.67	$ 2.67	$ 5.40	$ 10.26

Impacts to Overall User Costs

User costs for all vehicles at all river crossings during the AM and PM peak periods were calculated using the three components listed above. These user costs give an indication of how much each MOT option impacts river crossings in the Louisville area. Table 4 shows the results for each MOT option. MOT 5 shows the highest increase in user costs above the base, followed by MOT 6 and then MOT 2. MOT 1 has the smallest increase in user costs.

Table 4 - User Costs for All River Crossings (AM & PM Peak Periods)

MOT OPTION	ALL VEHICLES	
	TRIP COST	CHANGE
Base	$23.43	
MOT 1	$23.97	2%
MOT 2	$24.94	6%
MOT 3	$24.40	4%
MOT 4	$24.30	4%
MOT 5	$26.60	13%
MOT 6	$25.08	7%

Heavy Truck Trips

Another way of looking at the impacts to cross-river trips is to examine user costs for cars and trucks separately. Table 5 shows the user costs calculated separately for cars and trucks for all bridge crossings during the AM and PM peak periods. In all MOT options, car trips show a greater percent increase in user costs than truck trips. Although, the actual increases are greater for trucks trips than car trips.

Table 5 - Change in User Costs – Cars vs. Trucks (AM & PM Peak Periods)

MOT OPTION	CARS		TRUCKS	
	COST	CHANGE	COST	CHANGE
Base	$17.49		$79.36	
MOT 1	$18.01	3%	$80.06	1%
MOT 2	$18.91	8%	$81.62	3%
MOT 3	$20.40	17%	$84.89	7%
MOT 4	$18.30	5%	$81.77	3%
MOT 5	$18.30	5%	$80.68	2%
MOT 6	$19.00	9%	$82.22	4%

Consideration has been given to detouring heavy trucks away from the I-64 Sherman Minton Bridge Corridor for MOT options that have partial closures on the bridge. The idea is to provide improved work zone safety for workers directly adjacent to live traffic and to provide better traffic operations through the work zone.

In order to test the effectiveness of such a scenario, heavy trucks were prohibited from using I-64 between the Spring Street Interchange in Indiana to I-264 in Kentucky for MOT 1 and MOT 2. These options were chosen because both have one or two lanes open on the bridge. Removing the heavy trucks from the bridge may improve operations on the I-64 Sherman Minton Bridge corridor, but truck trip costs will increase as they are detoured to longer, tolled routes. The average trip costs for bridge crossings were examined to determine the effects on car trips and heavy truck trips and the results can be seen below in Table 6.

Table 6 - Regional Trip Cost Comparison for Heavy Truck Detours (Daily Bridge Crossings)

MOT OPTION	CAR BRIDGE CROSSINGS		HEAVY TRUCK BRIDGE CROSSINGS	
	TRIP COST	CHANGE	TRIP COST	CHANGE
MOT 1	$17.53		$87.22	
MOT 1 – No Trucks	$17.49	-0.1%	$91.44	4.9%
MOT 2	$18.29		$88.79	
MOT 2 – No Trucks	$18.34	0.1%	$91.52	3.1%

The removal of heavy trucks from the I-64 Sherman Minton Bridge corridor has little to no effect on the regional average car bridge crossing trips. However, under the heavy truck detour scenarios, trip costs for heavy trucks increase 4.9 percent in MOT 1 and 3.1 percent in MOT 2.

2.2.4 IMPACTS TO EJ VERSUS NON-EJ TRIPS

Environmental Justice communities within the study area are prevalent and are of particular concern for this project. For EJ populations, there is a need to determine whether there are disproportionately high and adverse economic effects resulting from the proposed action. One way of assessing this is to compare the change in costs that the average traveler experiences versus what EJ populations experience. This methodology has been applied for similar projects.

In order to provide focus for this project on these areas of concern, EJ communities within the study area have been determined according to KIPDA's EJ study based on U.S. Census data. These areas identified by KIPDA were used to determine the SMRP EJ communities. Traffic Analysis Zones (TAZs) used by the TDM were categorized as EJ TAZs or non-EJ TAZs based on whether the zone is within an EJ community. It is assumed that any trip originating from an EJ TAZ will be designated an EJ trip and any trip originating from a non-EJ TAZ will be designated a non-EJ trip. The TDM tracks trips

by EJ and non-EJ TAZs, and user costs have been calculated for the two categories for each MOT option. This analysis focused on AM peak period cross-river trips for all river crossings. In comparing EJ versus Non-EJ trips, components of the user cost calculations are shown separately in Table 7, Table 8, Table 9, and Table 10.

The analysis presented in Table 7 through Table 10 includes all cross-river trips from the entire model area. This level of analysis provides a measure of the effects of the project on the whole region. By definition, all EJ trips represent trips that begin within the study area, which is relatively close to the river compared to the rest of the model area. This contributes to the base case results showing lower average travel times and shorter average trip lengths for EJ trips compared to non-EJ trips.

Table 7 – Average Travel Time (AM Peak Period)

MOT OPTION	EJ TRIPS		NON-EJ TRIPS	
	MINUTES	CHANGE	MINUTES	CHANGE
Base	26.9		35.0	
MOT 1	27.8	3%	35.9	3%
MOT 2	29.5	10%	37.0	6%
MOT 3	30.1	12%	35.3	1%
MOT 4	28.9	7%	36.0	3%
MOT 5	32.9	23%	38.3	9%
MOT 6	30.1	12%	36.7	5%

The average cross-river travel times show the same general pattern across the options as the study area travel times discussed in a previous section. The travel times increase with increasing closures on the Sherman Minton Bridge from MOT 1 to MOT 2 to MOT 5, with the other three options falling between MOT 1 and MOT 2. The average EJ cross-river trip is shorter than the average non-EJ cross-river trip in the Base case (26.9 minutes versus 35.0 minutes). As stated above, this is partially because many EJ communities are clustered closely to the river and near bridge crossings. The EJ trips see a higher increase than the non-EJ trips in terms of percentages. This is also because of the proximity of many of the EJ communities to the Sherman Minton Bridge. On average, limiting or closing the capacity on the Sherman Minton Bridge forces EJ cross-river trips to travel farther to an alternate crossing downtown compared with the regional non-EJ cross-river trips.

Table 8 – Average Trip Length (AM Peak Period)

MOT OPTION	EJ TRIPS		NON-EJ TRIPS	
	MILES	CHANGE	MILES	CHANGE
Base	12.7		20.3	
MOT 1	12.5	-1%	20.1	-1%
MOT 2	12.5	-2%	20.4	0%
MOT 3	13.5	6%	20.5	1%
MOT 4	12.8	1%	20.2	0%
MOT 5	14.0	10%	21.4	6%
MOT 6	13.3	4%	20.8	3%

For reasons stated above, the average cross-river trip lengths in the base case are much shorter for EJ trips than non-EJ trips. The average trip lengths show little change or even decreases with one- and two-lane closures on the Sherman Minton Bridge in MOT 1 and MOT 2. This is due to the trips in the Base case that currently take a longer route to access a toll-free bridge that would shift to a closer tolled bridge in MOT 1 and MOT 2. However, in the scenarios with full closures, all the trips must find an alternate bridge crossing, including the trips that are very close to the Sherman Minton Bridge.

Comparatively, under MOTs 3, 4, 5, and 6, the EJ trips experience higher trip length increases by percentage than the non-EJ trips.

Table 9 - Percentage of Tolled River Crossings (AM Peak Period)

MOT OPTION	EJ TRIPS		NON-EJ TRIPS	
	TOLLED CROSSINGS	CHANGE	TOLLED CROSSINGS	CHANGE
Base	7%		40%	
MOT 1	12%	73%	47%	19%
MOT 2	20%	185%	62%	56%
MOT 3	10%	39%	55%	38%
MOT 4	15%	106%	50%	27%
MOT 5	34%	379%	86%	118%
MOT 6	21%	194%	64%	61%

Table 10 - Average Toll Cost (AM Peak Period)

MOT OPTION	EJ TRIPS		NON-EJ TRIPS	
	TOLL COST	CHANGE	TOLL COST	CHANGE
Base	$0.19		$1.06	
MOT 1	$0.33	73%	$1.26	19%
MOT 2	$0.54	185%	$1.65	56%
MOT 3	$0.26	39%	$1.47	38%
MOT 4	$0.39	105%	$1.35	27%
MOT 5	$0.91	376%	$2.30	118%
MOT 6	$0.55	192%	$1.70	61%

The average toll costs per cross-river trip show a similar picture as the other measures. The actual toll rates charged by Riverlink are assumed to be the same across all scenarios. The average toll costs reflected in the table considers trips that pay a full toll on a tolled bridge and trips that pay no toll on a non-tolled bridge. For example, the average toll costs for trips in the base case are well below the cost of a single toll, which reflects the fact that many of the trips are on non-tolled bridges (toll cost equals $0.00), The lower Base average toll rate for the EJ trips compared with non-EJ trips simply reflects a lower share of Base condition EJ trips paying a toll. This is not surprising given the EJ communities proximity to the toll-free Sherman Minton and Clark Memorial bridges. The average toll cost per cross-river trip increases with increasing closures on the Sherman Minton Bridge from MOT 1 to MOT 2 to MOT 5, with the other three options generally falling somewhere in between. Comparatively, the EJ trips experience higher toll cost increases by percentage than the non-EJ trips.

The average trip cost for all river-crossing EJ and non-EJ trips is calculated for each MOT option by assigning dollar values to each of the three components listed above. These are compared to the average trip cost for the Base/Existing case to determine a percent change per option. The results are reported in Table 11. The comparison indicates that the percent change in user cost from Base to MOT option is greater for the EJ trips than non-EJ trips in each option. The largest difference occurs in MOT 5 with the full closure of the bridge. However, under MOTs 1 and 2, the actual change is lower for EJ trips compared with non-EJ trips. Under MOTs 3, 4, 5, and 6 the actual change trends similar to the percentage change.

Table 11 - Change in User Costs (AM Peak Period)

MOT OPTION	EJ TRIPS		NON-EJ TRIPS		DIFFERENCE EJ VS. NON-EJ
	TRIP COST	CHANGE	TRIP COST	CHANGE	CHANGE
Base	$11.84		$19.07		
MOT 1	$12.25	3.4%	$19.59	2.7%	0.7%
MOT 2	$13.02	10.0%	$20.44	7.2%	2.8%
MOT 3	$13.16	11.1%	$19.64	3.0%	8.1%
MOT 4	$12.72	7.4%	$19.75	3.6%	3.9%
MOT 5	$14.82	25.2%	$21.84	14.5%	10.7%
MOT 6	$13.40	13.1%	$20.50	7.5%	5.7%

Note: Some differences due to rounding

Sherman Minton Trips - Impacts to EJ Versus Non-EJ Trips

Further analysis was conducted focusing exclusively on the impacts to just the trips currently using the Sherman Minton Bridge. The analysis considers the current Sherman Minton Bridge trips and how they would be affected by each MOT option, even if they are diverted to another bridge. This user cost analysis, again comparing EJ versus Non-EJ trips, was done for the AM peak period. The user cost calculation components are shown in Table 12, Table 13, and Table 14.

As with the analysis of all regional cross-river trips above, the EJ locations are all within the study area around the Sherman Minton bridge and the Non-EJ locations are from throughout the region, this impacts the base travel time and trip length for both EJ and Non-EJ groups. As expected, in the base case, EJ trips will have shorter average travel times and trip lengths compared with their Non-EJ counterpart.

Table 12 - Average Travel Time – Current Sherman Minton River-Crossing Trips (AM Peak Period)

MOT OPTION	EJ TRIPS		NON-EJ TRIPS	
	MINUTES	CHANGE	MINUTES	CHANGE
Base	27.3		36.2	
MOT 1	28.9	6%	38.8	7%
MOT 2	31.7	16%	43.0	19%
MOT 3	32.6	19%	41.2	14%
MOT 4	30.6	12%	40.3	11%
MOT 5	37.2	36%	47.9	32%
MOT 6	32.6	19%	42.5	17%

Table 13 - Average Trip Length– Current Sherman Minton River-Crossing Trips (AM Peak Period)

MOT OPTION	EJ TRIPS		NON-EJ TRIPS	
	MILES	CHANGE	MILES	CHANGE
Base	13.9		21.0	
MOT 1	13.6	-2%	20.9	0%
MOT 2	13.6	-3%	22.4	7%
MOT 3	15.2	10%	24.0	14%
MOT 4	14.1	1%	21.9	4%
MOT 5	15.9	14%	26.2	25%
MOT 6	14.8	7%	23.7	13%

Both EJ and Non-EJ the base Sherman Minton river-crossing trips are on average slightly longer in distance and travel time compared with all regional river-crossing trips. As expected, the MOT options cause greater impacts to the current Sherman Minton trips than other river-crossing trips in both magnitude and as a percentage of the base conditions.

Table 14 - Average Toll Cost– Current Sherman Minton River-Crossing Trips (AM Peak Period)

MOT OPTION	EJ TRIPS		NON-EJ TRIPS	
	TOLL COST	CHANGE*	TOLL COST	CHANGE*
Base	$0.00		$0.00	
MOT 1	$0.23	8%	$0.44	16%
MOT 2	$0.57	21%	$1.25	47%
MOT 3	$0.12	4%	$0.70	26%
MOT 4	$0.32	12%	$0.57	21%
MOT 5	$1.16	43%	$2.67	100%
MOT 6	$0.59	22%	$1.38	52%

* – Change expressed as the percentage of the base composite toll cost of $2.67.

As was done for all river-crossing trips, results reported in Table 15 show the average trip cost for current Sherman Minton river-crossing EJ and non-EJ trips calculated for each MOT option. These are compared to the average trip cost for the Base case to determine a percent change per option. The percent change for the EJ trips is also compared to the percent change of the non-EJ trips. As done with this analysis, focusing on just the trips currently using the Sherman Minton Bridge, the change in user costs for EJ trips versus non-EJ trips prove to be much closer than when comparing trips for all bridges. As reported, the non-EJ trips user costs increase at a higher rate than the EJ trips in all but one MOT option.

Table 15 - Change in User Costs - Current Sherman Minton River-Crossing Trips (AM Peak Period)

MOT OPTION	EJ TRIPS		NON-EJ TRIPS		EJ & NON-EJ Trips	
	TRIP COST	CHANGE	TRIP COST	CHANGE	TRIP COST	CHANGE
Base	$12.06		$18.66		$17.46	
MOT 1	$12.72	5%	$20.08	8%	$18.74	7%
MOT 2	$13.97	16%	$22.85	22%	$21.23	22%
MOT 3	$14.20	18%	$21.95	18%	$20.54	18%
MOT 4	$13.49	12%	$21.01	13%	$19.64	12%
MOT 5	$16.89	40%	$26.82	44%	$25.01	43%
MOT 6	$14.59	21%	$22.95	23%	$21.43	23%

The model estimates that EJ trips are more likely to stay on the Sherman Minton bridge or to seek out the alternative toll-free route using the Clark Memorial Bridge. Table 16 reports the number of AM peak period river-crossing trips across each bridge. As shown, only 7% of EJ river crossing trips in the base case are tolled compared with 40% of Non-EJ trips. Under the full closure condition, MOT 5, EJ tolled river crossing trips increased by 27% while the Non-EJ increase by 47%. Combined with the proximity of EJ communities near the Sherman Minton and Clark Memorial bridges more non-EJ trips end-up using the tolled bridge. The non-EJ trips are quicker to leave the Sherman Minton bridge as capacity is reduced on Sherman Minton and are displaced from using the Clark Memorial as EJ trips search for a new non-tolled option.

Table 16 - AM Peak Period EJ and Non-EJ Cross-river Trips by Bridge

	BASE	MOT 1	MOT 2	MOT 3	MOT 4	MOT 5	MOT 6
EJ Cross-river trips by Bridge							
Sherman Minton	2,870	2,352	1,276	1,484	1,859	0	1,349
Clark Memorial	1,447	1,722	2,428	2,703	2,112	3,073	2,334
Kennedy/Lincoln (Tolled)	251	445	699	366	513	1,218	748
Lewis & Clark (Tolled)	81	130	245	95	166	358	217
% of Tolled River Crossings	7%	12%	20%	10%	15%	34%	21%
Change in % Tolled		5%	13%	3%	7%	27%	14%
Non-EJ Cross-river trips by Bridge							
Sherman Minton	12,907	10,745	6,873	9,498	10,141	0	6,252
Clark Memorial	5,834	5,627	4,986	4,516	5,261	4,254	4,988
Kennedy/Lincoln (Tolled)	8,109	10,212	13,895	12,437	11,014	20,958	14,796
Lewis & Clark (Tolled)	4,214	4,479	5,309	4,613	4,647	5,851	5,027
% of Tolled River Crossings	40%	47%	62%	55%	50%	86%	64%
Change in % Tolled		8%	22%	15%	11%	47%	24%

2.3 HIGHWAY NETWORK AND LOCAL IMPACTS

The previous measures focused on impacts to travel in the larger area. This section brings the focus in to specific roadways in the larger highway network and even down to local communities.

2.3.1 IMPACTS TO THE HIGHWAY NETWORK

This component of the analysis measures the ability of the roadway system to accommodate the changes in travel patterns due to capacity limitations on the Sherman Minton Bridge for each MOT option. The analysis is divided into two components: the I-64 corridor that includes the Sherman Minton Bridge and the rest of the highway network that is most likely to absorb diverted traffic. The impact of each option was assessed by the roadway network's ability to accommodate both diverted and non-diverted traffic. Under partial bridge closure MOT options, some trips will continue to use the I-64 Sherman Minton Bridge corridor, but under limited capacity. Other trips will find alternative routes. The TDM was used to estimate the trips that will remain on the Sherman Minton Bridge and the trips that will divert to other routes. Therefore, it is important to analyze both the I-64 Sherman Minton Bridge corridor and the surrounding roadway network.

Highway Network Analysis – Potential Bottleneck Locations

This analysis was used to determine whether the existing roadway surrounding the Sherman Minton Bridge would be able to adequately process traffic diverted from the Sherman Minton Bridge. The highway network was examined under each MOT alterative in order to identify roadway segments most likely to become bottlenecks due to increased demand from diverted traffic. In order to narrow the network down to the most critical links, a tiered screening methodology similar to that used on the Louisville Southern Indiana Ohio River Bridges project (LSIORB) was applied and further refined to identify segments with estimated peak-hour volumes that would be at or near the capacity of the roadway and most likely to create a bottleneck.

First, the TDM was used to generate link volumes by TOD period. These volumes were compared to volumes on the same links under the Base/Existing Conditions. The resulting link volumes and capacity characteristics were then processed using the screening criteria shown in Figure 3. The first tier identified links that are estimated to increase by a certain volume threshold under a particular MOT option. Low-volume links such as arterials have a different threshold than higher-volume links. Links identified in the first tier were then evaluated in the second tier where volume-to-capacity (v/c) ratios were examined. Links with base v/c ratios indicating at least moderate congestion were identified. Next,

those links expected to experience an additional increase in v/c due to diverted traffic were identified. Estimated AM and PM peak-hour traffic demands were then estimated for this subset of links under each MOT option.

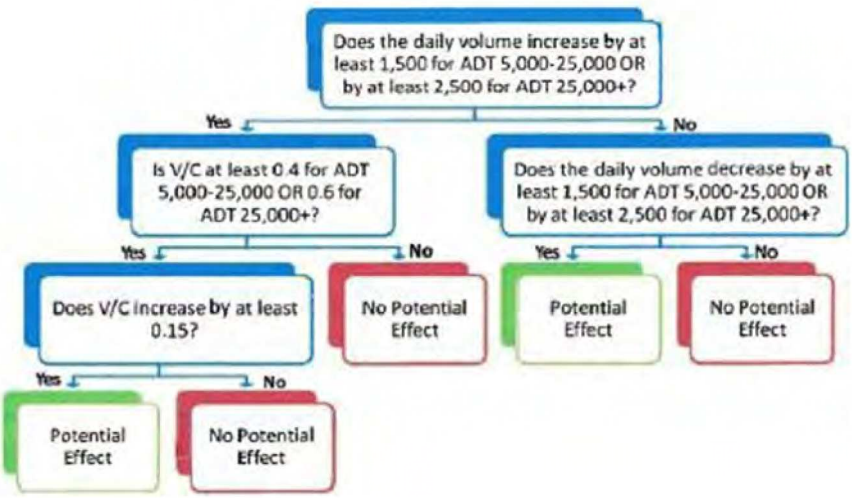


Figure 3 - Screening Criteria

The peak-hour volumes were then compared to a threshold of 1,900 vehicles per hour, which represents the threshold between LOS D and LOS E in the Highway Capacity Manual. This threshold was chosen to identify segments that are most likely to reach capacity and become a bottleneck in the roadway network. Figure 4 highlights network segments within the study area that experience congestion under existing conditions. Figure 5 through Figure 10 report the segments that are most likely to become a bottleneck under each MOT option. Not surprisingly, the MOT options that cause the most traffic diversions (MOT 5 and MOT 6) are also most likely to generate congestion elsewhere on the roadway network.

As shown in Figure 4, the existing roadway network already experiences bottlenecks on a regular basis at several locations:

- EB I-64 at US-150 (AM)
- WB I-265 to WB I-64 (PM)
- EB I-64 south of I-71 (PM)
- WB I-64 at WB I-264 (PM)
- Clark Memorial Bridge (AM & PM)

Potential bottleneck segments for the MOT options are shown in Figure 5 through Figure 10. These figures highlight new or worsening congestion locations. Common locations show potential for additional congestion under several MOT options:

- Sherman Minton Bridge (under partial closure scenarios)
- EB I-265 to SB I-65
- NB I-65 to WB I-265
- WB I-265 to WB I-64
- EB I-64 to EB I-265

Additionally, the figures highlight potential congestion locations that are unique to the individual MOT options. Local street segments along Spring Street in New Albany appear below and will be discussed in more detail in a subsequent section.

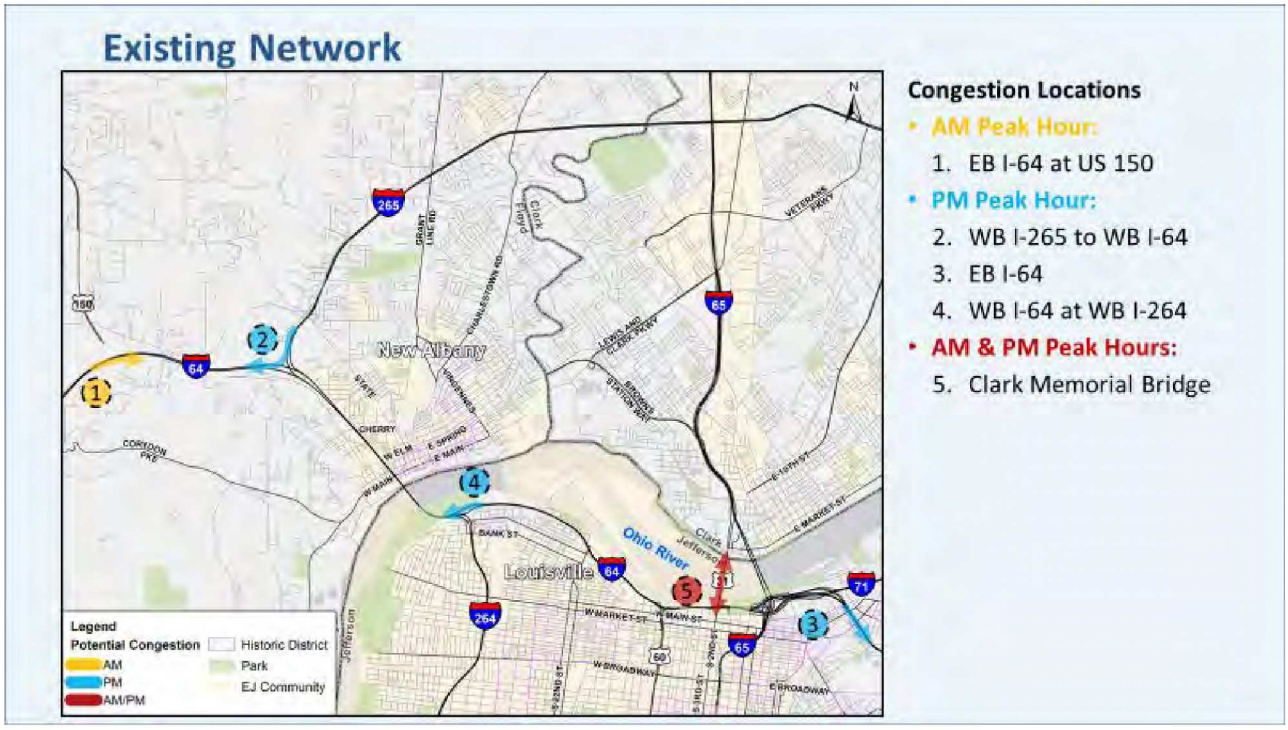


Figure 4 - Existing Traffic Conditions – Bottleneck Segments

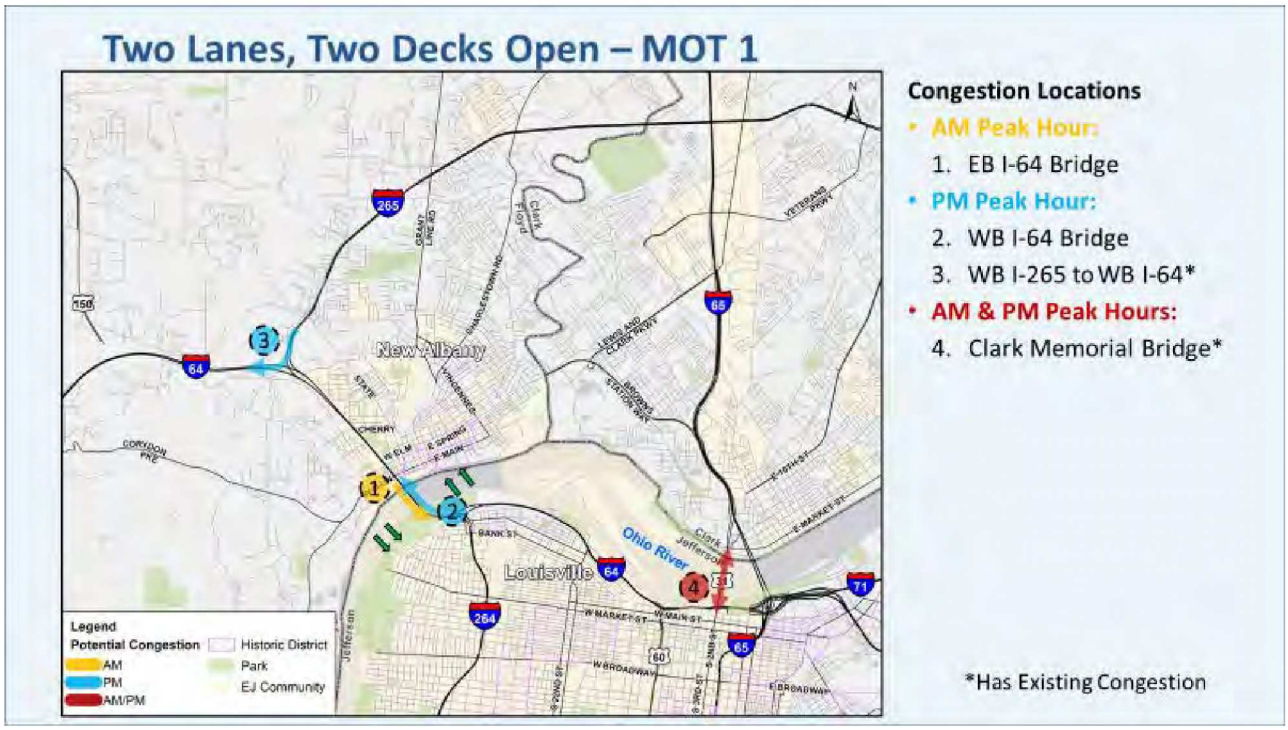


Figure 5 - MOT 1 Potential Bottleneck Segments

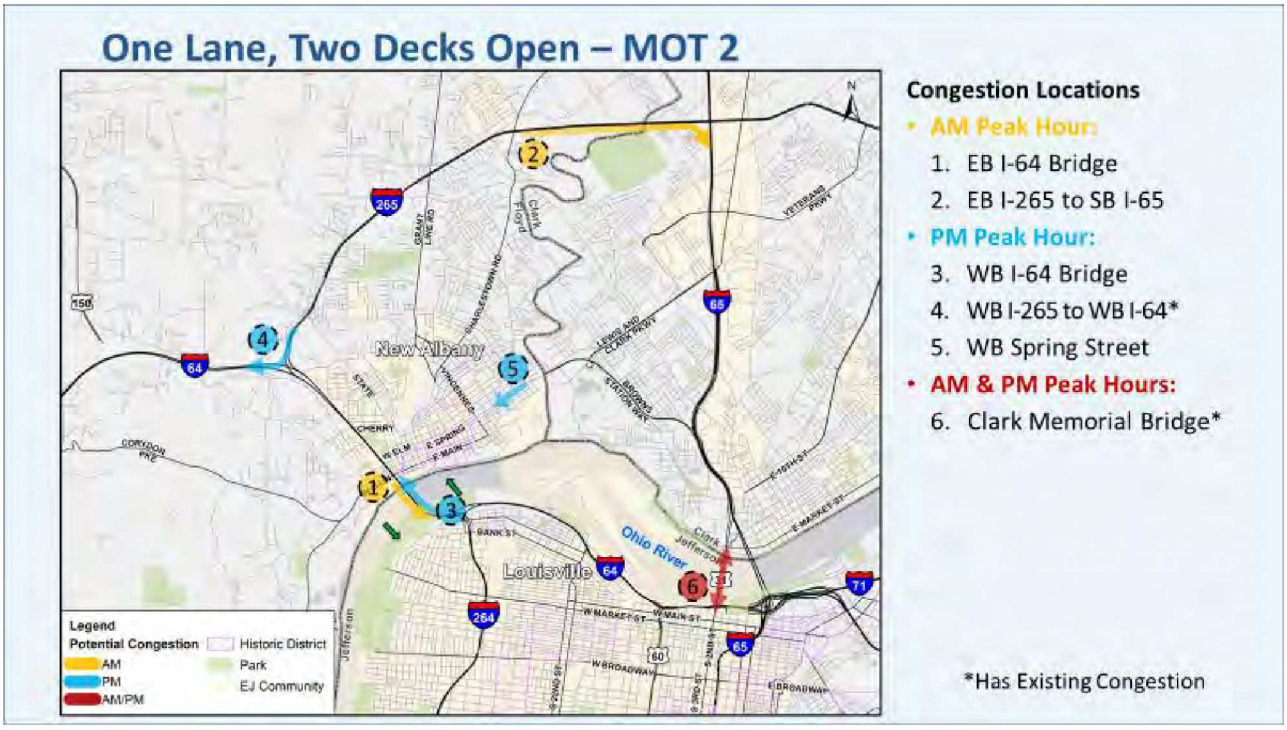


Figure 6 - MOT 2 Potential Bottleneck Segments

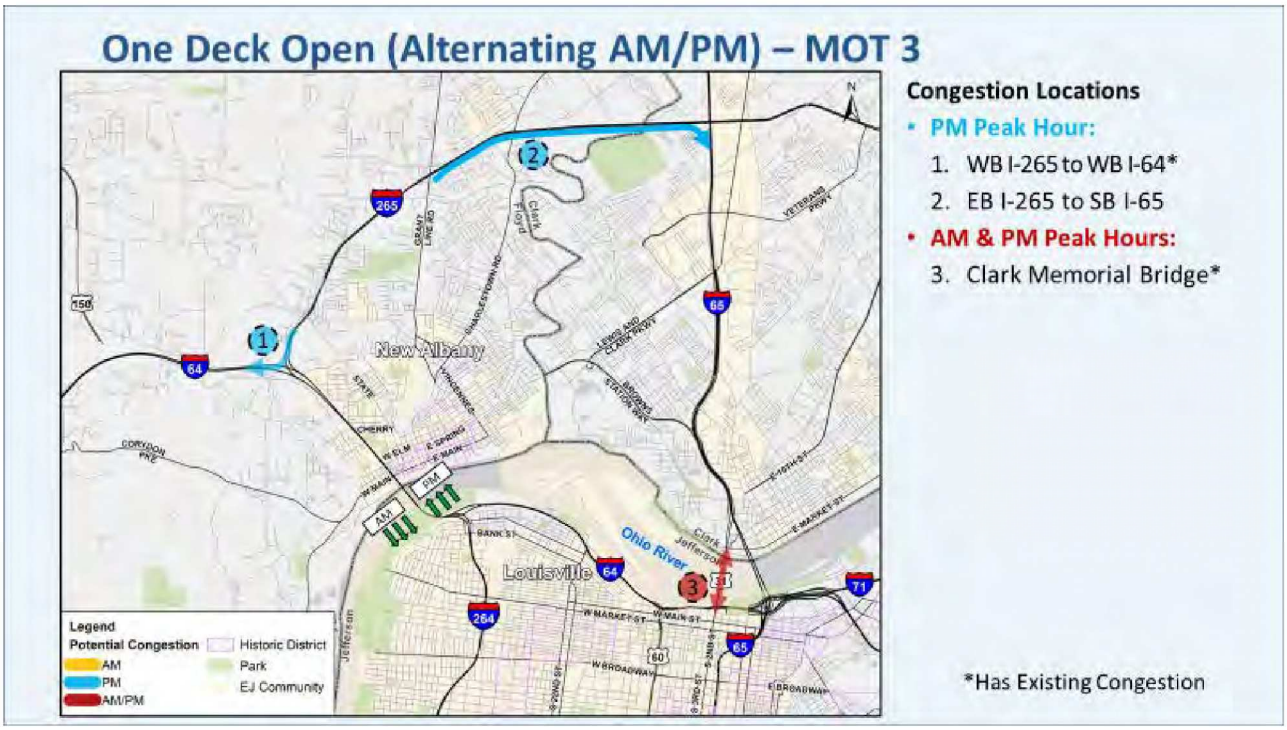


Figure 7 - MOT 3 Potential Bottleneck Segments

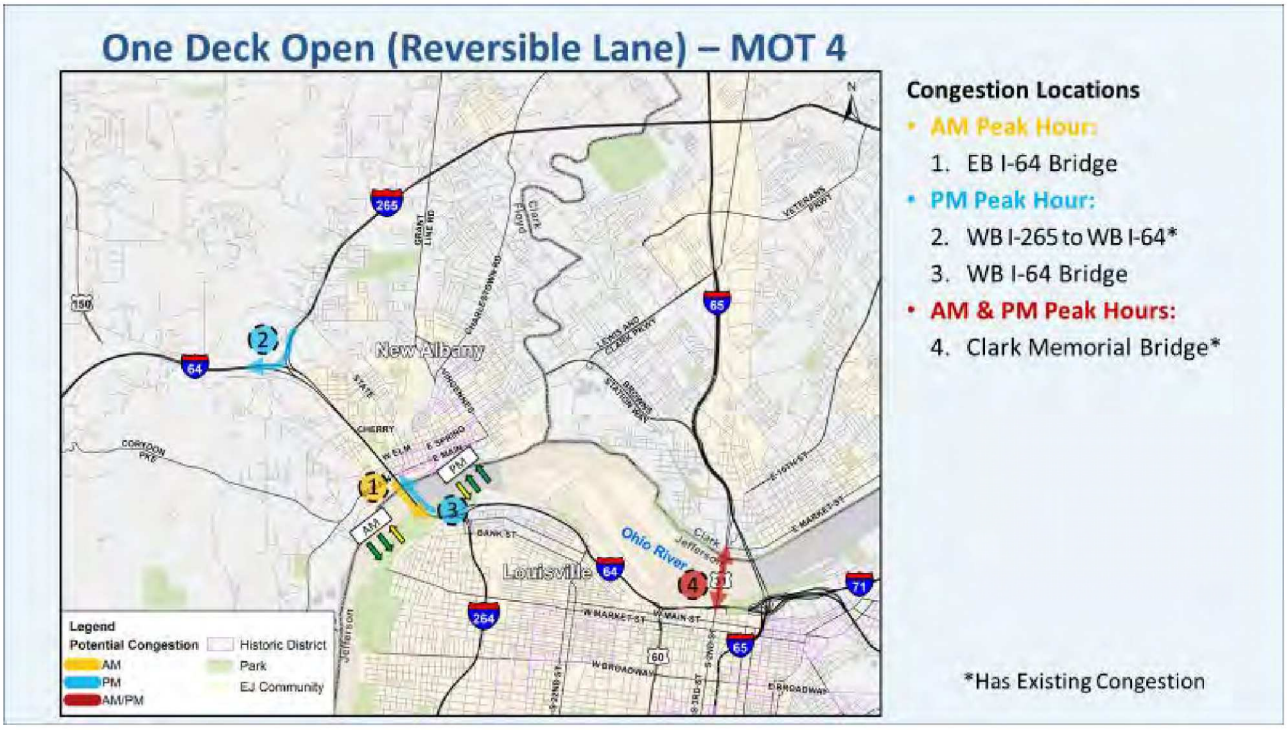


Figure 8 - MOT 4 Potential Bottleneck Segments

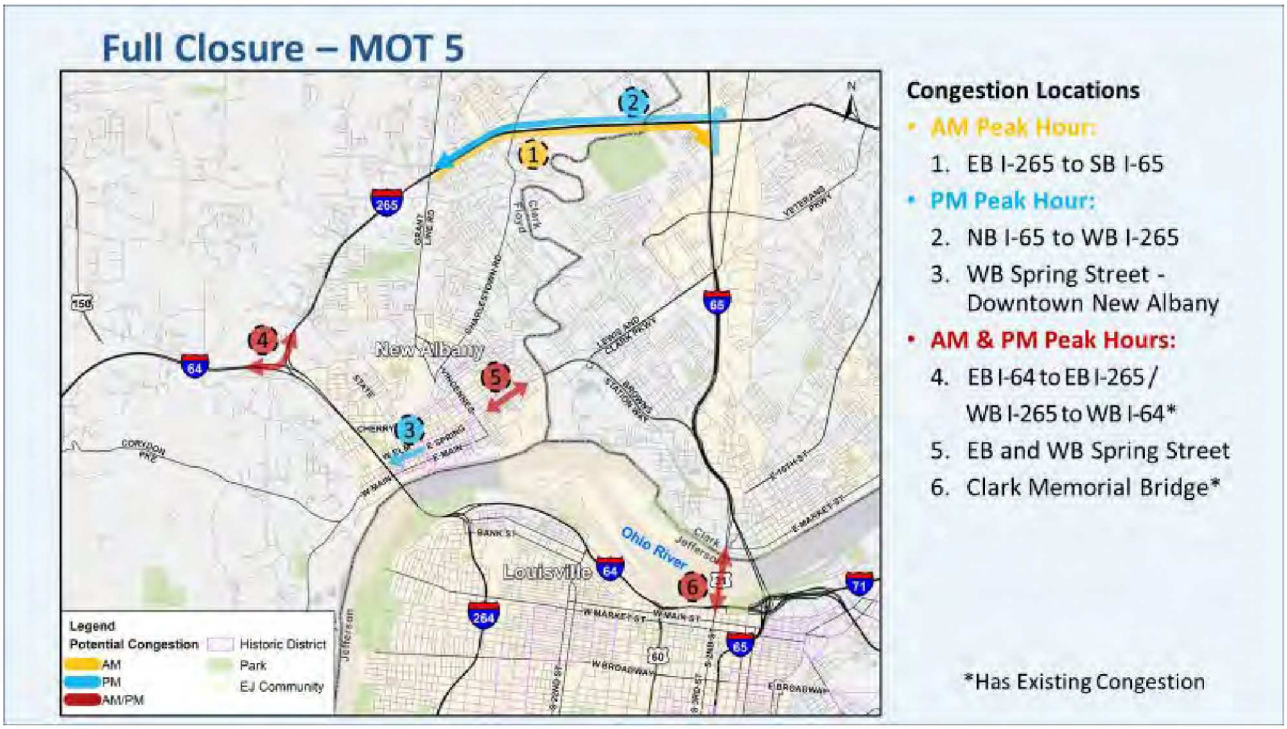


Figure 9 - MOT 5 Potential Bottleneck Segments

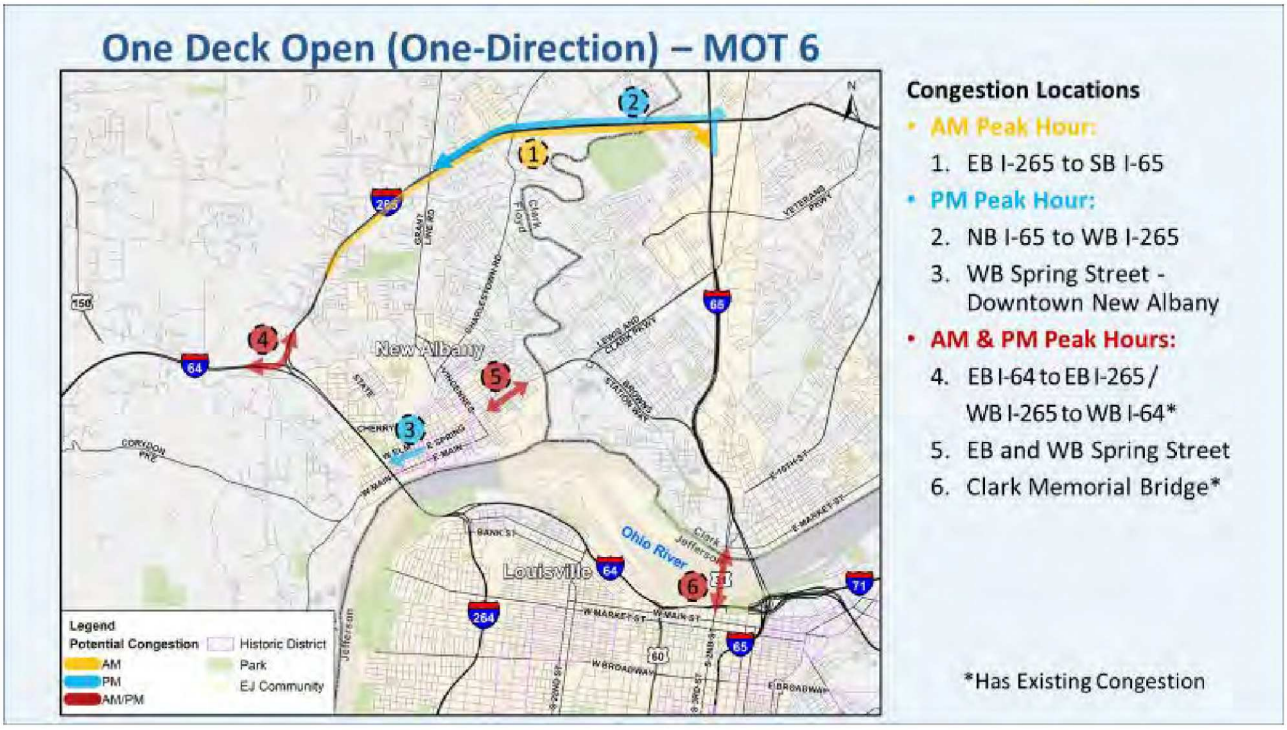


Figure 10 - MOT 6 Potential Bottleneck Segments

I-64 Sherman Minton Bridge Corridor

Vehicles that do not divert from the Sherman Minton Bridge may also experience congestion if there are lane closures in the corridor. The various MOT options include lane closures that will begin at a point upstream of the bridge. This portion of the analysis evaluates how the I-64/Sherman Minton Bridge corridor will handle traffic demand that continues to use the bridge during partial closure scenarios. Corridor travel times and work zone queuing that may result due to lane closures were estimated for each MOT option.

The TDM was used to estimate the traffic volumes but not directly used to estimate the queue lengths. Rather, the queuing analysis was conducted using methodology similar to the procedures described in the *Indiana Department of Transportation (INDOT) Interstate Highways Congestion Policy 2017*. The TDM modeled link volumes by TOD period were converted to hourly volumes by direction according to observed hourly counts in the corridor. These volumes and other pertinent pieces of data were input for the INDOT Queue Analysis Spreadsheet. The spreadsheet tool generated queue lengths by hour of the day. Queue lengths were calculated within and around the work zone at locations where a MOT option would cause lane reductions. The queue lengths for each MOT were calculated at the primary location of lane reductions related to the lane closures on the Sherman Minton Bridge. Secondary locations with lane reductions related to other aspects of a MOT option were also estimated.

Maximum queue length (miles) during the AM and PM peak periods are reported in Table 17. It should be noted, the INDOT Queue Analysis Spreadsheet does not consider driver's reaction to existing queues with hourly volumes fixed regardless of the presence of existing queues. The queue lengths reported should be viewed as a comparative measure to gauge the impact of one MOT option to another. The queueing results do not report the possibility of queues in the mid-day off-peak hours or queues that may develop elsewhere in the study area due to diverting traffic (especially under full closure options). Also, the queuing analysis does not consider upstream interchanges or other features that would further impact the queues.

MOT 2 would experience the most significant work zone queuing followed by MOT 4 and then MOT 1. It is estimated that MOT 3, MOT 5 and MOT 6 would experience little work zone queueing as these options utilize either full closure of the Sherman Minton bridge or maintain 3 full lanes.

Table 17 - Estimated Queue Lengths – AM & PM by Direction

MOT OPTION-PHASE	PRIMARY LOCATION SECONDARY LOCATIONS	MAXIMUM QUEUE LENGTH (MILES)				OVERALL MAXIMUM
		AM PEAK PERIOD		PM PEAK PERIOD		
		EASTBOUND	WESTBOUND	EASTBOUND	WESTBOUND	
MOT 1	Sherman Minton Bridge	1.1	0.0	0.0	1.8	1.8
	I-64 WB @ I-264		0.0		1.5	
MOT 2	Sherman Minton Bridge	1.5 [1]	0.5 [1]	3.7	5.4	5.4
	I-64 WB @ I-264		0.0		0.0	
MOT 3	Sherman Minton Bridge	0.0	*FC*	*FC*	0.0	0.0
	I-264 NB @ Bank Street Interchange		0.0		0.0	
MOT 4	Sherman Minton Bridge	0.9	2.3 [2]	2.8	0.9	2.8
	I-64 EB @ I-264	0.2		0.0		
	I-64 WB @ I-264		1.3		0.6	
MOT 5	Sherman Minton Bridge	*FC*	*FC*	*FC*	*FC*	0.0
MOT 6-1	Sherman Minton Bridge	*FC*	0.0	*FC*	0.0	0.0
MOT 6-2	Sherman Minton Bridge	0.0	*FC*	0.0	*FC*	0.0

NOTE: *FC* indicates *Full Closure* of the Sherman Minton Bridge for a MOT option by direction

[1] Queue reported at end of peak period. However, queues continue to build into the midday and afternoon.

[2] Queue reported from midday as queue continues to build after peak period.

Travel times estimates were also reviewed for the I-64 corridor and may be a better indicator of congestion. Specifically, modeled travel times along I-64 between US-150 in Indiana and 22nd Street in Louisville (see Figure 11) for each MOT were compared to the base/existing scenario. The peak period/peak direction MOT travel times and comparisons to the base travel time are reported in Table 18. As expected, short of full closure of the Sherman Minton bridge (as in MOT 5), travel times increase through the corridor as additional lanes are closed. Estimated travel time increases range from 4 to 15 minutes. Compared to the base travel time of 8 minutes, the largest increase in travel time under MOT 2 approaches 200%. While MOT 1 and MOT 4 travel times increase between 50-75%.

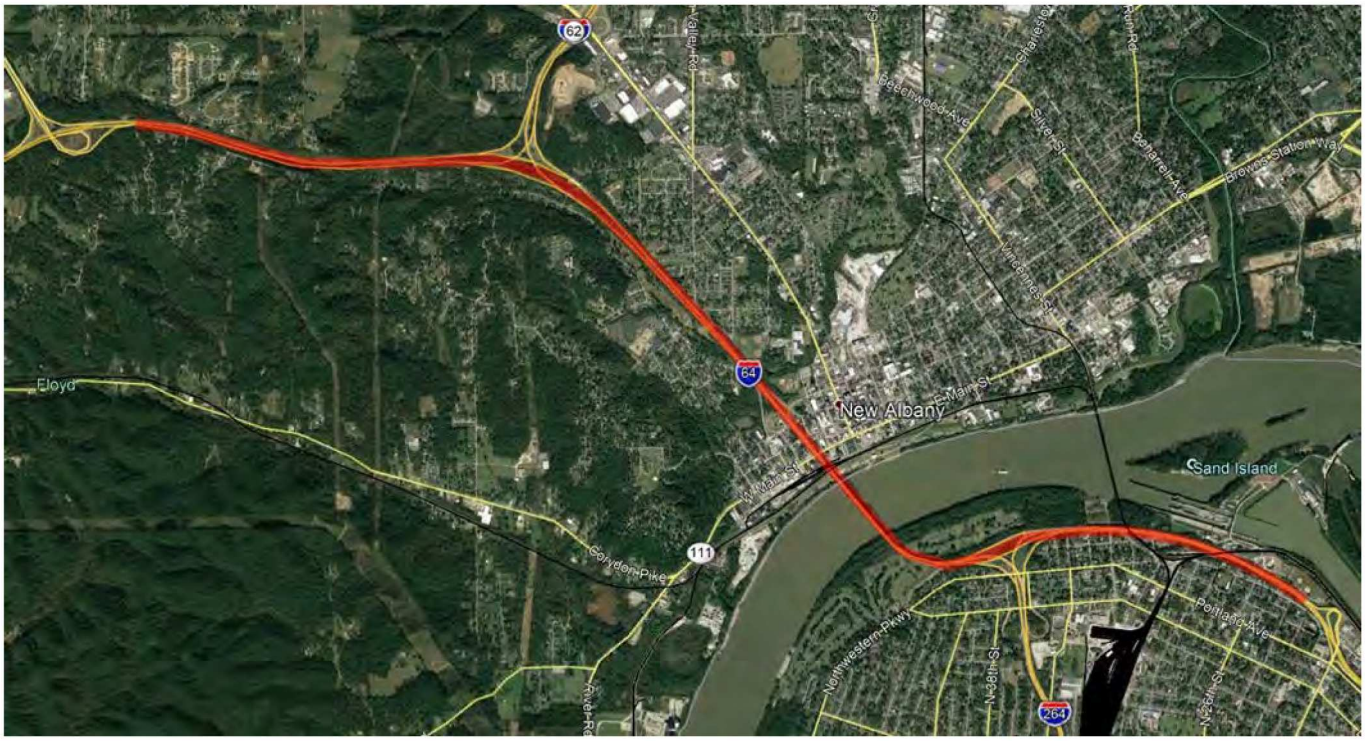


Figure 11 - I-64 Corridor from US-150 to I-264

Table 18 - I-64 Corridor Estimated Travel Times (US-150 to I-264)

MOT OPTION	EASTBOUND – AM PEAK PERIOD			WESTBOUND – PM PEAK PERIOD		
	TRAVEL TIME (MINUTES)	DIFFERENCE FROM BASE	PERCENT CHANGE	TRAVEL TIME (MINUTES)	DIFFERENCE FROM BASE	PERCENT CHANGE
Base	8			8		
MOT 1	13	5	63%	14	6	75%
MOT 2	22	14	175%	23	15	188%
MOT 3	8	0	0%	8	0	0%
MOT 4	13	5	63%	12	4	50%
MOT 5	*FC*	*FC*	*FC*	*FC*	*FC*	*FC*
MOT 6	*FC*/8	0	0%	*FC*/8	0	0%

NOTE: *FC* indicates *Full Closure* of the Sherman Minton Bridge for a MOT option by direction. MOT option 6 includes full closure of eastbound or westbound travel in phases.

The distance between US-150 and 22nd Street along I-64 is approximately 6.3 miles. Over this distance the average speed for each MOT option was also compared to the base/existing as reported in Table 19. Speeds along the corridor are estimated to be as low as 17mph for MOT 2 while MOT 1 and MOT 4 maintain speeds in the range of upper 20s to low 30s.

Table 19 - I-64 Corridor Estimated Congested Average Speed (US-150 to I-264)

MOT OPTION	EASTBOUND – AM PEAK			WESTBOUND – PM PEAK		
	SPEED (MILES/HOUR)	DIFFERENCE FROM BASE	PERCENT CHANGE	SPEED (MILES/HOUR)	DIFFERENCE FROM BASE	PERCENT CHANGE
Base	49			50		
MOT 1	29	-20	-41%	27	-23	-46%
MOT 2	17	-32	-65%	17	-33	-66%
MOT 3	49	0	0%	50	0	0%
MOT 4	29	-20	-41%	31	-19	-38%
MOT 5	*FC*	*FC*	*FC*	*FC*	*FC*	*FC*
MOT 6	*FC*/49	0	0%	*FC*/50	0	0%

NOTE: *FC* indicates *Full Closure* of the Sherman Minton Bridge for a MOT option by direction. MOT option 6 includes full closure of eastbound or westbound travel in phases.

Detour Travel Times

Another way to evaluate the impact of MOT options is to compare multiple routes between two common points. Travel times were extracted from the TDM for three plausible detour routes from the I-64/Sherman Minton Bridge route from Indiana to Kentucky. The origin and destination of the travel times measured started on I-64 near US-150 and ended along I-65 near downtown Louisville. The four routes are highlighted in Figure 12 between common points A and B and are as described:

- Route one (magenta) is the existing condition (no construction) heading east along I-64, crossing the river on the Sherman Minton Bridge
- The second route (red) heads east along I-265, south on I-65, crossing the river on the Kennedy Bridge
- The third route (yellow) heads east from I-64 initially on Market Street and then Brown Station Way before crossing the river on the Kennedy Bridge
- The fourth route (green) also heads east from I-64 on Market Street and Brown Station Way before crossing the river on the Clark Memorial Bridge

Travel times for Route 1 represent the existing or no construction condition. Routes 2, 3 and 4 were analyzed under the MOT scenarios. Table 20 shows the difference in travel time for the selected detour routes compared with the existing Route 1, I-64 travel times. The table also reports the additional distance and tolls associated with the detour routes. The differences are reported for eastbound travel during the AM peak period and westbound during the PM peak period to highlight the impacts to a typical Indiana to Kentucky work commuter. The table reports the additional time, distance, and tolls using the I-64/Sherman Minton Bridge route as a reference. As an illustration, the Brown Station Way/Clark Memorial Bridge route would take 13.7 minutes longer under the base condition and 24.0 minutes longer during MOT 5.

A similar exercise was conducted for a typical trip that might be traveling from West Louisville to the Commercial/Medical Center area of northwestern New Albany along State Street. The routes are shown in Figure 13 with the results reported in Table 21. In this case both Kentucky to Indiana and return trips were analyzed during the PM peak Period. In most cases this trip pattern is more impacted than the Indiana to Kentucky work commuter trip. Note under MOT 6 the leg of the trip to New Albany is estimated to take 30.1 minutes longer using the toll-free Clark Memorial Bridge/Brown Station Way route compared to the base I-64/Sherman Minton Bridge route.

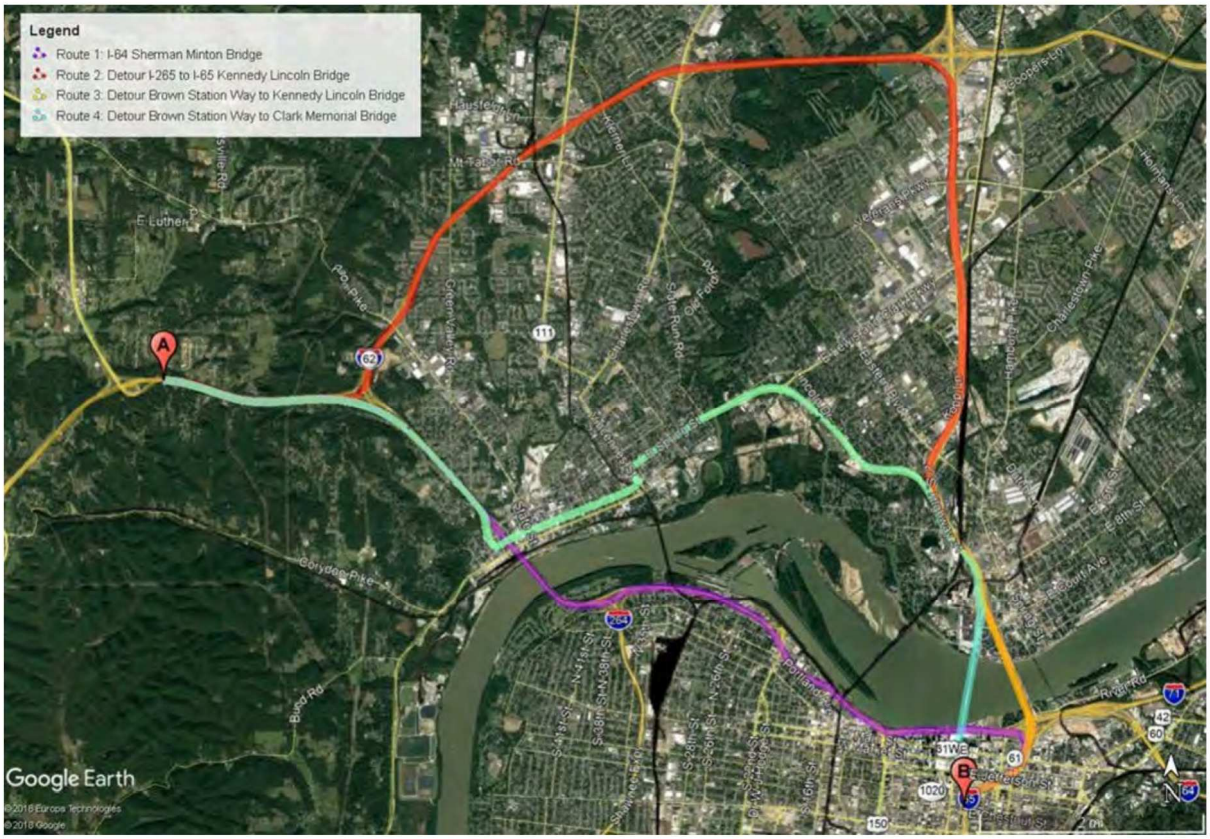


Figure 12 - Example Alternate Routes Indiana to Kentucky

Table 20 - Indiana to Kentucky Alternate Routes Peak Period Travel Time Changes

Routes	Added Distance (Miles)	Added Toll	Additional Travel Time (Minutes)							
			Base	MOT 1	MOT 2	MOT 3	MOT 4	MOT 5	MOT 6-1 WB Open	MOT 6-2 EB Open
Eastbound (AM Peak)										
I-64 Sherman Minton Bridge	-	$ -	0.0	5.4	14.2	0.0	5.1	NA	NA	0.0
I-265 to I-65 Kennedy Lincoln Bridge	5.7	$ 2.67	5.6	5.7	7.5	5.7	5.7	16.0	16.3	5.6
Brown Station Way to Kennedy Lincoln Bridge	2.0	$ 2.67	6.9	7.0	8.6	7.0	7.4	15.9	16.4	6.7
Brown Station Way to Clark Memorial Bridge	1.7	$ -	13.7	14.3	16.5	14.1	14.9	24.0	24.6	13.6
Westbound (PM Peak)										
I-64 Sherman Minton Bridge	-	$ -	0.0	6.2	15.2	0.0	4.7	NA	0.0	NA
I-265 to I-65 Kennedy Lincoln Bridge	5.9	$ 2.67	6.2	6.5	8.7	6.0	6.3	17.8	6.1	18.6
Brown Station Way to Kennedy Lincoln Bridge	1.3	$ 2.67	6.8	7.2	9.5	6.5	7.1	17.9	6.4	18.7
Brown Station Way to Clark Memorial Bridge	1.1	$ -	15.0	16.1	18.9	15.1	16.2	27.7	14.8	28.5

Note: NA indicates route is not available during a full closure MOT

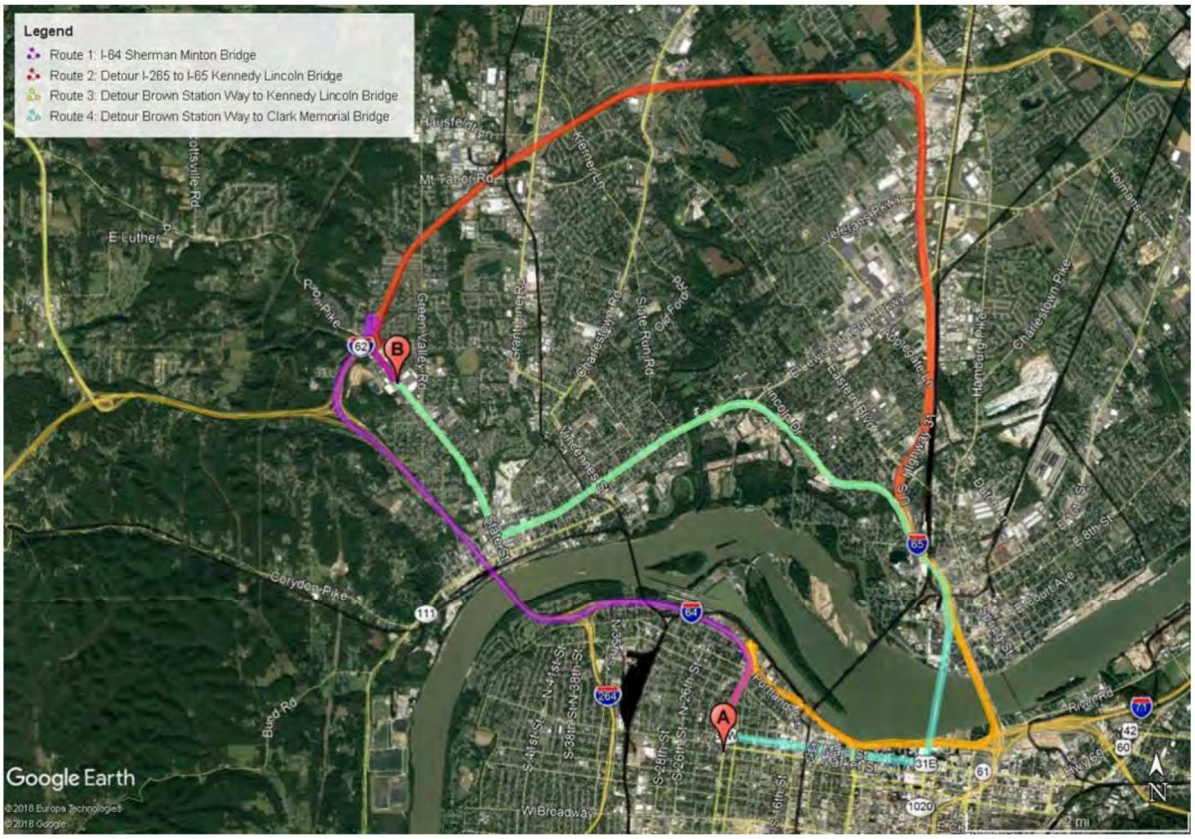


Figure 13 - Example Alternate Routes Kentucky to Indiana

Table 21 - Kentucky to Indiana Alternate Routes Peak Period Travel Time Changes

Eastbound (PM Peak)										
Routes	Added Distance (Miles)	Added Toll	Additional Travel Time (Minutes)							
			Base	MOT 1	MOT 2	MOT 3	MOT 4	MOT 5	MOT 6-1 WB Open	MOT 6-2 EB Open
I-64 Sherman Minton Bridge	-	$ -	0.0	0.2	5.9	NA	6.4	NA	NA	0.0
I-265 to I-65 Kennedy Lincoln Bridge	5.7	$ 2.67	9.6	9.5	9.4	12.3	10.0	10.9	12.4	9.2
Brown Station Way to Kennedy Lincoln Bridge	2.0	$ 2.67	10.8	10.2	10.1	13.3	10.4	12.2	13.7	10.0
Brown Station Way to Clark Memorial Bridge	1.7	$ -	15.7	15.1	15.4	19.2	15.8	18.2	19.6	15.1
Westbound (PM Peak)										
I-64 Sherman Minton Bridge	-	$ -	0.0	6.0	14.8	1.7	6.3	NA	0.0	NA
I-265 to I-65 Kennedy Lincoln Bridge	5.9	$ 2.67	9.2	9.5	10.6	9.7	10.5	17.0	9.0	18.1
Brown Station Way to Kennedy Lincoln Bridge	1.3	$ 2.67	11.0	11.0	13.2	10.5	11.2	21.5	10.7	22.2
Brown Station Way to Clark Memorial Bridge	1.1	$ -	17.7	18.4	21.0	17.5	18.5	29.4	17.5	30.1

Note: NA indicates route is not available during a full closure MOT

2.3.2 IMPACTS TO LOCAL COMMUNITIES – LOCAL STREET CONGESTION FROM DIVERSION

Another concern for potential impacts to communities (EJ and historic areas in particular) is the potential for congestion caused by diverted through-traffic. This analysis identifies significant increases in congestion through communities in general, with a specific focus on EJ communities and historic areas within the study area.

Travel demand models are generally less sensitive in predicting trips on local streets. In some cases, not all the local street network is modeled. Also, the models tend to route vehicles on parallel side streets to find a best path instead of staying on main thoroughfares as actual drivers tend to do. Therefore, screenlines were used to pick up patterns across multiple parallel/competing routes. A screenline or screenline analysis counts the total number of vehicles that pass over an imaginary (screen) line that cuts across a roadway or multiple roadways. Model output from the Base case was compared with output from each MOT option to find the change in traffic due to each MOT option.

In order to estimate whether congestion is likely to result with the addition of diverted trips, a per-lane through volume was examined. A base saturation flow rate of 1,800 vehicles per hour was used with an estimated green-time percentage of 60 percent to come up with a peak-hour capacity of 1,080 vehicles per hour per lane. The Highway Capacity Manual states that for planning purposes, anything less than or equal to 85 percent of capacity is considered "Under Capacity". 85 to 95 percent is considered "Near Capacity". 95 percent or above is considered at capacity and above. Identifying segments with peak-hour volumes at or above 85 percent of capacity would roughly equate to LOS E and F conditions.

West-to-east diversion from the I-64 Sherman Minton Bridge to the downtown bridges through local communities was observed across New Albany and Clarksville on Spring Street/Brown Station Way corridor and to a much lesser extent on local streets in West Louisville. Three areas were looked at along Spring Street/Brown Station Way on the Indiana side and one area was focused on for West Louisville on the Kentucky side. Figure 14 shows the location of each screenline. Analyses of each of these four areas are described below.

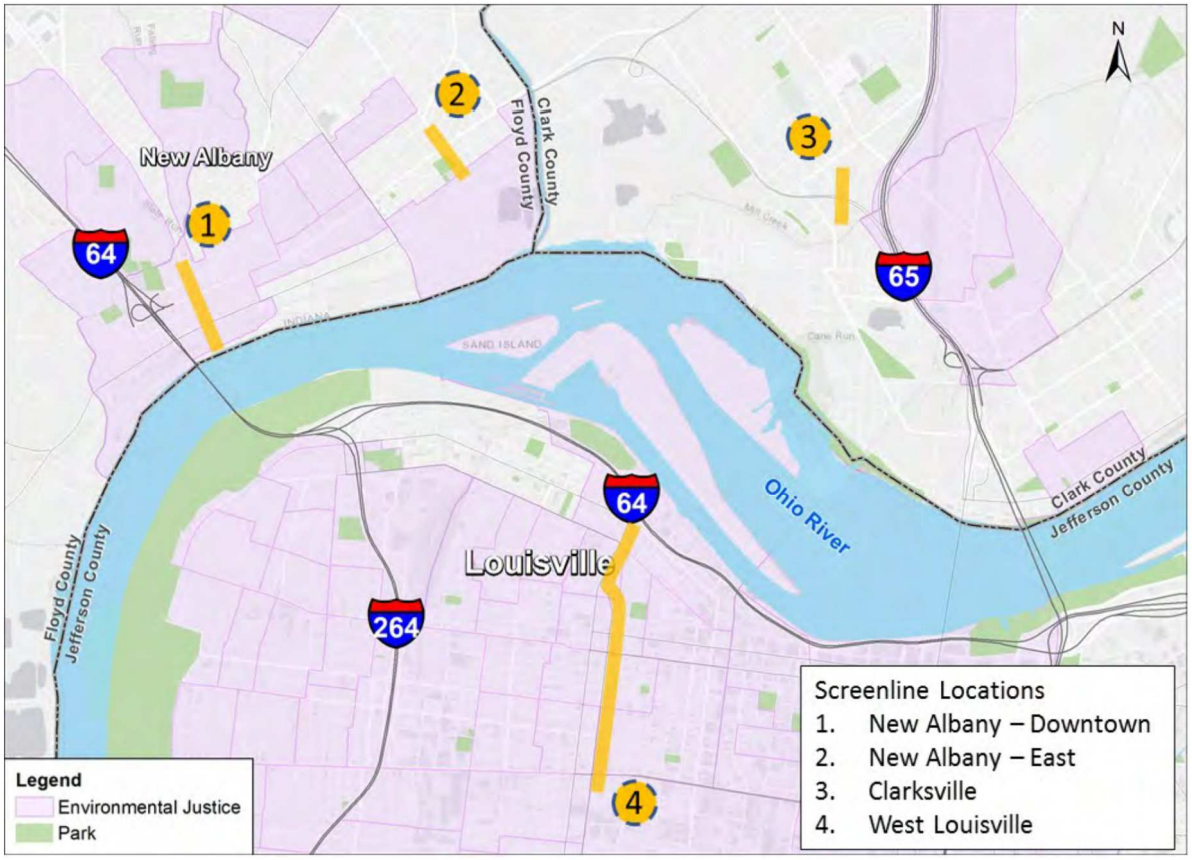


Figure 14 - Screenline Locations

New Albany – Downtown – Oak/Elm/Spring/Market/Main @ State

Downtown New Albany is an EJ community with a traditional grid street network and contains an historic district. The street network was extensively modified in 2017 to convert one-way street pairs to two-way streets in order to lower traffic speeds. This section of the east-west corridor between I-64 and the downtown bridges is made up of several east-west streets on which the traffic is distributed. A screenline just east of State Street across Oak Street, Elm Street, Spring Street, Market Street, Main Street, and Water Street was examined. The predicted traffic volumes across the screenline was calculated for each MOT option and compared to the Base case to determine the change in traffic due to the MOT option. The location of this screenline is illustrated in Figure 15.

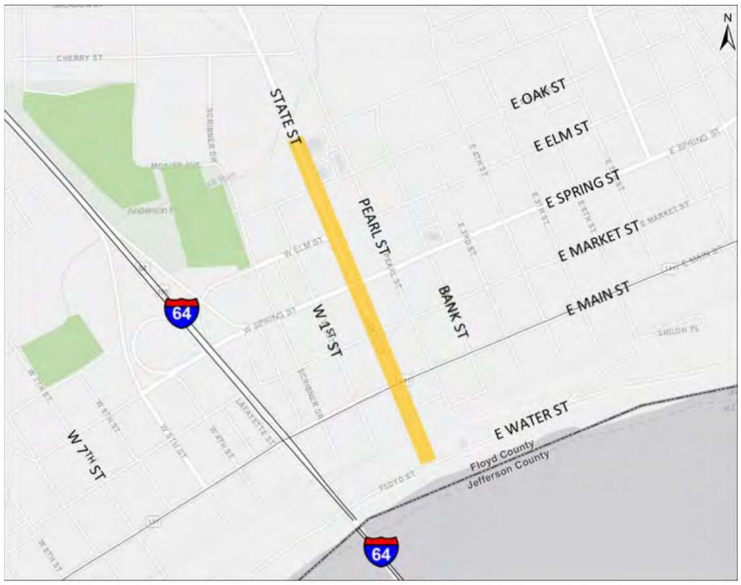


Figure 15 - Screenline – New Albany – Downtown

The estimated change in traffic across this screenline by direction during the AM and PM peak hours is shown below in Table 22. The options show a combination of decreases and increases in peak-hour traffic. This is due in part to traffic shifts from the Sherman Minton Bridge to the downtown bridges.

Table 22 - Change in Screenline Peak-Hour Traffic (vehicles across all lanes) – New Albany Downtown

MOT OPTION	WESTBOUND		EASTBOUND	
	AM	PM	AM	PM
MOT 1	-190	10	20	-280
MOT 2	-450	10	160	-700
MOT 3	160	-550	-320	150
MOT 4	-210	-170	10	-220
MOT 5	-380	460	720	-580
MOT 6	160	770	940	150

The overall change in traffic across the screenline was then projected onto the individual streets to assess the probability that congestion may occur due to diversion in this area. This was done by proportionally assigning the net change of the screenline to the individual roadways based on existing counts. The resultant peak-hour traffic estimate for the roadway with the highest volume by direction was checked against the per-lane capacity mentioned above to assess the likelihood

of congestion on that link. For eastbound traffic, the highest volume is on Elm Street and for westbound traffic it is on Spring Street. The resultant peak-hour per lane traffic volumes and likelihood of congestion are shown below in Table 23.

Table 23 - Estimated Peak-Hour Traffic (vehicles per lane) – Spring and Elm – New Albany – Downtown

MOT OPTION	WESTBOUND (SPRING)		EASTBOUND (ELM)	
	AM	PM	AM	PM
Base	650	730	270	490
MOT 1	550	740	280	380
MOT 2	410	740	330	200
MOT 3	740	470	170	560
MOT 4	540	650	280	400
MOT 5	450	950	500	250
MOT 6	740	1100	570	560

Note: yellow = near capacity; red = at or above capacity

Only Spring Street in the westbound direction in the PM peak hour shows a high likelihood of experiencing congestion in MOT 6 and a moderate likelihood in MOT 5. This is due to the available set of parallel routes in downtown New Albany that helps distribute the increase in traffic. It is also due to this screenline being on the western edge of the east-west corridor. Changes in traffic increase moving from west to east as more trip origins are included. This will be seen in the next screenline farther east.

New Albany – East – Spring/Elm/Market @ Silver Street

Eastern New Albany at Silver Street is on the eastern edge of an EJ community as shown in Figure 14. This section of the east-west corridor between I-64 and the downtown bridges narrows down to three local streets (Elm, Spring, and Market) before narrowing further to just Brown Station Way to the east. Spring Street is the primary route of the three. A screenline just west of Silver Street across Elm Street, Spring Street, and Market Street was examined. The screenline is shown in Figure 16.

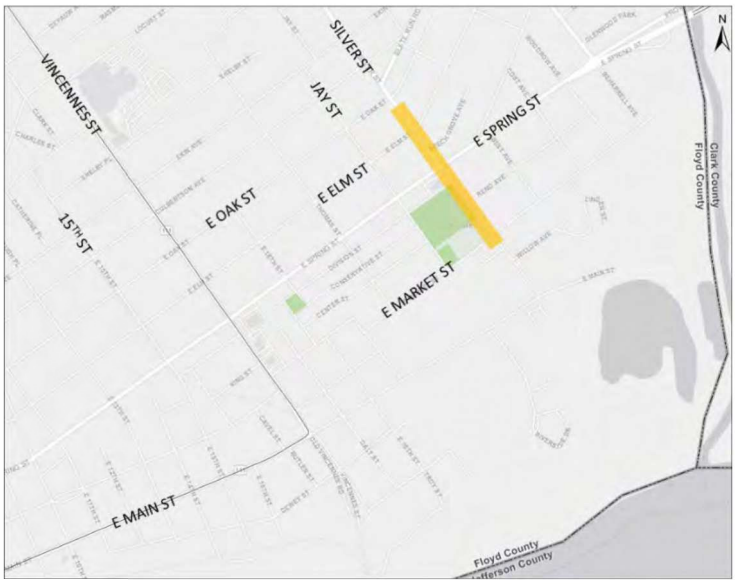


Figure 16 - Screenline - New Albany - East

The predicted traffic volumes across the screenline were calculated for each MOT option and compared to the Base case to determine the change in traffic due to the MOT option and shown below in Table 24. Some of the options show a decrease in traffic for a certain direction during at least one peak hour. The presence of both increases and decreases in traffic is due in part to shifts from the Sherman Minton Bridge on the west to the downtown bridges on the east. The largest increases in traffic occur in MOT 5 and MOT 6.

Table 24 - Change in Screenline Peak-Hour Traffic (vehicles across all lanes) – New Albany – East

MOT OPTION	WESTBOUND		EASTBOUND	
	AM	PM	AM	PM
MOT 1	-90	40	40	-150
MOT 2	-110	280	340	-210
MOT 3	320	-10	50	340
MOT 4	-30	90	170	-60
MOT 5	240	640	780	160
MOT 6	320	680	800	340

The overall change in traffic across the screenline was then projected onto the individual streets to assess the probability that congestion may occur due to diversion. Spring Street has a much higher existing volume than the other two streets. The resultant peak-hour traffic volumes and likelihood of congestion on Spring Street in eastern New Albany are shown below in Table 25.

Table 25 - Estimated Peak-Hour Traffic (vehicles per lane) – Spring – New Albany – East

MOT OPTION	WESTBOUND (SPRING)		EASTBOUND (SPRING)	
	AM	PM	AM	PM
Base	540	710	430	580
MOT 1	470	750	470	470
MOT 2	450	930	720	420
MOT 3	810	710	480	850
MOT 4	520	780	580	540
MOT 5	740	1210	1080	710
MOT 6	810	1240	1100	850

Note: yellow = near capacity; red = at or above capacity

It is important to note that in the Base case, westbound traffic on Spring Street during the PM peak hour is already significant. Therefore, any substantial additional traffic puts it over capacity. This should be taken into consideration when assessing projected capacity on westbound Spring Street in the PM for the options. Though five of the options show westbound PM traffic increasing, only MOT 2, MOT 5 and MOT 6 show conditions substantially worse than the Base conditions. For the other directions and time periods, MOT 5, and MOT 6 both show eastbound AM traffic near or above capacity. MOT 5 and MOT 6 are most likely to have new congestion in multiple directions. MOT 2 is likely to have new congestion in at least one direction. MOT 1, MOT 3 and MOT 4 are least likely to show new congestion beyond what already appears during the Base conditions in the PM in the westbound direction.

Clarksville – Brown Station Way @ Randolph Street

The east-west corridor between I-64 and the downtown bridges is carried by Brown Station Way through Clarksville. Brown Station Way is a higher capacity arterial with two lanes in each direction and few intersections with cross streets. This area of Clarksville is not an EJ community. A screenline across Brown Station Way just east of Randolph Street was examined. The screenline is illustrated in Figure 17.

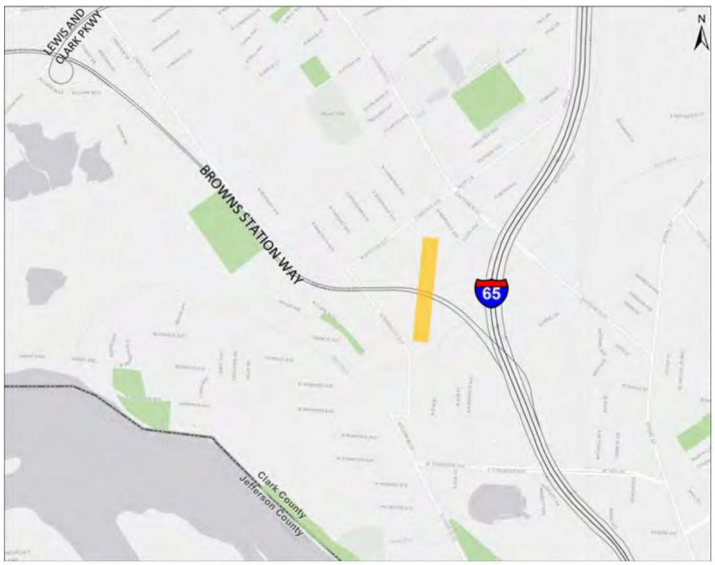


Figure 17 - Screenline - Clarksville

The predicted traffic volumes across the screenline were calculated for each MOT option and compared to the Base case to determine the change in traffic due to the MOT option and shown below in Table 26. All the options show an increase in traffic except for MOT 1. The largest increases in traffic occur in MOT 5 and MOT 6.

Table 26 - Change in Screenline Peak-Hour Traffic (vehicles across all lanes) – Clarksville

MOT OPTION	WESTBOUND		EASTBOUND	
	AM	PM	AM	PM
MOT 1	-10	240	170	-10
MOT 2	10	690	670	80
MOT 3	530	320	280	680
MOT 4	90	450	430	250
MOT 5	540	970	1080	660
MOT 6	530	970	1080	680

The overall change in traffic across the screenline was then projected onto Brown Station Way to assess the probability that congestion may occur due to diversion. The resultant peak-hour traffic volumes and likelihood of congestion on Spring Street in Clarksville are shown below in Table 27. Because capacity is determined on a per-lane basis and Brown Station Way is two lanes in each direction, the volumes listed in the table are per lane.

Table 27 - Estimated Peak-Hour Traffic (vehicles per lane) – Brown Station Way - Clarkesville

MOT OPTION	WESTBOUND		EASTBOUND	
	AM	PM	AM	PM
Base	190	420	340	210
MOT 1	190	560	440	200
MOT 2	190	760	680	250
MOT 3	450	580	480	560
MOT 4	230	640	560	330
MOT 5	460	900	880	540
MOT 6	450	900	880	550

Brown Station Way operates well below capacity during the Base case. Therefore, Brown Station Way can absorb even the highest amount of diverted traffic (MOT 5 and MOT 6) while still remaining below capacity. Brown Station Way is expected to operate at acceptable levels of service under all MOT options.

West Louisville – 22nd Street

The primary roadway between the Sherman Minton Bridge and the downtown bridges is I-64. If cross-river trips from Kentucky to Indiana divert from the Sherman Minton Bridge to the downtown bridges, I-64 along the river carries most of this movement. However, potential diversion through the community was also studied in West Louisville. The street network in West Louisville is an arterial grid that generally operates under capacity. The main north-south roadways are 22nd Street and 9th Street to the east. The main east-west arterials are Portland Street and Bank Street to the north and Main Street (2 lanes EB and WB), Market Street (1 lane EB and WB), Muhammad Ali Boulevard (2 lanes WB), Chestnut Street (2 lanes EB), and Broadway (2 lanes EB and WB) to the south. These arterials provide sufficient laneage to allow east-west travel with excess capacity to spare. All of West Louisville is an EJ community. This area also includes a historic district. A screenline just west of 22nd Street was examined to gauge changes in east-west travel patterns. The screenline is illustrated in Figure 18.

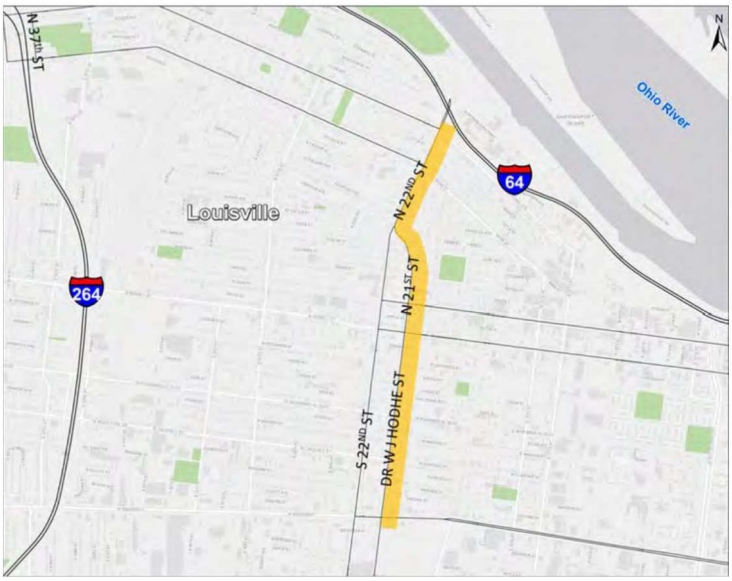


Figure 18 - Screenline - West Louisville

The predicted traffic volumes across the screenline were calculated for each MOT option and compared to the Base case to determine the change in traffic due to the MOT option and shown below in Table 28. All the options show a very modest increase in traffic considering the number of arterial routes included. The largest increases in traffic occur in MOT 4 where there are restrictions to ramps within the I-64/I-264 interchange.

Table 28 - Change in Screenline Peak-Hour Traffic (vehicles across all lanes) – West Louisville

MOT OPTION	WESTBOUND		EASTBOUND	
	AM	PM	AM	PM
MOT 1	60	190	-60	100
MOT 2	90	30	-90	20
MOT 3	160	240	130	10
MOT 4	230	480	30	320
MOT 5	210	140	-60	0
MOT 6	130	240	120	50

The overall change in traffic across the screenline was then projected onto the east-west arterials mentioned above to assess the probability that congestion may occur due to diversion. Table 29 below shows the net change in per-lane traffic if the traffic were distributed among the east-west arterials.

Table 29 - Estimated Peak-Hour Traffic Change (vehicles per lane) – West Louisville

MOT OPTION	WESTBOUND		EASTBOUND	
	AM	PM	AM	PM
MOT 1	10	30	-10	20
MOT 2	20	10	-20	10
MOT 3	30	40	20	10
MOT 4	40	70	10	50
MOT 5	30	20	-10	0
MOT 6	20	40	20	10

The minimal increases in per-lane peak-hour traffic onto an already under capacity network is not likely to cause any noteworthy congestion in West Louisville. Even the highest increase experienced in MOT 4 would only be on the order of about one additional vehicle per minute.

2.3.3 MITIGATION

As mentioned previously, the identification of potential bottleneck locations on the highway network also identified potential areas for mitigation. This section examines the potential effectiveness of mitigating these segments by increasing the capacity of the segment by adding one lane. The four ramps that connect I-265 to I-64 and I-65 are predicted in some options to exceed the 1,900 vehicle per hour threshold. Table 30 shows these per-lane ramp volume estimates for each MOT option for the AM and PM peak hours. Each of the ramps are currently one lane. The WB I-265 to WB I-64 is already over the threshold under existing conditions. Table 31 shows the per-lane ramp volumes if a second lane is added to each ramp. Under the mitigated conditions, all four ramps would be under the 1,900 vehicles per lane indicating operations better than LOS E. The feasibility of adding a second lane to these ramps would need to be confirmed. All but the NB I-65 to WB I-265 ramp had a second lane added during the 2011 emergency closure.

Table 30 - Ramp Bottleneck Locations – Unmitigated

MOT OPTION	RAMP I-64 EB TO I-265 EB		RAMP I-265 WB TO I-64 WB		RAMP I-265 EB TO I-65 SB		RAMP I-65 NB TO I-265 WB	
	AM	PM	AM	PM	AM	PM	AM	PM
Existing Volume	1400	1010	780	1970	1060	1100	555	1070
Existing Lanes	1	1	1	1	1	1	1	1
Unmitigated per-lane Volume								
Base	1400	1010	780	1970	1060	1100	555	1070
MOT 1	1460	940	760	2070	1480	1010	490	1420
MOT 2	1790	1090	790	2220	1900	1100	500	1770
MOT 3	1390	1440	1290	1930	1050	1730	1220	1180
MOT 4	1460	1120	810	2020	1490	1210	530	1380
MOT 5	2100	1010	1170	2420	2200	1720	1080	2000
MOT 6	2080	1440	1190	2410	2180	1730	1130	1990

Note: Shaded cells indicate estimated volumes exceed the 1,900 vehicle per hour per lane threshold for acceptable operations.

Table 31 - Ramp Bottleneck Locations – Mitigated

MOT OPTION	RAMP I-64 EB TO I-265 EB		RAMP I-265 WB TO I-64 WB		RAMP I-265 EB TO I-65 SB		RAMP I-65 NB TO I-265 WB	
	AM	PM	AM	PM	AM	PM	AM	PM
Existing Volume	1400	1010	780	1970	1060	1100	555	1070
Existing Lanes	1	1	1	1	1	1	1	1
Mitigated per-lane Volume								
Mitigated Lanes	2	2	2	2	2	2	2	2
Base	NA	NA	NA	985	NA	NA	NA	NA
MOT 1	NA	NA	NA	1035	NA	NA	NA	NA
MOT 2	NA	NA	NA	1110	950	NA	NA	NA
MOT 3	NA	NA	NA	965	NA	NA	NA	NA
MOT 4	NA	NA	NA	1010	NA	NA	NA	NA
MOT 5	1050	NA	NA	1210	1100	NA	NA	1000
MOT 6	1040	NA	NA	1205	1090	NA	NA	995

Some mainline segments along I-265 between I-64 and I-65 are also predicted in some options to exceed the 1,900 vehicle per hour threshold. Table 32 and Table 33 show the EB I-265 and WB I-265 per-lane ramp volume estimates for each MOT option for the AM and PM peak hours. Each of these mainline segments are currently two lanes. MOT 1 and MOT 4 show no segments over the threshold while MOT 2 has only one segment in the AM peak hour with an estimated volume above the threshold. Table 34 and Table 35 show the per-lane segment volumes if a third lane were added to each segment. Under the mitigated conditions, all the segments would be under the 1,900 vehicles per lane indicating mitigated operations better than LOS E. The feasibility of adding a third lane to these segments would need to be confirmed.

Table 32 - EB I-265 Bottleneck Locations – Unmitigated

MOT OPTION	EB I-265 I-64 TO STATE		EB I-265 STATE TO IN 111		EB I-265 IN 111 TO CHARLESTOWN		EB I-265 CHARLESTOWN TO I-65	
	AM	PM	AM	PM	AM	PM	AM	PM
Existing Volume	2360	2710	2720	2650	2490	2940	2600	2800
Existing Lanes	2	2	2	2	2	2	2	2
Unmitigated per-lane Volume								
Base	1,180	1,355	1,360	1,325	1,245	1,470	1,300	1,400
MOT 1	1,305	1,080	1,475	1,005	1,420	1,240	1,625	1,285
MOT 2	1,310	720	1,655	845	1,710	1,210	1,985	1,355
MOT 3	835	1,720	1,045	1,620	1,000	1,900	1,175	1,915
MOT 4	1,350	1,430	1,420	1,215	1,370	1,420	1,590	1,485
MOT 5	1,265	1,355	1,845	1,130	2,035	1,630	2,345	1,775
MOT 6	1,545	1,565	2,070	1,620	2,155	1,900	2,390	1,915

Note: Shaded cells indicate estimated volumes exceed the 1,900 vehicle per hour per lane threshold for acceptable operations.

Table 33 - EB I-265 Bottleneck Locations – Mitigated

MOT OPTION	EB I-265 I-64 TO STATE		EB I-265 STATE TO IN 111		EB I-265 IN 111 TO CHARLESTOWN		EB I-265 CHARLESTOWN TO I-65	
	AM	PM	AM	PM	AM	PM	AM	PM
Existing Volume	2360	2710	2720	2650	2490	2940	2600	2800
Existing Lanes	2	2	2	2	2	2	2	2
Mitigated per-lane Volume								
Mitigated Lanes	3	3	3	3	3	3	3	3
Base	NA	NA	NA	NA	NA	NA	NA	NA
MOT 1	NA	NA	NA	NA	NA	NA	NA	NA
MOT 2	NA	NA	NA	NA	NA	NA	1,320	NA
MOT 3	NA	NA	NA	NA	NA	1,270	NA	1,280
MOT 4	NA	NA	NA	NA	910	NA	NA	NA
MOT 5	NA	NA	NA	NA	1,360	NA	1,560	NA
MOT 6	NA	NA	1,380	NA	1,440	1,270	1,590	1,280

Table 34 - WB I-265 Bottleneck Locations – Unmitigated

MOT OPTION	WB I-265 I-65 TO CHARLESTOWN		WB I-265 CHARLESTOWN TO IN 111		WB I-265 IN 111 TO STATE		WB I-265 STATE TO I-64	
	AM	PM	AM	PM	AM	PM	AM	PM
Existing Volume	2610	2700	2570	2870	2370	2400	1970	2740
Existing Lanes	2	2	2	2	2	2	2	2
Unmitigated per-lane Volume								
Base	1,305	1,350	1,285	1,435	1,185	1,200	985	1,370
MOT 1	1,165	1,605	1,025	1,575	810	1,255	590	1,425
MOT 2	1,135	1,860	955	1,740	610	1,270	260	1,280
MOT 3	1,705	1,235	1,620	1,200	1,455	780	1,320	975
MOT 4	1,255	1,435	1,125	1,370	975	1,075	920	1,360
MOT 5	1,490	2,250	1,240	2,125	815	1,480	385	1,285
MOT 6	1,710	2,290	1,620	2,235	1,455	1,735	1,190	1,645

Note: Shaded cells indicate estimated volumes exceed the 1,900 vehicle per hour per lane threshold for acceptable operations.

Table 35 - WB I-265 Bottleneck Locations – Mitigated

MOT OPTION	WB I-265 I-65 TO CHARLESTOWN		WB I-265 CHARLESTOWN TO IN 111		WB I-265 IN 111 TO STATE		WB I-265 STATE TO I-64	
	AM	PM	AM	PM	AM	PM	AM	PM
Existing Volume	2360	2710	2720	2650	2490	2940	2600	2800
Existing Lanes	2	2	2	2	2	2	2	2
Mitigated per-lane Volume								
Mitigated Lanes	3	3	3	3	3	3	3	3
Base	NA	NA	NA	NA	NA	NA	NA	NA
MOT 1	NA	NA	NA	NA	NA	NA	NA	NA
MOT 2	NA	NA	NA	NA	NA	NA	NA	NA
MOT 3	NA	NA	NA	NA	NA	NA	NA	NA
MOT 4	NA	NA	NA	NA	NA	NA	NA	NA
MOT 5	NA	1,500	NA	1,420	NA	NA	NA	NA
MOT 6	NA	1,530	NA	1,490	NA	NA	NA	NA

Appendix A – SMRP TDM Documentation

SMRP Travel Demand Model

1.1 TRAVEL DEMAND MODEL SELECTION

The project team utilized a project-specific travel demand model to estimate the changes in travel patterns due to different MOT options. At the beginning of the project, the project team evaluated three models for potential use on the project: 1) the KIPDA regional model, 2) the Louisville-Southern Indiana Ohio River Bridges EIS Project (LSIORB) model, and 2) the LSIORB Traffic and Revenue Study Model. The KIPDA regional model was updated in 2018 and chosen as the starting point for development of the SMRP TDM. The KIPDA model was chosen because it is the regionally accepted planning model and was recently updated, making it the most up-to-date model of the three. This model selection was summarized in a travel demand model selection memorandum which can be seen in Appendix A. The KIPDA model has a base year of 2015 and forecast year of 2020. Given the project is evaluating a two- to three-year temporary condition during rehabilitation in the bridge, scheduled to begin in 2021, the KIPDA 2020 model was used as the starting point for the SMRP TDM development. TDM development assumed no significant regional shifts in land use development or other factors (other than the project itself) would drastically change travel patterns between now and the end of the project.

1.2 SMRP TDM DEVELOPMENT AND VALIDATION

The SMRP Team had extensive discussions regarding the data output needed from the model to satisfy the requirements for the NEPA documentation, EJ evaluation, and the traffic operations analyses that will be instrumental in drafting the procurement documents for the project. The traffic analysis requires the ability to measure travel pattern changes induced by MOT plan restrictions on a time-of-day (TOD) basis. The nature of the MOT plans also dictated a need for the ability to explicitly analyze truck and passenger vehicle volumes separately. Some MOT scenarios may vary by TOD, and MOT plans could differ for trucks (e.g. potential truck prohibitions during peak hours) as compared with passenger vehicles. The project area also has communities with EJ populations (low-income and minority) adjacent to the Sherman Minton Bridge on both sides of the Ohio River. The EJ evaluation requires an ability to track trips originating from traffic analysis zones (TAZs) contained in EJ communities. Based on these analysis requirements, the following components were added to or modified in the KIPDA model to create the SMRP TDM:

- Time-of-Day (TOD) – The KIPDA model is a daily model. Using the KIPDA trip tables as a base, disaggregated trip tables by time of day were created for the SMRP TDM in order to carry out assignment by AM, PM, Midday, and Nighttime periods. This allows for testing of MOT scenarios with closures that vary by time period.
- Trucks – Separate truck trip capabilities were added to the KIPDA model as routing of trucks was deemed to be an important consideration for the SMRP.
- EJ Trips – The SMRP model has designated “EJ” traffic analysis zones (TAZ) that correspond with the EJ communities within the study area in order to track EJ community travel patterns.
- Tolls – A dollar-based tolling component was added as the KIPDA model previously used a turn penalty to simulate tolls. This gives the team the ability to potentially test possible mitigation strategies involving toll reductions.
- “Big Data” – Streetlight origin-destination data was obtained and used to update and modify the trip tables by vehicle class and time of day.

Model Development

As with the KIPDA Model, the SMRP TDM was developed using TransCAD travel demand forecasting software. The SMRP TDM (as does the KIPDA model) covers the areas of Jefferson, Oldham and Bullitt counties in Kentucky; and, Clark and Floyd counties in Indiana. The region is divided into 1030 TAZs. This includes 984 TAZs internal to the region and 46 that represent external stations or gateways into (or out of) the region at roadways that cross the TDM boundary. Figure 1 shows the SMRP study area relative to the SMRP TDM TAZ system.

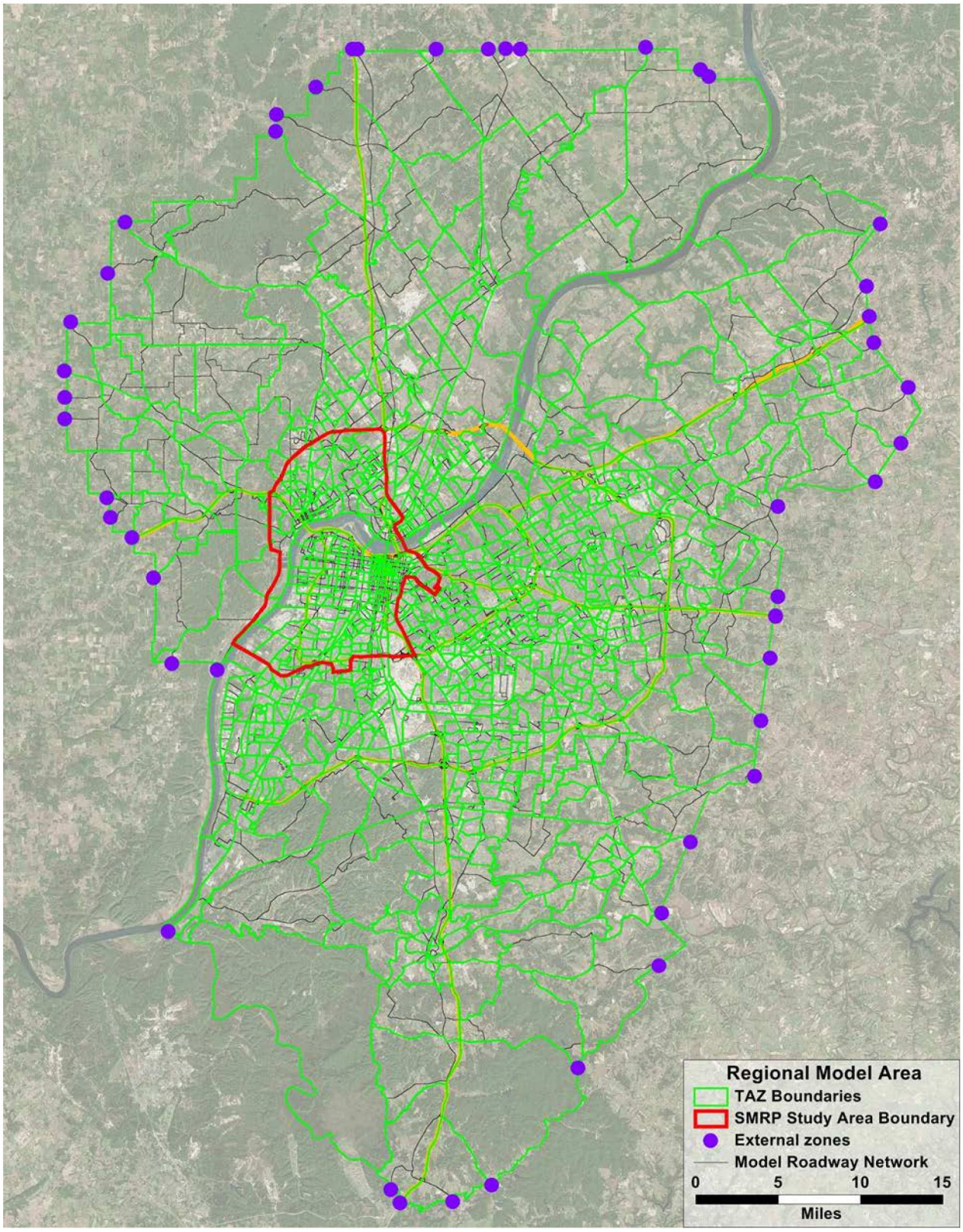


Figure 1 - Regional TAZ System

The SMRP TDM produces assignments for four time periods:

- AM Peak Period (6:00AM to 9:00AM)
- Midday Period (9:00AM to 3:00PM)
- PM Peak Period (3:00PM to 6:00PM)
- Night Period (6:00PM to 6:00AM)

Within each time period, four classes of vehicles are assigned: passenger cars, light trucks, heavy trucks and EJ trips. Although the EJ trips are also passenger cars they were treated as a separate vehicle class in order to be able to compare EJ versus Non-EJ travel patterns and the impacts of the MOT scenarios on each. The EJ trips were simply defined as passenger car trips originating from EJ TAZs within the Study Area.

The KIPDA model regional roadway network was used in the development of the SMRP TDM. Network attributes were modified to facilitate the multi-class vehicle assignments by time period. Other modifications included:

- Roadway capacities reflecting the number of hours within each time period
- Passenger car equivalents (PCEs) for trucks
- Tolls by vehicle class
- Modified volume-delay functions to be more suitable for period assignments
- Modified free-flow speeds in the area of New Albany during model validation

Several modeling parameters were included in the TDM to enhance the model's ability to predict changes in travel patterns for the individual vehicle classes. These parameters reflect the perceived and actual costs of making a trip and allow for calculating changes in total user costs associated with the MOT options. The parameters include Value-of-time (VOT), Vehicle operating cost (VOC) and toll cost. Travel time is monetized by assuming a value of time per minute and is distinct for each vehicle class. Similarly, distance is monetized by assuming a vehicle operating cost per mile. The VOC is also distinct between passenger cars, light trucks and heavy trucks. Tolls are applied to a specific trip when the trip uses a tolled bridge crossing.

The passenger car VOTs were chosen to be representative of the regional median income. Using the Consumer price index (CPI), 2016 American Community Survey data was adjusted to determine the 2018 median regional income of $56,901 ($27.36 per hour). Research indicates that a VOT as a percentage of a driver wage rate can vary between 35%-120% depending on the trip type and purpose.[1] Similarly, a reasonable VOT for trucks can also be wide ranging depending on the driver's wage rate and the type of freight being transported.[2] These observed ranges in VOT allowed for adjustments to be made to the applied values during model validation.

The passenger car VOC was based on data reported from the American Automobile Association.[3] These costs include fuel, maintenance, repair and tires. For truck VOC, the American Transportation Research Institute survey data reports an average marginal cost per mile for all trips.[4] The VOC was only used in calculating user costs and not within the TDM for trip assignment.

The toll costs for each vehicle class were determined from data supplied by Riverlink. Toll rates varied for each vehicle class depending on the source and method of payment as shown in Figure 2. The composite toll rates for each vehicle class along with the modeled VOT and VOC are reported in Table 1.

[1] White, Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis, US Department of Transportation memo, September 27, 2016, Table 2.
[2] An Analysis of the Operational Costs of Trucking, American Transportation Research Institute, October, 2018, Page 7.
[3] Your Driving Costs, AAA, 2018 edition.
[4] An Analysis of the Operational Costs of Trucking, American Transportation Research Institute, October, 2018, Table 8.

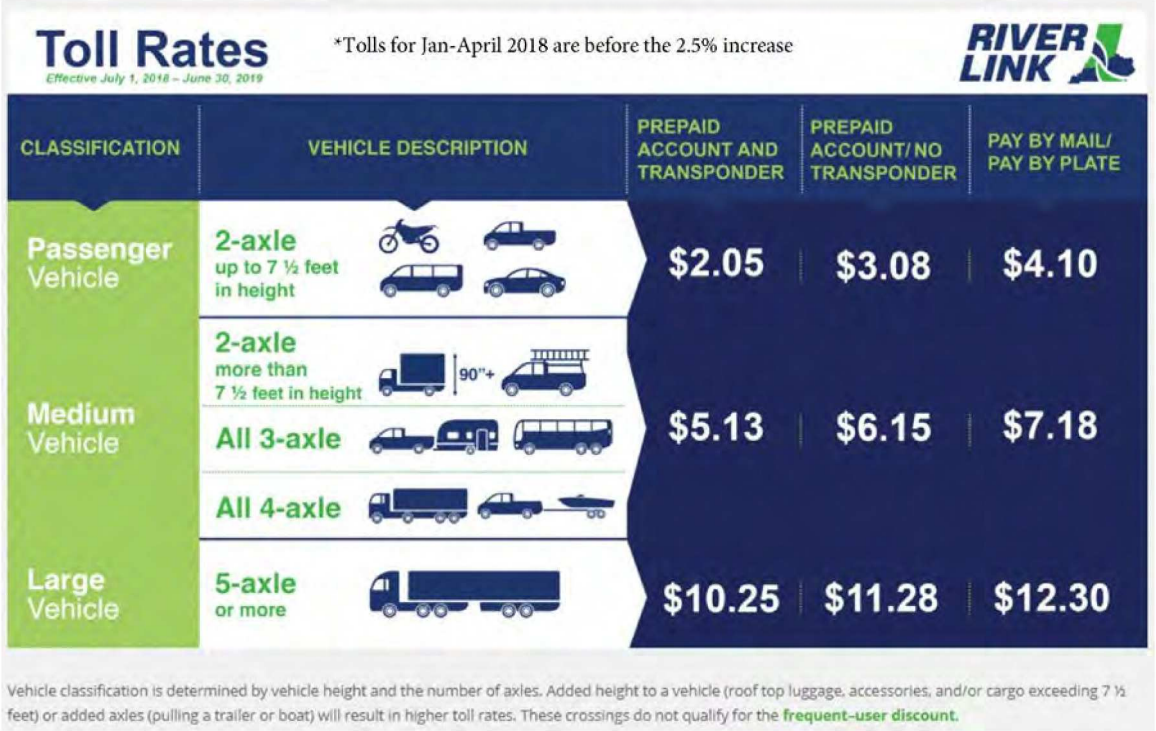


Figure 2 - RiverLink Toll Rates

Table 1 - User Cost Parameter Values

PARAMETER	CARS		TRUCKS	
	EJ	NON-EJ	LIGHT	HEAVY
Operating Cost ($/mile)	$ 0.22	$ 0.22	$ 0.52	$ 0.75
Value of Time ($/minute)	$ 0.3292	$ 0.3873	$ 0.6317	$ 1.1026
% of Median Income	72%	85%	NA	NA
Toll Cost ($)	$ 2.67	$ 2.67	$ 5.40	$ 10.26

Estimating TOD trip tables by vehicle class was a critical component of the SMRP TDM development. The SMRP trip tables were developed using three primary data sources:

- KIPDA Model daily trip tables
- Regional traffic counts
- StreetLight origin-destination travel pattern data

The SMRP TDM trip tables were developed in two segments, interstate trips and intrastate trips. Interstate trips were defined as trips that require an Ohio River crossing utilizing one of the four bridges available within the region. Intrastate trips are those trips with both a trip's origin and destination on one side of the river, either both ends in Indiana or both ends in Kentucky. Although regional trip making as a whole is important to the traffic analysis, cross river trips will be the most effected by the MOT options. As such, significant efforts were focused on the accurate estimation of river crossing trips.

Streetlight travel pattern data was based on 117 districts (an aggregation of the 1030 KIPDA TAZs). These districts are shown in Figure 3. Consistent with available traffic counts, Streetlight data reflected travel patterns in early 2018 for Tuesday through Thursday for each hour of the day. This time period was used to match the time period of the 2018 *Louisville-Southern Indiana Ohio River Bridges Project Post Construction Traffic Monitoring Study*. The StreetLight data includes records for each district-to-district pair with an index value of the relative flows for both cars and trucks. Additionally, the data was extracted with the ability to indicate which of the four bridges were used for interstate trips.

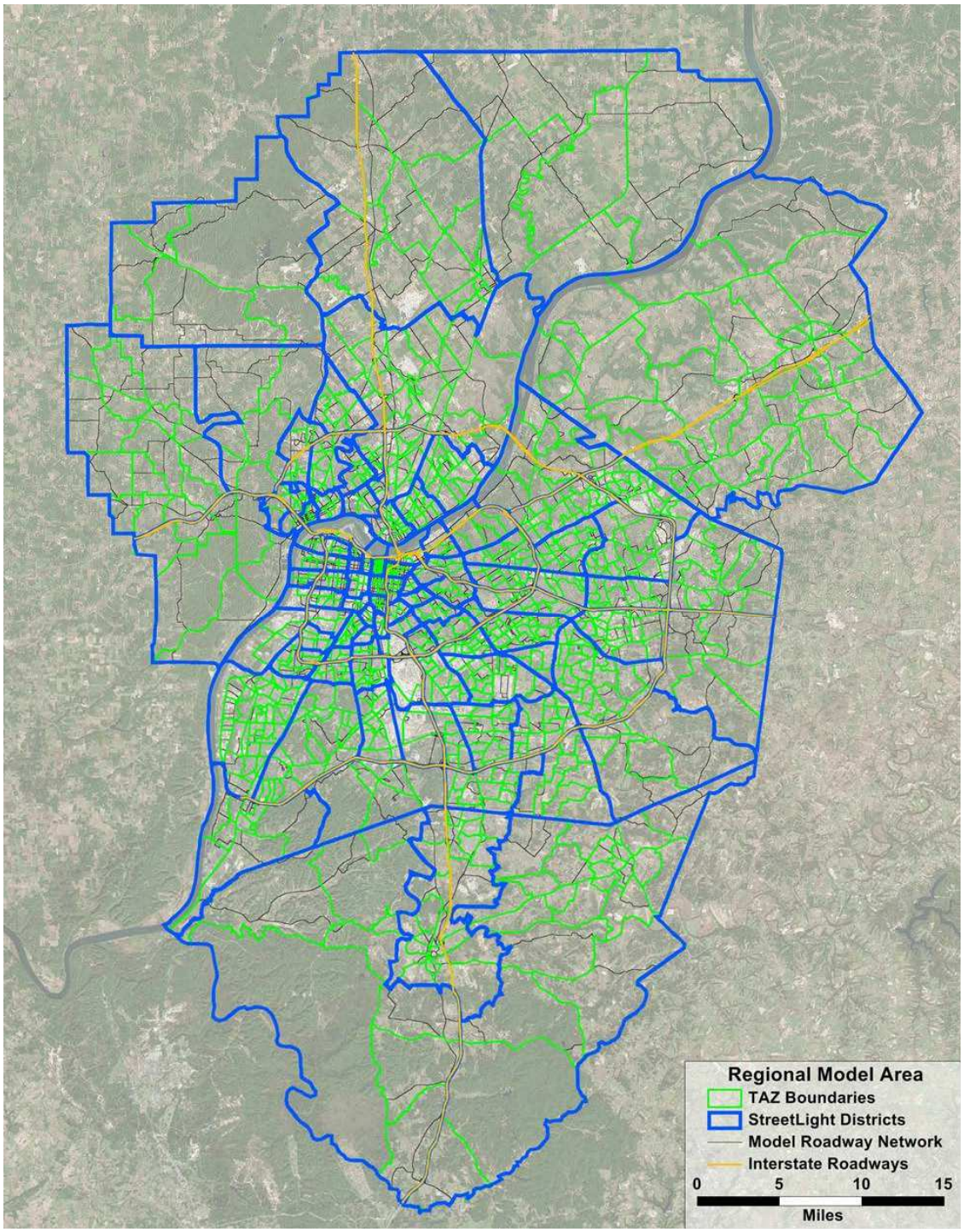


Figure 3 - StreetLight District System

Converting the Streetlight district-level trip patterns to TAZ- based trip tables required a multistep process. First the interstate (bridge crossing) trip index values were expanded to match the bridge traffic counts by time of day, by bridge, and by direction for cars and then for trucks. The expansion of the district-to-district trip index values generates the estimated district-to-district trips. These district-to-district trips were then distributed (disaggregated) to the KIPDA TAZs based on the KIPDA daily trips for each TAZ within a Streetlight district.

The intrastate (non-bridge crossing) trips were developed in two parts. First the Internal-to-Internal (I-I) index trips were expanded to the daily KIPDA estimated I-I trip totals. During model validation the processing of these I-I trip was modified such that the origin-destination (O-D) patterns were also sourced from the KIPDA trip tables. The Streetlight data was used to allocate these trips by time period. An estimate of truck percentages was made roughly based on vehicle classification counts for non-interstate roadways.

The intrastate (non-bridge crossing) Internal-to-External (I-E), External-to-Internal (E-I) and External-to-External (E-E) trip index values were expanded to daily external station traffic count targets by vehicle classification. The traffic count targets were set after processing the interstate (bridge crossing) external trip ends. As needed, the district-to-district trips were then distributed (disaggregated) to the KIPDA TAZs based on the KIPDA daily trips for each TAZ within a Streetlight district.

Model Validation

The TDM was validated primarily against a comprehensive set of traffic counts collected in 2018 in the study area as part of the LSIORB Post-Construction Monitoring commitment and recent counts obtained from KYTC, INDOT, and Louisville Metro. These counts were also used as a basis for the traffic operations analyses. The highest priority was given to matching the river crossing traffic counts for each of the four bridges by time-of-day and by vehicle class. Validation at the regional level focused on the daily estimates produced by the TDM across all vehicle types. The validation process consisted of a series of 44 travel model adjustment iterations applied in order to improve the comparison of TDM estimates as compared totraffic counts. An array of model parameter and network adjustments were investigated and adopted during validation. As listed below, some adjustments are related only to improving the multi- class time-of-day estimates,while others were designed to improve the daily estimates:

- Volume-delay relationships. Ultimately used the relationships[5] from the Louisville-Southern Indiana Ohio River Bridges project model.
- Removed time penalty from Clark Memorial Bridge (US-31)
- Value-of-time (VOT) parameters. Examined the values within “reasonable” ranges to achieve better balance between tolled and non-tolled bridges by vehicle class.
- Modified facility type, capacities, and volume-delay parameters on Clark Memorial Bridge (US-31) to reflect signal optimization into and out of downtown during peak directions of travel.
- Examined impact of including operating cost in assignment – determined not to include.
- General review of peak period roadway capacities.
- Changed number of lanes on Spring Street southbound on-ramp to I-64 to reflect ramp merge with mainline from a single lane.
- The interstate bridge crossing trip tables were rescaled to so that the assignment results better matched traffic count targets
- Limited adjustments to composite toll rates to reflect potential for different driver mix in how the tolls are paid (transponder, no transponder, mail) by time-of-day and direction and to more closely match bridge crossing targets.

[5] Bureau of Public Roads volume-delay equations by facility type.

- Lowered capacity of the Sherman Minton Bridge (I-64) to reflect difference from other interstate roadway segments that provide full lateral clearance.
- Reduced arterial free-flow speeds in the area of New Albany

Validation Results

As previously stated, validation of the TDM primarily relied on the comparison of estimated volumes to traffic counts (observed volumes); with the most detailed comparisons applied to the four river bridge crossings (Sherman Minton I-64, Clark Memorial US-31, Kennedy/Lincoln I-65 and East End (Lewis & Clark) I-265). The following tables present the river crossing and regional validation results as percentage difference (%Diff) by river crossing, percent root mean square error (%RMSE) by volume group, and by facility type.

Table 2 below shows the accuracy of TDM estimates for vehicular movements using the river bridges by time-of- day, and by vehicle type. This is where model accuracy is expected to be at its highest as the project focus is on forecasting volumes on the bridges under MOT plan options. FHWA guidelines indicate that daily expected accuracy for combined vehicle types, for major roadway facilities (such as freeways) should be within +/- 7%. These tables show that any given bridge, on a daily basis for all vehicle types, validates within +/- 3%. Even when examining a particular time-of- day and vehicle type combination for an individual bridge, most validate within +/- 7% except for some relatively low- volume combinations. Given this reasoning, the TDM validates well to observed river crossing volumes.

Table 2 - Validation of Bridge Crossings by Time-of-Day Sherman-Minton Bridge I-64

Period	Cars			Light Trucks			Heavy Trucks			TOTAL		
	Model	Count	Diff	Model	Count	Diff	Model	Count	Diff	Model	Count	Diff
AM Peak	15,778	15,402	2.4%	339	333	1.7%	1,045	988	5.7%	17,161	16,723	2.6%
Midday	19,281	19,128	0.8%	683	678	0.8%	2,926	2,898	1.0%	22,890	22,704	0.8%
PM Peak	19,267	18,579	3.7%	265	253	4.7%	1,317	1,204	9.4%	20,849	20,036	4.1%
Night	18,272	18,135	0.8%	278	278	0.1%	2,217	2,187	1.4%	20,767	20,600	0.8%
Daily	72,598	71,244	1.9%	1,565	1,542	1.5%	7,504	7,277	3.1%	81,668	80,063	2.0%

Clark Memorial Bridge US-31

Period	Cars			Light Trucks			Heavy Trucks			TOTAL		
	Model	Count	Diff	Model	Count	Diff	Model	Count	Diff	Model	Count	Diff
AM Peak	7,281	7,056	3.2%	124	99	25.7%	0	0	0.0%	7,405	7,155	3.5%
Midday	12,301	12,131	1.4%	350	350	0.0%	0	0	0.0%	12,651	12,481	1.4%
PM Peak	8,710	9,344	-6.8%	68	102	-33.0%	0	0	0.0%	8,778	9,446	-7.1%
Night	11,075	10,906	1.5%	115	112	2.8%	0	0	0.0%	11,190	11,018	1.6%
Daily	39,366	39,437	-0.2%	658	663	-0.8%	0	0	0.0%	40,024	40,100	-0.2%

Kennedy/Lincoln Bridge I-65

Period	Cars			Light Trucks			Heavy Trucks			TOTAL		
	Model	Count	Diff	Model	Count	Diff	Model	Count	Diff	Model	Count	Diff
AM Peak	8,359	9,009	-7.2%	289	329	-12.2%	1,482	1,550	-4.4%	10,130	10,888	-7.0%
Midday	12,962	13,314	-2.6%	813	823	-1.2%	4,401	4,427	-0.6%	18,176	18,564	-2.1%
PM Peak	11,429	11,436	-0.1%	385	364	5.7%	1,844	1,948	-5.3%	13,657	13,748	-0.7%
Night	9,262	9,583	-3.4%	394	399	-1.2%	3,942	3,973	-0.8%	13,598	13,955	-2.6%
Daily	42,011	43,342	-3.1%	1,881	1,915	-1.8%	11,669	11,898	-1.9%	55,562	57,155	-2.8%

Lewis and Clark – East End Bridge I-265

Period	Cars			Light Trucks			Heavy Trucks			TOTAL		
	Model	Count	Diff	Model	Count	Diff	Model	Count	Diff	Model	Count	Diff
AM Peak	4,294	4,245	1.2%	149	140	6.5%	656	645	1.7%	5,099	5,030	1.4%
Midday	4,761	4,732	0.6%	236	232	1.8%	1,305	1,306	-0.1%	6,302	6,270	0.5%
PM Peak	5,024	5,070	-0.9%	87	86	1.1%	474	483	-1.9%	5,584	5,639	-1.0%
Night	4,022	4,006	0.4%	120	119	1.1%	1,059	1,058	0.1%	5,201	5,183	0.3%
Daily	18,101	18,053	0.3%	592	577	2.7%	3,494	3,492	0.0%	22,187	22,122	0.3%

Table 3 and Table 4 below indicate how well the TDM validates regionally compared with traffic counts using root mean square error and the percentage difference (%Diff). The smaller the values of root mean square error and volume-to-count ratio, the better the model estimates match the traffic counts. These tables also compare the TDM estimates versus FHWA recommended accuracy for regional travel models. In the case of root mean square error, FHWA guidance cites guidelines from Ohio DOT and Florida DOT shown here to demonstrate the range of expected accuracy. In Table 3

comparisons by volume range and Table 4 comparisons by facility type, the SMRP model generally falls within recommended accuracy and validates well considering this model is a "project-focused" model whose accuracy, by design, is greatest for vehicular movements using the river bridges.

Table 3 - Daily Model Validation by Volume Group

Roadway Volume Range	Number of Records	Root Mean Square Error (%)		
		SMRP Model	ODOT Guidelines[1]	FDOT Guidelines[2]
0 – 1,000	39	129.4	127	174
1,000 – 2,500	32	112.7	75	97
2,500 – 5,000	59	63.0	54	69
5,000 – 10,000	121	47.2	40	50
10,000 – 25,000	150	36.8	28	34
25,000 – 50,000	109	19.2	20	24
50,000 +	30	17.2	15	17
All	540	31.6		

1 - Ohio: Giaimo, Gregory, Travel Demand Forecasting Manual 1–Traffic Assignment Procedures; cited in "Travel Model Validation and Reasonableness Checking Manual", 2nd Edition; September 2010, Federal Highway Administration.

2 - Florida: FSUTMS-Cube Framework Phase II, Model Calibration and Validation Standards: Model Validation Guidelines and Standards; cited in "Travel Model Validation and Reasonableness Checking Manual", 2nd Edition; September 2010, Federal Highway Administration.

Table 4 - Daily Model Validation by Facility Type

Facility Type	Number of Records	Volume-to-Count Ratio (%Diff)	
		SMRP Model	FHWA Guidelines[3]
Interstate & CD Roads	144	5.0	6 - 7
Divided Arterials	60	13.2	7 – 15
Undivided Arterials	86	7.6	10 - 15
Collectors	32	-4.0	15 – 25
One-Way Roads	32	-12.1	None
Ramps	94	-15.6	None
External Stations	92	0.3	None
All	540	3.0	2 - 5

3 – ranges based on absolute deviation guidelines for several DOTs cited in "Travel Model Validation and Reasonableness Checking Manual", 2nd Edition; September 2010, Federal Highway Administration.

In addition to comparisons with observed volumes, validation included comparisons of model estimated vs. "observed" travel times for multiple combinations of origin and destination locations in the region. The "observed" travel times were reported by Google Maps. Figure 4 below shows the locations of origins and destinations.

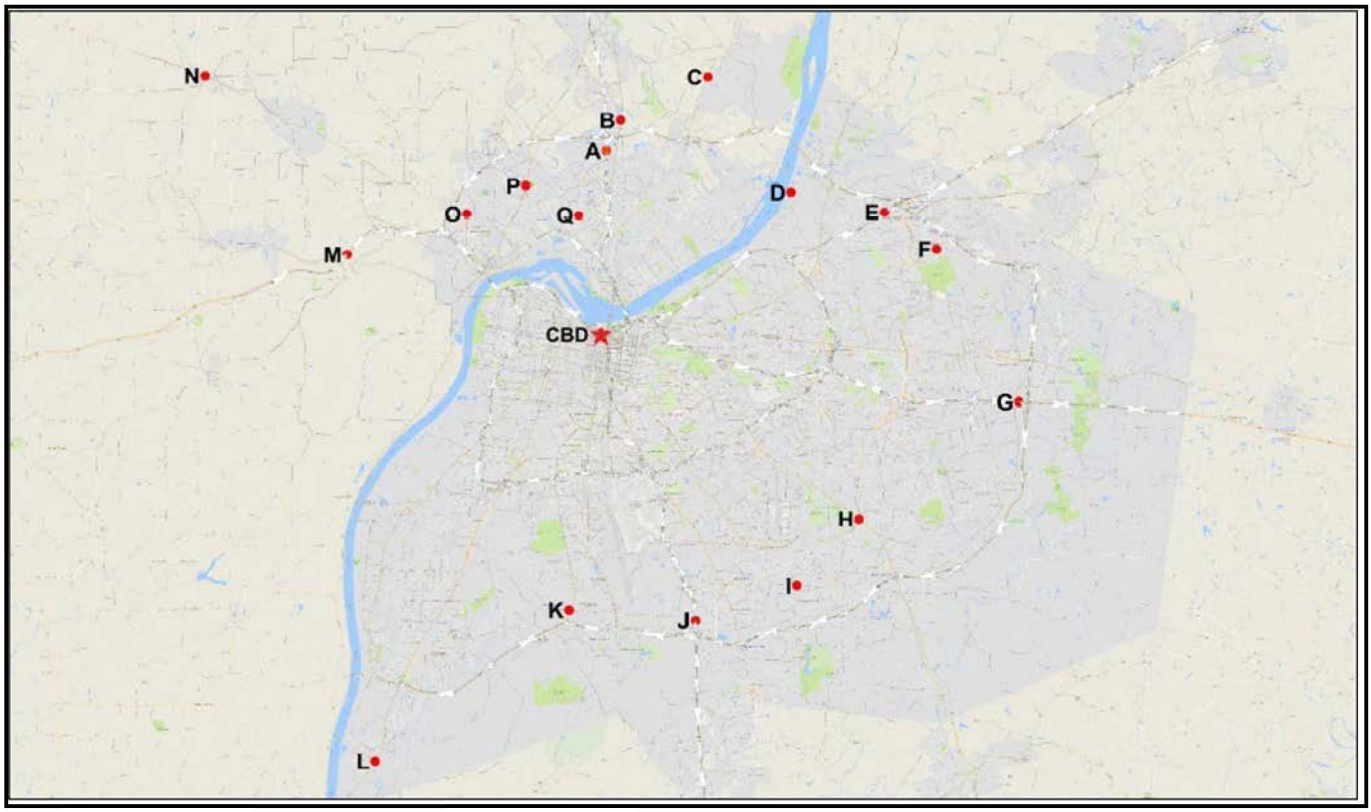


Figure 4 - Travel Time Validation, Selected Locations

Point-to-point travel times estimated by the TDM where compared with travel times reported by Google Maps. Travel times where examined by time-of-day for three (3) groups of travel paths: "To Downtown" (CBD), Interstate (IN-KY), and Intrastate (IN-IN and KY-KY). Google Maps departure time assumptions where as follows:

- AM Peak Period – 7:30 AM
- Midday Period – 12:00 PM
- PM Peak Period – 5:00 PM
- Evening/Night Period – 2:00 AM

Google Maps reports a travel time range. Analysis indicates there is generally a stronger correlation of the TDM estimated travel times to the "low" end of the Google Map times range. The scatter diagrams in Figure 5 below generally confirm this conclusion for all origin and destination travel paths as noted by the relatively high R2 values. As estimated and observed values are closer to match, the R2 values increase approaching 1.0 (indicating a perfect match). This is understandable if the higher values of the sampled Google travel times are generated by non-recurring congestion. However, the frequency distribution of the Google-reported times is not known. Perhaps more importantly, the Model estimates are (loosely) an average within the periods and therefore do not reflect "peak of the peak period" conditions whereas the Google times may.

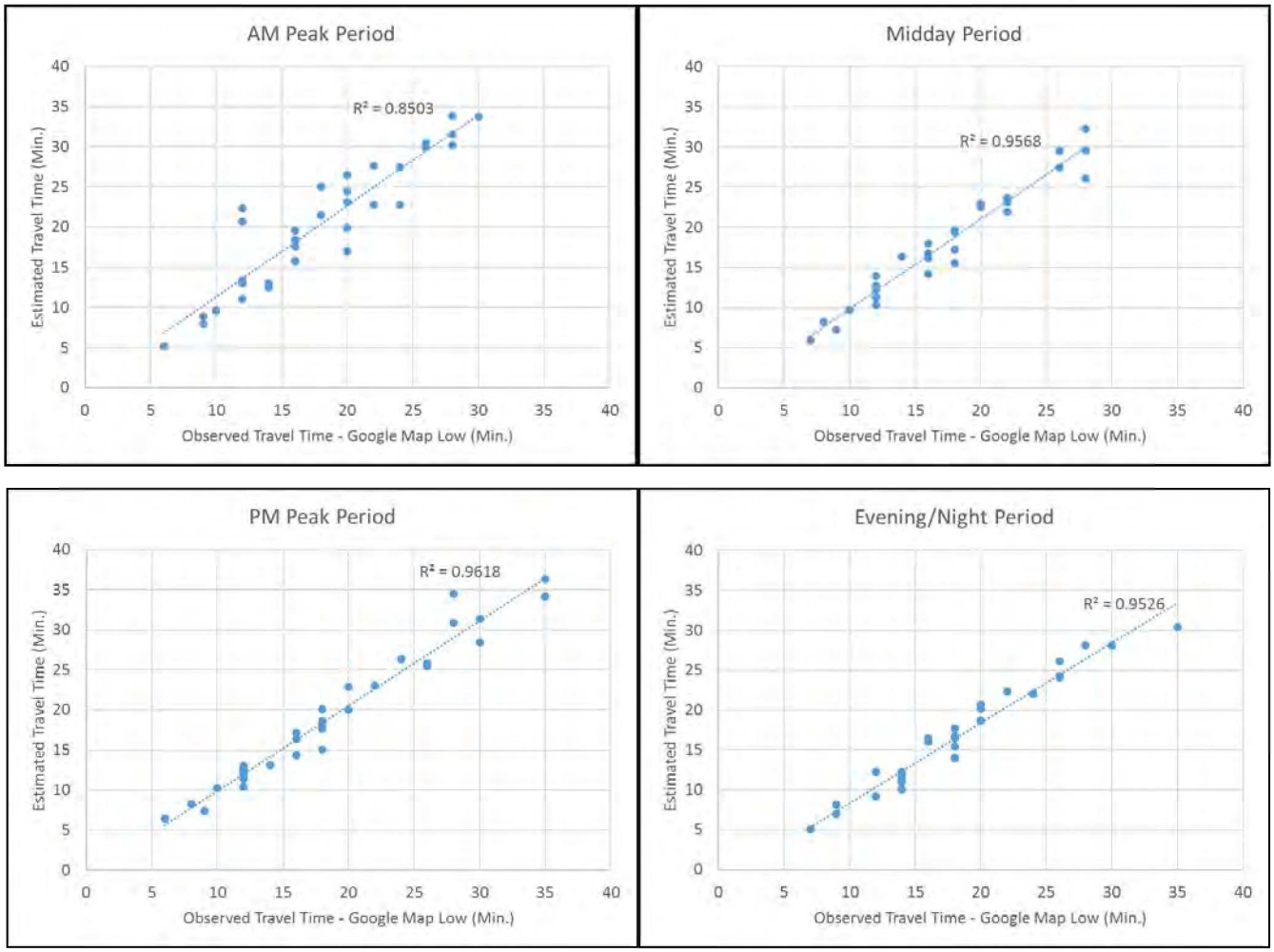


Figure 5 - Travel Time Validation, Observed Versus Estimated Travel Times

1.2 SMRP TDM APPLICATION

The TDM assumes that the modified KIPDA trip tables are fixed in order to evenly compare MOT options. The total number of daily bridge crossings is also assumed to be fixed. The SMRP model performs traffic assignments based on the modified roadway network, per MOT option. The options analysis assessed possible diversion through local communities, changes in user costs (travel time + tolls + trip distance), congestion on the I-64 corridor, and possible bottleneck locations in the highway network due to changes in travel patterns under each MOT option. Each of the six MOT scenarios were modeled and run using the TDM to produce link volumes, travel time, travel distance, and bridge usage estimates. The link volumes represent an equilibrium condition for a "typical" day occurring several weeks into the MOT phase when drivers have settled into an adjusted route. The link volumes and other measures for each scenario were compared to the link volumes for the base network to determine changes in travel patterns and identify probable diversion routes.

Appendix A – TDM Selection Memo

Sherman Minton Renewal Project (SMRP) Memo

Date: October 4, 2018

Subject: Maintenance of Traffic Analysis – Selection of Travel Demand Model

Attendees:

Name	Affiliation	Email Address	Present?
Mary Jo Hamman	MBI – Project Manager	MHamman@mbakerintl.com	X
William Thomas	MBI – Senior Traffic Advisor	BThomas@mbakerintl.com	X
David Adams	PTG – Traffic Engineering	david.j.adams@parsons.com	X
Craig Moore	PTG – Traffic Lead	Craig.Moore@parsons.com	X
Toby Randolph	PTG – MOT Lead	Tobias.Randolph@parsons.com	X

INTRODUCTION

The Indiana Department of Transportation (INDOT) and Kentucky Transportation Cabinet (KYTC) propose to rehabilitate the I-64 Sherman Minton Bridge and its associated approaches. The rehabilitation process includes a maintenance of traffic (MOT) plan. The MOT plan will balance the need to accommodate cross-river travel in the area with the need to provide a safe and adequate working space for the bridge maintenance and construction activities. The scope for this project includes development of a NEPA document, anticipated to be an INDOT Categorical Exclusion (CE) Level 4, and procurement documents for a Design-Build/Best Value rehabilitation contract. Phase I work for this project includes the analysis of different MOT strategies, ranging from peak-hour lane closures to full bridge closures, as well as analyzing the resulting traffic diversion and delay on roadways in the Sherman Minton Bridge area of influence.

SELECTION OF THE TRAVEL DEMAND MODEL

A regional travel demand model will inform the evaluation of the effects of specific MOT strategies on the area roadway network. One of the first steps for this evaluation, is the determination of the most appropriate travel model to use from a pool of several candidate models.

CANDIDATE MODELS

The three models, briefly described below, were considered as candidates for use.

KIPDA (Kentuckiana Regional Planning and Development Agency) Model

KIPDA, as the Louisville region's metropolitan planning organization (MPO), maintains a regional model as a tool for providing analyses supporting their metropolitan planning process. This includes the development of a long-range transportation plan. The KIPDA Model is a traditional four-step daily travel

model using the TransCAD development platform. KIPDA recently updated the model to utilize a 2015 base year[1]. In addition, the recent update provides 2020 and 2025 model sets that will provide useful data for this project. The model update also includes new socio-economic data by traffic analysis zone (TAZ) that went through a stringent vetting and review process. The model update was completed in July of 2018.

Louisville-Southern Indiana Ohio River Bridges Project Model (LSIORBP Model)

The LSIORBP Model is a time-of-day (TOD) model developed in TransCAD by a consultant to INDOT and KYTC to assess alternatives as part of the Louisville-Southern Indiana Ohio River Bridges Project (LSIORBP) Supplemental Final Environmental Impact Statement. It has a base-year of 2007 and a forecast year of 2030. The LSIORBP Model was developed primarily to assess changes in travel patterns (including diversion) based on the project's proposal for new river crossings, a redesigned downtown Louisville interchange of I-65, I-64 and I-71, and the introduction of tolling on the new bridges. The ORB Model stratifies passenger vehicle trips by household income and treats passenger vehicles, light trucks, and heavy trucks separately. The model accounts for tolling by representing toll values and values-of-time differently for passenger vehicles (by household income) and truck type.

Traffic and Revenue Study Model

A traffic assignment model was developed by a consultant to INDOT and KYTC to estimate traffic and revenue forecasts for different tolling scenarios associated with new bridge crossings. The model uses the Cube/Voyager development platform. The model has a base year of 2012 and forecast years of 2018, 2023, and 2030. Trip matrices, highway networks, and network attribute files were provided to the SMRP Team, but the actual model is considered proprietary and is not available for use on the project. Therefore, this model in its entirety was not further considered for use in this project.

MODEL SELECTION

The Technical Procurement Advisor (TPA) consultant contract for the SMRP was awarded to Michael Baker International (MBI) in the spring of 2018 with Notice to Proceed issued in August of 2018. The SMRP Team (Team) met with KIPDA on August 15, 2018 to discuss the current state of the KIPDA Model. KIPDA staff confirmed that the model update was complete and already in use on other projects in the region. KIPDA then provided the model to the Team to consider its applicability and use on the SMRP.

Upon review of the KIPDA and LSIORBP models, the Team has concluded that the best path forward for this project is to use the updated KIPDA Model as a starting point for development of a SMRP model.

The KIPDA Model has gone through KIPDA's review process and vetting as the accepted model for the MPO's work. The KIPDA Model has updated socio-economic data for the 2015 base year as well as 2020

[1] The previous version of the KIPDA model featured a 2007 base year.

and 2025 scenarios. KIPDA has also updated the roadway network for the 2015, 2020 and 2025 scenarios. One of the goals of the Team is to obtain concurrence with the modeling methodology from INDOT and KYTC. Using the KIDPA model helps achieve this also with the local MPO and provides a level of comfort with INDOT and KYTC, who use the KIPDA model forecasts in their planning activities.

The LSIORBP Model has a dated base year (2007), before the beginning of the Great Recession (2008), which strongly affected travel behavior. Updating the model to reflect present behavior will require at least several adjustments: an update of socio-economic data and the transportation networks. While the updated socio-economic data and networks from the KIPDA Model could be used as a basis for the updating the LSIORBP Model, reducing the amount of work necessary for updating the networks; differing TAZ structures between the two models will make this process challenging. As cited above, the age of the LSIORBP Model base year may also present a need to update trip generation rates, recalibrate trip distribution, and mode choice components. The recent KIPDA Model update included an update of these components. Also, the LSIORBP Model is not endorsed by KIPDA for studies moving forward. Based on the accelerated schedule of the project and the more contemporary nature of the updated KIPDA Model, the SMRP Team suggests that an update of the LSIORBP Model is not the best option for this project.

The SMRP Team has had extensive discussions regarding the data output needed from the model to satisfy the requirements for the NEPA documentation, environmental justice (EJ) evaluation, and the traffic operations analyses that will be instrumental in drafting the procurement documents for the project. Specifically, for the EJ analysis, the scope indicates a need to measure travel pattern changes induced by MOT plan restrictions on a TOD basis; tracking trips originating from TAZs contained in EJ impact areas[2]. The MOT hot spot analysis also needs traffic volumes on a TOD basis. Moreover, the nature of potential MOT plans dictates a need for TOD data and the ability to explicitly analyze truck and passenger vehicle volumes separately. Some MOT scenarios may vary by TOD, and MOT plans will likely differ for trucks (e.g. truck prohibitions during peak hours) as compared with passenger vehicles. This led to the conclusion that modifications to the KIPDA Model will be required to meet the goals of the project and data needs of the analyses specified by the scope[3]. The modifications will enable the KIPDA Model to estimate passenger vehicle and truck volumes separately, and by TOD. The section below provides a more detailed discussion of these modifications. Note that the proposed modifications address the disadvantages of using the KIPDA model listed in Table 1.

Conclusion

While both the KIPDA and LSIORBP models require modifications/updates for use on this project, it is the opinion of the SMRP Team that the KIPDA Model modifications require less time. The Team

[2] Defined using race and income data from the 2012 – 2016 American Community Survey.
[3] SMRP: Scope of Work/Methodology Discussion for TDM, EJ, CIA, and Section 106 Analysis.

recommends the use of the KIPDA Model as the basis for the SMRP Model. The KIPDA Model, once modified, will become the SMRP Model.

NEXT STEPS

The SMRP Model (Modifying the KIPDA Model)

A modified KIPDA Model will serve as the SMRP Model for use in forecasting changes in travel patterns and volumes in response to MOT plans in effect during the rehabilitation of the Sherman Minton Bridge.

A general description of these modifications follows:

- Updating the KIPDA Model base year to 2018. The SMRP scope specifies this modification. It will consist of modifying transportation networks from the 2020 model set to reflect 2018 conditions. Therefore, this network will reflect the reconstruction of the I-65 crossing and approaches, a new Downtown Bridge constructed east of the existing Kennedy Bridge, and the new Lewis and Clark Bridge over the Ohio River. Modifications will also consist of updating the socioeconomic data. This update will entail interpolating population, household, and employment between KIPDA 2015 land use and the 2020 forecast to reflect 2018 land use activity, while verifying the timing of any major development planned between 2015 and 2020 and adjusting interpolated values accordingly. Year 2018 daily vehicle trip tables produced with this updated information will serve as input to the next modification step.

- Develop TOD Trip Tables and Networks. This modification will focus on the Year 2018 daily vehicle trip tables and roadway network. Information from several data sources will inform the SMRP Team in disaggregating, or factoring, the daily vehicle trip tables into peak and off-peak periods. The periods will consist of an AM peak, midday, PM peak, and evening/night periods. The diurnal distribution of travel demand from available traffic count[4] and GPS/LBS[5] data will inform the definition of the time periods. The GPS/LBS data, and information already obtained from the Traffic and Revenue Study Model, will help to determine the apportioning of trips to their various time periods. The Team will also develop roadway networks reflecting traffic operations, available routes, and capacities reflective of the time-of-day.

- Develop TOD Trip Assignment Component. The Team will modify the daily trip assignment component used in the KIPDA Model to reflect a trip assignment for each TOD period. The trip assignment will reflect use of the appropriate TOD trip tables and networks. A summary procedure will combine TOD volume estimates to daily values. Using available count data, the Team will validate the daily estimated volumes to within tolerances in accordance with KIPDA

[4] 2018 hourly traffic counts from the *LSIORB Project Post-Construction Traffic Monitoring Study*.
[5] Global positioning system and location-based services associated with mobile devices. Described further in the section below.

standards. The Team will examine the accuracy of TOD estimated volumes compared to count data as well but given data and schedule constraints may not be able to attain as accurate a validation for TOD compared to daily.

- Develop a capability to differentiate truck trips. Depending on time available after the implementation of the TOD component, differentiating truck trips from all traffic will entail either 1) splitting the TOD vehicle trip tables into separate passenger vehicle and truck trip tables to be subsequently assigned simultaneously to the TOD networks, or by 2) post-processing model output for combined vehicle types to yield separate passenger vehicle and truck volumes. Either option will rely on truck trip data obtained from GPS/LBS data and recent ground counts. Under option 1, the Team plans further modification of the trip assignment component to explicitly incorporate toll values and values-of-time separately for passenger vehicles and trucks – refining the way the KIPDA model accounts for the reaction of travelers to tolls. Using available count data, the project Team will validate resulting model estimates of passenger and truck volumes to the extent possible. Under option 2, accounting for changes in truck routing due to MOT plans will involve a manual re-assignment of truck trips based on data cited above. This will require manually differentiating a traffic assignment for combined vehicle types into passenger vehicles and trucks.

GPS/LBS Data

The SMRP Team proposes to purchase GPS/LBS data or "big data" to further examine regional travel patterns for cross-river trips in support of the SMRP Model. In this context, the "big data" represent a comprehensive, anonymous collection of movement patterns indicated by GPS navigational and smart devices, for which advanced pattern recognition algorithms produce insights into movement patterns. This "observed" source of trip pattern data will help inform the SMRP Team about any needed adjustments to the trip tables produced by the SMRP Model—particularly cross-river trips including the Sherman Minton Bridge.

Two "big data" vendors, AirSage and StreetLight, were considered. The SMRP Team has familiarity with both data vendors through past project work. While each has their strengths and weaknesses (relative to each other), the SMRP Team recommends StreetLight for this project. The primary differentiator is the StreetLight data product is more cost- and time-effective at leveraging the many different types of data needed for the project, given the budget for data acquisition and the project timeline. These data include separate volume and travel patterns of personal and commercial vehicles. In addition, StreetLight's "InSight" graphical, internet-based interface allows users to experiment with different time periods (hours of the day), time intervals (months and years), and analysis zone structures (origins, destinations, and screenlines) to formulate the necessary database to meet project needs before purchase. Upon confirming the parameters of the data purchase, the interface quickly compiles the information in formats compatible with widely used GIS platforms and the KIPDA Model.

Table 1 – Comparison of Available Travel Models

Model	Advantages	Disadvantages
KIPDA	• Vetted by KIPDA as the accepted model for the MPO's work. • Updated socio-economic data roadway networks for the 2015 base year as well as 2020 and 2025 scenarios. • Socio-economic data and geographic aggregation consistent with data used in EJ community identification. • Tolls accounted for in both trip distribution and assignment steps in the model.	• No provision for time-of-day estimates, model only produces daily demand estimates. • Passenger vehicles and trucks are not modeled separately. • Tolls are represented by time penalties based on a static Year 2030 vehicle mix that determines toll values and values-of-time.
LSIORBP	• Model was previously used to support NEPA analysis for the LSIORBP and was created using input from key stakeholders. • Provides for time-of-day estimates. • Stratifies passenger vehicle trips by household income. • Models passenger vehicles, light trucks, and heavy trucks separately. • Explicitly represents toll values accounting for different values-of-time associated with passenger vehicles (by household income) and truck types.	• Base year socio-economic data and networks represent 2007 conditions and travel behavior.