INTERCHANGE MODIFICATION STUDY SUM – 76 – Central Interchange PID #101402

City of Akron, Summit County, Ohio



Prepared For:

Ohio Department of Transportation District 4 2088 South Arlington Road Akron, OH 44306

Prepared By:

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Revised January 2018







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I. Executive Summary:

This Interchange Modification Study (IMS) is being prepared at the request of the Ohio Department of Transportation (ODOT). The SUM–76–Central Interchange (PID 101402) project is the first identified project to be derived from the Akron Beltway Planning Study (PID 95831). The central interchange is located in the City of Akron, Summit County, Ohio (see **Figure 1** for a project location map) and is a major systems interchange that allows motorists to access multiple major highways such as: Interstate 77 (I-77), Interstate 76 (I-76), and State Route 8 (SR-8). The central interchange also serves as a major hub for motorists to access the City of Akron and its surrounding cities and suburbs. See **Figure 2** for a map of the study area.

The purpose of this study is to determine if the proposed improvements of the SUM–76– Central Interchange (PID 101402) project will degrade the operation of the central interchange and the adjacent freeways and interchanges surrounding it and if so, what actions are required to address such degradation. The planning study identified the need to replace the left handed exit ramps of I-76 EB to SR-8 NB and I-76 WB to I-77 SB. These ramps are being replaced in advance prior to the finalization of the planning study in order to correct their sub-standard geometrics and poor physical condition. This improvement project will also eliminate the two (2) partial interchanges of Lovers Lane and Inman Street. The safety review from the planning study of the entire Akron Beltway identified the central interchange as the "worst" performing area of the Akron Beltway with 300 crashes occurring between the years of 2009 – 2011. Many of the crashes that have occurred in the central interchange area are due to capacity and congestion issues as well as sub-standard geometrics.

The Opening Year for the proposed central interchange improvement project is 2020 with the Design Year established as 2040. Capacity analysis for all basic freeway segments, ramp merge / diverge junctions, weave segments and intersections were only performed for the Design Year 2040 AM and PM peak hours. The Opening Year was not considered for analysis because the Design Year accounts for the highest amount of traffic that will utilize the central interchange, therefore all improvements will be designed for the Design Year conditions. The 'No-Build' condition represents the existing roadway configuration and operating conditions within the study area. The 'Build' condition incorporates the proposed improvements being recommended as part of this project (shown in **Figure 4**). The intersection capacity analyses for the Design Year 2040 AM and PM peak hours identifies that the study intersections are anticipated to operate with acceptable Levels-of-Service and minimal delay under both the 'No-Build' and 'Build' traffic conditions.

Based on the information and analysis in this study, the Akron Beltway Team concludes that the SUM–76–Central Interchange (PID 101402) Improvement Project will have no impact on the operation of the central interchange or adjacent interchanges that would require mitigation. Therefore, the recommended roadway improvements and interchange modifications, as detailed in this study, should be pursued.



II. Introduction and Background:

This Interchange Modification Study (IMS) is being prepared at the request of the Ohio Department of Transportation (ODOT). The SUM–76–Central Interchange (PID 101402) project is the first identified project to be derived from the Akron Beltway Planning Study (PID 95831). The purpose of the Akron Beltway Planning Study is to study and provide preliminary engineering for improvements that will optimize traffic flow throughout the Akron Beltway. The planning study identified the need to replace the left handed exit ramps of I-76 EB to SR-8 NB and I-76 WB to I-77 SB. These ramps are being replaced in advance prior to the finalization of the planning study in order to correct their sub-standard geometrics and poor physical condition. This improvement project will not only address the poor bridge conditions of the two (2) left handed exit ramps but it will also eliminate the two (2) partial interchanges of Lovers Lane and Inman Street. The removal of these partial interchanges will eliminate weave conditions in order to address safety concerns and improve traffic flow. This project will also reconfigure the lane assignments of each left handed ramp to provide dedicated drop lanes as well as two (2) through lanes for I-76 which will address both safety and operation concerns.

This study will evaluate the impact that the proposed SUM–76–Central (PID 101402) project will have on the central interchange and the adjacent freeways and interchanges surrounding it in order to determine if the improvements can be completed without causing degradation. If degradation occurs as a result of the proposed construction project, this study will also identify what measures must be taken in order to restore the 'No-Build' Levels-of-Service.

The central interchange is located in the City of Akron, near the downtown area, and is a major system interchange that services I-76, I-77 and SR-8. The central interchange currently handles approximately 225,000 vehicles per day through the mainline movements and interchange ramps. In addition, adjacent communities surrounding the City of Akron also utilize this interchange. See **Figure 1** for Project Location Map.

A detailed review of the Akron Metropolitan Area Transportation Study (AMATS) Long Range Plan and its Transportation Improvement Plan (TIP) for fiscal years 2016 thru 2019 was conducted. The only project currently listed on the TIP in the vicinity is the SUM – IR 76 Main / Broadway (PID 77269) Major Reconstruction Project. This project will remove the access points of the I-76/77 / Wolf Ledges Parkway / Grant Street interchange while changing the access points and geometry of the I-76/77 / Main Street / Broadway Street interchange. This project will be completed prior to the start of the central interchange project and its final configuration was taken into account when performing the capacity analysis discussed later in this report.

This Interchange Modification Study (IMS) is required for Federal Highway Administration (FHWA) and ODOT approval before any access point modifications to existing freeway interchanges may be made. This study documents any operational deficiencies of the existing interchange based on the Design Year traffic and will assess the impact of the proposed improvements based on future planned development, traffic operations, project cost, and environmental impacts.



III. Purpose and Need:

The purpose and need for the SUM – 76 – Central Interchange (PID 101402) Project is to address safety concerns of the deficient bridges of the left handed exit ramps from I-76 to I-77 SB and SR-8 NB that were identified from the Akron Beltway Planning Study (PID 95831). The safety review from the planning study of the entire Akron Beltway identified the central interchange as the "worst" performing area of the entire Akron Beltway with 300 crashes occurring between the years of 2009 – 2011. Many of the crashes that have occurred in the central interchange area are due to capacity and congestion issues as well as sub-standard geometrics.

This study will determine if the proposed improvements of the SUM–76–Central Interchange (PID 101402) project will degrade the operation of the central interchange and the adjacent freeways and interchanges surrounding it and if so, what actions are required to address such degradation.

IV. Study Area:

The central interchange is located in the City of Akron, Summit County, Ohio (see **Figure 1** for a project location map). The central interchange is a major systems interchange that allows motorists to access multiple major highways such as: I-77, I-76 and SR-8. It also serves as a major hub for motorists to access the City of Akron and its surrounding communities. These major highways allow motorists to travel to major cities in Ohio or across state borders. SR-8 from the central interchange extends north where it ultimately intersects Interstate 271, in Macedonia, which enables motorists to access the greater Cleveland area. I-77 extends to the north and south from the central interchange. I-77 originates from the north in Cleveland, Ohio and traverses south through multiple states and terminates in Columbia, South Carolina. I-76 extends to the east and west from the central interchange. I-76 originates from its interchange with Interstate 71 in Seville, Ohio and travels east through Pennsylvania and New Jersey where it ultimately terminates in the City of Bellmawr.

There are four (4) adjacent interchanges surrounding the central interchange. The first interchange is the I-76/77 / Main Street / Broadway Street interchange located to the west of the central interchange. This interchange serves as a major access point for motorists to access downtown Akron as well as The University of Akron. The second interchange is the I-76 / South Arlington Street interchange located to the east and serves as a local access to a primarily residential area. The third interchange is the SR-8 / Carroll Street / Buchtel Avenue interchange located to the north and serves as a main access point for The University of Akron as well as many residences. The fourth and final adjacent interchange is the I-77 / East Archwood Avenue interchange located to the south which serves a primarily residential area.



The study area for this IMS also includes the following four (4) signalized intersections:

- East Archwood Avenue / Burkhardt Avenue
- East Archwood Avenue / Coventry Street
- Lovers Lane / Burkhardt Avenue
- South Arlington Street / I-76 WB Exit Ramp / 2nd Avenue / Martin Avenue

See **Figure 2** for a map of the study area.

V. Existing Conditions:

Current Access Locations:

Within the study limits of this Interchange Modification Study are six (6) traditional freeway access points; described as follows:

- 1. Interstate 76/77 / Main Street / Broadway Street interchange
- 2. Interstate 77 / Lovers Lane Exit Ramp (partial interchange)
- 3. Interstate 77 / East Archwood Avenue interchange
- 4. Interstate 76 / South Arlington Street interchange
- 5. Interstate 76 / Inman Street Exit Ramp (partial interchange)
- 6. State Route 8 / Carroll Street / Buchtel Avenue interchange

Physical Conditions:

The natural profile of the highways entering / exiting the central interchange are relatively level. The profile of the central interchange itself is comprised of many different levels as highways are crossing over the top and under one another. Further detail on the geometry of the central interchange is provided in the section below. The four (4) interchanges adjacent to the central interchange also maintain a relatively level profile.

Existing Roadway Description / Geometry and Traffic Control:

The functional classification of I-76 and I-77 is Urban Interstate while State Route 8 is classified as an Urban other Freeway and Expressway according to The Ohio Department of Transportation (ODOT). The posted speed limit throughout the study area is 55 miles-perhour (mph) with the exception of I-76 to the east of the central interchange that has a posted speed limit of 60 mph. These speed limits are to remain after construction is complete.

The interchange itself contains eight (8) system interchange ramps. I-76 comprises the east and west "legs" of the interchange and has two (2) mainline bridges that traverse over the lower levels of the interchange. SR-8 mainline NB and SB (which forms the north "leg" of the interchange) makes up the lowest level of the interchange and has no bridge structures. The I-77 mainline comprises the south "leg" of the interchange as well as overlapping with the I-76 west "leg" of the interchange. Out of the eight (8) systems interchange ramps, all eight (8) have an area of sub-standard geometric conditions. **Table 1** on the following page



Table 1: Sub-Standard Design Elements on Northeast Interchange Ramps							
Ramp Description	Sub-Standard Horizontal Alignment	Sub-Standard Vertical Profile					
I-77 NB to I-76 WB / I-77 NB (Mainline I-77)	Yes	Yes					
SR-8 SB to I-76 WB / I-77 NB	Yes	No					
I-76 EB / I-77 SB to I-77 SB (Mainline I-77)	Yes	Yes					
I-76 WB to I-77 SB	Yes	Yes					
I-77 NB to I-76 EB	Yes	Yes					
SR-8 SB to I-76 EB	Yes	Yes					
I-76 WB to SR-8 NB	No	Yes					
I-76 EB to SR-8 NB	Yes	Yes					

contains a description of all eight (8) interchange ramps and shows what sub-standard design element exists on the ramp itself.

As shown in **Table 1**, seven (7) of the eight (8) interchange ramps have sub-standard horizontal alignments, the only ramp that does not is the I-76 WB to SR-8 NB ramp. Additionally, seven (7) of the eight (8) interchange ramps have sub-standard vertical profiles, the only ramp that does not is the SR-8 SB to I-76 WB / I-77 NB ramp. Overall, all eight (8) interchange ramps have an area of sub-standard geometric conditions.

There are four (4) existing signalized intersections that were included in the IMS study area. The four (4) intersections included within the study area are as follows:

East Archwood Avenue / Burkhardt Avenue intersection:

This intersection is currently signalized using a span wire configuration with signal poles located on the northwest, southwest and southeast corners of the intersection. The intersection consists of three (3) approaches with the following lane configurations: EB East Archwood Avenue – one (1) lane (thru-right), WB East Archwood Avenue – two (2) lanes (left, thru), SB Burkhardt Avenue – two (2) lanes (left, thru-right). A fourth leg to this intersection exists for Burkhardt Avenue and it operates as a one-way southbound road.

East Archwood Avenue / Coventry Street intersection:

This intersection is currently signalized using a span wire configuration with signal poles located on the northeast and southwest corners of the intersection. The intersection consists of three (3) approaches with the following lane configurations: EB East Archwood Avenue – two (2) lanes (left, thru), WB East Archwood Avenue – one (1) lane (thru-right), NB Coventry Street – one (1) lane (left-thru-right). A fourth leg to this intersection exists for Coventry Street and it operates as a one-way northbound road.



Lovers Lane / Burkhardt Avenue intersection:

This intersection is currently signalized using a span wire configuration with the signal poles located on the northwest and southeast corners of the intersection. The intersection consists of three (3) approaches with the following lane configurations: EB Lovers Lane – one (1) lane (thru-right), WB Lovers Lane – one (1) lane (left-thru), SB Burkhardt Avenue – two (2) lanes (left-thru, right). A fourth leg to this intersection exists for Burkhardt Avenue and it operates as a one-way southbound road.

South Arlington Street / I-76 WB Exit Ramp / 2nd Avenue / Martin Avenue intersection:

This intersection is currently signalized using mast arms with the signal poles located on the northwest, northeast and southeast corner of the intersection. There are two (2) WB approaches with the first being the I-76 WB exit ramp which has no outbound receiving lanes and the second being 2nd Avenue which allows for bidirectional travel. The intersection consists of five (5) approaches with the following lane configurations: EB Martin Avenue – one (1) lane (left-thru-right) with the thru movement corresponding to vehicles destined for 2nd Avenue, I-76 WB Exit Ramp – one (1) lane (left-thru-right), WB 2nd Avenue – one (1) lane (left-thru-right) with the thru movement corresponding to vehicles destined for Martin Avenue, NB South Arlington Street – three (3) lanes (left, thru, thru-right) with the left turn movement corresponding to vehicles destined for 2nd Avenue, and SB South Arlington Street – three (3) lanes (left, thru, thru-right) with the left turn movement corresponding to vehicles destined for 2nd Avenue, and SB South Arlington Street – three (3) lanes (left, thru, thru-right) with the left turn movement corresponding to vehicles destined for 2nd Avenue, and SB South Arlington Street – three (3) lanes (left, thru, thru-right) with the left turn movement corresponding to vehicles destined for 2nd Avenue, and SB South Arlington Street – three (3) lanes (left, thru, thru-right) with the left turn movement corresponding to vehicles destined for 2nd Avenue.

Crash History:

The Akron Beltway Design Team completed a comprehensive safety review of the entire Akron Beltway. As a result of that review, the central interchange was identified as the "worst" performing area of the Akron Beltway. A safety summary memo of the central interchange titled <u>SUM-76-11.48 (PID 101402) Northeast Interchange Safety Study</u> <u>Summary Memo</u> dated September 25th, 2015 was prepared by the Akron Beltway Design Team. This memo documented that the area within the central interchange between the two (2) sets of left handed exit ramps (I-76 EB to SR-8 NB and I-76 WB to I-77 SB) was the area which showed the greatest potential for safety improvements.

Crash data was obtained from ODOT's GIS Crash Analysis Tool (GCAT) for the calendar years of 2009 to 2011 for the entire Akron Beltway area. In addition, an Interchange Safety Analysis Tool Enhanced (ISATe) analysis was completed for the entire Akron Beltway. The goal of the ISATe analysis was to evaluate the performance of the entire Akron Beltway as well as to pinpoint areas where safety improvements could be impactful. These crash years 2009 – 2011 were chosen to be utilized for these analyses due to various construction projects that were occurring throughout the study area between 2012 and the present, which could skew the results of the crash statistics. A total of 300 crashes occurred within the study area (Central Interchange) and have been analyzed as part of this detailed review. These crashes include 141 rear-end, 90 fixed object, 66 sideswipe-passing, 2 parked vehicle and 1 overturning crash. 66% of all crashes occurred in daylight and 61% occurred on dry



pavement. 70% of the crashes were property damage only and 29% of the crashes were injury crashes with one (1) fatal crash occurring during these three (3) years.

A fatal crash occurred on June 22nd, 2009 at 11:38 PM on I-76 WB approaching SR-8. The vehicle ran off the left side of the highway, striking the concrete barrier that protects the bridge piers for the SR-8 ramp. The vehicle overturned under the bridge for the ramp from I-76 EB to SR-8 NB.

The large number of rear-end crashes (47%) throughout the study area points to a congestion issue within the study area. Along an uncongested highway, rear-end crashes are less common as traffic should not be slowing down, which is what typically leads to rear-end crashes. An uncongested highway is more likely to have sideswipe-passing crashes, which can be caused by vehicles changing lanes without properly checking the adjacent lane to ensure no vehicles are in the lane.

The fixed object crashes (30%) occurring throughout the study area are mainly occurring on the left handed exit ramps, which are geometrically sub-standard with tight curve radii. When vehicles enter the left handed exit ramps, they are traveling at too high of a speed to successfully negotiate the curve and wind up running off the road and striking a fixed object.

VI. Analysis Years:

The analysis year utilized for this IMS was determined to be a Design Year of 2040. The Opening Year was not considered for analysis because the Design Year accounts for the highest amount of traffic that will utilize the central interchange, therefore all improvements will be designed for the design year condition. Certified traffic was obtained and used for the analyses. The 'No-Build' condition represents the existing roadway configuration and operating conditions within the study area. The 'Build' condition incorporates the proposed improvements being recommended as part of this project (shown in **Figure 4**). Both the 'No-Build' and 'Build' scenarios assume the completion of the I-77 / I-76 / Main Street / Broadway Street interchange reconstruction (PID 77269).

VII. Alternatives Considered:

For the purpose of analyzing the existing and proposed conditions for the central interchange, the following two (2) scenarios were evaluated:

'No-Build':

The 'No-Build' alternative assumes no changes to the existing roadway configuration or traffic operations at the interchange or surrounding roadway network and is the base condition to which the subsequent alternative is compared. See **Figure 3** for a depiction of the existing traffic conditions.



'Build':

The 'Build' alternative incorporates the following proposed improvements:

- Reconstruct the ramp from I-76 WB to I-77 SB on a new alignment
- Reconstruct the ramp from I-76 EB to SR-8 NB on a new alignment.
- Reconstruct the I-76 WB bridge through the central interchange on a new alignment
- Change the alignment of the I-76 WB to SR-8 NB ramp
- Remove the I-77 SB / Lovers Lane exit ramp
- Remove the I-76 WB / Inman Street exit ramp
- Remove the Lafollette Street Bridge over I-77 and build a replacement structure further to the south

From an operations standpoint, the proposed improvements at the central interchange will provide capacity benefits to the I-76 EB and WB mainline movements as well as create even lane utilization for the I-76 / I-77 EB approach into the central interchange. There are currently four (4) travel lanes on I-76 / I-77 EB near the central interchange with the right most lane ending prior to entering the interchange area. This right most lane will no longer terminate prior to the central interchange and will be carried through under the 'Build' conditions. The proposed improvements will create dedicated lanes for all three (3) movements. The left most lane will be a dedicated exit lane for SR-8 NB, the center two (2) lanes will be dedicated lanes to continue on I-76 EB and the right most lane will be a dedicated exit lane for I-77 SB. The proposed improvements will also remove the traffic wishing to enter SR-8 NB from the two (2) lane bridge for I-76 EB mainline by moving the diverge point for the left handed exit ramp further west. This improvement alone will improve the operation of the interchange by reducing the number of vehicles traveling across the I-76 EB mainline bridge.

Similar improvements are also being proposed on the westbound approach to the central interchange. Four (4) westbound lanes approach the interchange area with the left most lane being a dedicated exit ramp to I-77 SB, the center two (2) lanes will be dedicated lanes to continue on I-76 WB and the right most lane will be a dedicated exit lane to SR-8 NB. Additionally, the left handed exit ramp to I-77 SB has been moved further east, prior to the I-76 WB mainline bridge, to reduce the amount of traffic that will be traveling on the two (2) lane bridge which will further improve the operation of the interchange.

Additionally, due to geometric spatial constraints between I-76 EB, SR-8 and the existing Johnston Street Bridge, the most feasible design speed for the I-76 EB to SR-8 NB is 40 mph. The proposed improvements utilize low speed ramp-to-ramp merges near the Johnston Street Bridge due to the merge point between the ramps moving further northward as a result of the design speed increase of the ramp from I-76 WB to SR-8 NB, as noted above. A design exception for shoulder width is also required to avoid impacting the existing Johnston Street Bridge over SR-8.



The final operations improvement to the central interchange area is removing the exit ramp to Lovers Lane from I-77 SB. This partial interchange causes operational issues as it creates a weaving section immediately after the I-76 EB to I-77 SB and I-76 WB to I-77 SB ramps merge together. Vehicles that originated from I-76 WB that wish to exit onto Lovers Lane need to switch lanes in order to access the exit ramp. This weave section is approximately 0.15 miles long, which does not leave a lot of time for traffic to successfully change lanes without significantly slowing down in the left lane of the ramp to wait for a gap in traffic. In the proposed configuration, traffic wishing to access Lovers Lane will travel further south to utilize the East Archwood Avenue exit ramp from I-77 SB. It should be noted that this will still create a weaving area; however the vehicles would now have 0.5 miles to make this lane change if necessary. Similar improvements are being recommended on I-76 WB traffic that would traditionally exit at Inman Street will exit I-76 WB earlier by utilizing the South Arlington Street exit.

The proposed improvements should reduce the amount of lane changing and merging on the approaches to the central interchange, which will reduce the amount of sideswipepassing crashes that are currently occurring at the interchange. The improved operations will also reduce the amount of slowing and stopping of traffic, which will in turn reduce the amount of rear-end crashes occurring near the interchange as well as reducing emissions within the study area.

See **Figure 4** for a conceptual rendering of the proposed improvements for the study area.

VIII. Certified Traffic Volumes:

The Opening Year 2020 and Design Year 2040 traffic volumes utilized for this study were developed by the Akron Beltway Team utilizing methodologies previously reviewed and approved by ODOT. The certified traffic request was submitted to the ODOT Office of Statewide Planning and Research on April 28th, 2016 and was approved on September 7th, 2016. See **Appendix A** for the certified traffic plates containing the Opening Year 2020 and Design Year 2040 ADT, AM peak hour and PM peak hour traffic volumes along with the TD and T24 design designations that were utilized in this IMS.

The certified traffic volumes for the Lovers Lane and Inman Street exit ramps were rerouted in order to develop the Design Year 2040 'Build' traffic volumes as these partial interchanges will be eliminated under the 'Build' conditions. The Lovers Lane traffic was rerouted further south to the East Archwood Avenue Exit and the Inman Street traffic was rerouted to exit the highway earlier by utilizing the South Arlington Street Exit. See **Figure 5** for the Design Year 2040 'Build' traffic volumes.



IX. Traffic Analysis:

Methodology:

Capacity analyses were performed for the AM and PM peak hours for the Design Year 2040 traffic conditions in order to determine the operating conditions experienced by each intersection, freeway segment, ramp merge / diverge junction and weave segment.

The intersection capacity analysis was performed utilizing Highway Capacity Software (HCS) 2010 (Version 6.8) from the McTrans Transportation Research Center and Synchro (Version 8) developed by Trafficware. Analysis results reported by HCS 2010 are based on the <u>Highway Capacity Manual (HCM) 2010</u> and results reported by Synchro are based on the <u>Highway Capacity Manual (HCM) 2000</u> calculation outputs.

In addition to using HCS 2010, Synchro was used as a supplemental analysis tool to analyze the intersection capacity of the South Arlington Street / I-76 WB Exit Ramp / 2nd Avenue / Martin Avenue intersection. This intersection is comprised of five (5) approaches and is unable to be properly analyzed with HCS 2010 software. As such, the analysis results for this intersection were reported using the Synchro HCM 2000 outputs as the HCM 2010 does not currently support intersections with more than four (4) approaches.

Capacity analyses for freeway segments, ramp merge / diverge junctions and weave segments were performed utilizing HCS 2010 (Version 6.7). Analysis results reported by HCS 2010 are based on the <u>Highway Capacity Manual (HCM) 2010</u>. Each freeway segment, ramp merge / diverge junction and weave segment was assigned a specific number for purposes of this evaluation. See **Figure 6** for a location key map that identifies the freeway segments, ramp merge / diverge junctions and weave segments of the 'No-Build' conditions and **Figure 7** for a location key map of the 'Build' conditions.

Intersection Analysis:

Intersection capacity analysis was performed for the Design Year 2040 conditions in order to determine the operating conditions experienced by each intersection. The quality of the operating conditions experienced by an intersection is measured in terms of Level-of-Service (LOS), which is determined by the amount of delay experienced by motorists. Levels-of-Service can range from LOS A to LOS F. Level-of-Service ratings of A, B, and C are considered to be in the acceptable range. Level-of-Service D is typically considered acceptable in urban and suburban areas (which this study area has been determined to be within). Levels-of-Service E and F are considered below average with significant levels of delay experienced by vehicles. The thresholds related to average control delay for signalized intersections are shown in **Table 2** on the following page.



Table 2: Level–of–Service Criteria for Signalized Intersections					
Level-of-Service	Delay Threshold – (Sec)				
А	< 10				
В	> 10 - 20				
С	> 20 - 35				
D	> 35 - 55				
E	> 55 - 80				
F	> 80				

Table 3 below summarizes the Intersection Capacity Analysis and details the Levels-of-Service and delay experienced under the Design Year 2040 'No-Build' and 'Build' conditions for the signalized intersections within the study area. See **Appendix B** for the intersection capacity analysis printouts.

Table 3: Intersection Capacity Analysis Summary –									
Design Year 2	040 'Ne	p-Build'	vs. 'Bui	Id' Con	ditions				
	1	No-Build'	Conditio	ns		'Build' Conditions			
Intersection / Movement	AM	Peak	PM Peak		AM Peak		PM Peak		
	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	
Archwood Avenue / Burkhardt Avenue									
Eastbound Thru-Right	В	11.9	В	13.8	В	12.5	В	14.8	
Eastbound Approach	В	11.9	В	13.8	В	12.5	В	14.8	
Westbound Left	В	14.2	В	18.6	В	14.8	В	19.6	
Westbound Thru	В	10.6	В	11.0	В	11.1	В	11.6	
Westbound Approach	В	11.3	В	12.0	В	11.8	В	12.7	
Southbound Left		11.4	В	13.7	В	11.5	В	13.9	
Southbound Thru-Right		12.4	В	14.1	В	13.2	В	15.6	
Southbound Approach		12.0	В	13.9	В	12.5	В	14.8	
Intersection Total	В	11.9	В	13.4	В	12.4	В	14.4	
Archwood Avenue / Coventry Street									
Eastbound Left	С	21.7	С	29.9	С	23.0	С	30.4	
Eastbound Thru	A	7.3	А	8.5	A	8.2	А	9.2	
Eastbound Approach	В	16.4	В	16.6	В	15.6	В	16.6	
Westbound Thru-Right	В	10.6	В	10.3	В	11.5	В	10.4	
Westbound Approach	В	10.6	В	10.3	В	11.5	В	10.4	
Northbound Left-Thru-Right	В	16.5	В	16.7	В	15.7	В	16.7	
Northbound Approach	В	16.5	В	16.7	В	15.7	В	16.7	
Intersection Total	В	13.7	В	14.2	В	13.9	В	14.3	



Table 3: Intersection Capacity Analysis Summary –								
Design Year 2040	'Νο-Βι	uild' vs.	'Build' (Conditio	ons (Coi	nt.)		
	'No-Build' Conditions				'Build' Conditions			
Intersection / Movement	AM Peak		PM Peak		AM Peak		PM Peak	
	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)
Lovers Lane / Burkhardt Avenue								
Eastbound Thru-Right	В	11.1	В	11.4	В	10.3	В	11.1
Eastbound Approach	В	11.1	В	11.4	В	10.3	В	11.1
Westbound Left-Thru	В	11.2	В	11.1	В	10.9	В	10.9
Westbound Approach	В	11.2	В	11.1	В	10.9	В	10.9
Southbound Left-Thru	В	11.2	В	11.6	В	10.8	В	11.1
Southbound Right	В	10.9	В	11.0	В	10.7	В	11.0
Southbound Approach	В	11.1	В	11.4	В	10.8	В	11.1
Intersection Total	B 11.1		В	11.3	В	10.6	В	11.0
South Arlington Street / I-76 WB Exit Ramp / 2 nd Avenue / Martin Avenue								
Eastbound Left-Thru-Right	В	13.2	В	19.5	В	10.7	В	16.0
Eastbound Approach	В	13.2	В	19.5	В	10.7	В	16.0
I-76 WB Left-Thru-Right	С	22.1	С	29.3	С	24.8	С	30.0
I-76 WB Approach	С	22.1	С	29.3	С	24.8	С	30.0
2 nd Avenue WB Left-Thru-Right	С	20.9	С	21.7	С	21.0	С	22.4
2 nd Avenue WB Approach	С	20.9	С	21.7	С	21.0	С	22.4
Northbound Left	В	14.5	А	7.5	В	19.4	В	10.8
Northbound Thru-Right	В	14.3	А	9.3	В	18.3	В	13.4
Northbound Approach	В	14.3	А	9.3	В	18.5	В	13.4
Southbound Left	В	12.5	А	9.5	В	15.4	В	14.5
Southbound Thru-Right	В	13.9	В	10.7	В	17.2	В	16.4
Southbound Approach	В	13.8	В	10.5	В	17.1	В	16.2
Intersection Total	В	15.8	В	11.8	В	19.4	В	17.0

As shown in **Table 3**, the analysis of the Design Year 2040 'No-Build' and 'Build' traffic conditions indicates that all four (4) existing signalized intersections within the study area are projected to operate with acceptable Levels-of-Service under the Design Year conditions. The Design Year 2040 'Build' traffic scenario indicates that there will be an increase in overall intersection delay at the Archwood Avenue / Burkhardt Avenue, Archwood Avenue / Coventry Street and South Arlington Street / I-76 WB Exit Ramp / 2nd Avenue / Martin Avenue intersections due to the additional rerouted traffic from the Lovers Lane and Inman Street ramp closures. Although these intersections experience a slight increase in traffic, the Design Year 2040 'Build' traffic scenario indicates that these intersections are anticipated to continue to operate with acceptable Levels-of-Service.



Freeway Section Analysis:

The quality of the operating conditions experienced by a freeway segment is measured in terms of Level-of-Service (LOS) which is determined by the density of traffic on the road. The density of traffic is measured by passenger cars per mile per lane (pc/mi/ln). Levels-of-Service can range from LOS A to LOS F. Level-of-Service ratings of A, B, and C are considered to be in the acceptable range with little to no delay to motorists. Level-of-Service D is typically considered acceptable in urban and suburban areas and is the grade where motorists begin to slow down and experience congestion. Levels-of-Service E and F are considered unacceptable with significant congestion and delay experienced by motorists. **Table 4** below identifies the LOS criteria for freeway segments.

Table 4: Level–of–Service Criteria for Basic Freeway Segments					
Dasic Heeway Segments					
Level-of-Service	(pc/mi/ln)				
А	0 - 11				
В	> 11 - 18				
С	> 18 - 26				
D	> 26 - 35				
E	> 35 - 45				
F	> 45				

 Table 5 summarizes the HCS Freeway Capacity Analysis and details the Levels-of-Service
 and density experienced under the Design Year 2040 'No-Build' vs. 'Build' traffic conditions of the basic freeway segments within the study area. With geometric changes being implemented under the 'Build' condition some freeway segments will not be identified by the same identification number between the two (2) conditions. See Figure 6 for a location key map that identifies the freeway segments, ramp merge / diverge junctions and weave segments of the 'No-Build' conditions and Figure 7 for a location key map of the 'Build' conditions. These freeway segments include freeway segments F-3, F-6 and F-14. Freeway segment F-3 represents a different freeway segment under each condition while freeway segments F-6 and F-14 are not included under the 'Build' condition, further detail will be provided in the paragraph following **Table 5**. With the exception of the freeway segments detailed above, all other freeways segments will have the same identification number between the 'No-Build' and 'Build' conditions. See Figure 8 and Figure 9 for diagrams displaying the Levels-of-Service experienced during the AM and PM peak hours, respectively, under the Design Year 2040 'No-Build' traffic conditions and Figure 10 and Figure 11 for diagrams displaying the Levels-of-Service experienced during the AM and PM peak hours, respectively, under the Design Year 2040 'Build' traffic conditions. See **Appendix C** for the HCS Freeway Capacity Analysis printouts.



'No-Build' Conditions'Build' ConditionsFreeway Segment'No-Build' Conditions'Build' ConditionsAM PeakPM PeakAM PeakPMLOSDensity (pc/mi/ln)I-77 SB / I-76 EBC19.5D28.4C19.5DI-72 (NB Main St On-Ramp to I- 77 SB Off-Ramp)C20.5DI-3 (SR-8 NB Off-Ramp)C27.4F46.4 <t< th=""><th colspan="8">Table 5: Mainline Freeway Segment Analysis Summary – Design Year 2040 'No-Build' vs. 'Build' Conditions</th></t<>	Table 5: Mainline Freeway Segment Analysis Summary – Design Year 2040 'No-Build' vs. 'Build' Conditions							
Freeway Segment $AM \vdash eak$ $PM \vdash eak$ $AM \vdash eak$ PM LOS $Density(pc/mi/ln)LOSDensity(pc/mi/ln)LOSDensity(pc/mi/ln)LOSI-77 SB / I-76 EBIIIIIII-77 SB / I-76 EBIIIIIIF-1 (SB Main St On-ramp to NBMain St On-Ramp)C19.5D28.4C19.5DF-2 (NB Main St On-Ramp to I-77 SB Off-Ramp)C20.5D31.1C20.5DF-3 (NB Main St On-Ramp to I-77 SB Off-Ramp)D27.4F46.4IIF-3 (SR-8 NB Off-Ramp to I-77SB Off-Ramp)IIIIIIIF-3 (SR-8 NB Off-Ramp)IIIIIIIIF-3 (SR-8 NB Off-Ramp)IIIIIIIIF-3 (SR-8 NB Off-Ramp)IIIIIIIIF-3 (SR-8 NB Off-Ramp)IIII$								
LOSDensity (pc/mi/ln)LOSDensity (pc/mi/ln)LOSDensity (pc/mi/ln)LOSI-77 SB / I-76 EBImage: Construct of the structure o	Peak							
I-77 SB / I-76 EB Image: Constraint of the state s	Density (pc/mi/ln)							
I-77 SB / I-76 EB Image: Constraint of the state o								
F-1 (SB Main St On-ramp to NB Main St On-Ramp) C 19.5 D 28.4 C 19.5 D F-2 (NB Main St On-Ramp) C 20.5 D 31.1 C 20.5 D F-3 (NB Main St On-Ramp) D 27.4 F 46.4								
F-2 (NB Main St On-Ramp to I- 77 SB Off-Ramp) C 20.5 D 31.1 C 20.5 D F-3 (NB Main St On-Ramp to I- 77 SB Off-Ramp) D 27.4 F 46.4 C 19.7 D F-3 (SR-8 NB Off-Ramp to I- 77 SB Off-Ramp) D 27.4 F 46.4 C 19.7 D	28.4							
F-3 (NB Main St On-Ramp to I- 77 SB Off-Ramp) D 27.4 F 46.4 F-3 (SR-8 NB Off-Ramp to I-77 SB Off-Ramp) C 19.7 D	31.1							
F-3 (SR-8 NB Off-Ramp to I-77 SB Off-Ramp) C 19.7 D								
	34.4							
F-4 (I-76 EB / I-77 SB Split to I- 76 WB On-Ramp) C 25.3 E 42.5 C 25.3 E	42.5							
F-5 (I-76 WB On-Ramp to Lovers Ln Off-Ramp) C 25.8 D 34.0 C 25.8 D	34.0							
F-6 (Lovers Ln Off-Ramp to SR-8 SB Merge)C23.9D32.3								
F-7 (Archwood Ave Off-Ramp to Wilbeth Rd Off-Ramp)D34.9F171.7D34.9F	171.7							
I-77 NB / I-76 WB								
F-8 (Wilbeth Rd On-Ramp toF107.9E40.9F107.9EArchwood Ave On-RampF107.9E40.9F107.9E	40.9							
F-9 (I-77 NB / SR-8 NB Split to I- 77 NB / I-76 EB Split) D 28.6 D 26.5 D 28.6 D	26.5							
F-10 (I-77 NB / I-76 EB Split to SR-8 SB Merge) D 31.8 C 25.6 D 31.8 C	25.6							
F-11 (SR-8 SB / I-77 NB Merge to I-76 WB) D 28.2 C 24.5 D 28.2 C	24.5							
F-12 (SR-8 SB / I-77 NB Merge to Broadway St Off-Ramp) D 34.9 C 23.3 D 34.9 C	23.3							
F-13 (Broadway St Off-Ramp to Main St On-Ramp)C20.2B17.2C20.2B	17.2							
I-76 Eastbound								
F-14 (I-77 SB Off-Ramp to SR-8 NB Off-Ramp) D 28.5 F 48.6								
F-15 (SR-8 NB Off-Ramp to SR-8 SB / I-77 NB Merge) B 15.9 D 29.8 B 15.9 D	29.8							
F-16 (SR-8 SB / I-77 NB Merge to Kelly Ave Off-Ramp) C 19.8 D 27.2 C 19.8 D	27.2							
F-17 (SR-8 SB / I-77 NB Merge to Kelly Ave Off-Ramp) C 24.2 D 34.8 C 24.2 D	34.8							
F-18 (Kelly Ave Off-Ramp to S. Arlington St On-Ramp)C20.6D30.9C20.6D	30.9							

Note: Orange highlighted cells indicate a Level of Service E. Red highlighted cells indicate a Level of Service F.



Table 5: Mainline Freeway Segment Analysis Summary – Design Year 2040 'No-Build' vs. 'Build' Conditions (Cont.)								
		'No-Build'	Conditions			'Build' C	onditions	
Freeway Sogmont	AM Peak		Peak PM Peak AM Peak P		AM Peak PM Peak		PM	Peak
rreeway segment	LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)
I-76 Westbound								
F-19 (S. Arlington St. Off-Ramp to Fuller St. On-Ramp)	F	52.3	С	25.1	F	50.0	С	24.4
F-20 (Inman St. Off-Ramp to SR- 8 NB Off-Ramp)	F	62.3	D	30.3	E	35.0	С	22.7
F-21 (SR-8 NB Off-Ramp to I-77 SB Off-Ramp)	F	159.7	E	37.0	E	37.2	С	24.2
F-22 (I-77 SB Off-Ramp to SR-8 SB / I-77 NB Merge)	E	43.6	С	21.3	E	43.6	С	21.3
SR-8 Southbound								
F-23 (Buchtel Ave Off-Ramp to Carroll St. On-Ramp)	D	31.2	F	51.6	D	31.2	F	51.6
F-24 (Carroll St. On-Ramp to I- 76 EB / WB Off-Ramp)	E	36.0	F	89.5	E	36.0	F	89.5
F-25 (I-76 EB / WB Off-Ramp to I-77 SB On-Ramp)	D	31.0	F	163.7	D	31.0	F	163.7
SR-8 Northbound								
F-26 (I-76 EB/WB Off-Ramp to SR-8 NB On-Ramp)	F	260.4	Е	37.8	F	260.4	E	37.8
F-27 (Carroll St. Off-Ramp to Buchtel Ave. On-Ramp)	F	68.4	D	34.3	F	68.4	D	34.3
Central Interchange Ramps								
F-28 (I-76 EB to SR-8 NB)	C	23.4	С	22.6	C	23.4	С	22.6
F-29 (SR-8 SB to I-76 EB)	C	19.7	С	18.4	С	19.7	С	18.4
F-30 (I-77 NB to I-76 EB)	C	25.4	D	27.5	C	25.4	D	27.5
F-31 (SR-8 SB / I-77 NB to I-76 EB)	С	22.6	С	23.0	С	22.6	С	23.0
F-32 (I-76 WB to SR-8 NB)	D	30.3	С	18.7	D	30.3	С	18.7
F-33 (I-76 WB to I-77 SB)	D	26.3	D	28.2	D	26.3	D	28.2
F-34 (SR-8 SB to I-76 EB / WB)	С	22.2	С	20.9	С	22.2	С	20.9
F-35 (SR-8 SB to I-76 WB)	С	24.8	С	23.4	С	24.8	С	23.4
F-36 (I-76 EB / WB to SR-8 NB)	D	26.9	С	20.7	D	26.9	С	20.7
	1							

Note: Orange highlighted cells indicate a Level of Service E. Red highlighted cells indicate a Level of Service F.



As shown in **Table 5** on the previous pages, the results of the mainline freeway analyses indicate that freeway segments F-3, F-4 and F-7, of I-77 SB / I-76 EB, are anticipated to operate at an unacceptable LOS E or worse during the PM peak hour under the Design Year 2040 'No-Build' conditions. These freeway segments experience poor levels-of-service as they have insufficient capacity to contain the combination of traffic from the three (3) major highways (I-76, I-77 and SR-8). It should be noted that, freeway segment F-3 appears to show an improvement from a LOS F to a LOS D from the 'No-Build' condition to the 'Build' condition, however it does not represent the same freeway segment between the two (2) conditions. It should also be noted that, a LOS result is not reported for freeway segment F-6 under the 'Build' condition as freeway segment F-5 will now be carried through to the merge junction with SR-8 SB because there will no longer be a change in traffic volumes with the removal of the Lovers Lane exit ramp.

With no change to the geometrics and no change between the 'No-Build' and 'Build' traffic volumes for the I-77 NB or the I-76 WB / I-77 NB shared use section, the capacity results for freeway segments F-8 to F-13 report the same levels-of-service for both peak hours under the 'No-Build' and 'Build' conditions. As shown in **Table 5**, freeway segment F-8 is anticipated to operate at a LOS F and E during the AM and PM peak hours, respectively, under the Design Year 2040 'No-Build' and 'Build' conditions.

The I-76 EB freeway segment F-14 reports an unacceptable LOS F during the PM peak hour under the Design Year 2040 'No-Build' conditions. It should be noted that, a LOS result is not reported for freeway segment F-14 under the 'Build' condition as it was excluded from the analysis due to the geometric reconfiguration of the I-76 EB / I-77 SB to SR-8 NB exit ramp (F-28). Under the 'Build' condition this ramp movement will occur before the I-77 SB exit ramp (F-4) movement as opposed to after under the 'No-Build' condition.

Freeway segments F-19 and F-20 of I-76 WB report different LOS under each condition due to the removal of the Inman Street exit ramp. Motorists currently utilizing the Inman Street exit ramp were assumed to exit the highway earlier at the South Arlington Street exit ramp. Therefore, the LOS results for F-19 slightly improve from the 'No-Build' to 'Build' condition. Freeway segment F-20 will still represent the same freeway segment and traffic volume for both conditions with the only difference being the number of lanes analyzed. Freeway segment F-20 was analyzed with three (3) lanes under the 'No-Build' condition and four (4) lanes under the 'Build' condition due to the removal of the Inman Street exit ramp. This additional lane will improve the LOS F (62.3 pc/mi/ln) experienced during the AM peak hour under the 'No-Build' condition to a LOS E (35.0+ pc/mi/ln) under the 'Build' condition, a 44% decrease in density. The same condition occurred for freeway segment F-21. F-21 represents the same freeway segment for both conditions but due to the geometric reconfiguration of the I-76 WB to I-77 SB exit ramp (F-33) an additional lane for this segment will be created under the 'Build' condition. Freeway segment F-21 was analyzed with two (2) lanes under the 'No-Build' condition and three (3) lanes under the 'Build' condition. This additional lane will improve the LOS F (159.7 pc/mi/ln) experienced during the AM peak hour under the 'No-Build' condition to a LOS E (37.2 pc/mi/ln) under the 'Build' condition, a 77% decrease in density.



SR-8 SB freeway segments F-23, F-24 & F-25 are anticipated to operate at an unacceptable LOS F during the PM peak hour under both the 'No-Build' and 'Build' conditions while the SR-8 NB freeway segments F-26 & F-27 are anticipated to operate at an unacceptable LOS F during the AM peak hour under both the 'No-Build' and 'Build' conditions. Freeway segments F-24 (AM peak only) and F-26 (PM peak only) are also anticipated to operate at an unacceptable LOS E under both conditions. All the remaining fly-over and connector ramps contained within the central interchange are anticipated to operate with acceptable levels-of-service during the peak hours under both the 'No-Build' and 'Build' conditions.

A majority of the freeway segments report no changes in terms of density from the Design Year 2040 'No-Build' to 'Build' conditions for the following two (2) reasons:

- 1. The volume of the freeway segment remains constant
- 2. The capacity provided remains constants (i.e. number of travel lanes)

Although the reported densities from the capacity analysis remain the same across the two (2) analysis conditions, the proposed improvements should reduce the amount of slowing and stopping of traffic, lane changing, and merging on the approaches to the central interchange. Due to the limitations of the HCS software, these conditions are not represented in the analysis results.

Ramp Junction Analyses:

Merge and diverge areas of influence are considered separately from the mainline freeway segment analysis. Merge / diverge analyses were performed for all ramp junctions within the study area. **Table 6** below summarizes the levels-of-service criteria for ramp areas of influence.

Table 6: Level-of-Service Criteria for						
Ramp Areas of Influence						
Level-of-Service	Density Threshold – (pc/mi/ln)					
A	0 – 10					
В	> 10 - 20					
С	> 20 - 28					
D	> 28 - 35					
E	> 35					
F	Demand Exceeds Capacity					

Table 7 summarizes the Ramp Areas of Influence Levels-of-Service experienced under the Design year 2040 conditions. It should be noted that diverges D-2 and D-6 were analyzed as major diverges. A major diverge occurs when the number of lanes leaving the diverge area is one (1) more than the number entering it. Major diverges follow the same density thresholds when reporting levels-of-service. The following diverge areas of influence have been eliminated under the 'Build' condition due to its new geometric layout: D-1, D-3 and D-5. See **Appendix D** for the HCS Ramp Areas of Influence analyses printouts.



Table 7: Ramp Areas of Influence Analysis Summary – Design Year 2040 'No-Build' vs. 'Build' Conditions									
'No-Build' Conditions				'Build' Conditions					
Ramp Area of Influence	AM	Peak	РМ	PM Peak		Peak	PM Peak		
	LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	
D-1 (Lovers Lane Off-Ramp)	С	27.3	E	35.0					
D-2* (Broadway St Off-Ramp)	D	33.4	С	22.4	D	33.4	С	22.4	
D-3 (SR-8 NB Off-Ramp)	С	26.7	F	39.9					
D-4 (Fuller St Off-Ramp)	С	24.2	D	30.9	С	24.2	D	30.9	
D-5 (I-77 SB Off-Ramp)	F	51.7	D	34.3		•	•		
D-6* (I-76 EB / WB Off-Ramp)	D	34.3	E	48.7	D	34.3	E	48.7	
M-1 (NB Main St On-Ramp)	В	15.0	С	23.7	В	15.0	С	23.7	
M-2 (Carroll St On-Ramp)	D	29.3	F	43.2	D	29.3	F	43.2	

Note: Red highlighted cells indicate a Level of Service F. * Major Diverge Area

As shown in **Table 7**, the analyses of the Design Year 2040 traffic conditions shows that under the Design Year 2040 'No-Build' conditions the diverge junction D-1 is anticipated to operate at an unacceptable LOS E during the PM peak hour while the diverge junctions D-3 (PM peak only) and D-5 (AM peak only) are anticipated to operate at an unacceptable LOS F. The Lovers Lane exit ramp will be removed under the 'Build' conditions and therefore the poor operation of diverge junction D-1 will also be eliminated. The diverge junctions D-3 and D-5 will also be eliminated under the 'Build' condition with the geometric reconfiguration of the I-76 left handed exit ramps. The new configuration of these ramps will be a drop lane under the 'Build' condition. The major diverge junction D-6 is anticipated to operate at an unacceptable LOS E during the PM peak hour under both the 'No-Build' and 'Build' conditions due to the poor operation of the freeway segment that precedes it (F-24). The merge junction M-2 is anticipated to operate at an unacceptable LOS F during the PM peak hour under both the 'No-Build' and 'Build' conditions. This poor operation is due to the poor operation of the freeway segment it is merging with (F-23).

Weave Segment Analysis:

Weave segments are considered separately from basic freeway segments and ramp merge and diverge junction analyses. A weave segment is a segment in which two (2) or more separate traffic streams traveling in the same general direction cross paths along a significant length of freeway without the aid of traffic control devices (except for guide signs). Weaving segments are formed when a diverge segment closely follows a merge segment or when a one-lane off-ramp closely follows a one-lane on-ramp and the two (2) are connected by a continuous auxiliary lane. Weave segments follow the same level-of-service criteria as ramp areas of influence, refer to **Table 6** on the previous page.



Table 8 summarizes the Weave Segment Levels-of-Services experienced under the Design year 2040 conditions. It should be noted that weave segment W-3 is eliminated under the 'Build' condition with the removal of the Inman Street exit ramp. See **Appendix E** for the HCS weave segment analysis printouts.

Table 8: Weave Segment Analysis Summary –								
	Design Ye	ear 2040 'N	No-Build'	vs. ['] Build'	Condition	S		
	'No-Build' Conditions 'Build' Conditions							
Ramp Area of Influence	AM	AM Peak PM Peak A/		AM Peak		РМ	Peak	
	LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)
I-77 Southbound								
W-1 (I-76 / SR-8 SB Merge to Archwood Ave. Off-Ramp)	F	*	F	*	F	*	F	*
I-77 Northbound								
W-2 (Archwood Ave On-Ramp to I-76 / SR-8 Split)	F	*	F	*	F	*	F	*
I-76 Westbound								
W-3 (Fuller St On-Ramp to Inman St Off-Ramp)	E	41.4	С	25.8				
SR-8 Northbound								
W-4 (I-76 / SR-8 NB Merge to Carroll St. Off-Ramp)	F	*	F	*	F	*	F	*

Note: Orange highlighted cells indicate a Level of Service E. Red highlighted cells indicate a Level of Service F. *Results not reported by HCS

As shown on **Table 8**, the analysis of the Design Year 2040 'No-Build' and 'Build' traffic conditions shows that all weave segments are anticipated to operate at an unacceptable Level-of-Service E or worse during the peak hours with the exception of weave segment W-3 during the PM peak hour under the 'No-Build' condition. The weave segment W-3 will no longer exist under the 'Build' conditions with the removal of the Inman Street exit ramp. It should be noted that the weave segments with no reported results are anticipated to operate so poorly that HCS does not calculate a result and the proposed improvements have no impact on these calculations.



Storage Length Calculations and Recommendations:

Storage length calculations were not performed as part of this study as no intersection turn lanes will be affected by the improvements proposed under the SUM–76–Central Interchange (PID 101402) Improvement Project.

Based on the information and analysis in this study, the Akron Beltway Team concludes that the SUM–76–Central Interchange (PID 101402) Improvement Project will have no impact on the operation of the central interchange or adjacent interchanges that would require mitigation.

X. Cost Estimate:

A cost estimate was developed for the SUM – 76 – Central Interchange (PID 101402) project. The cost includes pavement, roadway, drainage, erosion control, utilities, lighting, traffic control, structures, retaining walls, maintenance of traffic, right-of-way and other miscellaneous items. The current estimated total for the project is \$53,000,000 including all design aspects. The attached detailed cost estimate was completed as part of the <u>SUM-76-11.48 (PID 101402) Northeast Interchange Safety Study Summary Memo</u> dated September 25th, 2015. See **Appendix F** for the detailed cost estimate.

This project has secured 100% funding from four (4) sources. The largest portion of funding (66% of total project costs) committed to the project is to come from the ODOT Priority System Major Rehabilitation Program (MR) and totals \$35,000,000. The Transportation Review Advisory Council (TRAC) has also committed funds totaling \$4,000,000 (7.55% of total project costs). An additional \$4,000,000 (7.55% of total project costs) was secured through the Highway Safety Program (HSP) after the Akron Beltway Design Team submitted a safety study to the HSP. The remaining \$10,000,000 (18.9% of total project costs) will be allocated to the project by ODOT District 4.

XI. Environmental Summary:

The Akron Beltway Design Team completed an environmental overview of the central interchange and prepared an environmental summary of the known resources in the central interchange project area under the <u>SUM-76 Central Interchange (PID 101402)</u> <u>Environmental Overview</u> document dated April 28th, 2016.

Stream information was provided by the Ohio Department of Natural Resources (ODNR) and no streams were found to be within the study area. The Federal Emergency Management Agency (FEMA) also reports that there are no flood plains located within the study area. The northern part of the study area was found to be within the City of Akron – Little Cuyahoga River Basin and the southern part of the study area was found to be within the Portage Lakes – Tuscarawas River Basin, according to the watershed boundaries from the Natural Resources Conservation Service (NRCS).



The Ohio Wetland Inventory (OWI), provided by the ODNR (circa 1970s), suggests the presence of a shallow marsh wetland in the northeast quadrant of the central interchange. The OWI also shows shrub/scrub and shallow marsh wetlands north of Johnston Street and east of SR-8, just outside the study area. The National Wetland Inventory (NWI), provided by the U.S. Fish & Wildlife Service, indicates that there are no NWI wetlands within the study area. A report prepared by ODOT in 2006 identified a small low-quality wetland in the southeast quadrant of the central interchange located outside of the right-of-way at the north end of Merton Avenue.

A literature search of resources of the ODNR Division of Natural Areas and Preserves, U.S. Fish & Wildlife Service and Heritage Data Services for the study area did not reveal the presence of any endangered or threatened species, suitable habitat or other special features within the study area.

According to the Summit County Department of Development database there are no Section 4(f) public parks or recreational lands within the study area. It should be noted that playgrounds or other outdoor areas at Goodrich Middle School may be considered Section 4(f) resources depending upon school policy regarding access by the general public. A search of the United States Department of the Interior National Park Service indicates that no parks paid for by the Land & Water Conservation fund are located in or near the study area. The Ohio Historic Preservation Office (OHPO) database was searched for National Register listings, Ohio historic structures and archaeological sites near or within the study area and none were reported. It should be noted that the database contained records for multiple Ohio historic structures and a National Register determination of eligibility site near the study area and the Ohio historic structures are listed because they were built before 1966.

The only public facilities located near or within the study area are the Summit County Engineer's Office, located in the southwest quadrant of the study area, and the Goodrich Middle School, located in the southeast quadrant of the study area.

There are no landfills, superfund sites or suspect sites listed on the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) or National Priorities List (NPL) databases located within or near the study area. Several Resource Conservation and Recovery Act (RCRA) sites were found outside the study area including: Goodrich Middle School (southeast quadrant), Summit County Engineer's Office (southwest quadrant), Alcon Tool Company (southwest quadrant), Gross Pat Cleaners (southwest quadrant), A&C Welding Inc. (northeast quadrant) and Hoban High School (southeast quadrant).

The U.S. Census Block Groups representing the study area have both minority and lowincome populations that exceed 40%. Therefore, the project area should be considered a sensitive environmental justice area. The potential effect on minority and low-income populations resulting from changes in access (ramp and bridge closures) along with residential displacements and neighborhood-oriented business relocations will need to be considered as the project advances.



XII. Conclusions:

This Interchange Modification Study (IMS) is being prepared at the request of the Ohio Department of Transportation (ODOT). The SUM–76–Central Interchange (PID 101402) project is the first identified project to be derived from the Akron Beltway Planning Study (PID 95831).

The purpose of this study is to determine if the proposed improvements of the SUM–76– Central (PID 101402) project will degrade the operation of the central interchange and the adjacent freeways and interchanges surrounding it and if so, what actions are required to address such degradation.

The planning study identified the need to replace the left handed exit ramps of I-76 EB to SR-8 NB and I-76 WB to I-77 SB. These ramps are being replaced in advance prior to the finalization of the planning study in order to correct their sub-standard geometrics and poor physical condition. This improvement project will also eliminate the two (2) partial interchanges of Lovers Lane and Inman Street.

The safety review from the planning study identified the central interchange as the "worst" performing area of the Akron Beltway with 300 crashes occurring between the years of 2009 – 2011. Many of the crashes that have occurred in the central interchange area are due to capacity and congestion issues as well as sub-standard geometrics of all eight (8) interchange ramps.

The Opening Year for the proposed central interchange improvement project is 2020 with the Design Year established as 2040. Capacity analysis for all basic freeway segments, ramp merge / diverge junctions, weave segments and intersections were only performed for the Design Year 2040 AM and PM peak hours. The intersection capacity analyses for the Design Year 2040 AM and PM peak hours identified that the study intersections are anticipated to operate with acceptable Levels-of-Service and minimal delay under both the 'No-Build' and 'Build' traffic conditions. The capacity analysis also identified many freeway segments, ramp merge / diverge junctions and weave segments within the study area that operate with unacceptable levels-of-service under both the Design Year 2040 'No-Build' and 'Build' traffic conditions.

Based on the information and analysis in this study, the Akron Beltway Team concludes that the SUM–76–Central Interchange (PID 101402) Improvement Project will have no impact on the operation of the central interchange or adjacent interchanges that would require mitigation.

The SUM–76–Central Interchange (PID 101402) Improvement Project should be pursued while incorporating the recommended roadway improvements and modifications detailed in this study. Each individual improvement will contribute to the overall function of the central interchange and allow it to continue to provide for the current needs and future demands expected by the traveling public.



XIII. Recommendations:

From the Akron Beltway Planning Study (PID 95831) it was recommended that the left handed exit ramps of I-76 EB to SR-8 NB and I-76 WB to I-77 SB be reconstructed in order to correct their sub-standard geometrics and poor physical condition. The planning study also recommended the elimination of the two (2) partial interchanges of Lovers Lane and Inman Street. The elimination of these partial interchanges will eliminate weave conditions and improve traffic flow. Reconfiguring the lane assignments of each left handed ramp to provide dedicated drop lanes for the ramps as wells as two (2) through lanes for I-76 will address both safety and operation concerns. The SUM–76–Central Interchange (PID 101402) project includes the following improvements:

- Reconstruct the ramp from I-76 WB to I-77 SB on a new alignment
- Reconstruct the ramp from I-76 EB to SR-8 NB on a new alignment.
- Reconstruct the I-76 WB bridge through the central interchange on a new alignment
- Change the alignment of the I-76 WB to SR-8 NB ramp
- Remove the I-77 SB / Lovers Lane exit ramp
- Remove the I-76 WB / Inman Street exit ramp
- Remove the Lafollette Street Bridge over I-77 and build a replacement structure further to the south

The proposed improvements identified within this Interchange Modification Study will correct sub-standard geometrics of the I-76 left handed exit ramps, improve traffic flow by creating dedicated drop lanes for said exit ramps and remove two (2) partial interchanges which will eliminate two (2) weaving segments from the central interchange. All of the improvements detailed above will contribute to improving the overall operation of the central interchange as well as improving safety. None of the improvements will degrade the operation of the central interchange or the adjacent freeways and interchanges surrounding it.



FIGURES



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APPENDIX A CERTIFIED TRAFFIC PLATES

INTER-OFFICE COMMUNICATION

TO: Lorie Feudner, District 4

FROM: Bryan Raderstorf, Office of Statewide Planning and Research

- SUBJECT: SUM-76-11.56
- DATE: September 7, 2016

In reply to a request dated April 28, 2016, the Office of Statewide Planning and Research has reviewed the 2020/2040 traffic for the subject study and the volumes that were provided are reasonable.

The forecasts shown on the attached pages are certified for use in the subject project.

If you have any questions, please contact me at (614) 752-5736.



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APPENDIX B INTERSECTION CAPACITY ANALYSIS

DESIGN YEAR 2040 'NO-BUILD' CONDITIONS

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General Inform	nation								ntersect	tion Info	rmatio	on			≤ L <u>.</u>
Agency		GPD Group							Duration,	h	0.25			* 4	×
Analyst		Brett M. Ferrell		Analys	sis Dat	e Jun 8	2016		Area Typ	е	Other		4		*
Jurisdiction		City of Akron		Time F	Period	AM P	eak Hou	ır 🛛	PHF		0.92		* -*	₩ĴE	↓ ↓ ↓ ↓
Urban Street		Archwood Avenue		Analys	sis Yea	r 2040			Analysis	Period	1> 7:0	00			*
Intersection		Burkhardt Avenue		File Na	ame	1. Arc	hwood &	& Burk	hardt_20	40 'No-E	Build' A	M.xus			
Project Descrip	tion	Design Year 2040 'I	No-Build	d' AM Pe	eak Ho	ur							1	* * * * * 1	7
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Demand Inform	nation				EB			WE	3		NB	- II		SB	
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Unseed, S	Voo	Simult Con E/M	On	Green	25.3	24.7	0.0	0.0	0.0	0.0	_		~~		
Earco Modo	Fixed	Simult Cop N/S	On	Pod	3.0	3.0	0.0	0.0	0.0	0.0	_	5	¥	7	0
Force Mode	Fixeu	Sinuit. Gap N/S	Oli	Reu	2.0	2.0	0.0	0.0	0.0	0.0		3	0	1	0
Timer Results			_	FBI		FBT	WB		WBT	NBI		NRT	SBI		SBT
Assigned Phase	<u>م</u>					2			6					-	4
Case Number	<u> </u>			<u> </u>		80			60		+				10.0
Phase Duration	S					30.3			30.3						29.7
Change Period	(Y+R	c) S				5.0			5.0						5.0
Max Allow Hear	ax Allow Headway (<i>MAH</i>), s					3.1			3.1						3.3
Queue Clearan	ax Allow Headway (<i>MAH</i>), s ueue Clearance Time (<i>g</i> s), s					8.1			8.9						8.3
Green Extensio	n Time	(ge), s				0.7			0.7						0.8
Phase Call Pro	bability	(90),0				1.00			1.00		+				1.00
Max Out Proba	bility		_			0.00			0.00				-		0.00
						0.00	1		0100						
Movement Gro	oup Res	sults			EB			WB			NB			SB	
Approach Move	ement			L	Т	R	L	Т	R	L	Т	R	L	Т	R
Assigned Move	ment				2	12	1	6					7	4	14
Adjusted Flow I	Rate (v), veh/h			272		22	98					141	250	
Adjusted Satura	ation Flo	ow Rate (s), veh/h/l	n		1823		1071	1810					1740	1647	
Queue Service	Time (g s), s			6.1		0.8	2.0					3.1	6.3	
Cycle Queue C	learanc	e Time (<i>g c</i>), s			6.1		6.9	2.0					3.1	6.3	
Green Ratio (g	/C)				0.42		0.42	0.42					0.41	0.41	
Capacity (c), v	/eh/h				769		463	763					716	678	
Volume-to-Cap	acity Ra	atio (X)			0.353		0.047	0.128					0.197	0.369	
Back of Queue	(Q), ft	/In (50 th percentile))		52.6	<u> </u>	4.6	17.3					27.7	53.4	
Back of Queue	(Q), ve	eh/In (50 th percenti	ile)		2.1		0.2	0.7					1.1	2.1	
Queue Storage	Ratio (RQ) (50 th percent	tile)		0.00		0.00	0.00					0.00	0.00	
Uniform Delay	(d1), s	/veh			11.8		14.1	10.6					11.3	12.2	
Incremental De	lay (<i>d</i> 2), s/veh			0.1		0.0	0.0					0.0	0.1	
Initial Queue De	nitial Queue Delay (<i>d</i> ₃), s/veh						0.0	0.0					0.0	0.0	
Control Delay (Control Delay (d), s/veh						14.2	10.6					11.4	12.4	
Level of Service	-evel of Service (LOS)						В	В					В	В	
Approach Delay	pproach Delay, s/veh / LOS					В	11.3	5	В	0.0			12.0)	В
Intersection De	iay, s/ve	en / LOS				11	.9						В		
Multimodal Po	sulte				ER			\//P			NR			SB	
Pedestrian LOS	Score	/108								_				00	
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Cycle, s	60.0	Reference Phase	2		<u>⊷</u> ≉ •	- 54	_						4		
Offset, s	0	Reference Point	End		04.7							1	2	3	4
Uncoordinated	Yes	Simult. Gap E/W	On	Yellow	31.7	18.3	0.0	0.0		0.0			$ \rightarrow $		к†л
Force Mode	Fixed	Simult. Gap N/S	On	Red	2.0	2.0	0.0	0.0	0.0	0.0		5	6	7	8
				r					-						
Timer Results				EBI	-	EBT	WBI	-	WBT	NE	BL	NBT	SBL	-	SBT
Assigned Phase	е					2			6			8			
Case Number						6.0			8.0			12.0			
Phase Duration	1, S					36.7			36.7			23.3			
Change Period	ange Period, (Y+R c), s					5.0			5.0			5.0			
Max Allow Hea	ange rendu, (14777), s ix Allow Headway (MAH), s					3.6			3.6			3.2			
Queue Clearan	ce Time	e (g s), s				30.7			15.1			7.3			
Green Extensio	on Time	(g _e), s				0.4			2.4			0.3			
Phase Call Pro	bability					1.00			1.00			1.00			
Max Out Proba	bility					1.00			0.02			0.00			
Movement Gro	oup Res	sults			EB			WE	}		NB			SB	
Approach Move	ement		_	L	Т	R	L	Т	R	L	T	R	L	T	R
Assigned Move	ment			5	2			6	16	3	8	18			
Adjusted Flow I	Rate (v), veh/h		239	141			511			207	-			
Adjusted Satura	ation Flo	w Rate (s), veh/h/l	n	877	1845			161	2		1818	3			
Queue Service	Time (g	g s), S		15.5	2.3			13.1			5.3				
Cycle Queue C	learance	e Time (g c), s		28.7	2.3			13.1			5.3				
Green Ratio (g	r/C)			0.53	0.53			0.53	3		0.30)			
Capacity (c), v	/eh/h			391	975			851			554				
Volume-to-Cap	acity Ra	itio(X)		0.611	0.145	1		0.60	0		0.37	2			
Back of Queue	(Q), ft/	In (50 th percentile)		76.4	18.9			94			53.8	3			
Back of Queue	(Q), ve	eh/In (50 th percenti	le)	3.0	0.7			3.8			2.1				
Queue Storage	Ratio (RQ) (50 th percent	ile)	0.00	0.00			0.00)		0.00)			
Uniform Delay	(d 1), s/	/veh		19.7	7.2			9.8			16.3	3			
Incremental De	lay (<i>d</i> 2), s/veh		2.0	0.0			0.8			0.2				
Initial Queue D	elay(d	з), s/veh		0.0	0.0			0.0			0.0				
Control Delay (<i>d</i>), s/ve	eh		21.7	7.3			10.6	3		16.5	5			
Level of Service	e (LOS)			С	Α			В			В				
Approach Dela	y, s/veh	/ LOS		16.4		В	10.6		В	16	5	В	0.0		
Intersection De	lay, s/ve	h / LOS				13	3.7						В		
Male								14/5						05	
Nutrimodal Re	sults	/1.02			EB			VVE)		NB			SB	
Pedestrian LOS	S Score	/ 105													
BICYCIE LOS SC	ore / LC	15													

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Eoreo Modo	Fixed	Simult Cap N/S	On	Pod	3.0	3.0	0.0	0.0	0.0	0.0	_	5	×.	7	0
Force wode	Fixed	Simult. Gap N/S	On	Reu	2.0	2.0	0.0	0.0	0.0	0.0		5	0	1	0
Timor Posults			_	EBI		EBT	W/B	1	W/BT	NB	1	NBT	SB	1	SBT
Assigned Phase	<u> </u>					2			6				50	<u>''L</u>	4
Case Number	5			<u> </u>		2			8.0	-	-		-		+ 11.0
Phase Duration	S					30.1		-	30.1		-+				29.9
Change Period	(V±R	c) S				5.0			5.0	<u> </u>	+				5.0
Max Allow Hear	ange Period, ($Y + R_c$), s ax Allow Headway (<i>MAH</i>), s					3.1	<u> </u>		3.1	-	-		-		33
Queue Clearan	ax Allow Headway (MAH), s ueue Clearance Time (q s), s					49	<u> </u>		5.5	-	-		-		5.0
Green Extensio	n Time	$(a_{e})_{s}$				0.5			0.5	-	-		-		0.1
Phase Call Pro	hability	(90),0				1.00			1.00		-		-		1.00
Max Out Proba	bility					0.00			0.00	-	-				0.00
max out roba	onity					0.00			0.00						0.00
Movement Gro	oup Res	sults			EB			WB			NE	3		SB	
Approach Move	ement			L	Т	R	L	Т	R		Т	R	L	Т	R
Assigned Move	ment				2	12	1	6					7	4	14
Adjusted Flow F	Rate (v), veh/h			130			163						141	87
Adjusted Satura	ation Flo	ow Rate (s), veh/h/l	n		1675			1697						1749	1533
Queue Service	Time (g s), S			2.9			0.0						3.1	2.1
Cycle Queue C	learanc	e Time (<i>g c</i>), s			2.9			3.5						3.1	2.1
Green Ratio (g	/C)				0.42			0.42		<u> </u>			<u> </u>	0.42	0.42
Capacity (c), v	/eh/h				701			782		<u> </u>				726	636
Volume-to-Capa	acity Ra	atio (X)			0.186			0.208	3	L			<u> </u>	0.195	0.137
Back of Queue	(Q), ft	/In (50 th percentile))		24.8			29.7	<u> </u>				<u> </u>	27.5	17.4
Back of Queue	(Q), ve	eh/In (50 th percenti	ile)		0.9			1.2	<u> </u>	<u> </u>			<u> </u>	1.1	0.7
Queue Storage	Ratio (RQ) (50 th percent	tile)		0.00			0.00		<u> </u>	<u> </u>		<u> </u>	0.00	0.00
Uniform Delay ((d 1), s	/veh			11.0			11.2		Ļ			<u> </u>	11.2	10.9
Incremental De	lay (<i>d</i> 2	e), s/veh			0.0			0.0		<u> </u>	<u> </u>			0.0	0.0
Initial Queue De	nitial Queue Delay (d_3), s/veh							0.0		<u> </u>			<u> </u>	0.0	0.0
Control Delay (Control Delay (d), s/veh							11.2						11.2	10.9
Level of Service	Level of Service (LOS)							В					<u> </u>	В	В
Approach Delay	Approach Delay, s/veh / LOS					В	11.2	2	В	0.0)		11.	1	В
Intersection De	lay, s/ve	eh / LOS				11	.1						В	_	
Multimodal Ba	sulte				EP						NIC	3		CD.	
Pedestrian LOS	Score	/105						VD		-		J	-	36	
Riguelo LOS Co											-		-		
BICYCIE LOS SC	JUIE / LC														

Central Interchange IMSDesign Year 2040 'No-Build1: South Arlington Street & Martin Avenue/I-76 WB Exit Ramp & 2nd Avenue

Design Year 2040 'No-Build' AM Peak Hour

10/07/2016

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL2	SBT	SBR
Lane Configurations		\$			\$		۲	∱ î≽		۲	≜ ⊅	
Traffic Volume (vph)	10	0	30	120	20	90	100	420	50	30	380	40
Future Volume (vph)	10	0	30	120	20	90	100	420	50	30	380	40
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)		5.0			5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor		1.00			1.00		1.00	0.95		1.00	0.95	
Frt		0.90			0.95		1.00	0.98		1.00	0.99	
Flt Protected		0.99			0.97		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1582			1524		1644	3236		1613	3181	
Flt Permitted		0.90			0.81		0.48	1.00		0.43	1.00	
Satd. Flow (perm)		1448			1272		831	3236		736	3181	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adi, Flow (vph)	11	0	33	130	22	98	109	457	54	33	413	43
RTOR Reduction (vph)	0	32	0	0	0	0	0	0	0	0	12	0
Lane Group Flow (vph)	0	12	0	0	250	0	109	511	0	33	444	0
Heavy Vehicles (%)	1%	1%	1%	9%	9%	9%	4%	4%	4%	6%	6%	6%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases	1 01111	4		1 01111	8		1 01111	2		1 01111	6	
Permitted Phases	4	•		8	Ū		2	-		6	0	
Actuated Green, G (s)		14.4		Ŭ	14.4		16.4	16.4		16.4	16.4	
Effective Green, g (s)		14.4			14.4		16.4	16.4		16.4	16.4	
Actuated g/C Ratio		0.28			0.28		0.32	0.32		0.32	0.32	
Clearance Time (s)		5.0			5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		409			359		267	1042		237	1024	
v/s Ratio Prot		107			007		207	c0 16		207	0.14	
v/s Ratio Perm		0.01			c0.20		0.13	00110		0.04	0.1.1	
v/c Ratio		0.03			0.70		0.41	0 49		0.14	0.43	
Uniform Delay, d1		13.2			16.3		13.5	13.9		12.2	13.6	
Progression Factor		1 00			1 00		1 00	1 00		1 00	1 00	
Incremental Delay, d2		0.0			5.8		1.0	0.4		0.3	0.3	
Delay (s)		13.2			22.1		14.5	14.3		12.5	13.9	
Level of Service		B			С		B	B		B	B	
Approach Delay (s)		13.2			22.1		2	14.3		2	13.8	
Approach LOS		B			С			В			В	
Intersection Summary												
HCM 2000 Control Delay			15.8	Н	CM 2000	Level of	Service		В			
HCM 2000 Volume to Capacity	v ratio		0.51		2 2000	2010101	2 3. 1.00		D			
Actuated Cycle Length (s)			50.9	S	um of lost	t time (s)			15.0			
Intersection Canacity Utilizatio	n		67.9%		CULevel	of Service			. с.			
Analysis Period (min)	••		15						v			
c Critical Lane Group												

	¥	~	ŧ۷
Movement	SWL	SWR	SWR2
Lane Configurations	M		
Traffic Volume (vph)	20	50	10
Future Volume (vph)	20	50	10
Ideal Flow (vphpl)	1800	1800	1800
Total Lost time (s)	5.0		
Lane Util. Factor	1.00		
Frt	0.90		
Flt Protected	0.99		
Satd. Flow (prot)	1567		
Flt Permitted	0.99		
Satd. Flow (perm)	1567		
Peak-hour factor, PHF	0.92	0.92	0.92
Adj. Flow (vph)	22	54	11
RTOR Reduction (vph)	78	0	0
Lane Group Flow (vph)	9	0	0
Heavy Vehicles (%)	2%	2%	2%
Turn Type	Prot		
Protected Phases	10		
Permitted Phases			
Actuated Green, G (s)	5.1		
Effective Green, g (s)	5.1		
Actuated g/C Ratio	0.10		
Clearance Time (s)	5.0		
Vehicle Extension (s)	3.0		
Lane Grp Cap (vph)	157		
v/s Ratio Prot	c0.01		
v/s Ratio Perm			
v/c Ratio	0.06		
Uniform Delay, d1	20.7		
Progression Factor	1.00		
Incremental Delay, d2	0,1		
Delay (s)	20,9		
Level of Service	С		
Approach Delay (s)	20,9		
Approach LOS	С		
Intersection Summarv			

-								14							
General Inform	nation								Intersed	tion In	orma	tion		▲\\ ↓	× L.
Agency		GPD Group							Duratior	i, h	0.2	5		4 4	K
Analyst		Brett M. Ferrell		Analys	is Dat	te Jun 8,	2016		Area Ty	be	Oth	er	<u></u> 4		*
Jurisdiction		City of Akron		Time F	Period	PM Pe	eak Hou	ır	PHF		0.9	2	* -*	W	
Urban Street		Archwood Avenue		Analys	is Yea	ar 2040			Analysis	Period	1>	7:00			*
Intersection		Burkhardt Avenue		File Na	ame	5. Arc	hwood &	& Burk	hardt_2	040 'No	·Build'	PM.xus			
Project Descrip	tion	Design Year 2040 'I	No-Build	' PM Pe	ak Ho	our								41471	* (*
							1								
Demand Inform	nation				EB			W	B		N	В		SB	
Approach Move	ement			L	Т	R	L	Т	R			r R	<u> </u>	Т	R
Demand (v), v	eh/h				440) 30	40	26	0				270	100	180
0				i	1		_	-		_					
Signal Informa	ition		-			e and									\mathbf{A}
Cycle, s	60.0	Reference Phase	2		₿'	E						1		3	4
Offset, s	0	Reference Point	End	Green	26.8	23.2	0.0	0.0	0.0	0.0			_		
Uncoordinated	Yes	Simult. Gap E/W	On	Yellow	3.0	3.0	0.0	0.0	0.0	0.0					
Force Mode	Fixed	Simult. Gap N/S	On	Red	2.0	2.0	0.0	0.0	0.0	0.0		5	6	7	8
			_												
Timer Results				EBL	-	EBT	WB	-	WBT	NB		NBT	SBI	-	SBT
Assigned Phase	9				_	2		_	6		\rightarrow				4
Case Number					_	8.0		_	6.0		_				10.0
Phase Duration	, S	<u>,</u>			_	31.8		_	31.8		\rightarrow				28.2
Change Period	hange Period, (Y+R c), s lax Allow Headway (MAH), s					5.0			5.0		_		<u> </u>		5.0
Max Allow Head	ax Allow Headway (MAH), s					3.1	<u> </u>		3.1	-	_		<u> </u>	_	3.3
Queue Clearan		e (gs), s		<u> </u>		14.7	<u> </u>		17.2		_		<u> </u>	_	10.4
Green Extensio	n lime	(ge), s		<u> </u>	_	1.5	<u> </u>	_	1.4	-	\rightarrow		<u> </u>	_	1.2
Phase Call Pro	bability			<u> </u>		1.00	<u> </u>		1.00				<u> </u>		1.00
Max Out Proba	bility					0.03			0.08						0.01
Movement Gro	oup Res	ults			EB	_		WB			NE	3		SB	
Approach Move	ement			L	Т	R	L	Т	R	L	Т	R	L	Т	R
Assigned Move	ment				2	12	1	6					7	4	14
Adjusted Flow I	Rate (v), veh/h			511		43	283					293	304	
Adjusted Satura	ation Flo	w Rate (s), veh/h/l	n		1842	2	860	1810)				1740	1637	
Queue Service	Time (g	g s), S			12.7		2.4	6.1					7.5	8.4	
Cycle Queue C	learanc	e Time (g c), s			12.7		15.2	6.1					7.5	8.4	
Green Ratio (g	/C)				0.45		0.45	0.45	;				0.39	0.39	
Capacity (c), v	/eh/h				823		321	808					673	633	
Volume-to-Capa	acity Ra	itio(X)			0.621	1	0.135	0.35	D I				0.436	0.481	
Back of Queue	(Q), ft/	(In (50 th percentile))		114		11.2	52.4					67.6	71.7	
Back of Queue	(Q), ve	eh/In (50 th percenti	le)		4.6		0.4	2.1					2.7	2.9	
Queue Storage	Ratio (RQ) (50 th percent	tile)		0.00		0.00	0.00					0.00	0.00	
Uniform Delay	(d 1), s	/veh			12.7		18.5	10.9)				13.6	13.9	
Incremental De	lay (d 2), s/veh			1.1		0.1	0.1					0.2	0.2	
Initial Queue De	elay (<i>d</i>	з), s/ve h			0.0		0.0	0.0					0.0	0.0	
Control Delay (control Delay (<i>d</i> ₃), s/ven						18.6	11.0					13.7	14.1	
Level of Service	evel of Service (LOS)						В	В					В	В	
Approach Delay	, s/veh	/ LOS		13.8		В	12.0)	В	0.0)		13.9		В
Intersection De	lay, s/ve	h / LOS				13	3.4						В		
Multimodal Re	sults				EB			WB			NE	3		SB	
Pedestrian LOS	Score	/ LOS													
Bicycle LOS Sc	ore / LC	DS													

·																	
General Inform	nation								Inters	secti	on Info	ormati	on		1444		
Agency		GPD Group							Durati	ion, l	h	0.25					×.
Analyst		Brett M. Ferrell		Analys	is Date	e Jun 8	2016		Area ⁻	Туре	•	Othe	r				4
Jurisdiction		City of Akron		Time F	Period	PM P	eak Hou	ır	PHF			0.92		*	w‡		+ <u>+</u> +
Urban Street		Archwood Avenue		Analys	is Yea	r 2040			Analy	sis F	Period	1> 7:	00	7			*
Intersection		Coventry Street		File Na	ame	6. Arc	hwood	& Cov	entry_	2040) 'No-B	uild' Pl	M.xus		4		
Project Descript	tion	Design Year 2040 'I	No-Build	' PM Pe	eak Ho	ur									1414	14 M	1
D					50				<u> </u>		1			1	0		
Demand Inform	nation				EB		<u> </u>	VV	. I			NB		<u> </u>	SI	3	D
Approach Move	ement			L		R			<u> </u>	R		1	R			\rightarrow	ĸ
Demand (V), V	en/n	_		270	440			21	0 3	510	90	20	20				
Signal Informa	tion				5	_					1				_		
Cycle, s	60.0	Reference Phase	2		<u></u> •	Ξ	_							2			
Offset, s	0	Reference Point	End				~	_				_	1	2		3	4
Uncoordinated	Yes	Simult, Gap F/W	On	Green	32.8	17.2	0.0	0.0		$\frac{0.0}{0}$	0.0	- 11		A			-
Force Mode	Fixed	Simult, Gap N/S	On	Red	2.0	2.0	0.0	0.0) 0).0).0	0.0	_	5	6		7	Y
	1 into a		•		12.0	12:0	10.0	Tore			1010						
Timer Results				EBL	_	EBT	WB	L	WBT	r T	NBL	-	NBT	SB	L	S	BT
Assigned Phase	Э					2			6				8				
Case Number						6.0			8.0				12.0				
Phase Duration	, s					37.8			37.8	T			22.2				
Change Period,	(Y+R	c), S				5.0			5.0				5.0				
Max Allow Head	ax Allow Headway (MAH), s					3.5			3.5				3.3				
Queue Clearan	ax Allow Headway (<i>MAH</i>), s ueue Clearance Time (<i>g</i> s), s					34.8			16.0				5.8				
Green Extensio	n Time	(ge), s				0.0			3.6				0.2				
Phase Call Pro	bability					1.00			1.00				1.00	1			
Max Out Probal	bility					1.00			0.08				0.00				
Movement Gro	oup Res	ults			EB			WE	3			NB		<u> </u>	SE	}	
Approach Move	ement			L	Т	R		T	R	2	L	T	R		Т	\rightarrow	R
Assigned Move	ment	· · · ·		5	2			6	16	6	3	8	18			+	
Adjusted Flow H	Rate (v), veh/h		293	478			565		4		141		<u> </u>		+	
Adjusted Satura	ation Flo	w Rate (s), veh/h/l	n	834	1845			166	3	\rightarrow		1736		<u> </u>		+	
Queue Service	Time (g	gs), S ∓: ()		18.8	9.5			14.()	4		3.8		<u> </u>	<u> </u>	+	
Cycle Queue C	learance	e lime (gc), s		32.8	9.5			14.()	-		3.8	<u> </u>	<u> </u>		+	
Green Ratio (g	/C)			0.55	0.55			0.55	>	-		0.29		<u> </u>	<u> </u>	+	
Capacity (c), v	en/n	4:- ()()		382	1008			911		+		498		<u> </u>		+	
Volume-to-Capa		$\frac{1}{10} \left(X \right)$		0.769	0.474			0.62	1	-		0.284				+	
Back of Queue	$(Q), \pi/$	in (50 th percentile)	10)	119.1	74.4			101.	1	+		36.8				+	
Back of Queue	Q), Ve	$P(x) = \frac{1}{2} \frac{1}{$	ie) ile)	4.7	2.9			4.0		+		1.4		<u> </u>	<u> </u>	+	
Queue Storage	Rallo (.iie)	0.00	0.00			0.00	,	+		16.6		<u> </u>		+	
Incrementel De	$(u_1), s_1$			21.0	0.3			9.3	_	+		0.1		<u> </u>	<u> </u>	+	
Incremental De	ncremental Delay (<i>d</i> ₂), s/veh							1.0		-		0.1		<u> </u>		+	
	hitial Queue Delay (d 3), s/veh							10.0	>	\rightarrow		16.7		<u> </u>	-	+	
Level of Sonvice	Control Delay (d), s/veh							10.3 P	,	-		10.7 R				+	
Approach Dolo	Level of Service (LOS)					R	10.4		P		16 7		B	0.0			
Intersection Dol	pproach Delay, s/veh / LOS					1	10.3		в		10.7		U	0.0 R			
	ay, 5/ve					14	r.∠							U			
Multimodal Re	sults				EB			WE	3			NB			SE	3	
Pedestrian LOS	Score	/LOS															_
Bicycle LOS Sc	ore / LC	DS								1					\rightarrow		

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General Inform	nation								Intersec	tion Info	ormatio	on			× []_
Agency		GPD Group							Duration	h	0.25			2 P	R
Analyst		Brett M. Ferrell		Analys	sis Dat	e Jun 8	2016		Area Typ	е	Other	•	4		4
Jurisdiction		City of Akron		Time F	Period	PM P	eak Hou	ır	PHF		0.92		* -*	WEE	₩
Urban Street		Lovers Lane		Analys	sis Yea	ar 2040			Analysis	Period	1> 7:0	00			*
Intersection		Burkhardt Avenue		File Na	ame	7. Lov	ers Lan	e & Bi	urkhardt_	2040 'N	o-Build	' PM.xus			
Project Descrip	tion	Design Year 2040 'I	No-Build	d' PM Pe	eak Ho	our								***	* (*
										1					
Demand Inform	nation				EB			WE	3		NB			SB	
Approach Move	ement			L	Т	R	L	Т	R	L	Т	R	L	Т	R
Demand (v), v	eh/h				170) 40	20	170)				70	60	50
	41am			I	1	1 111	1				_				
Signal Informa	tion		2	e		<u> </u>									\mathbf{A}
Cycle, s	60.0	Reference Phase	2		₿'	2						1	Z 2	3	4
Offset, s	0	Reference Point	End	Green	25.7	24.3	0.0	0.0	0.0	0.0					
Uncoordinated	Yes	Simult. Gap E/W	On	Yellow	3.0	3.0	0.0	0.0	0.0	0.0	_				
Force Mode	Fixed	Simult. Gap N/S	On	Red	2.0	2.0	0.0	0.0	0.0	0.0		5	6	7	8
Timer Deculto			_			EDT			WDT	ND		NDT			ODT
Assigned Deser				EBI		EBI	VVB		VVB1	INBL	·	INBT	581	-	581
Assigned Phase	9				-	2		\rightarrow	6				<u> </u>		4
Case Number						8.0			8.0		_				11.0
Change Duration	, S					50.7			50.7				<u> </u>	-	29.3
Max Allow Hoor	ange Period, (Y+R c), s ax Allow Headway (MAH), s					0.0 2.1			5.0 2.1						2.0
	ax Allow Headway (MAH), s ueue Clearance Time (a_s), s					7.2		\rightarrow	5.1		-				5.5
Groop Extensio	n Timo	$(g_s), s$		<u> </u>	-	7.3			0.4		-				0.4
Bhase Call Brok		(<i>g</i> e), s		<u> </u>	+	1.00		\rightarrow	0.0	<u> </u>			<u> </u>		0.4
Max Out Broba	bility					0.00			0.00						0.00
	onity					0.00			0.00						0.00
Movement Gro	oup Res	ults			EB			WB			NB			SB	
Approach Move	ement			L	Т	R	L	Т	R	L	Т	R	L	Т	R
Assigned Move	ment				2	12	1	6					7	4	14
Adjusted Flow F	Rate (v), veh/h			228			207						141	54
Adjusted Satura	ation Flo	w Rate (s), veh/h/l	n		1717	•		1754						1762	1533
Queue Service	Time (g	gs), s			5.3			0.0						3.1	1.3
Cycle Queue C	learance	e Time (<i>g c</i>), s			5.3			4.4						3.1	1.3
Green Ratio (g	/C)				0.43			0.43						0.40	0.40
Capacity (c), v	reh/h				735			818						714	621
Volume-to-Capa	acity Ra	tio (<i>X</i>)			0.310)		0.253	3					0.198	0.088
Back of Queue	(Q), ft/	In (50 th percentile)			45.2			37.8						28	10.9
Back of Queue	(Q), ve	eh/In (50 th percenti	le)		1.7			1.5						1.1	0.4
Queue Storage	Ratio (RQ) (50 th percent	tile)		0.00			0.00						0.00	0.00
Uniform Delay ((d 1), s	/veh			11.3			11.1						11.5	11.0
Incremental De	lay (<i>d</i> 2), s/veh			0.1			0.1						0.0	0.0
Initial Queue De	nitial Queue Delay (<i>d</i> ₃), s/veh				0.0			0.0						0.0	0.0
Control Delay (Control Delay (d), s/veh				11.4			11.1						11.6	11.0
Level of Service	evel of Service (LOS)				В			В						В	В
Approach Delay	pproach Delay, s/veh / LOS					В	11.1		В	0.0			11.4		В
Intersection De	lay, s/ve	h / LOS				11	.3						B		
								14/5						0.5	
Nultimodal Re	sults	/1.00			EB			WB			NB			SB	
Pedestrian LOS	Score	/ LUS													
BICYCIE LOS SC	ore / LC	15													

Central Interchange IMSDesign Year 2040 'No-Bu1: South Arlington Street & Martin Avenue/I-76 WB Exit Ramp & 2nd Avenue

Design Year 2040 'No-Build' PM Peak Hour

10/07/2016

	_#	-	\mathbf{r}	4	-	•	1	Ť	۲	4	Ļ	-
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL2	SBT	SBR
Lane Configurations		4			4		٦	†î≽		٦	t₽	
Traffic Volume (vph)	10	0	40	50	10	50	10	580	50	100	770	70
Future Volume (vph)	10	0	40	50	10	50	10	580	50	100	770	70
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)		5.0			5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor		1.00			1.00		1.00	0.95		1.00	0.95	
Frt		0.89			0.94		1.00	0.99		1.00	0.99	
Flt Protected		0.99			0.98		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1575			1516		1644	3250		1613	3186	
Flt Permitted		0.93			0.83		0.25	1.00		0.36	1.00	
Satd. Flow (perm)		1478			1284		433	3250		615	3186	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adi, Flow (vph)	11	0	43	54	11	54	11	630	54	109	837	76
RTOR Reduction (vph)	0	46	0	0	0	0	0	0	0	0	10	0
Lane Group Flow (vph)	0	8	0	0	119	0	11	684	0	109	903	0
Heavy Vehicles (%)	1%	1%	1%	9%	9%	9%	4%	4%	4%	6%	6%	6%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases	1 01111	4		1 01111	8		1 onn	2		1 onn	6	
Permitted Phases	4			8	Ū		2	-		6	Ū	
Actuated Green, G (s)		7.5		Ű	7.5		25.1	25.1		25.1	25.1	
Effective Green, g (s)		7.5			7.5		25.1	25.1		25.1	25.1	
Actuated g/C Ratio		0.14			0.14		0.48	0.48		0.48	0.48	
Clearance Time (s)		5.0			5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		210			183		206	1550		293	1520	
v/s Ratio Prot		210			100		200	0.21		270	c0 28	
v/s Ratio Perm		0.01			c0.09		0.03	0.2.1		0.18	00.20	
v/c Ratio		0.04			0.65		0.05	0 44		0.37	0.59	
Uniform Delay d1		19.4			21.3		74	91		87	10.0	
Progression Factor		1 00			1 00		1 00	1 00		1 00	1 00	
Incremental Delay, d2		0.1			8.0		0.1	0.2		0.8	0.6	
Delay (s)		19.5			29.3		7.5	9.3		9.5	10.7	
Level of Service		B			C		A	A		A	B	
Approach Delay (s)		19.5			29.3		71	9.3			10.5	
Approach LOS		В			С			A			В	
Intersection Summarv												
HCM 2000 Control Delay			11.8	Н	CM 2000	Level of	Service		В			
HCM 2000 Volume to Capacity	ratio		0.53		2 2000	2010101	2 3. 1.00		D			
Actuated Cycle Length (s)			52.6	S	um of lost	t time (s)			15.0			
Intersection Capacity Utilization	n		71.5%		CULevel	of Service			. с.			
Analysis Period (min)	-		15		5 20001				Ŭ			
c Critical Lane Group			. 3									

	4	~	ŧ۷
Movement	SWL	SWR	SWR2
Lane Configurations	M		
Traffic Volume (vph)	10	10	30
Future Volume (vph)	10	10	30
Ideal Flow (vphpl)	1800	1800	1800
Total Lost time (s)	5.0		
Lane Util. Factor	1.00		
Frt	0.89		
Flt Protected	0.99		
Satd. Flow (prot)	1559		
Flt Permitted	0.99		
Satd. Flow (perm)	1559		
Peak-hour factor, PHF	0.92	0.92	0.92
Adj. Flow (vph)	11	11	33
RTOR Reduction (vph)	50	0	0
Lane Group Flow (vph)	5	0	0
Heavy Vehicles (%)	2%	2%	2%
Turn Type	Prot		
Protected Phases	10		
Permitted Phases			
Actuated Green, G (s)	5.0		
Effective Green, g (s)	5.0		
Actuated g/C Ratio	0.10		
Clearance Time (s)	5.0		
Vehicle Extension (s)	3.0		
Lane Grn Can (vph)	148		
v/s Ratio Prot	c0 00		
v/s Ratio Perm	00.00		
v/c Ratio	0.04		
Uniform Delay d1	21.6		
Progression Eactor	1 00		
Incremental Delay d2	0.1		
Delay (s)	21.7		
Level of Service	21.7 C		
Annroach Delay (s)	21 7		
Approach LOS	21.7 C		
	U U		
Intersection Summary			

DESIGN YEAR 2040 'BUILD' CONDITIONS

General Inform	nation								Intersect	ion Info	rmatic	on	4	4741	× []
Agency		GPD Group							Duration,	h	0.25			* 4	k
Analyst		Brett M. Ferrell		Analys	sis Dat	e Jun 8	2016		Area Typ	е	Other		4		4
Jurisdiction		City of Akron		Time F	Period	AM P	eak Hou	ır	PHF		0.92		*-*	W	↓ ↓
Urban Street		Archwood Avenue		Analys	sis Yea	r 2040			Analysis	Period	1> 7:0	00			T T
Intersection		Burkhardt Avenue		File Na	ame	1. Arc	hwood a	& Burk	hardt_20	40 'Build	' AM.x	us			4
Project Descrip	tion	Design Year 2040 'I	Build' Al	M Peak	Hour									41491	* 7
		-		li.			14								
Demand Inform	nation				EB			W	3		NB			SB	
Approach Move	ement			L	Т	R	L	Т	R	L	Т	R	L	Т	R
Demand (v), v	eh/h				220	30	20	90					211	127	212
<u> </u>				1	1		1	-							
Signal Informa	tion		-	-											\mathbf{A}
Cycle, s	60.0	Reference Phase	2		R'							1	Z 2	3	4
Offset, s	0	Reference Point	End	Green	24.5	25.5	0.0	0.0	0.0	0.0					
Uncoordinated	Yes	Simult. Gap E/W	On	Yellow	3.0	3.0	0.0	0.0	0.0	0.0					
Force Mode	Fixed	Simult. Gap N/S	On	Red	2.0	2.0	0.0	0.0	0.0	0.0		5	6	7	8
Timer Desults						EDT			WDT	NDI					ODT
Assigned Deep				EBI	-	2	VVB		VVB1	NBL		INB I	SBL	-	5B1 4
Case Number	с					2			60		+				4
Phase Duration	. c					29.5			29.5						30.5
Change Period	(Y+R)	c) s				5.0			5.0						5.0
Max Allow Head	ax Allow Headway (MAH), s					3.1			3.1						3.3
Queue Clearan	ax Allow Headway (MAH), s ueue Clearance Time (g s), s					8.2			9.1						12.0
Green Extensio	n Time	(ge), s				0.7			0.7						1.2
Phase Call Prol	bability	() // -				1.00			1.00						1.00
Max Out Proba	bility					0.00			0.00						0.01
	,														
Movement Gro	oup Res	sults			EB			WB			NB			SB	
Approach Move	ement			L	Т	R	L	Т	R	L	Т	R	L	Т	R
Assigned Move	ment				2	12	1	6					7	4	14
Adjusted Flow F	Rate (v), veh/h			272		22	98					229	368	
Adjusted Satura	ation Flo	ow Rate (s), veh/h/l	n		1823		1071	1810					1740	1642	
Queue Service	Time (g	g s), s			6.2		0.9	2.0					5.2	10.0	
Cycle Queue C	learanc	e Time (<i>g c</i>), s			6.2		7.1	2.0					5.2	10.0	
Green Ratio (g	/C)				0.41	<u> </u>	0.41	0.41					0.42	0.42	
Capacity (c), v	/eh/h				745		446	739					739	698	
Volume-to-Capa	acity Ra	itio(X)			0.365		0.049	0.132	2				0.310	0.528	
Back of Queue	$(Q), \pi/$	in (50 th percentile)			54.4		4.8	17.8					46	84	
Back of Queue	(Q), Ve	BO(50 th percentil)	ie)		2.2		0.2	0.7					1.8	3.4	
Uniform Dolay			liie)		12.2		14.9	11 1					11 4	12.00	
Incremental De	(u +), s				0.1		0.0	0.0					0.1	0.4	
Incrementar De	ay (uz				0.1		0.0	0.0					0.1	0.4	
Control Dolay (nitial Queue Delay (d_3), s/veh						14.9	11 1					11.5	12.2	
Level of Service	Control Delay (d), s/veh						14.0 R	- 11.1 B					R R	B	
Approach Delay	evel of Service (LOS)					B	11 9		B	0.0			12 5		В
Intersection Del	lav. s/ve	h / LOS		12.0		12	2.4		-	0.0			B		-
													-		
Multimodal Re	sults				EB			WB			NB			SB	
Pedestrian LOS	S Score	/ LOS													
Bicycle LOS Sc	ore / LC	DS													

r									r					11		
General Inform	nation								Inte	ersecti	ion Inf	ormati	on	_	***	44 L <u>a</u>
Agency		GPD Group		0		0			Dur	ration,	h	0.25				×.
Analyst		Brett M. Ferrell		Analys	is Dat	te Jun 8	, 2016		Are	еа Туре)	Othe	-	<u></u> →_,		4
Jurisdiction		City of Akron		Time F	Period	AM P	eak Ho	bur	PH	F		0.92		*	WÌE	- 4 - →
Urban Street		Archwood Avenue		Analys	is Yea	ar 2040			Ana	alysis F	Period	1> 7:	00	r 4		7 7
Intersection		Coventry Street		File Na	ame	2. Arc	hwood	l & Cov	/entr	y_204	0 'Build	l' AM.xι	ıs		*	
Project Descrip	tion	Design Year 2040 'I	Build' Al	/I Peak	Hour									1	* 1 * *	* 1
D					= = =				(D		1			1	0.5	
Demand Inform	nation				EB		<u> </u>	W	/B		<u> </u>	NB		<u> </u>	SB	
Approach Move	ement			L		R	44			R			R	<u> </u>		R
Demand (v), v	eh/h			210	211			9	0	380	20	160	10			
Signal Informa	tion					5										
Cycle, s	60.0	Reference Phase	2			ا هر	7							4		
Offset, s	0	Reference Point	End		00.7		Ω		<u> </u>				1	2	3	4
Uncoordinated	Yes	Simult. Gap E/W	On	Yellow	30.7	19.3	0.0	0.0) า	0.0	0.0	-		4		sta
Force Mode	Fixed	Simult. Gap N/S	On	Red	2.0	2.0	0.0	0.0	5 D	0.0	0.0		5	6	7	
						, i i i				÷						
Timer Results				EBL	-	EBT	W	BL	W	BT	NBI	-	NBT	SBL	-	SBT
Assigned Phase	е					2			6	3			8			
Case Number						6.0			8.	.0			12.0			
Phase Duration	, S					35.7			35	5.7			24.3			
Change Period	hange Period, $(Y+R_c)$, s					5.0			5.	.0			5.0			
Max Allow Head	ax Allow Headway (MAH), s					3.5			3.	.5			3.2			
Queue Clearan	ce Time	(<i>g</i> s), s				30.7			15	5.6			7.2			
Green Extensio	n Time	(g _e), s				0.0			2.	.5			0.3			
Phase Call Pro	bability					1.00			1.(00			1.00			
Max Out Proba	bility					1.00			0.0	04			0.00			
Movement Gro	un Res	ults			EB			\//F	2			NB			SB	
Approach Move	ement				Т	R		Т	, 	R	1	Т	R	1	Т	R
Assigned Move	ment			5	2		<u> </u>	6	+	16	3	8	18	_		
Adjusted Flow I	Rate (v), veh/h		228	229			511			-	207				
Adjusted Satura	ation Flo	w Rate (s), veh/h/l	n	877	1845	5		161	0			1818				
Queue Service	Time (d	as). S		15.1	4.2			13.	6			5.2				
Cvcle Queue C	learance	e Time (q c), s		28.7	4.2	+		13.	6			5.2				
Green Ratio (g	/C)			0.51	0.51	1		0.5	1			0.32				
Capacity (c), v	/eh/h			370	944			824	1			585				
Volume-to-Cap	acity Ra	tio (X)		0.617	0.243	3		0.62	20			0.353				
Back of Queue	(Q), ft/	In (50 th percentile)		75.7	34.1			100	.5			52				
Back of Queue	(Q), ve	eh/In (50 th percenti	le)	3.0	1.3			4.0)			2.0				
Queue Storage	Ratio (RQ) (50 th percent	ile)	0.00	0.00			0.0	0			0.00				
Uniform Delay	(d1), s/	/veh		20.7	8.2			10.	5			15.6				
Incremental De	lay (<i>d</i> 2), s/veh		2.3	0.0			1.1				0.1				
Initial Queue De	nitial Queue Delay (d_3), s/veh				0.0			0.0)			0.0				
Control Delay (control Delay (d), s/veh							11.	5			15.7				
Level of Service	evel of Service (LOS)							В				В				
Approach Dela	pproach Delay, s/veh / LOS					В	11	.5	E	3	15.7	7	В	0.0		
Intersection De	lay, s/ve	h / LOS				1	3.9							В		
N 141 · · · ·																
Multimodal Re	sults	// 00			EB			WE	5			NB			SB	
Pedestrian LOS	Score	/ LUS														
BICYCLE LOS SC	ore / LC	5														

General Inform	nation								Intersec	tion Info	ormatio	on		1474¢†.	× [L_	
Agency		GPD Group							Duratior	, h	0.25			2 F	k	
Analyst		Brett M. Ferrell		Analys	sis Date	Jun 8,	2016		Area Ty	be	Othe	r	4		4	
Jurisdiction		City of Akron		Time F	Period	AM Pe	ak Hou	r	PHF		0.92			W	* _	
Urban Street		Lovers Lane		Analys	sis Year	· 2040			Analysis	Period	1> 7:00				*	
Intersection		Burkhardt Avenue		File Na	ame	3. Lov	ers Lan	e & Bi	urkhardt	_2040 'B	uild' AN	/l.xus				
Project Descrip	tion	Design Year 2040 'I	Build' Al	/ Peak	Hour								<u>ነፋዮቀ</u> ነ ⊭7			
		5														
Demand Inform	nation				EB			W	3		NB			SB		
Approach Move	ement			L	Т	R	L	Т	R	L	Т	R	L	Т	R	
Demand (v), v	eh/h				80	40	30	12	0				26	11	23	
				1												
Signal Informa	tion	1		-		216									\mathbf{k}	
Cycle, s	60.0	Reference Phase	2		₿°							1	\mathbf{d}	3		
Offset, s	0	Reference Point	End	Green	25.6	24.4	0.0	0.0	0.0	0.0	_		_	5	~	
Uncoordinated	Yes	Simult. Gap E/W	On	Yellow	3.0	3.0	0.0	0.0	0.0	0.0						
Force Mode	Fixed	Simult. Gap N/S	On	Red	2.0	2.0	0.0	0.0	0.0	0.0		5	6	7	8	
											26					
Timer Results			EBL	-	EBT	WBI	-	WBT	NBL	-	NBT	SB	L	SBT		
Assigned Phase					2			6						4		
Case Number					8.0			8.0						11.0		
Phase Duration, s					30.6			30.6						29.4		
Change Period,	, (Y+R	c), S							5.0						5.0	
Max Allow Headway (MAH), s						3.1			3.1						3.3	
Queue Clearance Time (g_s), s						3.5			5.4						2.8	
Green Extensio	n Time	(g _e), s				0.5			0.5						0.1	
Phase Call Prol	bability					1.00			1.00						1.00	
Max Out Proba	bility					0.00			0.00						0.00	
Movement Gro	oup Res	sults			EB			WB			NB			SB		
Approach Move	ement		_	L	T	R	L	T	R	L	T	R	L	T	R	
Assigned Move	ment				2	12	1	6					7	4	14	
Adjusted Flow F	Rate (v), veh/h			66	64		163						40	25	
Adjusted Satura	ation Flo	ow Rate (s), veh/h/l	n		1776	1583		1697	·					1748	1533	
Queue Service	Time (d	a s). S			1.3	1.5		0.0						0.8	0.6	
Cycle Queue C	learanc	e Time (<i>q</i> _c), s			1.3	1.5		3.4	-					0.8	0.6	
Green Ratio (g	/C)				0.43	0.43		0.43						0.41	0.41	
Capacity (c), v	/eh/h				758	675		796						711	624	
Volume-to-Capa	acity Ra	itio(X)			0.087	0.095		0.205	5					0.057	0.040	
Back of Queue	(Q), ft/	/In (50 th percentile)			11.8	11.5		29						7.5	4.9	
Back of Queue	(Q), ve	eh/In (50 th percenti	le)		0.4	0.4		1.2	1					0.3	0.2	
Queue Storage	Ratio (RQ) (50 th percent	tile)		0.00	0.00		0.00						0.00	0.00	
Uniform Delay ((d 1), s	/veh			10.2	10.3		10.8						10.8	10.7	
Incremental Delay (<i>d</i> ₂), s/veh					0.0	0.0		0.0						0.0	0.0	
Initial Queue Delay (d_3), s/veh					0.0	0.0		0.0						0.0	0.0	
Control Delay (d), s/veh					10.3	10.3		10.9						10.8	10.7	
Level of Service (LOS)					В	В		В						В	В	
Approach Delay, s/veh / LOS			10.3	3	В	10.9		В	0.0			10.8	3	В		
Intersection Delay, s/veh / LOS						10	.6						В			
Multimodal Re	sults				EB			WB			NB			SB		
Pedestrian LOS	Score	/ LOS														
Bicycle LOS Sc	ore / LC	DS														

Central Interchange IMSDesign Year 2040 'But1: South Arlington Street & Martin Avenue/I-76 WB Exit Ramp & 2nd Avenue

Design Year 2040 'Build' AM Peak Hour

10/13/2016

	_#	-	\rightarrow	✓	+	×.	_ ▲	T T	T.	4	↓ I	-
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL2	SBT	SBR
Lane Configurations		\$			4		۲	ŧ₽		۲	¢₽	
Traffic Volume (vph)	10	0	30	140	20	180	100	420	50	30	380	40
Future Volume (vph)	10	0	30	140	20	180	100	420	50	30	380	40
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)		5.0			5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor		1.00			1.00		1.00	0.95		1.00	0.95	
Frt		0.90			0.93		1.00	0.98		1.00	0.99	
Flt Protected		0.99			0.98		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1582			1502		1644	3236		1613	3181	
Flt Permitted		0.90			0.85		0.46	1.00		0.40	1.00	
Satd. Flow (perm)		1435			1298		792	3236		686	3181	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	0	33	152	22	196	109	457	54	33	413	43
RTOR Reduction (vph)	0	28	0	0	0	0	0	0	0	0	13	0
Lane Group Flow (vph)	0	16	0	0	370	0	109	511	0	33	443	0
Heavy Vehicles (%)	1%	1%	1%	9%	9%	9%	4%	4%	4%	6%	6%	6%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		18.0			18.0		12.9	12.9		12.9	12.9	
Effective Green, g (s)		18.0			18.0		12.9	12.9		12.9	12.9	
Actuated g/C Ratio		0.35			0.35		0.25	0.25		0.25	0.25	
Clearance Time (s)		5.0			5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		508			459		201	821		174	807	
v/s Ratio Prot								c0.16			0.14	
v/s Ratio Perm		0.01			c0.29		0.14			0.05		
v/c Ratio		0.03			0.81		0.54	0.62		0.19	0.55	
Uniform Delay, d1		10.7			14.8		16.4	16.8		14.9	16.4	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.0			10.0		3.0	1.5		0.5	0.8	
Delay (s)		10.7			24.8		19.4	18.3		15.4	17.2	
Level of Service		В			С		В	В		В	В	
Approach Delay (s)		10.7			24.8			18.5			17.1	
Approach LOS		В			С			В			В	
Intersection Summary												
HCM 2000 Control Delay			19.4	Н	CM 2000	Level of	Service		В			
HCM 2000 Volume to Capacit	ty ratio		0.64									
Actuated Cycle Length (s)			50.8	S	um of lost	time (s)			15.0			
Intersection Capacity Utilization	on		74.9%	IC	CU Level o	of Service	•		D			
Analysis Period (min)			15									
c Critical Lane Group												

Central Interchange IMS	Design Year 2040 'Build' Al	M Peak Hour
1: South Arlington Street & Martin Avenue/I-76 W	B Exit Ramp & 2nd Avenue	10/13/2016

	- F	~	t
Movement	SWL	SWR	SWR2
Lane Configurations	M		
Traffic Volume (vph)	20	50	10
Future Volume (vph)	20	50	10
Ideal Flow (vphpl)	1800	1800	1800
Total Lost time (s)	5.0		
Lane Util. Factor	1.00		
Frt	0.90		
Flt Protected	0.99		
Satd. Flow (prot)	1567		
Flt Permitted	0.99		
Satd. Flow (perm)	1567		
Peak-hour factor, PHF	0.92	0.92	0.92
Adj. Flow (vph)	22	54	11
RTOR Reduction (vph)	79	0	0
Lane Group Flow (vph)	8	0	0
Heavy Vehicles (%)	2%	2%	2%
Turn Type	Prot		
Protected Phases	10		
Permitted Phases			
Actuated Green, G (s)	4.9		
Effective Green, g (s)	4.9		
Actuated g/C Ratio	0.10		
Clearance Time (s)	5.0		
Vehicle Extension (s)	3.0		
Lane Grp Cap (vph)	151		
v/s Ratio Prot	c0.01		
v/s Ratio Perm			
v/c Ratio	0.06		
Uniform Delay, d1	20.8		
Progression Factor	1.00		
Incremental Delay, d2	0.2		
Delay (s)	21.0		
Level of Service	С		
Approach Delay (s)	21.0		
Approach LOS	С		
Intersection Summary			
intersection summary			

General Inform	nation								Intersed	tion In	forma	tion		4 7 1	a L <u>a</u>	
Agency		GPD Group							Duratior	i, h	0.25	5		4 4	k	
Analyst		Brett M. Ferrell		Analys	sis Dat	te Jun 8	2016		Area Ty	be	Oth	er	<u>소</u>		4	
Jurisdiction		City of Akron		Time F	Period	PM P	eak Hou	ır	PHF		0.92	2	* -*	w		
Urban Street		Archwood Avenue		Analys	sis Yea	ar 2040			Analysis	Period	1>7	7:00			*	
Intersection		Burkhardt Avenue		File Na	ame	5. Arc	hwood a	& Burl	khardt_2)40 'Bui	ld' PM	.xus				
Project Descrip	tion	Design Year 2040 'I	Build' Pl	M Peak	Hour								<u>1414747</u>			
						,						ļ.				
Demand Inform	nation				EB			W	В		N	B		SB		
Approach Move	ement			L	Т	R	L	Т	R	L	T	- R	L	Т	R	
Demand (v), v	eh/h				440) 30	40	26	0				332	153	225	
	1				1	1 111		1		_						
Signal Informa		Defenses Dhees	0	-		<u> </u>									ሐ	
Cycle, s	60.0	Reference Phase	2		R	e.						1	S 2	3	4	
Offset, s	0	Reference Point	End	Green	25.9	24.1	0.0	0.0	0.0	0.0						
Uncoordinated	Yes	Simult. Gap E/W	On	Yellow	3.0	3.0	0.0	0.0	0.0	0.0	_		Y			
Force Mode	Fixed	Simult. Gap N/S	On	Red	2.0	2.0	0.0	0.0	0.0	0.0	-	5	6	7	8	
Timer Deculto					FDT		1	W/DT	NE	1	NDT	CDI				
Assigned Phase				EDL		2	VVD		<u>vvbi</u> 6	INC			301	-	1	
Case Number					-	8.0			60		+			-	10.0	
Case Number Phase Duration is						30.9			30.9		-				29.1	
Change Period $(Y+R_c)$ s						5.0			5.0						5.0	
Max Allow Head	dway(/	<i>MAH</i>), s				3.1			3.1						3.3	
Queue Clearan	ce Time	e (gs), s				15.1			17.6		_				13.9	
Green Extensio	n Time	(ge), s				1.5			1.3						1.5	
Phase Call Pro	bability					1.00			1.00						1.00	
Max Out Proba	bility					0.05			0.13					(0.07	
	_						_									
Movement Gro	oup Res	sults			EB		<u> </u>			<u> </u>				SB	D	
Approach Move	ment			L	1	R 10			R			ĸ			R	
Adjusted Flow	meni Doto (u) vob/b				12	12	0	_			_	7	4	14	
Adjusted Flow I), ven/n			311		43	203					301	411		
Adjusted Satura			n		1842	<u> </u>	860	181	J			_	1740	1650		
Queue Service	Time ((ys), s			13.1		2.5	6.3	_			_	9.4	11.9		
Croop Ratio (e filme (<i>g c</i>), s			13.1		15.0	0.3					9.4	0.40		
Capacity (c) y	/C) /eh/h				795	<u>'</u>	304	781	,		-		699	663		
Volume-to-Cap	acity Ra	utio (X)			0.643	3	0.143	0.36	2				0.516	0.620		
Back of Queue	(Q), ft	/In (50 th percentile))		120.5	5	11.6	54.8	3				84.4	105.9		
Back of Queue	(Q), ve	eh/In (50 th percenti	ile)		4.8		0.5	2.2					3.4	4.2		
Queue Storage	Ratio (RQ) (50 th percent	tile)		0.00		0.00	0.00)				0.00	0.00		
Uniform Delay	(d1), s	/veh			13.4		19.5	11.5	;				13.6	14.3		
Incremental De	lay (d 2), s/veh			1.4		0.1	0.1					0.3	1.3		
Initial Queue Delay (<i>d</i> ₃), s/veh					0.0		0.0	0.0					0.0	0.0		
Control Delay (d), s/veh					14.8		19.6	11.6	;			1	13.9	15.6		
Level of Service (LOS)					В		В	В					В	В		
Approach Delay, s/veh / LOS				14.8	3	В	12.7	7	В	0.0)		14.8	3	В	
Intersection De	lay, s/ve	eh / LOS				14	1.4						В			
														05		
Multimodal Re	sults	/1.00			EB			WE	5	-	NB	5		SB		
Pedestrian LOS	Score	/ LUS														
BICYCIE LOS SC	ore / LC	75														

								11							
General Inforn	nation								Intersed	tion In	formati	on	_	4441	
Agency		GPD Group							Duratior	i, h	0.25		_		Ł
Analyst		Brett M. Ferrell		Analys	is Dat	e Jun 8	2016		Area Ty	be	Othe	r	×		4
Jurisdiction		City of Akron		Time F	Period	PM P	eak Hou	ır	PHF		0.92			W∔E	÷
Urban Street		Archwood Avenue		Analys	is Yea	r 2040		Analysis Pe			² eriod 1> 7:00				ب ۲
Intersection		Coventry Street		File Na	File Name 6. Archwood & Coventry_2040 'Build' PM.xus									*	
Project Descrip	tion	Design Year 2040 'I	Build' Pl	M Peak	Hour								1	4 1 4 Y	14
Domand Inform	nation				ГР		14/				NE		SD SD		
Approach Move	mation					P				<u> </u>					D
Approach wove				270	502	ĸ		21	<u>к</u>		20	20			
Demand (V), V				270	502			21	0 310	90	20	20			
Signal Informa	ation		_		6	<u> </u>									
Cycle, s	60.0	Reference Phase	2		<u>⊢</u> ″ *	- 54	2						4		
Offset, s	0	Reference Point	End	Croop	22.7	17.2	0.0				_	1	2	3	4
Uncoordinated	Yes	Simult. Gap E/W	On	Yellow	32.7	3.0	0.0	0.0	0.0	0.0	_		4		61 2
Force Mode	Fixed	Simult. Gap N/S	On	Red	2.0	2.0	0.0	0.0	0.0	0.0		5	6	7	
Timer Results				EBL	-	EBT	WB	L	WBT	NE	L	NBT	SBL	-	SBT
Assigned Phase					2			6			8				
Case Number						6.0			8.0			12.0			
Phase Duration	1, S					37.7			37.7			22.3			
Change Period	, (Y+R	c), S				5.0			5.0			5.0			
Max Allow Headway (MAH), s						3.5			3.5			3.3			
Queue Clearance Time (g_s), s						34.7			16.0			5.8			
Green Extensio	on Time	(ge), s				0.0			3.8			0.2			
Phase Call Pro	bability					1.00			1.00			1.00			
Max Out Proba	bility					1.00			0.10			0.00			
Movement Gro	oup Res	aults	_		FB			WB			NB			SB	
Approach Move	ement				Т	R	1	Т	R		Т	R	1	Т	R
Assigned Move	ment			5	2			6	16	3	8	18			
Adjusted Flow	Rate (v), veh/h	_	293	546			565	-		141				
Adjusted Satura	ation Flo	w Rate (s), veh/h/l	n	834	1845	1		1666	3		1736				
Queue Service	Time (g	g s), S		18.7	11.5	1		14.0			3.8				
Cycle Queue C	learanc	e Time (g c), s		32.7	11.5			14.0			3.8				
Green Ratio (g	r/C)			0.55	0.55	1		0.55			0.29				\square
Capacity (c), v	/eh/h			380	1005			908			501	1			
Volume-to-Cap	acity Ra	tio(X)		0.773	0.543	;		0.62	3		0.282				
Back of Queue	(Q), ft/	In (50 th percentile)		120.4	91.7			102.4	4		36.6				
Back of Queue	(Q), ve	eh/In (50 th percenti	le)	4.7	3.6			4.1			1.4				
Queue Storage	Ratio (RQ) (50 th percent	ile)	0.00	0.00			0.00			0.00				
Uniform Delay	(d 1), s	/veh		21.7	8.8			9.4			16.5				
Incremental Delay (<i>d</i> ₂), s/veh				8.7	0.3			1.0			0.1				
Initial Queue Delay (d 3), s/veh			0.0	0.0			0.0			0.0					
Control Delay (d), s/veh				30.4	9.2			10.4			16.7				
Level of Service (LOS)				С	Α			В			В				
Approach Delay, s/veh / LOS			16.6		В	10.4	1	В	16.	7	В	0.0			
Intersection De	lay, s/ve	h / LOS				14	4.3						В		
														0.5	
Nultimodal Re	sults	/1.00			EB			WB			NB			SB	
Pedestrian LOS	S Score	/ LUS												\rightarrow	
BICYCIE LOS SC	core / LC	15													

General Inform	nation								ntersect	ion Info	rmatio	on		I 4 44 44 ↓ .	⊨ L		
Agency		GPD Group						1	Duration,	h	0.25		┓ _┛ ┛	2 ₽			
Analyst		Brett M. Ferrell		Analys	is Dat	te Jun 8,	2016		Area Typ	е	Other	•	4		4		
Jurisdiction		City of Akron		Time F	Period	PM Pe	eak Hou	ur I	PHF		0.92		*-*	W	•≠		
Urban Street		Lovers Lane		Analys	sis Yea	ar 2040			Analysis	Period	1> 7:00				*		
Intersection		Burkhardt Avenue		File Na	ame	7. Lov	ers Lan	e & Bu	irkhardt_	2040 'Bi	uild' PN	/l.xus					
Project Descrip	tion	Design Year 2040 'I	Build' Pl	M Peak	Hour									<u> </u>			
Demand Inform	nation			EB		5		WE	3		NB			SB			
Approach Move	ement			L	Т	R	L	Т	R	L	Т	R	L	Т	R		
Demand (v), v	eh/h				170) 40	20	170)				20	17	13		
				10							_				-		
Signal Informa	tion	1		=		_21U									\mathbf{A}		
Cycle, s	60.0	Reference Phase	2	-	₿'	6						1	$\mathbf{\nabla}_{2}$	3	4		
Offset, s	0	Reference Point	End	Green	26.1	23.9	0.0	0.0	0.0	0.0	_						
Uncoordinated	Yes	Simult. Gap E/W	On	Yellow	3.0	3.0	0.0	0.0	0.0	0.0							
Force Mode	Fixed	Simult. Gap N/S	On	Red	2.0	2.0	0.0	0.0	0.0	0.0		5	6	7	8		
				D			0						0				
Timer Results				EBL	-	EBT	WB	L	WBT	NBL		NBT	SBI	-	SBT		
Assigned Phase					2			6						4			
Case Number						8.0			8.0						11.0		
Phase Duration	, S					31.1			31.1						28.9		
Change Period, (Y+R c), s						5.0			5.0						5.0		
Max Allow Head	dway(<i>I</i>	MAH), s				3.1			3.1						3.3		
Queue Clearan	ce Time	e (g s), s				7.2			6.4						2.8		
Green Extensio	n Time	(ge), s				0.8			0.8						0.1		
Phase Call Pro	bability					1.00			1.00						1.00		
Max Out Proba	bility					0.00			0.00						0.00		
Movement Gro	oup Res	sults			EB			WB			NB			SB	-		
Approach Move	ement				1	R			R	L	1	R			R		
Assigned Move	ment	<u>`````````````````````````````````````</u>			2	12	1	6						4	14		
Adjusted Flow I	Rate (v	r), veh/h			228			207						40	14		
Adjusted Satura	ation Flo	ow Rate (s), veh/h/l	n		1717	7		1754						1762	1533		
Queue Service	Time (g	g s), S			5.2			0.0						0.8	0.3		
Cycle Queue C	learanc	e Time (<i>g c</i>), s			5.2			4.4						0.8	0.3		
Green Ratio (g	v/C)				0.44	·		0.44						0.40	0.40		
Capacity (c), v	/eh/h				747			829						702	611		
Volume-to-Cap	acity Ra	atio (X)			0.306	6		0.249						0.057	0.023		
Back of Queue	(Q), ft/	/in (50 th percentile)			44.2			37						1.1	2.8		
Back of Queue	(Q), Ve	BO(50 th percent)	ie) tilo)		1.7			1.5					<u> </u>	0.3	0.1		
Queue Storage			lile)		11.0			10.00					<u> </u>	11 1	0.00		
Uniform Delay (<i>d</i> 1), s/veh					0.1			0.1						0.0	0.0		
Incremental Delay (d 2), s/ven					0.1	-		0.1						0.0	0.0		
Initial Queue Delay (d 3), s/veh					0.0			10.0						0.0	11.0		
Control Delay (<i>a</i>), s/veh					П.1 в			10.9						П.Т D	П.U в		
Level of Service (LOS)				11 1		P	10.0		B	0.0			11 1				
Approach Delay, s/veh / LOS				11.1		11	0		U	0.0			R (1.)		D		
	ay, 5/ve					11	.0						J				
Multimodal Re	sults				EB			WB			NB			SB			
Pedestrian LOS	S Score	/ LOS															
Bicycle LOS Sc	ore / LC	DS															
,																	

Central Interchange IMS

Design Year 2040 'Build' PM Peak Hour

1: South Arlington Street & Martin Avenue/I-76 WB Exit Ramp & 2nd Avenue

8/23/2016

	_#	-	\mathbf{r}	∢	←	•	1	Ť	۲	G.	Ļ	~
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL2	SBT	SBR
Lane Configurations		4			\$		۲	t₽		٦	≜ †⊅	
Volume (vph)	10	0	40	80	10	130	10	580	50	100	770	70
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)		5.0			5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor		1.00			1.00		1.00	0.95		1.00	0.95	
Frt		0.89			0.92		1.00	0.99		1.00	0.99	
Flt Protected		0.99			0.98		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1575			1493		1644	3250		1613	3186	
Flt Permitted		0.92			0.86		0.21	1.00		0.33	1.00	
Satd. Flow (perm)		1456			1303		358	3250		560	3186	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	0	43	87	11	141	11	630	54	109	837	76
RTOR Reduction (vph)	0	41	0	0	0	0	0	0	0	0	10	0
Lane Group Flow (vph)	0	13	0	0	239	0	11	684	0	109	903	0
Heavy Vehicles (%)	1%	1%	1%	9%	9%	9%	4%	4%	4%	6%	6%	6%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		13.1			13.1		21.2	21.2		21.2	21.2	
Effective Green, g (s)		13.1			13.1		21.2	21.2		21.2	21.2	
Actuated g/C Ratio		0.24			0.24		0.39	0.39		0.39	0.39	
Clearance Time (s)		5.0			5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		349			312		139	1261		217	1237	
v/s Ratio Prot								0.21			c0.28	
v/s Ratio Perm		0.01			c0.18		0.03			0.19		
v/c Ratio		0.04			0.77		0.08	0.54		0.50	0.73	
Uniform Delay, d1		15.9			19.3		10.5	12.9		12.7	14.3	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.0			10.7		0.2	0.5		1.8	2.2	
Delay (s)		16.0			30.0		10.8	13.4		14.5	16.4	
Level of Service		В			С		В	В		В	В	
Approach Delay (s)		16.0			30.0			13.4			16.2	
Approach LOS		В			С			В			В	
Intersection Summary												
HCM 2000 Control Delay			17.0	Н	CM 2000	Level of S	Service		В			
HCM 2000 Volume to Capacity ratio			0.65									
Actuated Cycle Length (s)			54.6	S	um of lost	time (s)			15.0			
Intersection Capacity Utilizat	tion		78.5%	IC	CU Level o	of Service	:		D			
Analysis Period (min)			15									

c Critical Lane Group
		~	ŧ٧
Movement	SWL	SWR	SWR2
Lane Configurations	M		
Volume (vph)	10	10	30
Ideal Flow (vphpl)	1800	1800	1800
Total Lost time (s)	5.0		
Lane Util. Factor	1.00		
Frt	0.89		
Flt Protected	0.99		
Satd. Flow (prot)	1559		
Flt Permitted	0.99		
Satd. Flow (perm)	1559		
Peak-hour factor, PHF	0.92	0.92	0.92
Adj. Flow (vph)	11	11	33
RTOR Reduction (vph)	50	0	0
Lane Group Flow (vph)	5	0	0
Heavy Vehicles (%)	2%	2%	2%
Turn Type	Prot		
Protected Phases	10		
Permitted Phases			
Actuated Green, G (s)	5.3		
Effective Green, g (s)	5.3		
Actuated g/C Ratio	0.10		
Clearance Time (s)	5.0		
Vehicle Extension (s)	3.0		
Lane Grp Cap (vph)	151		
v/s Ratio Prot	c0.00		
v/s Ratio Perm			
v/c Ratio	0.04		
Uniform Delay, d1	22.3		
Progression Factor	1.00		
Incremental Delay, d2	0.1		
Delay (s)	22.4		
Level of Service	С		
Approach Delay (s)	22.4		
Approach LOS	С		
Intersection Summary			

APPENDIX C HCS FREEWAY CAPACITY ANALYSIS

DESIGN YEAR 2040 'NO-BUILD' CONDITIONS

AM PEAK HOUR

	BASIC FRE	EEWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information	0	
Analyst	Brett Ferrell		Highway/Direction of Trave	l-77 Sou Eastbou	thbound/I-76 nd
Agency or Company Date Performed Analysis Time Period	GPD Group 06/01/16 AM Peak Hou	ır	From/To Jurisdiction Analysis Year	F-1 'No-Build 2040	d'
Project Description SUM-	76-Central Inte	erchange (PID	101402)		
Oper.(LOS)			es.(N)	🗌 Plan	ning Data
Flow Inputs					
Volume, V AADT	3800	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T	0.92 8	
Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	%RVs, P _R General Terrain: Grade % Length Up/Down %	0 Level mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
Ε _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.962	
Speed Inputs			Calc Speed Adj and	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	4		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x I	N x f _{HV 1074}	nc/h/ln	Design (N) Design LOS v. = (V. or DDHV) / (PHE x	Nxf	
x f _p)	1011	p0/11/11	x f_)	HV	pc/h/ln
S	55.0	mph	S P		mph
$D = v_p / S$	19.5	pc/mi/ln	$D = v_p / S$		pc/mi/ln
LOS	С		Required Number of Lanes	5, N	
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed	S - Spee D - Densi FFS - Free BFFS - Ba	d ity e-flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11
			-		

HCS 2010TM Version 6.80

	BASIC FRE	EEWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst	Brett Ferrell		Highway/Direction of Trave	l-77 Sou Eastbou	thbound/I-76 nd
Agency or Company Date Performed Analysis Time Period	GPD Group 06/01/16 AM Peak Hou	ır	From/To Jurisdiction Analysis Year	F-2 'No-Build 2040	1'
Project Description SUM-	76-Central Inte	erchange (PID	101402)		
Oper.(LOS)			es.(N)	🗌 Plan	ning Data
Flow Inputs					
Volume, V AADT	3980	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T	0.92 9	
Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	%RVs, P _R General Terrain: Grade % Length Up/Down %	0 Level mi	
Calculate Flow Adjust	tments				
f _p	1.00		E _R	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.957	
Speed Inputs			Calc Speed Adj and	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	4		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x N	V x f _{HV 1130}	nc/h/ln	Design (N) Design LOS v. = (V. or DDHV) / (PHE x	Nxf	
x f _p)	1100	pornini	xf)	HV	pc/h/ln
S	55.0	mph	S		mph
$D = v_p / S$	20.5	pc/mi/ln	D = v _n / S		pc/mi/ln
LOS	С		Required Number of Lanes	s, N	·
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design h	S - Speer D - Densi FFS - Free BFFS - Bas	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EEWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst	Brett Ferrell		Highway/Direction of Trave	l-77 Sou Eastbou	ithbound/I-76 nd
Agency or Company Date Performed Analysis Time Period	GPD Group 06/01/16 AM Peak Hoı	ur	From/To Jurisdiction Analysis Year	F-3 'No-Build 2040	d'
Project Description SUM-	76-Central Inte	erchange (PID	101402)		
✓ Oper.(LOS)			Des.(N)	Plan	ining Data
Flow Inputs					
Volume, V AADT	3980	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T	0.92 9	
Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	%RVs, P _R General Terrain: Grade % Length Up/Down %	0 Level mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.957	
Speed Inputs			Calc Speed Adj and	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	3		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x I	N x f _{HV 1507}	pc/h/ln	Design (N) Design LOS v = (V or DDHV) / (PHF x	N x f	
x f _p)	1001	p0/1/1/11	$x f_{r}$)	HV	pc/h/ln
S	55.0	mph	S p		mph
$D = v_p / S$	27.4	pc/mi/ln	$D = v_p / S$		pc/mi/ln
LOS	D		Required Number of Lanes	s, N	
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service	S - Spee D - Densi FFS - Free BFFS - Ba	d ity e-flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11
DDHV - Directional design	hour volume		11-3		

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	BASIC FR	EEWAY SE	GMENTS WORKSHEE	T	
General Information			Site Information		
Analyst	Brett Ferrell		Highway/Direction of Trave	el I-77 Sout F_4	thbound
Date Performed	06/01/16		Jurisdiction	'No-Buila	ľ
Analysis Time Period	AM Peak Hou	ır	Analysis Year	2040	
Project Description SUM-	-76-Central Inte	erchange (PID	101402)		
Oper.(LOS)			Des.(N)	Plan	ning Data
Flow Inputs					
Volume, V	2520	veh/h	Peak-Hour Factor, PHF	0.92	
AADT		veh/day	%Trucks and Buses, P _T	3	
Peak-Hr Prop. of AADT, K			%RVs, P _R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
Coloulata Elovy Adiua	tmanta		Up/Down %		
				4.0	
Г _р	1.00		E _R	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 2)]$	1)] <i>0.985</i>	
Speed Inputs			Calc Speed Adj and	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	2		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed,		mph			·
I OS and Porformanc	o Moseuros	-	Dosign (N)		
Operational (LOS)			Design (N)		
v _p = (V or DDHV) / (PHF x l	N x f _{HV} (acc			N f	
x f _n)	1390	pc/h/ln	$v_p = (V \text{ or DDHV}) / (PHF x)$	N X I _{HV}	pc/h/ln
S	55.0	mph	x f _p)		
$D = v_p / S$	25.3	pc/mi/ln	S		mph
LOS	С		$D = v_p / S$		pc/mi/ln
	-		Required Number of Lanes	s, N	
Glossary			Factor Location		
N - Number of lanes	S - Spee	d	E _p - Exhibits 11-10 11-12		f Exhibit 11-8
V - Hourly volume	D - Densi	ty	$E_{\rm R} = E_{\rm X}$	11_13	f _ Exhibit 11-9
v _p - Flow rate	FFS - Free	-flow speed	f Dage 11 19		
LOS - Level of service	BFFS - Ba	se free-flow		11.0	1RD - Page 11-11
speed			LUS, S, FFS, V_p - EXNIBITS	11-2,	
DDHV - Directional design	hour volume		11-3		

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	BASIC FRE	EEWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	ır	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-77 South F-5 'No-Build' 2040	bound
Project Description SUM-	76-Central Inte	erchange (PID	101402)		
Oper.(LOS)			es.(N)	Planni	ng Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K	2560	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R	0.92 4 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _ρ Ε _τ	1.00 1.5		E _R f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1	1.2)] 0.980	
Speed Inputs			Calc Speed Adi and I	FFS	
Lane Width		ft			
Rt-Side Lat Clearance		ft	f		mph
Number of Lanes. N	2		ι _{LW} f		mph
Total Ramp Density, TRD		ramps/mi	'LC TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph	110	00.0	тири
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{HV}		<u>Design (N)</u> Design LOS		
x f _p)	1419	pc/h/ln	$v_p = (V \text{ or DDHV}) / (PHF x)$ x f _p)	N X I _{HV}	pc/h/ln
D = y / S	25.8	nc/mi/ln	S		mph
LOS	23.0 C	permini	D = v _p / S Required Number of Lanes	s, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design	S - Speed D - Densi FFS - Free BFFS - Bas hour volume	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	f _l 11-13 f _l T 11-2,	_{-w} - Exhibit 11-8 _{-C} - Exhibit 11-9 RD - Page 11-11

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	ır	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-77 South F-6 'No-Build' 2040	bound
Project Description SUM-	76-Central Inte	rchange (PID	101402)	2070	
✓ Oper.(LOS)			es.(N)	Planni	ng Data
Flow Inputs					-
Volume, V AADT	2370	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T	0.92 4	
Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	%RVs, P _R General Terrain: Grade % Length Up/Down %	0 Level mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
Ε _T	1.5		f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1)] 0.980	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	2		f _{IC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{HV}		<u>Design (N)</u> Design LOS		
x f _p)	1314	pc/h/ln	v _p = (V or DDHV) / (PHF x x f)	N x f _{HV}	pc/h/ln
S	55.0	mph	s 'p'		mph
$D = v_p / S$	23.9	pc/mi/ln	D = v / S		nc/mi/ln
LOS	С		P Required Number of Lanes	s, N	P • • • • • • •
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design	S - Speed D - Densi FFS - Free BFFS - Bas hour volume	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	f _I 11-13 f _I T 11-2,	_{_W} - Exhibit 11-8 _{_C} - Exhibit 11-9 RD - Page 11-11

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	BASIC FRE	EEWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst	Brett Ferrell		Highway/Direction of Trave	l I-77 Sout	hbound
Date Performed	06/01/16		Jurisdiction	r-7 'No-Build	,
Analysis Time Period	AM Peak Hou	ır	Analysis Year	2040	
Project Description SUM-	76-Central Inte	erchange (PID	101402)		
Oper.(LOS)			es.(N)	Planr	ning Data
Flow Inputs					
Volume, V	5140	veh/h	Peak-Hour Factor, PHF	0.92	
AADT		veh/day	%Trucks and Buses, P_T	5	
Peak-Hr Prop. of AADT, K			%RVs, P _R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
Ε _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] <i>0.976</i>	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	3		fue		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FES	55 0	mph
Base free-flow Speed,		mph	110	00.0	mpn
BFFS		прп			
LOS and Performanc	e Measures		Design (N)		
Operational (LOS)			<u>Design (N)</u>		
$v_{x} = (V \text{ or } DDHV) / (PHF x)$	N x funz		Design LOS		
xf)	1909	pc/h/ln	$v_p = (V \text{ or DDHV}) / (PHF x)$	N x f _{HV}	nc/h/ln
s	54 7	mnh	x f _p)		p0/1/11
D = y/S	24.0	npn nc/mi/ln	S		mph
$D = v_p / S$	54.9	permini	$D = v_p / S$		pc/mi/ln
LUS	D		Required Number of Lanes	3, N	
Glossary			Factor Location		
N - Number of lanes	S - Spee	d	E Exhibite 11 10 11 12		f Exhibit 11.8
V - Hourly volume	D - Densi	ty	$E_{\rm R}^{-}$ Exhibits 11-10, 11-12	11 10	f Exhibit 11.0
v Flow rate	FFS - Free	-flow speed	$E_{T} = E_{X} + 100000000000000000000000000000000000$	11-13	
LOS - Level of service	BFFS - Ba	se free-flow	r _p - Page 11-18		IRD - Page 11-11
speed			LOS, S, FFS, v _p - Exhibits	11-2,	
DDHV - Directional design	hour volume		11-3		

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	el I-77 North F-8 'No-Build' 2040	bound
Project Description SUM-	76-Central Inte	rchange (PID	101402)	2010	
✓ Oper.(LOS)			es.(N)	Plann	ing Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT_K	7770	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _D	0.92 4 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
E _T	1.5		f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1)] 0.980	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	3		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{HV}		<u>Design (N)</u> Design LOS		
x f _p)	11 2872	pc/h/ln	v _p = (V or DDHV) / (PHF x x f)	N x f _{HV}	pc/h/ln
S	26.6	mph	S		mph
$D = v_p / S$	107.9	pc/mi/ln	$D = v_n / S$		pc/mi/ln
LOS	F		Required Number of Lanes	s, N	·
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design l	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	f 11-13 f - 11-2,	_{LW} - Exhibit 11-8 _{LC} - Exhibit 11-9 IRD - Page 11-11

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst	Brett Ferrell		Highway/Direction of Trave	el I-77 North	bound
Agency or Company	GPD Group 06/01/16		From/10 Jurisdiction	F-9 'No-Ruild'	
Analysis Time Period	AM Peak Hou	r	Analysis Year	2040	
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)			es.(N)	Planni	ng Data
Flow Inputs					
Volume, V	2850	veh/h	Peak-Hour Factor, PHF	0.92	
AADT		veh/day	%Trucks and Buses, P _T	3	
Peak-Hr Prop. of AADT, K			%RVs, P _P	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.985	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f, w		mph
Number of Lanes, N	2		fue		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	, FES	55.0	mnh
Base free-flow Speed,		mph		00.0	mpri
BFFS		трп			
LOS and Performance	e Measures		Design (N)		
Operational (LOS)			<u>Design (N)</u>		
V = (V or DDHV) / (PHE x N)	l v f		Design LOS		
$v_p = (v \text{ or } D D h v) / (r h x h)$	¹	pc/h/ln	$v_p = (V \text{ or DDHV}) / (PHF x)$	N x f _{HV}	n o /b /l n
x ' _p)	55.0		x f _p)		pc/n/m
5	55.0	mpn	S		mph
$D = v_p / S$	28.6	pc/mi/ln	$D = v_n / S$		pc/mi/ln
LOS	D		Required Number of Lanes	s, N	
Glossary			Factor Location		
N - Number of lanes	S - Speed	4			
	D - Deneil	V	E_{R} - Exhibits 11-10, 11-12	f	_{LW} - Exhibit 11-8
· Flow rate		flow speed	E _T - Exhibits 11-10, 11-11,	11-13 f	_{LC} - Exhibit 11-9
p - Flow rate	BEES Dor	now speeu	f _p - Page 11-18	٦	RD - Page 11-11
speed	D113 - Dat		LOS, S, FFS, v _p - Exhibits	11-2,	
DDHV - Directional design h	nour volume		11-3		

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	I I-77 NB / I F-10 'No-Build' 2040	I-76 WB Ramp
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)		D	es.(N)	Plann	ing Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K x D	3200	veh/h veh/day veh/h	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R General Terrain: Grade % Length	0.92 1 0 Level mi	
			Up/Down %		
Calculate Flow Adius	tments				
f.	1.00		En	1.2	
ρ Ε _T	1.5		к f _{HV} = 1/[1+Р _т (Е _т - 1) + Р _R (Е _R - 1)] 0.995	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{I W}		mph
Number of Lanes, N	2		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			r
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x I x f _p) S	N x f _{HV} 1748 55 0	pc/h/ln	<u>Design (N)</u> Design LOS v _p = (V or DDHV) / (PHF x x f _p)	N x f _{HV}	pc/h/ln
D = v / S	31.8	nc/mi/ln	S		mph
LOS	D	p0/11/11	D = v _p / S Required Number of Lanes	5, N	pc/mi/ln
Glossarv			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	d fy flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 1 - - 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	ır	Highway/Direction of Trave From/To Jurisdiction Analysis Year	I I-77 NB / F-11 No-Buila 2040	′ I-76 WB Ramp ''
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)			es.(N)	Planı	ning Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K x D	2830	veh/h veh/day veh/h	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R General Terrain: Grade % Length	0.92 2 0 Level mi	
			Up/Down %		
Calculate Flow Adjus	tments				
f	1.00		E _R	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.990	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{I W}		mph
Number of Lanes, N	2		f _{IC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x I	N x f _{HV} 1553	pc/h/ln	<u>Design (N)</u> Design LOS v _n = (V or DDHV) / (PHF x	N x f _{HV}	
x f _p) S	55.0	mph	x f _p)		pc/h/ln
D = v. / S	28.2	nc/mi/ln	S		mph
LOS	D	pormin	D = v _p / S Required Number of Lanes	5, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design	S - Speed D - Densi FFS - Free BFFS - Bas hour volume	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst	Brett Ferrell		Highway/Direction of Trave	el I-77 Nort Westbou	hbound/I-76 nd
Agency or Company Date Performed Analysis Time Period	GPD Group 06/01/16 AM Peak Hou	ır	From/To Jurisdiction Analysis Year	F-12 'No-Buila 2040	<i>י</i>
Project Description SUM-3	76-Central Inte	erchange (PID	101402)		
Oper.(LOS)			es.(N)	🗌 Planı	ning Data
Flow Inputs					
Volume, V AADT	6730	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T	0.92 9	
Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	%RVs, P _R General Terrain: Grade % Length Up/Down %	0 Level mi	
Calculate Flow Adjust	tments				
f _p	1.00		E _R	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.957	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	4		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x N	N x f _{HV} 1911	pc/h/ln	<u>Design (N)</u> Design LOS v _o = (V or DDHV) / (PHF x	N x f _{uv}	
x f _p)		•	x f _n)	110	pc/h/ln
S D-V /S	54.7	mph	S		mph
$D = v_p / S$	34.9 D	pc/mi/in	$D = v_p / S$		pc/mi/ln
200	D		Required Number of Lanes	s, N	
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design h	S - Speer D - Densi FFS - Free BFFS - Bas	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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			1	
		Site Information		
Brett Ferrell		Highway/Direction of Trave	l I-77 Norti Westbou	hbound/I-76 nd
GPD Group 06/01/16 AM Peak Hou	ır	From/To Jurisdiction Analysis Year	F-13 'No-Build 2040	,
76-Central Inte	erchange (PID	101402)		
	🗌 D	es.(N)	Planr	ning Data
3870	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T	0.92 11	
	veh/h	%RVs, P _R General Terrain: Grade % Length Up/Down %	0 Level mi	
tments				
1.00		E _R	1.2	
1.5		f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1)] 0.948	
		Calc Speed Adj and I	FS	
	ft			
	ft	f _{LW}		mph
4		f _{LC}		mph
	ramps/mi	TRD Adjustment		mph
55.0	mph	FFS	55.0	mph
	mph			
e Measures		Design (N)		
I x f _{HV 1100}	po/b/lp	Design (N) Design LOS v. = (V. or DDH\/) / (PHE v.	Nyf	
1109	permin	$v_p = (v \text{ of } D D H v) / (1 H H x)$	IN A HV	pc/h/ln
55.0	mph	S		mph
20.2	pc/mi/ln	$D = v_p / S$		pc/mi/ln
С		Required Number of Lanes	s, N	•
		Factor Location		
S - Speed D - Densi FFS - Free BFFS - Bas	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11
	Brett Ferrell GPD Group 06/01/16 AM Peak Hou 76-Central Inter 3870 38	Brett Ferrell GPD Group 06/01/16 AM Peak Hour 76-Central Interchange (PID D 3870 veh/h veh/day veh/h 55.0 ft ft ft ft ft ft ft ft ft ft	Site InformationBrett FerrellHighway/Direction of TraveGPD Group 06/01/16From/To JurisdictionAM Peak HourAnalysis Year76-Central Interchange (PID 101402)Des.(N)3870veh/h veh/dayPeak-Hour Factor, PHF %Trucks and Buses, PT %RVs, PR General Terrain: Grade3870veh/h veh/dayPeak-Hour Factor, PHF %Trucks and Buses, PT %RVs, PR General Terrain: Grade1.00ER Trucks and Buses, PT %RVs, PR General Terrain: Up/Down %1.00FR Trucks and Buses, PT %RVs, PR General Terrain: Trucks and Buses, PT %RVs, PR General Terrain: Grade1.00FR Trucks and Buses, PT %RVs, PR General Terrain: Grade1.00FR Trucks and Buses, PT %RVs, PR General Terrain: Grade1.00FR Trucks and Buses, PT %RVs, PR General Terrain: Grade1.00FR Trucks Trucks and Buses, PT %RVs, PR General Terrain: Grade1.00FR Truck Trucks Trucks Trucks MPR1.00FR Trucks Trucks Trucks Trucks Trucks Trucks Solution1.11Station Trucks Solution1.12Station Trucks Solution1.12Station Trucks Solution1.12Solution Trucks Solution1.12Solution Trucks Solution1.12Solution Trucks Trucks C1.12Solution Trucks Trucks Solution1.12Solution Trucks Trucks Solution1.12Solut	Site InformationBrett FerrellHighway/Direction of TravelI-77 North WestbouGPD GroupFrom/ToF-1306/01/16JurisdictionNo-BuildAM Peak HourAnalysis Year204076-Central Interchange (PID 101402)Des.(N)Planr3870veh/hPeak-Hour Factor, PHF0.92veh/day% Trucks and Buses, P _T 11%RVs, P _R 0General Terrain:LevelGrade% Lengthmi1.00E _R 1.21.5ftfLftfLfLftfLFSftfLftfLftfLftfLftfLftfLftfLftfLftfLftfLftfLftfLftfLftfLftfLftfLftfL </td

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	ır	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-76 Eastb F-14 'No-Build' 2040	bound
Project Description SUM-	76-Central Inte	erchange (PID	101402)		
Oper.(LOS)			es.(N)	🗌 Plann	ing Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K	2720	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R	0.92 12 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.943	
Speed Inputs			Calc Speed Adj and I	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	2		f _{IC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{uv}		<u>Design (N)</u> Design LOS		
x f _p)	1567	pc/h/ln	$v_p = (V \text{ or DDHV}) / (PHF x)$ x f _p)	N x f _{HV}	pc/h/ln
S D - V / S	55.U	mpn	S		mph
$D = v_p / S$	28.5 D	pc/m/m	$D = v_p / S$		pc/mi/ln
200	D		Required Number of Lanes	s, N	
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design	S - Speed D - Densi FFS - Free BFFS - Bas hour volume	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 f - 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analvsis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	ır	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-76 Eastb F-15 'No-Build' 2040	ound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)			Des.(N)	Planni	ng Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D	1560	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R General Terrain:	0.92 6 0 Level	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	mi	
Calculate Flow Adjus	tments				
f _n	1.00		E _R	1.2	
Ε _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.971	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	2		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			·
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{uv}		<u>Design (N)</u> Design LOS		
x f _p)	11 873	pc/h/ln	$v_p = (V \text{ or DDHV}) / (PHF x)$ x f _p)	N x f _{HV}	pc/h/ln
S	55.0	mph	S P		mph
$D = v_p / S$	15.9	pc/mi/ln	$D = v_p / S$		pc/mi/ln
LOS	В		Required Number of Lanes	s, N	
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design I	S - Speed D - Densi FFS - Free BFFS - Bas hour volume	d ty flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	f 11-13 f 11-2,	_{LW} - Exhibit 11-8 _{LC} - Exhibit 11-9 RD - Page 11-11

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	ır	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-76 Eastl F-16 'No-Build' 2040	bound ,
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)			es.(N)	Planr	iing Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K	3780	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _P	0.92 12 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _ρ Ε _τ	1.00 1.5		E _R f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1	1.2)]0.943	
Speed Inputs			Calc Speed Adi and I	FFS	
Lane Width		ft			
Rt-Side Lat Clearance		ft	f		mah
Number of Lanes. N	4	it i	'LW f		mph
Total Ramp Density, TRD		ramps/mi	'LC TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph		00.0	трп
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{HV}		<u>Design (N)</u> Design LOS		
x f _p) S	55 0	pc/h/ln mph	$v_p = (V \text{ or DDHV}) / (PHF x)$ x f _p)	N X I _{HV}	pc/h/ln
$D = v_n / S$	19.8	pc/mi/ln	S		mph
LOS	C	P	D = v _p / S Required Number of Lanes	s, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design I	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	ır	Highway/Direction of Trave From/To Jurisdiction Analysis Year	el I-76 Eastl F-17 'No-Build' 2040	bound
Project Description SUM-	76-Central Inte	rchange (PID	101402)	2070	
✓ Oper.(LOS)			es.(N)	Plann	ing Data
Flow Inputs					0
Volume, V	3780	veh/h	Peak-Hour Factor, PHF	0.92	
AADT		veh/day	%Trucks and Buses, P _T	12	
Peak-Hr Prop. of AADT, K			%RVs, P _R	0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length	Level mi	
		-	Up/Down %		
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.943	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{I W}		mph
Number of Lanes, N	3		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performanc	e Measures		Design (N)		
Operational (LOS)			<u>Design (N)</u>		
$v_{x} = (V \text{ or } DDHV) / (PHF x)$	N x funz		Design LOS		
$x f_{n}$)	1452	pc/h/ln	$v_p = (V \text{ or DDHV}) / (PHF x)$	N x f _{HV}	pc/h/ln
S	60.0	mph	x f _p)		
$D = v_p / S$	24.2	pc/mi/ln	S D = w / C		mph
LOS	С		$D = V_p / S$ Required Number of Lanes	s N	pc/mi/ln
Glossary			Factor Location	-,	
	<u> </u>	4			
		u tu	E _R - Exhibits 11-10, 11-12		f _{LW} - Exhibit 11-8
		flow apod	E _T - Exhibits 11-10, 11-11,	11-13	f _{LC} - Exhibit 11-9
v _p - riuw rate	BEES - Ba	now speeu	f _p - Page 11-18		TRD - Page 11-11
speed			LOS, S, FFS, v_p - Exhibits	11-2,	
DDHV - Directional design	hour volume		11-3		

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
			I		
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	ır	Highway/Direction of Trave From/To Jurisdiction Analysis Year	I I-76 Eastb F-18 'No-Build' 2040	bound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)			ves.(N)	Plann	ing Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K	3210	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R	0.92 13 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _p Ε _T	1.00 1.5		E_{R} $f_{HV} = 1/[1+P_{T}(E_{T} - 1) + P_{R}(E_{R} - 1)$	1.2)] 0.939	
Speed Inputs			Calc Speed Adi and I	FS	
Lane Width		ft			
Rt-Side Lat Clearance		ft	f		mph
Number of Lanes, N	3		LW f		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph		00.0	mpn
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{HV} (acc		<u>Design (N)</u> Design LOS	N 6	
x f _p) S	60.0	pc/h/ln mph	$v_p = (V \text{ or DDHV}) / (PHF x)$ x f _p)	N x f _{HV}	pc/h/ln
$D = v_p / S$	20.6	pc/mi/ln	S		mph
LOS	С	·	D = v _p / S Required Number of Lanes	s, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design l	S - Speed D - Densi FFS - Free BFFS - Bas hour volume	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	1 11-13 1 - 11-2,	r _{LW} - Exhibit 11-8 F _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed	Brett Ferrell GPD Group 06/01/16		Highway/Direction of Trave From/To Jurisdiction	el I-76 West F-19 'No-Build'	bound
Analysis Time Period	AM Peak Hou	ir	Analysis Year	2040	
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Flow Inputs			Jes.(N)	Plann	ing Data
	6410	vob/b	Dook Hour Footor, DHE	0.02	
AADT	0410	veh/day	%Trucks and Buses, P _T	0.92 11	
Peak-Hr Prop. of AADT, K			%RVs, P _R	0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _n	1.00		E _R	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.948	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	3		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performanc	e Measures		Design (N)		
Operational (LOS)			<u>Design (N)</u>		
v _p = (V or DDHV) / (PHF x l	N x f _{HV 2450}	n e /h /ln		Nivf	
x f _p)	2450	pc/n/in	$v_p = (V \cup D \cup D \cup V) / (F \cap F X)$	HV	pc/h/ln
S	46.9	mph	×' _p /		mah
$D = v_p / S$	52.3	pc/mi/ln			mpn
LOS	F		$D = v_p / S$ Required Number of Lanes	s, N	pc/mi/m
Glossary			Factor Location		
N - Number of lanes	S - Speed	t	E Exhibito 11 10 11 10		
V - Hourly volume	D - Densi [,]	ty	$E_{\rm R}$ - EXHIBITS 11-10, 11-12	11 10	
v _n - Flow rate	FFS - Free	- flow speed	$E_{T} = EXIIIDILS [1] = 10, [1] = 11,$	11-13	
LOS - Level of service	BFFS - Bas	se free-flow	LOS, S, FFS, v _p - Exhibits	11-2,	ואט - Page 11-11
DDHV - Directional design	hour volume		11-3		

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Г	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	r	Highway/Direction of Travel From/To Jurisdiction Analysis Year	l-76 Westb F-20 'No-Build' 2040	pound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)			es.(N)	Planni	ng Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K	6710	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R	0.92 10 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
Ε _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.952	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	3		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{LNZ}		<u>Design (N)</u> Design LOS		
x f _p)	11 2553	pc/h/ln	v _p = (V or DDHV) / (PHF x f x f _p)	N x f _{HV}	pc/h/ln
S D - V / S	41.0	mpn	S		mph
$D = v_p / S$	02.3 F	pc/mi/in	$D = v_p / S$		pc/mi/ln
200	1		Required Number of Lanes	, N	
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design I	S - Speed D - Densit FFS - Free BFFS - Bas	flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 1 11-3	f _l 11-13 f _l T 11-2,	_{-W} - Exhibit 11-8 _{-C} - Exhibit 11-9 'RD - Page 11-11

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-76 Westk F-21 'No-Build' 2040	bound
Project Description SUM-	76-Central Inte	rchange (PID	101402)	2070	
✓ Oper.(LOS)			es.(N)	Planni	ng Data
Flow Inputs					-
Volume, V AADT	5200	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T	0.92 13	
Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	%RVs, P _R General Terrain: Grade % Length Up/Down %	0 Level mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.939	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	2		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{uv}		<u>Design (N)</u> Design LOS		
x f _p)	[¬] 3010	pc/h/ln	v _p = (V or DDHV) / (PHF x x f)	N x f _{HV}	pc/h/ln
S	18.9	mph	S		mph
D = v _p / S	159.7	pc/mi/ln	$D = v_n / S$		pc/mi/ln
LOS	F		P Required Number of Lanes	s, N	P
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design I	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	f 11-13 f 1 11-2,	_{LW} - Exhibit 11-8 _{LC} - Exhibit 11-9 ⁻ RD - Page 11-11

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	BASIC FRE	EEWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst	Brett Ferrell		Highway/Direction of Trave	el I-76 Westi F-22	bound
Date Performed	06/01/16		Jurisdiction	'No-Build'	
Analysis Time Period	AM Peak Hou	ır	Analysis Year	2040	
Project Description SUM-	·76-Central Inte	erchange (PID	101402)		
Oper.(LOS)			es.(N)	Plann	ing Data
Flow Inputs					
Volume, V	3900	veh/h	Peak-Hour Factor, PHF	0.92	
AADT		veh/day	%Trucks and Buses, P _T	9	
Peak-Hr Prop. of AADT, K			%RVs, P _R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
Oslavista Flava Adima	<u></u>		Up/Down %		
Calculate Flow Adjus	tments		_		
^f p	1.00		E _R	1.2	
Ε _Τ	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] <i>0.957</i>	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	2		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed,		mph		••••	
BFFS					
LOS and Performanc	e Measures		Design (N)		
Operational (LOS)			<u>Design (N)</u>		
$v_{x} = (V \text{ or } DDHV) / (PHF x)$	N x fuy		Design LOS		
xf)	2215	pc/h/ln	$v_p = (V \text{ or DDHV}) / (PHF x)$	N x f _{HV}	nc/h/ln
s	50 7	mph	x f _p)		po/11/11
D = v / S	43.6	nc/mi/ln	S		mph
	43.0 E	pe/m/m	D = v _p / S		pc/mi/ln
200	L		Required Number of Lanes	3, N	
Glossary			Factor Location		
N - Number of lanes	S - Speed	d	E Exhibite 11 10 11 12	f	Evhibit 11.8
V - Hourly volume	D - Densi	ty	$E_{\rm R}$ = Exhibits 11-10, 11-12	11 12 f	LW - Exhibit 11.0
v - Flow rate	FFS - Free	-flow speed	$L_T = EXHIBITS + 1 - 10, + 1 - 11,$		
LOS - Level of service	BFFS - Ba	se free-flow	¹ p - Page 11-18		I КО - Page 11-11
speed			LOS, S, FFS, v_p - Exhibits	11-2,	
DDHV - Directional design	hour volume		11-3		

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Г	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	r	Highway/Direction of Travel From/To Jurisdiction Analysis Year	State Route 8 F-23 'No-Build' 2040	3 Southbound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)		D	es.(N)	Planning 🗌	Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D	4600	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R General Terrain:	0.92 6 0 Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
Calculate Flow Adius	tments		Op / DOm /70		
f	1 00			12	
E _T	1.5		-R f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1)]0.971	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	3		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			•
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x I	N x f _{HV 4 7 4 7}		Design (N) Design LOS	d v f	
x f _p) S	55.0	pc/n/in mph	v _p = (v or DDHv)7 (PHF x r x f _p)	n x i _{HV}	pc/h/ln
$D = v_n / S$	31.2	pc/mi/ln	S (C		mph
LOS	D		D = v _p / S Required Number of Lanes	, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 1 11-3	f _{LW} 11-13 f _{LC} TRI 11-2,	- Exhibit 11-8 - Exhibit 11-9 ጋ - Page 11-11

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	BASIC FREEWAY SEGMENTS WORKSHEET						
General Information Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	r	Highway/Direction of Travel From/To Jurisdiction Analysis Year	State Route F-24 'No-Build' 2040	8 Southbound		
Project Description SUM-	76-Central Inte	rchange (PID	101402)				
Oper.(LOS)		🗌 D	es.(N)	🗌 Planning	Data		
Flow Inputs							
Volume, V AADT Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K x D	5250	veh/h veh/day veh/h	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R General Terrain: Grade % Length	0.92 6 0 Level mi			
			Up/Down %				
Calculate Flow Adjus	tments						
f _ρ Ε _τ	1.00 1.5		E_R $f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	1.2]0.971			
Speed Inputs			Calc Speed Adj and F	FS			
Lane Width		ft					
Rt-Side Lat. Clearance		ft	f		mph		
Number of Lanes, N	3		f. a		mph		
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph		
FFS (measured)	55.0	mph	FFS	55 0	mph		
Base free-flow Speed, BFFS		mph		55.0	трп		
LOS and Performance	e Measures		Design (N)				
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x f x f _p) S D = v _p / S LOS	N x f _{HV} 1959 54.4 36.0 E	pc/h/ln mph pc/mi/ln	<u>Design (N)</u> Design LOS v _p = (V or DDHV) / (PHF x N x f _p) S D = v _p / S Required Number of Lanes	N x f _{HV} , N	pc/h/ln mph pc/mi/ln		
Glossary			Factor Location				
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design l	S - Speed D - Densit FFS - Free BFFS - Bas	t y flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 7 11-3	f _{LW} 11-13 f _{LC} TR 11-2,	- Exhibit 11-8 - Exhibit 11-9 D - Page 11-11		

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BASIC FREEWAY SEGMENTS WORKSHEET						
General Information			Site Information			
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l SR-8 Sou F-25 'No-Build' 2040	thbound	
Project Description SUM-	76-Central Inte	rchange (PID	101402)			
Oper.(LOS)		D	es.(N)	Plann	ing Data	
Flow Inputs						
Volume, V AADT Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D	3050	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R General Terrain:	0.92 6 0 Level		
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	mi		
Calculate Flow Adjus	tments		•			
f _p	1.00		E _R	1.2		
Ē _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.971		
Speed Inputs			Calc Speed Adj and F	FS		
Lane Width		ft				
Rt-Side Lat. Clearance		ft	f _{LW}		mph	
Number of Lanes, N	2		f _{LC}		mph	
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph	
FFS (measured)	55.0	mph	FFS	55.0	mph	
Base free-flow Speed, BFFS		mph				
LOS and Performanc	e Measures		Design (N)			
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{HV / = = =}		<u>Design (N)</u> Design LOS			
x f _p)	55.0	pc/h/ln	v _p = (V or DDHV) / (PHF x x f _p)	N x f _{HV}	pc/h/In	
D = v. / S	31.0	pc/mi/ln	S		mph	
LOS	D	P 0111111	D = v _p / S Required Number of Lanes	5, N	pc/mi/ln	
Glossary			Factor Location			
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	d flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	f 11-13 f - 11-2,	_{LW} - Exhibit 11-8 _{LC} - Exhibit 11-9 IRD - Page 11-11	

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BASIC FREEWAY SEGMENTS WORKSHEET						
General Information			Site Information			
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	r	Highway/Direction of Travel From/To Jurisdiction Analysis Year	State Route F-26 'No-Build' 2040	8 Northbound	
Project Description SUM-	76-Central Inte	rchange (PID	101402)			
Oper.(LOS)		D	es.(N)	Planning	j Data	
Flow Inputs						
Volume, V AADT Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D	5600	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R General Terrain:	0.92 5 0 Level		
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	mi		
Calculate Flow Adius	tments					
f _n	1.00		Ep	1.2		
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.976		
Speed Inputs			Calc Speed Adj and F	FS		
Lane Width		ft				
Rt-Side Lat. Clearance		ft	f _{LW}		mph	
Number of Lanes, N	2		f _{LC}		mph	
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph	
FFS (measured)	55.0	mph	FFS	55.0	mph	
Base free-flow Speed, BFFS		mph				
LOS and Performanc	e Measures		Design (N)			
<u>Operational (LOS)</u> v ₋ = (V or DDHV) / (PHF x I	N X fuy		<u>Design (N)</u> Design LOS			
x f _p) S	[¬] 3120 12.0	pc/h/ln mph	v _p = (V or DDHV) / (PHF x f x f _p)	√ x f _{HV}	pc/h/ln	
D = v _p / S	260.4	pc/mi/ln	S D = ··· / C		mph	
LOS	F		$D = v_p / S$ Required Number of Lanes	, N	pc/mi/in	
Glossary			Factor Location			
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design l	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	l Jy flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 1 11-3	f _{LW} 11-13 f _{LC} TR 11-2,	, - Exhibit 11-8 - Exhibit 11-9 D - Page 11-11	

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BASIC FREEWAY SEGMENTS WORKSHEET						
General Information			Site Information			
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	r	Highway/Direction of Travel From/To Jurisdiction Analysis Year	State Route F-27 'No-Build' 2040	8 Northbound	
Project Description SUM-	76-Central Inte	rchange (PID	101402)			
Oper.(LOS)		D	es.(N)	Planning	Data	
Flow Inputs						
Volume, V AADT Peak-Hr Prop. of AADT, K	7060	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R	0.92 5 0		
DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi		
Calculate Flow Adjus	tments					
f _p	1.00		E _R	1.2		
Ε _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$]0.976		
Speed Inputs			Calc Speed Adj and F	FS		
Lane Width		ft				
Rt-Side Lat. Clearance		ft	f _{LW}		mph	
Number of Lanes, N	3		f _{LC}		mph	
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph	
FFS (measured)	55.0	mph	FFS	55.0	mph	
Base free-flow Speed, BFFS		mph				
LOS and Performanc	e Measures		Design (N)			
<u>Operational (LOS)</u> v ₋ = (V or DDHV) / (PHF x I	N X fuy		<u>Design (N)</u> Design LOS			
x f _p)	^{nv} 2622	pc/h/ln	v _p = (V or DDHV) / (PHF x N x f _p)	N x f _{HV}	pc/h/ln	
D = y / S	50.5 68.4	nc/mi/ln	S		mph	
LOS	F	pormin	D = v _p / S Required Number of Lanes,	, N	pc/mi/ln	
Glossary			Factor Location			
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	l Fy flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 1 11-3	f _{LW} 11-13 f _{LC} TRI 11-2,	- Exhibit 11-8 - Exhibit 11-9 D - Page 11-11	

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	BASIC FREEWAY SEGMENTS WORKSHEET						
General Information			Site Information				
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l SR-8 No. F-28 'No-Buila 2040	rthbound Ramp "		
Project Description SUM-	76-Central Inte	rchange (PID	101402)				
Oper.(LOS)			es.(N)	Planı	ning Data		
Flow Inputs							
Volume, V AADT Peak-Hr Prop. of AADT, K	2320	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R	0.92 4 0			
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi			
Calculate Flow Adjus	tments						
f _p	1.00		E _R	1.2			
Ε _T	1.5		f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1)] 0.980			
Speed Inputs			Calc Speed Adj and F	FS			
Lane Width		ft					
Rt-Side Lat. Clearance		ft	f _{LW}		mph		
Number of Lanes, N	2		f _{LC}		mph		
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph		
FFS (measured)	55.0	mph	FFS	55.0	mph		
Base free-flow Speed, BFFS		mph					
LOS and Performanc	e Measures		Design (N)				
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{uv}		<u>Design (N)</u> Design LOS				
x f _p)	1286	pc/h/ln	v _p = (V or DDHV) / (PHF x x f _p)	N x f _{HV}	pc/h/ln		
	55.U	no/mi/ln	S		mph		
LOS	23.4 C	pc/m/m	D = v _p / S Required Number of Lanes	s, N	pc/mi/ln		
Glossarv			Factor Location				
N - Number of lanes	S - Speed	t			f Fuchikit 44.0		
V - Hourly volume	D - Densi ⁱ	ty	E_{R} - Exhibits 11-10, 11-12 E Exhibits 11-10, 11-11	11 12	I _{LW} - EXHIDIL 11-8		
v _p - Flow rate LOS - Level of service	FFS - Free BFFS - Bas	-flow speed se free-flow	f_p - Page 11-18	11-13	TRD - Page 11-11		
speed DDHV - Directional design	hour volume		11-3	· ·-∠,			

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	BASIC FREEWAY SEGMENTS WORKSHEET						
General Information			Site Information				
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-76 East F-29 'No-Build' 2040	bound Ramp		
Project Description SUM-	76-Central Inte	rchange (PID	101402)				
✓ Oper.(LOS)		D	ves.(N)	Plann	ing Data		
Flow Inputs							
Volume, V AADT Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D	1940	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R General Terrain:	0.92 5 0 Level			
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	mi			
Calculate Flow Adjus	tments						
f _n	1.00		E _R	1.2			
Ε _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.976			
Speed Inputs			Calc Speed Adj and I	FS			
Lane Width		ft					
Rt-Side Lat. Clearance		ft	f _{LW}		mph		
Number of Lanes, N	2		f _{LC}		mph		
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph		
FFS (measured)	55.0	mph	FFS	55.0	mph		
Base free-flow Speed, BFFS		mph					
LOS and Performanc	e Measures		Design (N)				
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x fuy		<u>Design (N)</u> Design LOS				
x f _p)	¹¹ 1081	pc/h/ln	v _p = (V or DDHV) / (PHF x x f _p)	N x f _{HV}	pc/h/ln		
5 D-v /s	55.U 10.7	mpn no/mi/ln	S		mph		
LOS	Т <u>э</u> .7 С	pe/mi/m	D = v _p / S Required Number of Lanes	: N	pc/mi/ln		
Glossary			Factor Location	, , , ,			
N. Number of lance	<u> </u>	4					
V - Hourly volume v _p - Flow rate LOS - Level of service	D - Densit FFS - Free BFFS - Bas	flow speed se free-flow	E_R - Exhibits 11-10, 11-12 E_T - Exhibits 11-10, 11-11, f_p - Page 11-18 LOS, S, FFS, v_p - Exhibits	11-13 1 - - 11-2.	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11		
DDHV - Directional design	hour volume		11-3	,			

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BASIC FREEWAY SEGMENTS WORKSHEET						
General Information			Site Information			
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	ır	Highway/Direction of Trave From/To Jurisdiction Analysis Year	I I-76 Eastbo F-30 'No-Build' 2040	ound	
Project Description SUM-	76-Central Inte	rchange (PID	101402)			
✓ Oper.(LOS)			es.(N)	Planni	ng Data	
Flow Inputs						
Volume, V AADT	2500	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T	0.92 6		
Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	%RVs, P _R General Terrain: Grade % Length Up/Down %	0 Level mi		
Calculate Flow Adjus	tments					
f _p	1.00		E _R	1.2		
E _T	1.5		t _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1)] <i>0.971</i>		
Speed Inputs			Calc Speed Adj and I	FS		
Lane Width		ft				
Rt-Side Lat. Clearance		ft	f _{LW}		mph	
Number of Lanes, N	2		f _{IC}		mph	
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph	
FFS (measured)	55.0	mph	FFS	55.0	mph	
Base free-flow Speed, BFFS		mph			·	
LOS and Performanc	e Measures		Design (N)			
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{HV}		<u>Design (N)</u> Design LOS			
x f _p)	1399	pc/h/ln	$v_p = (V \text{ or DDHV}) / (PHF x)$ x f _p)	N x f _{HV}	pc/h/ln	
S	55.0	mph	S		mph	
$D = v_p / S$	25.4	pc/mi/ln	$D = v_p / S$		pc/mi/ln	
LOS	С		Required Number of Lanes	s, N	•	
Glossary			Factor Location			
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design I	S - Speed D - Densi FFS - Free BFFS - Bas hour volume	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	f _l 11-13 f _l T 11-2,	_{-W} - Exhibit 11-8 _{-C} - Exhibit 11-9 RD - Page 11-11	

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BASIC FREEWAY SEGMENTS WORKSHEET						
General Information			Site Information			
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	r	Highway/Direction of Travel From/To Jurisdiction Analysis Year	I-76 Eastb F-31 'No-Build' 2040	ound Ramp	
Project Description SUM-	76-Central Inte	rchange (PID	101402)			
Oper.(LOS)		D	es.(N)	🗌 Planni	ng Data	
Flow Inputs						
Volume, V AADT Dook Hr Bron, of AADT, K	2220	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %P\/s_P	0.92 6 0		
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	u Level mi		
Calculate Flow Adjus	tments					
f _p E r	1.00 1.5		E_R $f_{LNZ} = 1/(1+P_T(E_T - 1) + P_R(E_R - 1))$	1.2 10.971		
Speed Inputs			Calc Speed Adi and F	FS		
		fi				
Rt-Side Lat Clearance		ft	f		mph	
Number of Lanes, N	2		I _{LW}		mph	
Total Ramp Density, TRD		ramps/mi	'LC TRD Adjustment		mph	
FFS (measured)	55.0	mph	FES	55 0	mph	
Base free-flow Speed, BFFS		mph	113	55.0	трп	
LOS and Performance	e Measures		Design (N)			
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{HV}		<u>Design (N)</u> Design LOS			
x f _p)	¹¹ 1243	pc/h/ln mph	v _p = (V or DDHV) / (PHF x f x f _p)	√x t _{HV}	pc/h/ln	
D = v / S	22.6	nc/mi/ln	S		mph	
LOS	C	pormin	D = v _p / S Required Number of Lanes	, N	pc/mi/ln	
Glossary			Factor Location			
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 1 11-3	f _I 11-13 f _I 11-2,	_{_W} - Exhibit 11-8 _{_C} - Exhibit 11-9 ⁻ RD - Page 11-11	

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BASIC FREEWAY SEGMENTS WORKSHEET						
General Information			Site Information			
Analyst	Brett Ferrell		Highway/Direction of Trave	I SR-8 No	rthbound Ramp	
Agency or Company Date Performed	GPD Group 06/01/16		Jurisdiction	r-32 'No-Build	ľ	
Analysis Time Period	AM Peak Hou	r	Analysis Year	2040		
Project Description SUM-	76-Central Inte	rchange (PID	101402)			
Oper.(LOS)		D	es.(N)	Plan	ning Data	
Flow Inputs						
Volume, V	3020	veh/h	Peak-Hour Factor, PHF	0.92		
AADT		veh/day	%Trucks and Buses, P_T	3		
Peak-Hr Prop. of AADT, K			%RVs, P _R	0		
Peak-Hr Direction Prop, D			General Terrain:	Level		
DDHV = AADT x K x D		veh/h	Grade % Length	mi		
			Up/Down %			
Calculate Flow Adjus	tments					
f _p	1.00		E _R	1.2		
E _T	1.5		f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1)] <i>0.985</i>		
Speed Inputs			Calc Speed Adj and I	FFS		
Lane Width		ft				
Rt-Side Lat. Clearance		ft	f _{I W}		mph	
Number of Lanes, N	2		fuc		mph	
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph	
FFS (measured)	55.0	mph	FFS	55 0	mph	
Base free-flow Speed,		mph		00.0	mpn	
BFFS		трп				
LOS and Performanc	e Measures		Design (N)			
Operational (LOS)			<u>Design (N)</u>			
v = (V or DDHV) / (PHF x)	N x f		Design LOS			
v _p = (v or bbriv)/(r m x r v f)	1666 No. 1	pc/h/ln	$v_p = (V \text{ or DDHV}) / (PHF x)$	N x f _{HV}	no/h/ln	
^ 'p)	55.0	man h	x f _p)		pc/n/m	
	55.0	mpn ma (mai//m	S		mph	
$D = v_p / S$	30.3	pc/mi/in	$D = v_n / S$		pc/mi/ln	
LUS	D		Required Number of Lanes	s, N		
Glossary			Factor Location			
N - Number of lanes	S - Speed	k	E Exhibite 11 10 11 12		f Evhibit 11.9	
V - Hourly volume	D - Densi	v	$E_{\rm R}$ - EXHIBITS 11-10, 11-12	44.40	I _{LW} - EXHIDIL 11-0	
v - Flow rate	FFS - Free	-flow speed	$E_{T} = EXNIDITS 11-10, 11-11,$	11-13	T_{LC} - Exhibit 11-9	
LOS - Level of service	BFFS - Bas	se free-flow	т _р - Раде 11-18		IRD - Page 11-11	
speed	-	-	LOS, S, FFS, v _p - Exhibits	11-2,		
DDHV - Directional design	hour volume		11-3			

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst	Brett Ferrell		Highway/Direction of Trave	el I-77 South	nbound
Agency or Company	GPD Group 06/01/16		Jurisdiction	r-33 'No-Build'	
Analysis Time Period	AM Peak Hou	ır	Analysis Year	2040	
Project Description SUM-	76-Central Inte	erchange (PID	101402)		
Oper.(LOS)			es.(N)	Plann	ing Data
Flow Inputs					
Volume, V	2600	veh/h	Peak-Hour Factor, PHF	0.92	
AADT		veh/day	%Trucks and Buses, P _T	5	
Peak-Hr Prop. of AADT, K			%RVs, P _R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
-			Up/Down %		
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
Ε _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.976	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f, w		mph
Number of Lanes, N	2		f		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55 0	mph
Base free-flow Speed,		mph		00.0	mpri
BFFS					
LOS and Performanc	e Measures		Design (N)		
Operational (LOS)			<u>Design (N)</u>		
v = (V or DDHV) / (PHF x I)	N x f		Design LOS		
xf)	1448	pc/h/ln	$v_p = (V \text{ or DDHV}) / (PHF x)$	N x f _{HV}	nc/h/ln
s	55 0	mph	x f _p)		p0,11,111
D = v / S	26.3	nc/mi/ln	S		mph
	20.0 D	po/111/11	$D = v_p / S$		pc/mi/ln
200	D		Required Number of Lanes	3, N	
Glossary			Factor Location		
N - Number of lanes	S - Speed	d	E Exhibite 11 10 11 12		Evhihit 11 0
V - Hourly volume	D - Densi	ty	$L_R = E_{A} + 10115 + 1 - 10, + 1 - 12$	11 12	
v Flow rate	FFS - Free	- -flow speed	$E_{T} = EXTIDUTS 11-10, 11-11,$	11-13 1	LC - Exnidit 11-9
LOS - Level of service	BFFS - Bas	se free-flow	т _р - Раде 11-18		IRD - Page 11-11
speed		-	LOS, S, FFS, v _p - Exhibits	11-2,	
DDHV - Directional design	hour volume		11-3		

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
Conoral Information			Site Information		
General mormation			Sile mormation	176 East	houndMasthound
Analyst	Brett Ferrell		Highway/Direction of Trave	Ramp	bound/westbound
Agency or Company Date Performed Analysis Time Period	GPD Group 06/01/16 AM Peak Hou	ır	From/To Jurisdiction Analysis Year	F-34 'No-Build 2040	,
Project Description SUM-	76-Central Inte	erchange (PID	101402)	2070	
Oper.(LOS)		 D	es.(N)	Planr	ning Data
Flow Inputs					-
Volume, V AADT	2200	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T	0.92 4	
Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	%RVs, P _R General Terrain: Grade % Length Up/Down %	0 Level mi	
Calculate Flow Adjust	tments				
f _p	1.00		E _R	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.980	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	2		fic		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x N x f)	N x f _{HV} 1220	pc/h/ln	<u>Design (N)</u> Design LOS v _p = (V or DDHV) / (PHF x I	N x f _{HV}	pc/b/ln
S	55 0	mnh	x f _p)		p0/1/11
$D = v_n / S$	22.2	pc/mi/ln	S		mph
LOS	С	F -	D = v _p / S Required Number of Lanes	, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design h	S - Speed D - Densi FFS - Free BFFS - Bas	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-77 NB / F-35 'No-Build 2040	1-76 WB Ramp '
Project Description SUM-	76-Central Inte	rchange (PID	101402)	2070	
✓ Oper.(LOS)		D	es.(N)	Planr	ning Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT_K	2460	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _D	0.92 4 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
É _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] <i>0.980</i>	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{I W}		mph
Number of Lanes, N	2		f _{IC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			·
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x fuv		<u>Design (N)</u> Design LOS		
x f _p)	1364	pc/h/ln	$v_p = (V \text{ or DDHV}) / (PHF x)$ x f _p)	N x f _{HV}	pc/h/ln
S D-V (S	55.0	mph	S		mph
$D = V_p / S$ LOS	24.8 C	pc/mi/in	$D = v_p / S$		pc/mi/ln
			Required Number of Lanes	S, N	
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design I	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst	Brett Ferrell		Highway/Direction of Trave	State Rou Ramp	te 8 Northbound
Agency or Company Date Performed Analysis Time Period	GPD Group 06/01/16 AM Peak Hou	r	From/To Jurisdiction Analysis Year	F-36 'No-Build' 2040	
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)		🗌 D	es.(N)	🗌 Plann	ing Data
Flow Inputs					
Volume, V AADT	2670	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T	0.92 4	
Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	%RVs, P _R General Terrain: Grade % Length Up/Down %	0 Level mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
Ε _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.980	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	2		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x N	N x f _{HV} 1480	pc/h/ln	<u>Design (N)</u> Design LOS v _p = (V or DDHV) / (PHF x I	N x f _{HV}	20/15/12
s	55.0	mnh	x f _p)		pc/n/m
$D = v_{\rm s} / S$	26.9	pc/mi/ln	S		mph
LOS	D	portiunt	D = v _p / S Required Number of Lanes	, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design I	S - Speed D - Densi FFS - Free BFFS - Bas	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits ⁻ 11-3	11-13 1 - 11-2,	r _{LW} - Exhibit 11-8 F _{LC} - Exhibit 11-9 TRD - Page 11-11

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PM PEAK HOUR

	BASIC FRE	EEWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst	Brett Ferrell		Highway/Direction of Trave	l-77 Sou Eastbou	thbound/I-76 nd
Agency or Company Date Performed Analysis Time Period	GPD Group 06/01/16 PM Peak Hoı	ur	From/To Jurisdiction Analysis Year	F-1 'No-Build 2040	<u>'</u> '
Project Description SUM-	76-Central Inte	erchange (PID	101402)		
Oper.(LOS)			Des.(N)	🗌 Plan	ning Data
Flow Inputs					
Volume, V AADT	5530	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T	0.92 8	
Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	%RVs, P _R General Terrain: Grade % Length Up/Down %	0 Level mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.962	
Speed Inputs			Calc Speed Adj and	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	4		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x I	N x f _{HV} 1563	pc/h/ln	<u>Design (N)</u> Design LOS v _n = (V or DDHV) / (PHF x	N x f _{uv}	
x f _p)			$x f_{p}$	ΠV	pc/h/ln
S D u (C	55.0	mph	S		mph
$D = V_p / S$	28.4	pc/mi/ln	$D = v_p / S$		pc/mi/ln
105	D		Required Number of Lanes	s, N	
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed	S - Spee D - Densi FFS - Free BFFS - Ba	d ity e-flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11
טחטט - virectional design	nour volume		I Ŭ		

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	BASIC FRE	EEWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst	Brott Forroll		Highway/Direction of Trave	, I-77 Sou	thbound/I-76
	GPD Group		From/To	Eastbou	nd
Date Performed Analysis Time Period	06/01/16 PM Peak Hou	ur	Jurisdiction Analysis Year	'No-Build 2040	1
Project Description SUM-	76-Central Inte	erchange (PID	101402)		
Oper.(LOS)			Des.(N)	🗌 Plan	ning Data
Flow Inputs					
Volume, V AADT	6030	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T	0.92 9	
Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	%RVs, P _R General Terrain: Grade % Length Up/Down %	0 Level mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
Ε _T	1.5		f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1)] 0.957	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	4		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performanc	e Measures		Design (N)		
Operational (LOS)	NI 6		<u>Design (N)</u> Design LOS		
x f _p)	N X I _{HV} 1712	pc/h/ln	v _p = (V or DDHV) / (PHF x x f)	N x f _{HV}	pc/h/ln
S	55.0	mph	S		mph
$D = v_p / S$	31.1	pc/mi/ln	$D = v_n / S$		pc/mi/ln
LOS	D		Required Number of Lanes	s, N	Ρ
Glossary			Factor Location		
N - Number of lanes	S - Spee	d	E Evhibite 11 10 11 10		f Exhibit 11.0
V - Hourly volume	D - Densi	ity	$E_{\rm R}^{-}$ Exhibits 11-10, 11-12 E Exhibits 11-10, 11-11	11 13	I _{LW} - EXHIDIL 11-0 f Exhibit 11.0
v _p - Flow rate	FFS - Free	e-flow speed	$L_T = L_{111010} + 1 - 10, + 1 - 11,$ f = Page 11-18	11-13	¹ LC - LATIIUIL 11-9 TRD - Page 11 11
LOS - Level of service speed	BFFS - Ba	se free-flow	LOS, S, FFS, v_p - Exhibits	11-2,	Traye II-II
DDHV - Directional design	hour volume		11-3		

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	BASIC FRE	EEWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information	0	
Analyst	Brett Ferrell		Highway/Direction of Trave	el I-77 Sou Eastbou	thbound/I-76 nd
Agency or Company Date Performed Analysis Time Period	GPD Group 06/01/16 PM Peak Hoı	ır	From/To Jurisdiction Analysis Year	F-3 'No-Build 2040	j'
Project Description SUM-	76-Central Inte	erchange (PID	101402)		
✓ Oper.(LOS)			es.(N)	🗌 Plan	ning Data
Flow Inputs					
Volume, V AADT	6030	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T	0.92 9	
Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	%RVs, P _R General Terrain: Grade % Length Up/Down %	0 Level mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
Ε _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.957	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	3		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x I	N x f _{HV 2222}		Design (N) Design LOS	Nyf	
x f _p)	2203	pc/n/in	$v_p = (V O D D D V) / (FIF X)$	HV	pc/h/ln
s	49.2	mph	s		mph
$D = v_p / S$	46.4	pc/mi/ln	D = v / S		npn pc/mi/ln
LOS	F		Required Number of Lanes	s, N	po,111,111
Glossary			Factor Location		
N - Number of lanes	S - Spee	d			
V - Hourly volume	D - Densi	ity	E_{R} - EXHIDILS 11-10, 11-12 E Exhibite 11 10, 11 11	11 12	I _{LW} - EXHIDIL 11-8
v _p - Flow rate	FFS - Free	-flow speed	$L_T = L_{111010} + 11 - 10, + 11 - 11,$ f _ Page 11-18	11-13	TRD_{-} Page 11 11
LOS - Level of service speed	BFFS - Ba	se free-flow	LOS, S, FFS, v_p - Exhibits	11-2,	пло - raye 11-11
DDHV - Directional design	hour volume		11-3		

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-77 South F-4 'No-Build' 2040	bound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)		D	es.(N)	Planni	ng Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop. D	3960	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R General Terrain:	0.92 3 0 1 evel	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	mi	
Calculate Flow Adjus	tments				
f _p E _T	1.00 1.5		E _R f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1	1.2)] 0.985	
Speed Inputs			Calc Speed Adi and F	FS	
Lane Width		ft		_	
Rt-Side Lat. Clearance		ft	f		mph
Number of Lanes, N	2		LW f		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55 0	mph
Base free-flow Speed, BFFS		mph		00.0	mpn
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{HV a cont}		<u>Design (N)</u> Design LOS		
x f _p)	¹¹¹ 2184 51 4	pc/h/ln mph	$v_p = (V \text{ or DDHV}) / (PHF x)$ x f _p)	N x f _{HV}	pc/h/ln
$D = v_{\rm s} / S$	42.5	pc/mi/ln	S		mph
LOS	E	P	D = v _p / S Required Number of Lanes	i, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design l	S - Speed D - Densi FFS - Free BFFS - Bas	flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	f _l 11-13 f _l T 11-2,	_{-W} - Exhibit 11-8 _{-C} - Exhibit 11-9 'RD - Page 11-11

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	I I-77 Souti F-5 'No-Build 2040	hbound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)			es.(N)	Plann	ing Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT. K	3370	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs_P_	0.92 4 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _p Ε _τ	1.00 1.5		E _R f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1	1.2)] 0.980	
Speed Inputs			Calc Speed Adj and I	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f		mph
Number of Lanes, N	2		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			ľ
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	۸ x f		<u>Design (N)</u> Design LOS		
x f _p)	[™] 1868	pc/h/ln	$v_p = (V \text{ or DDHV}) / (PHF x)$ x f _p)	N x f _{HV}	pc/h/ln
S D = v / C	54.9	mpn	S		mph
$D = V_p / S$	34.0	pc/mi/ln	$D = v_p / S$		pc/mi/ln
105	D		Required Number of Lanes	s, N	
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design l	S - Speed D - Densit FFS - Free BFFS - Bas	flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-77 Southb F-6 'No-Build' 2040	bound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)		🗌 D	es.(N)	🗌 Plannin	ig Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K	3210	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R	0.92 4 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _p Ε _T	1.00 1.5		E_{R} $f_{HV} = 1/[1+P_{T}(E_{T} - 1) + P_{R}(E_{R} - 1)$	1.2)] 0.980	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f		mph
Number of Lanes, N	2	-	LW f. a		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55 0	mph
Base free-flow Speed, BFFS		mph		00.0	mpri
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{HV /}		<u>Design (N)</u> Design LOS		
x f _p)	¹¹⁷⁷⁹ 55 0	pc/h/ln mph	v _p = (V or DDHV) / (PHF x x f _p)	N x f _{HV}	pc/h/ln
$D = v_{\rm s} / S$	32.3	pc/mi/ln	S		mph
LOS	D	P	D = v _p / S Required Number of Lanes	s, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design	S - Speed D - Densi FFS - Free BFFS - Bas hour volume	d flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	f _L 11-13 f _L TI 11-2,	_w - Exhibit 11-8 _c - Exhibit 11-9 RD - Page 11-11

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-77 Souti F-7 'No-Build' 2040	hbound ,
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)			es.(N)	Plann	ing Data
Flow inputs					
Volume, V AADT Deale Hr Bron, of AADT, K	8160	ven/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %PVc	0.92 5	
Peak-Hr Prop. of AAD1, K Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	0 Level mi	
Calculate Flow Adjus	tments				
f _p E r	1.00 1.5		E_R $f_{LNZ} = 1/(1+P_T(E_T - 1) + P_R(E_R - 1)$	1.2 0.976	
Speed Inputs			Calc Speed Adi and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f		mph
Number of Lanes, N	3		f		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			·
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{uv}		<u>Design (N)</u> Design LOS		
x f _p)	17.6	pc/h/ln	v _p = (V or DDHV) / (PHF x x f _p)	N x f _{HV}	pc/h/ln
5 D-v /s	17.0	no/mi/ln	S		mph
LOS	F	pc/m/m	D = v _p / S Required Number of Lanes	, N	pc/mi/ln
Glossarv			Factor Location		
N - Number of lanes	S - Speed	ł			
V - Hourly volume	D - Densi	ty	$E_{\rm R}$ - EXNIDITS 11-10, 11-12	11 10	f _{LW} - EXNIDIT 11-8
v _p - Flow rate	FFS - Free	-flow speed	$E_{T} = E_{X111011S} + 1 = 10, + 1 = 11,$ f = Page 11-18	11-13	$I_{LC} = EXIJUL + 1 - 9$
LOS - Level of service speed	BFFS - Bas	se free-flow	LOS, S, FFS, v_p - Exhibits	11-2,	IND - Faye 11-11
DDHV - Directional design	hour volume		11-0		

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-77 Northbo F-8 'No-Build' 2040	bund
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)		D	es.(N)	Planning	g Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K	5780	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R	0.92 4 0	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	Levei mi	
Calculate Flow Adjus	tments				
f _p Ε _T	1.00 1.5		E _R f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1)	1.2)] 0.980	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f		mph
Number of Lanes, N	3		'LW f. o		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x I	N x f _{HV of oc}		<u>Design (N)</u> Design LOS	NIVE	
x f _p) S	52.2	pc/n/in mph	v _p = (V or DDHV)7 (PHF X) x f _p) s	in x t _{HV}	pc/h/ln
$D = v_p / S$	40.9	pc/mi/ln	D = v / S		nc/mi/ln
LOS	E		Required Number of Lanes	, N	pomm
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design I	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	d flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	f _{LV} 11-13 f _{LC} TF 11-2,	_v - Exhibit 11-8 ₅ - Exhibit 11-9 RD - Page 11-11

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-77 Northb F-9 'No-Build' 2040	ound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)		D	es.(N)	Plannin	ig Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K	2640	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _P	0.92 3 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _ρ Ε _Τ	1.00 1.5		E _R f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1)	1.2)] 0.985	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f		mph
Number of Lanes, N	2		f		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{HV}		<u>Design (N)</u> Design LOS		
x f _p)	¹¹ 1456	pc/h/ln mph	v _p = (V or DDHV) / (PHF x x f _p)	N x f _{HV}	pc/h/ln
$D = v_{\rm s} / S$	26.5	pc/mi/ln	S		mph
LOS	D	portiunt	D = v _p / S Required Number of Lanes	, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design I	S - Speed D - Densi FFS - Free BFFS - Bas hour volume	d flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	fլ. 11-13 fլ. TI 11-2,	_W - Exhibit 11-8 _C - Exhibit 11-9 RD - Page 11-11

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	I I-77 NB / F-10 No-Build 2040	' I-76 WB Ramp "
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
✓ Oper.(LOS)			ves.(N)	Plan	ning Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K	2580	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R	0.92 1 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjust	tments				
f _p	1.00		E _R	1.2	
Ε _T	1.5		f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1)] 0.995	
Speed Inputs			Calc Speed Adj and I	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{I W}		mph
Number of Lanes, N	2		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	۷ x f		<u>Design (N)</u> Design LOS		
x f _p)	1409	pc/h/ln	$v_p = (V \text{ or DDHV}) / (PHF x)$ x f_)	N x f _{HV}	pc/h/ln
S	55.0	mph	s p ^p		mph
D = v _p / S	25.6	pc/mi/ln	D = v / S		pc/mi/ln
LOS	С		Required Number of Lanes	s, N	p 01111111
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design I	S - Speec D - Densit FFS - Free- BFFS - Bas	l y flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
0			0.4.4.4.4.4.4.4.4.4.4.4.4.4.4.4.4.4.4.4		
General Information			Site Information	· · · · ·	
Analyst	Brett Ferrell		Highway/Direction of Trave	I-77 NB /	I-76 WB Ramp
Date Performed	06/01/16		Jurisdiction	'No-Build	,
Analysis Time Period	PM Peak Hou	ır	Analysis Year	2040	
Project Description SUM-	76-Central Inte	erchange (PID	101402)		
Oper.(LOS)		D	es.(N)	Planr	ning Data
Flow Inputs					
Volume, V	2450	veh/h	Peak-Hour Factor, PHF	0.92	
AADT		veh/day	%Trucks and Buses, P _T	2	
Peak-Hr Prop. of AADT, K			%RVs, P _R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
	1 1 -		Up/Down %		
Calculate Flow Adjus	tments				
т _р	1.00		E _R	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.990	
Speed Inputs			Calc Speed Adj and I	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	2		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FES	55 0	mph
Base free-flow Speed,		mph		00.0	b
BFFS		mpn			
LOS and Performanc	e Measures		Design (N)		
Operational (LOS)			<u>Design (N)</u>		
$v_{x} = (V \text{ or } DDHV) / (PHF x)$	N x fux		Design LOS		
xf)	1345	pc/h/ln	$v_p = (V \text{ or DDHV}) / (PHF x)$	N x f _{HV}	nc/h/ln
s	55.0	mph	x f _p)		p0/1/11
D = y / S	24.5	nc/mi/ln	S		mph
$D = v_p / O$	24.5	pc/m/m	$D = v_p / S$		pc/mi/ln
LU3	U		Required Number of Lanes	», N	
Glossary			Factor Location		
N - Number of lanes	S - Speed	t	E Exhibite 11 10 11 12		f Exhibit 11.9
V - Hourly volume	D - Densi	ty	$L_R = L_{A} + 10, 11 - 12$	11 10	f Exhibit 11.0
v Flow rate	FFS - Free	- flow speed	$E_{\rm T} = E_{\rm XIIIDIUS} + 1 - 10, + 1 - 11,$	11-13	
LOS - Level of service	BFFS - Bas	se free-flow	r _p - Page 11-18		IRD - Page 11-11
speed			LOS, S, FFS, v _p - Exhibits	11-2,	
DDHV - Directional design	hour volume		11-3		

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	BASIC FRE	EEWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst	Brett Ferrell		Highway/Direction of Trave	I-77 Nort	hbound/I-76
Agency or Company Date Performed Analysis Time Period	GPD Group 06/01/16 PM Peak Hou	ır	From/To Jurisdiction Analysis Year	" Westbou F-12 'No-Builc 2040	ınd I'
Project Description SUM-	76-Central Inte	erchange (PID	101402)		
Oper.(LOS)			Des.(N)	🗌 Plan	ning Data
Flow Inputs					
Volume, V AADT	4510	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T	0.92 9	
Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	%RVs, P _R General Terrain: Grade % Length Up/Down %	0 Level mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.957	
Speed Inputs			Calc Speed Adj and	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	4		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x N	N x f _{HV} 1281	pc/h/ln	<u>Design (N)</u> Design LOS v _n = (V or DDHV) / (PHF x	N x f _{HV}	
x f _p)			x f _p)	110	pc/h/ln
S D=v /S	55.0	mph	S		mph
LOS	23.3 C	pc/mi/in	$D = v_p / S$		pc/mi/ln
			Required Number of Lanes	s, N	
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design f	S - Speer D - Densi FFS - Free BFFS - Bas	d -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FR	EEWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst	Brett Ferrell		Highway/Direction of Trave	el ^{I-77} Nort Westbou	hbound/I-76 Ind
Agency or Company Date Performed Analysis Time Period	GPD Group 06/01/16 PM Peak Hou	ur	From/To Jurisdiction Analysis Year	F-13 'No-Build 2040	1'
Project Description SUM-	76-Central Inte	erchange (PID	101402)		
Oper.(LOS)			es.(N)	🗌 Plan	ning Data
Flow Inputs					
Volume, V AADT	3300	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T	0.92 11	
Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	%RVs, P _R General Terrain: Grade % Length Up/Down %	0 Level mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.948	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	4		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x I	N x f _{HV 946}	nc/h/ln	Design (N) Design LOS v. = (V or DDHV) / (PHF x	Nxfuu	
x f _p)	010	p0/11/11	$x f_{r}$)	HV HV	pc/h/ln
S	55.0	mph	S P		mph
$D = v_p / S$	17.2	pc/mi/ln	D = v _n / S		pc/mi/ln
LOS	В		Required Number of Lanes	s, N	·
Glossary			Factor Location		
N - Number of lanes	S - Spee	d	E _ Exhibits 11-10 11-12		f _ Exhibit 11-8
V - Hourly volume	D - Densi	ity	$E_{\rm R}$ = Exhibits 11-10, 11-11.	11-13	f_{LW} = Exhibit 11-9
v _p - Flow rate LOS - Level of service	FFS - Free BFFS - Ba	e-flow speed se free-flow	f _p - Page 11-18 LOS, S, FFS, v - Exhibits	11-2.	TRD - Page 11-11
DDHV - Directional design	hour volume		11-3	,	

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-76 Eastb F-14 'No-Build' 2040	ound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
✓ Oper.(LOS)		D	es.(N)	Planni	ng Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K	4050	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R	0.92 12 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
Ε _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.943	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	2		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v ₋ = (V or DDHV) / (PHF x I	N x fuy		<u>Design (N)</u> Design LOS		
x f _p)	[™] 2333	pc/h/ln	v _p = (V or DDHV) / (PHF x x f _e)	N x f _{HV}	pc/h/ln
S	48.0	mph	S P		mph
$D = v_p / S$	48.6	pc/mi/ln	$D = v_p / S$		pc/mi/ln
LOS	F		Required Number of Lanes	s, N	
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design I	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	f _l 11-13 f _l T 11-2,	_{-W} - Exhibit 11-8 _{-C} - Exhibit 11-9 'RD - Page 11-11

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	I-76 Eastl F-15 'No-Build' 2040	bound ,
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)			es.(N)	Plann	ning Data
	2020	voh/h	Dook Hour Easter, DHE	0.02	
AADT	2930	veh/day	%Trucks and Buses, P _T	6	
Peak-Hr Prop. of AAD I, K Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	0 Level mi	
Calculate Flow Adjus	tments				
f _p	1.00			1.2	
	1.5		$I_{HV} = 1/(1+P_T(E_T - 1) + P_R(E_R - 1)$)]0.971	
Speed Inputs			Calc Speed Adj and I	-FS	
Lane Width		ft			
Rt-Side Lat. Clearance	-	ft	f _{LW}		mph
Number of Lanes, N	2		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured) Base free-flow Speed,	55.0	mph mph	FFS	55.0	mph
BFFS					
LOS and Performance	e measures		Design (N)		
Operational (LOS) v = (V or DDHV) / (PHE x I	۱xf		<u>Design (N)</u> Design LOS		
$x f_p$ ($t = 22110$) $f(t = 1000)$	1640 fr 1640	pc/h/ln	v _p = (V or DDHV) / (PHF x x f _p)	N x f _{HV}	pc/h/ln
S / C	55.0	mph	S		mph
$D = v_p / S$	29.8	pc/mi/ln	$D = v_p / S$		pc/mi/ln
LOS	D		Required Number of Lanes	s, N	
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design l	S - Speed D - Densit FFS - Free BFFS - Bas	flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	ır	Highway/Direction of Trave From/To Jurisdiction Analysis Year	el I-76 East F-16 'No-Build 2040	bound '
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)			es.(N)	Planr	ning Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K	5190	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R	0.92 12 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _ρ Ε _τ	1.00 1.5		E _R f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1	1.2)] 0.943	
Speed Inputs			Calc Speed Adi and I	FFS	
		ft			
Rt-Side Lat Clearance		ft	f		mph
Number of Lanes. N	4	it i	'LW f		mph
Total Ramp Density, TRD		ramps/mi	'LC TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55 0	mph
Base free-flow Speed, BFFS		mph		00.0	mpn
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x I	N x f _{HV 1 105}		Design (N) Design LOS	NIVE	
x f _p) S	1495 55.0	mph	v _p = (v or DDHv)7 (PHF x x f _p) S	IN X I _{HV}	pc/h/ln mph
LOS	D	pe/mi/m	D = v _p / S Required Number of Lanes	s, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-76 Eastb F-17 'No-Build' 2040	ound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)		D	es.(N)	Planni	ng Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K	5190	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R	0.92 12 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _ρ Ε _Τ	1.00 1.5		E _R f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1)	1.2)] 0.943	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f		mph
Number of Lanes, N	3		fue		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v ₋ = (V or DDHV) / (PHF x I	N X fuy		<u>Design (N)</u> Design LOS		
x f _p)	^{nv} 1993	pc/h/ln	v _p = (V or DDHV) / (PHF x x f _p)	N x f _{HV}	pc/h/ln
5 D-v / S	34.9	no/mi/ln	S		mph
LOS	54.8 D	pormini	D = v _p / S Required Number of Lanes	, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design I	S - Speed D - Densi FFS - Free BFFS - Bas	d flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	f _l 11-13 f _l T 11-2,	_{_W} - Exhibit 11-8 _{_C} - Exhibit 11-9 RD - Page 11-11

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	ır	Highway/Direction of Trave From/To Jurisdiction Analysis Year	el I-76 East F-18 'No-Build' 2040	bound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)			es.(N)	Plann	ing Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K	4730	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R	0.92 13 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _p Ε _T	1.00 1.5		E_{R} $f_{HV} = 1/[1+P_{T}(E_{T} - 1) + P_{R}(E_{R} - 1)$	1.2)] 0.939	
Speed Inputs			Calc Speed Adi and I	FFS	
Lane Width		ft		_	
Rt-Side Lat. Clearance		ft	f		mph
Number of Lanes, N	3		LW f		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FES	60.0	mph
Base free-flow Speed, BFFS		mph		00.0	mpri
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x I	N x f _{HV 1005}		<u>Design (N)</u> Design LOS	NI ~ £	
x f _p) S	59.1	pc/h/ln mph	$v_p = (V \text{ or } DDHV) / (PHF X)$ x f _p)	N X T _{HV}	pc/h/ln
$D = v_n / S$	30.9	pc/mi/ln	S (C		mph
LOS	D	-	D = v _p / S Required Number of Lanes	s, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-76 Westl F-19 'No-Build' 2040	bound
Project Description SUM-	76-Central Inte	rchange (PID	101402)	2070	
✓ Oper.(LOS)			es.(N)	Planni	ing Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT_K	3940	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _D	0.92 11 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.948	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	3		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{uv}		<u>Design (N)</u> Design LOS		
x f _p)	11 1506	pc/h/ln	v _p = (V or DDHV) / (PHF x x f)	N x f _{HV}	pc/h/ln
S	60.0	mph	S		mph
D = v _p / S	25.1	pc/mi/ln	$D = v_n / S$		pc/mi/ln
LOS	С		Required Number of Lanes	s, N	
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design I	S - Speed D - Densi FFS - Free BFFS - Bas hour volume	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	f 11-13 f 11-2,	_{LW} - Exhibit 11-8 _{LC} - Exhibit 11-9 IRD - Page 11-11

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	ır	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-76 Westl F-20 'No-Build' 2040	bound
Project Description SUM-	76-Central Inte	rchange (PID	101402)	2070	
✓ Oper.(LOS)			es.(N)	Planni	ng Data
Flow Inputs					-
Volume, V AADT	4380	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T	0.92 10	
Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	%RVs, P _R General Terrain: Grade % Length Up/Down %	0 Level mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.952	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	3		f _{IC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			·
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{HV (2000}		<u>Design (N)</u> Design LOS	N f	
x f _p)	1666	pc/h/ln	$v_p = (V \text{ or } DDHV) / (PHF X)$ x f _n)	N X I _{HV}	pc/h/ln
S D = w / C	55.0	mph	S		mph
$D = V_p / S$	30.3	pc/mi/ln	$D = v_p / S$		pc/mi/ln
LUS	D		Required Number of Lanes	s, N	
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design l	S - Speed D - Densi FFS - Free BFFS - Bas hour volume	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	f 11-13 f 11-2,	_{LW} - Exhibit 11-8 _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
			•		
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Beak Hou	r	Highway/Direction of Trave From/To Jurisdiction	I I-76 Westb F-21 'No-Build' 2040	ound
Project Description SUM	76-Central Inte	rchange (PID	101402)	2040	
Oper (LOS)			ves (N)	Plannii	ng Data
Flow Inputs			00.(17)		9 2 4 4
Volume. V	3450	veh/h	Peak-Hour Factor, PHF	0.92	
AADT		veh/day	%Trucks and Buses, P_{T}	13	
Peak-Hr Prop. of AADT. K		,	%RVs, P _p	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
Oslavlata Flave Adius	4		Up/Down %		
Calculate Flow Adjus	tments				
^t p	1.00		E _R	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.939	
Speed Inputs			Calc Speed Adj and I	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	2		f _{IC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performanc	e Measures		Design (N)		
			Design (N)		
Operational (LOS)			Design LOS		
v _p = (V or DDHV) / (PHF x l	N x f _{HV} 1997	pc/h/ln	$v_n = (V \text{ or } DDHV) / (PHF x)$	N x f	
x f _p)		P	x f _n)	ΠV	pc/h/ln
S	54.0	mph	S		mph
$D = v_p / S$	37.0	pc/mi/ln	D = v / S		nc/mi/ln
LOS	E		Required Number of Lanes	s, N	permin
Glossary			Factor Location		
N - Number of lanes	S - Speed	k			
V - Hourly volume	D - Densi	tv	$E_{\rm R}$ - Exhibits 11-10, 11-12	t_	. _W - Exnidit 11-8
v - Flow rate	FFS - Free	-flow speed	E_{T} - Exhibits 11-10, 11-11,	11-13 f	_{.C} - Exnidit 11-9
LOS - Level of service	BFFS - Bas	se free-flow	f _p - Page 11-18	Т	RD - Page 11-11
speed	2		LOS, S, FFS, v _p - Exhibits	11-2,	
DDHV - Directional design	hour volume		11-3		

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Г	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l-76 Westb F-22 'No-Build' 2040	ound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)			es.(N)	Plannir	ng Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT. K	2060	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs_P	0.92 9 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _ρ Ε _τ	1.00 1.5		E_{R} $f_{HV} = 1/[1+P_{T}(E_{T} - 1) + P_{R}(E_{R} - 1)$	1.2 0.957	
Speed Inputs			Calc Speed Adi and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f		moh
Number of Lanes, N	2		'LW f. o		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55 0	mph
Base free-flow Speed, BFFS		mph		00.0	
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	۷ x f _{нv}		<u>Design (N)</u> Design LOS		
x f _p)	¹¹⁷⁰	pc/h/ln	v _p = (V or DDHV) / (PHF x f x f _p)	νx f _{HV}	pc/h/ln
	21.2	no/mi/ln	S		mph
LOS	21.3 C	permini	D = v _p / S Required Number of Lanes	, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design l	S - Speed D - Densit FFS - Free BFFS - Bas	l :y flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits ⁻ 11-3	f _{L'} 11-13 f _L TI 11-2,	_W - Exhibit 11-8 _C - Exhibit 11-9 RD - Page 11-11

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analvsis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	State Rout F-23 'No-Build' 2040	e 8 Southbound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)			ves.(N)	Planni	ng Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K Peak Hr Direction Prop. D	6410	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R General Terrain;	0.92 6 0	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.971	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	3		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			·
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{HV}		<u>Design (N)</u> Design LOS		
x f _p)	¹¹¹ 2392	pc/h/ln	v _p = (V or DDHV) / (PHF x x f _p)	N x f _{HV}	pc/h/ln
5 D=v /S	40.3 51.6	nc/mi/ln	S		mph
LOS	51.0 F	po/m/m	D = v _p / S Required Number of Lanes	, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	d ty flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	f _l 11-13 f _l T 11-2,	_{.W} - Exhibit 11-8 _{.C} - Exhibit 11-9 RD - Page 11-11

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Г	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Travel From/To Jurisdiction Analysis Year	State Route 8 F-24 'No-Build' 2040	} Southbound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)		D	es.(N)	Planning	Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop. D	7460	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R General Terrain:	0.92 6 0 1 evel	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$]0.971	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	3		f _{IC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{HV}		<u>Design (N)</u> Design LOS		
x f _p)	2784	pc/h/ln	v _p = (V or DDHV) / (PHF x N x f _p)	N x f _{HV}	pc/h/ln
D = v / S	89.5	nc/mi/ln	S		mph
LOS	F	p0/11/11	D = v _p / S Required Number of Lanes,	, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	l Flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 1 11-3	f _{LW} 11-13 f _{LC} - TRI 11-2,	- Exhibit 11-8 · Exhibit 11-9) - Page 11-11

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	ır	Highway/Direction of Trave From/To Jurisdiction Analysis Year	I SR-8 Sout F-25 'No-Build' 2040	hbound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)			Des.(N)	Planni	ng Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop. D	5390	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R General Terrain:	0.92 6 0 1 evel	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
E _T	1.5		f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1)] 0.971	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	2		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x fuv		<u>Design (N)</u> Design LOS		
x f _p)	3017	pc/h/ln	$v_p = (V \text{ or DDHV}) / (PHF x)$ x f _p)	N x f _{HV}	pc/h/ln
S D uu (O	18.4	mph	S		mph
$D = V_p / S$	163.7 E	pc/mi/ln	$D = v_p / S$		pc/mi/ln
LUS	F		Required Number of Lanes	s, N	
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design l	S - Speed D - Densi FFS - Free BFFS - Bas hour volume	flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	f 11-13 f 11-2,	_{LW} - Exhibit 11-8 _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Г	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Travel From/To Jurisdiction Analysis Year	State Route F-26 'No-Build' 2040	8 Northbound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
✓ Oper.(LOS)			es.(N)	🗌 Planning	j Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K x D	3640	veh/h veh/day veh/h	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R General Terrain: Grade % Length	0.92 5 0 Level mi	
		VCIIIII	Up/Down %		
Calculate Flow Adjus	tments				
f	1.00		Ep	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.976	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	2		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			·
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x f x f _p) s	N x f _{HV} 2028	pc/h/ln	<u>Design (N)</u> Design LOS v _p = (V or DDHV) / (PHF x f x f _p)	N x f _{HV}	pc/h/ln
D = y / S	37.8	nc/mi/ln	S		mph
LOS	E	p0/11/11	D = v _p / S Required Number of Lanes	, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	d flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits ² 11-3	f _{LW} 11-13 f _{LC} TR 11-2,	_/ - Exhibit 11-8 - Exhibit 11-9 .D - Page 11-11

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	I State Rout F-27 'No-Build' 2040	e 8 Northbound
Project Description SUM-	76-Central Inte	rchange (PID	101402)	2010	
✓ Oper.(LOS)			es.(N)	Planni	ng Data
Flow Inputs					
Volume, V AADT Peak Hr Prop. of AADT. K	5070	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs_P	0.92 5	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
É _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.976	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{I W}		mph
Number of Lanes, N	3		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			r
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{HV (2000}		<u>Design (N)</u> Design LOS		
x f _p)	1883	pc/h/ln	$v_p = (V \text{ or } DDHV) / (PHF X)$ x f _p)	N X T _{HV}	pc/h/ln
S D-v /S	54.8	mpn	S		mph
LOS	34.3 D	pc/mi/in	D = v _p / S Required Number of Lanes	N	pc/mi/ln
Glasson				, 1	
 N - Number of lanes V - Hourly volume v_p - Flow rate LOS - Level of service speed DDHV - Directional design I 	S - Speed D - Densit FFS - Free- BFFS - Bas	1 Fy flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	f _l 11-13 f _l T 11-2,	_{-W} - Exhibit 11-8 _{-C} - Exhibit 11-9 RD - Page 11-11

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	I SR-8 Nor F-28 'No-Build 2040	thbound Ramp ,
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)			es.(N)	Planr	ning Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K y D	2240	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R General Terrain: Grade % Length	0.92 4 0 Level mi	
		Venin	Up/Down %		
Calculate Flow Adjus	tmonts				
	1.00		F	1.0	
'p	1.00			1.2	
	1.5		$I_{HV} = I/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)]0.980	
Speed Inputs			Calc Speed Adj and I	-FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	2		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			·
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x I	N x f _{HV} 1242	pc/h/ln	<u>Design (N)</u> Design LOS v _p = (V or DDHV) / (PHF x	N x f _{HV}	20/b/lp
(p)	55.0	mph	x f _p)		pc/n/in
D = y / S	22.6	nc/mi/ln	S		mph
LOS	C	pormin	D = v _p / S Required Number of Lanes	s, N	pc/mi/ln
Glossarv			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design	S - Speed D - Densi FFS - Free BFFS - Bas hour volume	ty flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-76 Eastb F-29 'No-Build' 2040	bound Ramp
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
✓ Oper.(LOS)		D	es.(N)	Plann	ing Data
Flow Inputs					
Volume, V AADT Peak Hr Prop. of AADT K	1820	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RV/s_P	0.92 5	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
E _T	1.5		f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1)] 0.976	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{I W}		mph
Number of Lanes, N	2		f _{IC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{HV}		<u>Design (N)</u> Design LOS		
x f _p)	1014	pc/h/ln	v _p = (V or DDHV) / (PHF x x f _a)	N x f _{HV}	pc/h/ln
S	55.0	mph	S P		mph
$D = v_p / S$	18.4	pc/mi/ln	$D = v_p / S$		pc/mi/ln
LOS	С		Required Number of Lanes	, N	·
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design I	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	d flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	1 11-13 1 - 11-2,	r _{LW} - Exhibit 11-8 F _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	ır	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-76 Eastl F-30 'No-Build' 2040	bound ,
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)			es.(N)	Planr	ning Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K	2700	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R	0.92 6 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _p E _T	1.00 1.5		E _R f _{HV} = 1/[1+P _T (E _T - 1) + P _P (E _P - 1	1.2)]0.971	
Speed Inputs			Calc Speed Adi and I	FFS	
		#			
Rt-Side Lat Clearance		ft	5		manh
Number of Lanes, N	2	1	I _{LW}		mph
Total Ramp Density, TRD		ramps/mi	LC TRD Adjustment		mph
FFS (measured)	55.0	mph	FES	55.0	mph
Base free-flow Speed, BFFS		mph	110	55.0	трп
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x I	N x f _{HV 4 5 4 4}	n o /b //m	Design (N) Design LOS	Nyf	
s (fp)	55.0	pc/n/in mph	v _p = (v or DDHv)/(PHF x x f _p)	IN X I _{HV}	pc/h/ln
$D = v_p / S$	27.5	pc/mi/ln	S		mph
LOS	D	·	D = v _p / S Required Number of Lanes	s, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design	S - Speed D - Densi FFS - Free BFFS - Bas hour volume	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EEWAY SE	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst	Brett Ferrell		Highway/Direction of Trave	l I-76 East	bound Ramp
Date Performed	06/01/16		Jurisdiction	'No-Buila	li .
Analysis Time Period	PM Peak Hou	ır	Analysis Year	2040	
Project Description SUM-	76-Central Inte	erchange (PID	101402)		
Oper.(LOS)			Des.(N)	Plan	ning Data
Flow Inputs					
Volume, V	2260	veh/h	Peak-Hour Factor, PHF	0.92	
AADT		veh/day	%Trucks and Buses, P _T	6	
Peak-Hr Prop. of AADT, K			%RVs, P _R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
	1 1		Up/Down %		
Calculate Flow Adjus	tments				
^f p	1.00		E _R	1.2	
E _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.971	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	2		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed,		mph			
BFFS					
LOS and Performanc	e Measures		Design (N)		
Operational (LOS)			<u>Design (N)</u>		
$v_{x} = (V \text{ or } DDHV) / (PHF x)$	N x fuy		Design LOS		
xf)	1265	pc/h/ln	$v_p = (V \text{ or DDHV}) / (PHF x)$	N x f _{HV}	nc/h/ln
s	55 0	mph	x f _p)		portant
D = v / S	23.0	nc/mi/ln	S		mph
	20.0	permin	$D = v_p / S$		pc/mi/ln
203	C		Required Number of Lanes	3, N	
Glossary			Factor Location		
N - Number of lanes	S - Spee	d	E Exhibite 11 10 11 12		f Exhibit 11.8
V - Hourly volume	D - Densi	ty	$E_{R} = E_{X} + 100000000000000000000000000000000000$	11 12	f Exhibit 11.0
v - Flow rate	FFS - Free	-flow speed	$\mathbf{E}_{T} = Exiliality + T_{T} = E_{T} + E_{T} $	11-13	
LOS - Level of service	BFFS - Ba	se free-flow	r _p - Page 11-18		IRD - Page 11-11
speed			LOS, S, FFS, v _p - Exhibits	11-2,	
DDHV - Directional design	hour volume		11-3		

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	ır	Highway/Direction of Trave From/To Jurisdiction Analysis Year	I SR-8 Noi F-32 'No-Build 2040	rthbound Ramp ''
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)		D	es.(N)	Planr	ning Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop. D	1860	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R General Terrain:	0.92 3 0	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	mi	
Calculate Flow Adjus	tments				
f _p E _T	1.00 1.5		E_{R} $f_{HV} = 1/[1+P_{T}(E_{T} - 1) + P_{R}(E_{R} - 1)$	1.2)] 0.985	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f		mph
Number of Lanes, N	2	-	LW f		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55 0	mph
Base free-flow Speed, BFFS		mph		00.0	
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x I	N x f _{HV} 1026	pc/h/ln	<u>Design (N)</u> Design LOS v _o = (V or DDHV) / (PHF x	N x f _{uv}	
x f _p) S D = v _p / S LOS	55.0 18.7 C	mph pc/mi/ln	x f _p) S D = v _p / S Required Number of Lanes	s, N	pc/h/ln mph pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	d ty flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-77 South F-33 'No-Build' 2040	bound
Project Description SUM-	76-Central Inte	rchange (PID	101402)	2040	
Oper.(LOS)			es.(N)	Planni	ng Data
Flow Inputs			()		5
Volume, V	2780	veh/h	Peak-Hour Factor, PHF	0.92	
AADT		veh/day	%Trucks and Buses, P _T	5	
Peak-Hr Prop. of AADT, K			%RVs, P _R	0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length	Level mi	
			Up/Down %		
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
E _T	1.5		f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1)] 0.976	
Speed Inputs			Calc Speed Adj and I	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{I W}		mph
Number of Lanes, N	2		fic		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55 0	mph
Base free-flow Speed, BFFS		mph		00.0	mpn
LOS and Performanc	e Measures		Design (N)		
Operational (LOS)	Nyf		<u>Design (N)</u> Design LOS		
$x f_p$)	1549 1549	pc/h/ln	$v_p = (V \text{ or } DDHV) / (PHF x)$	N x f _{HV}	pc/h/ln
S	55.0	mph	^ 'p)		mah
$D = v_p / S$	28.2	pc/mi/ln			mpn na/mi/ln
LOS	D		Required Number of Lanes	s, N	pc/m/m
Glossary			Factor Location		
N - Number of lanes	S - Speed	<u> </u>	F Exhibits 11-10 11-12	f	- Exhibit 11-8
V - Hourly volume	D - Densi	ty	$=_{R}$ = Exhibits 11-10, 11 11	ין 11_13 f	_W Exhibit 11_0
v _p - Flow rate	FFS - Free	-flow speed	$F_{T} = F_{T} = F_{T$	ן טו-וו ד	$\frac{1}{2} = \frac{1}{2} = \frac{1}$
LOS - Level of service speed	BFFS - Bas	se free-flow	$V_p = Faye + From From From From From From From From$	ا 11-2,	ки - Page 11-11
DDHV - Directional design	hour volume		11-3		

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst	Brett Ferrell		Highway/Direction of Trave	I-76 East	bound/Westbound
Agency or Company Date Performed Analysis Time Period	GPD Group 06/01/16 PM Peak Hou	r	From/To Jurisdiction Analysis Year	Ramp F-34 'No-Build 2040	,
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)		D	es.(N)	Planr	ning Data
Flow Inputs					
Volume, V AADT	2070	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T	0.92 4	
Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	%RVs, P _R General Terrain: Grade % Length Up/Down %	0 Level mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
Ε _T	1.5		f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1))] 0.980	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{i w}		mph
Number of Lanes, N	2		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x N x f)	N x f _{HV} 1147	pc/h/ln	<u>Design (N)</u> Design LOS v _p = (V or DDHV) / (PHF x l	N x f _{HV}	pc/b/lp
s	55 0	mnh	x f _p)		pennin
$D = v_{\rm s} / S$	20.9	pc/mi/ln	S		mph
LOS	C	portiunt	D = v _p / S Required Number of Lanes	, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design l	S - Speed D - Densi FFS - Free BFFS - Bas	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	I I-77 NB / F-35 'No-Build 2040	I-76 WB Ramp ,
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)		D	es.(N)	Planr	ning Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K Peak Hr Direction Prop. D	2320	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R General Terrain;	0.92 4 0	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	mi	
Calculate Flow Adjus	tments				
f _p E _T	1.00 1.5		E _R f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1	1.2)] 0.980	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f		mph
Number of Lanes, N	2		'LW f		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55 0	mph
Base free-flow Speed, BFFS		mph		00.0	
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x I	N x f _{HV 4000}		<u>Design (N)</u> Design LOS	NI £	
x f _p) S	55.0	pc/h/ln mph	v _p = (V or DDHV)7 (PHF X X f _p) S	N X T _{HV}	pc/h/ln mph
D = v _p / S LOS	23.4 C	pc/mi/ln	D = v _p / S Required Number of Lanes	s, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design	S - Speed D - Densi FFS - Free BFFS - Bas hour volume	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst	Brett Ferrell		Highway/Direction of Trave	State Rou Ramp	ite 8 Northbound
Agency or Company Date Performed Analysis Time Period	GPD Group 06/01/16 PM Peak Hou	r	From/To Jurisdiction Analysis Year	F-36 'No-Build' 2040	,
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)		D	es.(N)	Plann	ing Data
Flow Inputs					
Volume, V AADT	2050	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T	0.92 4	
Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	%RVs, P _R General Terrain: Grade % Length Up/Down %	0 Level mi	
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
Ε _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.980	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	2		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _p = (V or DDHV) / (PHF x N	N x f _{HV} 1136	pc/h/ln	<u>Design (N)</u> Design LOS v _n = (V or DDHV) / (PHF x l	N x f _{HV}	
x f _p)	FF 0		x f _p)		pc/h/ln
5 D-V /S	55.U 20.Z	mpn no/mi/ln	S		mph
LOS	20.7 C	portinini	D = v _p / S Required Number of Lanes	i, N	pc/mi/ln
Glossarv			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design h	S - Speed D - Densi FFS - Free BFFS - Bas	d ty -flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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DESIGN YEAR 2040 'BUILD' CONDITIONS

AM PEAK HOUR

	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
0			0.4.1.6		
General Information			Site Information		
Analyst	Brett Ferrell		Highway/Direction of Trave	I I-76 Easi	tbound
Date Performed	06/01/16		Jurisdiction	'Build'	
Analysis Time Period	AM Peak Hou	r	Analysis Year	2040	
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)		D	es.(N)	Plan	ning Data
Flow Inputs					
Volume, V	2820	veh/h	Peak-Hour Factor, PHF	0.92	
AADT		veh/day	%Trucks and Buses, P _T	12	
Peak-Hr Prop. of AADT, K			%RVs, P _R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		
Calculate Flow Adjus	tments		_		
f _p	1.00		E _R	1.2	
Ε _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.943	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{I W}		mph
Number of Lanes, N	3		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed,		mph		••••	
BFFS					
LOS and Performance	e Measures		Design (N)		
Operational (LOS)			<u>Design (N)</u>		
$v_{x} = (V \text{ or } DDHV) / (PHF x I)$	N x funz		Design LOS		
xf)	1083	pc/h/ln	$v_p = (V \text{ or DDHV}) / (PHF x)$	N x f _{HV}	nc/h/ln
s	55.0	mph	x f _p)		po/11/11
D = y / S	10.7	ng/mi/lp	S		mph
$D = v_p / S$	19.7	pc/m/m	$D = v_p / S$		pc/mi/ln
LU3	C		Required Number of Lanes	3, N	
Glossary			Factor Location		
N - Number of lanes	S - Speed	k	E Exhibite 11 10 11 10		f Evhihit 11 0
V - Hourly volume	D - Densi	ty	L_R^{-1} LATING 11-10, 11-12 E Exhibite 11 10, 11-12	11 10	
v Flow rate	FFS - Free	- flow speed	$\Box_{T} = \Box_{X} \square $	11-13	
LOS - Level of service	BFFS - Bas	se free-flow	r _p - Page 11-18		IRD - Page 11-11
speed			LOS, S, FFS, v _p - Exhibits	11-2,	
DDHV - Directional design	hour volume		11-3		

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-76 Wes F-19 'Build' 2040	tbound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)		D	es.(N)	Planr	ning Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K	6300	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R	0.92 11 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _ρ Ε _Τ	1.00 1.5		E_{R} $f_{HV} = 1/[1+P_{T}(E_{T} - 1) + P_{R}(E_{R} - 1)$	1.2)] 0.948	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f.w		mph
Number of Lanes, N	3		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			·
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{HV}		<u>Design (N)</u> Design LOS		
x f _p) S	48.1	pc/h/ln mph	v _p = (V or DDHV) / (PHF x x f _p) e	N x f _{HV}	pc/h/ln
D = v _p / S	50.0	pc/mi/ln	5 D-v /S		nipii no/mi/ln
LOS	F		Required Number of Lanes	s, N	perminin
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design l	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	d Flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Г	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	r	Highway/Direction of Travel From/To Jurisdiction Analysis Year	I-76 West F-20 'Build' 2040	bound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)		D	es.(N)	Plann	ing Data
FIOW INPUTS					
Volume, V AADT Peak-Hr Prop. of AADT. K	6710	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs_P ₋	0.92 10 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _ρ Ε _τ	1.00 1.5		E_R $f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)$	1.2]0.952	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{LW}		mph
Number of Lanes, N	4		f _{IC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x fuv		<u>Design (N)</u> Design LOS		
x f _p)	¹¹¹ 1915	pc/h/ln	v _p = (V or DDHV) / (PHF x f x f _p)	N x f _{HV}	pc/h/ln
D = y / S	35.0	nc/mi/ln	S		mph
LOS	55.0 E	pormin	D = v _p / S Required Number of Lanes	, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design I	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	d flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 1 11-3	1 11-13 1 - 11-2,	r _{LW} - Exhibit 11-8 F _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Г	
			1		
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 AM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-76 Wes F-21 'Build' 2040	tbound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)		D	es.(N)	Plan	ning Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K	5200	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R	0.92 13 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _ρ Ε _τ	1.00 1.5		E_{R} $f_{HV} = 1/[1+P_{T}(E_{T} - 1) + P_{R}(E_{R} - 1)]$	1.2]0.939	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f		mph
Number of Lanes, N	3		fue		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		, mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			·
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{HV}		<u>Design (N)</u> Design LOS		
x f _p) S	53.9	pc/h/ln mph	v _p = (V or DDHV) / (PHF x l x f _p)	N x f _{HV}	pc/h/ln
$D = v_p / S$	37.2	pc/mi/ln	S		mph
LOS	E	F -	D = v _p / S Required Number of Lanes	, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design l	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	d ty flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits ⁻ 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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PM PEAK HOUR

	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-76 Easi F-3 'Build' 2040	tbound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)		D	es.(N)	Plan	ning Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K Peak-Hr Direction Prop, D	4910	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R General Terrain:	0.92 12 0 Level	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	mi	
Calculate Flow Adjus	tments				
f _p E _T	1.00 1.5		E _R f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1	1.2)] 0.943	
Speed Inputs			Calc Speed Adj and I	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f		mph
Number of Lanes, N	3		fue		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{HV}		<u>Design (N)</u> Design LOS		
x f _p) S	¹¹ 1886 54.8	pc/h/ln mph	v _p = (V or DDHV) / (PHF x x f _p)	N x f _{HV}	pc/h/ln
$D = v_n / S$	34.4	pc/mi/ln	S		mph
LOS	D	F -	D = v _p / S Required Number of Lanes	5, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design I	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Trave From/To Jurisdiction Analysis Year	l I-76 Wes F-19 'Build' 2040	tbound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)		D	es.(N)	Planı	ning Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K	3830	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R	0.92 11 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _p E _T	1.00 1.5		E_{R} $f_{HV} = 1/[1+P_{T}(E_{T} - 1) + P_{R}(E_{R} - 1)$	1.2)] 0.948	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f		mph
Number of Lanes, N	3		f _{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		, mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			·
LOS and Performanc	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{HV}		<u>Design (N)</u> Design LOS		
x f _p) S	60.0	pc/h/ln mph	v _p = (V or DDHV) / (PHF x x f _p)	N x f _{HV}	pc/h/ln
$D = v_p / S$	24.4	pc/mi/ln	S		mph
LOS	С	·	D = v _p / S Required Number of Lanes	, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design	S - Speed D - Densi FFS - Free BFFS - Bas hour volume	d ty flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits 11-3	11-13 11-2,	f _{LW} - Exhibit 11-8 f _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Г	
General Information			Site Information		
Analyst Agency or Company Date Performed Analysis Time Period	Brett Ferrell GPD Group 06/01/16 PM Peak Hou	r	Highway/Direction of Travel From/To Jurisdiction Analysis Year	I-76 Westi F-20 'Build' 2040	bound
Project Description SUM-	76-Central Inte	rchange (PID	101402)		
Oper.(LOS)		D	es.(N)	Plann	ing Data
Flow Inputs					
Volume, V AADT Peak-Hr Prop. of AADT, K	4380	veh/h veh/day	Peak-Hour Factor, PHF %Trucks and Buses, P _T %RVs, P _R	0.92 10 0	
Peak-Hr Direction Prop, D DDHV = AADT x K x D		veh/h	General Terrain: Grade % Length Up/Down %	Level mi	
Calculate Flow Adjus	tments				
f _ρ Ε _τ	1.00 1.5		E _R f _{HV} = 1/[1+P _T (E _T - 1) + P _R (E _R - 1)	1.2]0.952	
Speed Inputs			Calc Speed Adj and F	FS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f		mph
Number of Lanes, N	4		fue		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		, mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			•
LOS and Performance	e Measures		Design (N)		
<u>Operational (LOS)</u> v _n = (V or DDHV) / (PHF x I	N x f _{HV}		<u>Design (N)</u> Design LOS		
x f _p) S	55.0	pc/h/ln mph	v _p = (V or DDHV) / (PHF x f x f _p)	√x f _{HV}	pc/h/ln
D = v _p / S	22.7	pc/mi/ln	S D = ··· / C		mpn
LOS	С		$D = V_p / S$ Required Number of Lanes	, N	pc/mi/ln
Glossary			Factor Location		
N - Number of lanes V - Hourly volume v _p - Flow rate LOS - Level of service speed DDHV - Directional design I	S - Speed D - Densit FFS - Free BFFS - Bas hour volume	d ty flow speed se free-flow	E _R - Exhibits 11-10, 11-12 E _T - Exhibits 11-10, 11-11, f _p - Page 11-18 LOS, S, FFS, v _p - Exhibits ΄ 11-3	11-13 f 11-2,	_{LW} - Exhibit 11-8 _{LC} - Exhibit 11-9 TRD - Page 11-11

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	BASIC FRE	EWAY SEC	GMENTS WORKSHEE	Т	
General Information			Site Information		
Analyst Agency or Company	Brett Ferrell GPD Group		Highway/Direction of Trave From/To	el I-76 Wes F-21	stbound
Date Performed	06/01/16		Jurisdiction	'Build'	
Analysis Time Period	PM Peak Hou	r raharan (DID	Analysis Year	2040	
Project Description SUM-	76-Central Inte	rcnange (PID	101402)		
Flow Inputs			es.(N)	Plan	ning Data
	3450	veh/h	Peak Hour Eactor DHE	0.02	
AADT	5450	veh/dav	%Trucks and Buses. P_{τ}	0.92 13	
Peak-Hr Prop of AADT K			%RVs.P ₋	0	
Peak-Hr Direction Prop. D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		
Calculate Flow Adjus	tments				
f _p	1.00		E _R	1.2	
Ε _T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$)] 0.939	
Speed Inputs			Calc Speed Adj and I	FFS	
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f _{I W}		mph
Number of Lanes, N	3		fic		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55 0	mph
Base free-flow Speed,		mph		00.0	mpn
BFFS					
LOS and Performanc	e Measures		Design (N)		
Operational (LOS)			<u>Design (N)</u>		
v _n = (V or DDHV) / (PHF x I	N x f _{HV}				
x f _n)	1331	pc/h/ln	$v_p = (V \text{ or } DDHV) / (PHF X)$	N X T _{HV}	pc/h/ln
ร์	55.0	mph	x t _p)		
$D = v_n / S$	24.2	pc/mi/ln	S (A		mph
LOS	С	·	$D = v_p / S$		pc/mi/ln
			Required Number of Lanes	5, N	
Glossary			Factor Location		
N - Number of lanes	S - Speed	t	E _P - Exhibits 11-10, 11-12		f _{uw} - Exhibit 11-8
V - Hourly volume	D - Densi	ty	E ₋ - Exhibits 11-10, 11-11,	11-13	f Exhibit 11-9
v _p - Flow rate	FFS - Free	-flow speed	f - Page 11-18	-	TRD - Page 11-11
LOS - Level of service	BFFS - Bas	se free-flow	LOS. S. FFS. v - Exhibits	11-2.	
speeu DDHV - Directional design	hour volume		11-3	,	

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APPENDIX D HCS RAMP JUNCTION ANALYSES

DIVERGE JUNCTION ANALYSIS

DESIGN YEAR 2040 'NO-BUILD' CONDITIONS

AM PEAK HOUR

RAMPS AND RAMP JUNCTIONS WORKSHEET										
General Infor	mation			Site Infor	mation					
Analyst	Brett	Ferrell	Fr	eeway/Dir of Tr	avel I-77 Southbound					
Agency or Company	GPD	Group	Ju	inction		D-1 (Lo	overs Lane R	amp)		
Date Performed	06/01	1/16	Ju	irisdiction		'No-Bui	ild'			
Analysis Time Period	AM F	eak Hour	Ar	nalysis Year		2040				
	SUM-70-Certa	ai merchange	(PID 101402)							
mputs		Freeway Num	ber of Lanes N	2						
Upstream Adj R	amp	Damp Numbe	or of Lance N	2					Downstrear Pamp	m Adj
Yes	On		and Longth	I					–	
			Lane Length, L _A	450					✓ Yes	On
✓ No	Off			150					No	✓ Off
f	•	Freeway volu	ime, v _F	2560					L. =	1735 ft
	L		e, V _R	190					aown	1100 11
V., = ve	eh/h	Freeway Free	-Flow Speed, S _{FF}	55.0					V _D = 2	280 veh/h
ů		Ramp Free-F	low Speed, S _{FR}	35.0						
Conversion to	o pc/h Und	der Base	Conditions	r	1					
(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv		f _{HV}	f _p	v = V/PHF >	k f _{HV} x f _p
Freeway	2560	0.92	Level	4	0	0.	980	1.00	283	8
Ramp	190	0.92	Level	4	0	0.	980	1.00	21	1
UpStream										
DownStream	280	0.92	Level	3	0	0.	985	1.00	309	9
	-	Merge Areas			Diverge Areas					
Estimation of	۲۷ ₁₂				Estimat	tion o	t v ₁₂			
	V ₁₂ = V _F	(P _{FM})					V ₁₂ = \	/ _R + (V _F - V _R)P _{FD}	
L _{EQ} =	(Equa	ition 13-6 or	13-7)		L _{EQ} =		(E	quation 13-12	2 or 13-13)	
P _{FM} =	using	Equation (Exhibit 13-6)		P _{FD} =		1.00	0 using Equ	ation (Exhib	it 13-7)
V ₁₂ =	pc/h				V ₁₂ =		283	8 pc/h		
V ₃ or V _{av34}	pc/h (Equation 13	-14 or 13-17)		V ₃ or V _{av34} 0 pc/h (Equation 13-14 or 13-17)					
Is V ₃ or V _{av34} > 2,70	0 pc/h? 🗌 Ye	s 🗌 No			Is V ₃ or V _{av34} > 2,700 pc/h? Yes No					
Is V_3 or V_{av34} > 1.5 '	[•] V ₁₂ /2 Ye	s 🗌 No			Is V_3 or $V_{av34} > 1.5 * V_{12}/2$ Yes No					
If Yes,V ₁₂₂ =	pc/h (Equation 13	-16, 13-18, or		If Yes, $V_{12a} = pc/h$ (Equation 13-16, 13-18, or 13-					
Canacity Che	13-19)				Canacit	$\begin{array}{c}1 \\ 1 \\ 1 \\ 2 \\ 2 \\ 2 \\ 2 \\ 2 \\ 2 \\ 2 \\ $				
			anacity	1.05 F2		<u>y on</u>	Actual	Car	acity	1.0S.F2
	Actual			20011	V _E		2838	Exhibit 13-8	4500	No
V==		Exhibit 13-8			$V_{-a} = V_{-a}$	V_	2627	Exhibit 13-8	4500	No
• FO					VFO V	- •R	2021	Exhibit 12 10	4000	No
		<u> </u>					211		2000	NU
Flow Entering		Max	Area Dosirablo	Violation?	FIOWEI	nterin	g Diverg	Max Dosirabl		Violation?
Vela	Actual	Exhibit 13-8	Desilable	VIOIALIOITE	V.		2838	Evhibit 13-8	4400·∆II	No
R12	ico Dotorn	nination ((if not E)			f Son	vice Det	rmination	$\frac{1}{100.7}$.)
$D_{-} = 5475 \pm 0$	00734 v = +	0 0078 V	- 0 00627			$D_{-} = 4$	252 + 0 0	086 V 0.0	091.	/
$D_{R} = (nc/mi/ln)$	$D_R = 5.475 \pm 0.00734 v_R \pm 0.0078 v_{12} \pm 0.00627 L_A$					² R ⁻	/mi/ln)	12 0.0	00 LD	
$D_R = (pc/m/m)$	/ 12 2)				$P_R = 2$		(111/11) ait 40.0)			
LOS = (Exhibit 13-2) LOS = C (Exhibit 13-2)										
Speed Detern	innation				Speed I	Jeter	mination	<u> </u>		
M _S = (Exibit 13	3-11)				$D_{s} = 0$.447 (E	xnibit 13-1	2)		
S _R = mph (Exh	ibit 13-11)				S _R = 4	9.2 mph	(Exhibit 1	3-12)		
S ₀ = mph (Exh	ibit 13-11)				S₀= N	I/A mph	(Exhibit 13	3-12)		
S = mph (Exh	iddit 13-13)				S= 4	9.2 mph	(Exhibit 1	3-13)		

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HCM 2010: MAJOR DIVERGE AREA ANALYSIS

Analyst:	Brett Ferrell	Freeway/Direction of Travel:	I-77 NB / I-76 WB
Date:	06/01/16	Junction:	D-2 (Broadway Street Ramp)
Analysis Year:	2040 'No-Build'	Analysis Time Period:	AM Peak Hour
Description:	SUM-76-Central Interchange (PI	D 101402)	

Equation:

 $D_{MD} = 0.0175 * V_f$

Inputs: D_{MD} = density in the major diverge influence area (pc/mi/ln) V_F = demand flow rate immediately upstream of the major diverge influence area (pc/h)

Analysis

 D_{MD} = ## (pc/mi/ln)

 $V_F = 1,911 (pc/h/ln)$

 $D_{MD} = 0.0175 * 1,911$

 $D_{MD} = 33.44$

Level of Service Determination

Level of Service	Density (pc/mi/ln)
А	≤ 10
В	> 10 - 20
С	> 20 – 28
D	> 28 – 35
E	> 35
F	Demand Exceeds Capacity

 $D_{MD} = 33.4 \text{ pc/mi/ln}$

Level of Service for Major Diverge Area: D



RAMPS AND RAMP JUNCTIONS WORKSHEET										
General Infor	mation			Site Infor	mation					
Analyst	Brett	Ferrell	Fr	eeway/Dir of Tr	avel	avel I-76 Eastbound				
Agency or Company	GPD	Group	Ju	nction		D-3 (St	tate Route 8	NB Ramp)		
Date Performed	06/01	06/01/16 Jurisdiction				'No-Bu	ild'			
Project Description	SUM-76-Centr	'eak Hour al Interchance		alysis rear		2040				
Inputs	00m-70-0enti	armerenange								
		Freeway Nun	nber of Lanes. N	2						. A .I'
Upstream Adj R	amp	Ramp Numbe	er of Lanes N	-				L	Jownstrear Ramn	n Adj
Yes	On	Acceleration	ane Length L.	I				ľ		
	7	Deceleration	Lane Length L	500					∐ Yes	On
I No □	」Off	Freeway Volu	ime V	2720					✓ No	Off
L = f	t	Pamp Volum	o V	1160				L	=	ft
up		Frooway Fro	e, v _R	55.0						
V _u = v	eh/h	Dome Free F	Ilow Speed, S _{FF}	55.0 25.0					√ _D =	veh/h
0	//- 1.1			35.0						
Conversion to	opc/nuno	der Base	Conditions	1	1					
(pc/h)	(Veh/hr)	PHF	Terrain	%Truck	%Rv		f _{HV}	f _p v	/ = V/PHF >	κ f _{HV} x f _p
Freeway	2720	0.92	Level	12	0	0.	.943	1.00	313	4
Ramp	1160	0.92	Level	4	0	0.	.980	1.00	128	6
UpStream										
DownStream		Marga Araaa						iverge Arees		
Estimation of	Fv	werge Areas			Estimat	ion o	uf v	iverge Areas		
	• 12	<u>, </u>			Lotinut		<u>12</u>	<u> </u>		
	V ₁₂ = V _F	(P _{FM})					V ₁₂ =	v _R + (v _F - v _R)P _{FD}	
L _{EQ} =	(Equa	ition 13-6 or	· 13-7)		L _{EQ} =		(E	quation 13-12	2 or 13-13)	
P _{FM} =	using	Equation (Exhibit 13-6)		P _{FD} =		1.0	00 using Equ	ation (Exhibi	t 13-7)
V ₁₂ =	pc/h				$v_{12} = 3134 \text{ pc/h}$					
v_3 or v_{av34}	pc/h (Equation 13	3-14 or 13-17)		$v_3 \text{ or } v_{av34} = 0 \text{ pc/n} (\text{Equation } 13-14 \text{ or } 13-17)$					
Is V_3 or $V_{av34} > 2,70$	10 pc/h? Ye	s 🗌 No			$ s _{3} or V_{av34} > 2,700 pc/n? Yes V No$					
Is V_3 or $V_{av34} > 1.5$	[^] V ₁₂ /2 ∐Ye	s 🗌 No	16 12 10 or		IS V_3 or $V_{av34} > 1.5 V_{12}/2$ Yes V No					
If Yes,V _{12a} =	13-19)		5-10, 13-10, 01		If Yes, $V_{12a} = 19$					
Capacity Che	ecks				Capacit	y Ch	ecks	/		
	Actual	(Capacity	LOS F?			Actual	Сар	acity	LOS F?
					V _F		3134	Exhibit 13-8	4500	No
V _{FO}		Exhibit 13-8			V _{FO} = V _F	- V _R	1848	Exhibit 13-8	4500	No
					V _R		1286	Exhibit 13-10	2000	No
Flow Entering	a Merae In	fluence A	Area		Flow Er	nterin	a Diver	ae Influenc	e Area	
	Actual	Max	Desirable	Violation?			Actual	Max Desirabl	e	Violation?
V _{R12}		Exhibit 13-8			V ₁₂	;	3134	Exhibit 13-8	4400:All	No
Level of Serv	ice Detern	nination ((if not F)		Level of	f Ser	vice Det	termination	íf not F)
D _R = 5.475 + 0.	00734 v _R +	0.0078 V ₁₂	- 0.00627 L _A			D _R = 4	4.252 + 0.	0086 V ₁₂ - 0.0	09 L _D	
$D_{\rm R} = (\rm pc/mi/ln)$				D _R = 2	6.7 (pc	/mi/ln)		_		
LOS = (Exhibit 13-2) $LOS = C (Fxhibit 13-2)$										
Speed Detern	nination				Speed I	Deter	minatio	n		
$M_{\rm s} = (Evibit 1)$	3_11)				$D_{c} = 0$.544 (F	xhibit 13-	12)		
S = mnh (Exh	$\frac{1}{10}$				$S_{D} = 4$	7.9 mnh	(Exhibit	, 13-12)		
$\sim_{\rm R}$ inplice XII S = mph (Exh	$\frac{101110-11}{10111}$				S ₀ = N	/A mnh	(Exhibit 1	3-12)		
S = mph (Exh	nibit 13-13)				S = 4	7 9 mnh	(Exhibit	13-13)		
S = mpn (Exhibit 13-13) $S = 47.9 mpn (Exhibit 13-13)$										

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RAMPS AND RAMP JUNCTIONS WORKSHEET										
General Infor	rmation			Site Infor	mation					
Analyst	Brett	Ferrell	Fr	eeway/Dir of Tr	avel	I-76 Ea	stbound			
Agency or Company	GPD	Group	Ju	nction		D-4 (Arlington Street Ramp)				
Date Performed	06/01	1/16	Ju	risdiction		'No-Bu	ild'			
Analysis Time Period	AM F	eak Hour	Ar	nalysis Year		2040				
	SUM-70-Centr	armerchange	(PID 101402)							
mputs		Freeway Num	ber of Lanes N	3						
Upstream Adj R	lamp	Ramp Numbe	ar of Lanes N	1					Downstrea Ramn	m Adj
□Yes □	On	Acceleration	Lane Length, L_{Δ}	I						√ On
✓ No	Off	Deceleration	Lane Length L _D	600						
		Freeway Volu	ıme, V _F	3780						
L _{up} = f	ť	Ramp Volume	e, V _R	570					down =	1825 ft
	ch/h	Freeway Free	e-Flow Speed, S _{FF}	60.0				,	V., =	200 veh/h
v _u - v	en/m	Ramp Free-F	low Speed, S _{FR}	35.0					• D	200 VCI//1
Conversion t	o pc/h Und	der Base	Conditions							
(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv		f _{HV}	f _p	v = V/PHF	x f _{HV} x f _p
Freeway	3780	0.92	Level	12	0	0.	943	1.00	435	55
Ramp	570	0.92	Level	4	0	0.	980	1.00	63	2
UpStream										
DownStream	200	0.92	Level	6	0	0.	971	1.00	22	4
Estimation	f v	Merge Areas			Ectimat	tion	Di	verge Areas		
Estimation of	v 12				LSumat		12			
	V ₁₂ = V _F	(P _{FM})					V ₁₂ =	V _R + (V _F - V _R)P _{FD}	
L _{EQ} =	(Equa	ition 13-6 or	13-7)		L _{EQ} = (Equation 13-12 or 13-13)					
P _{FM} =	using	Equation (Exhibit 13-6)		P _{FD} =		0.6	22 using Equ	ation (Exhib	oit 13-7)
V ₁₂ =	pc/h				$V_{12} = 2948 \text{ pc/h}$					
V ₃ or V _{av34}	pc/h (Equation 13	-14 or 13-17)		V ₃ or V _{av34} 1407 pc/h (Equation 13-14 or 13-17)					
Is V_3 or $V_{av34} > 2,70$	00 pc/h? 🗌 Ye	s 🗌 No			Is V ₃ or V _{av34} > 2,700 pc/h? □ Yes ☑ No					
Is V ₃ or V _{av34} > 1.5	*V ₁₂ /2 Ye	s 🗌 No			Is V_3 or $V_{av34} > 1.5 * V_{12}/2$ Yes No					
If Yes,V _{12a} =	pc/n (13-19)	Equation 13	-16, 13-18, or		If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13- 19)					
Capacity Che	ecks				Capacity Checks					
	Actual	(Capacity	LOS F?			Actual	Car	pacity	LOS F?
					V _F		4355	Exhibit 13-8	6900	No
V _{FO}		Exhibit 13-8			$V_{FO} = V_{F}$	V _R	3723	Exhibit 13-8	6900	No
					Vp		632	Exhibit 13-10	2000	No
Flow Entering	n Merae In	fluence 4	Irea			nterin	a Diver	ne Influenc	e Area	
	Actual	Max	Desirable	Violation?			Actual	Max Desirab	le	Violation?
V _{R12}		Exhibit 13-8			V ₁₂		2948	Exhibit 13-8	4400:All	No
Level of Serv	ice Detern	nination (ïf not F)		Level o	f Serv	vice Det	erminatior	n (if not F	-)
D _R = 5.475 + 0.	.00734 v _R +	0.0078 V ₁₂	- 0.00627 L _A			D _R = 4	1.252 + 0.0	0086 V ₁₂ - 0.0	009 L _D	
D _R = (pc/mi/ln	$D_{\rm p}$ = (pc/mi/ln)					4.2 (pc	/mi/ln)		2	
LOS = (Exhibit 13-2)										
Speed Deterr	nination				Speed I	Deter	minatio	n		
M _s = (Exibit 1	3-11)				$D_s = 0.485$ (Exhibit 13-12)					
S _R = mph (Exh	nibit 13-11)				S _R = 5	1.3 mph	(Exhibit 1	3-12)		
S ₀ = mph (Exh	, nibit 13-11)				S ₀ = 6	4.2 mph	(Exhibit 1	3-12)		
S = mph (Exh	nibit 13-13)				S = 5	4.8 mph	(Exhibit 1	3-13)		
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RAMPS AND RAMP JUNCTIONS WORKSHEET										
General Info	rmation			Site Infor	mation					
Analyst	Brett	Ferrell	Fre	eeway/Dir of Tra	avel	I-76 We	estbound			
Agency or Company	/ GPD	Group	Ju	nction	D-5 (I-77 Southbound Ramp)					
Date Performed	06/01	1/16	Ju	risdiction		'No-Bui	ild'			
Analysis Time Perio	d AM F	Peak Hour	An	alysis Year		2040				
Project Description	SUIVI-76-Centr	al Interchange	(PID 101402)							
mputs		Freeway Num	her of Lanes N	2						
Upstream Adj F	Ramp	Domp Numbo	r of Lance N	2					Downstrea	m Adj
Yes	On			I						
				475					∐Yes	On
✓ No	Off	Erooway Volu		4/0					🗹 No	Off
= .	ft	Domp Volume	nie, v _F	5200					L _{down} =	ft
-up			, v _R	1300					down	-
V _u = v	/eh/h	Freeway Free	Flow Speed, S _{FF}	55.0					V _D =	veh/h
0	· · · · · //· · / /··		low Speed, S _{FR}	35.0						
Conversion t	<u>o pc/n Uner de la composición de la composicinde la composición de la composición d</u>	der Base	Conditions		<u> </u>	_				
(pc/h)	(Veh/hr)	PHF	Terrain	%Truck	%Rv		f _{HV}	f _p	v = V/PHF	x f _{HV} x f _p
Freeway	5200	0.92	Level	13	0	0.	939	1.00	60	20
Ramp	1300	0.92	Level	5	0	0.	976	1.00	14	48
UpStream										
DownStream									_	
Estimation o	fv	werge Areas			Estimation of V ₄₂					
	12	<u> </u>			LStimat		<u>12</u>			
l	V ₁₂ = V _F	(P _{FM})					V ₁₂ =	V _R + (V _F - V	R)P _{FD}	
L _{EQ} =	(Equa	ation 13-6 or	13-7)		L _{EQ} =		(Equation 13-1	12 or 13-13)
P _{FM} =	using	Equation (I	Exhibit 13-6)		P _{FD} =		1.	000 using Eq	uation (Exhil	oit 13-7)
V ₁₂ =	pc/h				V ₁₂ = 6020 pc/h					
V ₃ or V _{av34}	pc/h (Equation 13	-14 or 13-17)		V ₃ or V _{av34} 0 pc/h (Equation 13-14 or 13-17)					
Is V ₃ or V _{av34} > 2,7	00 pc/h? 🗌 Ye	s 🗌 No			Is V ₃ or V _{av34} > 2,700 pc/h? ☐ Yes ☑ No					
Is V_3 or V_{av34} > 1.5	*V ₁₂ /2 Ye	s 🗌 No			Is V_3 or $V_{av34} > 1.5 * V_{12}/2$ Yes V No					
If Yes,V _{12a} =	pc/h (Equation 13	-16, 13-18, or		If Yes,V _{12a} = pc/h (Equation 13-16, 13-18, or 13-					
Capacity Che	ecks				Capacity Checks					
	Actual	C	apacity	LOS F?		<u>, , , , , , , , , , , , , , , , , , , </u>	Actual	Ca	apacity	LOS F?
					V _F		6020	Exhibit 13-8	8 4500	Yes
Vro		Exhibit 13-8			$V_{\Gamma O} = V_{\Gamma}$	- V _D	4572	Exhibit 13-8	8 4500	Yes
FO							1448	Exhibit 13-1	0 2000	No
Elow Enterin	<u>a Morao In</u>	l I	roa			torin		rao Influon		
	Actual	Max	Desirable	Violation?			Actual	Max Desiral	ble	Violation?
V _{P12}		Exhibit 13-8			V ₁₂	6	6020	Exhibit 13-8	4400:All	Yes
Level of Serv	vice Detern	nination (if not F)		Level of	f Serv	vice De	terminatio	n (if not l	=)
$D_{\rm p} = 5.475 \pm 0.00734 \text{y}_{\rm p} \pm 0.0078 \text{V}_{\star o} = 0.00627 \text{L}_{\star}$						$D_p = 4$	1.252 + 0	.0086 V ₁₂ - 0.	.009 L _D	/
$D_p = (pc/mi/ln)$					$D_{\rm p} = 51.7 ({\rm nc/mi/ln})$					
LOS = (Exhibit 13-2)					LOS = F	(Fxhil	oit 13-2)			
Speed Determination Speed Determination					n					
M = (Evibit 1)	3 11)				$D_0 = 0$	558 (F	xhibit 13	.12)		
S = mph(Exil	$\frac{J-11}{13}$				$S_{p} = 47$	7.7 mnh	(Exhibit	13-12)		
S = math (Exil	$\frac{101113-11}{101112}$				к т S ₀ = N	/A mnh	(Exhibit	13-12)		
S = mnh (Exi	hibit 13-13)				S = 1	7 7 mnh	(Exhibit	13_13)		
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HCM 2010: MAJOR DIVERGE AREA ANALYSIS

Analyst:	Brett Ferrell	Freeway/Direction of Travel:	SR-8 Southbound
Date:	06/01/16	Junction:	D-6 (I-76 EB / WB Ramp)
Analysis Year:	2040 'No-Build'	Analysis Time Period:	AM Peak Hour
Description:	SUM-76-Central Interchange (PI	D 101402)	

Equation:

 $D_{MD} = 0.0175 * V_f$

Inputs: D_{MD} = density in the major diverge influence area (pc/mi/ln) V_F = demand flow rate immediately upstream of the major diverge influence area (pc/h)

Analysis

 D_{MD} = ## (pc/mi/ln)

 $V_F = 1,959 \text{ (pc/h/ln)}$

 $D_{MD} = 0.0175 * 1,959$

 $D_{MD} = 34.28$

Level of Service Determination

Level of Service	Density (pc/mi/ln)
A	≤ 10
В	> 10 - 20
С	> 20 – 28
D	> 28 – 35
E	> 35
F	Demand Exceeds Capacity

D_{MD} = 34.28 pc/mi/ln

Level of Service for Major Diverge Area: D



PM PEAK HOUR

RAMPS AND RAMP JUNCTIONS WORKSHEET										
General Infor	rmation			Site Infor	mation					
Analyst	Brett	Ferrell	Fr	eeway/Dir of Tr	avel I-77 Southbound					
Agency or Company	GPD	Group	Ju	Inction		D-1 (Lo	overs Lane R	amp)		
Date Performed	06/01	1/16	Ju	irisdiction		'No-Bu	ild'			
Analysis Time Period	D PM P	Peak Hour	Ar	halysis Year		2040				
	SUM-70-Centr	ai merchange	(PID 101402)							
mputs		Freeway Num	her of Lanes N	2						
Upstream Adj R	lamp	Damp Numbe	or of Lance N	2					Downstrear Pamp	n Adj
Yes	On			I					nainp	
		Deceleration	Lane Length, L _A	150					✓ Yes	On
I No □	_ Off	Freeway Volu	ime V_	3370					🗌 No	✓ Off
L _{up} = f	ť	Ramp Volume	e V_	160					L _{down} =	1735 ft
up		Freeway Free	-Flow Speed S	55.0						
V _u = v	eh/h	Ramp Free-F	low Speed S	35.0					$V_{\rm D} = 4$	140 veh/h
Conversion t	o nc/h Uni	der Base	Conditions							
			<u>-</u>	0/ T	0/ D		<u>د</u>			. f f
(pc/h)	(Veh/hr)	PHF	Terrain	% I ruck	%Rv		™ _{HV}	т _р	v = v/PHF	c t _{HV} x t _p
Freeway	3370	0.92	Level	4	0	0.	980	1.00	373	6
Ramp	160	0.92	Level	4	0	0.	980	1.00	177	,
UpStream DownStroam	440	0.02	Loval	2	0	0	0.95	1.00	101	
DownStream	440	0.92 Merge Areas	Level	5	0	0.	.900 Div	verge Areas	400)
Estimation of	fv ₄₂				Estimat	tion o	$\frac{1}{10}$			
	12 V = V	(P)					$\frac{12}{12}$	/ + (\/ _ \/)P	
I =	*12 *F (Equa	('FM) ation 13-6 or	13-7)		I =		* 12 (E	"R '\"F "R quation 13-1	?' FD 2 or 13-13)	
- _{EQ} P =	usina	Equation (Exhibit $13-6$		- _{EQ} P =		1.0		ation (Evhib	+ 13_7)
. FM М., =	nc/h				· FD V =		373	n using ∟qu 6 nc/b		(15-7)
Vaor Vaa	pc/h (Equation 13	(-14 or 13-17)		$V_3 \text{ or } V_{2024}$ 0 pc/h (Equation 13-14 or 13-17)					
$13^{\circ} V_{av34}$)0 nc/h? 🗔 🗸 🗠				$ SV_2 \text{ or } V_{av24} > 2,700 \text{ pc/h}$? Yes VN0					
$I_{av34} = 1.5$	* V/2 🔲 Ve				$ V_3 \circ V_{3V_34} - V_{10}/2 = V_{00} = V_{00}$ $ V_2 \circ V_{0V_24} > 1.5 * V_{10}/2 = Y_{00} = V_{00}$					
	pc/h (Equation 13	3-16, 13-18, or		$f_{12} = \frac{1}{12} r_{12} = \frac{1}{12} r_{12} r_{13} r_{13}$					
li fes,v _{12a} –	13-19)		· ·		$117 \text{ Yes}, v_{12a} = 19$					
Capacity Che	ecks				Capacit	ty Ch	ecks			
	Actual	(Capacity	LOS F?			Actual	Cap	pacity	LOS F?
					V _F		3736	Exhibit 13-8	4500	No
V _{FO}		Exhibit 13-8			$V_{FO} = V_{FO}$	- V _R	3559	Exhibit 13-8	4500	No
					V _R		177	Exhibit 13-10	2000	No
Flow Entering	g Merge In	fluence A	Area		Flow Er	nterin	g Diverg	ge Influend	ce Area	
	Actual	Max	Desirable	Violation?		<u> </u>	Actual	Max Desirab	le	Violation?
V _{R12}		Exhibit 13-8			V ₁₂		3736	Exhibit 13-8	4400:All	No
Level of Serv	vice Detern	nination (it not F)		Level o	t Ser	vice Det	ermination	n (if not F)
$D_{R} = 5.475 + 0.5$.00734 v _R +	0.0078 V ₁₂	- 0.00627 L _A			$D_R = 2$	1.252 + 0.0	1086 V ₁₂ - 0.0	009 L _D	
D _R = (pc/mi/ln)				D _R = 3	5.0 (pc	/mi/ln)				
LOS = (Exhibit 13-2) LOS = E (Exhibit 13-2)										
Speed Deterr	nination				Speed I	Deter	minatio	า		
M _S = (Exibit 1	3-11)				$D_s = 0$.444 (E	xhibit 13-1	2)		
S _R = mph (Exh	nibit 13-11)				S _R = 4	9.2 mph	i (Exhibit 1	3-12)		
S ₀ = mph (Exh	nibit 13-11)				S ₀ = N	I/A mph	(Exhibit 13	3-12)		
S = mph (Exh	nibit 13-13)				S = 4	9.2 mph	(Exhibit 1	3-13)		
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HCM 2010: MAJOR DIVERGE AREA ANALYSIS

Analyst:	Brett Ferrell	Freeway/Direction of Travel:	I-77 NB / I-76 WB
Date:	06/01/16	Junction:	D-2 (Broadway Street Ramp)
Analysis Year:	2040 'No-Build'	Analysis Time Period:	PM Peak Hour
Description:	SUM-76-Central Interchange (PI	D 101402)	

Equation:

 $D_{MD} = 0.0175 * V_f$

Inputs: D_{MD} = density in the major diverge influence area (pc/mi/ln) V_F = demand flow rate immediately upstream of the major diverge influence area (pc/h)

Analysis

 D_{MD} = ## (pc/mi/ln)

 $V_F = 1,281 (pc/h/ln)$

 $D_{MD} = 0.0175 * 1,281$

 $D_{MD} = 22.42$

Level of Service Determination

Level of Service	Density (pc/mi/ln)
А	≤ 10
В	> 10 - 20
С	> 20 – 28
D	> 28 – 35
E	> 35
F	Demand Exceeds Capacity

D_{MD} = 22.42 pc/mi/ln

Level of Service for Major Diverge Area: C



RAMPS AND RAMP JUNCTIONS WORKSHEET											
General Information Site Information											
Analyst Brett Ferrell F				Freeway/Dir of Travel			I-76 Eastbound				
Agency or Company GPD Group			Ju	nction		D-3 (State Route 8 NB Ramp)					
Date Performed 06/01/16			Ju	risdiction		'No-Bu	ild'				
Analysis Time Period	D PM F	Peak Hour	An	alysis Year		2040					
Project Description	Project Description SUM-76-Central Interchange (PID 101402)										
Freeway Number of Lanes N 2											
Upstream Adj R	lamp	Domp Numbe	r of Lance N	2					Downstrea	m Adj	
□ Yes □	On		ane Length	I						_	
	_	Deceloration	Lane Length L	500					∐Yes	On	
✓ No	Off	Ereeway Volu	ume V	500 4050					🗹 No	Off	
	7	Pamp Volum	nine, v _F	4000					L _{down} =	ft	
up		Frooway Froo	s, v _R	FE 0					down		
V _u = v	eh/h	Down Free E	Iow Speed, S _{FF}	55.0					V _D =	veh/h	
O a ma va ma i a m A	a			35.0							
Conversion t	opc/nun	der Base	Conditions		<u> </u>						
(pc/h)	(Veh/hr)	PHF	Terrain	%Truck	%Rv		f _{HV}	f _p	v = V/PHF	x f _{HV} x f _p	
Freeway	4050	0.92	Level	12	0	0.	943	1.00	466	6	
Ramp	1120	0.92	Level	4	0	0.	980	1.00	124	2	
UpStream											
DownStream											
Estimation of	fv	werge Areas			Diverge Areas						
	12	<u>/-</u> .									
	V ₁₂ = V _F	(P _{FM})			$V_{12} = V_{R} + (V_{F} - V_{R})P_{FD}$						
L _{EQ} = (Equation 13-6 or 13-7)				L_{EQ} = (Equation 13-12 or 13-13)							
P _{FM} = using Equation (Exhibit 13-6)				P _{FD} =	r_{FD} = 1.000 using Equation (Exhibit 13-7)						
V ₁₂ = pc/h				$v_{12} = 4666 \text{ pc/h}$							
V ₃ or V _{av34}	pc/h (Equation 13	-14 or 13-17)		$V_3^{}$ or $V_{av34}^{}$		0	pc/h (Equatio	n 13-14 or	13-17)	
Is V_3 or $V_{av34} > 2,700$ pc/h? \Box Yes \Box No					Is $\rm V_3$ or $\rm V_{av}$	₃₄ > 2,7	00 pc/h?	Yes 🗹 No			
Is V_3 or $V_{av34} > 1.5 * V_{12}/2$ Yes No					Is $\rm V_3$ or $\rm V_{av}$	₃₄ > 1.5	* V ₁₂ /2	Yes 🗹 No			
If Yes,V _{12a} = pc/h (Equation 13-16, 13-18, or					If Yes,V _{12a} =	=	p 10	c/h (Equation	13-16, 13-	18, or 13-	
Canacity Checks					Capacity Checks						
Actual Capacity LOS F?				Actual Capacity LOS F?							
					V _F		4666	Exhibit 13-8	4500	Yes	
VEO		Exhibit 13-8			$V_{EO} = V_{E}$	- V _D	3424	Exhibit 13-8	4500	No	
FO							1242	Exhibit 13-1	2000	No	
Elow Entering	<u>i</u> a Merae In	fluence /	Iroa			ntorin		rae Influen			
Actual Max Desirable Violation?							Actual	Max Desirab	le	Violation?	
V _{P12}		Exhibit 13-8			V ₁₂	4	1666	Exhibit 13-8	4400:All	Yes	
Level of Service Determination (if not F)					Level of Service Determination (if not F)						
$D_{R} = 5.475 + 0.00734 v_{R} + 0.0078 V_{12} - 0.00627 L_{\Delta}$				D _R = 4.252 + 0.0086 V ₁₂ - 0.009 L _D							
$D_{\rm R}$ = (pc/mi/ln)					$D_{\rm p} = 39.9 (\rm pc/mi/ln)$						
LOS = (Exhibit 13-2)						LOS = F (Exhibit 13-2)					
Speed Determination					Speed Determination						
M = (Evibit 4	3 11)				D = 0.540 (Exhibit 13-12)						
$w_{\rm S} = (\text{EXIDIC 13-11})$				$S_{p} = 480 \text{ mph} (Exhibit 13-12)$							
				$S_{\rm R} = N/4 \text{ mph} (Exhibit 13-12)$							
$p_0 = mph (Exhibit 13-11)$					$\sim_0 \qquad \text{IVA HIPH (EXHIDIC 13-12)}$						
					p- 48	o.u mph	(⊏xnibit	13-13)		040 44:05 11	
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RAMPS AND RAMP JUNCTIONS WORKSHEET										
General Information Site Information										
Analyst Brett Ferrell Freeway/Dir of T				ravel I-76 Eastbound						
Agency or Company GPD Group			Ju	Junction		D-4 (Arlington Street Ramp)				
Date Performed 06/01/16			Ju	risdiction		'No-Bu	ild'			
Analysis Time Perio	DI PM F	Peak Hour	Ar	nalysis Year		2040				
	SUM-76-Centr	ai interchange	(PID 101402)							
mputs		Freeway Num	ber of Lanes N	3						
Upstream Adj F	Ramp	Pamp Numbe	or of Lance N	1					Downstrea Pamp	m Adj
Yes	On		and Longth	I					nainp	
	_	Deceleration	Lane Length I	600					✓ Yes	✓ On
I No □	_] Off	Freeway Volu	ime V_	5190					🗌 No	Off
L _{up} =	ft	Ramp Volume	e. Vp	460					L _{down} =	1825 ft
up		Freeway Free	-Flow Speed, S _{FF}	60.0					. ,	
$V_u = v$	/eh/h	Ramp Free-F	low Speed, S _{FR}	35.0					V _D =	250 veh/h
Conversion	to pc/h Uni	der Base	Conditions							
(nc/h)	V		Torrain	%Truck	0/ D.v		f	f		vf vf
(pc/II)	(Veh/hr)	F111	Tenain	/0TTUCK	/0111		'HV	'p	v – v/i i ii .	^ ' HV ^ ' p
Freeway	5190	0.92	Level	12	0	0.	943	1.00	598	30
Ramp	460	0.92	Level	4	0	0.	980	1.00	51	0
DownStream	250	0.92	level	6	0	0	971	1.00	28	0
		Merge Areas		•			D	iverge Areas		-
Estimation o	f v ₁₂				Estimation of v ₁₂					
	$V_{12} = V_{E}$	(P _{EM})			$V_{12} = V_p + (V_r - V_p)P_{rp}$					
$L_{ro} = (Fquation 13-6 \text{ or } 13-7)$				L _{FO} =		12 (E	Equation 13-1	2 or 13-13)		
	using Equation (Exhibit 13-6)						0.5	587 usina Eau	, Jation (Exhib	oit 13-7)
$f_{12} = pc/h$				$V_{12} =$		37	21 pc/h	(,	
V_{2} pc/h (Equation 13-14 or 13-17)				V_2 or V_{av24}		22	59 pc/h (Equa	ation 13-14	or 13-17)	
V_{av34} = point (Equation 15-14 of 15-17) Is V _a or V _{av} > 2.700 pc/h? = Vee = No					Is V ₂ or V ₂		'00 pc/h?	Yes √No		,
$ SV_a \text{ or } V_{av34} + 2.700 \text{ point} = 168 \text{ No}$					Is V ₂ or V	vo4 	*V₁₀/2 □	Yes No		
pc/h (Equation 13-16, 13-18, or						v34 =	12 – p	c/h (Equation	13-16, 13-	18, or 13-
13-19)					11 1 03, V 12a		19))		
Capacity Checks										
L	Actual		Capacity	LOS F?	V		Actual	Cap		LOS F?
N		E 1 1 1 40 0					5960		0900	INO
v _{FO}		Exhibit 13-8			$v_{FO} = v_{FO}$	F ^{-V} R	5470	Exhibit 13-8	6900	No
					V _R		510	Exhibit 13-10	2000	No
Flow Entering Merge Influence Area					Flow E	nterin	<u>ig Diver</u>	<u>ge Influen</u>	ce Area	
	Actual	Max	Desirable	Violation?	V		Actual	Max Desirab		Violation?
	ico Dotorr	EXHIBIT 13-0	(if not E)			f Son		Exhibit 15-0	4400.All	
Level of Service Determination (if not F) $D = 5.475 \pm 0.00734 \text{ y} \pm 0.0078 \text{ y} = 0.00627 \text{ y}$					$D_{-} = 4.252 \pm 0.0086 V_{-} 0.009 I_{-}$					
$D_{\rm r} = ({\rm pc/mi}/{\rm p})$					$D_{\rm R} = 30.9 ({\rm pc/mi/lp})$					
$\sigma_{\rm R}$ (point(iii)) 10S = (Exhibit 13-2)						$P_{\rm R} = 0.5 (point(n))$				
LUS - (Exhibit 13-2) LUS Speed Determination						Speed Determination				
							vhihit 12	12)		
$M_{\rm S}$ = (Exibit 13-11)					v_s^- 0.4/4 (EXHIBIT 13-12) S = 515 mph (Exhibit 13-12)					
P_R mph (Exhibit 13-11)				v_{R}^{-} 31.3 Hiph (EXHIDIC 13-12) S.= 60.0 mph (Evhibit 13.12)						
$S_0^{=}$ mph (EX	niDit 13-11) hihit 13₋13)				v_0^- 00.3 mpn (Exhibit 13-12)					
					p = 54./ mpn (EXNIDIT 13-13)					

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RAMPS AND RAMP JUNCTIONS WORKSHEET										
General Infor	mation			Site Infor	mation					
Analyst Brett Ferrell Freeway/Dir of Tra			ravel I-76 Westbound							
Agency or Company GPD Group Junctio		nction	D-5 (I-77 Southbound Ramp)		und Ramp)					
Date Performed 06/01/16 Jurisdiction		risdiction		'No-Bu	ild'					
Analysis Time Period	SLIM-76-Centr	'eak Hour		alysis Year		2040				
Inputs	30101-70-0enti	armerchange	(FID 101402)							
		Freeway Nur	nber of Lanes, N	2						A 11
Upstream Adj R	amp	Ramp Numbe	er of Lanes N	-					Jownstrear Ramp	n Adj
Yes	On	Acceleration	Lane Length L.	I						
	-	Deceleration	Lane Length L	175					∐ Yes	On
I No □	_Off	Freeway Volu	ime V	3/50					✓ No	Off
L = f	t	Ramn Volum	o V	1300				l	=	ft
up		Freeway Free	e-Flow Speed S	55.0						
V _u = v	eh/h	Damp Eroo E	How Speed, S	25.0				ľ	∨ _D =	veh/h
	<u>a na/h 11n</u>		Conditions	55.0						
Conversion			Conditions	1	1	-				
(pc/h)	(Veh/hr)	PHF	Terrain	%Truck	%Rv		f _{HV}	f _p	/ = V/PHF >	c f _{HV} x f _p
Freeway	3450	0.92	Level	13	0	0.	939	1.00	399	4
Ramp	1390	0.92	Level	5	0	0.	976	1.00	154	9
UpStream		ļ								
DownStream		Merge Areas)iverge Areas		
Estimation of	FV40	inerge / ineue			Estimation of V ₄₀					
	12	(P)			$\frac{12}{12}$					
$v_{12} = v_F (P_{FM})$				_		v ₁₂ –	$^{\circ}R$ $^{\circ}(^{\circ}F$ $^{\circ}R$	/'FD 2 or 13 13)		
$L_{EQ} = (Equation 13-6 \text{ of } 13-7)$				EQ =		(1	Qualion 13-12	2 01 13-13) ation (Evhib	+ 10 7)	
$F_{\rm FM}$ = $r_{\rm C}/h$				FD T		1.0	000 using ⊑qu 04 po/b		(13-7)	
V_{12}^{-}	pc/fi	Equation 13	3 14 or 13 17		V_{12}		0	no/h (Equation	n 13 14 or	12 17)
$v_3 v_{av34}$	pc/n (0 nc/h2 ⊡ vo		5-14-01-13-17)		s V or V	> 2 7	0 100 pc/b2 ⊡		1113-14 01	13-17)
Is v_3 or $v_{av34} < 2,700$ pc/// \square Yes \square No					Is V or V	34 ⁻ 2,' > 1 5	3*V /2 □			
$r_{2} v_{3} v_{1} v_{av34} \sim r_{10} v_{12} / 2$ Yes No						34 - 1.0	' ^{12′-} ∟ D	c/h (Equation	13-16, 13-1	8. or 13-
If Yes,V _{12a} = 13-19)					19)					
Capacity Checks					Capacity Checks					
	Actual	(Capacity	LOS F?			Actual	Cap	acity	LOS F?
					V _F		3994	Exhibit 13-8	4500	No
V _{FO}		Exhibit 13-8			$V_{FO} = V_{F}$	- V _R	2445	Exhibit 13-8	4500	No
					V _R		1549	Exhibit 13-10	2000	No
Flow Entering Merge Influence Area					Flow Entering Diverge Influence Area					
	Actual	Max	Desirable	Violation?			Actual	Max Desirabl	е	Violation?
V _{R12}		Exhibit 13-8			V ₁₂		3994	Exhibit 13-8	4400:All	No
Level of Service Determination (if not F)					Level of	fSer	vice De	termination	n (if not F)
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$					D _R = 4.252 + 0.0086 V ₁₂ - 0.009 L _D					
D _R = (pc/mi/ln) [D _R = 34.3 (pc/mi/ln)				
LOS = (Exhibit 13-2)					LOS = D (Exhibit 13-2)					
Speed Determination Speed Determination										
M _s = (Exibit 13-11)					D _s = 0.567 (Exhibit 13-12)					
S _R = mph (Exhibit 13-11)				S _R = 47.6 mph (Exhibit 13-12)						
S ₀ = mph (Exhibit 13-11)					S ₀ = N/A mph (Exhibit 13-12)					
S = mph (Exhibit 13-13)					S = 47.6 mph (Exhibit 13-13)					

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HCM 2010: MAJOR DIVERGE AREA ANALYSIS

Analyst:	Brett Ferrell	Freeway/Direction of Travel:	SR-8 Southbound			
Date:	06/01/16	Junction:	D-6 (I-76 EB / WB Ramp)			
Analysis Year:	2040 'No-Build'	Analysis Time Period:	PM Peak Hour			
Description:	SUM-76-Central Interchange (PID 101402)					

Equation:

 $D_{MD} = 0.0175 * V_f$

Inputs: D_{MD} = density in the major diverge influence area (pc/mi/ln) V_F = demand flow rate immediately upstream of the major diverge influence area (pc/h)

Analysis

 D_{MD} = ## (pc/mi/ln)

 $V_F = 2,784 \text{ (pc/h/ln)}$

 $D_{MD} = 0.0175 * 2,784$

 $D_{MD} = 48.72$

Level of Service Determination

Level of Service	Density (pc/mi/ln)
A	≤ 10
В	> 10 - 20
С	> 20 – 28
D	> 28 – 35
E	> 35
F	Demand Exceeds Capacity

D_{MD} = 48.72 pc/mi/ln

Level of Service for Major Diverge Area: E



MERGE JUNCTION ANALYSIS

DESIGN YEAR 2040 'NO-BUILD' CONDITIONS

AM PEAK HOUR
	RAMPS AND RAMP JUNCTIONS WORKSHEET									
General Infor	mation			Site Infor	mation					
Analyst	Brett	Ferrell	Fre	eway/Dir of Tra	avel I	I-77 So	uthbound/	-76 Eastbound		
Agency or Company	GPD	Group	Ju	nction	Ν	M-1 (M	ain Street	Ramp)		
Date Performed	06/01	1/16	Ju	risdiction	1	'No-Bui	ild'			
Analysis Time Period	AM P	Peak Hour	An	alysis Year	2	2040				
	SUM-76-Centra	al interchange	(PID 101402)							
inputs		Eroowov Num	hor of Longo N	4					r	
Upstream Adj Ramp			ider of Lanes, N	4					Downstrea	am Adj
	1		er of Lanes, N	1					катр	
		Acceleration I	_ane Length, L _A	850					🗌 Yes	On
□ No □ Off	F	Deceleration	Lane Length L _D						✓ No	Off
	_	Freeway Volu	ime, V _F	3800						4
L _{up} = 1150	ft	Ramp Volume	e, V _R	180					L _{down} –	п
V = 400 vc	h/h	Freeway Free	-Flow Speed, S _{FF}	55.0					V_ =	veh/h
⁴ 30 Ve	511/11	Ramp Free-F	low Speed, S _{FR}	35.0						
Conversion to	o pc/h Und	der Base	Conditions		5					
(pc/h)	V () (- h /h - r)	PHF	Terrain	%Truck	%Rv		f _{uv}	f	v = V/PHF	x f _{HV} x f
Erooway	(ven/nr)	0.02	Loval	0	0		062	β 1.00	1	206
Ramp	180	0.92	Level	5	0	0.	902 076	1.00	4	290
UnStream	490	0.32	Level	1	0	0.	995	1.00		535
DownStream	-100	0.02	Lovoi	1	, , , , , , , , , , , , , , , , , , ,	- 0.1	000	1.00	Ì	
		Merge Areas						Diverge Areas		
Estimation of	^v 12				Estimati	ion o	f v ₁₂			
	$V_{12} = V_{E}$	(P _{EM})								
L _{FO} =	(Equa	tion 13-6 o	r 13-7)				v ₁₂ =	v _R + (v _F - v _R	P _{FD}	•
P =	0 193	using Equa	tion (Exhibit 13-6)		L _{EQ} =			(Equation 13-	-12 or 13-1	3)
РМ V ₄₀ =	828 p	c/h			P _{FD} =		I	using Equatio	on (Exhibit 13	3-7)
12	1734 r	oc/h (Equati	on 13-14 or 13-		V ₁₂ =		I	pc/h		
V ₃ or V _{av34}	17)				V ₃ or V _{av34}			pc/h (Equation '	13-14 or 13-1	7)
Is V_3 or $V_{av34} > 2,70$	0 pc/h? 🗌 Yes	s 🗹 No			Is V ₃ or V _{av3}	₄ > 2,7	00 pc/h?	_Yes _No		
Is V_3 or $V_{av34} > 1.5 *$	V ₁₂ /2 Ves	s 🗌 No			Is V ₃ or V _{av3}	₄ > 1.5	* V ₁₂ /2	∐Yes ∐No	10 10 11	
If Yes,V ₁₂₀ =	1718	pc/h (Equati	on 13-16, 13-		If Yes,V _{12a} =		1:	pc/h (Equatio 3-19)	n 13-16, 13	3-18, or
Conceptu Che	18, or	13-19)			Conceit	· Ch	a a ka	,		
Capacity Che	CKS		Sana aite				Actual	C_	n n n i h i	
	Actual		Japacity	LUSF?	V		Actual	Ud Evhibit 12		LUGF?
					F	V			0	
V _{FO}	4497	Exhibit 13-8		No	v _{FO} – v _F	- v _R		Exhibit 13-	0	
					V _R			Exhibit 13	-	
Flow Entering	n Merae In	fluence A	rea	•	Flow En	terin	a Dive	rae Influer	ce Area	
	Actual	Max	Desirable	Violation?		1 4	Actual	Max Des	irable	Violation?
V _{R12}	1919	Exhibit 13-8	4600:All	No	V ₁₂			Exhibit 13-8		
Level of Serv	ice Detern	nination (ïf not F)		Level of	Serv	/ice De	terminatio	n (if not	F)
D _R = 5.475 +	0.00734 v _R + 0).0078 V ₁₂ - 0.	00627 L₄			$D_{\rm p} = 4$.252 + 0	.0086 V ₁₂ - 0	.009 L _D	
$D_{\rm p} = 15.0 (\rm pc/m$	i/ln)	12	~		D _p = (po	c/mi/lr	n)	12	D	
LOS = B (Exhibit	, 13-2)				10S = (E	xhibit	, 13-2)			
Speed Detern	nination				Speed D	otor	minatio	<u></u>		
					$D = /E^{1}$	yhihit 1	3-12)			
U.288 (Exil	oit 13-11)				S = m	h (⊑vh	ubit 13 10\			
$P_{R} = 51.3 \text{ mph}$ (Exhibit 13-11)				∼ _R − mp	או (⊏גוו שה (⊏עיי	iidit 13-12)			
$S_0 = 52.2 \text{ mph}$ (Exhibit 13-11)				0 ₀ - тр	on (Exh	iidit 13-12)			
p = 51.8 mph (Exhibit 13-13)				S= mp	on (Exh	iidit 13-13)			

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	RAMPS AND RAMP JUNCTIONS WORKSHEET										
General	l Infor	mation			Site Infor	mation					
Analyst		Brett	Ferrell	Fre	eway/Dir of Tr	avel S	State Ro	oute 8 Sou	uthbound		
Agency or C	Company	GPD	Group	Jur	nction	1	M-2 (Go	odkirk Str	eet Ramp)		
Date Perforr	med	06/01	/16	Jur	risdiction	1	'No-Buil	d'			
Analysis Tin	ne Period	AM P	eak Hour	An	alysis Year		2040				
Project Des	cription	SUM-76-Centr	al Interchange	(PID 101402)							
inputs			Fragway Num	bar of Lance N	2						
Upstream A	dj Ramp				3					Downstre	am Adj
			Ramp Numbe	r of Lanes, N	1					катр	
			Acceleration L	ane Length, L _A	900					🗌 Yes	🗌 On
🗹 No	Off	F	Deceleration L	ane Length L _D						I No	Off
			Freeway Volu	me, V _F	4600						<u>п</u> с.:
L _{up} =	ft		Ramp Volume	e, V _R	650					L _{down} =	π
V =	voh/h		Freeway Free	-Flow Speed, S _{FF}	55.0					V., =	veh/h
vu –	ven/n		Ramp Free-Fl	ow Speed, S _{FR}	35.0					- 0	
Convers	sion te	o pc/h Und	der Base	Conditions							
(pc/ł	h)	V () (ala /lan)	PHF	Terrain	%Truck	%Rv	f	: HV	f	v = V/PHF	x f _{HV} x f _n
Frooway	,	(ven/nr)	0.02	Loval	6	0	0.0	71	1.00		110 p
Ramn		650	0.92	Level	3	0	0.9	85	1.00		717
UpStream		030	0.52	Level	5	0	0.9	/05	1.00		/ 1/
DownStream	m										
			Merge Areas					Č	iverge Areas	-	
Estimat	tion of	^r v ₁₂				Estimation of v ₁₂					
		$V_{12} = V_{F}$	(P _{FM})					V - V		\D	
L _{EO} =		(Equa	ation 13-6 or	13-7)		_		v ₁₂ –	^V R ⁺ (^V F ⁻ ^V R	/ ^F FD	2)
		0.603	using Equat	ion (Exhibit 13-6)		EQ -		(Equation 13-	12 OF 13-1	3)
V ₁₀ =		3104	oc/h	()		P _{FD} =		ι	using Equatio	n (Exhibit 1.	3-7)
12		2046	oc/h (Equation	on 13-14 or 13-		v ₁₂ =		F	DC/h		
v ₃ or v _{av34}		17)				V ₃ or V _{av34}			pc/h (Equation 1	3-14 or 13-1	7)
Is V_3 or V_{av}	_{/34} > 2,70	0 pc/h? 🗌 Ye:	s 🗹 No			Is V ₃ or V _{av3}	₃₄ > 2,70	00 pc/h? [_	_Yes _No		
Is V_3 or V_{av}	_{/34} > 1.5 *	V ₁₂ /2 Ve	s 🗌 No			Is V ₃ or V _{av3}	₃₄ > 1.5 '	* V ₁₂ /2	Yes No	40.40.4	0.40
If Yes, V ₁₂₀ =	=	3104	oc/h (Equation	on 13-16, 13-		If Yes,V _{12a} =		1:	oc/n (Equation 3-19)	n 13-16, 1	3-18, or
		18, or	13-19)			Conosit	· Cha	- ka	5 107		
Capacit	y che	Actual		anaoit <i>i</i>	109 52			Actual	Car	agaity	
		Actual	Ĭ	apacity	LUGF?	V		Actual	Evhibit 12 (LUGF?
						F	<u></u>			0	
V _{FC}	0	5867	Exhibit 13-8		No	$v_{FO} = v_F$	- v _R		Exhibit 13-8	8	
						V _R			Exhibit 13-	-	
Flow Er	nterino	n Merae In	fluence A	rea		Flow En	terino	a Dive	rae Influen	ce Area	
		Actual	Max	Desirable	Violation?		A	ctual	Max Desi	irable	Violation?
V _{R1}	2	3821	Exhibit 13-8	4600:All	No	V ₁₂			Exhibit 13-8		
Level of	f Serv	ice Detern	nination (if not F)		Level of	Serv	ice De	terminatio	n (if not	<i>F</i>)
D _R =	= 5.475 +	0.00734 v _R + ().0078 V ₁₂ - 0.(0627 L _A			D _R = 4.	.252 + 0	.0086 V ₁₂ - 0.	.009 L _D	
$D_p = 29$	9.3 (pc/m	i/ln)				$D_p = (p)$	c/mi/ln)		5	
LOS = D	(Exhibit	, 13-2)				LOS = (E	xhibit	, 13-2)			
Speed Determination Spe					Speed D)etern	ninatic	n			
	400 /					D = (F)	xhihit 13	3-12)			
w _s = 0.	.436 (Exil	DIT 13-11)					h (Evhi	hit 12 10			
$P_R = 49$	$= 49.3 \text{ mph} (Exhibit 13-11) \qquad $										
$S_0 = 49$	9.4 mph (Exhibit 13-11)				0 ₀ - тр	יו (⊏צווו	UIL 13-12)			
5 = 49	= 49.4 mph (Exhibit 13-13) $S = mph (Exhibit 13-13)$										

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PM PEAK HOUR

	RAMPS AND RAMP JUNCTIONS WORKSHEET									
General Infor	mation			Site Infor	mation					
Analyst	Brett	Ferrell	Fre	eeway/Dir of Tra	avel I.	-77 Southbour	nd/I-76 Eastbound			
Agency or Company	GPD	Group	Ju	nction	Ν	N-1 (Main Stre	et Ramp)			
Date Performed	06/01	/16	Ju	risdiction	ľ	No-Build'				
Analysis Time Period	N PM P	eak Hour	An	alysis Year	2	2040				
	SUM-70-Centra	armerchange	(PID 101402)							
inputs		Freeway Num	ber of Lanes N	1				1		
Upstream Adj Ramp		Down Numbo		4				Downstrea	am Adj	
Yes Or	ı			1				катр		
		Acceleration	Lane Length, L _A	850				Yes	On	
□ No □ Of	f	Deceleration I	Lane Length L _D					✓ No	Off	
- 4450	ri L	Freeway Volu	ime, V _F	5530					ft	
∟ _{up} = 1150	π	Ramp Volume	e, V _R	500				⁻down	it.	
V., = 1210 v	/eh/h	Freeway Free	e-Flow Speed, S _{FF}	55.0				V _D =	veh/h	
u :=:•		Ramp Free-F	low Speed, S _{FR}	35.0				5		
Conversion t	o pc/h Und	der Base	Conditions	1			_			
(pc/h)	V (\/eb/br)	PHF	Terrain	%Truck	%Rv	f _{HV}	f _p	v = V/PHF	x f _{HV} x f _p	
Freeway	5530	0.92	l evel	8	0	0.962	1.00	6	251	
Ramp	500	0.92	Level	5	0	0.976	1.00		557	
UpStream	1210	0.92	Level	1	0	0.995	1.00		322	
DownStream								<u> </u>		
		Merge Areas					Diverge Areas	-		
Estimation of	fv ₁₂				Estimatio	on of v ₁₂				
	V ₁₂ = V _F	(P _{FM})			V = V + (V V)P					
L _{FO} =	(Equa	ation 13-6 o	r 13-7)		_	v 12	$-v_R + (v_F - v_F)$	ミリア FD 1.1.2 or 1.2 1	2)	
P _{EM} =	0.148	using Equat	tion (Exhibit 13-6)		- _{EQ} -		(Equation 13	-12 OF 13-1	3)) 7)	
V ₁₂ =	926 p	c/h	(FD -			SH (EXHIBIT IS	5-7)	
12 M. or M	2662	oc/h (Equati	on 13-14 or 13-		$v_{12} =$		pc/n		-,	
v ₃ 01 v _{av34}	17)				v_3 or v_{av34}	NO 700 //-/	pc/n (Equation	13-14 or 13-1	()	
Is V_3 or $V_{av34} > 2,70$	0 pc/h? 🗌 Ye	s 🗹 No			IS V_3 or V_{av3^2}	4 > 2,700 pc/n	<pre> ✓ Yes □ No</pre>	i.		
Is V_3 or $V_{av34} > 1.5$	* V ₁₂ /2 🗹 Ye	s 🗌 No			IS V ₃ or V _{av34}	₄ > 1.5 ° V ₁₂ /2		-	0.40	
If Yes,V _{12a} =	2500	oc/h (Equati	on 13-16, 13-		If Yes,V _{12a} =		pc/n (Equation 13-19)	on 13-16, 1.	3-18, 01	
Capacity Cho	18, or	13-19)			Canacity	Chacks	/			
Capacity Che	Actual		Sanaaitu	109 52				nacity	108 52	
	Actual		Japacity	LUGF?	V	Aciu	ai Ga		LUGF?	
					V -V	V	Exhibit 13	0		
V _{FO}	6808	Exhibit 13-8		No	v _{FO} – v _F -	· v _R	Exhibit 13	·0		
					V _R		10)-		
Flow Entering	' a Merae In	fluence A	rea		Flow Ent	terina Div	erae Influer	nce Area	I	
	Actual	Max	Desirable	Violation?		Actual	Max Des	sirable	Violation?	
V _{R12}	3057	Exhibit 13-8	4600:All	No	V ₁₂		Exhibit 13-8			
Level of Serv	ice Detern	nination (if not F)		Level of	Service L	Determinatio	on (if not	<i>F</i>)	
D _R = 5.475 +	0.00734 v _R + 0).0078 V ₁₂ - 0.	00627 L _A		C) _R = 4.252 +	- 0.0086 V ₁₂ - 0).009 L _D		
$D_{\rm R} = 23.7 (\rm pc/m$	ni/ln)				D _R = (po	c/mi/ln)		5		
LOS = C (Exhibit	13-2)				LOS = (E)	xhibit 13-2)				
Speed Deterr	nination				Speed D	etermina	tion			
	hit 10 44)				$D = (F_{v})$	(hibit 13-12)				
uvi _S – 0.344 (Exi	DIC 13-11)					h (Evhihit 12 /	12)			
S _R = 50.5 mph	(Exhibit 13-11)				∼ _R − mp	h (Everet 40 -	12)			
$S_0 = 50.0 \text{ mph}$	(Exhibit 13-11)				0₀− mp	n (Exnidit 13-1	12)			
S = 50.3 mph	= 50.3 mph (Exhibit 13-13) S = mph (Exhibit 13-13)									

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	RAMPS AND RAMP JUNCTIONS WORKSHEET										
General	l Infor	mation			Site Infor	mation					
Analyst		Brett	Ferrell	Fre	eway/Dir of Tr	avel	State F	Route 8 So	uthbound		
Agency or C	Company	GPD	Group	Jur	nction	I	M-2 (G	Goodkirk Sti	reet Ramp)		
Date Perfori	med	06/01	1/16	Jur	risdiction		'No-Bu	iild'			
Analysis Tin	ne Period	PM P	Peak Hour	An	alysis Year		2040				
Project Des	cription	SUM-76-Centra	al Interchange	(PID 101402)							
inputs				har of Lanca N	2					r	
Upstream A	dj Ramp			iber of Laries, in	3					Downstrea	am Adj
			Ramp Numbe	r of Lanes, N	1					катр	
			Acceleration L	ane Length, L _A	900					🗌 Yes	On
🗹 No	Off	F	Deceleration I	Lane Length L _D						I No	Off
			Freeway Volu	me, V _F	6410						
L _{up} =	ft		Ramp Volume	e, V _R	1050					∟ _{down} =	π
V =	voh/h		Freeway Free	-Flow Speed, S _{FF}	55.0					V., =	veh/h
v _u –	ven/n		Ramp Free-Fl	ow Speed, S _{FR}	35.0						Voluit
Convers	sion te	o pc/h Und	der Base	Conditions							
(pc/	h)	V () (ab /br)	PHF	Terrain	%Truck	%Rv		f _{HV}	f	v = V/PHF	x f _{HV} x f _n
Erooway	,	(ven/nr) 6410	0.02	l ovol	6	0		071	p 1.00	7	176
Ramp		1050	0.92	Level	3	0	0	.971	1.00	1	158
UpStream		1030	0.32	Level	5	0		.905	1.00	'	150
DownStrea	m										
			Merge Areas				-	[Diverge Areas		
Estimat	tion of	^r v ₁₂				Estimation of v ₁₂					
		V ₁₂ = V _F	(P _{FM})								
L _{FO} =		(Equa	ation 13-6 or	r 13-7)		$V_{12} = V_R + (V_F - V_R)^{\prime} FD$ L _{FO} = (Equation 13-12 or 13-13)					
P _{FM} =		0.603	using Equat	tion (Exhibit 13-6)		EQ -			Equation 13-	-120113-1	<i>い</i>
V ₁₂ =		4325	pc/h	, , , , , , , , , , , , , , , , , , ,		FD V -			using Equalic)- <i>(</i>)
		2851 p	pc/h (Equati	on 13-14 or 13-		$v_{12} - v_{12} - v$			pc/n	10 44 40 4	7)
v ₃ 01 v _{av34}		17)				v ₃ or v _{av34}		700 ··· - //- 0 F	pc/n (Equation	13-14 OF 13-1	7)
Is V ₃ or V _{av}	_{/34} > 2,70	0 pc/h? 🗹 Yes	s 🗌 No			IS V_3 or V_{av3}	₃₄ > 2,1	100 pc/n?			
Is V ₃ or V _{av}	_{/34} > 1.5 *	V ₁₂ /2 Ves	s 🗌 No			is V ₃ or V _{av3}	₈₄ > 1.5	o^v ₁₂ /2	_Yes ∐No	n 12 16 1	2 10 or
If Yes,V _{12a} =	=	4476 µ	pc/h (Equati	on 13-16, 13-		If Yes,V _{12a} =		1	pc/n (⊏qualio 3-19)	11 13-10, 1	5-10, 01
Canacit	w Cho	18, 01	13-19)			Canacit	/ Ch	ocks	,		
Capacit	y che	Actual		anacity	LOS F2			Actual	Ca	nacity	LOS F2
		Actual	Ĩ	Japacity	2001:	V_		Actual	Exhibit 13-	8	2001:
.						$-\gamma$	V		Exhibit 12	0	
V _F	0	8334	Exhibit 13-8		Yes	VFO VF	- v _R		Exhibit 13	0	
						V _R			10	-	
Flow Er	ntering	g Merge In	fluence A	Irea		Flow En	terin	ng Dive	rge Influer	ice Area	
		Actual	Max	Desirable	Violation?			Actual	Max Des	irable	Violation?
V _{R1}	2	5634	Exhibit 13-8	4600:All	Yes	V ₁₂			Exhibit 13-8		
Level of	f Serv	ice Detern	nination (if not F)		Level of	Ser	vice De	terminatio	n (if not	F)
D _R =	= 5.475 +	0.00734 v _R + 0	0.0078 V ₁₂ - 0.0	00627 L _A		[[D _R = 4	4.252 + 0	.0086 V ₁₂ - 0	.009 L _D	
D _R = 43	3.2 (pc/m	i/ln)				D _R = (p	c/mi/l	n)			
LOS = F	(Exhibit '	13-2)				LOS = (E	xhibit	t 13-2)			
Speed Determination						Speed D	eter	minatio	on		
$M_{-} = 1$	349 / = vil	hit 13_11)				D _s = (E)	xhibit 1	13-12)			
S = 2		Evhibit 12 11				S _□ = mr	oh (Exh	, hibit 13-12)			
S = 4	$S_{R}^{-} = 37.5 \text{ mph} (\text{Exhibit 13-11})$ $S_{R}^{-} = \text{mph} (\text{Exhibit 13-12})$										
$S_0 = 40$	0. I MPN (9. 9 mnh (Exhibit 13-11)					on (⊏vi	hibit 12 12)			
<u>y - 3</u>	= 39.9 mph (Exhibit 13-13) S = mph (Exhibit 13-13)										

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APPENDIX E HCS WEAVE SEGMENT ANALYSIS

DESIGN YEAR 2040 'NO-BUILD' CONDITIONS

AM PEAK HOUR

		F	REEWAY	WEAV	NG WOF	KSHEE	Г			
General	Informatio	on			Site Info	rmation				
Analyst Agency/Com Date Perforn Analysis Tim	pany ned e Period	Brett Fe GPD G 06/01/1 AM Pea	errell roup 6 ak Hour		Freeway/Dir of Travel I-77 Southbound Weaving Segment Location W-1 Analysis Year 2040 'No-Build'					
Project Desc	ription SUM-76	-Central Inter	change (PID 1	01402)						
Inputs										
Weaving cor Weaving nur Weaving seg Freeway free	figuration nber of lanes, N ment length, L _s p-flow speed, FF	S		One-Sided 4 1700ft 55 mph	Segment typ Freeway min Freeway ma: Terrain type	e imum speed, kimum capac	S _{MIN} ity, C _{IFL}		Freeway 45 2250 Level	
Convers	ions to po	/h Unde	r Base Co	ondition	S		•	1	•	
	V (veh/h)	PHF	Truck (%)	RV (%)	Ε _Τ	E _R	f _{HV}	fp	v (pc/h)	
V _{FF}	2770	0.92	6	0	1.5	1.2	0.971	1.00	3101	
V _{RF}	2370	0.92	4	0	1.5	1.2	0.980	1.00	2628	
V _{FR}	280	0.92	3	0	1.5	1.2	0.985	1.00	309	
V _{RR}	0	0.92	4	0	1.5	1.2	0.980	1.00	0	
V _{NW}	3101							V =	6038	
V _W	2937									
VR	0.486									
Configu	ration Cha	racterist	ics							
Minimum ma	aneuver lanes, N	N _{WL}		2 lc	Minimum we	aving lane ch	nanges, LC _{MIN}		lc/h	
Interchange	density, ID			1.0 int/mi	Weaving lan	e changes, L	C _w		lc/h	
Minimum RF	lane changes,	LC _{RF}		0 lc/pc	Non-weaving	g lane change	es, LC _{NW}		lc/h	
Minimum FF	lane changes,	LC _{FR}		2 lc/pc	Total lane ch	nanges, LC _{ALI}	_		lc/h	
Minimum RF	R lane changes,	LC _{RR}		lc/pc	Non-weaving	g vehicle inde	ex, I _{NW}		527	
Weaving	g Segment	Speed,	Density, I	_evel of	Service,	and Cap	acity			
Weaving sea Weaving sea	gment flow rate, gment capacity,	v c _w	:	5892 veh/h 4790 veh/h	Weaving inte Weaving seg	ensity factor, gment speed,	W S		mph	
Weaving seg	gment v/c ratio			1.230	Average wea	aving speed,	S _w		mph	
Weaving see	gment density, D)		pc/mi/ln	Average nor	-weaving spe	eed, S _{NW}		mph	
Level of Ser	vice, LOS			F	Maximum we	eaving length	, L _{MAX}		7668 ft	
Notes										
a. Weaving se Chapter 13, "I b. For volume	egments longer th Freeway Merge a s that exceed the	an the calcula nd Diverge Se weaving segr	ted maximum le gments". nent capacity, tl	ength should l	be treated as is vice is "F".	olated merge	and diverge an	eas using the p	procedures of	

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		F	REEWAY	(WEAV	ING WOF	RKSHEE	Т			
Genera	Informatio	on			Site Info	rmation				
Analyst Agency/Con Date Perfori Analysis Tin	npany ned ne Period	Brett Fe GPD G 06/01/1 AM Pea	errell roup 6 ak Hour		Freeway/Dir of TravelI-77 NorthboundWeaving Segment LocationW-2Analysis Year2040 'No-Build'					
Project Des	cription SUM-76	-Central Inter	rchange (PID 1	01402)	-					
Inputs										
Weaving co Weaving nu Weaving se Freeway fre	nfiguration mber of lanes, N gment length, L _s e-flow speed, FF	S		One-Sided 4 2570ft 55 mph	Segment typ Freeway min Freeway ma: Terrain type	e imum speed ximum capac	, S _{MIN} sity, C _{IFL}		Freeway 45 2250 Level	
Conver	sions to po	/h Unde	r Base Co	ondition	s	1	r			
	V (veh/h)	PHF	Truck (%)	RV (%)	Ε _Τ	E _R	f _{HV}	fp	v (pc/h)	
V _{FF}	4920	0.92	4	0	1.5	1.2	0.980	1.00	5455	
V _{RF}	680	0.92	2	0	1.5	1.2	0.990	1.00	747	
V _{FR}	2850	0.92	3	0	1.5	1.2	0.985	1.00	3144	
V _{RR}	0	0.92	0	0	1.5	1.2	1.000	1.00	0	
V _{NW}	5455							V =	9346	
V _W	3891									
VR	0.416									
Configu	ration Cha	racterist	tics							
Minimum m	aneuver lanes, N	N _{WL}		2 lc	Minimum we	eaving lane cl	hanges, LC _{MIN}		lc/h	
Interchange	e density, ID			0.8 int/mi	Weaving lan	e changes, L	.C _w		lc/h	
Minimum R	F lane changes,	LC _{RF}		2 lc/pc	Non-weaving	g lane chang	es, LC _{NW}		lc/h	
Minimum Fl	R lane changes,	LC _{FR}		0 lc/pc	Total lane ch	nanges, LC _{AL}	L		lc/h	
Minimum R	R lane changes,	LC _{RR}		lc/pc	Non-weaving	g vehicle inde	ex, I _{NW}			
Weavin	g Segment	Speed,	Density, I	_evel of	Service,	and Cap	oacity			
Weaving se Weaving se	gment flow rate, gment capacity,	v c _w		9185 veh/h 5652 veh/h	Weaving inte Weaving see	ensity factor, gment speed	W , S		mph	
Weaving se	gment v/c ratio			1.625	Average wea	aving speed,	S _w		mph	
Weaving se	gment density, [)		pc/mi/ln	Average nor	n-weaving sp	eed, S _{NW}		mph	
Level of Se	rvice, LOS			F	Maximum we	eaving length	n, L _{max}		6865 ft	
Notes										
a. Weaving s Chapter 13, ' b. For volume	egments longer the Freeway Merge a sthat exceed the	an the calcula nd Diverge Se weaving segr	ited maximum le gments". nent capacity, th	ength should l	be treated as is rvice is "F".	solated merge	and diverge ar	eas using the p	procedures of	

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		F	REEWAY	WEAV	ING WOF	RKSHEE	Г			
Genera	I Informati	on			Site Info	rmation				
Analyst Agency/Co Date Perfor Analysis Tir	mpany med me Period	GPD G 06/01/1 AM Pe	roup 16 ak Hour		Freeway/Dir of Travel I-76 Westbound Weaving Segment Location W-3 Analysis Year 2040 'No-Build'					
Project Des	scription SUM-76	6-Central Inte	rchange (PID 1	01402)						
Inputs					1					
Weaving co Weaving nu Weaving se Freeway fre	onfiguration umber of lanes, N egment length, L ee-flow speed, Fl	N S FS		One-Sided 4 1570ft 60 mph	Segment typ Freeway min Freeway ma: Terrain type	e imum speed, ximum capac	S _{MIN} ity, C _{IFL}		Freeway 50 2300 Level	
Conver	sions to p	c/h Unde	r Base Co	ondition	S	0	•	1		
	V (veh/h)	PHF	Truck (%)	RV (%)	Ε _Τ	E _R	f _{HV}	fp	v (pc/h)	
V _{FF}	6300	0.92	11	0	1.5	1.2	0.948	1.00	7224	
V _{RF}	410	0.92	6	0	1.5	1.2	0.971	1.00	459	
V _{FR}	110	0.92	6	0	1.5	1.2	0.971	1.00	123	
V _{RR}	0	0.92	0	0	1.5	1.2	1.000	1.00	0	
V _{NW}	7224			-		-		V =	7806	
V _W	582							-		
VR	0.075									
Config	uration Cha	aracteris	tics		•					
Minimum n	naneuver lanes,	N _{WL}		2 lc	Minimum we	eaving lane cl	nanges, LC _{MIN}		582 lc/h	
Interchang	e density, ID			0.8 int/mi	Weaving lan	e changes, L	C _w		938 lc/h	
Minimum F	RF lane changes,	$\mathrm{LC}_{\mathrm{RF}}$		1 lc/pc	Non-weaving	g lane change	es, LC _{NW}		1569 lc/h	
Minimum F	R lane changes,	$\rm LC_{FR}$		1 lc/pc	Total lane ch	nanges, LC _{ALI}	_		2507 lc/h	
Minimum F	RR lane changes	, LC _{RR}		lc/pc	Non-weaving	g vehicle inde	ex, I _{NW}		907	
Weavin	g Segmen	t Speed,	Density, I	_evel of	Service,	and Cap	acity			
Weaving s	egment flow rate	, V		7414 veh/h	Weaving inte	ensity factor,	W		0.327	
Weaving s	egment capacity	, c _w	;	8220 veh/h	Weaving seg	gment speed,	S		47.1 mph	
Weaving s	egment v/c ratio			0.902	Average wea	aving speed,	Sw		57.5 mph	
Weaving s	egment density,	D	41	I.4 pc/mi/ln	Average nor	n-weaving spe	eed, S _{NW}		46.4 mph	
Level of Se	ervice, LOS			E	Maximum we	eaving length	, L _{MAX}		3294 ft	
Notes		h = 1 4 h = 1 1 1	te due a ' '	and at 111			and all			
a. weaving : Chapter 13, b. For volum	segments longer t "Freeway Merge a lies that exceed the	nan the calcula and Diverge Se e weaving segi	ee maximum le gments". ment capacity, th	ngth should l	vice is "F".	solated merge	and diverge ar	eas using the	procedures of	

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	1.6						•			
Genera	Informatio	on			Site Info	rmation				
Analyst Agency/Cor Date Perfor Analysis Tir	npany med ne Period	Brett F GPD 0 06/01/ AM Pe	errell Group 16 ak Hour		Freeway/Dir of TravelState Route 8 NorthboundWeaving Segment LocationW-4Analysis Year2040 'No-Build'					
Project Des	cription SUM-76	6-Central Inte	rchange (PID 1	01402)						
Inputs										
Weaving co Weaving nu Weaving se Freeway fre	nfiguration mber of lanes, N gment length, L _g e-flow speed, Ff	I -S	_	One-Sided 4 2100ft 55 mph	Segment type Fre Freeway minimum speed, S _{MIN} Freeway maximum capacity, C _{IFL} Terrain type					
Conver	sions to po	c/n Unde	r Base Co	ndition	S	-			(")	
	V (veh/h)	PHF	Iruck (%)	RV (%)	E _T	E _R	t _{HV}	tp	v (pc/h)	
V _{FF}	4390	0.92	5	0	1.5	1.2	0.976	1.00	4891	
V _{RF}	2670	0.92	4	0	1.5	1.2	0.980	1.00	2960	
V _{FR}	1210	0.92	2	0	1.5	1.2	0.990	1.00	1328	
V _{RR}	0	0.92	0	0	1.5	1.2	1.000	1.00	0	
V _{NW}	4891							V =	9179	
V _W	4288									
VR	0.467									
Configu	iration Cha	aracteris	tics		1					
Minimum m	aneuver lanes, l	N _{WL}		2 lc	Minimum we	aving lane ch	nanges, LC _{MIN}		lc/h	
Interchange	e density, ID			0.8 int/mi	Weaving lan	e changes, L	C _w		lc/h	
Minimum R	F lane changes,	LC _{RF}		0 lc/pc	Non-weaving	g lane change	es, LC _{NW}		lc/h	
Minimum F	R lane changes,	LC _{FR}		2 lc/pc	Total lane ch	nanges, LC _{ALI}	-		lc/h	
Minimum R	R lane changes,	LC _{RR}		lc/pc	Non-weaving	g vehicle inde	ex, I _{NW}			
Weavin	g Segment	t Speed,	Density, I	_evel of	Service,	and Cap	acity			
Weaving se Weaving se	egment flow rate	, v c _w		8990 veh/h 5012 veh/h	Weaving inte Weaving seg	ensity factor, gment speed,	W S		mph	
Weaving se	egment v/c ratio			1.794	Average wea	aving speed,	Sw		mph	
Weaving se	egment density, l	D		pc/mi/ln	Average nor	-weaving spe	eed, S _{NW}		mph	
Level of Se	rvice, LOS			F	Maximum we	eaving length	, L _{MAX}		7445 ft	
Notes										
a. Weaving s Chapter 13, ' b. For volum	egments longer the Freeway Merge at the strate the strate exceed the strate strate the strate	nan the calcula and Diverge So weaving seg	ated maximum le egments". <u>ment capaci</u> ty, tl	ength should l <u>ne level of s</u> ei	be treated as is vice is <u>"F".</u>	olated merge	and diverge are	eas using the	procedures of	

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PM PEAK HOUR

		F	REEWAY	WEAV	ING WOF	KSHEE	Г			
General	Informatio	on			Site Info	rmation				
Analyst Agency/Com Date Perforr Analysis Tim	npany ned ne Period	Brett Fe GPD G 06/01/1 PM Pea	errell roup 6 ak Hour		Freeway/Dir of Travel I-77 Southbound Weaving Segment Location W-1 Analysis Year 2040 'No-Build'					
Project Desc	cription SUM-76	-Central Inter	change (PID 1	01402)						
Inputs					1					
Weaving cor Weaving nu Weaving seg Freeway free	nfiguration mber of lanes, N gment length, L _s e-flow speed, FF	S		One-Sided 4 1700ft 55 mph	Segment typ Freeway min Freeway ma: Terrain type	e imum speed, kimum capac	, S _{MIN} ity, C _{IFL}		Freeway 45 2250 Level	
Convers	sions to po	/h Unde	r Base Co	ondition	S	-	I			
	V (veh/h)	PHF	Truck (%)	RV (%)	Ε _Τ	E _R	f _{HV}	fp	v (pc/h)	
V _{FF}	4950	0.92	6	0	1.5	1.2	0.971	1.00	5542	
V _{RF}	3210	0.92	4	0	1.5	1.2	0.980	1.00	3559	
V _{FR}	440	0.92	3	0	1.5	1.2	0.985	1.00	485	
V _{RR}	0	0.92	0	0	1.5	1.2	1.000	1.00	0	
V _{NW}	5542							V =	9586	
V _W	4044									
VR	0.422									
Configu	ration Cha	racterist	ics		•					
Minimum ma	aneuver lanes, N	N _{WL}		2 lc	Minimum we	aving lane cl	nanges, LC _{MIN}		lc/h	
Interchange	density, ID			1.0 int/mi	Weaving lan	e changes, L	.C _w		lc/h	
Minimum RI	F lane changes,	LC _{RF}		0 lc/pc	Non-weaving	g lane chang	es, LC _{NW}		lc/h	
Minimum FF	R lane changes,	LC _{FR}		2 lc/pc	Total lane ch	nanges, LC _{ALI}	L		lc/h	
Minimum RI	R lane changes,	LC _{RR}		lc/pc	Non-weaving	g vehicle inde	ex, I _{NW}			
Weaving	g Segment	Speed,	Density, l	_evel of	Service,	and Cap	oacity			
Weaving se Weaving se	gment flow rate, gment capacity,	v c _w	!	9348 veh/h 5523 veh/h	Weaving inte Weaving sec	ensity factor, gment speed	W , S		mph	
Weaving se	gment v/c ratio			1.693	Average wea	aving speed,	S _w		mph	
Weaving se	gment density, [)		pc/mi/ln	Average nor	-weaving sp	eed, S _{NW}		mph	
Level of Ser	vice, LOS			F	Maximum we	eaving length	i, L _{max}		6928 ft	
Notes										
a. Weaving se Chapter 13, " b. For volume	egments longer th Freeway Merge a es that exceed the	an the calcula nd Diverge Se weaving segr	ted maximum le gments". nent capacity, th	ength should l	be treated as is ™ice is "F".	olated merge	and diverge an	eas using the p	procedures of	

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		F	REEWAY	WEAV	ING WOF	KSHEE	Т			
General	Informatio	on			Site Info	rmation				
Analyst Agency/Con Date Perforr Analysis Tim	npany ned ne Period	Brett Fo GPD G 06/01/1 PM Pea	errell roup 6 ak Hour		Freeway/Dir of Travel I-77 Northbound Weaving Segment Location W-2 Analysis Year 2040 'No-Build'					
Project Desc	cription SUM-76	-Central Inte	rchange (PID 1	01402)	-					
Inputs										
Weaving cor Weaving nur Weaving seg Freeway free	nfiguration mber of lanes, N gment length, L _s e-flow speed, FF	S		One-Sided 4 2570ft 55 mph	Segment typ Freeway min Freeway ma: Terrain type	e imum speed, kimum capac	, S _{MIN} ity, C _{IFL}		Freeway 45 2250 Leve	
Convers	sions to po	/h Unde	r Base Co	ondition	S		1	1	•	
	V (veh/h)	PHF	Truck (%)	RV (%)	Ε _Τ	E _R	f _{HV}	fp	v (pc/h)	
V _{FF}	3140	0.92	4	0	1.5	1.2	0.980	1.00	3481	
V _{RF}	500	0.92	2	0	1.5	1.2	0.990	1.00	549	
V _{FR}	2640	0.92	3	0	1.5	1.2	0.985	1.00	2913	
V _{RR}	0	0.92	0	0	1.5	1.2	1.000	1.00	0	
V _{NW}	3481							V =	6943	
V _W	3462									
VR	0.499									
Configu	ration Cha	racteris	tics		1					
Minimum m	aneuver lanes, N	N _{WL}		2 lc	Minimum we	aving lane ch	nanges, LC _{MIN}		lc/h	
Interchange	e density, ID			0.8 int/mi	Weaving lan	e changes, L	.C _w		lc/h	
Minimum R	F lane changes,	LC _{RF}		2 lc/pc	Non-weaving	g lane change	es, LC _{NW}		lc/h	
Minimum FF	R lane changes,	LC_{FR}		0 lc/pc	Total lane ch	nanges, LC _{ALI}	L		lc/h	
Minimum R	R lane changes,	LC _{RR}		lc/pc	Non-weaving	g vehicle inde	ex, I _{NW}		716	
Weaving	g Segment	Speed,	Density, I	_evel of	Service,	and Cap	oacity			
Weaving se Weaving se	gment flow rate, gment capacity,	v c _w		6827 veh/h 4719 veh/h	Weaving inte Weaving sec	ensity factor, gment speed,	W , S		mph	
Weaving se	gment v/c ratio			1.447	Average wea	aving speed,	S _w		mph	
Weaving se	gment density, [)		pc/mi/ln	Average nor	-weaving spe	eed, S _{NW}		mph	
Level of Ser	rvice, LOS			F	Maximum we	eaving length	i, L _{max}		7810 ft	
Notes										
a. vveaving s Chapter 13, " b. For volume	egments longer th Freeway Merge a es that exceed the	an the calcula nd Diverge Se weaving segr	egments". "ment capacity, th	ength should l	vice is "F".	iolated merge	and diverge an	eas using the p	proceaures of	

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		F	REEWAY	WEAV	ING WOF	RKSHEE	Т		
Genera	Informati	on			Site Info	rmation			
Analyst Agency/Con Date Perfori Analysis Tin	npany ned ne Period	GPD G 06/01/1 PM Pe	Group 16 ak Hour		Freeway/Dir of Travel I-76 Westbound Weaving Segment Location W-3 Analysis Year 2040 'No-Build'				
Project Des	cription SUM-7	6-Central Inte	rchange (PID 1	01402)					
Inputs					1				
Weaving co Weaving nu Weaving se Freeway fre	nfiguration mber of lanes, I gment length, L e-flow speed, F	N ^s FS		One-Sided 4 1570ft 60 mph	Segment typ Freeway min Freeway ma: Terrain type	e imum speed ximum capac	, S _{MIN} city, C _{IFL}		Freeway 50 2300 Level
Conver	sions to p	c/h Unde	r Base Co	ondition	S	I			
	V (veh/h)	PHF	Truck (%)	RV (%)	Ε _Τ	E _R	f _{HV}	fp	v (pc/h)
V _{FF}	3830	0.92	11	0	1.5	1.2	0.948	1.00	4392
V _{RF}	550	0.92	6	0	1.5	1.2	0.971	1.00	616
V _{FR}	110	0.92	6	0	1.5	1.2	0.971	1.00	123
V _{RR}	0	0.92	0	0	1.5	1.2	1.000	1.00	0
V _{NW}	4392					-	-	V =	5131
V _w	739							-	
VR	0.144								
Configu	ration Ch	aracteris	tics		•				
Minimum m	aneuver lanes,	N _{WL}		2 lc	Minimum we	aving lane c	hanges, LC _{MIN}		739 lc/h
Interchange	e density, ID			0.8 int/mi	Weaving lan	e changes, l	_C _w		1095 lc/h
Minimum R	F lane changes	, LC _{RF}		1 lc/pc	Non-weaving	g lane chang	es, LC _{NW}		985 lc/h
Minimum Fl	R lane changes	, LC _{FR}		1 lc/pc	Total lane ch	nanges, LC _{AL}	L		2080 lc/h
Minimum R	R lane changes	s, LC _{RR}		lc/pc	Non-weaving	g vehicle ind	ex, I _{NW}		552
Weavin	g Segmen	t Speed,	Density, I	_evel of	Service,	and Cap	pacity		
Weaving se Weaving se	gment flow rate	e, V V. C		4881 veh/h 8023 veh/h	Weaving inte Weaving seg	ensity factor, gment speed	W , S		0.282 49.7 mph
Weaving se	ament v/c ratio	, ° _W		0 608	Average wea	aving speed,	S _w		57.8 mph
Weaving se	gment density,	D	25	5.8 pc/mi/ln	Average nor	n-weaving sp	eed, S _{NW}		48.5 mph
Level of Se	rvice, LOS			С	Maximum we	eaving length	n, L _{MAX}		3972 ft
Notes									
a. Weaving s Chapter 13, '	egments longer f Freeway Merge	than the calcula and Diverge Se	ated maximum le egments".	ength should l	be treated as is	solated merge	and diverge ar	eas using the	procedures of

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			REEWA	WEAV	ING WOF	RKSHEE	T			
Genera	al Information	on			Site Info	rmation				
Analyst Agency/Co Date Perfo Analysis T	ompany ormed ïme Period	Brett F GPD 0 06/01/ PM Pe	errell Group 16 ak Hour		Freeway/Dir of TravelState Route 8 NorthboundWeaving Segment LocationW-4Analysis Year2040 'No-Build'					
Project De	escription SUM-76	6-Central Inte	rchange (PID 1	01402)						
Inputs										
Weaving c Weaving r Weaving s Freeway fi	configuration number of lanes, N segment length, L _s ree-flow speed, FF	I S S		One-Sided 4 2100ft 55 mph	Segment typ Freeway min Freeway ma: Terrain type	e imum speed ximum capac	, S _{MIN} tity, C _{IFL}		Freeway 45 2250 Leve	
Conve	rsions to po	/h Unde	r Base Co	ondition	s	0	•	1	-	
	V (veh/h)	PHF	Truck (%)	RV (%)	Ε _Τ	E _R	f _{HV}	fp	v (pc/h)	
V _{FF}	3020	0.92	5	0	1.5	1.2	0.976	1.00	3365	
V _{RF}	2050	0.92	4	0	1.5	1.2	0.980	1.00	2273	
V _{FR}	620	0.92	2	0	1.5	1.2	0.990	1.00	681	
V _{RR}	0	0.92	0	0	1.5	1.2	1.000	1.00	0	
V _{NW}	3365							V =	6319	
V _W	2954									
VR	0.467									
Config	uration Cha	aracteris	tics		.					
Minimum	maneuver lanes, l	N _{WL}		2 lc	Minimum we	eaving lane cl	hanges, LC _{MIN}		lc/h	
Interchan	ge density, ID			0.8 int/mi	Weaving lan	e changes, L	.C _w		lc/h	
Minimum	RF lane changes,	LC _{RF}		0 lc/pc	Non-weaving	g lane chang	es, LC _{NW}		lc/h	
Minimum	FR lane changes,	LC_{FR}		2 lc/pc	Total lane ch	nanges, LC _{AL}	L		lc/h	
Minimum	RR lane changes,	LC_{RR}		lc/pc	Non-weaving	g vehicle inde	ex, I _{NW}		565	
Weavii	ng Segment	Speed,	Density, I	_evel of	Service,	and Cap	oacity			
Weaving : Weaving :	segment flow rate, segment capacity,	v c _w		6185 veh/h 5009 veh/h	Weaving inte Weaving sec	ensity factor, gment speed	W , S		mph	
Weaving	segment v/c ratio			1.235	Average wea	aving speed,	S _w		mph	
Weaving	segment density, I	C		pc/mi/ln _	Average nor	n-weaving sp	eed, S _{NW}		mph	
Level of S	iervice, LOS			F	Maximum w	eaving length	n, L _{MAX}		7449 ft	
Notes							and all a			
a. vveaving Chapter 13 b. For volui	segments longer the , "Freeway Merge a mes that exceed the	an the calcula and Diverge Se weaving seg	ated maximum le egments". ment capacity, tl	ngth should l	rvice is "F".	solated merge	and diverge ar	eas using the	proceaures of	

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DESIGN YEAR 2040 'BUILD' CONDITIONS

AM PEAK HOUR

		F	REEWAY	WEAV	NG WOF	KSHEE	Т			
General Information				Site Information						
Analyst Brett M. Ferrell Agency/Company GPD Group Date Performed 06/01/16 Analysis Time Period AM Peak Hour				Freeway/Dir of Travel I-77 Southbound Weaving Segment Location W-1 Analysis Year 2040 'Build'						
Project Desc	cription SUM-76	-Central Inte	rchange (PID 1	01402)						
Inputs										
Weaving configurationOne-SidedWeaving number of lanes, N4Weaving segment length, Ls1250ftFreeway free-flow speed, FFS55 mph					Segment type Freeway minimum speed, S _{MIN} Freeway maximum capacity, C _{IFL} Terrain type				Freeway 45 2250 Leve	
Convers	sions to po	:/h Unde	r Base Co	ondition	S	-	1	1	1	
	V (veh/h)	PHF	Truck (%)	RV (%)	Ε _Τ	E _R	f _{HV}	fp	v (pc/h)	
V _{FF}	2770	0.92	6	0	1.5	1.2	0.971	1.00	3101	
V _{RF}	2370	0.92	4	0	1.5	1.2	0.980	1.00	2628	
V _{FR}	280	0.92	3	0	1.5	1.2	0.985	1.00	309	
V _{RR}	190	0.92	4	0	1.5	1.2	0.980	1.00	211	
V _{NW}	V _{NW} 3312							V =	6249	
V _w	2937									
VR	0.470									
Configu	ration Cha	racteris	tics							
Minimum maneuver lanes, N _{WL} 2 lc					Minimum weaving lane changes, LC _{MIN}					
Interchange density, ID 1.0 int/m				1.0 int/mi	Weaving lan	lc/h				
Minimum RF	lane changes,	LC _{RF}		0 lc/pc	Non-weaving lane changes, LC _{NW}					
Minimum FF	R lane changes,	LC _{FR}		2 lc/pc	Total lane ch	lc/h				
Minimum RF	R lane changes,	LC _{RR}		lc/pc	Non-weaving vehicle index, I_{NW} 44					
Weaving	g Segment	Speed,	Density, I	_evel of	Service,	and Cap	oacity			
Weaving segment flow rate, v6098 veh/lWeaving segment capacity, c4958 veh/l				6098 veh/h 4958 veh/h	Weaving inte Weaving sec	mph				
Weaving segment v/c ratio 1.230				Average weaving speed, S _w				mph		
Weaving segment density, D pc/mi/ln				Average non-weaving speed, S_{NW}				mph		
Level of Service, LUS F				Maximum weaving length, L _{MAX} 7478 f						
Notes										
a. vveaving se Chapter 13, " b. For volume	egments longer th Freeway Merge a es that exceed the	an the calcula nd Diverge Se weaving segr	eg maximum le gments". ment capacity, th	ength should l	vice is "F".	solated merge	and diverge ar	eas using the p	roceaures of	

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PM PEAK HOUR

		F	REEWAY	(WEAV	ING WOF	RKSHEE	Т			
General Information				Site Information						
Analyst Brett M. Ferrell Agency/Company GPD Group Date Performed 06/01/16 Analysis Time Period PM Peak Hour				Freeway/Dir of Travel I-77 Southbound Weaving Segment Location W-1 Analysis Year 2040 'Build'						
Project Desc	cription SUM-76	-Central Inter	rchange (PID 1	01402)						
Inputs										
Weaving configurationOne-SidWeaving number of lanes, NWeaving segment length, Ls125Freeway free-flow speed, FFS55 m					Segment typ Freeway min Freeway ma: Terrain type	Freeway 45 2250 Level				
Convers	sions to po	/h Unde	r Base Co	ondition	s		1	Ĩ.	•	
	V (veh/h)	PHF	Truck (%)	RV (%)	Ε _Τ	E _R	f _{HV}	fp	v (pc/h)	
V _{FF}	4950	0.92	6	0	1.5	1.2	0.971	1.00	5542	
V _{RF}	3210	0.92	4	0	1.5	1.2	0.980	1.00	3559	
V _{FR}	440	0.92	3	0	1.5	1.2	0.985	1.00	485	
V _{RR}	160	0.92	4	0	1.5	1.2	0.980	1.00	177	
V _{NW}	w 5719							V =	9763	
V _W	4044									
VR	0.414									
Configu	ration Cha	racterist	tics		1					
Minimum maneuver lanes, N _{WL} 2 lc					Minimum weaving lane changes, LC _{MIN} le					
Interchange density, ID 1.0 int/				1.0 int/mi	Weaving lane changes, LC_w					
Minimum RF	= lane changes,	LC _{RF}		0 lc/pc	Non-weaving lane changes, LC _{NW} Ic					
Minimum FF	R lane changes,	LC _{FR}		2 lc/pc	Total lane changes, LC _{ALL} lc/h					
Minimum RF	R lane changes,	LC _{RR}		lc/pc	Non-weaving vehicle index, I _{NW}					
Weaving	g Segment	Speed,	Density, I	Level of	Service,	and Cap	oacity			
Weaving segment flow rate, v9522 veh/hWeaving segment capacity, c5625 veh/h				9522 veh/h 5625 veh/h	Weaving intensity factor, W Weaving segment speed, S mpl					
Weaving segment v/c ratio 1.693				Average weaving speed, S _w mp						
Weaving segment density, D pc/mi/ln				Average non-weaving speed, S _{NW}				mph		
Level of Service, LOS F				Maximum weaving length, L _{MAX} 6841 ft						
Notes										
a. Weaving se Chapter 13, "I b. For volume	egments longer th Freeway Merge a es that exceed the	an the calcula nd Diverge Se weaving segr	ited maximum le gments". nent capacity, th	ength should l	be treated as is rvice is "F".	solated merge	and diverge ar	eas using the	procedures of	

HCS 2010TM Version 6.90

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APPENDIX F COST ESTIMATE

Northeast Interchange Safety Improvement Project

ITEM	DESCRIPTION	TOTAL QUANTITY	UNIT	ESTIMATED PRICE	TOTAL COST
	PAVEMENT				
	MAINLINE & RAMPS - LANES & SHOULDERS - ASPHALT	14,423	SY	\$52	\$750,000
		2,400	FI	\$125	\$300,000
	PAVEMENT SUBTOTAL:				\$1,050,000
	ROADWAY				
	PAVEMENT REMOVAL	14,434	SY	\$10	\$150,000
	EARTHWORK				
	EXCAVATION - SOIL	37,474	CY	\$9	\$350,000
	FILL - EMBANKMENT	250,335	CY	\$10	\$2,500,000
	POADWAY SUBTOTAL				\$3 000 000
	ROADWAT SOBIOTAL.				\$3,000,000
	DRAINAGE				
	DRAINAGE				
		0.45		* 1 050 000	0 040.000
	15% of Roadway and Pavement	0.15	LS	\$4,050,000	\$610,000
	DRAINAGE SUBTOTAL				\$610,000
	BRAINAGE GOBTOTAL				<i>4010,000</i>
	EROSION CONTROL				
	ERODIEN CONTROL				
	5% of Roadway and Rayomont	0.05	18	\$4.050.000	\$210.000
	3% of Roadway and Pavement	0.05	LO	\$4,050,000	\$210,000
	EROSION CONTROL SUBTOTAL:				\$210,000
	UTILITIES				
	5% of Roadway and Pavement	0.05	19	\$4,050,000	\$210.000
	o to of Roddway and Favorion	0.00	20	φ-1,000,000	φ210,000
	UTILITIES SUBTOTAL:				\$210,000
	LIGHTING				
	PARTIAL INTERCHANGE	0.25	LS	\$340,000	\$85,000
	MAINTENANCE OF TRAFFIC SUBTOTAL:				\$85,000
	TRAFFIC CONTROL				
	SIGNING (Urban Freeway)	0.25	MILE	\$400,000	\$100,000
	PAVEMENT MARKING (Multi-lane freeway)	0.81	MILE	\$37,000	\$30,000
	EDGE LINE	2.38	MILE	\$6,000	\$15,000
					A115 000
	IRAFFIC CONTROL SUBTOTAL:				\$145,000
	0701070220				
	STRUCTURES				
	BRIDGE REMOVAL				
	STANDARD BRIDGE REMOVAL	29,282	SF	\$25	\$730,000
	COMPLEX BRIDGE REMOVAL	21,484	SF	\$40	\$860,000
	SIMPLE, SINGLE SPAN STRUCTURE	7.530	SF	\$159	\$1.200.000
	MULTI-SPAN > 4000 SQ FT	70,291	SF	\$250	\$17,600,000
	STRUCTURES SUBTOTAL:				\$20,390,000

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Northeast Interchange Safety Improvement Project

ITEM	DESCRIPTION	TOTAL QUANTITY	UNIT	ESTIMATED PRICE	TOTAL COST	
	RETAINING WALLS					
	MSE RETAINING WALL	7,895	SF	\$165	\$1,300,000	
					<u> </u>	
	RETAINING WALLS SUBTOTAL:				\$1,300,000	
	MAINTENANCE OF TRAFFIC					
		0.05	18	¢27.000.000	¢1 250 000	
	WIRE FACED TEMPORARY MSE WALLS (FOR PART-WIDTH)	18,300	SF	¢∠1,000,000 \$30	\$550,000	
		10,000	0.	φοσ	\$000,000	
	MAINTENANCE OF TRAFFIC SUBTOTAL:				\$1,900,000	
	MISCELLANEOUS					
622		0.005	18	¢28.000.000	\$14E 000	
623	MOBILIZATION (PER 2013 CMS)	0.005	1.5	\$800,000	\$145,000	
024	PERFORMANCE BOND (0.5% OF ABOVE ITEMS)	0.005	LS	\$28,900,000	\$145,000	
619	FIELD OFFICE	18	MO	\$3,000	\$54,000	
					¢4 444 000	
	MISCELLANEOUS SUBTOTAL:				φ1,144,000	
	RIGHT OF WAY					
	TOTAL RIGHT-OF-WAY COST	1	LS	\$1,000,000	\$1,000,000	
					¢4 000 000	
	RIGHT OF WAY SUBTOTAL:				\$1,000,000	
	TOTAL CONST	RUCTION AND	RUCTION AND RIGHT OF WAY COST:			
	DESIGN ENGINEERING COST:	(16.1% OF	CONSTR	R. & R/W COST)	\$5,000,000	
	GEOTECHNICAL ENGINEERING COST:	(2.4% OF	CONSTR	R. & R/W COST)	\$750,000	
	ENVIRONMENTAL COST:	(2.4% OF	CONSTR	R. & R/W COST)	\$750,000	
	DESIGN CONTINGENCY COSTS	(25.1% OF	CONSTR	R & R/W COST)	\$7,800,000	
		(2011)0 01	0011011		¢1,000,000	
			PROJE	CT SUBTOTAL:	\$45,844,000	
		15.6% INFI	ATION	CONTINGENCY:	\$7,156.000	
					. ,	
				TOTAL:	\$53,000,000	