

ENVIRONMENTAL ASSESSMENT APPENDIX J: PERMANENT TRAFFIC IMPACTS

Indiana Division
August 12, 2019

Mr. Dan McCoy
Indiana Department of Transportation
Director of Traffic Engineering
100 N Senate Ave. Room N955
Indianapolis, IN 46204
Dear Mr. McCoy:
The Federal Highway Administration has reviewed the Interstate Access Document (IAD) for modification of the existing I-65/I-70 "North Split" Interchange in the City of Indianapolis, dated July 17, 2019. Modifications will eliminate weaves and improve bridge and pavement conditions. We find the proposed modifications acceptable based on safety, operations and engineering considerations.

An Environmental Assessment is being prepared for this project with a final environmental determination expected in fall/winter of 2020 . Once the environmental determination has been signed, final approval of this access modification may be given provided that the scope and design of the proposed project is consistent with the IAD.

This approval is subject to reevaluation if significant changes occur in the final design or if construction is delayed as specified in 23 CFR 771.219.

Should you have any further questions regarding this matter, please contact Ms. Eryn Fletcher, Senior Transportation Engineer, at (317) 226-7489.

Sincerely,


Mayela Sosa
Division Administrator

# I-65/I-70 North Split Project 

Indianapolis, Indiana
Des. Nos. 1592385 and 1600808

## TRAFFIC TECHNICAL MEMORANDUM

February 11, 2020

ANORTH SPLIT
UPGRADES
DRIVING PROGRESS

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$\uparrow$ NORTH SPLIT upgrades
driving progress

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## 1 INTRODUCTION

This technical memorandum summarizes the permanent traffic impacts associated with the proposed reconstruction of the I-65/I-70 North Split interchange in downtown Indianapolis. This document is prepared in support of the Environmental Assessment (EA) for the project. The EA is being developed to meet the requirements of the National Environmental Policy Act of 1969 (NEPA). NEPA requires Federal agencies to prepare an environmental analysis for projects that may significantly affect the environment. The Federal Highway Administration (FHWA) has determined an EA is the appropriate level of analysis for this project. The final step in the NEPA process, following the release of a draft EA and a public hearing would be the issuance of a Finding of No Significant Impact (FONSI) or the determination an Environmental Impact Statement (EIS) is required by FHWA.

A preliminary preferred alternative was identified in the North Split Alternatives Screening Report ${ }^{1}$ published in September 2018. After a series of public and stakeholder meetings and opportunity for public comment, the configuration of the interchange was refined early in 2019. Traffic impacts are determined by comparing traffic conditions with the refined preliminary preferred alternative (preferred alternative) compared to the No Build Alternative in the design year 2041. The analysis includes the connecting interstate system as well as non-project roadways such as downtown streets adjacent to and connecting with the North Split.
In accordance with Federal requirements, INDOT submitted a draft Interstate Access Document (IAD) to FHWA identifying changes to the interstate highway system with the preferred alternative. FHWA issued a Determination of Operational and Engineering Acceptability on August 12, 2019. Final IAD approval will not be granted until completion of the NEPA process since any changes would need to be fully accounted for in the IAD.

### 1.1 Level of Service

Level of Service (LOS) is a common way of describing the degree of traffic congestion on roadways, using "grades" on a letter scale from LOS A (best) to LOS F (worst). LOS relates to operations, not the physical condition of the roadway. The various levels of service on interstate highways are characterized as follows:

- LOS A - free flow operation;
- LOS B - ability to maneuver easily, minor incidents easily absorbed;
- LOS C - near free flow speeds, freedom to maneuver, queues only form behind significant interruptions;
- LOS D - speeds decline, freedom to maneuver restricted, queues form behind even minor incidents;
- LOS E - operation near or at capacity, no useable gaps in traffic stream, operations very volatile; and
- LOS F - demand exceeds capacity, breakdown in flow, queuing.

LOS is not just a function of total traffic volume. The geometrics of a roadway, operational conditions, and traffic control can all affect LOS. For example, freeway LOS can be affected by vehicles crossing paths (weaving) to enter or exit ramp junctions. Operations through weaving sections are a function of the number of crossing vehicles and the distance available to accomplish the movement. Intersection LOS on local streets is affected by traffic volume, turning movements, signal timing, and the number of available lanes.
Per the INDOT Design Manual, LOS B is desirable and LOS D is minimum for urban freeway reconstruction. Deviations sometimes occur due to the restrictive environment of urban areas. While not desirable, LOS E and or LOS F may be accepted for short periods on existing facilities based on trade-offs related to cost or impacts.

### 1.2 Methodology

The North Split traffic simulation model was used to estimate future traffic conditions for build and no-build scenarios. The North Split traffic simulation model is a derivative of the Indianapolis Metropolitan Planning Organization (MPO) nine-county TransCAD travel demand model. Refinements were made to MPO model network

[^0]and zones in the study area to support the development of a more detailed TransModeler traffic simulation model for use in a smaller traffic study area. Traffic modeling used in this analysis was coordinated with Indianapolis MPO staff and reviewed and approved by FHWA.
The North Split traffic study area is approximately six miles by six miles. As shown in Figure 1, it is roughly bounded by the White River to the west, $38^{\text {th }}$ Street to the north, Emerson Avenue to the east, and Raymond Street to the south. The traffic simulation model for 2041 includes proposed roadway improvements in the Indianapolis MPO Long Range Transportation Plan and future IndyGo transit projects. Origin-destination trip information is forecasted based on population and employment estimates provided by the Indianapolis MPO.

To review overall system efficiency, traffic conditions were analyzed at a system level in terms of total vehicle miles of travel and total vehicle hours of travel for all peak hour trips in the study area. Traffic conditions on individual facilities were analyzed using common traffic engineering tools: Highway Capacity Software (HCS) for interstates and Synchro software for intersections and street segments. Both tools provide measures of peak hour LOS for the preferred alternative and the No Build Alternative.

Figure 1: Traffic Study Area


Changes in permanent travel patterns were analyzed for the North Split Project based on the following parameters:

- All analyses were conducted for peak period conditions. The morning peak hour is from 8:15 AM to 9:15 AM and the afternoon peak hour is from 5:30 PM to 6:30 PM. The peak hours represent worst case conditions with respect to traffic impacts.
- AM and PM peak conditions for the preferred alternative for the year 2041 were analyzed and compared to the 2041 No Build Alternative.
- Only traffic changes in the traffic study area were considered in this analysis. Traffic changes outside of the traffic study area are anticipated to be minor.

Traffic safety analysis was conducted for this project using the crash prediction module of the Interactive Highway Safety Design Model (IHSDM) software. The IHSDM module uses information about roadway type, traffic volumes, and geometric features to predict the number of crashes that will occur on an existing or planned roadway facility. The IHSDM analysis for the preferred alternative was used to predict the percent reduction in crashes in the year 2041 on roadways constructed as part of this project, including the freeway mainline, ramps, and interchanges.

### 1.3 Project Purpose and Need

This is the first project to completely reconstruct the North Split interchange since it opened in 1976. Most of the bridges in the project area are at the end of their useful life and the pavement is in poor condition. Complete replacement of the bridges and pavement also provides the opportunity to improve safety and traffic operations. These priorities are reflected in the project purpose and need, shown below:

PURPOSE: The purpose of the I-65/l-70 North Split project is to rehabilitate and improve the existing interstate facilities leading to and through the I-65/I-70 North Split interchange in downtown Indianapolis.
NEEDS: The I-65/I-70 North Split project must meet the following transportation needs:

- Correct deteriorated bridge conditions. The proposed project is intended to correct deteriorated I-65/I70 North Split bridge conditions within the I-65/l-70 North Split project area.
- Correct deteriorated pavement conditions. The proposed project is intended to correct the deteriorated pavement conditions on the interstates within the I-65/I-70 North Split project area.
- Improve safety. The proposed project is intended to improve safety by reducing or eliminating conditions that contribute to crashes along I-65 and I-70.
- Improve interchange operations and reduce congestion. The proposed project is intended to improve operations in the I-65/I-70 North Split project area by removing weaving sections and improving level of service now and in 2041.


## 2 EXISTING TRAFFIC OPERATIONS

Congestion and queuing currently occur on each leg of the North Split in the AM and PM peak periods. Some congestion and queuing can be attributed to poor traffic operational performance at adjacent interchanges such as the South Split. This includes the "big weave" between the South Split and the North Split, which causes turbulence due to the large volume of traffic crossing paths to stay on I-65 or I-70 through this section. Most congestion in the North Split, however, is caused by weaving movements and bottlenecks in the interchange itself.

Two major weaving areas are located on the west leg of the North Split. A northbound I-65 weave occurs at the Meridian/Pennsylvania Street exit ramp and a southbound I-65 weave occurs at the Meridian/Delaware Street entrance ramp. Because of these weaving areas, it is common for interstate traffic to form queues up to two miles long on westbound $\mathrm{I}-70$ in the morning and on southbound $\mathrm{I}-65$ in the afternoon.
These two weaving areas also have the highest crash rates in the North Split project area. Other high crash locations are the I-65/I-70 southbound merge area and the I-70 eastbound curve from south leg to east leg of the interchange. Removing the weaves and improving conditions at the other high crash areas will provide major safety benefits, while eliminating the chief cause of delay and congestion in the interchange.

### 2.1 Existing Freeway Level of Service

Highway Capacity Software (HCS) was used to analyze mainline, merge, diverge, and weave segments for the AM and PM peak periods. The results are reported in terms of LOS and density. LOS values A through F are described in Section 1.1. LOS D is a typical minimum INDOT design goal for urban freeway reconstruction. At LOS E, the freeway is operating near capacity, with frequent delays. Demand exceeds capacity at LOS F, resulting in stop and go traffic conditions and queuing upstream.

Density is measured in passenger cars per mile per lane. LOS values coincide with differing density thresholds. For instance, for a mainline segment with a $55-\mathrm{mph}$ free flow speed, the maximum densities are 11 (LOS A), 18 (LOS B), 26 (LOS C), 35 (LOS D), and 45 (LOS E). Traffic flow is unstable at LOS F, making density measures unreliable.

Density provides additional information to be able to compare roadway segments with the same LOS and to determine how close a roadway segment is to having a better or worse LOS.

Table 1 shows the computed LOS and estimated traffic density for the existing interchange area based on 2017 conditions. As shown in Table 1, three segments (interstate, system ramp, or collector-distributor (C-D) road) within the project area currently operate at LOS F and five segments operate at LOS E during the AM peak. In the PM peak, six segments operate at LOS E.

Table 1: Existing Interstate Levels of Service and Traffic Density

| Freeway Segment |  |  | Number of Lanes | AM Peak |  | PM Peak |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | LOS | Density | LOS | Density |
| East Leg l-70 |  |  |  |  |  |  |  |
| Main Line | EB | I-70 inside North Split |  | 3 | D | 27.4 | E | 41.7 |
|  |  | North Split to Rural | 5 | C | 20.9 | D | 33.3 |
|  | WB | Rural-Keystone to North Split | 5 | E | 38.5 | D | 27.2 |
|  |  | I-70 WB and SB C-D Split | 3 | F | NA | E | 37.6 |
|  |  | I-70 WB to I-65 NB | 2 | E | 35.5 | C | 23.0 |
|  |  | I-70 WB inside North Split | 2 | F | NA | E | 38.9 |
|  |  | I-70 WB to SB C-D | 2 | D | 32.0 | B | 17.2 |
| West Leg l-65 |  |  |  |  |  |  |  |
| Main Line | NB | I-65 NB to I-70 Merge | 2 | E | 43.9 | D | 30.5 |
|  |  | I-65/70 Merge to Alabama | 4 | E | 35.6 | C | 23.9 |
|  |  | I-65 NB Alabama to West | 3 | D | 34.9 | D | 28.5 |
| Weave | NB | I-65/70 merge to Pennsylvania Exit | 4 | F | NA | C | 24.4 |
| Main Line | SB | I-65 SB West to Alabama | 3 | D | 28.9 | D | 29.9 |
|  |  | I-65 SB Alabama to SB C-D Split | 4 | C | 26.0 | D | 30.8 |
|  |  | I-65 SB Alabama to I-70 EB Ramp Split | 4 | C | 19.9 | D | 28.0 |
| Weave | SB | Delaware Entrance to I-65/70 | 4 | C | 27.1 | E | 35.7 |
| Main Line |  | I-70 EB Ramp | 2 | C | 25.4 | E | 39.1 |
|  |  | I-65 SB to I-70 WB Merge | 2 | C | 19.1 | C | 20.6 |
| South Leg, Mainline I-65/70 |  |  |  |  |  |  |  |
| Main <br> Line | SB | I-65/I-70 Merge to Washington | 3 | D | 34.2 | D | 33.3 |
|  | NB | Washington to l-65/70 Split | 4 | D | 30.3 | D | 27.7 |
|  |  | I-70 EB I-65/70 Split to Pine | 2 | D | 29.9 | E | 38.1 |
|  |  | I-65 NB I-65/70 Split to Pine | 2 | D | 29.5 | B | 17.9 |
| South Leg, C-D Road |  |  |  |  |  |  |  |
| Main Line | SB | C-D I-65/70 Merge to Davidson | 3 | D | 32.9 | B | 17.7 |
|  |  | C-D Davidson to Ohio | 2 | E | 36.1 | C | 21.0 |
| Weave | SB | I-65/70 Merge to Davidson | 3 | D | 33.4 | B | 16.2 |

### 2.2 Traffic Safety

The project team analyzed crashes in the project area between 2012 and $2016 .{ }^{2}$ The analysis included crashes on mainline I-65 and I-70, the westbound I-70 to southbound I-65 C-D road, and the directional ramps in the North Split interchange. Figure 2 illustrates the breakdown of crashes in the study area by type. The primary type of crash was "rear-end" with 775 crash events, representing $47 \%$ percent of all crashes. "Sideswipe" was the second-most predominant crash type with 465 crash events, representing $28 \%$ of all crashes. The proposed project is intended to improve safety by reducing or eliminating conditions that result in crashes for traffic using I-65 and I-70.
Crash rates per 100 million vehicle miles traveled (100 MVMT) for fatality, injury, and property damage crashes in the North Split are shown in Table 2. Crashes on ramps between the interstates and local roadways are not included to allow comparison between the North Split and urban interstates statewide The North Split crash rate is higher in all categories than crash rates experienced on other urban interstates in Indiana. Property damage crashes were about 2.3 times higher, and injury crashes were 2.8 times higher in the North Split. High crash rates per vehicle miles traveled indicate conditions other than high traffic volumes are contributing to the large number of crashes.

Figure 2: Five-Year Crash Summary (2012-2016)


Four areas accounted for approximately $30 \%$ of the total crashes in the project area between 2012 and 2016. These areas are shown in Figure 3 and are listed below:

1. I-65 northbound at Meridian/Pennsylvania Street exit ramp, west leg of North Split
2. I-65 southbound at Meridian/Delaware Street entrance ramp, west leg of North Split
3. I-65 southbound and I-70 westbound merge point on south leg of North Split
4. I-70 eastbound, abrupt curve from south leg to east leg of North Split

[^1]

Table 2: North Split to Statewide Crash Rate Comparison (2012-2016)
$\left.\begin{array}{|c|c|c|c|}\hline \text { Crash Severity } & \begin{array}{c}\text { 5-year Statewide Urban } \\ \text { Interstate Crash Rate per } \\ \mathbf{1 0 0} \mathbf{M V M T}^{1}\end{array} & \begin{array}{c}\text { 5-year North Split } \\ \text { Crash Rate per 100 } \\ \text { MVMT }\end{array} & \begin{array}{c}\text { North Split Crash Rate } \\ \text { vs }\end{array} \\ \hline \text { Satality } & 0.39 & 0.72 & \text { Statewide Crash Rate }\end{array}\right]$

1. Source: INDOT Office of Traffic Safety

Figure 3: High Crash Locations


The largest number of crashes in the North Split project area are on the west leg of the interchange, in the weaving areas of the Meridian/Pennsylvania Street exit ramp ${ }^{3}$ and the Meridian/Delaware Street entrance ramp. ${ }^{4}$ The most frequent crash type at the Meridian/Pennsylvania Street exit ramp is rear-end, followed by sideswipe. The most frequent crash type at the Meridian/Delaware Street entrance ramp is sideswipe, followed by rear-end.
In addition to creating the highest crash locations in the North Split interchange, the weaving areas of the of the Meridian/Pennsylvania Street exit ramp and the Meridian/Delaware Street entrance ramp are the greatest cause of existing traffic congestion. These weaving areas are described in the next section.

[^2]
### 2.3 North Split Weaving Areas

As shown in Figure 4, I-65 traffic exiting at Meridian/Pennsylvania Street must cross all I-70 traffic coming from the east through the interchange area past the exit. The I-65 northbound traffic must shift two lanes across I-70 traffic in a space of 1,575 feet to reach the exit. As I-70 traffic crosses I-65 exiting traffic, it loses a lane at the right side due to a lane drop at the Meridian/Pennsylvania Street exit ramp. These conflicts are further compounded by the large volume of I-70 traffic that quickly moves left to access the exit at West Street a short distance downstream.

Figure 4: Meridian/Pennsylvania Street Weave


I-65 traffic from the south must cross one lane and merge with a second lane to exit at Meridian/Pennsylvania Street.
As shown in Figure 5, traffic entering from Meridian and Delaware Street must cross all southbound I-65 traffic to continue onto I-70 eastbound. Vehicles making this movement cross one lane and merge into a second lane in a space of 1,875 feet. To exit at the C-D road that serves Ohio Street, New York Street, and Fletcher Avenue, I-65 traffic must move right into the lane where vehicles are entering from the Meridian/Delaware Street ramp. These conflicts are compounded by traffic entering I-65 southbound on the left at West Street that must cross two lanes to access the C-D road or to continue on I-65 southbound at the North Split.

Figure 5: Meridian/Delaware Street Weave


Traffic from Meridian and Delaware Streets to I-70 must cross one lane of I-65 and merge with a second lane to proceed on I-70. Traffic from Meridian and Delaware Streets to I-65 must cross traffic exiting from I-65 to the Collector-Distributer (C-D) road to downtown exits.

In addition to the two ramp weave areas described above, the crossing movement required for traffic passing from the South Split to the North Split on I-65 or I-70, is referred to as the "big weave" by INDOT staff. I-65 northbound traffic leaves the South Split on the right side and enters the North Split on the left side. I-70 eastbound traffic enters this section on the left side and leaves on the right side, which requires motorists to cross paths. This weave is longer ( 1.4 miles) than the weaves on the l-65 ramps, but the number of weaving vehicles is higher.

## 3 PREFERRED ALTERNATIVE TRAFFIC CHANGES

The preferred alternative (the "build alternative") is shown in Figure 6. Traffic operations changes in the preferred alternative are designed to address the high crash rates and improve the bottlenecks described in the previous section. The curvature is straightened on several ramp connections and merge areas are improved, but the greatest operational change is the elimination of the weaving areas at the Meridian/Pennsylvania Street exit ramp and the Meridian/Delaware Street entrance ramp.
Three options were considered for eliminating the two weaving areas without adding through lanes. These were identified as Alternatives 4a, 4b, and 4 c in the Alternatives Screening Report. The options presented trade-offs between movements served and the width of the project footprint on the west leg of the interchange.
After a series of public and stakeholder meetings and a public comment period, Alternative 4c was identified as the preliminary preferred alternative since it would eliminate the weaving areas and minimize the need to widen the interstate section. The weaving movements would be eliminated by allowing entry or exit only at the adjacent interstate lane. Concrete barrier walls would be installed to prohibit movements that would require vehicles to cross paths.
Two existing interchange movements would be eliminated in the preferred alternative. I-70 traffic from the east would no longer be able to exit at Meridian/Pennsylvania Street. Traffic entering at Delaware Street would no longer be able to access the C-D road, which serves Michigan Street, Ohio Street, Fletcher Avenue, and I-65 south. The effects of these changes are described below.

### 3.1 Elimination of Westbound I-70 Exit to Meridian/Pennsylvania Streets

Figure 7 illustrates the elimination of the westbound I-70 to Meridian/Pennsylvania Street exit ramp in red. Alternate downtown access points for westbound I-70 are shown in blue. The estimated volumes of traffic diverted to alternate routes are shown for the AM and PM peak periods in 2041.

The existing weave at the Meridian/Pennsylvania Street exit ramp could have been eliminated by closing access from either westbound I-70 or northbound I-65. The 2041 traffic simulation model estimates approximately 1,720 vehicles would use this exit ramp during the AM peak in the No Build Alternative, with approximately 890 vehicles ( $52 \%$ ) coming from westbound I-70 and approximately 830 vehicles ( $48 \%$ ) coming from northbound I-65. With traffic demand nearly evenly split, the decision to eliminate the westbound l-70 exit movement was based on the following:

- Access to Meridian/Pennsylvania Street is more critical for northbound I-65 because westbound I-70 has more options for accessing downtown streets from the north and from the east. Westbound I-70 can utilize the southbound C-D road to access North Street, Michigan Street, Ohio Street, and Fletcher Avenue, as well as East Street. Northbound I-65 access to downtown in this area is limited to Washington Street.
- Existing traffic counts are unlikely to fully reflect the desire of northbound motorists to exit at Meridian/Pennsylvania Street because of the existing weaving movement.
- The 2041 traffic simulation model estimates that 1,750 vehicles from westbound $\mathrm{I}-70$ would use the West Street exit ramp during the AM peak in the No Build Alternative, compared to only 140 vehicles from northbound I-65. With the existing left side exit to West Street, traffic flow and safety would be improved if vehicles from westbound I-70 were on the left side (inside) as they leave the North Split toward West Street.
- NORTH SPLIT $\rightarrow$ UPGRADES DRVING PROGBESS

Figure 6: Preferred Alternative


Figure 7: Expected Traffic Redistribution for Westbound I-70 to Meridian/Pennsylvania Street


### 3.2 Elimination of Delaware Street Entrance to the Collector-Distributor Road

The existing weave at the Meridian/Delaware Street entrance ramp is eliminated in the preferred alternative by removing the connection of this ramp to the southbound C-D road, including southbound I-65, and providing a direct ramp to eastbound I-70. Providing an unimpeded connection to eastbound I-70 in lieu of serving the southbound C-D road is the clear choice for the following reasons:

- Most traffic entering from the Meridian/Delaware Street ramp is accessing eastbound I-70. The 2041 traffic simulation model estimates approximately 1,765 vehicles would make this movement during the PM peak hour and 522 vehicles would make this movement during the AM peak hour.
- The connection from the Meridian/Delaware Street ramp to the C-D road and southbound I-65 is an indirect movement (going north to go south) and would be used by a much smaller number of motorists, approximately 140 vehicles in the PM peak and 240 vehicles in the AM peak according to the 2041 traffic simulation model.
- Nearly $100 \%$ of the vehicles from the Meridian/Delaware Street entrance ramp would be weaving across the southbound C-D road traffic to access southbound I-65, and not downtown Indianapolis. These motorists are leaving downtown, while the southbound C-D road motorists are entering downtown.

Traffic diversion for motorists that would have used the Meridian/Delaware Street entrance ramp to go south would be relatively small and the local roadway network can provide access to other interchanges. Figure 8 shows the eliminated movement in red and the most likely diversion routes in blue.

The existing Meridian Street interchange with I-65 is a spread diamond with access to Illinois Street, Meridian Street, Pennsylvania Street, and Delaware Street. Eliminating the southbound I-65 connection will create a partial interchange, which is typically avoided by FHWA since some motorists are unable to reenter at the same location. In this case, it is unlikely a motorist would exit at this location to purchase fuel, and then unexpectedly not be able to gain re-entry. Nevertheless, wayfinding signage will be provided to indicate the routes shown in blue in Figure
8. FHWA approved the use of a partial interchange in a Determination of Engineering and Operational Acceptability.

## 4 PREFERRED ALTERNATIVE TRAFFIC OPERATIONS

This section describes the anticipated traffic operations of the preferred alternative compared to the No Build Alternative during 2041 peak periods. Operations are described in terms of system-level performance, traffic safety, anticipated traffic queuing (back-ups), interstate LOS, and adjacent intersection LOS.

### 4.1 System-Level Performance

System-level performance measures are used to review the performance of the interstates and local roadways as an integrated transportation network. The system is represented by the 6-mile by 6-mile traffic study area of the traffic simulation model shown in Figure 1. System-level performance is measured in terms of total vehicle miles of travel (VMT), total vehicle hours of travel (VHT), and total delay for all roadways in the system.

VMT is a measure of trip length. One vehicle traveling one mile constitutes one vehicle-mile. Similarly, VHT is a measure of trip time. One vehicle traveling one hour constitutes one vehicle-hour. Delay, measured in hours, is the difference between a vehicle's time to complete a trip in a congested condition versus a free-flow condition. Freeflow represents the speed a vehicle would travel if there was no congestion on the roadway. The traffic simulation model delay calculation also includes additional time waiting at congested traffic signals. System-level performance measures for the No Build Alternative and the preferred alternative are summarized in Table 3.

Figure 8: Elimination of Meridian/Delaware Street Access to Southbound I-65/C-D


Table 3: 2041 System-Level Performance Measures

| Peak Hour | Performance Measure | No Build Alternative | Preferred Alternative |
| :---: | :---: | :---: | :---: |
| AM <br> 8:15 to 9:15 | VMT (miles) | 382,571 | 380,256 |
|  | VHT (hours) | 70,531 | 60,953 |
|  | Delay (hours) | 31,669 | 25,253 |
|  | VMT (miles) | 416,541 | 414,461 |
|  | VHT (hours) | Delay (hours) | 87,125 |

As shown in Table 3, all performance measures would be improved with the implementation of the preferred alternative. The lower VMT estimate indicates that trips would be shorter and more direct. Reductions in VHT and delay are even more pronounced during both peak periods, indicating a marked improvement in travel times resulting from the improvements to the North Split.

### 4.2 Traffic Safety Analysis

The IHSDM analysis for the preferred alternative was used to predict total number of crashes in the year 2041 on roadways constructed as part of this project, including the freeway mainline, ramps, and interchanges. The analysis of the No Build Alternative was used to predict the total year 2041 crashes within the same study area. Based on these estimates, Table 4 shows the predicted reductions in crash frequency at each of the top four crash locations in the interchange. Safety improvements at the top four crash locations are specifically called for in performance measures identified in the North Split Project purpose and need.

Table 4: Predicted 2041 North Split Crash Reduction at Top Four Locations

| Crash Location | Percent Crash Frequency Reduction |
| :--- | :---: |
| \#1 - NB I-65 at Meridian/Pennsylvania exit weave | $21 \%$ |
| \#2 - SB I-65 at Meridian/Delaware entrance weave | $21 \%$ |
| \#3 - SB I-65 and WB I-70 merge and 4-lane to 3-lane drop | $3 \%$ |
| \#4 - EB I-70 reduced speed curve in the North Split | $10 \%$ |

As shown in Table 4, crash rates at the top two crash locations (northbound I-65 weave at the Meridian/ Pennsylvania Street exit and southbound I-65 weave at the Meridian/Delaware Street entrance) are predicted to be approximately $21 \%$ lower in 2041 with the preferred alternative compared to the No Build Alternative. Crash rates
at the southbound $\mathrm{I}-65 / \mathrm{I}-70$ merge are predicted to be about $3 \%$ lower and crash rates at the eastbound $\mathrm{I}-70$ curve are predicted to be about $10 \%$ lower.

### 4.3 Interstate Queuing Analysis

Queuing, the slowing or stacking of vehicles, occurs in locations where the volume of traffic exceeds the capacity of the facility at that location. The traffic simulation model was used to estimate queue lengths on the Interstates for the No Build alternative and the preferred alternative. The four-hour periods represent the complete cycle of queuing initiation, establishment, and relief.

In the No Build Alternative, the microsimulation shows queues from all directions during the 2041 AM period. These include a three-mile queue on westbound I-70 backing up almost to Emerson Avenue, a three-mile queue on southbound I-65 extending north past $30^{\text {th }}$ Street, and a two-mile queue on northbound I-65/70 extending to the South Split. For the 2041 PM peak four-hour period, the microsimulation shows a queue on southbound I-65 north past $30^{\text {th }}$ Street.

The traffic simulation model shows minimal queuing in the preferred alternative during the 2041 AM and PM periods. This demonstrates the capacity benefits of eliminating the weaving areas from the interchange area. Traffic backups are virtually eliminated even though no new through lanes are added.

### 4.4 Interstate Levels of Service

Highway Capacity Software (HCS) was used to analyze mainline, merge, diverge, and weave segments for the AM and PM peak for a No Build Alternative and for the preferred alternative. The results are reported in terms of LOS and estimated traffic density. LOS values A through F are described in Section 1.1. LOS D is a typical minimum INDOT design goal for urban freeway reconstruction, but LOS E or F may be acceptable under some conditions. One of the goals of the North Split Project is to improve interstate LOS over the no build condition at the time of opening and in the design year of 2041.
Table 5 shows LOS and estimated traffic density under current conditions (2017) and at the estimated time of project completion (2021). Table 6 shows the forecasted LOS and estimated traffic density for the No Build Alternative and the preferred alternative in 2041.

Freeway LOS coincides with differing density thresholds, measured in passenger cars per mile per lane. The density information in Table 5 and Table 6 provides the ability to compare roadway segments with the same LOS and to determine how close a roadway segment is to having a better or worse LOS.
Although there will still be segments operating below LOS D, the current LOS will be improved with the preferred alternative, as shown in Table 5. Segments operating at LOS F will drop from three to two, and segments with LOS E will drop from eleven to nine. The two LOS F locations in the preferred alternative are short segments within the north split interchange itself.

In the 2041 PM peak, the preferred alternative will have five segments with a LOS F compared with nine segments with the No Build Alternative, as shown in Table 6. A total of 15 segments will operate at LOS E with the preferred alternative in 2041, compared with 14 segments at LOS E with the No Build Alternative.

Overall, interstate LOS will be improved with the preferred alternative compared to the No Build Alternative, although some segments will still be congested, particularly in 2041. As documented in the Alternatives Screening Report, further improvements to the LOS at sections with LOS E and F would require additional through lanes in each direction. An alternative to provide these added lanes was considered in the Alternatives Screening Report, but minimal support for that alternative was expressed in the public comment period, and it was eliminated based on public opposition to the wider footprint on each leg of the interchange.

Table 5: Current/Opening Interstate Levels of Service and Traffic Density

| Freeway Segment |  |  | \# of Lanes | No Build Alternative (2017) |  |  |  | Preferred Alternative (2021) |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | AM | PM |  | AM |  | PM |  |
|  |  |  | LOS | Den. | LOS | Den. | LOS | Den. | LOS | Den. |
| East Leg 1-70 |  |  |  |  |  |  |  |  |  |  |  |
| Main <br> Line | EB | I-70 inside North Split |  | 3 | D | 27.4 | E | 41.7 | C | 24.8 | E | 37.0 |
|  |  | North Split to Rural |  | 5 | C | 20.9 | D | 33.3 | B | 17.6 | D | 28.2 |
|  | WB | Rural-Keystone to North Split | 5 | E | 38.5 | D | 27.2 | E | 38.5 | D | 27.0 |
|  |  | I-70 WB and SB C-D Split | 3 | F | NA | E | 37.6 | F | NA | D | 31.5 |
|  |  | I-70 WB to I-65 NB | 2 | E | 35.5 | C | 23.0 | D | 28.2 | C | 21.0 |
|  |  | I-70 WB inside North Split | 2 | F | NA | E | 38.9 | E | 43.6 | E | 35.7 |
|  |  | I-70 WB to SB C-D | 2 | D | 32.0 | B | 17.2 | E | 35.2 | B | 16.1 |
| West Leg I-65 |  |  |  |  |  |  |  |  |  |  |  |
| Main Line | NB | I-65 NB to I-70 Merge | 2 | E | 43.9 | D | 30.5 | NA | NA | NA | NA |
|  |  | I-65 NB to Pennsylvania Exit | 2 | NA | NA | NA | NA | F | NA | D | 31.4 |
|  |  | I-65 Pennsylvania Exit to I-70 Merge | 2 | NA | NA | NA | NA | C | 25.4 | C | 22.2 |
|  |  | I-65/70 Merge to Alabama | 4 | E | 35.6 | C | 23.9 | D | 27.2 | C | 21.8 |
|  |  | I-65 NB Alabama to West | 3 | D | 34.9 | D | 28.5 | E | 36.3 | D | 29.1 |
| Weave | NB | I-65/70 merge to Pennsylvania Exit | 4 | F | NA | C | 24.4 | NA | NA | NA | NA |
| Main Line | SB | I-65 SB West to Alabama | 3 | D | 28.9 | D | 29.9 | D | 32.0 | D | 33.0 |
|  |  | I-65 SB Alabama to SB C-D Split | 4 | C | 26.0 | D | 30.8 | NA | NA | NA | NA |
|  |  | I-65 SB Alabama to I-70 EB Ramp Split | 2 | C | 19.9 | D | 28.0 | D | 32.0 | D | 33.0 |
| Weave | SB | Delaware Entrance to I-65/70 | 4 | C | 27.1 | E | 35.7 | NA | NA | NA | NA |
| Main Line | SB | I-70 EB Ramp | 2 | C | 25.4 | E | 39.1 | B | 17.2 | C | 18.5 |
|  |  | I-65 SB to SB C-D Split | 2 | NA | NA | NA | NA | C | 25.7 | C | 20.4 |
|  |  | I-65 SB to I-70 WB Merge | 2 | C | 19.1 | C | 20.6 | B | 17.2 | C | 18.5 |
|  |  | I-65 SB to Delaware Merge | 2 | NA | NA | NA | NA | C | 21.0 | D | 27.6 |
| South Leg, Mainline I-65/70 |  |  |  |  |  |  |  |  |  |  |  |
| Main Line | SB | I-65/I-70 Merge to Washington (4-lane) | 4 | NA | NA | NA | NA | D | 26.1 | C | 25.3 |
|  |  | I-65/I-70 Merge to Washington (3-lane) | 3 | D | 34.2 | D | 33.3 | D | 34.8 | D | 33.7 |
|  | NB | Washington to l-65/70 Split | 4 | D | 30.3 | D | 27.7 | D | 30.1 | D | 27.9 |
|  |  | I-70 EB I-65/70 Split to Pine | 2 | D | 29.9 | E | 38.1 | D | 29.7 | E | 38.3 |
|  |  | I-65 NB I-65/70 Split to Pine | 2 | D | 29.5 | B | 17.9 | D | 30.5 | C | 18.3 |
|  |  | I-65 NB Pine to Meridian | 3 | NA | NA | NA | NA | C | 24.9 | B | 17.1 |
| South Leg, C-D Road |  |  |  |  |  |  |  |  |  |  |  |
| Main Line | SB | C-D I-65/70 Merge to Davidson | 3 | D | 32.9 | B | 17.7 | E | 37.8 | B | 17.2 |
|  |  | C-D Davidson to Ohio | 2 | E | 36.1 | C | 21.0 | E | 35.2 | C | 18.9 |
| Weave | SB | I-65/70 Merge to Davidson | 3 | D | 33.4 | B | 16.2 | NA | NA | NA | NA |

Table 6: 2041 Interstate Levels of Service and Traffic Density

| Freeway Segment |  |  | \# of <br> Lanes | No Build Alternative |  |  |  | Preferred Alternative |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | AM | PM |  | AM |  | PM |  |
|  |  |  | LOS | Den. | LOS | Den. | LOS | Den. | LOS | Den. |
| East Leg l-70 |  |  |  |  |  |  |  |  |  |  |  |
| Main Line | EB | I-70 EB inside North Split |  | 3 | E | 36.0 | F | NA | D | 32.2 | F | NA |
|  |  | North Split to Rural |  | 6 | C | 25.1 | F | NA | C | 21.1 | D | 34.7 |
|  | WB | Rural-Keystone to North Split | 5 | E | 42.4 | D | 29.0 | E | 42.6 | D | 28.7 |
|  |  | I-70 WB and SB C-D Split | 3 | F | NA | E | 43.1 | F | NA | E | 35.7 |
|  |  | I-70 WB to I-65 NB | 2 | E | 35.9 | C | 20.2 | D | 28.6 | C | 18.7 |
|  |  | I-70 WB inside North Split | 2 | F | NA | F | NA | F | NA | E | 43.6 |
|  |  | I-70 WB to C-D | 2 | D | 31.9 | B | 15.1 | D | 34.4 | B | 14.8 |
| West Leg l-65 |  |  |  |  |  |  |  |  |  |  |  |
| Main Line | NB | I-65 NB to I-70 Merge | 2 | F | NA | D | 34.9 | NA | NA | NA | NA |
|  |  | I-65 NB to Pennsylvania Exit | 2 | NA | NA | NA | NA | F | NA | E | 37.2 |
|  |  | I-65 Pennsylvania Exit to I-70 Merge | 2 | NA | NA | NA | NA | D | 32.2 | C | 24.7 |
|  |  | I-65/70 merge to Alabama | 4 | E | 40.1 | C | 24.3 | D | 30.7 | C | 22.0 |
|  |  | I-65 NB Alabama to West | 3 | E | 40.5 | D | 28.6 | E | 41.0 | D | 29.3 |
| Weave | NB | I-65/70 merge to Pennsylvania Exit | 4 | F | NA | C | 24.4 | NA | NA | NA | NA |
| Main <br> Line | SB | I-65 SB West to Alabama | 3 | D | 30.0 | D | 33.8 | D | 33.2 | E | 35.9 |
|  |  | I-65 SB Alabama to SB C-D Split | 4 | D | 27.2 | E | 35.6 | NA | NA | NA | NA |
|  |  | I-65 SB Alabama to I-70 EB Ramp Split | 2 | C | 20.8 | D | 31.9 | D | 33.2 | E | 35.9 |
| Weave | SB | Delaware Entrance to I-65/70 | 4 | C | 27.1 | E | 35.7 | NA | NA | NA | NA |
| Main Line | SB | I-70 EB Ramp | 2 | D | 28.6 | F | NA | C | 21.5 | D | 34.7 |
|  |  | I-65 SB to SB C-D Split | 2 | NA | NA | NA | NA | C | 24.2 | C | 22.7 |
|  |  | I-65 SB to I-70 WB Merge | 2 | B | 17.8 | C | 21.6 | B | 15.2 | C | 19.1 |
|  |  | I-65 SB to Delaware Merge | 2 | NA | NA | NA | NA | C | 23.5 | D | 28.4 |
| South Leg, Mainline I-65/70 |  |  |  |  |  |  |  |  |  |  |  |
| Main <br> Line | SB | I-65/I-70 Merge to Washington (4-lane) | 4 | NA | NA | NA | NA | D | 29.8 | D | 29.6 |
|  |  | I-65/I-70 Merge to Washington (3-lane) | 3 | E | 39.0 | D | 34.9 | E | 39.7 | E | 39.5 |
|  |  | Washington to l-65/70 Split | 4 | E | 38.5 | E | 35.9 | E | 38.9 | E | 36.5 |
|  | , | I-70 EB I-65/70 Split to Pine | 2 | E | 38.8 | F | NA | E | 38.5 | F | NA |
|  | NB | I-65 NB I-65/70 Split to Pine | 2 | E | 37.7 | C | 21.0 | E | 38.8 | C | 22.3 |
|  |  | I-65 NB Pine to Meridian | 3 | NA | NA | NA | NA | E | 30.3 | C | 19.9 |
| South Leg, C-D Road |  |  |  |  |  |  |  |  |  |  |  |
| Main |  | C-D I-65/70 Merge to Davidson | 3 | D | 32.8 | C | 19.0 | E | 37.3 | B | 17.9 |
| Line | S | C-D Davidson to Ohio | 2 | E | 36.5 | C | 20.4 | D | 34.4 | C | 18.5 |
| Weave | SB | I-65/70 Merge to Davidson | 3 | D | 33.4 | B | 17.1 | NA | NA | NA | NA |

### 4.5 Intersection Levels of Service

An analysis of forecasted 2041 traffic conditions at adjacent intersections and interstate ramp terminals was conducted for the No Build Alternative and the preferred alternative. This analysis was performed for AM and PM peak periods using Synchro, a program typically used by traffic engineers to estimate intersection LOS. Table 7 shows the forecasted LOS and estimated delay during AM and PM peak at intersections along each leg of the interchange.

Section 1.1 describes the concept of LOS and general characteristics of LOS values A through F. LOS at intersections coincides with differing delay thresholds. For instance, the upper threshold is 55 seconds for LOS D and 80 seconds for LOS E. The delay measures in Table 7 can indicate how close the LOS is to a threshold and can be used to compare intersections with the same LOS.

Traffic signal phasing plans used in the Synchro analysis were determined by field observation and assumed to be consistent throughout the day. The signal phase timings were optimized in Synchro to provide an "apples to apples" comparison of operations among the different alternatives and peak periods.

As shown in Table 7, most of the intersections analyzed would operate at an acceptable LOS of A through D during both peak periods in 2041, indicating that the downtown roadway grid efficiently moves traffic. The intersections that are shown to operate at LOS E are generally the same with the No Build Alternative and the preferred alternative. No intersection within the project area is estimated to operate at LOS F.

Overall, the similarity in intersection LOS with the No Build Alternative and the preferred alternative indicates traffic operations on local streets would not be materially different after the North Split Project. This is not unexpected since the local street system is generally the same in both alternatives, and changes to access points to and from the interstates are minimal. These access changes and their impacts are described in Section 3.

Table 7: 2041 Intersection LOS and Delay

| Intersection | No Build Alternative |  |  |  | Preferred Alternative |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | AM |  | PM |  | AM |  | PM |  |
|  | LOS | Delay | LOS | Delay | LOS | Delay | LOS | Delay |
| East Leg (I-70) |  |  |  |  |  |  |  |  |
| Keystone at 25th St | B | 20.0 | D | 47.2 | B | 19.6 | D | 49.7 |
| Keystone at Enterprise Park Place | C | 20.0 | E | 65.4 | C | 20.2 | E | 65.5 |
| Keystone at I-70 WB Ramps | B | 13.9 | B | 17.7 | B | 13.6 | C | 21.4 |
| Rural at I-70 EB Ramps | A | 4.5 | A | 5.5 | A | 4.0 | A | 5.3 |
| Rural at Bloyd Ave | A | 3.8 | A | 9.6 | A | 3.9 | A | 9.5 |
| Rural at Mass Ave | B | 17.2 | C | 21.3 | B | 17.0 | B | 19.0 |
| Emerson at I-70 WB Ramps | A | 7.9 | A | 7.4 | A | 8.5 | A | 7.5 |
| Emerson at l-70 EB Ramps | B | 10.1 | B | 11.2 | B | 10.9 | B | 13.2 |
| West Leg (1-65) |  |  |  |  |  |  |  |  |
| 16th at Illinois | C | 20.3 | C | 32.1 | C | 21.2 | C | 30.5 |
| 16th at Pennsylvania | B | 13.9 | B | 15.7 | B | 13.8 | B | 15.6 |
| 12th St at Illinois | B | 11.1 | A | 8.5 | B | 10.6 | A | 9.1 |


| Intersection | No Build Alternative |  |  |  | Preferred Alternative |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | AM |  | PM |  | AM |  | PM |  |
|  | LOS | Delay | LOS | Delay | LOS | Delay | LOS | Delay |
| 12th St at Meridian | B | 18.9 | B | 13.2 | B | 17.5 | B | 14.0 |
| 12th St at Pennsylvania | B | 18.2 | B | 11.5 | B | 15.6 | B | 11.1 |
| I-65 Off Ramps at MLK | C | 33.7 | B | 14.2 | C | 33.7 | B | 13.1 |
| 11th St at MLK | E | 59.6 | B | 19.4 | E | 59.8 | D | 41.7 |
| 11th St at West | D | 44.0 | D | 45.9 | D | 37.1 | D | 36.8 |
| 11th St at Senate | B | 11.9 | B | 11.8 | B | 11.4 | B | 12.8 |
| 11th St at Illinois | B | 10.7 | A | 7.7 | B | 11.3 | A | 8.4 |
| 11th St at Meridian | B | 13.1 | B | 18.7 | B | 13.5 | C | 21.7 |
| 11th St at Pennsylvania | B | 11.3 | B | 10.4 | B | 10.9 | B | 10.9 |
| 11th St at Delaware | A | 9.3 | C | 29.4 | A | 8.9 | D | 45.6 |
| 10th St at MLK | C | 30.7 | B | 16.4 | C | 23.2 | B | 16.9 |
| 10th St at West | D | 46.8 | D | 39.6 | D | 52.4 | D | 40.1 |
| 10th St at Illinois | B | 11.0 | C | 34.8 | B | 11.2 | D | 40.8 |
| 10th St at Pennsylvania | A | 7.0 | B | 13.8 | A | 9.5 | B | 13.1 |
| 10th St at Delaware | A | 8.9 | B | 12.7 | A | 9.0 | B | 14.3 |
| South Leg 1-65/70 |  |  |  |  |  |  |  |  |
| Michigan at College | B | 15.2 | B | 13.4 | B | 17.0 | B | 13.3 |
| Michigan at Davidson | A | 8.7 | B | 15.2 | B | 12.8 | B | 15.2 |
| Michigan at Pine | B | 13.4 | B | 15.7 | B | 14.7 | B | 15.3 |
| Michigan at Highland | B | 15.8 | B | 15.9 | B | 16.0 | B | 15.6 |
| New York at College | A | 8.9 | B | 15.8 | A | 9.2 | B | 14.5 |
| New York at Ohio | B | 10.3 | B | 12.7 | B | 10.3 | B | 11.5 |
| Ohio at East | C | 21.5 | B | 11.6 | C | 20.3 | B | 11.5 |
| Ohio at College | B | 13.9 | B | 14.1 | B | 15.3 | B | 16.1 |
| Market at College | A | 9.7 | B | 18.6 | B | 13.0 | B | 18.3 |
| Market at Davidson | A | 1.8 | A | 6.0 | A | 2.0 | A | 5.5 |
| Market at Pine | A | 8.1 | A | 7.5 | A | 8.4 | A | 7.2 |
| Washington at Pennsylvania | B | 11.7 | B | 14.0 | B | 11.6 | B | 13.4 |
| Washington at East | B | 12.9 | B | 15.3 | B | 12.7 | B | 15.1 |
| Washington at College | B | 11.5 | B | 16.8 | B | 11.1 | B | 15.6 |


| Intersection | No Build Alternative |  |  |  | Preferred Alternative |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | AM |  | PM |  | AM |  | PM |  |
|  | LOS | Delay | LOS | Delay | LOS | Delay | LOS | Delay |
| Washington at l-65/70 SB On Ramp | E | 63.0 | D | 36.8 | E | 62.4 | C | 34.5 |
| Washington at I-65/70 NB Off Ramp | B | 16.4 | B | 13.3 | B | 15.2 | B | 13.2 |
| Washington at Southeastern | E | 64.7 | B | 10.9 | D | 44.3 | B | 11.0 |
| Maryland at Pennsylvania | A | 7.7 | B | 13.5 | A | 7.6 | B | 12.8 |
| Fletcher at l-65/70 SB Off Ramp | B | 15.0 | C | 21.9 | B | 14.9 | C | 20.8 |
| Fletcher at Calvary | B | 11.0 | B | 13.0 | B | 11.3 | B | 12.0 |
| Calvary at I-65/70 NB On Ramp | A | 4.4 | A | 7.7 | A | 4.1 | A | 8.1 |


[^0]:    ${ }^{1}$ North Split Alternatives Screening Report, INDOT, September 21, 2018
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[^1]:    ${ }^{2}$ Crash data retrieved from the Automated Reporting Information Exchange System (ARIES).

[^2]:    ${ }^{3}$ This exit is signed "Meridian St, Pennsylvania St" but the first street intersected by the ramp is Pennsylvania Street. This ramp is referred to as the "Meridian/Pennsylvania Street exit ramp" throughout the remainder of this memorandum.
    ${ }^{4}$ This ramp is referred to as the "Meridian/Delaware Street entrance ramp" throughout the remainder of this memorandum.

