State Route (SR) 30, Sarival Avenue to SR 202L

Traffic Report Addendum

Maricopa County, Arizona

Federal-aid Project No. NH-801-B(ARG)

ADOT Project No. 801 MA 000 H6876 01L

Prepared for:

Arizona Department of Transportation
Project Management Group
205 S. 17th Avenue
Phoenix, AZ 85007

Prepared by:

HDR
3200 E. Camelback Road, Suite 350
Phoenix, AZ 85018

September 10, 2018

This page is intentionally left blank.

Contents

Appendixes

Tables

Figures

Abbreviations and Acronyms

ADOT	Arizona Department of Transportation
ADT	average daily traffic
AM	morning
CDI	compact diamond interchange
FHWA	Federal Highway Administration
HCM	*Highway Capacity Manual*
HCS	Highway Capacity Software
HOV	high-occupancy vehicle
I-10	Interstate 10
LOS	level of service
MAG	Maricopa Association of Governments
MC 85	Maricopa County Route 85
mph	miles per hour
OD	origin-destination
PM	evening
RBA	Recommended Build Alternative
SR	State Route
TI	traffic interchange
v/c	volume-to-capacity ratio

Chapter 1. Introduction

1.1 Report Description

This report is an addendum to the *State Route (SR) 30, SR 303L to SR 202L Final Traffic Report* (April 2013). It updates the traffic report with an evaluation of the Recommended Build Alternative (RBA). It includes an update of projected traffic volumes and level of service (LOS) for a 2035 SR 30 opening year and a 2040 design year. Additionally, the SR 30 terminus on the west has been moved east from its original western terminus at Maricopa County Route 85 (MC 85) at Jackrabbit Trail to Sarival Avenue. The eastern terminus remains the same, at 59th Avenue in the area of SR 202L (South Mountain Freeway).

This addendum describes the analysis conducted for the morning (AM) and evening (PM) peak periods for the opening year of 2035 and future year of 2040 using traffic data and forecasts provided by the Maricopa Association of Governments (MAG). The study uses October 2017 MAG conformity model runs for 2035 opening year and 2040 design year traffic projections. The October 2017 MAG conformity model has SR 30 coded as six-lane facility for both 2035 and 2040.

A Phase 1 arterial-style four-lane SR 30 expressway is proposed for 2025. The October 2017 MAG conformity model runs for 2025 reflect the same. The travel demand analysis discussed in Chapter 3.0 shows the potential system benefits of this interim expressway configuration.

1.2 Project Location

The Study Area for the proposed SR 30 freeway is located southwest of downtown Phoenix and falls entirely within Maricopa County in south-central Arizona. The area encompasses the municipalities of Goodyear, Avondale, and Phoenix, along with unincorporated Maricopa County land. The Study Area is bounded generally by Cotton Lane on the west, Lower Buckeye Road on the north, 51st Avenue on the east, and the northern banks of the Gila and Salt Rivers on the south (see Figure 1.1). At the SR 30 connection with SR 202L, the Study Area extends north along SR 202L nearly to Interstate 10 (I-10, Papago Freeway) and extends south nearly to Elliot Road.

The proposed freeway would run east-to-west, parallel to and south of I-10, for about 14 miles. The western terminus of SR 30 would be located at Sarival Avenue. The eastern terminus would be located at the proposed SR 202L, near 59th Avenue. The Study Area is in the Arizona Department of Transportation's (ADOT's) Central District.

1.3 SR 30 Recommended Build Alternative

The RBA that has been selected by ADOT, the Federal Highway Administration (FHWA), and MAG in August 2017 is the Hybrid Alternative identified in the *State Route (SR) 30, SR 303L to SR 202L Final Traffic Report* (April 2013). This alternative closely follows the half-mile section between Broadway Road and Southern Avenue between Avondale Avenue and 91st Avenue. It deviates to the south at Avondale Boulevard, following the Southern Avenue alignment between Dysart Road and Avondale Boulevard.

The proposed SR 30 by 2035 would be constructed as a six-lane freeway facility with a 50-foot-wide median with cable barrier. This median would accommodate another general purpose lane and high-occupancy vehicle (HOV) lane in each direction in the future. When built out, it would have 12-foot-wide lanes with 12-foot-wide shoulders on both sides and a median concrete barrier. The service traffic interchanges (TIs) would be located at a minimum of 1-mile spacing, along with 12-foot-wide auxiliary lanes where warranted. The freeway would cross over the existing major crossroads, leaving the arterial streets at grade.

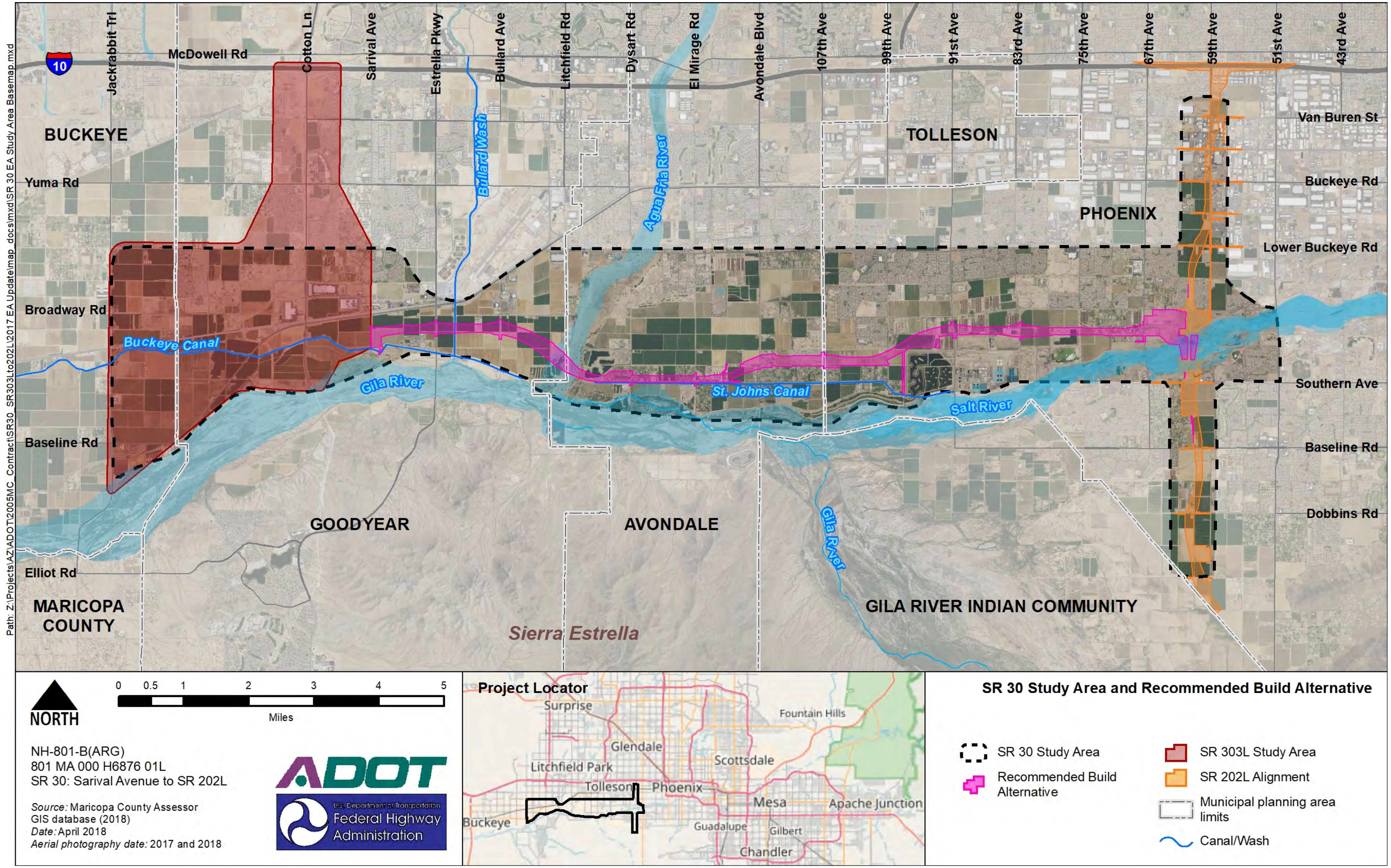
1.3.1 SR 30 Service Traffic Interchanges

Ten service TIs are proposed for the RBA. These interchanges were assumed to be full compact diamond interchange (CDI) types with the exception of Sarival and 67th Avenues, where a half-CDI type of interchange was evaluated. From west to east, the TI locations are as follows: Cotton Lane, Sarival Avenue, Estrella Parkway, Bullard Avenue, Dysart Road, Avondale Boulevard, 107th Avenue, 91st Avenue, 83rd Avenue, and 67th Avenue.

1.3.2 SR 30 and SR 202L System Traffic Interchange

The proposed system TI between SR 30 and SR 202L is located in Phoenix between Broadway Road and Southern Avenue, along the proposed SR 202L over the Salt River. The proposed SR 30 freeway would connect to the proposed SR 202L as a three-legged system TI (northern, southern, and western legs) during initial construction. An eastern leg is also planned as SR 30 is extended east in the future and is accommodated into the TI design. The October 2017 MAG conformity model runs for 2035 opening year and 2040 design year traffic projections include the eastern leg for accurate traffic routing and projections. The eastern leg of this TI is described in the *SR30/SR 202L Interchange Selection Report* (June 2018).

Figure 1.1. Project Location and Vicinity



Chapter 2. Traffic Analysis Methodology and Tools

2.1 Assumptions and Methodology

It is assumed that the proposed SR 30 freeway would be open to traffic around 2035. Freeway and signalized intersection traffic analysis methodologies as described in the Transportation Research Board's *Highway Capacity Manual* (HCM) (2010) were used to evaluate the operational performance of the proposed SR 30 freeway and the system and service TIs along SR 30.

2.2 Traffic Analysis Tools

2.2.1 Freeway Main Line: HCS Analysis

The freeway traffic operational analysis, as described in the HCM, introduces the LOS concept. It is a letter grading system, from A to F, that defines the traffic operations in a qualitative manner based on traffic flow and other roadway characteristics. LOS A depicts free-flow conditions with little or no delay and with free-flow speeds, while LOS F represents the worst condition, with unacceptable congestion, long queues, and delays. LOS A, B, and C are considered to be acceptable and free-flow speeds are maintained. Congestion becomes more noticeable at LOS D, with reduced speeds and less freedom to maneuver. Most agencies aim for LOS D to balance mobility and economics. LOS E occurs when demand has reached the capacity of the facility and maneuverability within the traffic stream is extremely limited. Figure 2.1 illustrates the LOS A to F concept based on flow condition.

The freeway main line operational analysis, based on HCM methodology, splits the freeway into three segments:

- Weaving segment: Weaving segments are formed when an auxiliary lane is used to connect adjacent on- and off-ramps spaced less than 1.5 miles apart. A lane change is required for all the traffic that is either joining or leaving the freeway main line.
- Ramp junction: The ramp junction (or merge and diverge) analysis is used in locations where a ramp enters or exits a freeway main line and is not coupled with a weaving area.
- Basic freeway segment: The basic freeway segments are all other segments that are outside of the weaving or ramp junction influence areas. This generally occurs between the successive off- and on-ramps. The basic freeway segment analysis is also used to analyze the body of the system TI ramps.

The HCM LOS criteria for freeway segments are presented in Table 2.1 based on the lane density ranges for each. The freeway operations analysis—which includes basic segments, weaving segments, and exit and entry ramps—is performed using the Highway Capacity Software (HCS™ 2010 version 6.1), which uses the methodology defined in HCM.

Figure 2.1. Level of Service

Level of Service A | Level of Service B | Level of Service C

Level of Service D | Level of Service E | Level of Service F

Table 2.1. *Highway Capacity Manual* Level of Service Criteria for Freeway Segments

Level of Service	Density Range (passenger car/mile/lane)		
	Freeway Segment Type		
	Basic	Weaving	Merge and Diverge
A	≤11	≤10	≤10
B	11–18	10–20	10–20
C	18–26	20–28	20–28
D	26–35	28–35	28–35
E	35–45	35–43	>35
F	>45	>43	Demand exceeds capacity

Source: Transportation Research Board, *Highway Capacity Manual*, 2010

HCS uses the morning and evening peak hour volumes and a number of roadway and driver characteristics to determine LOS. Some of the inputs that are constant along the corridor include:

- peak hour factor of 0.95
- truck factor of 10 percent
- free-flow speed based on the type of roadway:
  - freeway – 65 miles per hour (mph)
  - system ramp – 55 mph
  - service TI on ramp – 55 mph
  - service TI off ramp – 60 mph

2.2.2 Service Traffic Interchanges: Synchro Analysis

The service TI signal traffic analysis was performed using the Synchro simulation analysis package (Version 9.1, Build Series 909, Revision 20) developed by Trafficware, Inc. Synchro is a widely used traffic analysis tool that evaluates intersection delays and congestion based on procedures similar to those described in the 2010 HCM (Chapters 18, 19, and 20). It is often used for localized intersection analyses, signal coordination, and traffic study work. It was used to evaluate the ramp intersection performance. Major adjacent street intersections were included within the Synchro network to account for the effect of queues spilling back to the ramp terminal intersections.

Basic inputs to Synchro include traffic volumes, lane geometry, signal control, and signal timing and phasing. Synchro was used to optimize the signal cycle length and phasing during the analysis.

The HCM evaluates the LOS of individual lane groups and of the entire signalized intersection based on the control delay. It states that:

> Control delay is a measure of driver discomfort, frustration, fuel consumption, and increased travel time. The delay experienced by a motorist is made up of a number of factors that relate to control, geometrics, traffic, and incidents. Total delay is the difference between the travel time actually experienced and the reference travel time that would result during base conditions…
>
> Delay is a complex measure and depends on a number of variables, including the quality of progression, the cycle length, the green ratio, and the v/c ratio for the lane group.

The HCM LOS grade and associated range of intersection control delay for signalized and unsignalized intersections are presented in Table 2.2.

Table 2.2. *Highway Capacity Manual* Level of Service Criteria for Signalized and Unsignalized Intersections

Level of Service	Average Control Delay (seconds per vehicle)	
	Signalized	Unsignalized
A	≤10	≤10
B	10–20	10–15
C	20–35	15–25
D	35–55	25–35
E	55–80	35–50
F	>80	>50

Source: Transportation Research Board, *Highway Capacity Manual*, 2000

2.2.3 System Traffic Interchanges: VISSIM Analysis

VISSIM (Version 9.00-11) is a microscopic, behavior-based multipurpose traffic simulation program used to optimize complex transportation systems. VISSIM is based on car following and lane change logic, which can analyze vehicular traffic operations based on various driver behavior patterns and lane configurations, including HOV lanes and ramp metering.

VISSIM was used to evaluate traffic operations on the freeway main line and ramps associated with the SR 30/SR 202L TI and I-10/SR 202L TI and the SR 202L freeway connection between them. VISSIM was used in this area because of the complexities of this part of the design and the interaction of these design elements with each other. The analysis evaluated both AM and PM peak period conditions on an average weekday for the opening year 2035 and future year 2040 for the RBA at the SR 30/SR 202L system TI. LOS on freeway segments is the primary measure of effectiveness used to evaluate the operational performance of the Study Area network.

Because most of the modeled network is nonexistent today, the VISSIM model was calibrated to anticipate traffic conditions using similar parameters for driving behavior and vehicle performance that were used to develop the South Mountain Freeway VISSIM model.

Chapter 3. Travel Demand Overview

This section discusses travel demand and socioeconomic projections in the southwestern Phoenix metropolitan area. The traffic distribution on the regional freeway system and arterial street network with and without the proposed SR 30 freeway corridor, and other special event traffic, are also presented.

3.1 Population and Employment Growth

Maricopa County has been one of the fastest-growing regions in the United States. Between 2010 and 2016, data from the Arizona State Demographer's Office show that the Maricopa County population increased by 8 percent, adding 313,000 people. Shown in Table 3.1, MAG projects that Maricopa County population in households will increase by 42 percent from 2017 to 2040. Employment is projected to increase by 40 percent from 2017 to 2040. Within the SR 30 study area, MAG projects even higher growth rates, with population in households projected to more than double from 2017 to 2040 while employment is projected to more than triple.

Table 3.1. SR 30 Study Area Population and Employment Growth Projections

Description	2017	2025	2035	2040
SR 30 Study Area				
Population in households	46,180	67,725	86,000	96,500
Percentage change from 2017	—	47%	86%	109%
Employment	8,140	11,190	20,550	27,500
Percentage change from 2017	—	37%	152%	238%
Maricopa County				
Population in households	4,164,474	4,796,299	5,550,886	5,902,635
Percentage change from 2017	—	15%	33%	42%
Employment	1,762,612	2,008,459	2,310,886	2,476,057
Percentage change from 2017	—	14%	31%	40%

Source: Maricopa Association of Governments, 2017

3.2 SR 30 Travel Demand Models

The travel demand models for the SR 30 freeway corridor study were provided by MAG based on the 2025, 2035, and 2040 socioeconomic data, the SR 30 RBA alignment, and any planned roadway network improvements during that period. The 2035 travel demand models formed the basis for an opening year traffic analysis, while the 2040 travel demand model was used to provide an understanding of how travel demand would change beyond 2035.

It was assumed that the 2035 travel demand model represented the opening day initial construction of the SR 30 alignment with a three-legged SR 30/SR 202L system TI at the eastern terminus and the southbound-to-eastbound and westbound to northbound direct connections of SR 30 and SR 303L.

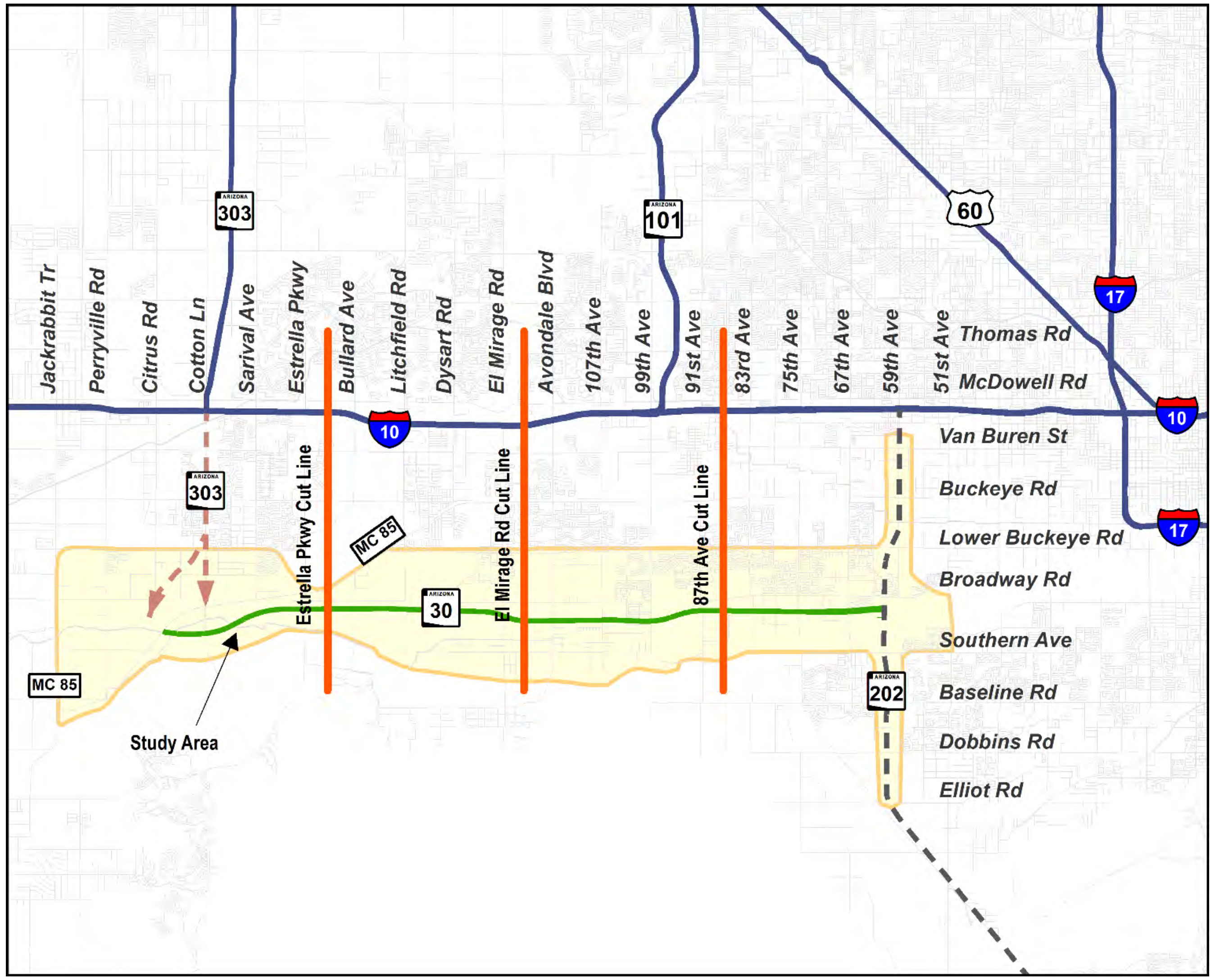
3.3 Traffic Distribution on Regional Roadway Network (with and without SR 30)

One of the objectives of the proposed SR 30 freeway is to improve traffic conditions in the southwestern region of the Phoenix metropolitan area by acting as an alternative east-to-west route to I-10, thus reducing congestion on I-10 as well as local arterial streets. It is also generally desired to route more traffic onto freeways compared with arterial streets, which improves the arterial streets' operations. With the use of a cut-line analysis, the traffic distribution on the regional street network with and without the proposed SR 30 freeway can be demonstrated, illustrating the benefits of the new freeway.

A cut line is an imaginary line placed over the road network that crosses a number of parallel roads in a given geographic area. It is drawn perpendicular to the set of parallel roads. It is a tool to measure the amount of traffic distributed among freeways and arterial streets that exist under the cut line for different conditions.

To assess the distribution of existing (2017), 2025, 2035, and 2040 eastbound and westbound traffic on I-10 and on arterial streets north and south of I-10, the Study Team conducted a cut-line analysis by drawing three imaginary north-to-south lines extending from Southern Avenue to Thomas Road (Figure 3.1).

Figure 3.1. Cut Line Locations



The length of the three cut lines was selected based on the assumption that the major east-to-west arterial streets crossing the three cut lines (Broadway Road, Lower Buckeye Road, Buckeye Road, Van Buren Street, McDowell Road, and Thomas Road) would generally be used as alternative routes for I-10 and SR 30.

The Study Team placed the Estrella Parkway cut line between Estrella Parkway and Bullard Avenue, the El Mirage Road cut line between El Mirage Road and Avondale Boulevard, and the 87th Avenue cut line between 91st and 83rd Avenues (see Figure 3.1). The cut-line analysis was performed for four conditions: (1) the existing (2017) condition, (2) the 2025 condition with and without the interim SR 30 expressway, (3) the 2035 condition with and without the proposed 3+0 SR 30 freeway, and (4) the 2040 condition with and without the proposed 3+0 SR 30 freeway. I-10 widening attributable to the SR 202L and SR 303L system TIs was also included in the 2035 and 2040 condition. Table 3.2 shows the distribution of PM peak period traffic along the cut lines for these different conditions along the freeways and east-to-west arterial streets. The PM peak period generally represents the most congested hours of the day.

This table also shows an estimate of the total cut line PM peak period freeway and arterial capacity, or “reserved capacity,” based on the MAG regional travel demand model.

Table 3.2. Traffic Distribution on Regional Street Network along Cut Lines

Cut Line	Year/Condition	PM Peak Period Traffic Volume (Reserved Capacity) in 000's			Distribution (%)		Volume Over Capacity		
		Total	Freeways	Arterial streets	Freeways	Arterial streets	Total	Freeways	Arterial streets
Estrella Parkway	2017/existing	67 (170)	44 (75)	23 (95)	66	34	0.40	0.59	0.24
	2025/without SR 30	81 (185)	52 (75)	29 (110)	64	36	0.44	0.69	0.27
	2025 with SR 30 expressway	82 (199)	51 (75)	31 (124)	62	38	0.42	0.68	0.25
	2035/without SR 30	113 (162)	74 (75)	39 (87)	65	35	0.70	0.98	0.45
	2035/with SR 30	127 (273)	94 (150)	33 (123)	74	26	0.47	0.62	0.27
	2040/without SR 30	122 (162)	78 (75)	44 (87)	64	36	0.75	1.04	0.51
	2040/with SR 30	146 (273)	105 (150)	41 (123)	72	28	0.54	0.70	0.34
El Mirage Road	2017/existing	76 (125)	57 (75)	19 (50)	75	25	0.61	0.77	0.38
	2025/without SR 30	91 (156)	65 (75)	26 (81)	71	29	0.58	0.88	0.39
	2025 with SR 30 expressway	93 (169)	64 (75)	29 (94)	69	31	0.64	0.84	0.36
	2035/without SR 30	114 (198)	66 (75)	48 (123)	58	42	0.65	0.93	0.48
	2035/with SR 30	132 (207)	101 (120)	31 (87)	77	23	0.64	0.84	0.36
	2040/without SR 30	129 (198)	70 (75)	59 (123)	54	46	0.65	0.93	0.48
	2040/with SR 30	146 (207)	110 (120)	36 (87)	76	24	0.71	0.92	0.41
87th Avenue	2017/existing	93 (154)	67 (83)	26 (71)	72	28	0.60	0.81	0.37
	2025/without SR 30	110(168)	76 (90)	34 (78)	69	31	0.66	0.85	0.44
	2025 with SR 30 expressway	114 (181)	75 (90)	39 (91)	66	34	0.63	0.84	0.42
	2035/without SR 30	130 (168)	86 (90)	44 (78)	66	34	0.78	0.96	0.56
	2035/with SR 30	156 (235)	125 (158)	31 (78)	80	20	0.66	0.79	0.40
	2040/without SR 30	139 (168)	91 (90)	48 (78)	66	34	0.83	1.01	0.62
	2040/with SR 30	169 (235)	134 (158)	35 (78)	80	20	0.72	0.85	0.45

Estrella Parkway Cut Line: This cut line is on the western end of the SR 30 corridor, where the existing population density is relatively low. In the 2017 existing condition, 66 percent of PM peak period traffic uses I-10. In 2025, the interim SR 30 expressway option does little to relieve congestion on I-10. As this area grows between now and 2040, the importance of SR 30 as a freeway becomes evident. Without SR 30, the portion of traffic using arterial streets increases. With SR 30, the freeways attract more than 70 percent of the volume. The 2040 PM peak period traffic attraction on arterial streets is around 28 percent with SR 30 compared with 46 percent without SR 30. Under 2040 conditions, I-10 and SR 30 would continue to attract a high percentage (72 percent) of the daily traffic.

The east-to-west arterial streets may not have sufficient capacity to handle 2040 travel demand. The net increase in freeway volumes would be around 18,000 trips in the 2040 PM peak period when compared with and without SR 30, while in the PM peak period SR 30 would reduce arterial street volume by 18,000 trips. Moreover, these arterial streets may be constrained operationally without the proposed SR 30 in 2040. Therefore, SR 30 as a freeway is filling the need of attracting regional trips and relieving demand on arterial streets.

El Mirage Road Cut Line: This cut line is located near the middle of the SR 30 corridor. The existing population and employment densities are relatively low for this area. In 2025, the proposed interim SR 30 expressway option would provide only minor relief to I-10. In 2040, the distribution of 64 and 75 percent of the daily traffic on freeways with and without SR 30, respectively, indicates the necessity to have the proposed SR 30 freeway as an alternate route. The 2035 daily traffic on arterial streets would be reduced from 36 percent to 25 percent when comparing conditions without and with SR 30.

As discussed above, the east-to-west arterial streets would be able to operate within the acceptable level without SR 30 in 2035. But, the significant attraction of additional users onto the freeway network in 2035 and beyond would be beneficial to the transportation system as a whole.

87th Avenue Cut Line: This cut line lies on the eastern end of the SR 30 corridor at 87th Avenue. The existing land use for most of this area is relatively built out. In 2025, the proposed interim SR 30 expressway option would attract up to 5,000 PM peak period trips, resulting in a more significant reduction of I-10 congestion. This suggests that the interim SR 30 expressway may be appropriate between SR 202L and Avondale Boulevard. For 2040, the daily traffic distribution would be around 79 and 66 percent on freeways with and without SR 30, respectively. The additional attraction of traffic onto freeways from arterial streets with SR 30 illustrates how it would serve as an alternative route and help meet travel demand in the region.

It is evident that the demand on existing freeways would reach capacity in 2040 without SR 30. The east-to-west arterial streets would have to handle any additional traffic generated beyond 2040 and would start experiencing operational issues when the volume-to-capacity ratio (V/C) reaches around 0.9. With the proposed SR 30, most of the demand would be shifted to freeways, resulting in better operations on the arterial street network.

3.4 Operational Performance of I-10 with and without SR 30

I-10 is the only major existing freeway serving the needs of east-west travel in the western Phoenix metropolitan area. With the projected growth for this region in 2040 and beyond, the effectiveness of I-10 as an Interstate transportation corridor as well as a regional route becomes vital. The SR 30 freeway is proposed as an alternative route to I-10 to address this additional travel demand. Therefore, it is very important to understand the operational performance of I-10 with and without this new freeway corridor. A basic V/C analysis was performed to understand the operational performance defined by LOS.

Delay is noticeable at LOS D, but is considered acceptable during peak hours. More discussion on LOS is presented in Section 2.2.1. The LOS on I-10 for every 1-mile segment between Perryville Road and 51st Avenue was calculated with and without SR 30 in 2025, 2035, and 2040. This analysis was performed for peak directions only during the AM and PM commutes. Eastbound and westbound I-10 are the AM and PM peak directions, respectively. The results of the analysis are presented in Table 3.3.

Notable observations from the analysis include:

- With or without SR 30, LOS will deteriorate through the 2040 planning horizon along the 12-mile section of I-10 between Bullard and 51st Avenues (both eastbound and westbound). By 2040, most segments of I-10 are forecast to operate at LOS E or F during the peak periods. While SR 30 would improve LOS for some segments of I-10, any new capacity provided by SR 30 would be filled by traffic shifting from the arterial streets.
- Travel demand for this project is so strong that even with a SR 30 Phase 2 roadway, LOS on both I-10 and SR 30 will deteriorate to LOS F for the majority of the corridors. This condition was recognized early on in this study, as was the realization that the number of lanes needed on SR 30 to improve SR 30 LOS was far beyond what the stakeholders deemed reasonable. As such, the maximum SR 30 highway cross section was established at four general purpose lanes, one HOV lane, and auxiliary lanes as needed to match the rest of the valley freeway system, regardless of projected LOS. This is defined as the Phase 3 roadway section and is not currently programmed prior to 2040. Additionally, the system ramps at the SR 30/SR 202L TI were capped at two lanes each. However, even with the Phase 3 SR 30 roadway, LOS in the two corridors is not expected to meaningfully improve in 2040.
- To mitigate the unmet travel demand in the I-10 and SR 30 corridors, a 50-foot wide high capacity transit corridor is being included in the proposed SR 30 corridor footprint to allow a future means to address this demand. Due to the uncertainty of technological change, the travel mode and technology is purposely not defined at this time for how the future high capacity transit corridor could eventually be used. This is defined as the future Phase 4 condition.

Table 3.3. Operational Performance of I-10 with and without SR 30, SR 303L to SR 202L (2040)

I-10 Segment		I-10 Eastbound (2025 AM Peak Period)		I-10 Westbound (2025 PM Peak Period)		I-10 Eastbound (2035 PM Peak Period)		I-10 Westbound (2035 PM Peak Period)		I-10 Eastbound (2040 AM Peak Period)		I-10 Westbound (2040 PM Peak Period)	
		Without SR 30	With Phase 1 SR 30	Without SR 30	With Phase 1 SR 30	Without SR 30	With Phase 2 SR 30	Without SR 30	With Phase 2 SR 30	Without SR 30	With Phase 2 SR 30	Without SR 30	With Phase 2 SR 30
	Perryville Road to Citrus Road	D	D	E	E	F	F	F	F	F	F	F	F
	Citrus Road to Cotton Lane	D	D	D	D	F	F	F	F	F	F	F	F
SR 30 (SR 303L to SR 202L) Limits	Cotton Lane to Sarival Avenue	D	C	D	D	E	E	E	E	F	E	F	E
	Sarival Avenue to Estrella Parkway	D	D	D	D	F	E	F	E	F	F	F	F
	Estrella Parkway to Bullard Avenue	E	D	E	E	F	E	F	E	F	F	F	F
	Bullard Avenue to Litchfield Road	E	E	E	E	F	E	F	E	F	F	F	F
	Litchfield Road to Dysart Road	E	E	E	E	F	E	F	E	F	F	F	F
	Dysart Road to El Mirage Road	E	E	F	F	F	F	F	F	F	F	F	F
	El Mirage Road to Avondale Boulevard	E	E	F	F	F	E	F	F	F	F	F	F
	Avondale Boulevard to 107th Avenue	F	F	E	E	F	F	F	E	F	F	F	E
	107th Avenue to 99th Avenue	E	E	D	D	F	E	E	D	F	F	F	E
	99th Avenue to 91st Avenue	E	E	F	F	F	E	F	F	F	F	F	F
	91st Avenue to 83rd Avenue	E	E	F	E	F	E	F	F	F	F	F	F
	83rd Avenue to 75th Avenue	F	E	F	F	F	E	F	F	F	F	F	F
	75th Avenue to 67th Avenue	F	F	F	F	F	F	F	F	F	F	F	F
	67th Avenue to 59th Avenue	F	F	E	E	F	F	F	E	F	F	F	F
	59th Avenue to 51st Avenue	F	F	F	F	F	E	F	F	F	F	F	F

Chapter 4. SR 30 Freeway Main Line Analysis

The SR 30 freeway main line analysis (excluding the area around and within the SR 30/SR 202L TI) evaluated the traffic operational performance of the freeway and ramp junctions based on the proposed lane configuration and projected traffic volumes. The main line analysis was conducted using HCS+ Version 6.1, using methodologies from the 2010 HCM, as described in Section 2.2.1.

4.1 Opening Year (2035) Analysis

The opening year analysis represents the condition when the SR 30 RBA would first open to the public as a 3+0 freeway. It uses traffic volumes generated from the 2035 MAG travel demand model to analyze the LOS of various segments of the freeway main line.

4.1.1 SR 30 Recommended Build Alternative in 2035

The 2035 average daily traffic (ADT) and peak hour forecasts used for the analysis of the RBA main line are presented in Figures 4.1 and 4.2, respectively. Notable observations from the forecasts are:

- Maximum daily traffic of 164,000 vehicles per day is forecast between 67th and 83rd Avenues.
- The system ramps connecting SR 30 and SR 303L have an estimated daily traffic of 62,000 vehicles per day.
- In the AM peak period, 76 percent of the SR 30 traffic using the SR 30 and SR 202L system TI is traveling eastbound, while 24 percent is traveling westbound.
- The directional split of PM peak period traffic using the SR 30 and SR 202L system TI is 63 percent westbound and 37 percent eastbound.

The AM and PM peak hour LOS results of the SR 30 RBA main line HCS analysis are presented in Figures 4.3 and 4.4 and Tables 4.1 and 4.2. Detailed HCS reports are provided in Appendix A.

Important observations from the freeway main line analysis are:

Morning (AM) Peak Hour

- Under 2035 traffic conditions, Table 4.1 shows that four eastbound freeway segments would operate at LOS C or better, three segments would operate at LOS D, four segments would operate at LOS E, and 15 segments would operate at LOS F.
- The westbound SR 30 RBA would operate at LOS C or better under 2035 traffic conditions.

Evening (PM) Peak Hour

- In the westbound direction with 2035 PM peak hour traffic conditions, seven segments of the SR 30 RBA would operate at LOS C or better. Seven segments would operate at LOS D, and six segments would operate at LOS E. Seven segments are forecast to have LOS F operations.
- Because HCS provides localized analysis, it should be noted that poor operations at a downstream segment can affect the operations at an upstream segment (resulting from the shockwave effect). These are not addressed with the HCS analysis.

Future Year (2040) Analysis

The future year 2040 analysis represents the traffic conditions 5 years after the SR 30 RBA may first open to the public. It uses traffic volumes generated from the 2040 MAG travel demand model to analyze the LOS of various segments of the freeway main line.

Figure 4.1. SR 30 Recommended Build Alternative Average Daily Traffic (2035)

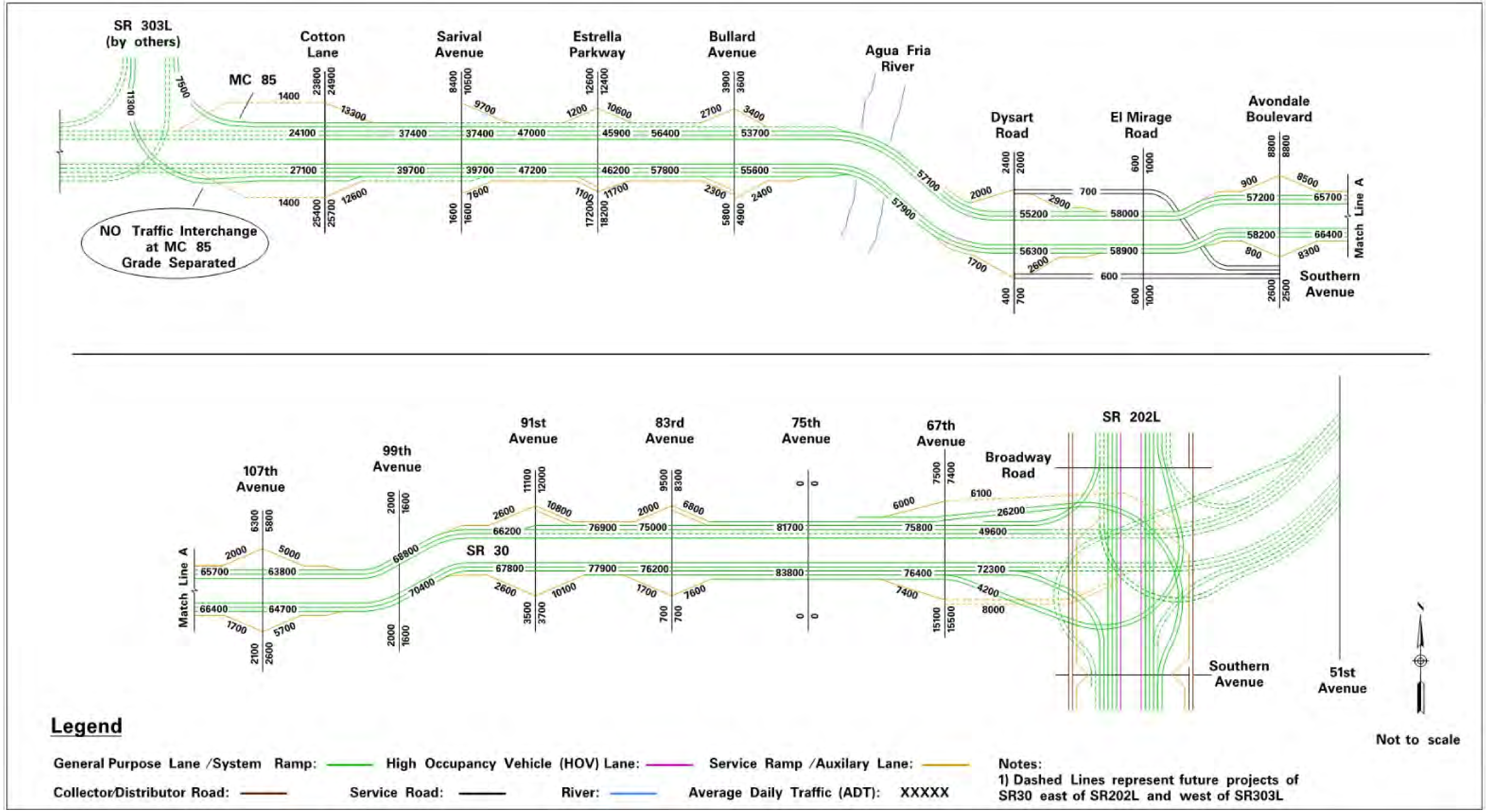


Figure 4.2. SR 30 Recommended Build Alternative AM/PM Peak Hour Traffic (2035)

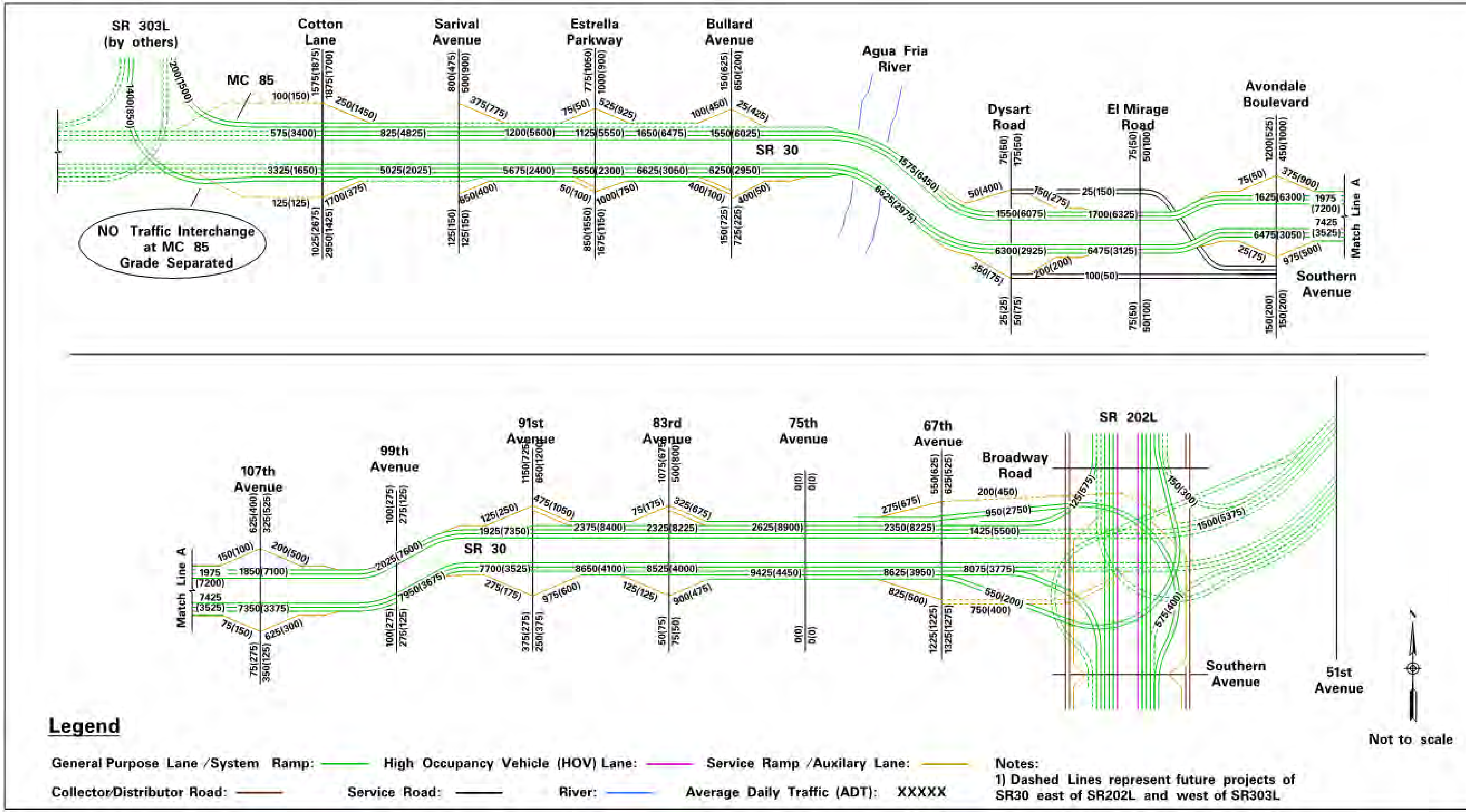


Figure 4.3. SR 30 Recommended Build Alternative AM Peak Hour HCS Level of Service (2035)

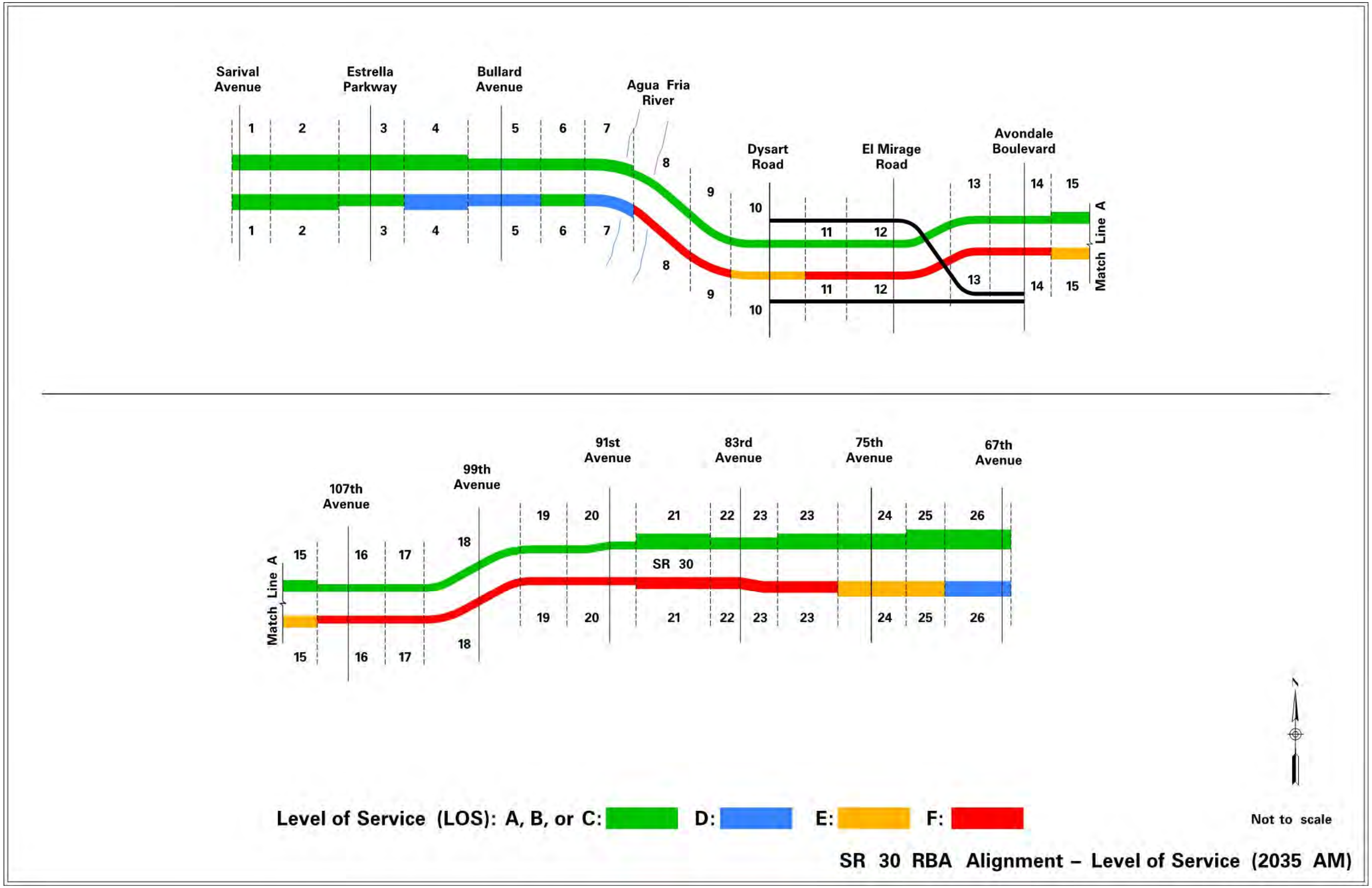


Figure 4.4. SR 30 Recommended Build Alternative PM Peak Hour HCS Level of Service (2035)

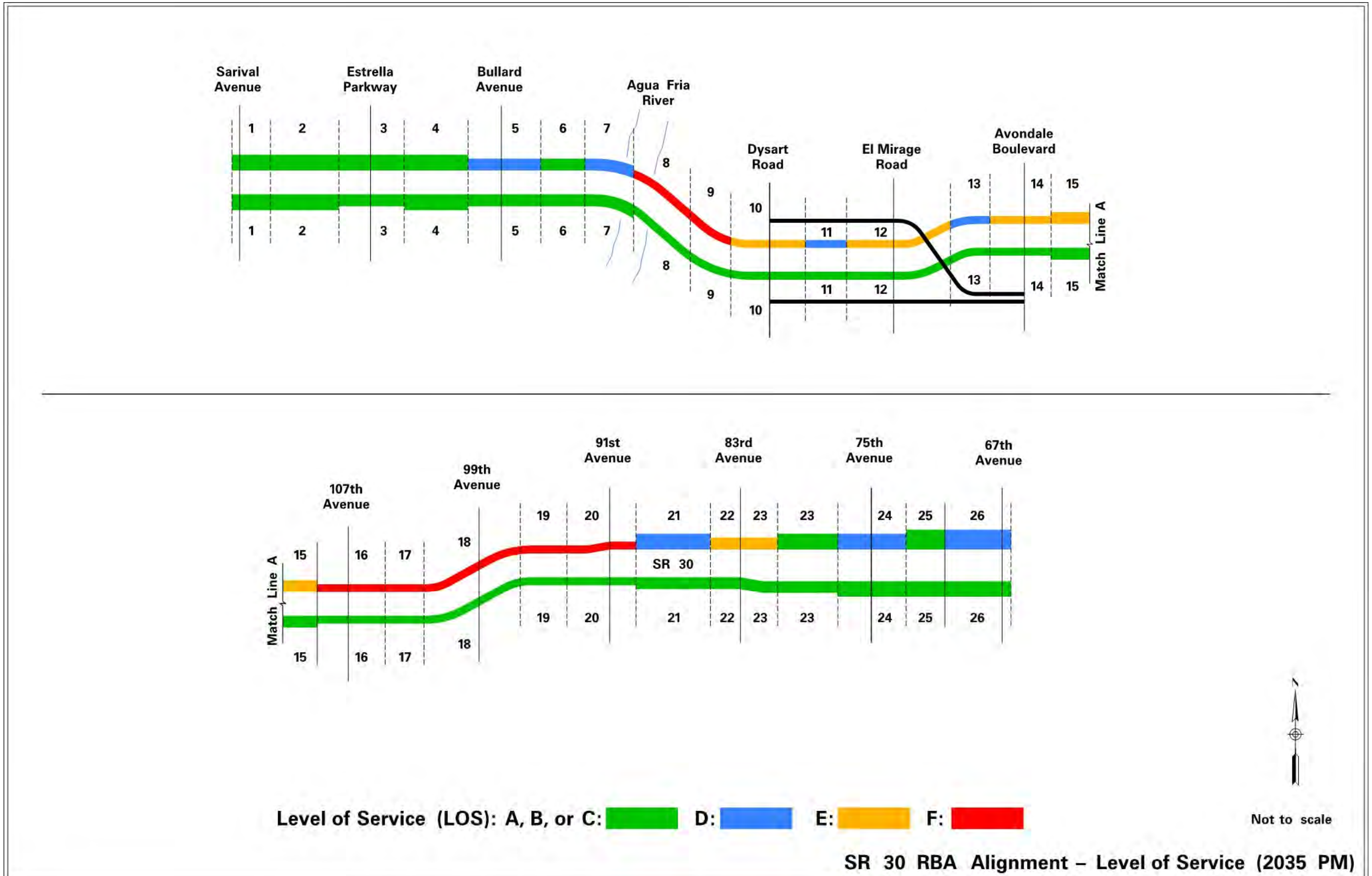


Table 4.1. SR 30 Recommended Build Alternative Main Line HCS Analysis, Eastbound Direction (2035)

Section ID	Section	Freeway Segment Type	Time Period	HCS Level of Service (LOS)	Number of Lanes	Main Line Volume	Weaving Lanes	Peak Hour Volume	On Ramp Volume	Off Ramp Volume	Volume FF	Volume RF	Volume FR	Volume RR	Weave Length
1	Main Line: At Sarival Avenue	Basic	AM	B	5	5,025									
			PM	A		2,025									
2	Between Estrella Parkway and Sarival Avenue	Weave	AM	C	5	5,675	5	5,675	650	50	4,975	650	50	0	2,200
			PM	A		2,400		2,400	400	100	1,900	400	100	0	
3	Main Line: At Estrella Parkway	Basic	AM	C	4	5,650									
			PM	A		2,300									
4	Between Bullard Avenue and Estrella Parkway	Weave	AM	D	5	6,625	5	6,625	1000	400	5,225	1,000	400	0	2,100
			PM	B		3,050		3,050	750	100	2,200	750	100	0	
5	Main Line: At Bullard Avenue	Basic	AM	D	4	6,250									
			PM	B		2,950									
6	On Ramp: Bullard Avenue	Merge	AM	C	4	6,250			400						
			PM	A		2,950			50						
7	Main Line: West of Agua Fria River	Basic	AM	D	4	6,625									
			PM	B		2,975									
8	Main Line: East of Agua Fria River	Basic	AM	F	3	6,625									
			PM	B		2,975									
9	Off Ramp: Dysart Road	Diverge	AM	F	3	6,625				350					
			PM	B		2,975				75					
10	Main Line: At Dysart Road	Basic	AM	E	3	6,300									
			PM	B		2,925									
11	On Ramp: Dysart Road	Merge	AM	F	3	6,300			200						
			PM	B		2,925			200						
12	Main Line: EI Mirage Road	Basic	AM	F	3	6,475									
			PM	B		3,125									
13	Off Ramp: Avondale Boulevard	Diverge	AM	F	3	6,475				25					
			PM	B		3,125				75					
14	Main Line: At Avondale Boulevard	Basic	AM	F	3	6,475									
			PM	B		3,050									
15	Between 107th Avenue and Avondale Boulevard	Weave	AM	E	4	7,425	4	7,425	975	75	6,375	975	75	0	1,620
			PM	B		3,525		3,525	500	150	2,875	500	150	0	
16	Main Line: At 107th Avenue	Basic	AM	F	3	7,350									
			PM	C		3,375									
17	On Ramp: 107th Avenue	Merge	AM	F	3	7,350			625						
			PM	B		3,375			300						
18	Main Line: At 99th Avenue	Basic	AM	F	3	7,950									
			PM	C		3,675									

Section ID	Section	Freeway Segment Type	Time Period	HCS Level of Service (LOS)	Number of Lanes	Main Line Volume	Weaving Lanes	Peak Hour Volume	On Ramp Volume	Off Ramp Volume	Volume FF	Volume RF	Volume FR	Volume RR	Weave Length
19	Off Ramp: 91st Avenue	Diverge	AM	F	3	7,950				275					
			PM	C		3,675				175					
20	Main Line: At 91st Avenue	Basic	AM	F	3	7,700									
			PM	C		3,525									
21	Between 83rd Avenue and 91st Avenue	Weave	AM	F	4	8,650	4	8,650	975	125	7,550	975	125	0	2,055
			PM	B		4,100		4,100	600	125	3,375	600	125	0	
22	Main Line: At 83rd Avenue	Basic	AM	F	4	8,525									
			PM	B		4,000									
23	On Ramp: At 83rd Avenue	Merge	AM	F	4	8,525			900						
			PM	B		4,000			475						
24	Main Line: At 75th Avenue	Basic	AM	E	5	9,425									
			PM	B		4,450									
25	Off Ramp: At 67th Avenue	Diverge	AM	E	5	9,425				825					
			PM	C		4,450				500					
26	Main Line: West of 67th Avenue	Basic	AM	D	5	8,625									
			PM	B		3,950									

Table 4.2. SR 30 Recommended Build Alternative Main Line HCS Analysis, Westbound Direction (2035)

Section ID	Section	Freeway Segment Type	Time Period	HCS Level of Service (LOS)	Number of Lanes	Main Line Volume	Weaving Lanes	Peak Hour Volume	On Ramp Volume	Off Ramp Volume	Volume FF	Volume RF	Volume FR	Volume RR	Weave Length
1	Main Line: At Sarival Avenue	Basic	AM	A	5	825									
			PM	B		4,825									
2	Between Estrella Parkway and Sarival Avenue	Weave	AM	A	5	1,200	5	1,200	75	375	750	75	375	0	2,225
			PM	C		5,600		5,600	50	775	4,775	50	775	0	
3	Main Line: At Estrella Parkway	Basic	AM	A	5	1,125									
			PM	C		5,550									
4	Between Bullard Avenue and Estrella Parkway	Weave	AM	A	5	1,650	5	1,650	100	525	1,025	100	525	0	2,085
			PM	C		6,475		6,475	450	925	5,100	450	925	0	
5	Main Line: At Bullard Avenue	Basic	AM	A	4	1,550									
			PM	D		6,025									
6	Off Ramp: Bullard Avenue	Diverge	AM	A	4	1,575				25					
			PM	C		6,450				425					
7	Main Line: West of Agua Fria River	Basic	AM	A	4	1,575									
			PM	D		6,450									
8	Main Line: East of Agua Fria River	Basic	AM	A	3	1,575									
			PM	F		6,450									
9	On Ramp: Dysart Road	Merge	AM	A	3	1,550			50						
			PM	F		6,075			400						
10	Main Line: At Dysart Road	Basic	AM	A	3	1,550									
			PM	E		6,075									
11	Off Ramp: Dysart Road	Diverge	AM	A	3	1,700				150					
			PM	D		6,325				275					
12	Main Line: EI Mirage Road	Basic	AM	A	3	1,700									
			PM	E		6,325									
13	On Ramp: Avondale Boulevard	Merge	AM	A	3	1,625			75						
			PM	D		6,300			50						
14	Main Line: At Avondale Boulevard	Basic	AM	A	3	1,625									
			PM	E		6,300									
15	Between 107th Avenue and Avondale Boulevard	Weave	AM	A	4	1,975	4	1,975	150	375	1,450	150	375	0	1,675
			PM	E		7,200		7,200	100	900	6,200	100	900	0	
16	Main Line: At 107th Avenue	Basic	AM	A	3	1,850									
			PM	F		7,100									
17	Off Ramp: 107th Avenue	Diverge	AM	B	3	2,025				200					
			PM	F		7,600				500					
18	Main Line: At 99th Avenue	Basic	AM	B	3	2,025									
			PM	F		7,600									

Section ID	Section	Freeway Segment Type	Time Period	HCS Level of Service (LOS)	Number of Lanes	Main Line Volume	Weaving Lanes	Peak Hour Volume	On Ramp Volume	Off Ramp Volume	Volume FF	Volume RF	Volume FR	Volume RR	Weave Length
19	On Ramp: 91st Avenue	Merge	AM	A	3	1,925			125						
			PM	F		7,350			250						
20	Main Line: West of 91st Avenue	Basic	AM	A	3	1,925									
			PM	F		7,350									
21	Between 83rd Avenue and 91st Avenue	Weave	AM	A	5	2,375	5	2,325	75	475	1,775	75	475	0	2,220
			PM	D		8,400		8,400	175	1,050	7,175	175	1,050	0	
22	Main Line: At 83rd Avenue	Basic	AM	A	4	2,325									
			PM	E		8,225									
23	Off Ramp: 83rd Avenue	Major Diverge	AM	A	5	2,625				325					
			PM	B		8,900				675					
24	Main Line: At 75th Avenue	Basic	AM	A	5	2,625									
			PM	D		8,900									
25	On Ramp: At 67th Avenue	Merge	AM	A	6	2,350			275						
			PM	C		8,225			675						
26	Main Line: West of 67th Avenue	Basic	AM	A	6	2,350									
			PM	D		8,225									

4.1.2 SR 30 Recommended Build Alternative in 2040

The 2040 ADT and peak hour forecasts used for the analysis of the SR 30 RBA main line are presented in Figures 4.5 and 4.6, respectively. Notable observations from the figures are:

- Maximum daily traffic of 192,000 vehicles per day is forecast between 67th and 83rd Avenues.
- The system ramps connecting SR 30 and SR 303L have an estimated daily traffic of 74,000 vehicles per day.
- In the AM peak period, 76 percent of the SR 30 traffic using the SR 30 and SR 202L system TI is traveling eastbound while 24 percent is traveling westbound.
- The directional split of PM peak period traffic using the SR 30 and SR 202L system TI is 64 percent westbound and 36 percent eastbound.

The AM and PM peak hour LOS results of the SR 30 RBA main line analysis are presented in Figures 4.7 and 4.8 and Tables 4.3 and 4.4. Detailed HCS reports are provided in Appendix A.

Important observations from the freeway main line analysis are:

Morning (AM) Peak Hour

- Two freeway segments would operate at LOS C or better, and four segments would operate at LOS D.
- Four freeway segments would operate at LOS E, and 16 segments would operate at LOS F. Please refer to Section 3.4 for a discussion of why LOS F is being presented as an acceptable condition, and the planned mitigations in the SR 30 corridor to help improve this condition in years beyond 2040.

Evening (PM) Peak Hour

- In the westbound direction with 2040 PM peak hour traffic conditions, five segments of the SR 30 RBA would operate at LOS C or better. Five segments would operate at LOS D and two segments would operate at LOS E. Fourteen segments are forecast to have LOS F operations. Please refer to Section 3.4 for a discussion of why LOS F is being presented as an acceptable condition, and the planned mitigations in the SR 30 corridor to help improve this condition in years beyond 2040.
- Because HCS provides localized analysis, it should be noted that poor operations at a downstream segment can affect the operations at an upstream segment (resulting from the shockwave effect). These are not addressed with the HCS analysis.

Figure 4.5. SR 30 Recommended Build Alternative Average Daily Traffic (2040)

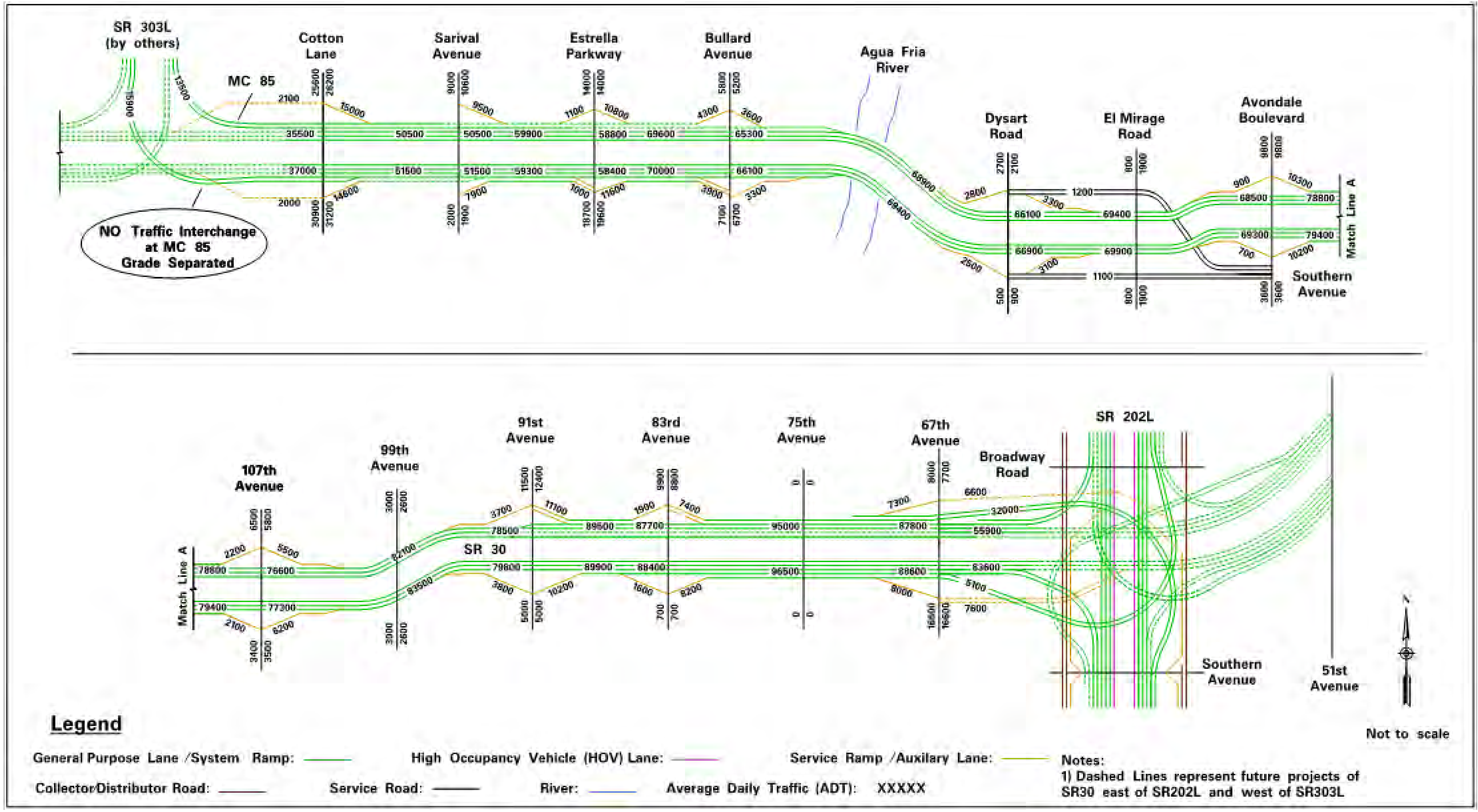


Figure 4.6. SR 30 Recommended Build Alternative AM/PM Peak Hour Traffic (2040)

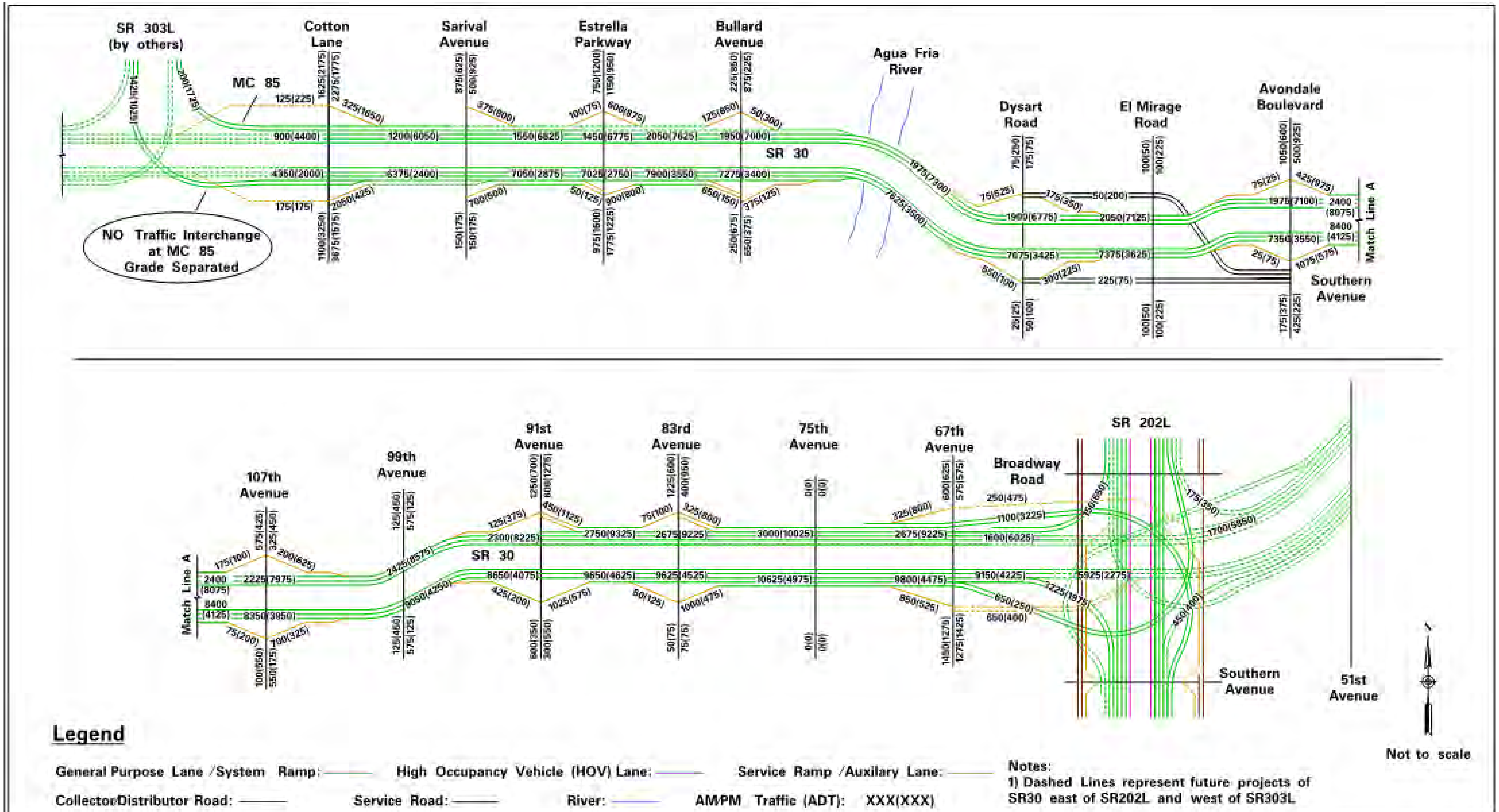


Figure 4.7. SR 30 Recommended Build Alternative AM Peak Hour HCS Level of Service (2040)

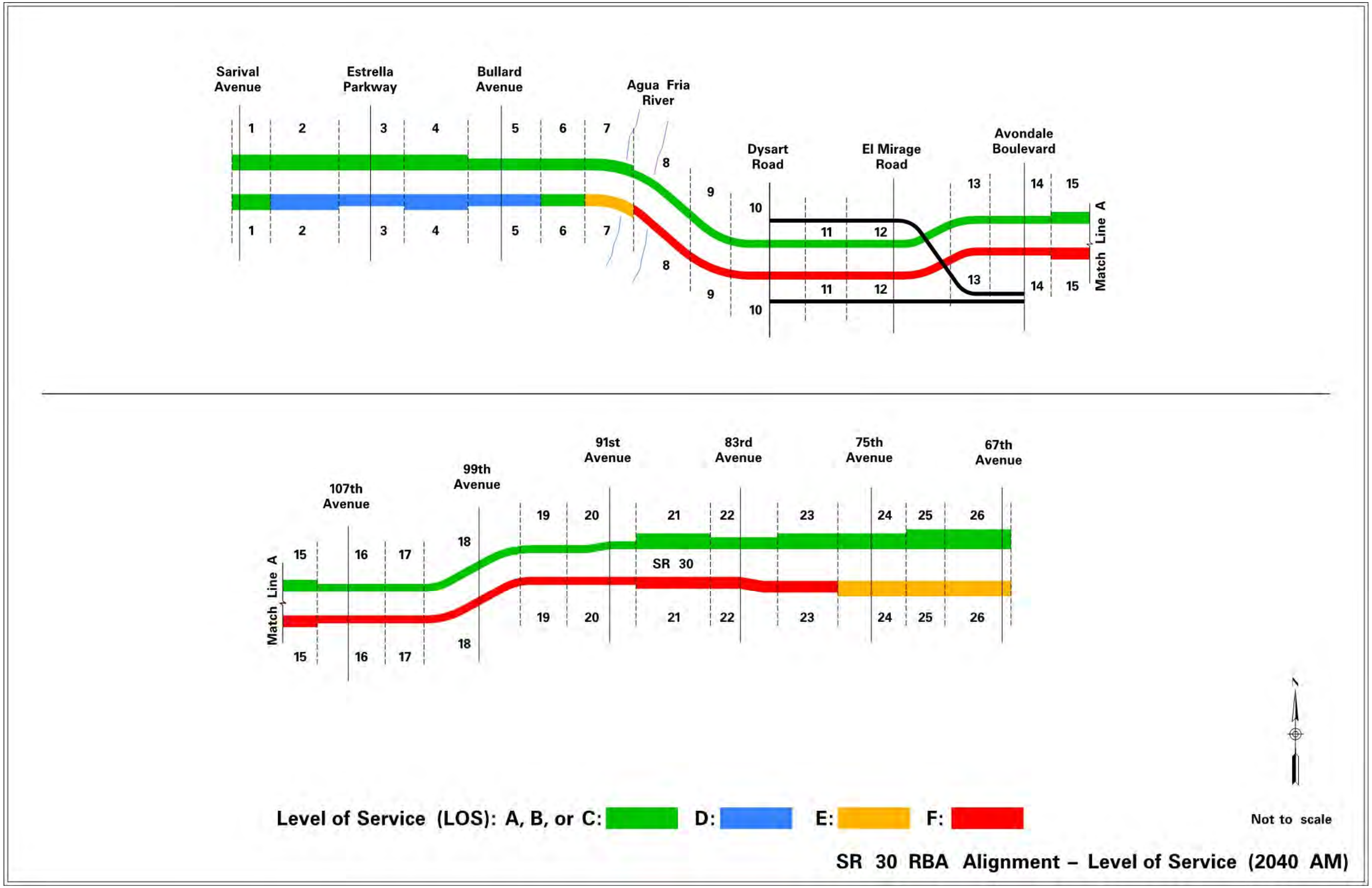


Figure 4.8. SR 30 Recommended Build Alternative PM Peak Hour HCS Level of Service (2040)

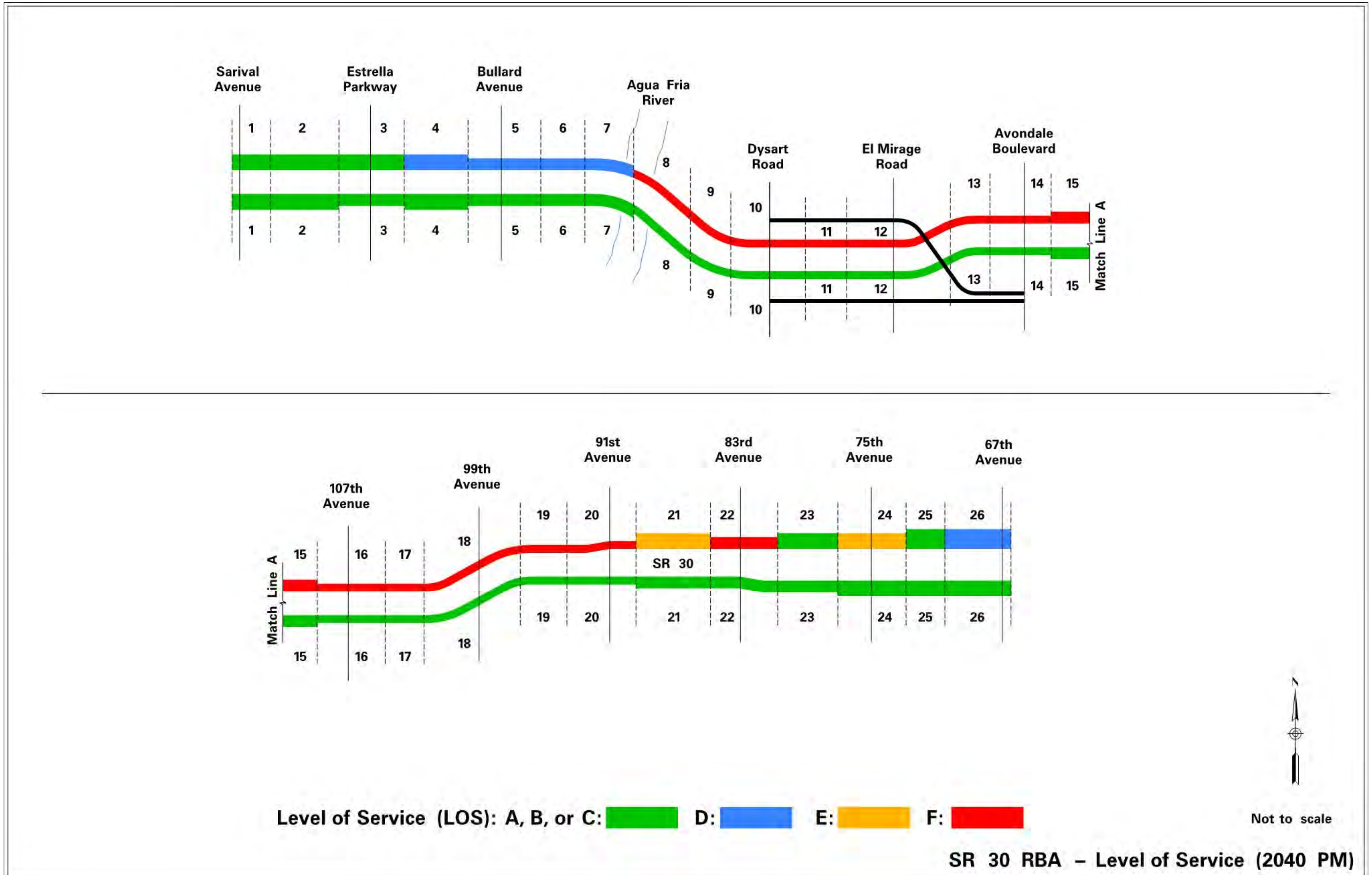


Table 4.3. SR 30 Recommended Build Alternative Main Line Analysis, Eastbound Direction (2040)

Section ID	Section	Freeway Segment Type	Time Period	HCS Level of Service (LOS)	Number of Lanes	Main Line Volume	Weaving Lanes	Peak Hour Volume	On Ramp Volume	Off Ramp Volume	Volume FF	Volume RF	Volume FR	Volume RR	Weave Length
1	Main Line: At Sarival Avenue	Basic	AM	C	5	6,375									
			PM	A		2,400									
2	Between Estrella Parkway and Sarival Avenue	Weave	AM	D	5	7,050	5	7,050	700	50	6,300	700	50	0	2,200
			PM	B		2,875		2,875	500	125	2,250	500	125	0	
3	Main Line: At Estrella Parkway	Basic	AM	D	4	7,025									
			PM	B		2,750									
4	Between Bullard Avenue and Estrella Parkway	Weave	AM	D	5	7,900	5	7,900	900	650	6,350	900	650	0	2,100
			PM	B		3,550		3,550	800	150	2,600	800	150	0	
5	Main Line: At Bullard Avenue	Basic	AM	D	4	7,275									
			PM	B		3,400									
6	On Ramp: Bullard Avenue	Merge	AM	C	4	7,275			375						
			PM	B		3,400			125						
7	Main Line: West of Agua Fria River	Basic	AM	E	4	7,625									
			PM	B		3,500									
8	Main Line: East of Agua Fria River	Basic	AM	F	3	7,625									
			PM	C		3,500									
9	Off Ramp: Dysart Road	Diverge	AM	F	3	7,625				550					
			PM	C		3,500				100					
10	Main Line: At Dysart Road	Basic	AM	F	3	7,075									
			PM	C		3,425									
11	On Ramp: Dysart Road	Merge	AM	F	3	7,075			300						
			PM	B		3,425			220						
12	Main Line: EI Mirage Road	Basic	AM	F	3	7,375									
			PM	C		3,625									
13	Off Ramp: Avondale Boulevard	Diverge	AM	F	3	7,375				25					
			PM	C		3,625				75					
14	Main Line: At Avondale Boulevard	Basic	AM	F	3	7,350									
			PM	C		3,550									
15	Between 107th Avenue and Avondale Boulevard	Weave	AM	F	4	8,400	4	8,400	1075	75	7,250	1,075	75	0	1,620
			PM	C		4,125		4,125	575	200	3,350	575	200	0	
16	Main Line: At 107th Avenue	Basic	AM	F	3	8,350									
			PM	C		3,950									
17	On Ramp: 107th Avenue	Merge	AM	F	3	8,350			700						
			PM	C		3,950			325						
18	Main Line: At 99th Avenue	Basic	AM	F	3	9,050									
			PM	C		4,250									

Section ID	Section	Freeway Segment Type	Time Period	HCS Level of Service (LOS)	Number of Lanes	Main Line Volume	Weaving Lanes	Peak Hour Volume	On Ramp Volume	Off Ramp Volume	Volume FF	Volume RF	Volume FR	Volume RR	Weave Length
19	Off Ramp: 91st Avenue	Diverge	AM	F	3	9,050				425					
			PM	C		4,250				200					
20	Main Line: At 91st Avenue	Basic	AM	F	3	8,650									
			PM	C		4,075									
21	Between 83rd Avenue and 91st Avenue	Weave	AM	F	4	9,650	4	9,650	1025	50	8,575	1,025	50	0	2,055
			PM	C		4,625		4,625	575	125	3,925	575	125	0	
22	Main Line: At 83rd Avenue	Basic	AM	F	4	9,625									
			PM	C		4,525									
23	On Ramp: At 83rd Avenue	Merge	AM	F	4	9,625			1,000						
			PM	B		4,525			475						
24	Main Line: At 75th Avenue	Basic	AM	E	5	10,625									
			PM	B		4,975									
25	Off Ramp: At 67th Avenue	Diverge	AM	E	5	10,625				825					
			PM	C		4,975				525					
26	Main Line: West of 67th Avenue	Basic	AM	E	5	9,800									
			PM	B		4,475									

Table 4.4. SR 30 Recommended Build Alternative Main Line Analysis, Westbound Direction (2040)

Section ID	Section	Freeway Segment Type	Time Period	HCS Level of Service (LOS)	Number of Lanes	Main Line Volume	Weaving Lanes	Peak Hour Volume	On Ramp Volume	Off Ramp Volume	Volume FF	Volume RF	Volume FR	Volume RR	Weave Length
1	Main Line: At Sarival Avenue	Basic	AM	A	5	1,200									
			PM	C		6,050									
2	Between Estrella Parkway and Sarival Avenue	Weave	AM	A	5	1,550	5	1,550	100	375	1,075	100	375	0	2,225
			PM	C		6,825		6,825	75	800	5,950	75	800	0	
3	Main Line: At Estrella Parkway	Basic	AM	A	5	1,450									
			PM	C		6,775									
4	Between Bullard Avenue and Estrella Parkway	Weave	AM	A	5	2,050	5	2,050	125	600	1,325	125	600	0	2,085
			PM	D		7,625		7,625	650	875	6,100	650	875	0	
5	Main Line: At Bullard Avenue	Basic	AM	A	4	1,950									
			PM	D		7,000									
6	Off Ramp: Bullard Avenue	Diverge	AM	A	4	1,975				50					
			PM	D		7,300				300					
7	Main Line: West of Agua Fria River	Basic	AM	A	4	1,975									
			PM	D		7,300									
8	Main Line: East of Agua Fria River	Basic	AM	B	3	1,975									
			PM	F		7,300									
9	On Ramp: Dysart Road	Merge	AM	A	3	1,900			75						
			PM	F		6,775			525						
10	Main Line: At Dysart Road	Basic	AM	A	3	1,900									
			PM	F		6,775									
11	Off Ramp: Dysart Road	Diverge	AM	B	3	2,050				175					
			PM	F		7,125				350					
12	Main Line: EI Mirage Road	Basic	AM	B	3	2,050									
			PM	F		7,125									
13	On Ramp: Avondale Boulevard	Merge	AM	A	3	1,975			75						
			PM	F		7,100			25						
14	Main Line: At Avondale Boulevard	Basic	AM	B	3	1,975									
			PM	F		7,100									
15	Between 107th Avenue and Avondale Boulevard	Weave	AM	B	4	2,400	4	2,400	175	425	1,800	175	425	0	1,675
			PM	F		8,075		8,075	100	975	7,000	100	975	0	
16	Main Line: At 107th Avenue	Basic	AM	B	3	2,225									
			PM	F		7,975									
17	Off Ramp: 107th Avenue	Diverge	AM	B	3	2,425				200					
			PM	F		8,575				625					
18	Main Line: At 99th Avenue	Basic	AM	B	3	2,425									
			PM	F		8,575									

Section ID	Section	Freeway Segment Type	Time Period	HCS Level of Service (LOS)	Number of Lanes	Main Line Volume	Weaving Lanes	Peak Hour Volume	On Ramp Volume	Off Ramp Volume	Volume FF	Volume RF	Volume FR	Volume RR	Weave Length
19	On Ramp: 91st Avenue	Merge	AM	B	3	2,300			125						
			PM	F		8,225			375						
20	Main Line: West of 91st Avenue	Basic	AM	B	3	2,300									
			PM	F		8,225									
21	Between 83rd Avenue and 91st Avenue	Weave	AM	A	5	2,750	5	2,750	75	450	2,225	75	450	0	2,220
			PM	E		9,325		9,325	100	1,125	8,100	100	1,125	0	
22	Main Line: At 83rd Avenue	Basic	AM	B	4	2,675									
			PM	F		9,225									
23	Off Ramp: 83rd Avenue	Major Diverge	AM	A	5	3,000				325					
								PM	B		10,025			800	
24	Main Line: At 75th Avenue						Basic	AM	A	5	3,000				
								PM	E		10,025				
25	On Ramp: At 67th Avenue						Merge	AM	A	6	2,675		325		
								PM	C		9,225		800		
26	Main Line: West of 67th Avenue						Basic	AM	A	6	2,675				
								PM	D		9,225				

Chapter 5. SR 30 Service Traffic Interchange Analysis

5.1 Background

The interchange analyses evaluated and recommended the SR 30 RBA service TI lane configuration, geometry, and type based on the traffic turning movement projections for 2035 and 2040. The Cotton Lane interchange is outside this traffic addendum Study Area and was not analyzed in this update.

The assumptions, approach, and results for all alternatives are discussed in the following sections. The methodology is discussed in detail in Section 2.2.2.

We used the service TI lane configurations and traffic control from the *State Route (SR) 30, SR 303L to SR 202L Final Traffic Report* (April 2013) and optimized the signal timing for the study scenarios.

5.2 Arterial Street Lane Configurations

SR 30 as a corridor would traverse Goodyear (MC 85 to the Agua Fria River), Avondale (Agua Fria River to 107th Avenue), and Phoenix (107th Avenue to the east). The lane configurations for the arterial streets approaching the TIs were based on local and regional transportation planning documents. Table 5.1 summarizes planned lane configurations. The basic number of through lanes on the crossroad was assumed to pass through the interchange.

Table 5.1. 2035 Lane Configurations for Arterial Streets Approaching Service Traffic Interchanges

Road	Local Jurisdiction	Street Classification	Right-of-way Width (in feet)	Number of Through Lanes in Each Direction
Sarival Avenue	Goodyear	Arterial	110	1
Estrella Parkway	Goodyear	Scenic Arterial	150	3
Bullard Avenue	Goodyear	Major Arterial	110	2
Dysart Road	Avondale	Major Arterial	130	3
Avondale Boulevard	Avondale	Major Arterial	130	3
107th Avenue	Avondale	Major Arterial	130	2
91st Avenue	Phoenix	Arterial	130	2
83rd Avenue	Phoenix	Arterial	130	2
67th Avenue	Phoenix	Arterial	130	3

Sources: City of Goodyear *Roadway Classification Map*, 2009; City of Avondale *Transportation Plan*, 2012; City of Phoenix *Street Classification Map*, 2010

The ADOT *Lessons Learned Document on Traffic Volume Projections and Operational Analysis* (2005) states that "the minimum number of turning lanes necessary to achieve an intersection approach and overall interchange LOS of D" should be the basis for ADOT plans. Any additional turn lanes could be added at the request of a local agency, but would require the local agency to share the additional cost with ADOT.

Additional guidance for providing additional turn lanes is found in the *ADOT Roadway Design Guidelines* (2007b). Its recommendations include:

- A right-turn lane should be provided if the right-turn volume is greater than 300 vehicles per hour.
- A left-turn lane should be provided at all appropriate locations, and a second left-turn lane should be provided when the volume is greater than 300 vehicles per hour.

5.3 Signal Timing

Numerous signal timing and phasing designs can be used to coordinate the two signals at a CDI. The Synchro analysis presented in this report assumed a single controller for both TI signals. Phasing and timing were optimized to improve the traffic flow at intersections and progression along the crossroad.

5.4 Service Traffic Interchange Analysis (Synchro Analysis)

Each of the following sections includes a review of each crossroad's characteristics, traffic volumes, Synchro analysis results, and recommendations for lane configurations for each alternative. However, the SR 30 corridor, from SR 303L to SR 202L, is envisioned to be open for the public around 2035, and the arterial lane configurations used in this report may change during this period because cities update their general plans at regular intervals based on new socioeconomic and travel demand forecast data. It is recommended this analysis be reevaluated during the final design phase of the project based on then-available arterial lane configurations from the general plans. Detailed Synchro reports for each TI are provided in Appendix B.

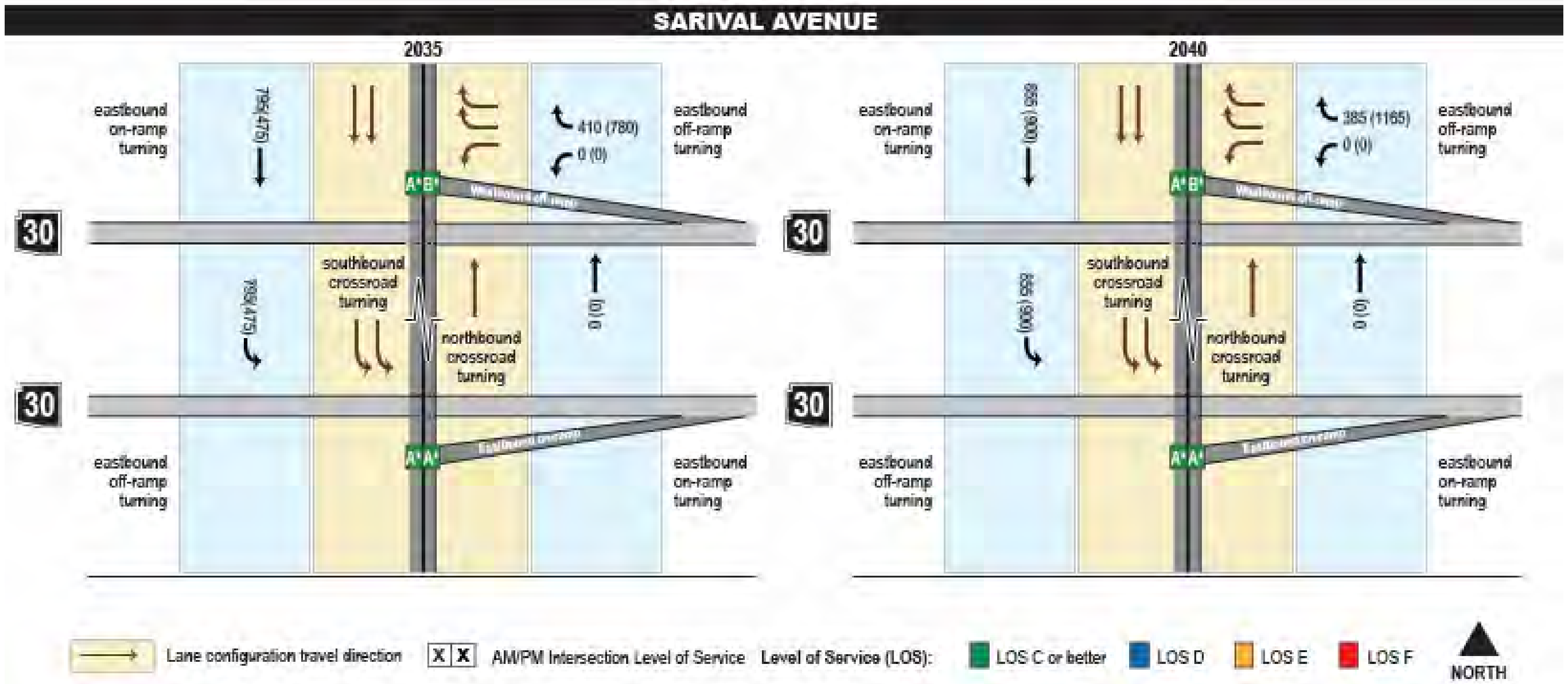
5.4.1 Sarival Avenue

Sarival Avenue is currently a dirt road south of MC 85. A half CDI (eastbound on ramps, westbound off ramps) is proposed between MC 85 and the Buckeye Canal. All four corners contain undeveloped agricultural land. Sarival Avenue would be a two-lane facility with one lane in each direction and would end at the proposed TI with no planned crossing over the Gila River.

The CDI at this location would have unsignalized intersections (STOP control for left turns and YIELD control for right turns). All other movements would be free flow at the TI. This is a dead-end intersection.

The recommended lane configuration and traffic volumes during the peak period are presented in Figure 5.1.

Figure 5.1. Sarival Avenue, Turning Movement Volume, Lane Configuration, and AM and PM Level of Service (2035 and 2040)



5.4.2 Estrella Parkway

Presently, Estrella Parkway is a two-lane arterial street south of Broadway Road that widens to four lanes north of Broadway Road. The TI is proposed south of Broadway Road. Surrounding land use mostly consists of agricultural land and vacant parcels. Most of the land would be converted to residential and commercial purposes around 2035. MC 85 is located just to the north, while the Gila River is located south of this proposed TI. Estrella Parkway will be widened to six lanes by 2035, with three travel lanes in each direction. A CDI with signalized intersections is proposed at this location.

The recommended lane configuration, traffic volumes during the peak period, and LOS results are presented in Figure 5.2. The Synchro analysis results for all the horizons are presented in Table 5.2.

Table 5.2. Estrella Parkway Service Traffic Interchange Analysis Results

SR 30 Study Horizon	Signal	Optimized Cycle Length[a] (seconds)	AM Peak Hour		PM Peak Hour	
			LOS	Delay (seconds/vehicle)	LOS	Delay (seconds/vehicle)
2035	North	65/65	B	12	B	13
	South		B	15	B	13
2040	North	65/70	B	14	B	18
	South		B	16	C	21

[a] AM/PM

5.4.3 Bullard Avenue

Bullard Avenue is a two-lane arterial street in Goodyear. The TI is proposed south of Broadway Road. The northern side of this proposed TI has light industrial land use along Broadway Road. Surrounding land uses mostly consist of agricultural land and vacant parcels. By 2035, most of the agricultural and vacant land would be converted to residential and industrial uses. Bullard Avenue will be a four-lane arterial street with two travel lanes in each direction in 2035. It has an existing bridge crossing over the Gila River. A CDI is proposed at this location with signalized intersections.

The recommended lane configuration, traffic volumes during the peak period, and LOS results are presented in Figure 5.3. The Synchro analysis results for all the horizons are presented in Table 5.3.

Table 5.3. Bullard Avenue Service Traffic Interchange Analysis Results

SR 30 Study Horizon	Signal	Optimized Cycle Length[a] (seconds)	AM Peak Hour		PM Peak Hour	
			LOS	Delay (seconds/vehicle)	LOS	Delay (seconds/vehicle)
2035	North	70/70	B	11	B	17
	South		B	14	C	24
2040	North	70/100	B	17	C	29
	South		B	15	C	24

[a] AM/PM

Figure 5.2. Estrella Parkway, Turning Movement Volume, Lane Configuration, and AM and PM Level of Service (2035 and 2040)

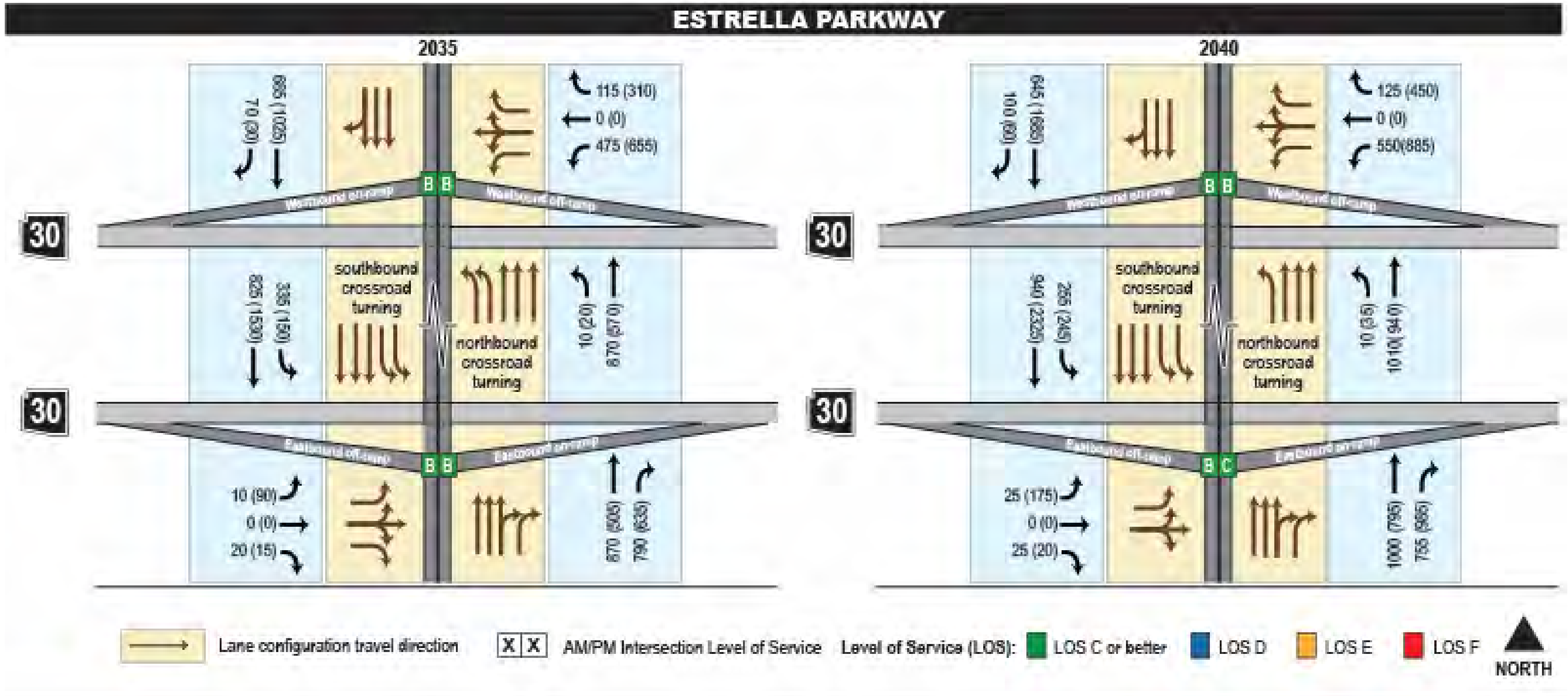
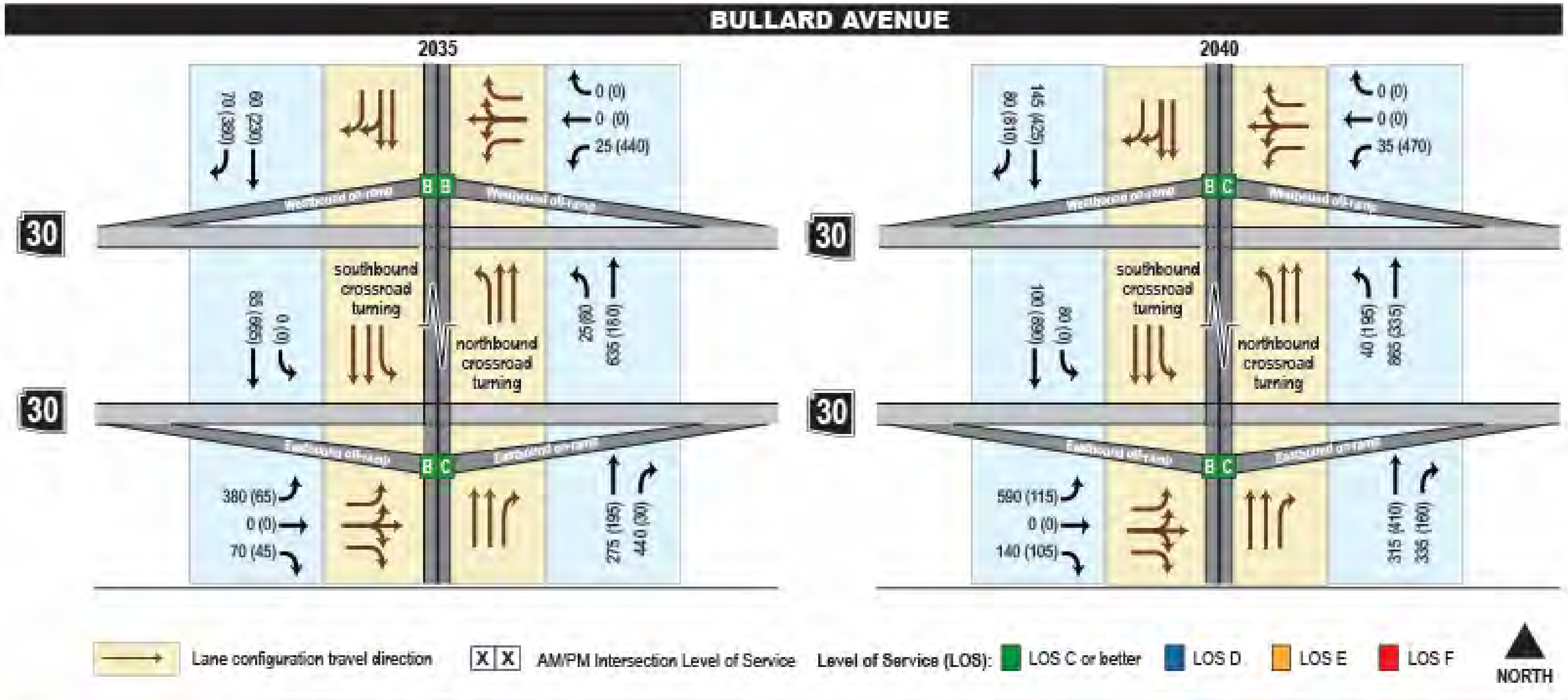


Figure 5.3. Bullard Avenue, Turning Movement Volume, Lane Configuration, and AM and PM Level of Service (2035 and 2040)



5.4.4 Dysart Road

Dysart Road is a two-lane arterial street in Avondale. The TI for the SR 30 RBA is proposed at Southern Avenue, converting Southern Avenue into a pair of one-way frontage roads going east.

The Gila River is located immediately south of the TI. Dysart Road is planned to be a six-lane arterial street, having three lanes in each direction in 2035. Currently, Dysart Road ends at Southern Avenue. In the proposed configuration, Dysart Road would have six lanes across the Gila River (according to the 2006 City of Avondale *Transportation Plan*) by 2035. It would be a significant road in the future because it is the only road that connects to the farthest extents of Avondale. A CDI is proposed at this location with signalized intersections.

The recommended lane configuration, traffic volumes during the peak period, and LOS results are presented in Figure 5.4. The Synchro analysis results for all the horizons are presented in Table 5.4.

Table 5.4. Dysart Road Service Traffic Interchange Analysis Results

SR 30 Study Horizon	Signal	Optimized Cycle Length[a] (seconds)	AM Peak Hour		PM Peak Hour	
			LOS	Delay (seconds/vehicle)	LOS	Delay (seconds/vehicle)
2035	North	70/70	B	14	B	17
	South		C	29	C	26
2040	North	70/90	B	13	C	32
	South		C	24	C	32

[a] AM/PM

5.4.5 Avondale Boulevard (115th Avenue)

Avondale Boulevard (115th Avenue) is currently a four-lane arterial street in Avondale. Surrounding land use mostly consists of residential developments, agricultural land, and vacant parcels. By 2035, most of the agricultural and vacant land would be converted to residential and commercial uses. ISM Raceway (formerly Phoenix International Raceway) is located just south of the proposed TI south of the Gila River over an existing four-lane bridged crossing of the Gila River. By 2035, it will be widened to six lanes, having three travel lanes in each direction. A CDI is proposed at this location with signalized intersections. Because of the special events that occur at ISM that draw large amounts of traffic, additional turn lanes may be considered in later design phases at this TI.

The recommended lane configuration, traffic volumes during the peak period, and LOS results are presented in Figure 5.5. The Synchro analysis results for all the horizons are presented in Table 5.5.

Table 5.5. Avondale Boulevard Service Traffic Interchange Analysis Results

SR 30 Study Horizon	Signal	Optimized Cycle Length[a] (seconds)	AM Peak Hour		PM Peak Hour	
			LOS	Delay (seconds/vehicle)	LOS	Delay (seconds/vehicle)
2035	North	90/90	B	14	B	15
	South		B	18	B	16
2040	North	80/75	B	12	B	17
	South		B	19	B	19

[a] AM/PM

Figure 5.4. Dysart Road, Turning Movement Volume, Lane Configuration, and AM and PM Level of Service (2035 and 2040)

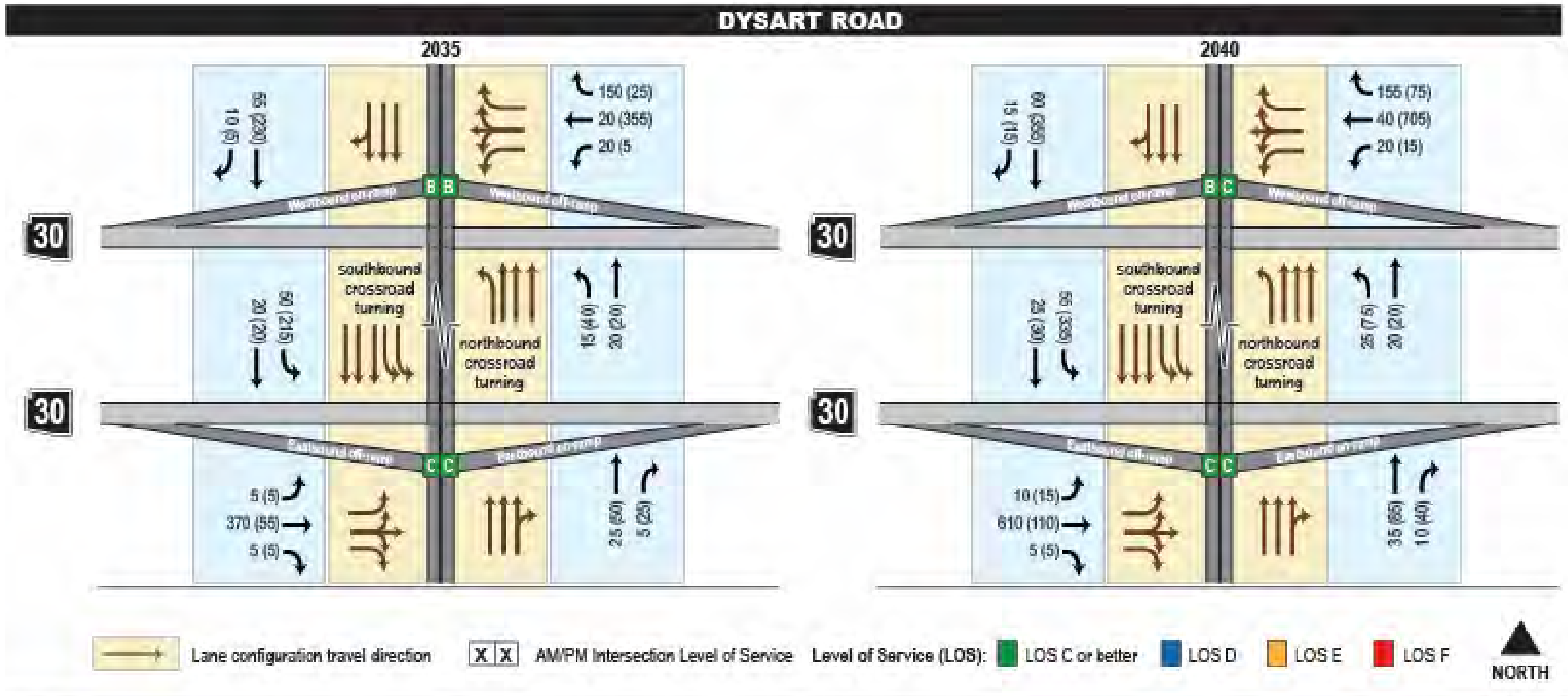
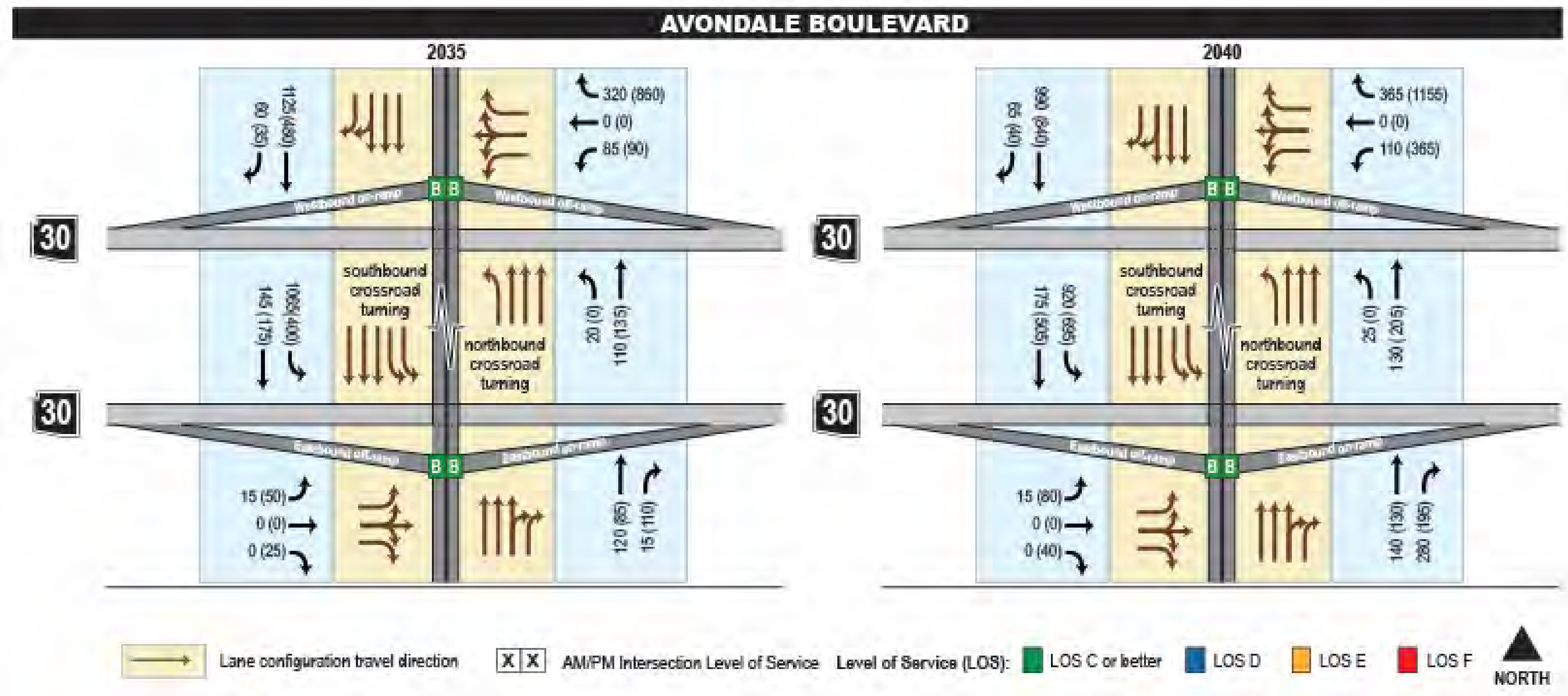


Figure 5.5. Avondale Boulevard, Turning Movement Volume, Lane Configuration, and AM and PM Level of Service (2035 and 2040)



5.4.6 107th Avenue

107th Avenue is currently a two-lane arterial street located at the boundary between Avondale and Phoenix. The surrounding land uses consist of residential, agricultural, and vacant lands. By 2035, most of the agricultural and vacant land would be converted to residential and commercial uses. The Gila River is located south of the proposed TI. 107th Avenue will be widened to four lanes, having two travel lanes in each direction by 2035. A CDI is proposed at this location with signalized intersections.

The recommended lane configuration, traffic volumes during the peak period and LOS results are presented in Figure 5.6. The Synchro analysis results for all the alignment horizons are presented in Table 5.6. 107th Avenue is not planned to cross the Gila River.

Table 5.6. 107th Avenue Service Traffic Interchange Analysis Results

SR 30 Study Horizon	Signal	Optimized Cycle Length[a] (seconds)	AM Peak Hour		PM Peak Hour	
			LOS	Delay (seconds/vehicle)	LOS	Delay (seconds/vehicle)
2035	North	60/60	A	7	B	12
	South		A	6	A	7
2040	North	60/60	A	7	B	13
	South		A	5	B	10

[a] AM/PM

5.4.7 91st Avenue

91st Avenue is currently a two-lane arterial street maintained by the City of Phoenix. Surrounding land uses within the Study Area feature residential developments, a wastewater treatment plant, and agricultural land. Most of the land would be converted from agricultural to residential and commercial use by 2035. A CDI is proposed at this location. 91st Avenue is planned to be widened to four lanes by 2035. This TI will be signalized.

The 2035 and 2040 AM and PM peak hour turning movement volumes, recommended lane configurations, and LOS results are shown in Figure 5.7. The Synchro analysis results for all the horizons are presented in Table 5.7.

Table 5.7. 91st Avenue Service Traffic Interchange Analysis Results

SR 30 Study Horizon	Signal	Optimized Cycle Length[a] (seconds)	AM Peak Hour		PM Peak Hour	
			LOS	Delay (seconds/vehicle)	LOS	Delay (seconds/vehicle)
2035	North	90/90	B	13	C	27
	South		C	21	C	23
2040	North	90/90	B	17	C	22
	South		B	11	B	19

[a] AM/PM

Figure 5.6. 107th Avenue, Turning Movement Volume, Lane Configuration, and AM and PM Level of Service (2035 and 2040)

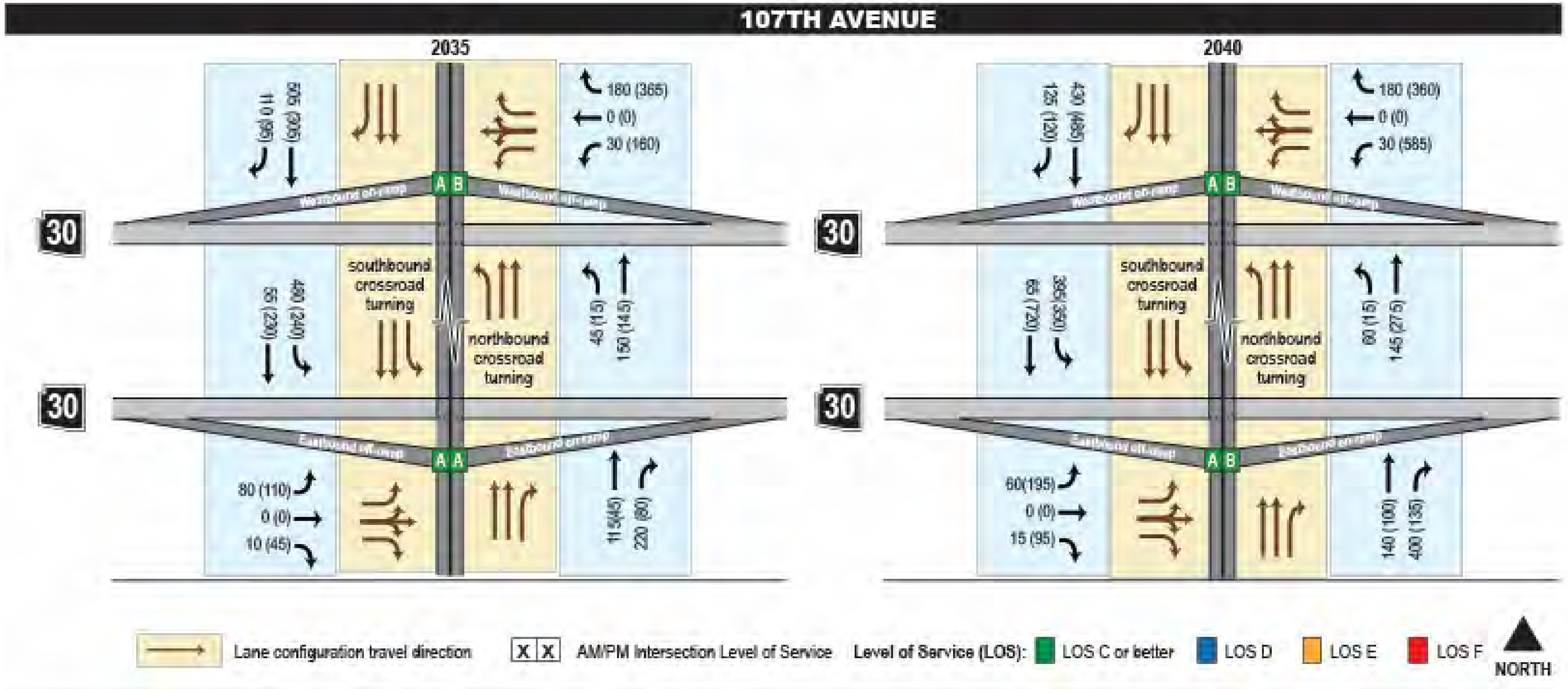
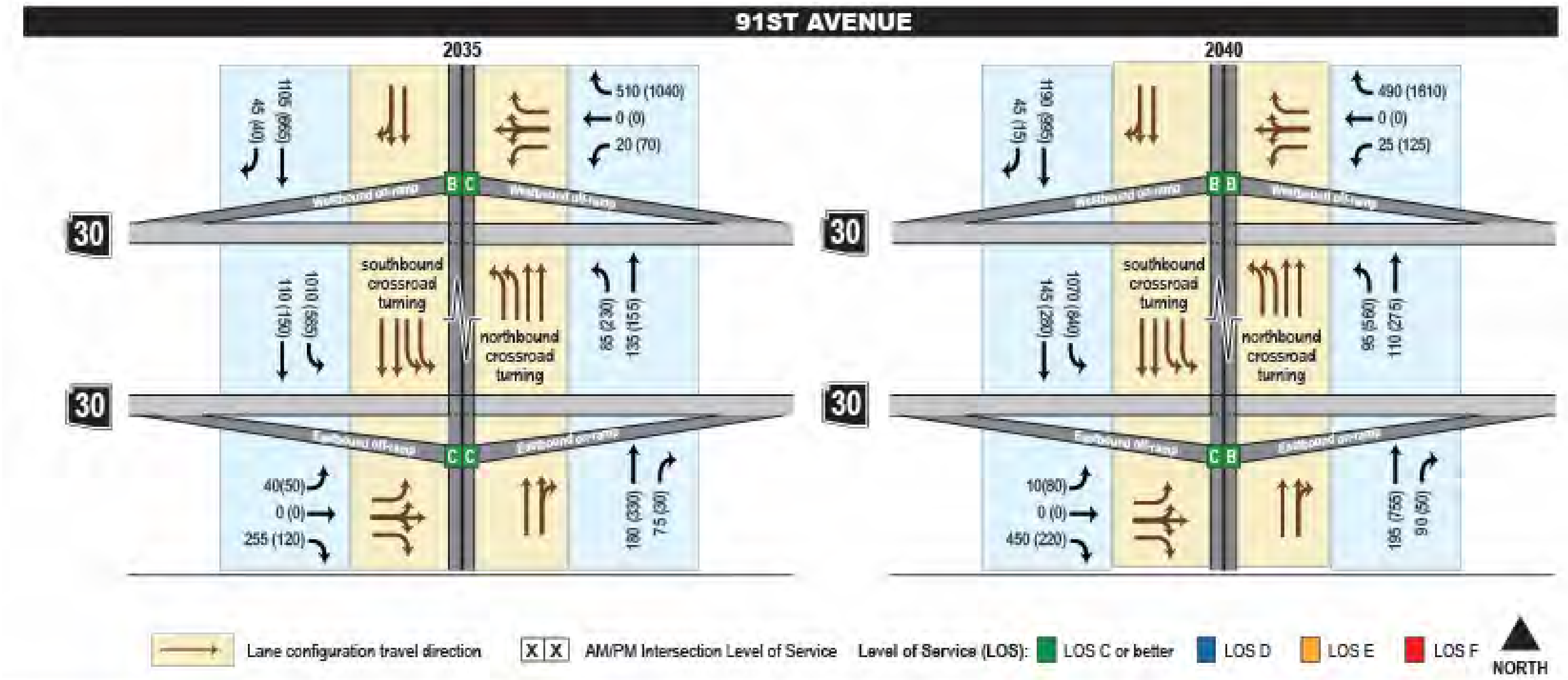


Figure 5.7. 91st Avenue, Turning Movement Volume, Lane Configuration, and AM and PM Level of Service (2035 and 2040)



5.4.8 83rd Avenue

83rd Avenue is currently a two-lane road. Surrounding land uses are mostly agricultural. Most of this land would be converted to residential and commercial use around 2035. A CDI is proposed at this location with traffic signals at the intersections. This roadway is planned to be widened to four lanes by 2035.

The 2035 AM and PM peak hour turning movement volumes, recommended lane configurations, and LOS are shown in Figure 5.8. The Synchro analysis results for both horizons are presented in Table 5.8.

Table 5.8. 83rd Avenue Service Traffic Interchange Analysis Results

SR 30 Study Horizon	Signal	Optimized Cycle Length[a] (seconds)	AM Peak Hour		PM Peak Hour	
			LOS	Delay (seconds/vehicle)	LOS	Delay (seconds/vehicle)
2035	North	90/90	B	17	C	22
	South		B	16	B	19
2040	North	90/90	B	17	C	26
	South		B	15	B	20

[a] AM/PM

5.4.9 67th Avenue

The 67th Avenue TI would be located at the eastern end of the proposed SR 30 freeway. Today, the surrounding area is primarily residential, with some scattered agricultural and vacant properties. Most of this agricultural and vacant land would convert to residential and commercial uses around 2035. 67th Avenue is currently a two-lane arterial street in Phoenix. By 2035, 67th Avenue is planned to be widened to six lanes, with three lanes in each travel direction. A half CDI (westbound on ramp, eastbound off ramp) is proposed at this location with signalized intersections. It is envisioned that this will become a full diamond TI when SR 30 is extended east of SR 202L. Provisions are proposed in the 67th Avenue typical section to accommodate this change.

The 2035 AM and PM peak hour turning movement volumes and the proposed lane configurations used in the LOS analysis are presented in the Figure 5.9. The Synchro analysis results for both horizons are presented in Table 5.9.

Table 5.9. 67th Avenue Service Traffic Interchange Analysis Results

SR 30 Study Horizon	Signal	Optimized Cycle Length[a] (seconds)	AM Peak Hour		PM Peak Hour	
			LOS	Delay (seconds/vehicle)	LOS	Delay (seconds/vehicle)
2035	North	70/70	B	16	C	27
	South		B	18	B	10
2040	North	70/100	B	14	C	34
	South		B	13	C	29

[a] AM/PM

Figure 5.8. 83rd Avenue, Turning Movement Volume, Lane Configuration, and AM and PM Level of Service (2035 and 2040)

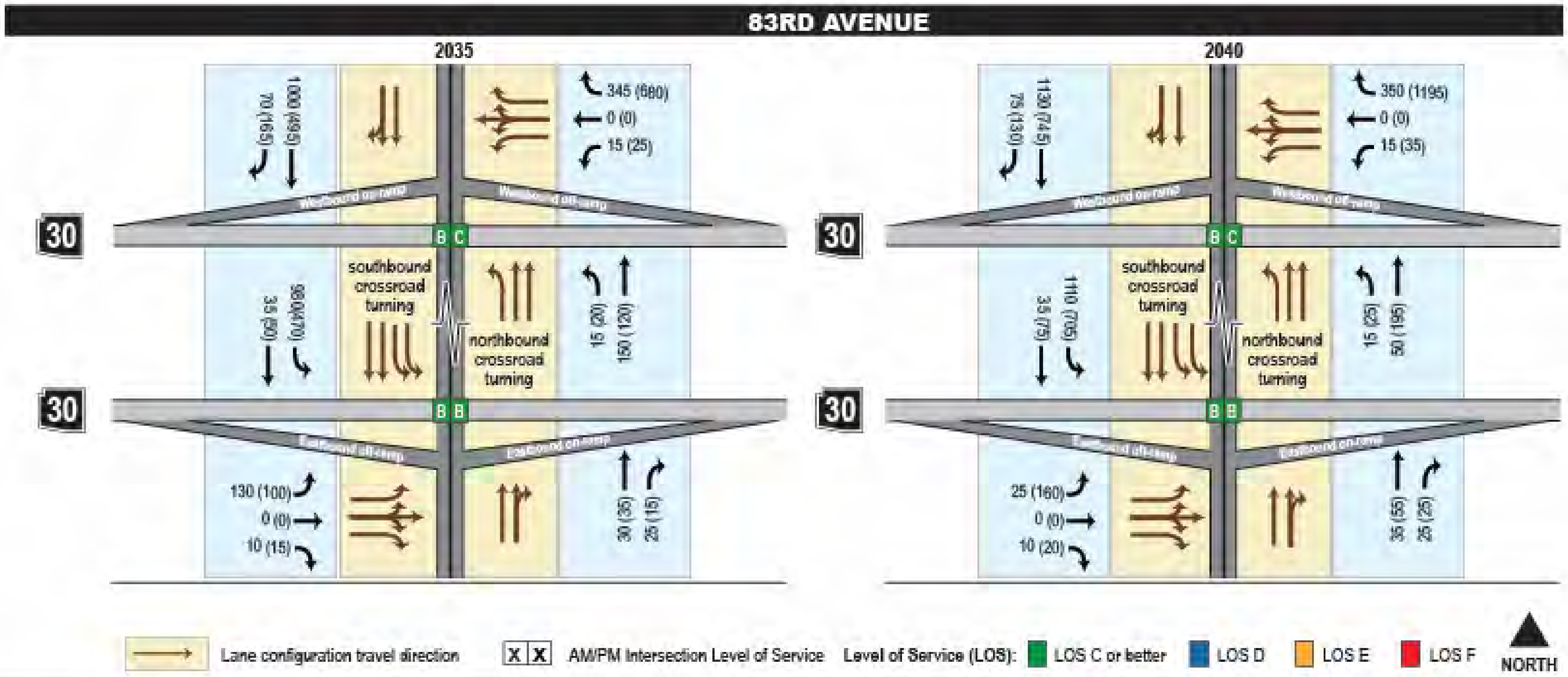
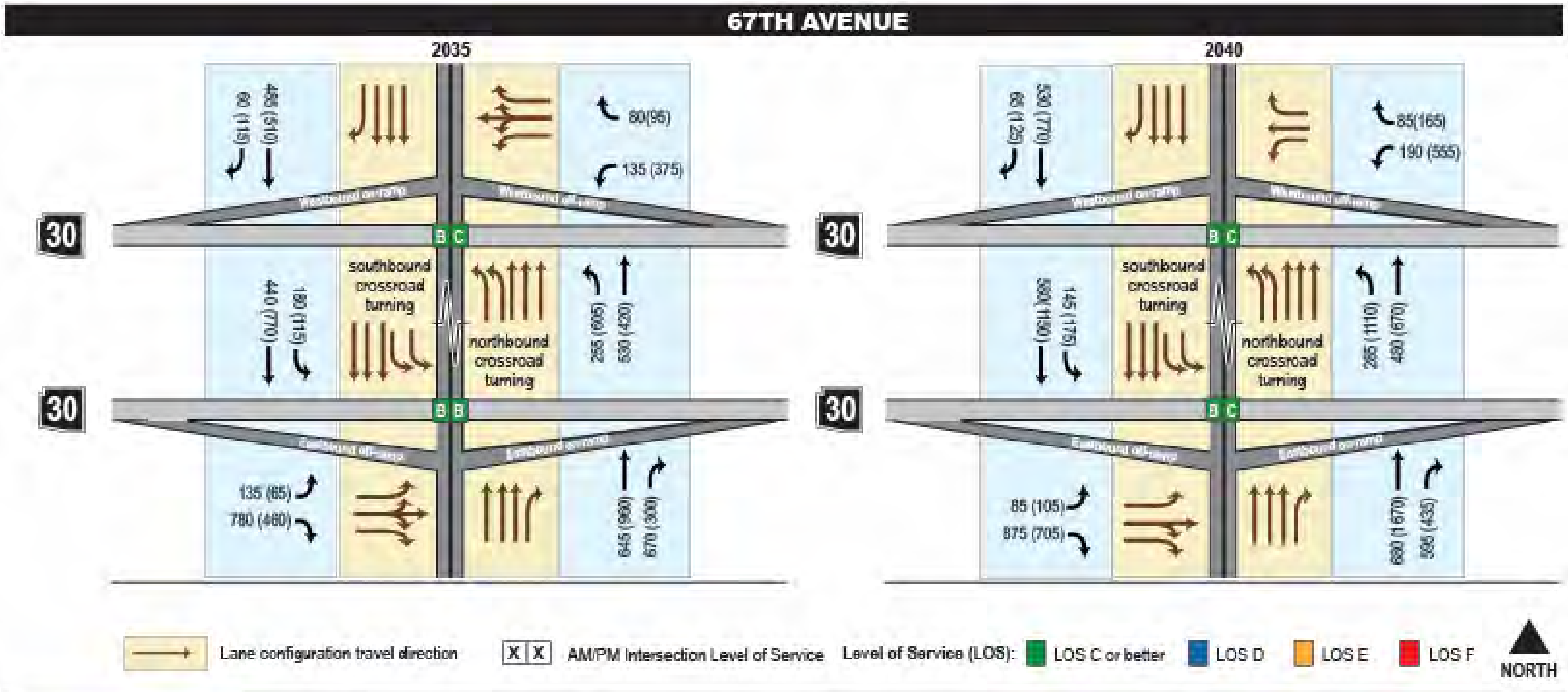


Figure 5.9. 67th Avenue, Turning Movement Volume, Lane Configuration, and AM and PM Level of Service (2035 and 2040)



5.4.10 Turning Movement Storage Length

This analysis used the minimum storage lengths proposed *State Route (SR) 30, SR 303L to SR 202L Final Traffic Report* (April 2013) for the crossroad and ramp turning lanes. These proposed minimum storage lengths are presented in Table 5.10.

Table 5.10. Turn Lane Minimum Storage Lengths (feet)

Turn Lane	Sarival Avenue	Estrella Parkway	Bullard Avenue	Dysart Road	El Mirage Road	Avondale Boulevard	107th Avenue	91st Avenue	83rd Avenue	67th Avenue
North Intersection										
Eastbound left	300	300	300	300	300	300	300	300	300	300
Eastbound right	250	250	250	250	250	250	250	250	250	250
Westbound left	**350**	300	300	300	300	**350**	**350**	**350**	**350**	300
Westbound right	250	**350**	**350**	250	250	**350**	250	**350**	250	250
Northbound left	300	300	**450**	300	300	300	**450**	300	300	300
Northbound right	250	250	250	250	250	250	250	250	250	250
Southbound left	300	300	300	300	300	300	300	300	300	300
Southbound right	250	250	250	250	250	250	250	250	250	250
South Intersection										
Eastbound left	300	**350**	300	300	300	300	300	**350**	**350**	**350**
Eastbound right	250	**350**	**350**	250	250	**350**	**350**	**350**	250	250
Westbound left	300	300	300	300	300	300	300	300	300	300
Westbound right	250	250	250	250	250	250	250	250	250	250
Northbound left	300	300	300	300	300	300	300	300	300	300
Northbound right	250	250	250	250	250	250	250	250	250	250
Southbound left	300	300	300	300	300	300	300	300	300	300
Southbound right	250	250	250	250	250	250	250	250	250	250

Note: Minimum 250 and 350-feet storage length for right and left turns, respectively. The locations where more than minimum storage is required is in red text.

Chapter 6. SR 30 and SR 202L System Traffic Interchange Analysis

6.1 Background

This section discusses the traffic operational analysis at the SR 30/SR 202L system TI conducted using the VISSIM micro simulation analysis tool. VISSIM was used to evaluate traffic operations on the freeway main line and ramps of SR 30, SR 202L, and I-10.

The operational analysis of the system TI at SR 30 and SR 202L required a comprehensive study of the network because of its unique configuration, which included TI ramps for the adjacent arterial street network and the nearby I-10 and SR 202L system TI. VISSIM micro simulation software version 9.00-11, developed by PTV, was used to analyze the traffic operations in the opening year 2035 and future year 2040 for the RBA system TI, as described in Section 1.3.2.

6.2 Interchange Operational Influence Area

The Study Area for the evaluation of the traffic operations at the SR 30/SR 202L system TI extended from the SR 202L/Elliot Road TI on the south to the I-10/SR 202L system TI on the north. The area also included the I-10 main line from 75th Avenue to 43rd Avenue and the proposed SR 30 freeway segment from east of SR 202L to the 91st Avenue service TI in the west. Figure 6.1 shows the study area modeled in VISSIM to evaluate the traffic operational performance of the SR 30/SR 202L system TI. The RBA for the proposed SR 30 freeway was used for the analysis.

6.3 VISSIM Model Development

The VISSIM model developed for the study consisted of four basic components: (1) roadway network (links and connectors), (2) volume data, (3) vehicle routes, and (4) model parameters. The following sections describe in detail the development of each of these components.

6.3.1 Roadway Network (Geometrics)

The roadway geometry for the SR 30 and SR 202L system TI was coded based on the RBA. These included the horizontal curvature and lane configurations for main line and ramps, excluding the HOV direct connector ramps. The roadway network for the SR 202L/I-10 system TI were coded based on the South Mountain Freeway alignment.

Figure 6.1. SR 30/SR 202L System Traffic Interchange – VISSIM Model Study Area Network

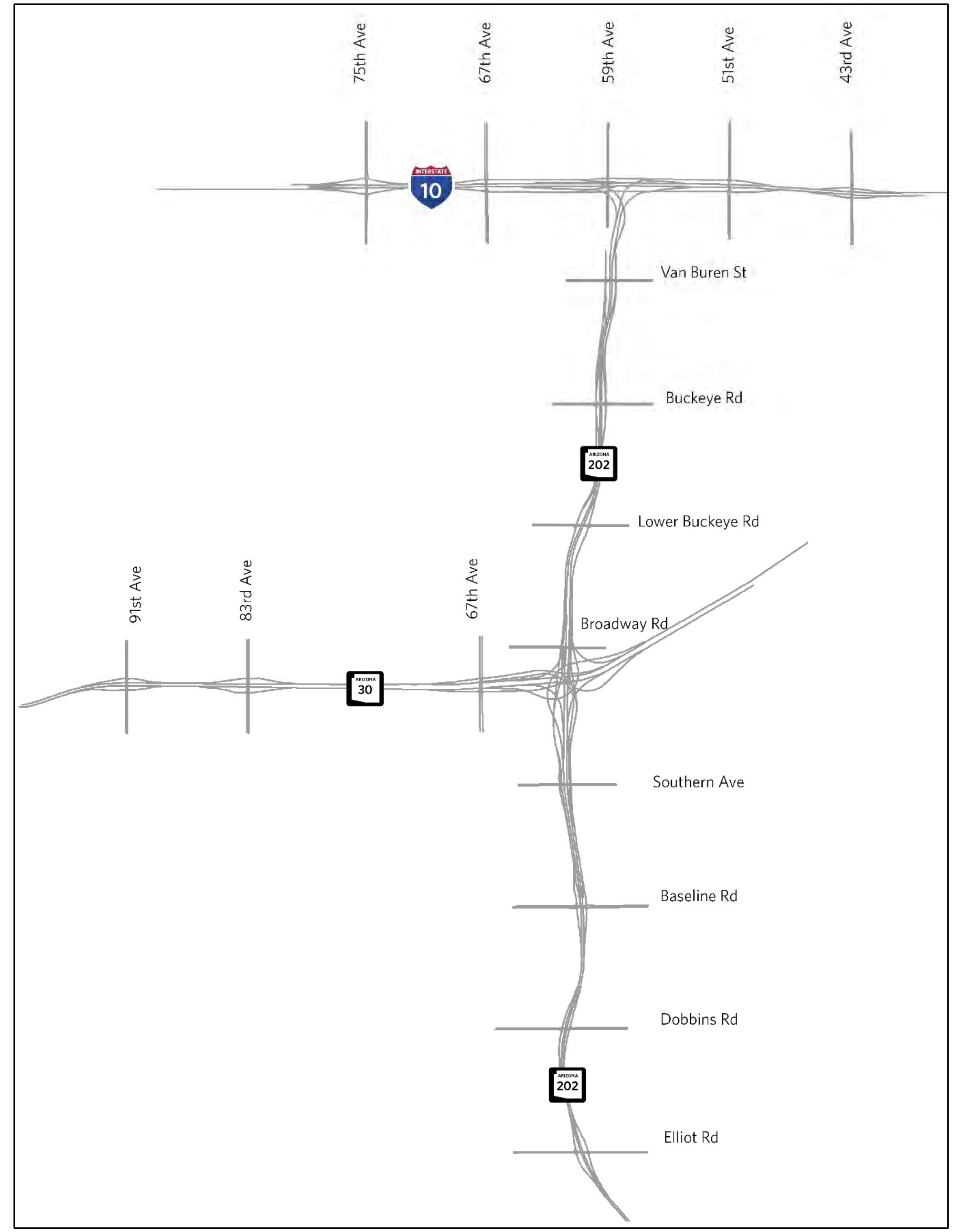
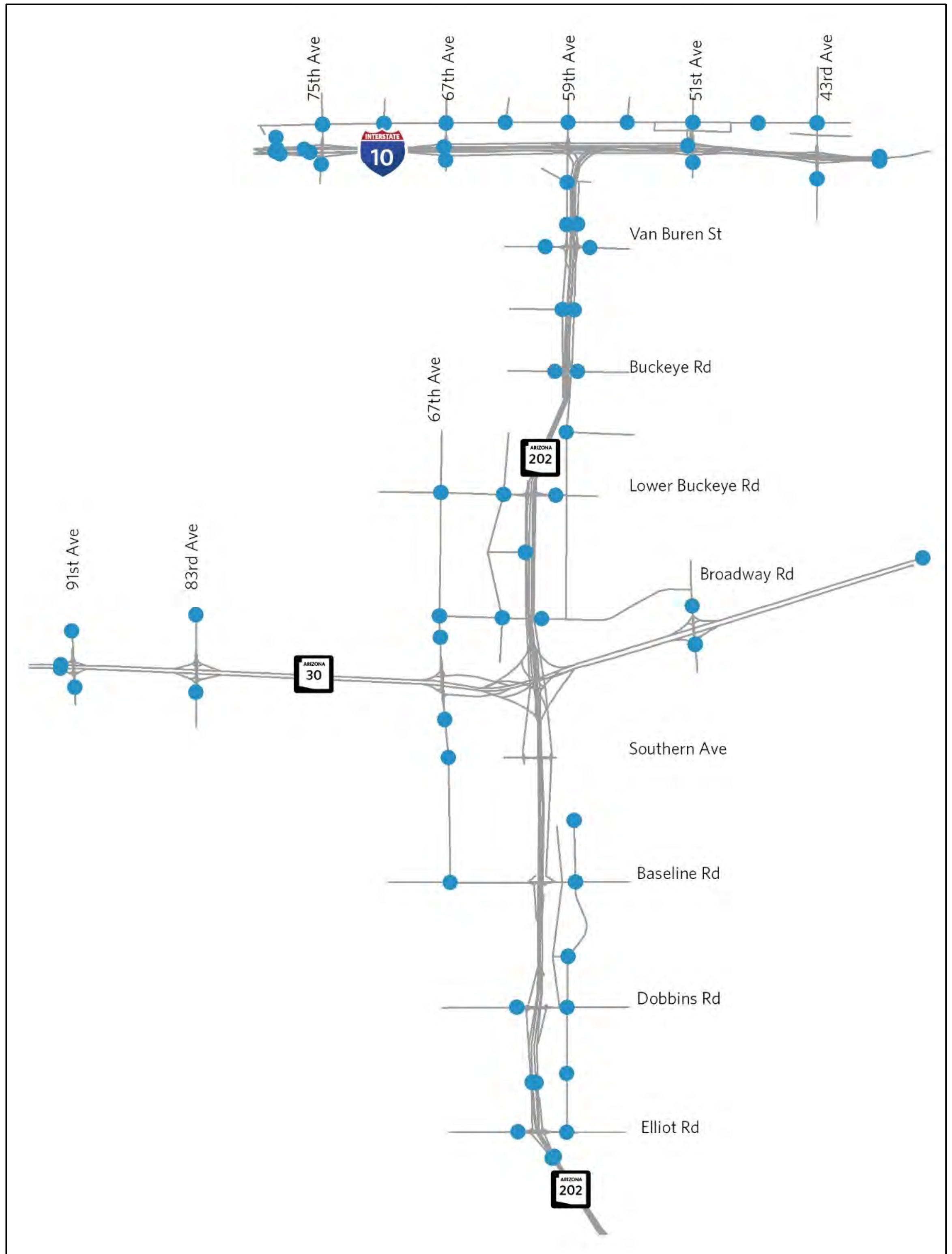


Figure 6.2. MAG Sub Area Network and Origin-Destination Nodes



6.3.2 Traffic Data

MAG provided 2035 and 2040 traffic volume projections for the entire Study Area network. These traffic projections included daily 3-hour AM and 4-hour PM peak period volumes. The peak period volumes were subdivided into hourly volumes using conversion factors provided by MAG. The 3-hour AM peak period volumes were subdivided into individual peak hourly volumes in the proportions of 0.31, 0.35, and 0.34 for hour 1, hour 2, and hour 3, respectively. The 4-hour PM peak period volumes were subdivided into three individual peak hourly volumes in the proportions of 0.24, 0.25, and 0.26 for hour 1, hour 2, and hour 3, respectively. These three peak hours of the corresponding peak period (AM or PM) were modeled in VISSIM for analysis along with a 0.5-hour seeding interval, which is estimated as 80 percent of the hour 1 volume. The seeding period was used to fill the network with traffic prior to the start of the data collection period.

MAG also provided the Study Team with origin-destination (OD) matrices for AM and PM peak hour peak volumes for a sub area network that was extracted from the 2035 MAG travel demand model network. The sub area network reflected the Study Area network that was developed in VISSIM. Figure 6.2 shows the external OD nodes and the sub area travel demand model network.

6.3.3 Vehicle Routes

Traffic patterns in VISSIM were modeled using static routes and routing decisions. Vehicle routing through the Study Area was achieved through the development of OD matrices. The OD matrices were developed using the MAG OD data and VISUM's OD matrix estimation feature, TFlowFuzzy.[1] The OD matrices were developed based on the peak hour volumes and applied throughout the peak period. The same traffic patterns were assumed for both cars and trucks, resulting in routing decisions that were applied to all vehicle types.

6.3.4 Model Parameters

The traffic flow model used by VISSIM is a discreet, stochastic, time step-based microscopic model, with driver and vehicle units as single entities. The model contains a psycho-physical car following model for longitudinal vehicle movement and a rule-based algorithm for lateral movements (lane changing). Various driving, vehicle, and lane changing behavior parameters are used to emulate this traffic flow model.

Because this is a future planned freeway network, the model was not calibrated to any existing conditions. The VISSIM model was developed using driver behavior parameters for basic freeway, merge/diverge, and weaving segments. Driver behavior parameters were based on the default values from VISSIM and were adjusted using engineering judgment and acceptable ranges for freeway car following and lane changing parameters. Speed distributions and vehicle compositions were adopted from the South Mountain Freeway VISSIM models.

[1] TFlowFuzzy is a matrix estimation method in VISUM used to adjust an OD matrix so that the result of the assignment more closely matches the volumes in the network.

6.4 Measures of Effectiveness

Operational performance is expressed in terms of measures of effectiveness, which include average vehicle speed, delay, miles of travel, travel time, and vehicle density. While the VISSIM model provides a variety of measures of effectiveness, only LOS for freeway segments based on vehicle density were used for this study.

6.4.1 Freeway Level of Service

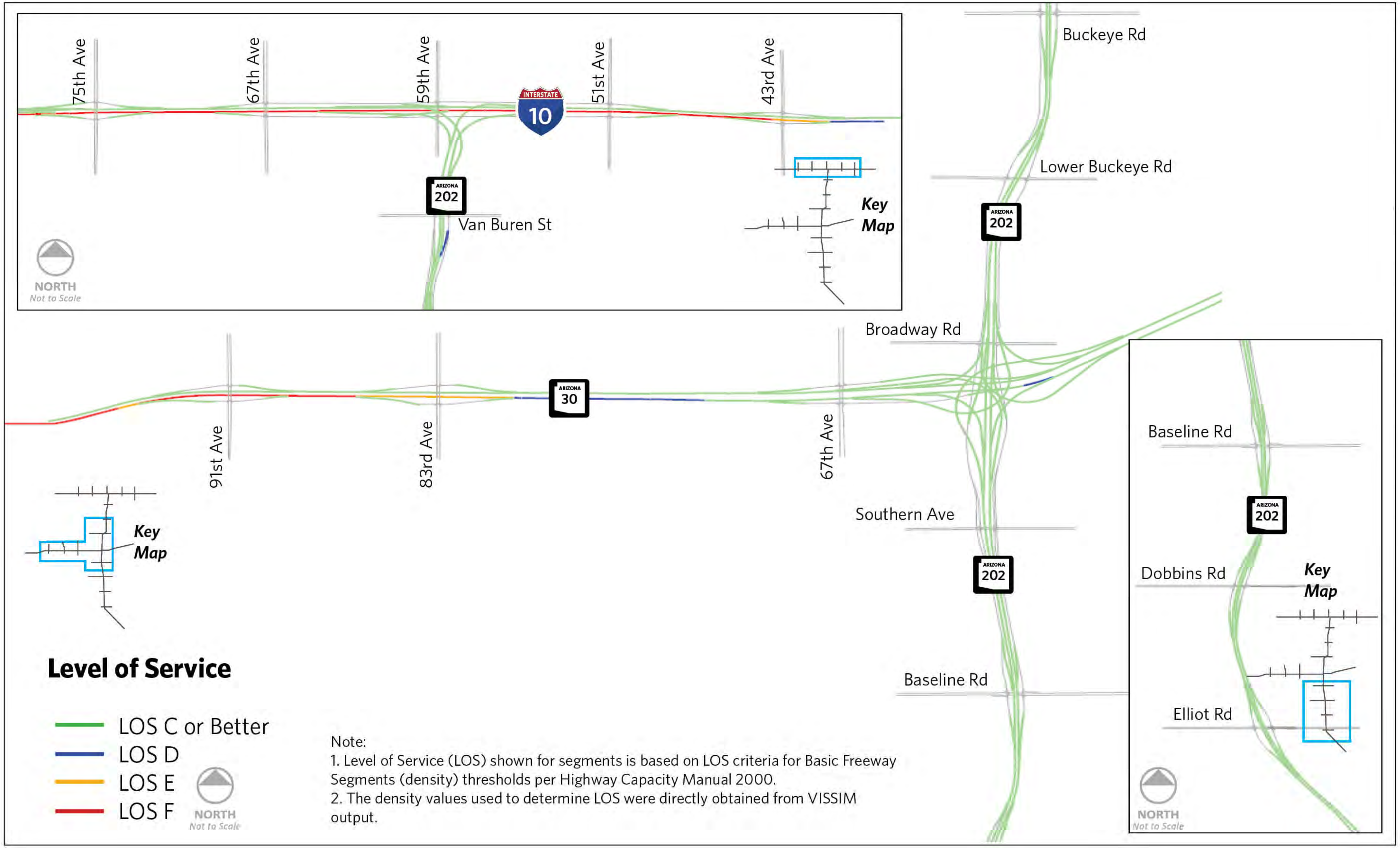
For freeways, VISSIM reports densities (and speeds) on a per-link basis, and does not typically distinguish between "main line," "ramp junction," and "weave section" (as HCM does) in calculating measures of effectiveness. VISSIM segmentation is typically based on the characteristics of the link (speed, number of lanes) or locations where interruptions/changes occur (ramp junction, lane drop, etc.). For this study, density was extracted for each segment in the VISSIM model, and the HCM freeway main line density-LOS correlation was used to evaluate all segments. The LOS letter designation derived using VISSIM-reported densities is approximate, since the densities from VISSIM are not reported in terms of passenger car per mile per lane, but are rather reported as number of vehicles per mile per lane. Table 2.1 shows the LOS by density for freeway segments.

6.5 VISSIM Analysis Results

Micro simulation analysis results for the RBA during the AM and PM peak periods are presented in Figures 6.3 through 6.14. To account for inherent variability in traffic flow and operations, 10 simulation runs were performed for each model scenario and the average results were reported. Notable observations from the micro simulation analysis include:

- The overall projected operations on SR 30 and SR 202L near the SR 30/SR 202L system TI are acceptable, with LOS D or better for both the opening year 2035 and future year 2040 AM peak periods. SR 30 eastbound west of 83rd Avenue, however, is operating at LOS F. The over-capacity conditions west of 83rd Avenue create a bottleneck that reduces the volume of traffic able to reach SR 202L.
- The overall projected operations on SR 30 and SR 202L near the SR 30/SR 202L system TI are failing, with LOS F for both the opening year 2035 and future year 2040 PM peak periods. Westbound SR 30 breaks down between the SR 202L system TI and 83rd Avenue, causing congestion and queue spillback that extends to the east and south of the system TI. By the second hour of the simulation, northbound SR 202L is operating at LOS F from SR 30 to south of Elliot Road. This congestion is the result of over-capacity conditions west of 83rd Avenue.
- Congested conditions are observed on I-10 in the eastbound direction in the AM peak period, with LOS F for both the opening year 2035 and future year 2040 scenarios. I-10 eastbound is operating at LOS E or better west of the system TI during the PM peak period, but congestion on northbound SR 202L in the PM peak period creates a bottleneck that reduces the volume of traffic able to reach I-10.
- In general, the operational performance near the SR 30/SR 202L system TI is better in the AM peak period than in the PM peak period, but the over-capacity conditions on eastbound SR 30 west of 83rd Avenue in the AM peak period limit the amount of traffic that is able to reach the system TI.
- Please refer to Section 3.4 for a discussion of why LOS F is being presented as an acceptable condition, and the planned mitigations in the SR 30 corridor to help improve this condition in years beyond 2040.

Figure 6.3. SR 30/SR 202L System Traffic Interchange, 2035 AM Peak Hour 1 Level of Service



Note:
1. Level of Service (LOS) shown for segments is based on LOS criteria for Basic Freeway Segments (density) thresholds per Highway Capacity Manual 2000.
2. The density values used to determine LOS were directly obtained from VISSIM output.

Figure 6.4. SR 30/SR 202L System Traffic Interchange, 2035 AM Peak Hour 2 Level of Service

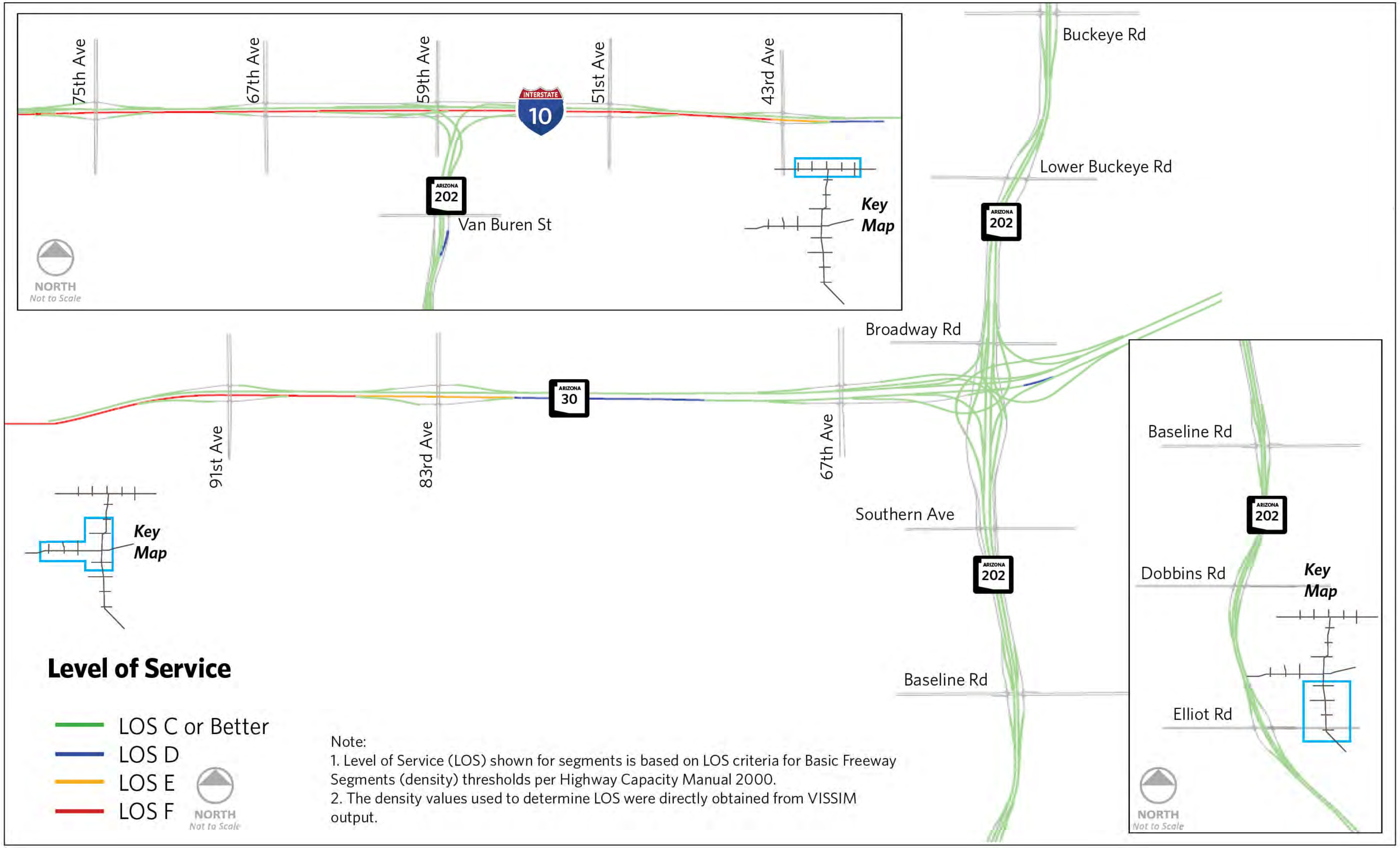


Figure 6.5. SR 30/SR 202L System Traffic Interchange, 2035 AM Peak Hour 3 Level of Service

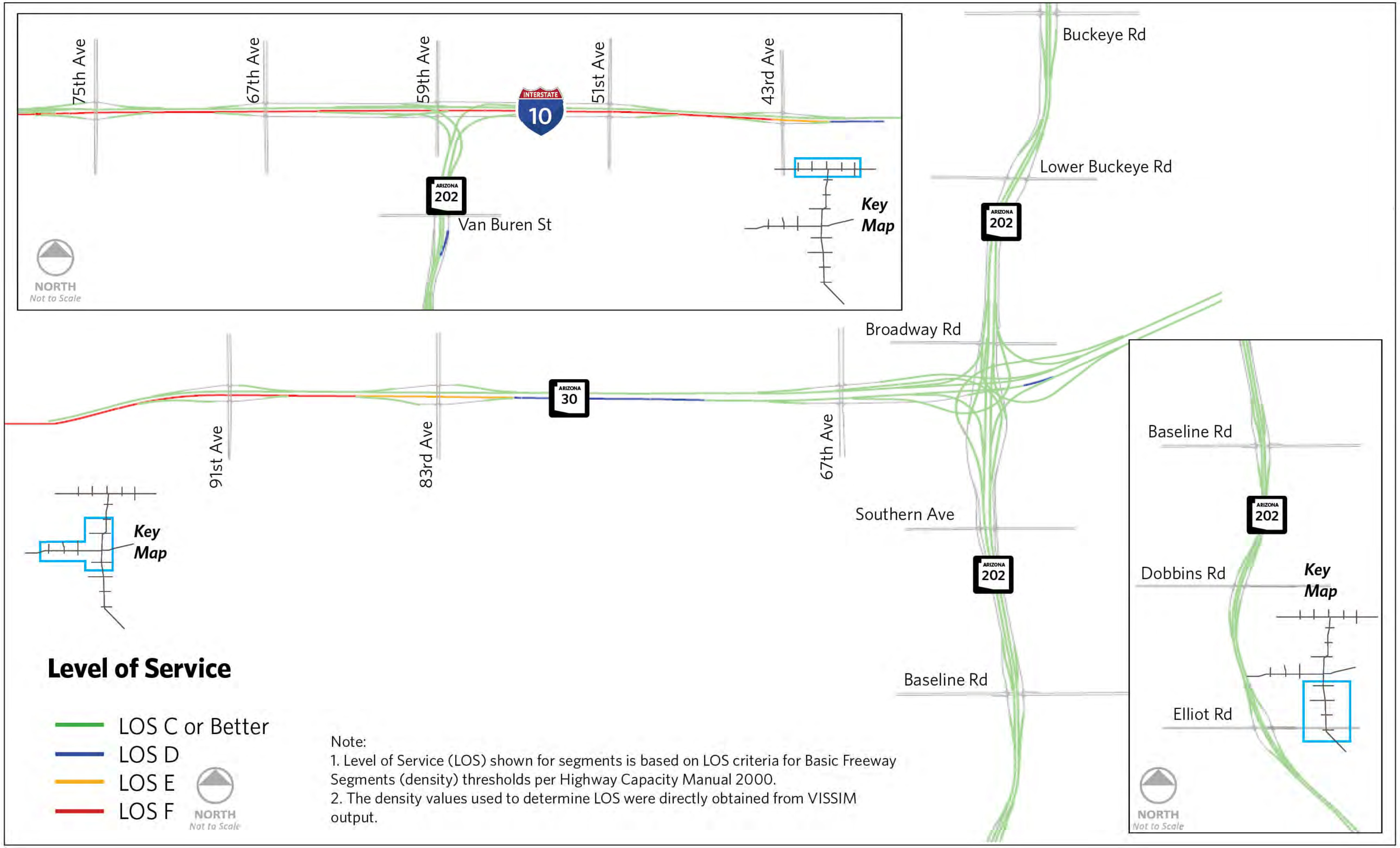


Figure 6.6. SR 30/SR 202L System Traffic Interchange, 2035 PM Peak Hour 1 Level of Service

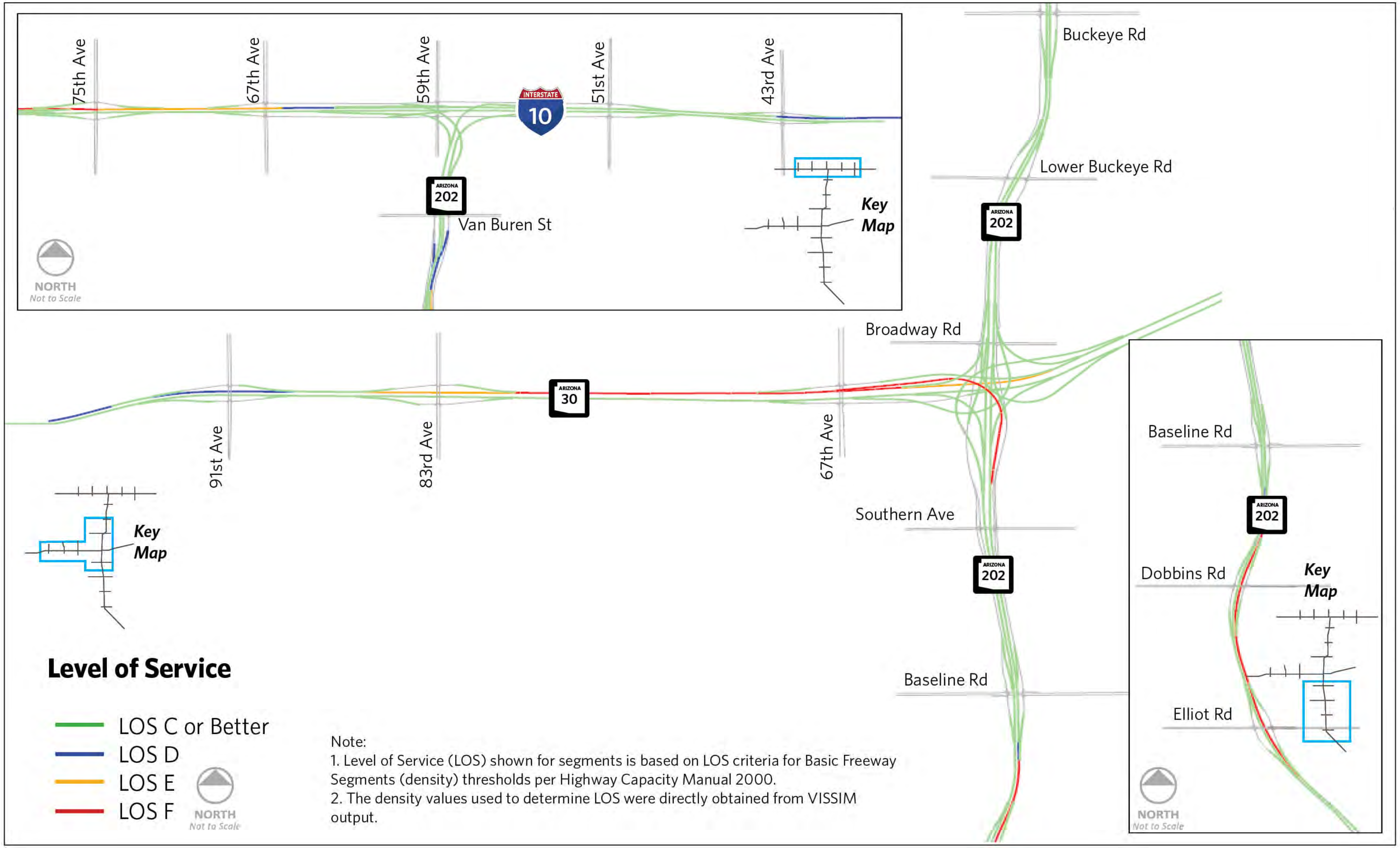


Figure 6.7. SR 30/SR 202L System Traffic Interchange, 2035 PM Peak Hour 2 Level of Service

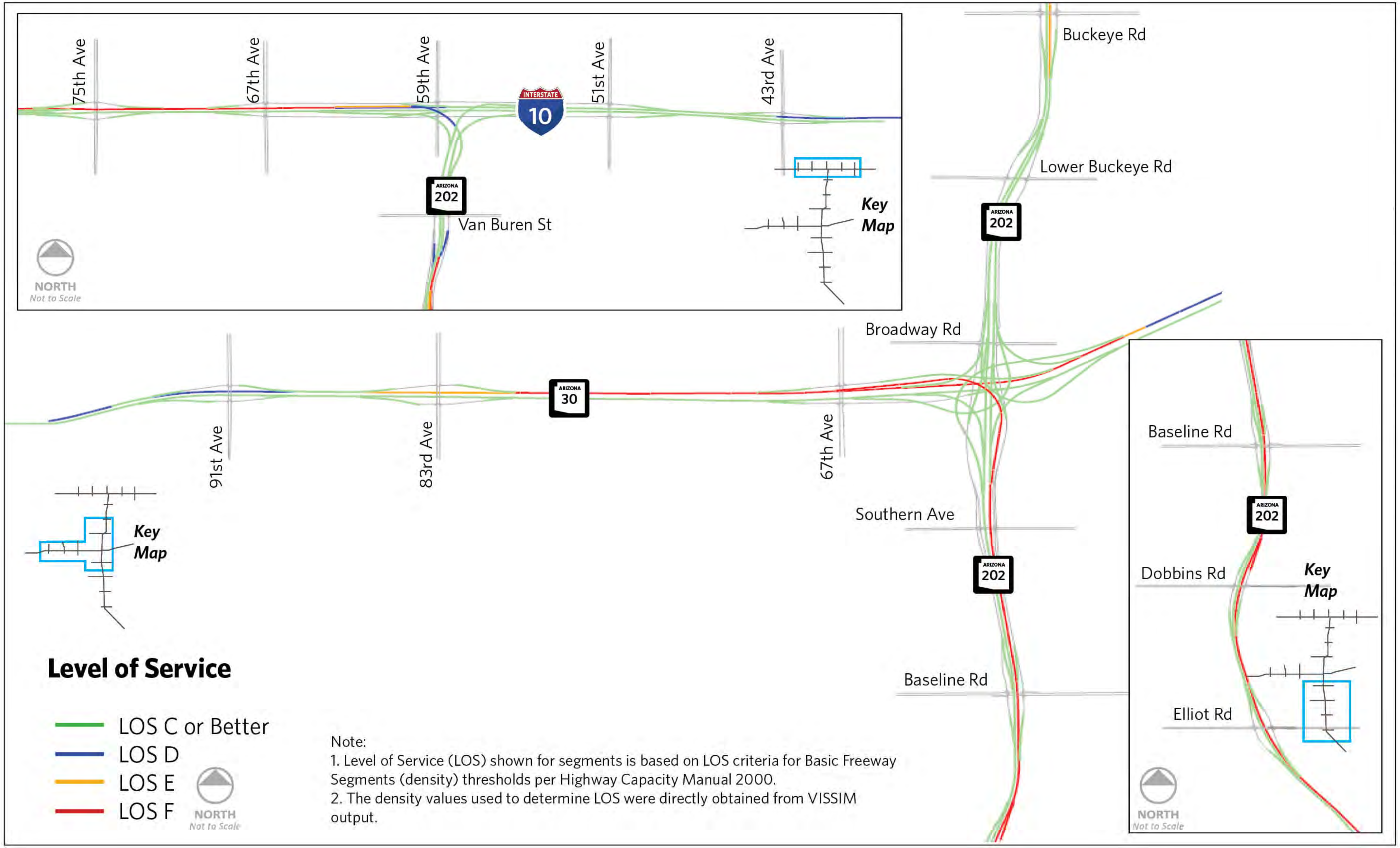


Figure 6.8. SR 30/SR 202L System Traffic Interchange, 2035 PM Peak Hour 3 Level of Service

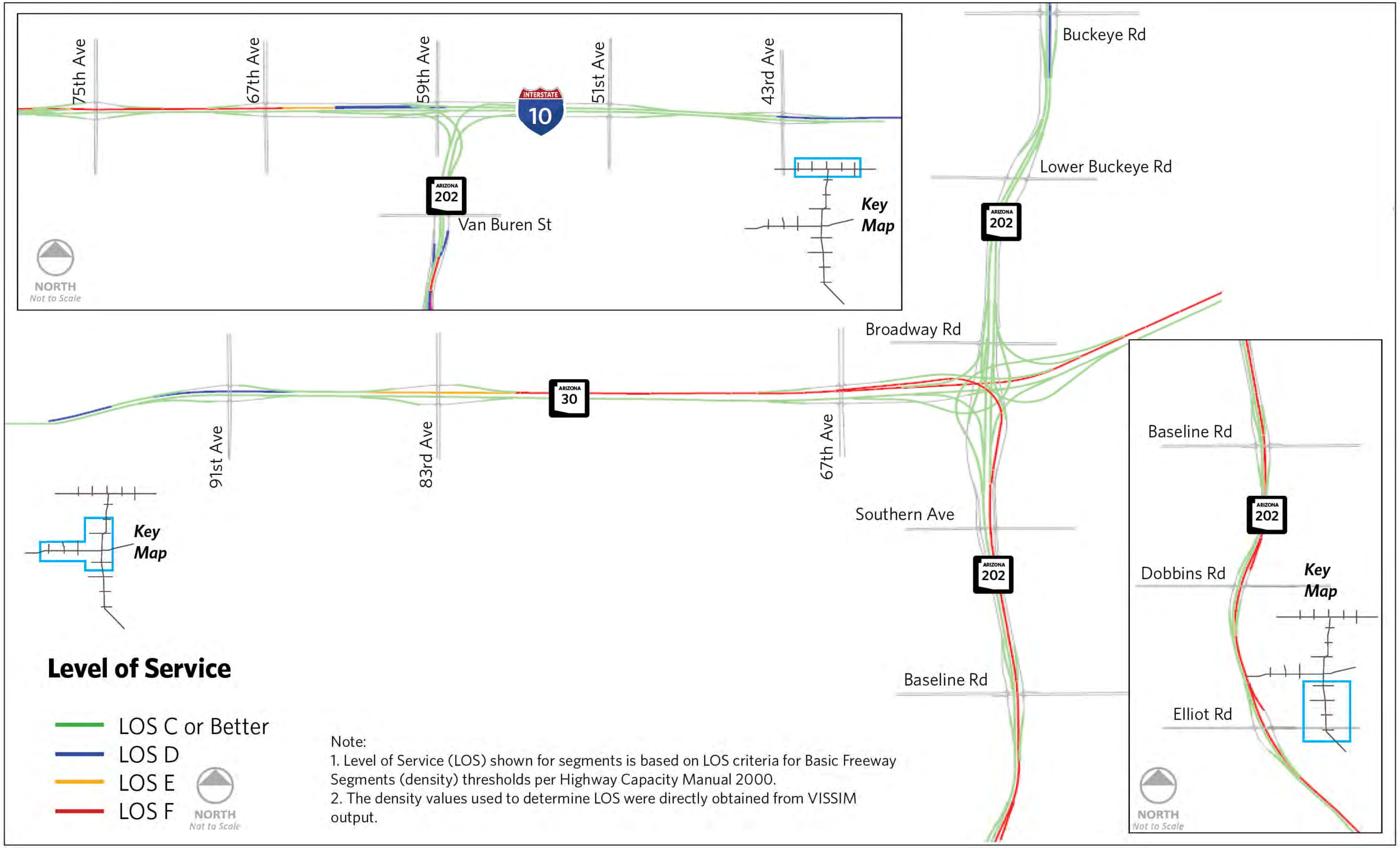


Figure 6.9. SR 30/SR 202L System Traffic Interchange, 2040 AM Peak Hour 1 Level of Service

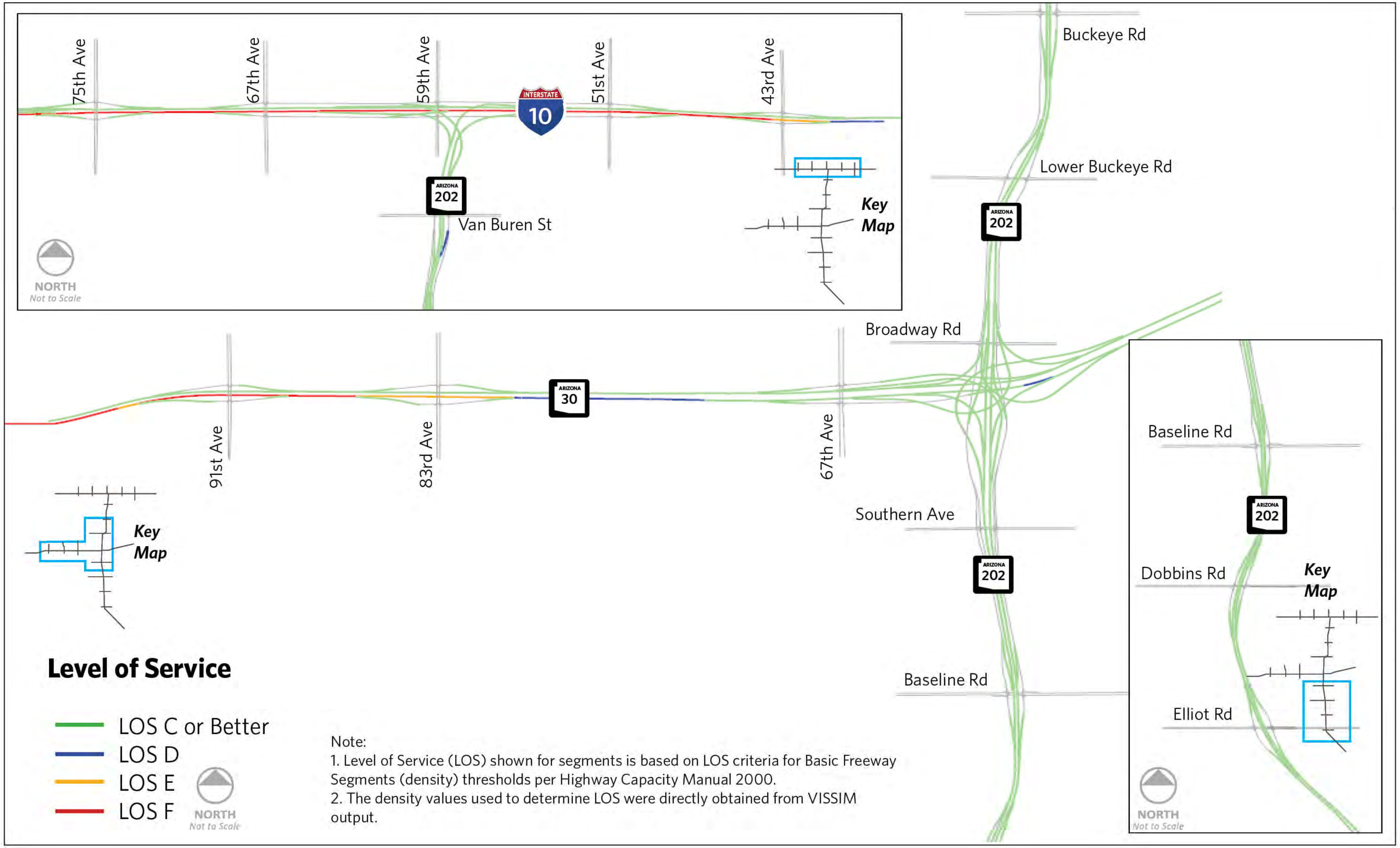


Figure 6.10. SR 30/SR 202L System Traffic Interchange, 2040 AM Peak Hour 2 Level of Service

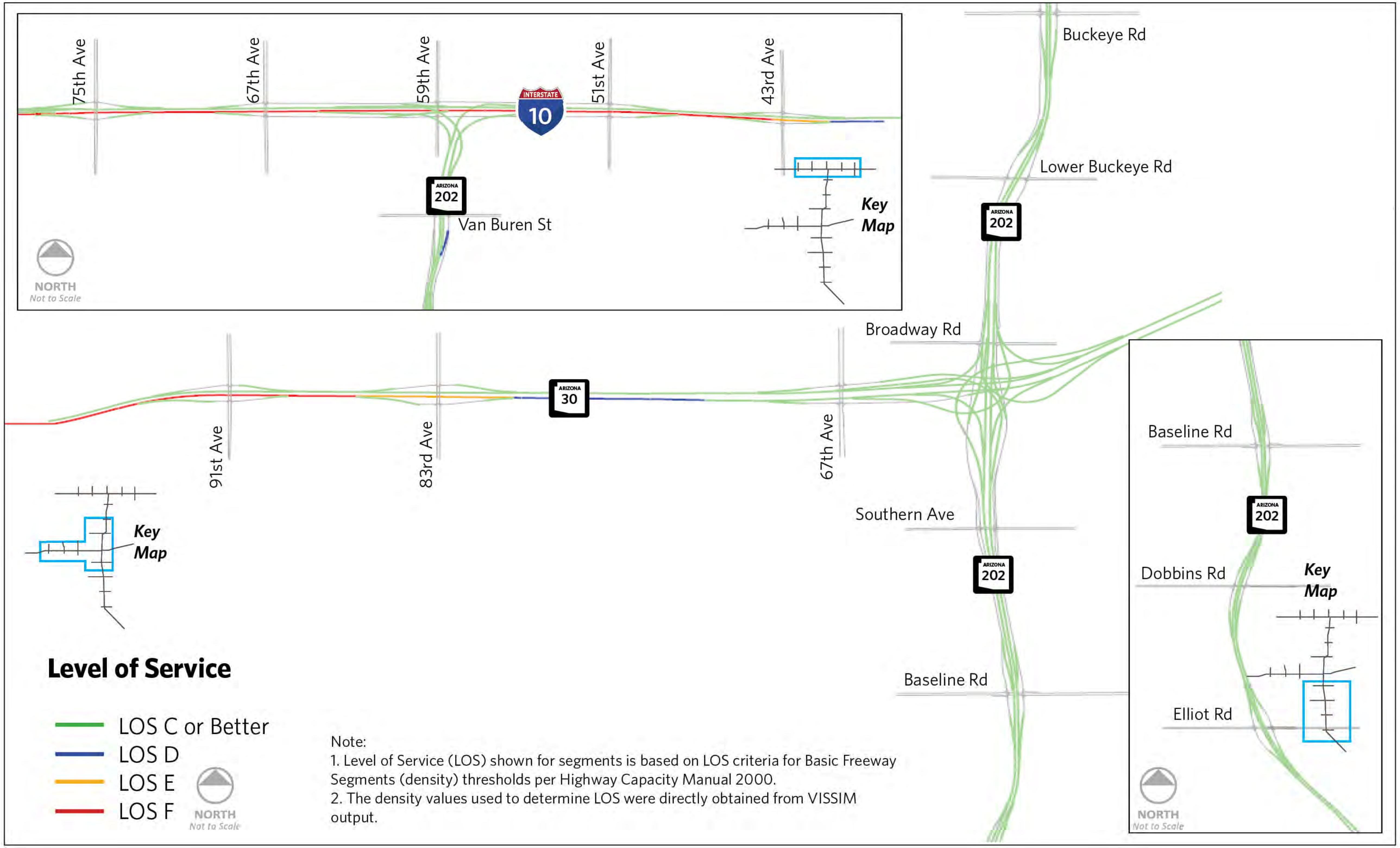


Figure 6.11. SR 30/SR 202L System Traffic Interchange, 2040 AM Peak Hour 3 Level of Service

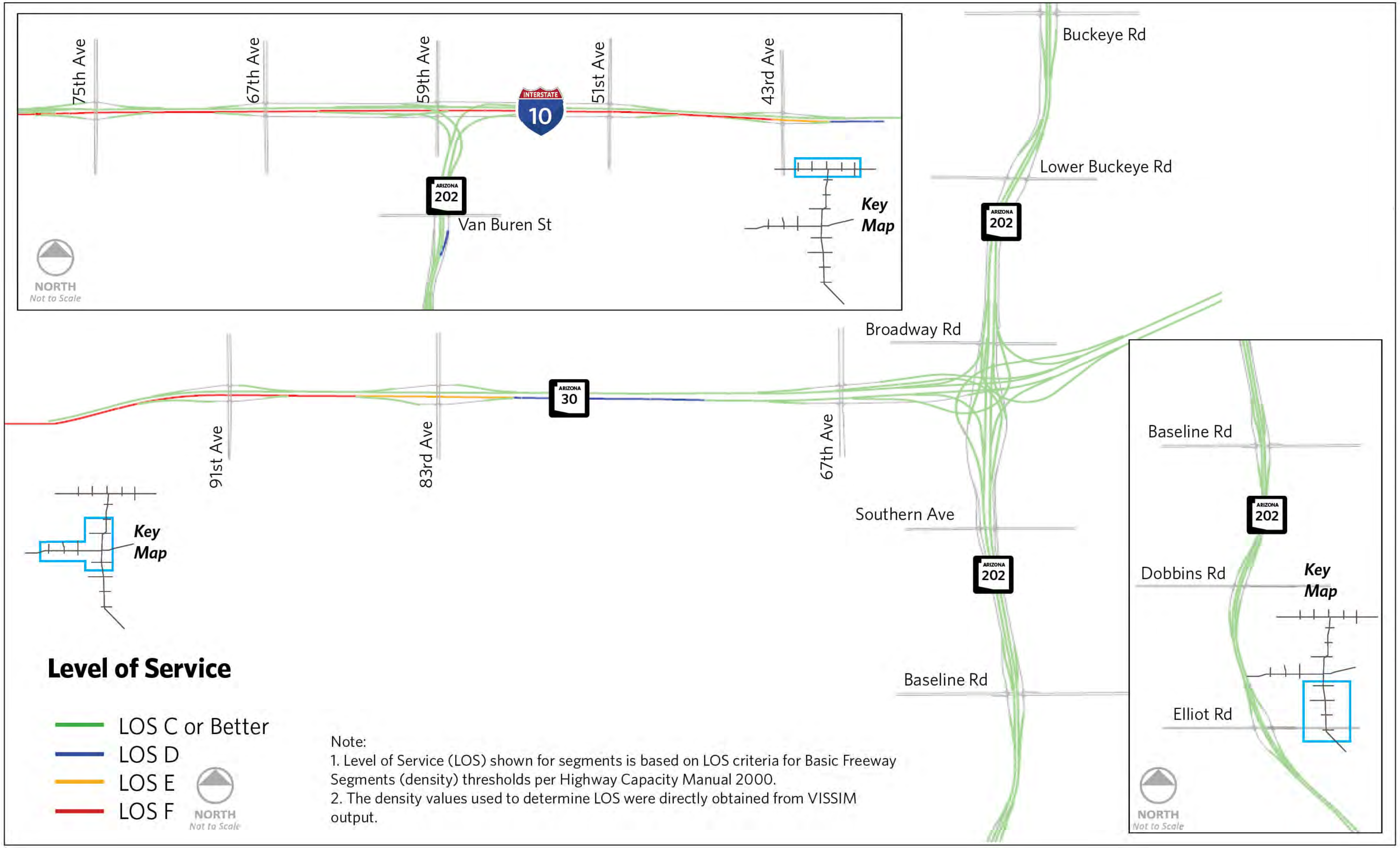


Figure 6.12. SR 30/SR 202L System Traffic Interchange, 2040 PM Peak Hour 1 Level of Service

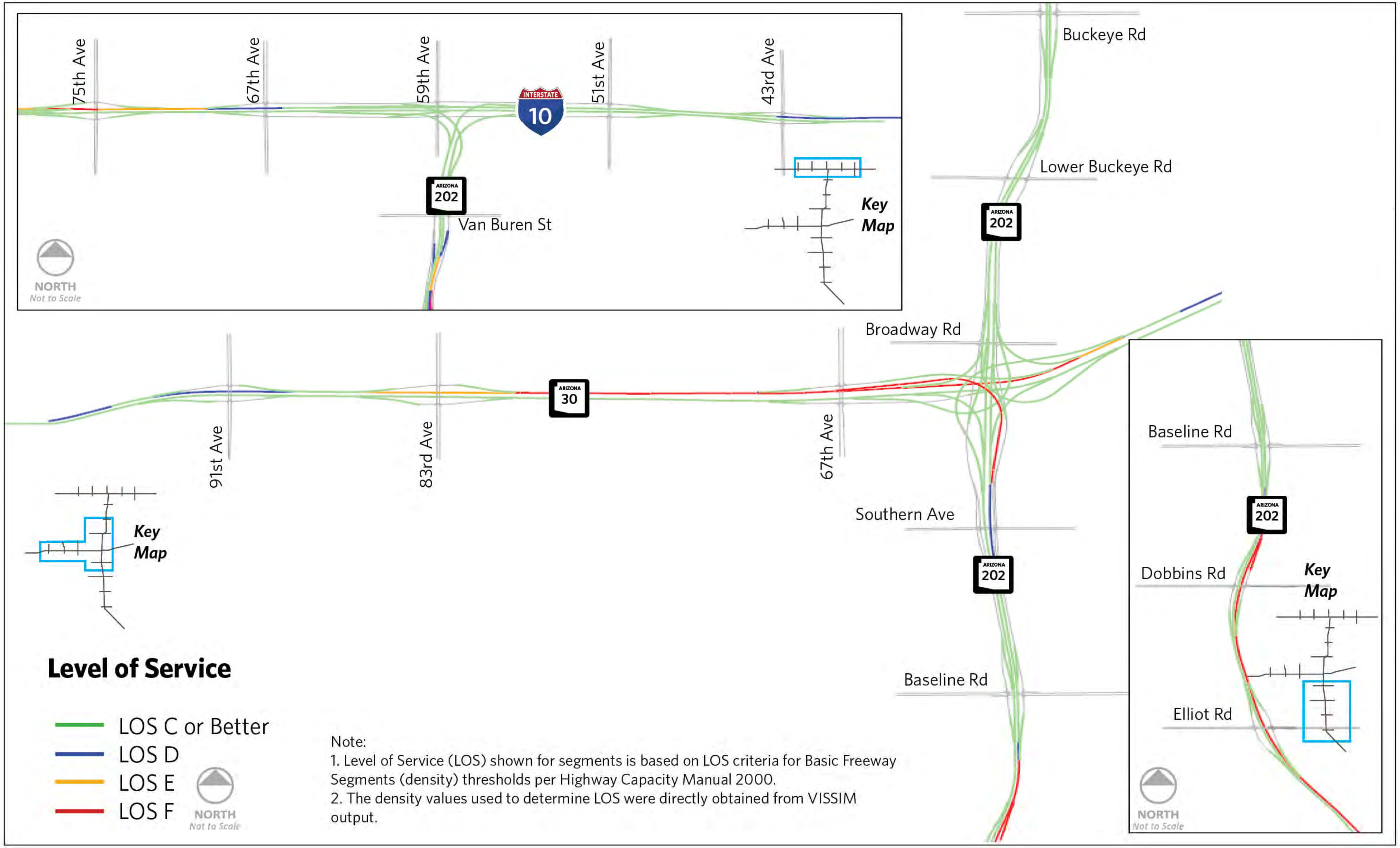


Figure 6.13. SR 30/SR 202L System Traffic Interchange, 2040 PM Peak Hour 2 Level of Service

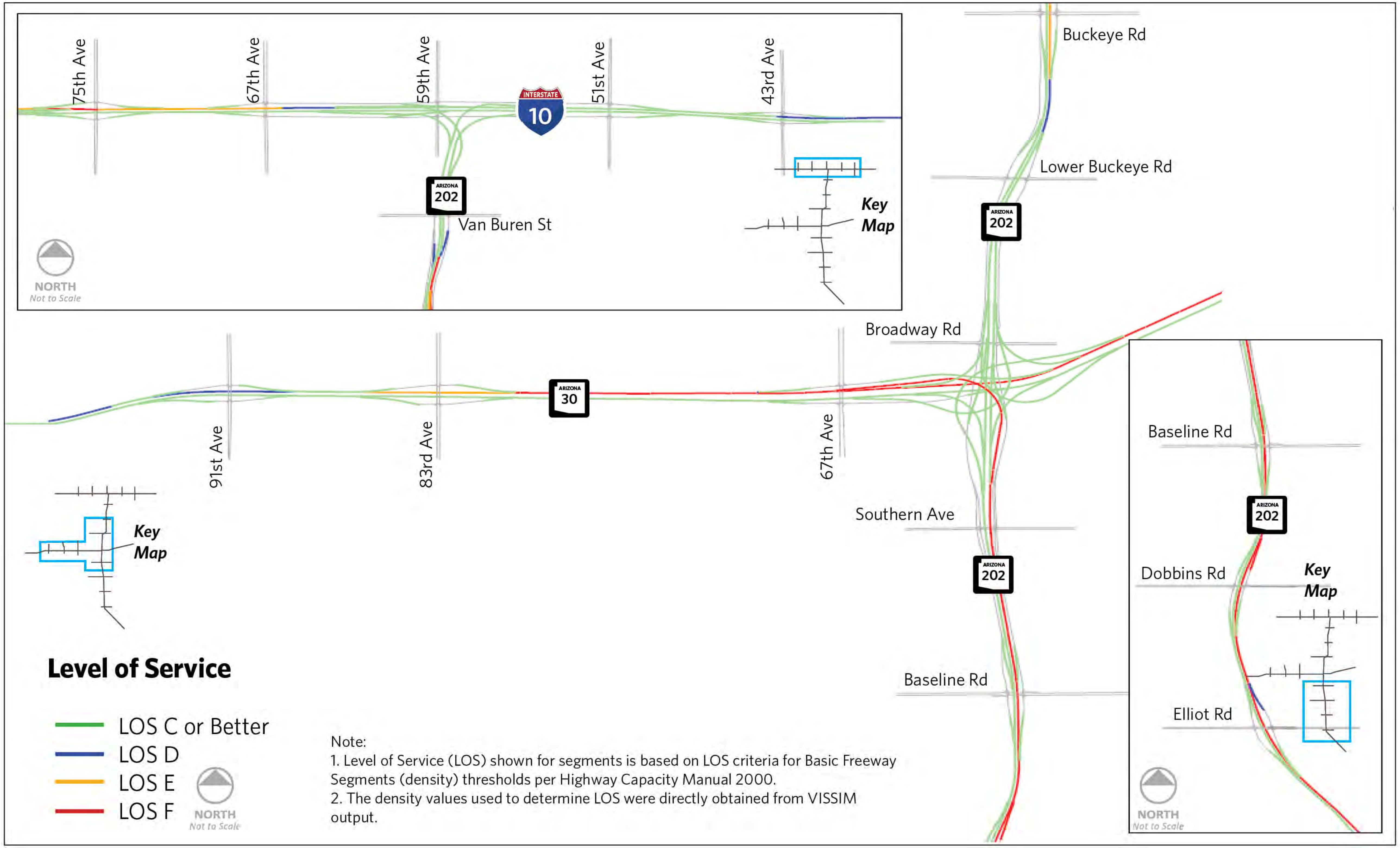
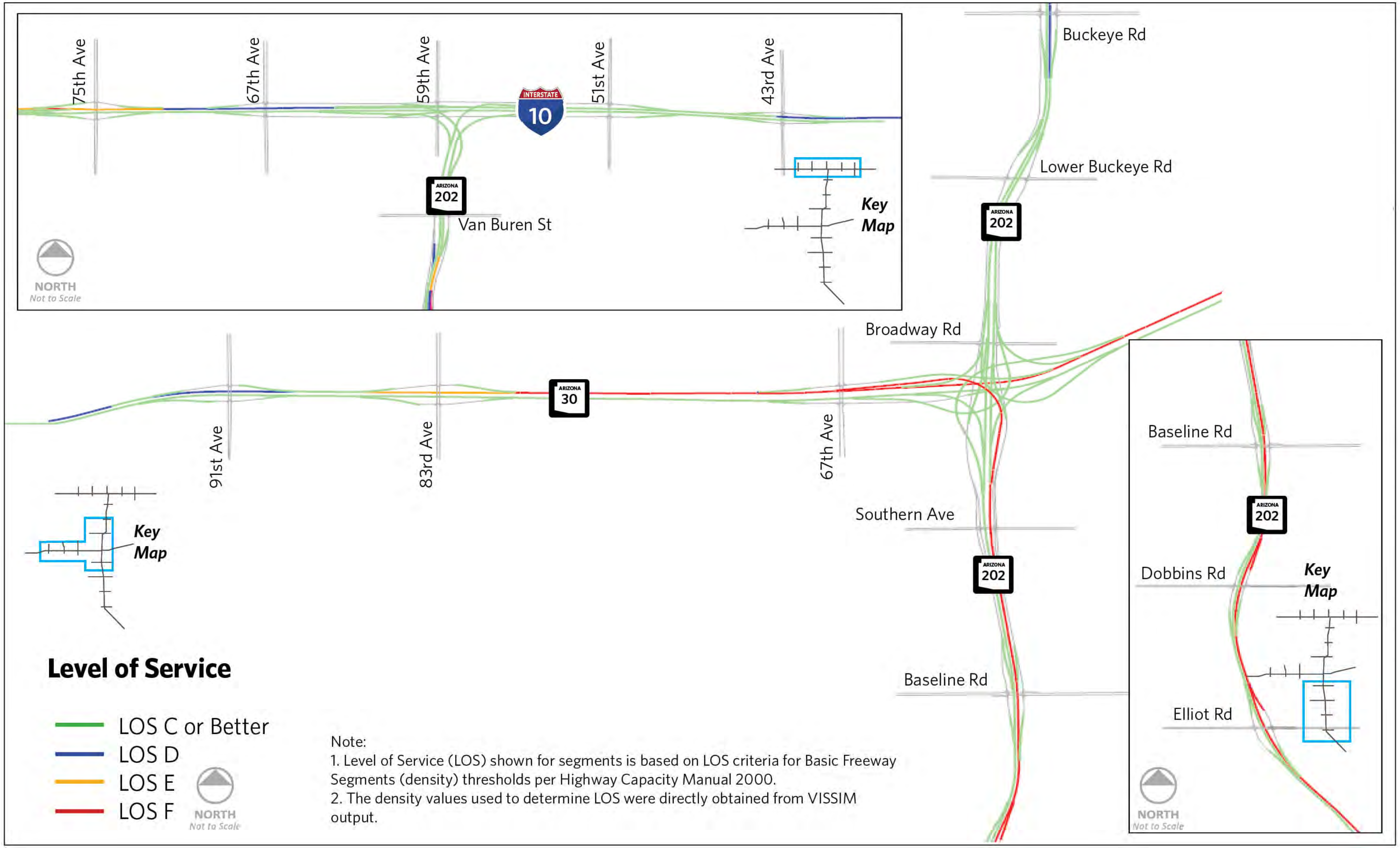


Figure 6.14. SR 30/SR 202L System Traffic Interchange, 2040 PM Peak Hour 3 Level of Service



Chapter 7. References

Arizona Department of Transportation (ADOT). 2005. *Lessons Learned Document. Traffic Volume Projections and Operational Analysis*.

———. 2007a. *SR 801, SR 303L to SR 202L, Alternatives Selection Report*.

———. 2007b. *ADOT Roadway Design Guidelines*. With revisions and amendments.

———. 2013. *State Route (SR) 30, SR 303L to SR 202L Final Traffic Report*.

City of Avondale. 2012. *Transportation Plan*.

City of Goodyear. 2009. *Roadway Classification Map*.

City of Phoenix. 2010. *Street Classification Map.*

Maricopa Association of Governments (MAG). 2008. *Interstate 10/Hassayampa Valley Roadway Framework Study*.

———. 2017. *Socioeconomic Projections of Population, Housing, and Employment by Municipal Planning Area and Regional Analysis Zone*.

Transportation Research Board. 2010. *Highway Capacity Manual*. Washington, D.C.

Appendix A

HCS Freeway Analysis Reports

This page is intentionally left blank.

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*XL*
Agency or Company	*HDR Engineering Inc.*
Date Performed	*12/29/2017*
Analysis Time Period	*AM*

Site Information

Highway/Direction of Travel	*Eastbound*
From/To	*At 75th Ave*
Jurisdiction	*ADOT*
Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*9425*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*5*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2083*	pc/h/ln
S	*58.4*	mph
D = v_p / S	*35.7*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

 HCS 2010™ Version 6.1 Generated: 12/29/2017 8:52 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*XL*
Agency or Company	*HDR Engineering Inc.*
Date Performed	*12/27/2017*
Analysis Time Period	*AM*

Site Information

Highway/Direction of Travel	*Eastbound*
From/To	*West of Agua Fria River*
Jurisdiction	*ADOT*
Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*6625*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*4*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1831*	pc/h/ln
S	*62.4*	mph
D = v_p / S	*29.4*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

 HCS 2010™ Version 6.1 Generated: 12/27/2017 10:08 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Westbound
Agency or Company	HDR Engineering Inc.	From/To	83rd Ave major Diverge
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	325	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 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)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	180	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	60.0	mph	S		mph
D = v_p / S	3.0	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	A		Required Number of Lanes, N		

Glossary

N - Number of lanes; S - Speed; V - Hourly volume; D - Density; v_p - Flow rate; FFS - Free-flow speed; LOS - Level of service; BFFS - Base free-flow speed; DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12; f_{LW} - Exhibit 11-8; E_T - Exhibits 11-10, 11-11, 11-13; f_{LC} - Exhibit 11-9; f_p - Page 11-18; TRD - Page 11-11; LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 12/29/2017 8:49 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Westbound
Agency or Company	HDR Engineering Inc.	From/To	At 75th Ave
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	2625	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	5		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	65.0	mph	FFS	65.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	580	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	65.0	mph	S		mph
D = v_p / S	8.9	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	A		Required Number of Lanes, N		

Glossary

N - Number of lanes; S - Speed; V - Hourly volume; D - Density; v_p - Flow rate; FFS - Free-flow speed; LOS - Level of service; BFFS - Base free-flow speed; DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12; f_{LW} - Exhibit 11-8; E_T - Exhibits 11-10, 11-11, 11-13; f_{LC} - Exhibit 11-9; f_p - Page 11-18; TRD - Page 11-11; LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 12/29/2017 8:55 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At 83rd Ave*
Date Performed	*12/28/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2325*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 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)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*642*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*9.9*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/28/2017 4:41 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At 99th Ave*
Date Performed	*12/27/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2025*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 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)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*746*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*11.5*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/27/2017 4:54 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At 107th Ave*
Date Performed	*12/27/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1850*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*682*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*10.5*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/27/2017 3:47 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Avondale Blvd*
Date Performed	*12/27/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1625*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*599*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*9.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/27/2017 3:17 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Bullard Ave*
Date Performed	*12/27/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1550*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*4*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*428*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	*65.0*	mph	S		mph
D = v_p / S	*6.6*	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	*A*		Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/27/2017 9:23 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Dysart Rd*
Date Performed	*12/27/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1550*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*571*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	*65.0*	mph	S		mph
D = v_p / S	*8.8*	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	*A*		Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/27/2017 1:45 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Westbound
Agency or Company	HDR Engineering Inc.	From/To	At Estrella Pkwy
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	1125 veh/h		Peak-Hour Factor, PHF	0.95
AADT	veh/day		%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	5		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	65.0	mph	FFS	65.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	249	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	65.0	mph	S		mph
D = v_p / S	3.8	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	A		Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/27/2017 8:51 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Westbound
Agency or Company	HDR Engineering Inc.	From/To	At Sarival Ave
Date Performed	12/26/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	825 veh/h		Peak-Hour Factor, PHF	0.95
AADT	veh/day		%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	5		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	65.0	mph	FFS	65.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	182	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	65.0	mph	S		mph
D = v_p / S	2.8	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	A		Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/26/2017 2:38 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*East of 91st Ave*
Date Performed	*12/29/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1925* veh/h		Peak-Hour Factor, PHF	*0.95*
AADT	veh/day		%Trucks and Buses, P_T	*10*
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*4*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*532*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*8.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/29/2017 1:51 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*East of Agua Fria River*
Date Performed	*12/27/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1575* veh/h		Peak-Hour Factor, PHF	*0.95*
AADT	veh/day		%Trucks and Buses, P_T	*10*
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*580*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*8.9*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/27/2017 10:53 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*El Mirage Rd*
Date Performed	*12/27/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1700*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 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)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*626*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*9.6*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/27/2017 2:30 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*West of 67th Ave*
Date Performed	*12/29/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2350*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*5*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*519*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*8.0*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/29/2017 9:44 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*West of 91st Ave*
Date Performed	*12/27/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1925* veh/h	Peak-Hour Factor, PHF	*0.95*
AADT	veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 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)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*709*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	*65.0*	mph	S		mph
D = v_p / S	*10.9*	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	*A*		Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/28/2017 8:57 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*West of Agua Fria River*
Date Performed	*12/27/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1575* veh/h	Peak-Hour Factor, PHF	*0.95*
AADT	veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 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)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*435*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	*65.0*	mph	S		mph
D = v_p / S	*6.7*	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	*A*		Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/27/2017 10:52 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At 83rd Ave*
Date Performed	*12/27/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*8525* veh/h		Peak-Hour Factor, PHF	*0.95*
AADT	veh/day		%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*4*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2356*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*52.0*	mph	S	mph
D = v_p / S	*45.3*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*F*		Required Number of Lanes, N	

Glossary

N - Number of lanes S - Speed
V - Hourly volume D - Density
v_p - Flow rate FFS - Free-flow speed
LOS - Level of service BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18 TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 12/28/2017 4:31 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At 91st Ave*
Date Performed	*12/27/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*7700* veh/h		Peak-Hour Factor, PHF	*0.95*
AADT	veh/day		%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2837*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*35.7*	mph	S	mph
D = v_p / S	*79.4*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*F*		Required Number of Lanes, N	

Glossary

N - Number of lanes S - Speed
V - Hourly volume D - Density
v_p - Flow rate FFS - Free-flow speed
LOS - Level of service BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18 TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 12/28/2017 8:48 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*XL*
Agency or Company	*HDR Engineering Inc.*
Date Performed	*12/27/2017*
Analysis Time Period	*AM*

Site Information

Highway/Direction of Travel	*Eastbound*
From/To	*At 99th Ave*
Jurisdiction	*ADOT*
Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*7950*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2929*	pc/h/ln
S	*31.8*	mph
D = v_p / S	*92.0*	pc/mi/ln
LOS	*F*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

 HCS 2010™ Version 6.1 Generated: 12/27/2017 4:52 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*XL*
Agency or Company	*HDR Engineering Inc.*
Date Performed	*12/27/2017*
Analysis Time Period	*AM*

Site Information

Highway/Direction of Travel	*Eastbound*
From/To	*At 107th Ave*
Jurisdiction	*ADOT*
Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*7350*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2708*	pc/h/ln
S	*40.7*	mph
D = v_p / S	*66.5*	pc/mi/ln
LOS	*F*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

 HCS 2010™ Version 6.1 Generated: 12/27/2017 3:41 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	From/To	At Avondale Blvd
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6475	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	3		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	65.0	mph
FFS (measured)	65.0	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2386	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	51.2	mph	S	mph
D = v_p / S	46.6	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	F		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010TM Version 6.1 Generated: 12/27/2017 3:15 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	From/To	At Bullard Ave
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6250	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	4		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	65.0	mph
FFS (measured)	65.0	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1727	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	63.5	mph	S	mph
D = v_p / S	27.2	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	D		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010TM Version 6.1 Generated: 12/27/2017 9:21 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	From/To	At Dysart Rd
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6300	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	3		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	65.0	mph
FFS (measured)	65.0	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2321	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	53.0	mph	S	mph
D = v_p / S	43.8	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	E		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/27/2017 1:42 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	From/To	At Estrella Pkwy
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	5650	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	4		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	65.0	mph
FFS (measured)	65.0	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1561	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	64.6	mph	S	mph
D = v_p / S	24.2	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	C		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/27/2017 8:48 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Sarival Ave*
Date Performed	*12/26/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5025*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*5*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1111*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*17.1*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/26/2017 2:34 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*East of Agua Fria River*
Date Performed	*12/27/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*6625*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2441*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*49.6*	mph	S	mph
D = v_p / S	*49.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*F*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/27/2017 10:12 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*East of Sarival Ave*
Date Performed	*12/26/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5025*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*4*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1388*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*21.4*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/26/2017 2:44 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*El Mirage Rd*
Date Performed	*12/27/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*6475*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2386*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*51.2*	mph	S	mph
D = v_p / S	*46.6*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*F*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/27/2017 2:28 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst: XL
Agency or Company: HDR Engineering Inc.
Date Performed: 12/29/2017
Analysis Time Period: AM

Site Information

Highway/Direction of Travel: Eastbound
From/To: West of 67th Ave
Jurisdiction: ADOT
Analysis Year: 2035

Project Description: SR 30 East HA (3+0)

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	8625	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Adjustments

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

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	5	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	65.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	65.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1907	pc/h/ln
S	61.4	mph
D = v_p / S	31.1	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

 HCS 2010™ Version 6.1 Generated: 12/29/2017 9:41 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst: XL
Agency or Company: HDR Engineering Inc.
Date Performed: 12/29/2017
Analysis Time Period: AM

Site Information

Freeway/Dir of Travel: Eastbound
Junction: 67th Ave OFF Ramp
Jurisdiction: ADOT
Analysis Year: 2035

Project Description: SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off
L_{up} = 9100 ft
V_u = 900 veh/h

Number of Lanes, N	5
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	170
Freeway Volume, V_F	9425
Ramp Volume, V_R	825
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	60.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off
L_{down} = ft
V_D = veh/h

Conversion to pc/h Under 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	9425	0.95	Level	10	0	0.952	1.00	10417
Ramp	825	0.95	Level	10	0	0.952	1.00	912
UpStream	900	0.95	Level	10	0	0.952	1.00	995
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 0.436 using Equation (Exhibit 13-7)
V_{12} = 4148 pc/h
V_3 or V_{av34} 2093 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	8334	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	7422	Exhibit 13-8	9400	No
V_R	912	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4148	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 38.4 (pc/mi/ln)
LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.185 (Exhibit 13-12)
S_R= 60.7 mph (Exhibit 13-12)
S_0= 67.0 mph (Exhibit 13-12)
S = 63.8 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 12/29/2017 9:05 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave OFF Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	5	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A		☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D	170	L_{down} = 1700 ft
V_u = veh/h	Freeway Volume, V_F	9425	V_D = 550 veh/h
	Ramp Volume, V_R	825	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under 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	9425	0.95	Level	10	0	0.952	1.00	10417
Ramp	825	0.95	Level	10	0	0.952	1.00	912
UpStream								
DownStream	550	0.95	Level	10	0	0.952	1.00	608

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 4148 pc/h

V_3 or V_{av34} 2093 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	8334	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	7422	Exhibit 13-8	9400	No
V_R	912	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4148	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 38.4 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.185 (Exhibit 13-12)

S_R= 60.7 mph (Exhibit 13-12)

S_0= 67.0 mph (Exhibit 13-12)

S = 63.8 mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 12/29/2017 2:54 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave on Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☐ On	Number of Lanes, N	3	☐ Yes ☐ On
☐ No ☑ Off	Acceleration Lane Length, L_A	800	☑ No ☐ Off
L_{up} = 2200 ft	Deceleration Lane Length L_D		L_{down} = ft
V_u = 2800 veh/h	Freeway Volume, V_F	5275	V_D = veh/h
	Ramp Volume, V_R	750	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	55.0	

Conversion to pc/h Under 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	5275	0.95	Level	10	0	0.952	1.00	5830
Ramp	750	0.95	Level	10	0	0.952	1.00	829
UpStream	2800	0.95	Level	10	0	0.952	1.00	3095
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = 2254.83 (Equation 13-6 or 13-7)

P_{FM} = 0.596 using Equation (Exhibit 13-6)

V_{12} = 3477 pc/h

V_3 or V_{av34} 2353 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	6659	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4306	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 33.7 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.522 (Exibit 13-11)

S_R= 53.0 mph (Exhibit 13-11)

S_0= 58.2 mph (Exhibit 13-11)

S = 54.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 1/4/2018 1:29 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave on Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☑ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 800	☐ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = 1400 ft
V_u = veh/h	Freeway Volume, V_F: 5275	V_D = 575 veh/h
	Ramp Volume, V_R: 750	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under 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	5275	0.95	Level	10	0	0.952	1.00	5830
Ramp	750	0.95	Level	10	0	0.952	1.00	829
UpStream								
DownStream	575	0.95	Level	10	0	0.952	1.00	636

Merge Areas

Estimation of v_{12}

$V_{12} = V_F$ (P_{FM})

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.600 using Equation (Exhibit 13-6)

V_{12} = 3497 pc/h

V_3 or V_{av34} 2333 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	6659	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4326	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 33.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.528 (Exibit 13-11)

S_R= 52.9 mph (Exhibit 13-11)

S_0= 58.3 mph (Exhibit 13-11)

S = 54.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010[TM] Version 6.1 Generated: 1/4/2018 1:31 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	83rd ON Ramp
Date Performed	12/28/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N: 4	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A: 1500	☑ No ☐ Off
L_{up} = 4300 ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = 125 veh/h	Freeway Volume, V_F: 8525	V_D = veh/h
	Ramp Volume, V_R: 900	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under 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	8525	0.95	Level	10	0	0.952	1.00	9422
Ramp	900	0.95	Level	10	0	0.952	1.00	995
UpStream	125	0.95	Level	10	0	0.952	1.00	138
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F$ (P_{FM})

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.093 using Equation (Exhibit 13-6)

V_{12} = 880 pc/h

V_3 or V_{av34} 4271 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No

If Yes,V_{12a} = 3768 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	10417	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4763	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 32.8 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 0.613 (Exibit 13-11)

S_R= 50.9 mph (Exhibit 13-11)

S_0= 55.3 mph (Exhibit 13-11)

S = 53.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010[TM] Version 6.1 Generated: 1/4/2018 12:56 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	83rd ON Ramp
Date Performed	12/28/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	4
Acceleration Lane Length, L_A	1500
Deceleration Lane Length L_D	
Freeway Volume, V_F	8525
Ramp Volume, V_R	900
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp

☑ Yes ☐ On

☐ No ☑ Off

L_{down} = 6200 ft

V_D = 825 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	8525	0.95	Level	10	0	0.952	1.00	9422
Ramp	900	0.95	Level	10	0	0.952	1.00	995
UpStream								
DownStream	825	0.95	Level	10	0	0.952	1.00	912

Merge Areas

Estimation of v_{12}

$$V_{12} = V_F\,(P_{FM})$$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.093 using Equation (Exhibit 13-6)

V_{12} = 880 pc/h

V_3 or V_{av34} 4271 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No

If Yes,V_{12a} = 3768 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	10417	Exhibit 13-8	Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4763	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734\,v_R + 0.0078\,V_{12} - 0.00627\,L_A$$

D_R = 32.8 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 0.613 (Exibit 13-11)

S_R= 50.9 mph (Exhibit 13-11)

S_0= 55.3 mph (Exhibit 13-11)

S = 53.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$$D_R = 4.252 + 0.0086\,V_{12} - 0.009\,L_D$$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 1/4/2018 1:00 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	91st Ave OFF Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{up} = 9100 ft

V_u = 625 veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	700
Freeway Volume, V_F	7950
Ramp Volume, V_R	275
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	60.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	7950	0.95	Level	10	0	0.952	1.00	8787
Ramp	275	0.95	Level	10	0	0.952	1.00	304
UpStream	625	0.95	Level	10	0	0.952	1.00	691
DownStream								

Merge Areas

Estimation of v_{12}

$$V_{12} = V_F\,(P_{FM})$$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734\,v_R + 0.0078\,V_{12} - 0.00627\,L_A$$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = 2764.03 (Equation 13-12 or 13-13)

P_{FD} = 0.526 using Equation (Exhibit 13-7)

V_{12} = 4769 pc/h

V_3 or V_{av34} 4018 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = 6087 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	8787	Exhibit 13-8	7050	Yes
$V_{FO} = V_F - V_R$	8483	Exhibit 13-8	7050	Yes
V_R	304	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4769	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$$D_R = 4.252 + 0.0086\,V_{12} - 0.009\,L_D$$

D_R = 50.3 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.130 (Exhibit 13-12)

S_R= 62.0 mph (Exhibit 13-12)

S_0= 64.7 mph (Exhibit 13-12)

S = 62.8 mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 12/27/2017 4:56 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	91st Ave OFF Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{up} = ft; V_u = veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	700
Freeway Volume, V_F	7950
Ramp Volume, V_R	275
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	60.0

Downstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off; L_{down} = 2600 ft; V_D = 975 veh/h

Conversion to pc/h Under 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	7950	0.95	Level	10	0	0.952	1.00	8787
Ramp	275	0.95	Level	10	0	0.952	1.00	304
UpStream								
DownStream	975	0.95	Level	10	0	0.952	1.00	1078

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 0.526 using Equation (Exhibit 13-7)
V_{12} = 4769 pc/h
V_3 or V_{av34} 4018 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = 6087 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	8787	Exhibit 13-8	7050	Yes
$V_{FO} = V_F - V_R$	8483	Exhibit 13-8	7050	Yes
V_R	304	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4769	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 50.3 (pc/mi/ln)
LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.130 (Exhibit 13-12)
S_R= 62.0 mph (Exhibit 13-12)
S_0= 64.7 mph (Exhibit 13-12)
S = 62.8 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 12/27/2017 4:58 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	107th Ave ON Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☑ Yes ☐ On ☐ No ☑ Off; L_{up} = 2600 ft; V_u = 75 veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	1300
Deceleration Lane Length L_D	
Freeway Volume, V_F	7350
Ramp Volume, V_R	625
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{down} = ft; V_D = veh/h

Conversion to pc/h Under 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	7350	0.95	Level	10	0	0.952	1.00	8124
Ramp	625	0.95	Level	10	0	0.952	1.00	691
UpStream	75	0.95	Level	10	0	0.952	1.00	83
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = 2938.21 (Equation 13-6 or 13-7)
P_{FM} = 0.592 using Equation (Exhibit 13-6)
V_{12} = 4813 pc/h
V_3 or V_{av34} 3311 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = 5424 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	8815	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	6115	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 44.7 (pc/mi/ln)
LOS = F (Exhibit 13-2)

Speed Determination

M_S = 1.943 (Exhibit 13-11)
S_R= 20.3 mph (Exhibit 13-11)
S_0= 56.1 mph (Exhibit 13-11)
S = 25.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = using Equation (Exhibit 13-7)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)
S_R= mph (Exhibit 13-12)
S_0= mph (Exhibit 13-12)
S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 12/27/2017 4:16 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	107th Ave ON Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1300	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = 9100 ft
V_u = veh/h	Freeway Volume, V_F: 7350	V_D = 275 veh/h
	Ramp Volume, V_R: 625	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under 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	7350	0.95	Level	10	0	0.952	1.00	8124
Ramp	625	0.95	Level	10	0	0.952	1.00	691
UpStream								
DownStream	275	0.95	Level	10	0	0.952	1.00	304

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 1222.36 (Equation 13-6 or 13-7)
P_{FM} = 0.614 using Equation (Exhibit 13-6)
V_{12} = 4987 pc/h
V_3 or V_{av34} 3137 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = 5424 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	8815	Exhibit 13-8	Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	6115	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 44.7 (pc/mi/ln)
LOS = F (Exhibit 13-2)

Speed Determination

M_S = 1.943 (Exibit 13-11)
S_R= 20.3 mph (Exhibit 13-11)
S_0= 56.1 mph (Exhibit 13-11)
S = 25.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = using Equation (Exhibit 13-7)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)
S_R= mph (Exhibit 13-12)
S_0= mph (Exhibit 13-12)
S = mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 12/27/2017 4:19 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Avondale Blvd OFF Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N: 3	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D: 700	L_{down} = ft
V_u = 200 veh/h	Freeway Volume, V_F: 6475	V_D = veh/h
	Ramp Volume, V_R: 25	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under 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	6475	0.95	Level	10	0	0.952	1.00	7157
Ramp	25	0.95	Level	10	0	0.952	1.00	28
UpStream	200	0.95	Level	10	0	0.952	1.00	221
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 946.54 (Equation 13-12 or 13-13)
P_{FD} = 0.580 using Equation (Exhibit 13-7)
V_{12} = 4161 pc/h
V_3 or V_{av34} 2996 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = 4457 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	7157	Exhibit 13-8	7050	Yes
$V_{FO} = V_F - V_R$	7129	Exhibit 13-8	7050	Yes
V_R	28	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4161	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 36.3 (pc/mi/ln)
LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.106 (Exhibit 13-12)
S_R= 62.6 mph (Exhibit 13-12)
S_0= 64.7 mph (Exhibit 13-12)
S = 63.3 mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 12/27/2017 2:35 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Avondale Blvd OFF Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{up} = ft; V_u = veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	700
Freeway Volume, V_F	6475
Ramp Volume, V_R	25
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	60.0

Downstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off; L_{down} = 3000 ft; V_D = 975 veh/h

Conversion to pc/h Under 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	6475	0.95	Level	10	0	0.952	1.00	7157
Ramp	25	0.95	Level	10	0	0.952	1.00	28
UpStream								
DownStream	975	0.95	Level	10	0	0.952	1.00	1078

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\,v_R + 0.0078\,V_{12} - 0.00627\,L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.580 using Equation (Exhibit 13-7)

V_{12} = 4161 pc/h

V_3 or V_{av34} 2996 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = 4457 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	7157	Exhibit 13-8	7050	Yes
$V_{FO} = V_F - V_R$	7129	Exhibit 13-8	7050	Yes
V_R	28	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4161	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\,V_{12} - 0.009\,L_D$

D_R = 36.3 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.106 (Exhibit 13-12)

S_R= 62.6 mph (Exhibit 13-12)

S_0= 64.7 mph (Exhibit 13-12)

S = 63.3 mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 12/27/2017 3:02 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Bullard Ave ON Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☑ Yes ☐ On ☐ No ☑ Off; L_{up} = 2600 ft; V_u = 400 veh/h

Number of Lanes, N	4
Acceleration Lane Length, L_A	1300
Deceleration Lane Length L_D	
Freeway Volume, V_F	6250
Ramp Volume, V_R	400
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{down} = ft; V_D = veh/h

Conversion to pc/h Under 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	6250	0.95	Level	10	0	0.952	1.00	6908
Ramp	400	0.95	Level	10	0	0.952	1.00	442
UpStream	400	0.95	Level	10	0	0.952	1.00	442
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = 2471.05 (Equation 13-6 or 13-7)

P_{FM} = 0.163 using Equation (Exhibit 13-6)

V_{12} = 1123 pc/h

V_3 or V_{av34} 2892 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No

If Yes,V_{12a} = 2763 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	7350	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3205	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\,v_R + 0.0078\,V_{12} - 0.00627\,L_A$

D_R = 22.1 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.274 (Exibit 13-11)

S_R= 58.7 mph (Exhibit 13-11)

S_0= 59.3 mph (Exhibit 13-11)

S = 59.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\,V_{12} - 0.009\,L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 12/27/2017 9:30 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Bullard Ave ON Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 4	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1300	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = 9100 ft
V_u = veh/h	Freeway Volume, V_F: 6250	V_D = 350 veh/h
	Ramp Volume, V_R: 400	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under 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	6250	0.95	Level	10	0	0.952	1.00	6908
Ramp	400	0.95	Level	10	0	0.952	1.00	442
UpStream								
DownStream	350	0.95	Level	10	0	0.952	1.00	387

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.163 using Equation (Exhibit 13-6)

V_{12} = 1123 pc/h

V_3 or V_{av34} 2892 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No

If Yes,V_{12a} = 2763 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	7350	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3205	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 22.1 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.274 (Exibit 13-11)

S_R= 58.7 mph (Exhibit 13-11)

S_0= 59.3 mph (Exhibit 13-11)

S = 59.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010[TM] Version 6.1 Generated: 12/27/2017 2:10 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd OFF Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N: 3	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D: 700	L_{down} = ft
V_u = 400 veh/h	Freeway Volume, V_F: 6625	V_D = veh/h
	Ramp Volume, V_R: 350	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under 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	6625	0.95	Level	10	0	0.952	1.00	7322
Ramp	350	0.95	Level	10	0	0.952	1.00	387
UpStream	400	0.95	Level	10	0	0.952	1.00	442
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 2104.82 (Equation 13-12 or 13-13)

P_{FD} = 0.559 using Equation (Exhibit 13-7)

V_{12} = 4265 pc/h

V_3 or V_{av34} 3057 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = 4622 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	7322	Exhibit 13-8	7050	Yes
$V_{FO} = V_F - V_R$	6935	Exhibit 13-8	7050	No
V_R	387	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4265	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 37.7 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.138 (Exhibit 13-12)

S_R= 61.8 mph (Exhibit 13-12)

S_0= 64.7 mph (Exhibit 13-12)

S = 62.8 mph (Exhibit 13-13)

 HCS2010[TM] Version 6.1 Generated: 12/27/2017 1:19 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd OFF Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☑ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☐ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 700	L_{down} = 2600 ft
V_u = veh/h	Freeway Volume, V_F: 6625	V_D = 200 veh/h
	Ramp Volume, V_R: 350	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under 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	6625	0.95	Level	10	0	0.952	1.00	7322
Ramp	350	0.95	Level	10	0	0.952	1.00	387
UpStream								
DownStream	200	0.95	Level	10	0	0.952	1.00	221

Merge Areas

Estimation of v_{12}

$V_{12} = V_F$ (P_{FM})

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.559 using Equation (Exhibit 13-7)

V_{12} = 4265 pc/h

V_3 or V_{av34} 3057 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = 4622 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	7322	Exhibit 13-8	7050	Yes
$V_{FO} = V_F - V_R$	6935	Exhibit 13-8	7050	No
V_R	387	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4265	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 37.7 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.138 (Exhibit 13-12)

S_R= 61.8 mph (Exhibit 13-12)

S_0= 64.7 mph (Exhibit 13-12)

S = 62.8 mph (Exhibit 13-13)

 HCS2010[TM] Version 6.1 Generated: 12/27/2017 1:23 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd ON Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☐ No ☑ Off	Acceleration Lane Length, L_A: 1300	☑ No ☐ Off
L_{up} = 2600 ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = 350 veh/h	Freeway Volume, V_F: 6300	V_D = veh/h
	Ramp Volume, V_R: 200	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under 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	6300	0.95	Level	10	0	0.952	1.00	6963
Ramp	200	0.95	Level	10	0	0.952	1.00	221
UpStream	350	0.95	Level	10	0	0.952	1.00	387
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F$ (P_{FM})

L_{EQ} = 2589.18 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 4275 pc/h

V_3 or V_{av34} 2688 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	7184	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4496	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 32.3 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 0.528 (Exibit 13-11)

S_R= 52.9 mph (Exhibit 13-11)

S_0= 56.1 mph (Exhibit 13-11)

S = 54.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010[TM] Version 6.1 Generated: 12/27/2017 2:02 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd ON Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1300	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = 9100 ft
V_u = veh/h	Freeway Volume, V_F: 6300	V_D = 25 veh/h
	Ramp Volume, V_R: 200	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under 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	6300	0.95	Level	10	0	0.952	1.00	6963
Ramp	200	0.95	Level	10	0	0.952	1.00	221
UpStream								
DownStream	25	0.95	Level	10	0	0.952	1.00	28

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = 112.59 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 4275 pc/h

V_3 or V_{av34} 2688 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	7184	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4496	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 32.3 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 0.528 (Exibit 13-11)

S_R= 52.9 mph (Exhibit 13-11)

S_0= 56.1 mph (Exhibit 13-11)

S = 54.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 12/27/2017 2:08 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave OFF Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☐ On	Number of Lanes, N: 4	☐ Yes ☐ On
☐ No ☑ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = 600 ft	Deceleration Lane Length L_D: 1500	L_{down} = ft
V_u = 150 veh/h	Freeway Volume, V_F: 1500	V_D = veh/h
	Ramp Volume, V_R: 200	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under 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	1500	0.95	Level	10	0	0.952	1.00	1658
Ramp	200	0.95	Level	10	0	0.952	1.00	221
UpStream	150	0.95	Level	10	0	0.952	1.00	166
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 848 pc/h

V_3 or V_{av34} 405 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1658	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	1437	Exhibit 13-8	9400	No
V_R	221	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	848	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = -2.0 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

D_s = 0.123 (Exhibit 13-12)

S_R= 62.2 mph (Exhibit 13-12)

S_0= 71.3 mph (Exhibit 13-12)

S = 66.3 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/4/2018 1:50 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave OFF Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	4
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	1500
Freeway Volume, V_F	1500
Ramp Volume, V_R	200
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	60.0

Downstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{down} = 5400 ft

V_D = 125 veh/h

Conversion to pc/h Under 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	1500	0.95	Level	10	0	0.952	1.00	1658
Ramp	200	0.95	Level	10	0	0.952	1.00	221
UpStream								
DownStream	125	0.95	Level	10	0	0.952	1.00	138

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 848 pc/h

V_3 or V_{av34} 405 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1658	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	1437	Exhibit 13-8	9400	No
V_R	221	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	848	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = -2.0 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

D_s = 0.123 (Exhibit 13-12)

S_R= 62.2 mph (Exhibit 13-12)

S_0= 71.3 mph (Exhibit 13-12)

S = 66.3 mph (Exhibit 13-13)

 HCS2010TM Version 6.1 Generated: 1/4/2018 1:52 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave ON Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{up} = 2000 ft

V_u = 950 veh/h

Number of Lanes, N	5
Acceleration Lane Length, L_A	1300
Deceleration Lane Length L_D	
Freeway Volume, V_F	2350
Ramp Volume, V_R	275
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under 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	2350	0.95	Level	10	0	0.952	1.00	2597
Ramp	275	0.95	Level	10	0	0.952	1.00	304
UpStream	950	0.95	Level	10	0	0.952	1.00	1050
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.443 using Equation (Exhibit 13-6)

V_{12} = 898 pc/h

V_3 or V_{av34} 564 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2330	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1202	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 6.6 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.191 (Exhibit 13-11)

S_R= 60.6 mph (Exhibit 13-11)

S_0= 64.8 mph (Exhibit 13-11)

S = 62.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010TM Version 6.1 Generated: 12/29/2017 9:20 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave ON Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 5	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1300	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = 9100 ft
V_u = veh/h	Freeway Volume, V_F: 2350	V_D = 325 veh/h
	Ramp Volume, V_R: 275	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under 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	2350	0.95	Level	10	0	0.952	1.00	2597
Ramp	275	0.95	Level	10	0	0.952	1.00	304
UpStream								
DownStream	325	0.95	Level	10	0	0.952	1.00	359

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

- L_{EQ} = (Equation 13-6 or 13-7)
- P_{FM} = 0.443 using Equation (Exhibit 13-6)
- V_{12} = 898 pc/h
- V_3 or V_{av34} 564 pc/h (Equation 13-14 or 13-17)
- Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
- Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
- If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2330	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1202	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

- D_R = 6.6 (pc/mi/ln)
- LOS = A (Exhibit 13-2)

Speed Determination

- M_S = 0.191 (Exibit 13-11)
- S_R= 60.6 mph (Exhibit 13-11)
- S_0= 64.8 mph (Exhibit 13-11)
- S = 62.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

- L_{EQ} = (Equation 13-12 or 13-13)
- P_{FD} = using Equation (Exhibit 13-7)
- V_{12} = pc/h
- V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
- Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
- Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
- If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

- D_R = (pc/mi/ln)
- LOS = (Exhibit 13-2)

Speed Determination

- D_s = (Exhibit 13-12)
- S_R= mph (Exhibit 13-12)
- S_0= mph (Exhibit 13-12)
- S = mph (Exhibit 13-13)

 HCS2010[TM] Version 6.1 Generated: 12/29/2017 9:23 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	83rd Ave OFF Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N: 5	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D: 700	L_{down} = ft
V_u = 275 veh/h	Freeway Volume, V_F: 2625	V_D = veh/h
	Ramp Volume, V_R: 325	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under 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	2625	0.95	Level	10	0	0.952	1.00	2901
Ramp	325	0.95	Level	10	0	0.952	1.00	359
UpStream	275	0.95	Level	10	0	0.952	1.00	304
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

- L_{EQ} = (Equation 13-6 or 13-7)
- P_{FM} = using Equation (Exhibit 13-6)
- V_{12} = pc/h
- V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
- Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
- Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
- If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

- D_R = (pc/mi/ln)
- LOS = (Exhibit 13-2)

Speed Determination

- M_S = (Exibit 13-11)
- S_R= mph (Exhibit 13-11)
- S_0= mph (Exhibit 13-11)
- S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

- L_{EQ} = (Equation 13-12 or 13-13)
- P_{FD} = 0.260 using Equation (Exhibit 13-7)
- V_{12} = 1020 pc/h
- V_3 or V_{av34} 940 pc/h (Equation 13-14 or 13-17)
- Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
- Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No
- If Yes,V_{12a} = 1160 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2901	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	2542	Exhibit 13-8	9400	No
V_R	359	Exhibit 13-10	4400	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1020	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

- D_R = -4.7 (pc/mi/ln)
- LOS = A (Exhibit 13-2)

Speed Determination

- D_s = 0.135 (Exhibit 13-12)
- S_R= 61.9 mph (Exhibit 13-12)
- S_0= 71.3 mph (Exhibit 13-12)
- S = 67.2 mph (Exhibit 13-13)

 HCS2010[TM] Version 6.1 Generated: 3/28/2018 3:09 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	91st Ave ON Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☐ On	Number of Lanes, N	3	☐ Yes ☐ On
☐ No ☑ Off	Acceleration Lane Length, L_A	1300	☑ No ☐ Off
L_{up} = 2600 ft	Deceleration Lane Length L_D		L_{down} = ft
V_u = 475 veh/h	Freeway Volume, V_F	1925	V_D = veh/h
	Ramp Volume, V_R	125	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	55.0	

Conversion to pc/h Under 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	1925	0.95	Level	10	0	0.952	1.00	2128
Ramp	125	0.95	Level	10	0	0.952	1.00	138
UpStream	475	0.95	Level	10	0	0.952	1.00	525
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = 1536.72 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 1306 pc/h

V_3 or V_{av34} 822 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2266	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1444	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 8.5 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.195 (Exibit 13-11)

S_R= 60.5 mph (Exhibit 13-11)

S_0= 63.8 mph (Exhibit 13-11)

S = 61.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 12/27/2017 5:00 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	91st Ave ON Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	1300	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D		L_{down} = 9100 ft
V_u = veh/h	Freeway Volume, V_F	1925	V_D = 200 veh/h
	Ramp Volume, V_R	125	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	55.0	

Conversion to pc/h Under 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	1925	0.95	Level	10	0	0.952	1.00	2128
Ramp	125	0.95	Level	10	0	0.952	1.00	138
UpStream								
DownStream	200	0.95	Level	10	0	0.952	1.00	221

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = 888.62 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 1306 pc/h

V_3 or V_{av34} 822 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2266	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1444	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 8.5 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.195 (Exibit 13-11)

S_R= 60.5 mph (Exhibit 13-11)

S_0= 63.8 mph (Exhibit 13-11)

S = 61.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 12/27/2017 5:02 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	107th Ave OFF Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N: 3	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D: 700	L_{down} = ft
V_u = 125 veh/h	Freeway Volume, V_F: 2025	V_D = veh/h
	Ramp Volume, V_R: 200	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2025	0.95	Level	10	0	0.952	1.00	2238
Ramp	200	0.95	Level	10	0	0.952	1.00	221
UpStream	125	0.95	Level	10	0	0.952	1.00	138
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 1305.85 (Equation 13-12 or 13-13)

P_{FD} = 0.694 using Equation (Exhibit 13-7)

V_{12} = 1621 pc/h

V_3 or V_{av34} 617 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2238	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	2017	Exhibit 13-8	7050	No
V_R	221	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1621	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 11.9 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.123 (Exhibit 13-12)

S_R= 62.2 mph (Exhibit 13-12)

S_0= 71.3 mph (Exhibit 13-12)

S = 64.4 mph (Exhibit 13-13)

HCS2010TM Version 6.1 Generated: 12/27/2017 4:42 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	107th Ave OFF Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☑ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☐ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 700	L_{down} = 2600 ft
V_u = veh/h	Freeway Volume, V_F: 2025	V_D = 150 veh/h
	Ramp Volume, V_R: 200	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2025	0.95	Level	10	0	0.952	1.00	2238
Ramp	200	0.95	Level	10	0	0.952	1.00	221
UpStream								
DownStream	150	0.95	Level	10	0	0.952	1.00	166

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.694 using Equation (Exhibit 13-7)

V_{12} = 1621 pc/h

V_3 or V_{av34} 617 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2238	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	2017	Exhibit 13-8	7050	No
V_R	221	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1621	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 11.9 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.123 (Exhibit 13-12)

S_R= 62.2 mph (Exhibit 13-12)

S_0= 71.3 mph (Exhibit 13-12)

S = 64.4 mph (Exhibit 13-13)

HCS2010TM Version 6.1 Generated: 12/27/2017 4:48 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Avondale Blvd ON Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☐ No ☑ Off	Acceleration Lane Length, L_A: 1300	☑ No ☐ Off
L_{up} = 2600 ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = 375 veh/h	Freeway Volume, V_F: 1625	V_D = veh/h
	Ramp Volume, V_R: 75	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under 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	1625	0.95	Level	10	0	0.952	1.00	1796
Ramp	75	0.95	Level	10	0	0.952	1.00	83
UpStream	375	0.95	Level	10	0	0.952	1.00	414
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 1453.91 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 1103 pc/h

V_3 or V_{av34} 693 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1879	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1186	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 6.5 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.191 (Exibit 13-11)

S_R= 60.6 mph (Exhibit 13-11)

S_0= 64.3 mph (Exhibit 13-11)

S = 61.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 12/27/2017 3:09 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Avondale Blvd ON Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1300	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = 9100 ft
V_u = veh/h	Freeway Volume, V_F: 1625	V_D = 150 veh/h
	Ramp Volume, V_R: 75	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under 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	1625	0.95	Level	10	0	0.952	1.00	1796
Ramp	75	0.95	Level	10	0	0.952	1.00	83
UpStream								
DownStream	150	0.95	Level	10	0	0.952	1.00	166

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 667.47 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 1103 pc/h

V_3 or V_{av34} 693 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1879	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1186	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 6.5 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.191 (Exibit 13-11)

S_R= 60.6 mph (Exhibit 13-11)

S_0= 64.3 mph (Exhibit 13-11)

S = 61.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 12/27/2017 3:11 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Bullard Ave OFF Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N	4	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D	700	L_{down} = ft
V_u = 50 veh/h	Freeway Volume, V_F	1575	V_D = veh/h
	Ramp Volume, V_R	25	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1575	0.95	Level	10	0	0.952	1.00	1741
Ramp	25	0.95	Level	10	0	0.952	1.00	28
UpStream	50	0.95	Level	10	0	0.952	1.00	55
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 775 pc/h

V_3 or V_{av34} 483 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1741	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	1713	Exhibit 13-8	9400	No
V_R	28	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	775	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 4.6 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

D_s = 0.106 (Exhibit 13-12)

S_R= 62.6 mph (Exhibit 13-12)

S_0= 71.3 mph (Exhibit 13-12)

S = 67.1 mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 1/3/2018 3:40 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Bullard Ave OFF Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	4	☑ Yes ☑ On
☑ No ☐ Off	Acceleration Lane Length, L_A		☐ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D	700	L_{down} = 2600 ft
V_u = veh/h	Freeway Volume, V_F	1575	V_D = 100 veh/h
	Ramp Volume, V_R	25	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1575	0.95	Level	10	0	0.952	1.00	1741
Ramp	25	0.95	Level	10	0	0.952	1.00	28
UpStream								
DownStream	100	0.95	Level	10	0	0.952	1.00	111

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 775 pc/h

V_3 or V_{av34} 483 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1741	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	1713	Exhibit 13-8	9400	No
V_R	28	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	775	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 4.6 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

D_s = 0.106 (Exhibit 13-12)

S_R= 62.6 mph (Exhibit 13-12)

S_0= 71.3 mph (Exhibit 13-12)

S = 67.1 mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 12/27/2017 10:02 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd OFF Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N	3	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D	700	L_{down} = ft
V_u = 75 veh/h	Freeway Volume, V_F	1700	V_D = veh/h
	Ramp Volume, V_R	150	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under 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	1700	0.95	Level	10	0	0.952	1.00	1879
Ramp	150	0.95	Level	10	0	0.952	1.00	166
UpStream	75	0.95	Level	10	0	0.952	1.00	83
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\,v_R + 0.0078\,V_{12} - 0.00627\,L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 816.92 (Equation 13-12 or 13-13)
P_{FD} = 0.705 using Equation (Exhibit 13-7)
V_{12} = 1374 pc/h
V_3 or V_{av34} 505 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1879	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	1713	Exhibit 13-8	7050	No
V_R	166	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1374	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\,V_{12} - 0.009\,L_D$

D_R = 9.8 (pc/mi/ln)
LOS = A (Exhibit 13-2)

Speed Determination

D_s = 0.118 (Exhibit 13-12)
S_R= 62.3 mph (Exhibit 13-12)
S_0= 71.3 mph (Exhibit 13-12)
S = 64.5 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 12/27/2017 2:16 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd OFF Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	3	☑ Yes ☑ On
☑ No ☐ Off	Acceleration Lane Length, L_A		☐ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D	700	L_{down} = 2600 ft
V_u = veh/h	Freeway Volume, V_F	1700	V_D = 50 veh/h
	Ramp Volume, V_R	150	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under 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	1700	0.95	Level	10	0	0.952	1.00	1879
Ramp	150	0.95	Level	10	0	0.952	1.00	166
UpStream								
DownStream	50	0.95	Level	10	0	0.952	1.00	55

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\,v_R + 0.0078\,V_{12} - 0.00627\,L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 0.705 using Equation (Exhibit 13-7)
V_{12} = 1374 pc/h
V_3 or V_{av34} 505 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1879	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	1713	Exhibit 13-8	7050	No
V_R	166	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1374	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\,V_{12} - 0.009\,L_D$

D_R = 9.8 (pc/mi/ln)
LOS = A (Exhibit 13-2)

Speed Determination

D_s = 0.118 (Exhibit 13-12)
S_R= 62.3 mph (Exhibit 13-12)
S_0= 71.3 mph (Exhibit 13-12)
S = 64.5 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 12/27/2017 2:24 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd ON Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☐ On	Number of Lanes, N	3	☐ Yes ☐ On
☐ No ☑ Off	Acceleration Lane Length, L_A	1300	☑ No ☐ Off
L_{up} = 2600 ft	Deceleration Lane Length L_D		L_{down} = ft
V_u = 150 veh/h	Freeway Volume, V_F	1550	V_D = veh/h
	Ramp Volume, V_R	50	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	55.0	

Conversion to pc/h Under 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	1550	0.95	Level	10	0	0.952	1.00	1713
Ramp	50	0.95	Level	10	0	0.952	1.00	55
UpStream	150	0.95	Level	10	0	0.952	1.00	166
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 1430.15 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 1052 pc/h

V_3 or V_{av34} 661 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	1768	Exhibit 13-8	No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1107	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 5.9 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.190 (Exibit 13-11)

S_R= 60.6 mph (Exhibit 13-11)

S_0= 64.4 mph (Exhibit 13-11)

S = 62.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 12/27/2017 1:33 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd ON Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	1300	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D		L_{down} = 9100 ft
V_u = veh/h	Freeway Volume, V_F	1550	V_D = 25 veh/h
	Ramp Volume, V_R	50	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	55.0	

Conversion to pc/h Under 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	1550	0.95	Level	10	0	0.952	1.00	1713
Ramp	50	0.95	Level	10	0	0.952	1.00	55
UpStream								
DownStream	25	0.95	Level	10	0	0.952	1.00	28

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 112.59 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 1052 pc/h

V_3 or V_{av34} 661 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	1768	Exhibit 13-8	No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1107	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 5.9 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.190 (Exibit 13-11)

S_R= 60.6 mph (Exhibit 13-11)

S_0= 64.4 mph (Exhibit 13-11)

S = 62.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 12/27/2017 2:21 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information

Analyst: XL
Agency/Company: HDR Engineering Inc.
Date Performed: 12/26/2017
Analysis Time Period: AM

Site Information

Freeway/Dir of Travel: Sarival Ave to Estrella Pkwy
Weaving Segment Location
Analysis Year: 2035

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2200ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	4975	0.95	10	0	1.5	1.2	0.952	1.00	5499
V_{RF}	50	0.95	10	0	1.5	1.2	0.952	1.00	55
V_{FR}	650	0.95	10	0	1.5	1.2	0.952	1.00	718
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	5499
V_{NW}	5499							V =	6272
V_W	773								
VR	0.123								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	718 lc/h
Interchange density, ID	0.83 int/mi	Weaving lane changes, LC_W	1407 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1362 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	2769 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.271

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	6272 pc/h	Weaving intensity factor, W	0.271
Weaving segment capacity, c_w	10619 veh/h	Weaving segment speed, S	53.9 mph
Weaving segment v/c ratio	0.563	Average weaving speed, S_W	54.3 mph
Weaving segment density, D	23.3 pc/mi/ln	Average non-weaving speed, S_{NW}	53.8 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	3767 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 12/26/2017 4:34 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information

Analyst: XL
Agency/Company: HDR Engineering Inc.
Date Performed: 12/28/2017
Analysis Time Period: AM

Site Information

Freeway/Dir of Travel: 83rd Ave to 91st Ave
Weaving Segment Location
Analysis Year: 2035

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2220ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1775	0.95	10	0	1.5	1.2	0.952	1.00	1962
V_{RF}	475	0.95	10	0	1.5	1.2	0.952	1.00	525
V_{FR}	75	0.95	10	0	1.5	1.2	0.952	1.00	83
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	1962
V_{NW}	1962							V =	2570
V_W	608								
VR	0.237								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	83 lc/h
Interchange density, ID	0.66 int/mi	Weaving lane changes, LC_W	724 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	644 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	1368 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.154

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2570 pc/h	Weaving intensity factor, W	0.154
Weaving segment capacity, c_w	9662 veh/h	Weaving segment speed, S	61.0 mph
Weaving segment v/c ratio	0.253	Average weaving speed, S_W	58.3 mph
Weaving segment density, D	8.4 pc/mi/ln	Average non-weaving speed, S_{NW}	61.9 mph
Level of Service, LOS	A	Maximum weaving length, L_{MAX}	4914 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 3/28/2018 3:23 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information

Analyst	XL
Agency/Company	HDR Engineering Inc.
Date Performed	12/27/2017
Analysis Time Period	AM

Site Information

Freeway/Dir of Travel	107th Ave to Avondale Blvd
Weaving Segment Location	
Analysis Year	2035

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	1675ft
Freeway free-flow speed, FFS	65 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2350
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1450	0.95	10	0	1.5	1.2	0.952	1.00	1603
V_{RF}	375	0.95	10	0	1.5	1.2	0.952	1.00	414
V_{FR}	150	0.95	10	0	1.5	1.2	0.952	1.00	166
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	1603
V_{NW}	1603							V =	2183
V_W	580								
VR	0.266								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	580 lc/h
Interchange density, ID	0.83 int/mi	Weaving lane changes, LC_W	955 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	468 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1423 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.199

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2183 pc/h	Weaving intensity factor, W	0.199
Weaving segment capacity, c_w	7920 veh/h	Weaving segment speed, S	57.8 mph
Weaving segment v/c ratio	0.263	Average weaving speed, S_W	56.7 mph
Weaving segment density, D	9.4 pc/mi/ln	Average non-weaving speed, S_{NW}	58.2 mph
Level of Service, LOS	A	Maximum weaving length, L_{MAX}	5219 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 3/28/2018 3:24 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information

Analyst	XL
Agency/Company	HDR Engineering Inc.
Date Performed	12/27/2017
Analysis Time Period	AM

Site Information

Freeway/Dir of Travel	Bullard Ave to Estrella Pkwy
Weaving Segment Location	
Analysis Year	2035

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	5
Weaving segment length, L_S	2085ft
Freeway free-flow speed, FFS	65 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2350
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1025	0.95	10	0	1.5	1.2	0.952	1.00	1133
V_{RF}	525	0.95	10	0	1.5	1.2	0.952	1.00	580
V_{FR}	100	0.95	10	0	1.5	1.2	0.952	1.00	111
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	1133
V_{NW}	1133							V =	1824
V_W	691								
VR	0.379								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	580 lc/h
Interchange density, ID	0.83 int/mi	Weaving lane changes, LC_W	1248 lc/h
Minimum RF lane changes, LC_{RF}	0 lc/pc	Non-weaving lane changes, LC_{NW}	400 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1648 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.188

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1824 pc/h	Weaving intensity factor, W	0.188
Weaving segment capacity, c_w	6033 veh/h	Weaving segment speed, S	58.3 mph
Weaving segment v/c ratio	0.288	Average weaving speed, S_W	57.1 mph
Weaving segment density, D	6.3 pc/mi/ln	Average non-weaving speed, S_{NW}	59.1 mph
Level of Service, LOS	A	Maximum weaving length, L_{MAX}	6445 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 1/3/2018 3:37 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Estrella Pkwy to Sarival Ave
Agency/Company	HDR Engineering Inc.	Weaving Segment Location	
Date Performed	12/26/2017	Analysis Year	2035
Analysis Time Period	AM		

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2225ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	750	0.95	10	0	1.5	1.2	0.952	1.00	829
V_{RF}	375	0.95	10	0	1.5	1.2	0.952	1.00	414
V_{FR}	75	0.95	10	0	1.5	1.2	0.952	1.00	83
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	829
V_{NW}	829							V =	1326
V_W	497								
VR	0.375								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	0 lc/h
Interchange density, ID	0.83 int/mi	Weaving lane changes, LC_W	694 lc/h
Minimum RF lane changes, LC_{RF}	0 lc/pc	Non-weaving lane changes, LC_{NW}	414 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	1108 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.130

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1326 pc/h	Weaving intensity factor, W	0.130
Weaving segment capacity, c_w	6098 veh/h	Weaving segment speed, S	62.0 mph
Weaving segment v/c ratio	0.207	Average weaving speed, S_W	59.2 mph
Weaving segment density, D	4.3 pc/mi/ln	Average non-weaving speed, S_{NW}	63.7 mph
Level of Service, LOS	A	Maximum weaving length, L_{MAX}	6400 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 1/3/2018 3:32 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	91st Ave to 83rd Ave
Agency/Company	HDR Engineering Inc.	Weaving Segment Location	
Date Performed	12/27/2017	Analysis Year	2035
Analysis Time Period	AM		

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2055ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	7550	0.95	10	0	1.5	1.2	0.952	1.00	8345
V_{RF}	125	0.95	10	0	1.5	1.2	0.952	1.00	138
V_{FR}	975	0.95	10	0	1.5	1.2	0.952	1.00	1078
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	8345
V_{NW}	8345							V =	9561
V_W	1216								
VR	0.127								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.66 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	0 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	9561 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	8442 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.079	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	3805 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 3/28/2018 3:15 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Avondale Blvd to 107th Ave
Agency/Company	HDR Engineering Inc.	Weaving Segment Location	
Date Performed	12/27/2017	Analysis Year	2035
Analysis Time Period	AM		

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1620ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	6375	0.95	10	0	1.5	1.2	0.952	1.00	7046
V_{RF}	75	0.95	10	0	1.5	1.2	0.952	1.00	83
V_{FR}	975	0.95	10	0	1.5	1.2	0.952	1.00	1078
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	7046
V_{NW}	7046							V =	8207
V_W	1161								
VR	0.141								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1161 lc/h
Interchange density, ID	0.83 int/mi	Weaving lane changes, LC_W	1529 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1559 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	3088 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.376

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	8207 pc/h	Weaving intensity factor, W	0.376
Weaving segment capacity, c_w	8274 veh/h	Weaving segment speed, S	47.4 mph
Weaving segment v/c ratio	0.945	Average weaving speed, S_W	51.3 mph
Weaving segment density, D	43.3 pc/mi/ln	Average non-weaving speed, S_{NW}	46.8 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	3947 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 3/28/2018 3:18 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Estrella Pkwy to Bullard Ave
Agency/Company	HDR Engineering Inc.	Weaving Segment Location	
Date Performed	12/27/2017	Analysis Year	2035
Analysis Time Period	AM		

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2100ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	5225	0.95	10	0	1.5	1.2	0.952	1.00	5775
V_{RF}	400	0.95	10	0	1.5	1.2	0.952	1.00	442
V_{FR}	1000	0.95	10	0	1.5	1.2	0.952	1.00	1105
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	5775
V_{NW}	5775							V =	7322
V_W	1547								
VR	0.211								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1105 lc/h
Interchange density, ID	0.83 int/mi	Weaving lane changes, LC_W	1776 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1365 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	3141 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.311

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	7322 pc/h	Weaving intensity factor, W	0.311
Weaving segment capacity, c_w	10262 veh/h	Weaving segment speed, S	50.6 mph
Weaving segment v/c ratio	0.680	Average weaving speed, S_W	53.2 mph
Weaving segment density, D	28.9 pc/mi/ln	Average non-weaving speed, S_{NW}	50.0 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	4652 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 3/28/2018 3:21 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At 75th Ave*
Date Performed	*12/29/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4450* veh/h		Peak-Hour Factor, PHF	*0.95*
AADT	veh/day		%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*5*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*984*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*15.1*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/29/2017 2:39 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At 83rd Ave*
Date Performed	*12/29/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4000* veh/h		Peak-Hour Factor, PHF	*0.95*
AADT	veh/day		%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*4*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1105*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*17.0*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/29/2017 2:17 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*XL*
Agency or Company	*HDR Engineering Inc.*
Date Performed	*12/29/2017*
Analysis Time Period	*PM*

Site Information

Highway/Direction of Travel	*Eastbound*
From/To	*At 91st Ave*
Jurisdiction	*ADOT*
Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3525*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1299*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*20.0*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes; S - Speed
V - Hourly volume; D - Density
v_p - Flow rate; FFS - Free-flow speed
LOS - Level of service; BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12; f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13; f_{LC} - Exhibit 11-9
f_p - Page 11-18; TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 12/29/2017 1:12 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*XL*
Agency or Company	*HDR Engineering Inc.*
Date Performed	*12/29/2017*
Analysis Time Period	*PM*

Site Information

Highway/Direction of Travel	*Eastbound*
From/To	*At 99th Ave*
Jurisdiction	*ADOT*
Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3675*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1354*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*20.8*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes; S - Speed
V - Hourly volume; D - Density
v_p - Flow rate; FFS - Free-flow speed
LOS - Level of service; BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12; f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13; f_{LC} - Exhibit 11-9
f_p - Page 11-18; TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 12/29/2017 1:05 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At 107th Ave*
Date Performed	*12/29/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3375* veh/h		Peak-Hour Factor, PHF	*0.95*
AADT	veh/day		%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1243*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*19.1*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/29/2017 12:57 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Avondale Blvd*
Date Performed	*12/29/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3050* veh/h		Peak-Hour Factor, PHF	*0.95*
AADT	veh/day		%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1124*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*17.3*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/29/2017 12:49 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	From/To	At Bullard Ave
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	2950	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 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)	65.0	mph	FFS	65.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	815	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	65.0	mph	S		mph
D = v_p / S	12.5	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	B		Required Number of Lanes, N		

Glossary

N - Number of lanes; S - Speed
V - Hourly volume; D - Density
v_p - Flow rate; FFS - Free-flow speed
LOS - Level of service; BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12; f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13; f_{LC} - Exhibit 11-9
f_p - Page 11-18; TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 12/29/2017 10:50 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	From/To	At Dysart Rd
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	2925	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 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)	65.0	mph	FFS	65.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1078	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	65.0	mph	S		mph
D = v_p / S	16.6	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	B		Required Number of Lanes, N		

Glossary

N - Number of lanes; S - Speed
V - Hourly volume; D - Density
v_p - Flow rate; FFS - Free-flow speed
LOS - Level of service; BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12; f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13; f_{LC} - Exhibit 11-9
f_p - Page 11-18; TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 12/29/2017 12:29 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Estrella Pkwy*
Date Performed	*12/27/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2300*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*4*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*636*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*9.8*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/29/2017 10:45 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Sarival Ave*
Date Performed	*12/29/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2025*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*5*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*448*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*6.9*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/29/2017 10:14 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*East of Agua Fria River*
Date Performed	*12/29/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2975* veh/h		Peak-Hour Factor, PHF	*0.95*
AADT	veh/day		%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1096*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*16.9*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/29/2017 11:15 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*East of Sarival Ave*
Date Performed	*12/26/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2025* veh/h		Peak-Hour Factor, PHF	*0.95*
AADT	veh/day		%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*4*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*560*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*8.6*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/29/2017 10:35 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*El Mirage Rd*
Date Performed	*12/29/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3125*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1151*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	*65.0*	mph	S		mph
D = v_p / S	*17.7*	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	*B*		Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/29/2017 12:40 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*West of 67th Ave*
Date Performed	*12/29/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3950*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*5*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*873*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	*65.0*	mph	S		mph
D = v_p / S	*13.4*	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	*B*		Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/29/2017 2:56 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	From/To	West of Agua Fria River
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	2975	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 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)	65.0	mph	FFS	65.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
			Design (N)		
Operational (LOS)			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	822	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	65.0	mph	S		mph
D = v_p / S	12.6	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	B		Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/29/2017 11:04 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Westbound
Agency or Company	HDR Engineering Inc.	From/To	83rd Ave major Diverge
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	675	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 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)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
			Design (N)		
Operational (LOS)			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	373	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	60.0	mph	S		mph
D = v_p / S	6.2	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	A		Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/29/2017 2:34 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At 75th Ave*
Date Performed	*12/29/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*8900* veh/h	Peak-Hour Factor, PHF	*0.95*
AADT	veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*5*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1967*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*60.4*	mph	S	mph
D = v_p / S	*32.5*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/29/2017 2:40 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At 83rd Ave*
Date Performed	*12/29/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*8225* veh/h	Peak-Hour Factor, PHF	*0.95*
AADT	veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*4*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2273*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*54.2*	mph	S	mph
D = v_p / S	*41.9*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*E*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/29/2017 2:18 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Westbound
Agency or Company	HDR Engineering Inc.	From/To	At 99th Ave
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	7600	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	3		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	65.0	mph
FFS (measured)	65.0	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2800	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	37.2	mph	S		mph
D = v_p / S	75.3	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	F		Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/29/2017 1:06 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Westbound
Agency or Company	HDR Engineering Inc.	From/To	At 107th Ave
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	7100	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	3		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	65.0	mph
FFS (measured)	65.0	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2616	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	44.0	mph	S		mph
D = v_p / S	59.4	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	F		Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/29/2017 12:57 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Avondale Blvd*
Date Performed	*12/29/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*6300* veh/h	Peak-Hour Factor, PHF	*0.95*
AADT	veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2321*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*53.0*	mph	S	mph
D = v_p / S	*43.8*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*E*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 *HCS 2010*TM Version 6.1 Generated: 12/29/2017 12:51 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Bullard Ave*
Date Performed	*12/27/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*6025* veh/h	Peak-Hour Factor, PHF	*0.95*
AADT	veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*4*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1665*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*64.0*	mph	S	mph
D = v_p / S	*26.0*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 *HCS 2010*TM Version 6.1 Generated: 12/29/2017 10:53 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Dysart Rd*
Date Performed	*12/29/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*6075* veh/h	Peak-Hour Factor, PHF	*0.95*
AADT	veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2238*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*40.7*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*E*		Required Number of Lanes, N	

Glossary

N - Number of lanes; S - Speed
V - Hourly volume; D - Density
v_p - Flow rate; FFS - Free-flow speed
LOS - Level of service; BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12; f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13; f_{LC} - Exhibit 11-9
f_p - Page 11-18; TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 12/29/2017 12:31 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Estrella Pkwy*
Date Performed	*12/27/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5550* veh/h	Peak-Hour Factor, PHF	*0.95*
AADT	veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*5*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1227*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*18.9*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary

N - Number of lanes; S - Speed
V - Hourly volume; D - Density
v_p - Flow rate; FFS - Free-flow speed
LOS - Level of service; BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12; f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13; f_{LC} - Exhibit 11-9
f_p - Page 11-18; TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 12/29/2017 10:46 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Sarival Ave*
Date Performed	*12/29/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4825*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*5*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1067*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*16.4*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary

N - Number of lanes; S - Speed
V - Hourly volume; D - Density
v_p - Flow rate; FFS - Free-flow speed
LOS - Level of service; BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12; f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13; f_{LC} - Exhibit 11-9
f_p - Page 11-18; TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 12/29/2017 10:29 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*East of 91st Ave*
Date Performed	*12/29/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*7350*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*4*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2031*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*59.4*	mph	S	mph
D = v_p / S	*34.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary

N - Number of lanes; S - Speed
V - Hourly volume; D - Density
v_p - Flow rate; FFS - Free-flow speed
LOS - Level of service; BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12; f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13; f_{LC} - Exhibit 11-9
f_p - Page 11-18; TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 12/29/2017 1:52 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*East of Agua Fria River*
Date Performed	*12/29/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*6450* veh/h	Peak-Hour Factor, PHF	*0.95*
AADT	veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	mi

Calculate Flow Adjustments

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 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)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2376*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*51.5*	mph	S	mph
D = v_p / S	*46.1*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*F*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/29/2017 11:18 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*El Mirage Rd*
Date Performed	*12/29/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*6325* veh/h	Peak-Hour Factor, PHF	*0.95*
AADT	veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	mi

Calculate Flow Adjustments

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 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)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2330*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*52.7*	mph	S	mph
D = v_p / S	*44.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*E*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/29/2017 12:41 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Westbound
Agency or Company	HDR Engineering Inc.	From/To	West of 67th Ave
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	8225	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	5		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	65.0	mph
FFS (measured)	65.0	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1818	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	62.5	mph	S	mph
D = v_p / S	29.1	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	D		Required Number of Lanes, N	

Glossary

N - Number of lanes; S - Speed
V - Hourly volume; D - Density
v_p - Flow rate; FFS - Free-flow speed
LOS - Level of service; BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12; f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13; f_{LC} - Exhibit 11-9
f_p - Page 11-18; TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 12/29/2017 2:57 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Westbound
Agency or Company	HDR Engineering Inc.	From/To	West of 91st Ave
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	7350	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	3		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	65.0	mph
FFS (measured)	65.0	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2708	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	40.7	mph	S	mph
D = v_p / S	66.5	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	F		Required Number of Lanes, N	

Glossary

N - Number of lanes; S - Speed
V - Hourly volume; D - Density
v_p - Flow rate; FFS - Free-flow speed
LOS - Level of service; BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12; f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13; f_{LC} - Exhibit 11-9
f_p - Page 11-18; TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 12/29/2017 1:49 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*West of Agua Fria River*
Date Performed	*12/29/2017*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2035*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*6450* veh/h		Peak-Hour Factor, PHF	*0.95*
AADT	veh/day		%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*4*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1782*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*62.9*	mph	S	mph
D = v_p / S	*28.3*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 12/29/2017 11:17 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave OFF Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N	5	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D	170	L_{down} = ft
V_u = 475 veh/h	Freeway Volume, V_F	4450	V_D = veh/h
	Ramp Volume, V_R	500	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under 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	4450	0.95	Level	10	0	0.952	1.00	4918
Ramp	500	0.95	Level	10	0	0.952	1.00	553
UpStream	475	0.95	Level	10	0	0.952	1.00	525
DownStream								

Merge Areas		Diverge Areas	
Estimation of v_{12}		**Estimation of v_{12}**	
$V_{12} = V_F (P_{FM})$		$V_{12} = V_R + (V_F - V_R)P_{FD}$	
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} =	0.436 using Equation (Exhibit 13-7)
V_{12} =	pc/h	V_{12} =	2242 pc/h
V_3 or V_{av34}	pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34}	1092 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h?	☐ Yes ☐ No	Is V_3 or V_{av34} > 2,700 pc/h?	☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2	☐ Yes ☐ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2	☐ Yes ☑ No
If Yes,V_{12a} =	pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} =	pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Capacity Checks (Diverge)

	Actual	Capacity		LOS F?
V_F	4427	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	3874	Exhibit 13-8	9400	No
V_R	553	Exhibit 13-10	2200	No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2242	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)		Level of Service Determination (if not F)	
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$		$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$	
D_R =	(pc/mi/ln)	D_R =	22.0 (pc/mi/ln)
LOS =	(Exhibit 13-2)	LOS =	C (Exhibit 13-2)
Speed Determination		**Speed Determination**	
M_S =	(Exibit 13-11)	D_s =	0.153 (Exhibit 13-12)
S_R=	mph (Exhibit 13-11)	S_R=	61.5 mph (Exhibit 13-12)
S_0=	mph (Exhibit 13-11)	S_0=	70.9 mph (Exhibit 13-12)
S =	mph (Exhibit 13-13)	S =	65.8 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/3/2018 4:13 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave OFF Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	5	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A		☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D	170	L_{down} = 1700 ft
V_u = veh/h	Freeway Volume, V_F	4450	V_D = 200 veh/h
	Ramp Volume, V_R	500	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under 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	4450	0.95	Level	10	0	0.952	1.00	4918
Ramp	500	0.95	Level	10	0	0.952	1.00	553
UpStream								
DownStream	200	0.95	Level	10	0	0.952	1.00	221

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 2242 pc/h

V_3 or V_{av34} 1092 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4427	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	3874	Exhibit 13-8	9400	No
V_R	553	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2242	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 22.0 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.153 (Exhibit 13-12)

S_R= 61.5 mph (Exhibit 13-12)

S_0= 70.9 mph (Exhibit 13-12)

S = 65.8 mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 12/29/2017 2:52 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave on Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☐ On	Number of Lanes, N	3	☐ Yes ☐ On
☐ No ☑ Off	Acceleration Lane Length, L_A	800	☑ No ☐ Off
L_{up} = 2200 ft	Deceleration Lane Length L_D		L_{down} = ft
V_u = 1775 veh/h	Freeway Volume, V_F	2025	V_D = veh/h
	Ramp Volume, V_R	400	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	55.0	

Conversion to pc/h Under 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	2025	0.95	Level	10	0	0.952	1.00	2238
Ramp	400	0.95	Level	10	0	0.952	1.00	442
UpStream	1775	0.95	Level	10	0	0.952	1.00	1962
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 1403.32 (Equation 13-6 or 13-7)

P_{FM} = 0.600 using Equation (Exhibit 13-6)

V_{12} = 1343 pc/h

V_3 or V_{av34} 895 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2680	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1785	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 14.2 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.256 (Exibit 13-11)

S_R= 59.1 mph (Exhibit 13-11)

S_0= 63.6 mph (Exhibit 13-11)

S = 60.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 1/4/2018 1:59 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave ON Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	3	☑ Yes ☑ On
☑ No ☐ Off	Acceleration Lane Length, L_A	800	☐ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D		L_{down} = 1400 ft
V_u = veh/h	Freeway Volume, V_F	2025	V_D = 400 veh/h
	Ramp Volume, V_R	400	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	55.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2025	0.95	Level	10	0	0.952	1.00	2238
Ramp	400	0.95	Level	10	0	0.952	1.00	442
UpStream								
DownStream	400	0.95	Level	10	0	0.952	1.00	442

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.600 using Equation (Exhibit 13-6)

V_{12} = 1343 pc/h

V_3 or V_{av34} 895 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2680	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1785	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 14.2 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.256 (Exibit 13-11)

S_R= 59.1 mph (Exhibit 13-11)

S_0= 63.6 mph (Exhibit 13-11)

S = 60.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/4/2018 2:05 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	83rd ON Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N	4	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A	1500	☑ No ☐ Off
L_{up} = 4300 ft	Deceleration Lane Length L_D		L_{down} = ft
V_u = 125 veh/h	Freeway Volume, V_F	4000	V_D = veh/h
	Ramp Volume, V_R	475	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	55.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4000	0.95	Level	10	0	0.952	1.00	4421
Ramp	475	0.95	Level	10	0	0.952	1.00	525
UpStream	125	0.95	Level	10	0	0.952	1.00	138
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.152 using Equation (Exhibit 13-6)

V_{12} = 673 pc/h

V_3 or V_{av34} 1874 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No

If Yes, V_{12a} = 1768 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4946	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2293	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 13.7 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.195 (Exibit 13-11)

S_R= 60.5 mph (Exhibit 13-11)

S_0= 62.0 mph (Exhibit 13-11)

S = 61.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/4/2018 1:03 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	83rd ON Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{up} = ft; V_u = veh/h

Number of Lanes, N	4
Acceleration Lane Length, L_A	1500
Deceleration Lane Length L_D	
Freeway Volume, V_F	4000
Ramp Volume, V_R	475
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☑ Yes ☐ On ☐ No ☑ Off; L_{down} = 6200 ft; V_D = 500 veh/h

Conversion to pc/h Under 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	4000	0.95	Level	10	0	0.952	1.00	4421
Ramp	475	0.95	Level	10	0	0.952	1.00	525
UpStream								
DownStream	500	0.95	Level	10	0	0.952	1.00	553

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.152 using Equation (Exhibit 13-6)

V_{12} = 673 pc/h

V_3 or V_{av34} 1874 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No

If Yes,V_{12a} = 1768 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4946	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2293	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 13.7 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.195 (Exibit 13-11)

S_R= 60.5 mph (Exhibit 13-11)

S_0= 62.0 mph (Exhibit 13-11)

S = 61.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/4/2018 1:03 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	91st Ave OFF Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off; L_{up} = 9100 ft; V_u = 300 veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	700
Freeway Volume, V_F	3675
Ramp Volume, V_R	175
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	60.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{down} = ft; V_D = veh/h

Conversion to pc/h Under 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	3675	0.95	Level	10	0	0.952	1.00	4062
Ramp	175	0.95	Level	10	0	0.952	1.00	193
UpStream	300	0.95	Level	10	0	0.952	1.00	332
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 2216.91 (Equation 13-12 or 13-13)

P_{FD} = 0.650 using Equation (Exhibit 13-7)

V_{12} = 2706 pc/h

V_3 or V_{av34} 1356 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4062	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	3869	Exhibit 13-8	7050	No
V_R	193	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2706	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 21.2 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.120 (Exhibit 13-12)

S_R= 62.2 mph (Exhibit 13-12)

S_0= 69.9 mph (Exhibit 13-12)

S = 64.6 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 12/29/2017 1:07 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	91st Ave OFF Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{up} = ft; V_u = veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	700
Freeway Volume, V_F	3675
Ramp Volume, V_R	175
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	60.0

Downstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off; L_{down} = 2600 ft; V_D = 600 veh/h

Conversion to pc/h Under 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	3675	0.95	Level	10	0	0.952	1.00	4062
Ramp	175	0.95	Level	10	0	0.952	1.00	193
UpStream								
DownStream	600	0.95	Level	10	0	0.952	1.00	663

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 0.650 using Equation (Exhibit 13-7)
V_{12} = 2706 pc/h
V_3 or V_{av34} 1356 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4062	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	3869	Exhibit 13-8	7050	No
V_R	193	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2706	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 21.2 (pc/mi/ln)
LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.120 (Exhibit 13-12)
S_R= 62.2 mph (Exhibit 13-12)
S_0= 69.9 mph (Exhibit 13-12)
S = 64.6 mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 12/29/2017 1:08 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	107th Ave ON Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☑ Yes ☐ On ☐ No ☑ Off; L_{up} = 2600 ft; V_u = 150 veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	1300
Deceleration Lane Length L_D	
Freeway Volume, V_F	3375
Ramp Volume, V_R	300
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{down} = ft; V_D = veh/h

Conversion to pc/h Under 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	3375	0.95	Level	10	0	0.952	1.00	3730
Ramp	300	0.95	Level	10	0	0.952	1.00	332
UpStream	150	0.95	Level	10	0	0.952	1.00	166
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = 1921.07 (Equation 13-6 or 13-7)
P_{FM} = 0.614 using Equation (Exhibit 13-6)
V_{12} = 2290 pc/h
V_3 or V_{av34} 1440 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4062	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2622	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 17.6 (pc/mi/ln)
LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.232 (Exibit 13-11)
S_R= 59.7 mph (Exhibit 13-11)
S_0= 61.6 mph (Exhibit 13-11)
S = 60.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = using Equation (Exhibit 13-7)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)
S_R= mph (Exhibit 13-12)
S_0= mph (Exhibit 13-12)
S = mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 12/29/2017 12:59 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	107th Ave ON Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{up} = ft; V_u = veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	1300
Deceleration Lane Length L_D	
Freeway Volume, V_F	3375
Ramp Volume, V_R	300
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☑ Yes ☐ On ☐ No ☑ Off; L_{down} = 9100 ft; V_D = 175 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3375	0.95	Level	10	0	0.952	1.00	3730
Ramp	300	0.95	Level	10	0	0.952	1.00	332
UpStream								
DownStream	175	0.95	Level	10	0	0.952	1.00	193

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = 776.04 (Equation 13-6 or 13-7)
P_{FM} = 0.614 using Equation (Exhibit 13-6)
V_{12} = 2290 pc/h
V_3 or V_{av34} 1440 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4062	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2622	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 17.6 (pc/mi/ln)
LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.232 (Exibit 13-11)
S_R= 59.7 mph (Exhibit 13-11)
S_0= 61.6 mph (Exhibit 13-11)
S = 60.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = using Equation (Exhibit 13-7)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)
S_R= mph (Exhibit 13-12)
S_0= mph (Exhibit 13-12)
S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 12/29/2017 1:01 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Avondale Blvd OFF Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off; L_{up} = 9100 ft; V_u = 200 veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	700
Freeway Volume, V_F	3125
Ramp Volume, V_R	75
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	60.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{down} = ft; V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3125	0.95	Level	10	0	0.952	1.00	3454
Ramp	75	0.95	Level	10	0	0.952	1.00	83
UpStream	200	0.95	Level	10	0	0.952	1.00	221
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 1533.30 (Equation 13-12 or 13-13)
P_{FD} = 0.670 using Equation (Exhibit 13-7)
V_{12} = 2341 pc/h
V_3 or V_{av34} 1113 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3454	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	3371	Exhibit 13-8	7050	No
V_R	83	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2341	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 18.1 (pc/mi/ln)
LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.110 (Exhibit 13-12)
S_R= 62.5 mph (Exhibit 13-12)
S_0= 70.9 mph (Exhibit 13-12)
S = 64.9 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 12/29/2017 12:43 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Avondale Blvd OFF Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☑ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☐ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 700	L_{down} = 3000 ft
V_u = veh/h	Freeway Volume, V_F: 3125	V_D = 500 veh/h
	Ramp Volume, V_R: 75	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under 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	3125	0.95	Level	10	0	0.952	1.00	3454
Ramp	75	0.95	Level	10	0	0.952	1.00	83
UpStream								
DownStream	500	0.95	Level	10	0	0.952	1.00	553

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.670 using Equation (Exhibit 13-7)

V_{12} = 2341 pc/h

V_3 or V_{av34} 1113 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3454	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	3371	Exhibit 13-8	7050	No
V_R	83	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2341	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 18.1 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.110 (Exhibit 13-12)

S_R= 62.5 mph (Exhibit 13-12)

S_0= 70.9 mph (Exhibit 13-12)

S = 64.9 mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 12/29/2017 12:44 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Bullard Ave ON Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☐ On	Number of Lanes, N: 4	☐ Yes ☐ On
☐ No ☑ Off	Acceleration Lane Length, L_A: 1300	☑ No ☐ Off
L_{up} = 2600 ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = 100 veh/h	Freeway Volume, V_F: 2950	V_D = veh/h
	Ramp Volume, V_R: 50	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under 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	2950	0.95	Level	10	0	0.952	1.00	3261
Ramp	50	0.95	Level	10	0	0.952	1.00	55
UpStream	100	0.95	Level	10	0	0.952	1.00	111
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.474 using Equation (Exhibit 13-6)

V_{12} = 1547 pc/h

V_3 or V_{av34} 857 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3316	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1602	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 9.8 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.197 (Exibit 13-11)

S_R= 60.5 mph (Exhibit 13-11)

S_0= 63.7 mph (Exhibit 13-11)

S = 62.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 12/29/2017 10:56 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / **Site Information**

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Bullard Ave ON Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	4	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	1300	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D		L_{down} = 9100 ft
V_u = veh/h	Freeway Volume, V_F	2950	V_D = 75 veh/h
	Ramp Volume, V_R	50	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	55.0	

Conversion to pc/h Under 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	2950	0.95	Level	10	0	0.952	1.00	3261
Ramp	50	0.95	Level	10	0	0.952	1.00	55
UpStream								
DownStream	75	0.95	Level	10	0	0.952	1.00	83

Merge Areas

Estimation of v_{12}

$$V_{12} = V_F \,(P_{FM})$$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.474 using Equation (Exhibit 13-6)

V_{12} = 1547 pc/h

V_3 or V_{av34} 857 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3316	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1602	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

D_R = 5.475 + 0.00734 v $_R$ + 0.0078 V_{12} - 0.00627 L_A

D_R = 9.8 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.197 (Exibit 13-11)

S_R= 60.5 mph (Exhibit 13-11)

S_0= 63.7 mph (Exhibit 13-11)

S = 62.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 12/29/2017 10:57 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / **Site Information**

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd OFF Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N	3	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D	700	L_{down} = ft
V_u = 50 veh/h	Freeway Volume, V_F	2975	V_D = veh/h
	Ramp Volume, V_R	75	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under 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	2975	0.95	Level	10	0	0.952	1.00	3288
Ramp	75	0.95	Level	10	0	0.952	1.00	83
UpStream	50	0.95	Level	10	0	0.952	1.00	55
DownStream								

Merge Areas

Estimation of v_{12}

$$V_{12} = V_F \,(P_{FM})$$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

D_R = 5.475 + 0.00734 v $_R$ + 0.0078 V_{12} - 0.00627 L_A

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = 391.97 (Equation 13-12 or 13-13)

P_{FD} = 0.674 using Equation (Exhibit 13-7)

V_{12} = 2243 pc/h

V_3 or V_{av34} 1045 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3288	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	3205	Exhibit 13-8	7050	No
V_R	83	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2243	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D

D_R = 17.2 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.110 (Exhibit 13-12)

S_R= 62.5 mph (Exhibit 13-12)

S_0= 71.1 mph (Exhibit 13-12)

S = 65.0 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 12/29/2017 11:22 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd OFF Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐Yes ☐On	Number of Lanes, N	3	☑Yes ☑On
☑No ☐Off	Acceleration Lane Length, L_A		☐No ☐Off
L_{up} = ft	Deceleration Lane Length L_D	700	L_{down} = 2600 ft
V_u = veh/h	Freeway Volume, V_F	2975	V_D = 200 veh/h
	Ramp Volume, V_R	75	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under 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	2975	0.95	Level	10	0	0.952	1.00	3288
Ramp	75	0.95	Level	10	0	0.952	1.00	83
UpStream								
DownStream	200	0.95	Level	10	0	0.952	1.00	221

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☐No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☐No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.674 using Equation (Exhibit 13-7)

V_{12} = 2243 pc/h

V_3 or V_{av34} 1045 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☑No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☑No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3288	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	3205	Exhibit 13-8	7050	No
V_R	83	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2243	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 17.2 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.110 (Exhibit 13-12)

S_R= 62.5 mph (Exhibit 13-12)

S_0= 71.1 mph (Exhibit 13-12)

S = 65.0 mph (Exhibit 13-13)

$HCS2010^{TM}$ Version 6.1 Generated: 12/29/2017 11:25 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd ON Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑Yes ☐On	Number of Lanes, N	3	☐Yes ☐On
☐No ☑Off	Acceleration Lane Length, L_A	1300	☑No ☐Off
L_{up} = 2600 ft	Deceleration Lane Length L_D		L_{down} = ft
V_u = 75 veh/h	Freeway Volume, V_F	2925	V_D = veh/h
	Ramp Volume, V_R	200	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	55.0	

Conversion to pc/h Under 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	2925	0.95	Level	10	0	0.952	1.00	3233
Ramp	200	0.95	Level	10	0	0.952	1.00	221
UpStream	75	0.95	Level	10	0	0.952	1.00	83
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = 1790.96 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 1985 pc/h

V_3 or V_{av34} 1248 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☑No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☑No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3454	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2206	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 14.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.213 (Exibit 13-11)

S_R= 60.1 mph (Exhibit 13-11)

S_0= 62.3 mph (Exhibit 13-11)

S = 60.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☐No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☐No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

$HCS2010^{TM}$ Version 6.1 Generated: 12/29/2017 12:35 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd ON Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1300	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = 9100 ft
V_u = veh/h	Freeway Volume, V_F: 2925	V_D = 75 veh/h
	Ramp Volume, V_R: 200	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under 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	2925	0.95	Level	10	0	0.952	1.00	3233
Ramp	200	0.95	Level	10	0	0.952	1.00	221
UpStream								
DownStream	75	0.95	Level	10	0	0.952	1.00	83

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 333.74 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 1985 pc/h

V_3 or V_{av34} 1248 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3454	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2206	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R = 14.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.213 (Exibit 13-11)

S_R= 60.1 mph (Exhibit 13-11)

S_0= 62.3 mph (Exhibit 13-11)

S = 60.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010[TM] Version 6.1 Generated: 12/29/2017 12:37 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave OFF Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☐ On	Number of Lanes, N: 4	☐ Yes ☐ On
☐ No ☑ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = 600 ft	Deceleration Lane Length L_D: 1500	L_{down} = ft
V_u = 300 veh/h	Freeway Volume, V_F: 5375	V_D = veh/h
	Ramp Volume, V_R: 450	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under 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	5375	0.95	Level	10	0	0.952	1.00	5941
Ramp	450	0.95	Level	10	0	0.952	1.00	497
UpStream	300	0.95	Level	10	0	0.952	1.00	332
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 2871 pc/h

V_3 or V_{av34} 1535 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5941	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	5444	Exhibit 13-8	9400	No
V_R	497	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2871	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R = 15.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.148 (Exhibit 13-12)

S_R= 61.6 mph (Exhibit 13-12)

S_0= 69.2 mph (Exhibit 13-12)

S = 65.3 mph (Exhibit 13-13)

 HCS2010[TM] Version 6.1 Generated: 1/4/2018 2:07 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave OFF Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	4	☑ Yes ☑ On
☑ No ☐ Off	Acceleration Lane Length, L_A		☐ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D	1500	L_{down} = 5400 ft
V_u = veh/h	Freeway Volume, V_F	5375	V_D = 575 veh/h
	Ramp Volume, V_R	450	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under 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	5375	0.95	Level	10	0	0.952	1.00	5941
Ramp	450	0.95	Level	10	0	0.952	1.00	497
UpStream								
DownStream	575	0.95	Level	10	0	0.952	1.00	636

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 2871 pc/h

V_3 or V_{av34} 1535 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5941	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	5444	Exhibit 13-8	9400	No
V_R	497	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2871	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 15.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.148 (Exhibit 13-12)

S_R= 61.6 mph (Exhibit 13-12)

S_0= 69.2 mph (Exhibit 13-12)

S = 65.3 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/4/2018 2:09 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave ON Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N	5	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A	1300	☑ No ☐ Off
L_{up} = 2000 ft	Deceleration Lane Length L_D		L_{down} = ft
V_u = 2750 veh/h	Freeway Volume, V_F	8225	V_D = veh/h
	Ramp Volume, V_R	675	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	55.0	

Conversion to pc/h Under 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	8225	0.95	Level	10	0	0.952	1.00	9091
Ramp	675	0.95	Level	10	0	0.952	1.00	746
UpStream	2750	0.95	Level	10	0	0.952	1.00	3039
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.125 using Equation (Exhibit 13-6)

V_{12} = 821 pc/h

V_3 or V_{av34} 2885 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No

If Yes,V_{12a} = 2636 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	7337	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3382	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 23.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.293 (Exibit 13-11)

S_R= 58.3 mph (Exhibit 13-11)

S_0= 59.7 mph (Exhibit 13-11)

S = 59.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 12/29/2017 2:49 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave ON Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	5	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	1300	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D		L_{down} = 9100 ft
V_u = veh/h	Freeway Volume, V_F	8225	V_D = 675 veh/h
	Ramp Volume, V_R	675	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	55.0	

Conversion to pc/h Under 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	8225	0.95	Level	10	0	0.952	1.00	9091
Ramp	675	0.95	Level	10	0	0.952	1.00	746
UpStream								
DownStream	675	0.95	Level	10	0	0.952	1.00	746

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.125 using Equation (Exhibit 13-6)

V_{12} = 821 pc/h

V_3 or V_{av34} = 2885 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No

If Yes,V_{12a} = 2636 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	7337	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3382	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 23.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.293 (Exibit 13-11)

S_R= 58.3 mph (Exhibit 13-11)

S_0= 59.7 mph (Exhibit 13-11)

S = 59.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010TM Version 6.1 Generated: 1/4/2018 2:11 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	83rd Ave OFF Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N	5	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D	700	L_{down} = ft
V_u = 675 veh/h	Freeway Volume, V_F	8900	V_D = veh/h
	Ramp Volume, V_R	675	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under 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	8900	0.95	Level	10	0	0.952	1.00	9837
Ramp	675	0.95	Level	10	0	0.952	1.00	746
UpStream	675	0.95	Level	10	0	0.952	1.00	746
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 2764.03 (Equation 13-12 or 13-13)

P_{FD} = 0.260 using Equation (Exhibit 13-7)

V_{12} = 2598 pc/h

V_3 or V_{av34} 2636 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No

If Yes,V_{12a} = 3148 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	7870	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	7124	Exhibit 13-8	9400	No
V_R	746	Exhibit 13-10	4400	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2598	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 12.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.170 (Exhibit 13-12)

S_R= 61.1 mph (Exhibit 13-12)

S_0= 66.0 mph (Exhibit 13-12)

S = 63.9 mph (Exhibit 13-13)

HCS2010TM Version 6.1 Generated: 3/28/2018 1:13 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	91st Ave ON Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☐ On	Number of Lanes, N	3	☐ Yes ☐ On
☐ No ☑ Off	Acceleration Lane Length, L_A	1300	☑ No ☐ Off
L_{up} = 2600 ft	Deceleration Lane Length L_D		L_{down} = ft
V_u = 1050 veh/h	Freeway Volume, V_F	7350	V_D = veh/h
	Ramp Volume, V_R	250	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	55.0	

Conversion to pc/h Under 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	7350	0.95	Level	10	0	0.952	1.00	8124
Ramp	250	0.95	Level	10	0	0.952	1.00	276
UpStream	1050	0.95	Level	10	0	0.952	1.00	1161
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = 2849.40 (Equation 13-6 or 13-7)

P_{FM} = 0.598 using Equation (Exhibit 13-6)

V_{12} = 4858 pc/h

V_3 or V_{av34} 3266 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = 5424 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	8400	Exhibit 13-8	Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	5700	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 41.7 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 1.344 (Exibit 13-11)

S_R= 34.1 mph (Exhibit 13-11)

S_0= 56.1 mph (Exhibit 13-11)

S = 39.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 12/29/2017 1:10 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	91st Ave ON Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	1300	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D		L_{down} = 9100 ft
V_u = veh/h	Freeway Volume, V_F	7350	V_D = 500 veh/h
	Ramp Volume, V_R	250	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	55.0	

Conversion to pc/h Under 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	7350	0.95	Level	10	0	0.952	1.00	8124
Ramp	250	0.95	Level	10	0	0.952	1.00	276
UpStream								
DownStream	500	0.95	Level	10	0	0.952	1.00	553

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = 2223.56 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 4987 pc/h

V_3 or V_{av34} 3137 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = 5424 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	8400	Exhibit 13-8	Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	5700	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 41.7 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 1.344 (Exibit 13-11)

S_R= 34.1 mph (Exhibit 13-11)

S_0= 56.1 mph (Exhibit 13-11)

S = 39.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 12/29/2017 1:11 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	107th Ave OFF Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑Yes ☑On	Number of Lanes, N: 3	☐Yes ☐On
☐No ☐Off	Acceleration Lane Length, L_A:	☑No ☐Off
L_{up} = 9100 ft	Deceleration Lane Length L_D: 700	L_{down} = ft
V_u = 250 veh/h	Freeway Volume, V_F: 7600	V_D = veh/h
	Ramp Volume, V_R: 500	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under 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	7600	0.95	Level	10	0	0.952	1.00	8400
Ramp	500	0.95	Level	10	0	0.952	1.00	553
UpStream	250	0.95	Level	10	0	0.952	1.00	276
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☐No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☐No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 1242.28 (Equation 13-12 or 13-13)

P_{FD} = 0.525 using Equation (Exhibit 13-7)

V_{12} = 4669 pc/h

V_3 or V_{av34} 3731 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑Yes ☐No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☑No

If Yes,V_{12a} = 5700 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	8400	Exhibit 13-8	7050	Yes
$V_{FO} = V_F - V_R$	7847	Exhibit 13-8	7050	Yes
V_R	553	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4669	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 47.0 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.153 (Exhibit 13-12)

S_R= 61.5 mph (Exhibit 13-12)

S_0= 64.7 mph (Exhibit 13-12)

S = 62.5 mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 12/29/2017 1:02 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	107th Ave OFF Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐Yes ☐On	Number of Lanes, N: 3	☑Yes ☑On
☑No ☐Off	Acceleration Lane Length, L_A:	☐No ☐Off
L_{up} = ft	Deceleration Lane Length L_D: 700	L_{down} = 2600 ft
V_u = veh/h	Freeway Volume, V_F: 7600	V_D = 100 veh/h
	Ramp Volume, V_R: 500	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under 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	7600	0.95	Level	10	0	0.952	1.00	8400
Ramp	500	0.95	Level	10	0	0.952	1.00	553
UpStream								
DownStream	100	0.95	Level	10	0	0.952	1.00	111

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☐No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☐No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.525 using Equation (Exhibit 13-7)

V_{12} = 4669 pc/h

V_3 or V_{av34} 3731 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑Yes ☐No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☑No

If Yes,V_{12a} = 5700 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	8400	Exhibit 13-8	7050	Yes
$V_{FO} = V_F - V_R$	7847	Exhibit 13-8	7050	Yes
V_R	553	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4669	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 47.0 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.153 (Exhibit 13-12)

S_R= 61.5 mph (Exhibit 13-12)

S_0= 64.7 mph (Exhibit 13-12)

S = 62.5 mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 12/29/2017 1:03 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Avondale Blvd ON Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☐ No ☑ Off	Acceleration Lane Length, L_A: 1300	☑ No ☐ Off
L_{up} = 2600 ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = 900 veh/h	Freeway Volume, V_F: 6300	V_D = veh/h
	Ramp Volume, V_R: 50	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	6300	0.95	Level	10	0	0.952	1.00	6963
Ramp	50	0.95	Level	10	0	0.952	1.00	55
UpStream	900	0.95	Level	10	0	0.952	1.00	995
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = 2553.65 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 4275 pc/h

V_3 or V_{av34} 2688 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	7018	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4330	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 31.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.474 (Exibit 13-11)

S_R= 54.1 mph (Exhibit 13-11)

S_0= 56.1 mph (Exhibit 13-11)

S = 54.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 12/29/2017 12:46 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Avondale Blvd ON Ramp
Date Performed	12/28/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1300	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = 9100 ft
V_u = veh/h	Freeway Volume, V_F: 6300	V_D = 275 veh/h
	Ramp Volume, V_R: 50	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	6300	0.95	Level	10	0	0.952	1.00	6963
Ramp	50	0.95	Level	10	0	0.952	1.00	55
UpStream								
DownStream	275	0.95	Level	10	0	0.952	1.00	304

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = 1222.36 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 4275 pc/h

V_3 or V_{av34} 2688 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	7018	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4330	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 31.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.474 (Exibit 13-11)

S_R= 54.1 mph (Exhibit 13-11)

S_0= 56.1 mph (Exhibit 13-11)

S = 54.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 12/29/2017 12:48 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Bullard Ave OFF Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑Yes ☑On	Number of Lanes, N: 4	☐Yes ☐On
☐No ☐Off	Acceleration Lane Length, L_A:	☑No ☐Off
L_{up} = 9100 ft	Deceleration Lane Length L_D: 700	L_{down} = ft
V_u = 400 veh/h	Freeway Volume, V_F: 6450	V_D = veh/h
	Ramp Volume, V_R: 425	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under 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	6450	0.95	Level	10	0	0.952	1.00	7129
Ramp	425	0.95	Level	10	0	0.952	1.00	470
UpStream	400	0.95	Level	10	0	0.952	1.00	442
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☐No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☐No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 0.436 using Equation (Exhibit 13-7)
V_{12} = 3373 pc/h
V_3 or V_{av34} 1878 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☑No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☑No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	7129	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	6659	Exhibit 13-8	9400	No
V_R	470	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3373	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 27.0 (pc/mi/ln)
LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.145 (Exhibit 13-12)
S_R= 61.7 mph (Exhibit 13-12)
S_0= 67.9 mph (Exhibit 13-12)
S = 64.8 mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 12/29/2017 11:01 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Bullard Ave OFF Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐Yes ☐On	Number of Lanes, N: 4	☑Yes ☑On
☑No ☐Off	Acceleration Lane Length, L_A:	☐No ☐Off
L_{up} = ft	Deceleration Lane Length L_D: 700	L_{down} = 2600 ft
V_u = veh/h	Freeway Volume, V_F: 6450	V_D = 450 veh/h
	Ramp Volume, V_R: 425	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under 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	6450	0.95	Level	10	0	0.952	1.00	7129
Ramp	425	0.95	Level	10	0	0.952	1.00	470
UpStream								
DownStream	450	0.95	Level	10	0	0.952	1.00	497

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☐No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☐No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 0.436 using Equation (Exhibit 13-7)
V_{12} = 3373 pc/h
V_3 or V_{av34} 1878 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☑No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☑No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	7129	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	6659	Exhibit 13-8	9400	No
V_R	470	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3373	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 27.0 (pc/mi/ln)
LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.145 (Exhibit 13-12)
S_R= 61.7 mph (Exhibit 13-12)
S_0= 67.9 mph (Exhibit 13-12)
S = 64.8 mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 12/29/2017 11:03 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd OFF Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N: 3	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D: 700	L_{down} = ft
V_u = 50 veh/h	Freeway Volume, V_F: 6325	V_D = veh/h
	Ramp Volume, V_R: 275	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	6325	0.95	Level	10	0	0.952	1.00	6991
Ramp	275	0.95	Level	10	0	0.952	1.00	304
UpStream	50	0.95	Level	10	0	0.952	1.00	55
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 263.55 (Equation 13-12 or 13-13)
P_{FD} = 0.571 using Equation (Exhibit 13-7)
V_{12} = 4124 pc/h
V_3 or V_{av34} 2867 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = 4291 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6991	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	6687	Exhibit 13-8	7050	No
V_R	304	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4124	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 34.9 (pc/mi/ln)
LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.130 (Exhibit 13-12)
S_R= 62.0 mph (Exhibit 13-12)
S_0= 64.7 mph (Exhibit 13-12)
S = 63.0 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 12/29/2017 12:38 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd OFF Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☑ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☐ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 700	L_{down} = 2600 ft
V_u = veh/h	Freeway Volume, V_F: 6325	V_D = 400 veh/h
	Ramp Volume, V_R: 275	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	6325	0.95	Level	10	0	0.952	1.00	6991
Ramp	275	0.95	Level	10	0	0.952	1.00	304
UpStream								
DownStream	400	0.95	Level	10	0	0.952	1.00	442

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 0.571 using Equation (Exhibit 13-7)
V_{12} = 4124 pc/h
V_3 or V_{av34} 2867 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = 4291 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6991	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	6687	Exhibit 13-8	7050	No
V_R	304	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4124	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 34.9 (pc/mi/ln)
LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.130 (Exhibit 13-12)
S_R= 62.0 mph (Exhibit 13-12)
S_0= 64.7 mph (Exhibit 13-12)
S = 63.0 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 12/29/2017 12:39 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd ON Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☐ No ☑ Off	Acceleration Lane Length, L_A: 1300	☑ No ☐ Off
L_{up} = 2600 ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = 275 veh/h	Freeway Volume, V_F: 6075	V_D = veh/h
	Ramp Volume, V_R: 400	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under 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	6075	0.95	Level	10	0	0.952	1.00	6714
Ramp	400	0.95	Level	10	0	0.952	1.00	442
UpStream	275	0.95	Level	10	0	0.952	1.00	304
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = 2583.18 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 4122 pc/h

V_3 or V_{av34} 2592 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	7156	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4564	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 32.7 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 0.552 (Exibit 13-11)

S_R= 52.3 mph (Exhibit 13-11)

S_0= 56.7 mph (Exhibit 13-11)

S = 53.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 12/29/2017 11:26 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd ON Ramp
Date Performed	12/29/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2035

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1300	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = 9100 ft
V_u = veh/h	Freeway Volume, V_F: 6075	V_D = 425 veh/h
	Ramp Volume, V_R: 400	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under 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	6075	0.95	Level	10	0	0.952	1.00	6714
Ramp	400	0.95	Level	10	0	0.952	1.00	442
UpStream								
DownStream	425	0.95	Level	10	0	0.952	1.00	470

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = 1889.83 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 4122 pc/h

V_3 or V_{av34} 2592 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	7156	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4564	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 32.7 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 0.552 (Exibit 13-11)

S_R= 52.3 mph (Exhibit 13-11)

S_0= 56.7 mph (Exhibit 13-11)

S = 53.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 1/3/2018 4:07 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information

Analyst	XL
Agency/Company	HDR Engineering Inc.
Date Performed	12/26/2017
Analysis Time Period	PM

Site Information

Freeway/Dir of Travel	Sarival Ave to Estrella Pkwy
Weaving Segment Location	
Analysis Year	2035

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2200ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1900	0.95	10	0	1.5	1.2	0.952	1.00	2100
V_{RF}	100	0.95	10	0	1.5	1.2	0.952	1.00	111
V_{FR}	400	0.95	10	0	1.5	1.2	0.952	1.00	442
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	2100
V_{NW}	2100							V =	2653
V_W	553								
VR	0.208								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	442 lc/h
Interchange density, ID	0.83 int/mi	Weaving lane changes, LC_W	1131 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	662 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	1793 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.192

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2653 pc/h	Weaving intensity factor, W	0.192
Weaving segment capacity, c_w	10310 veh/h	Weaving segment speed, S	58.8 mph
Weaving segment v/c ratio	0.245	Average weaving speed, S_W	56.9 mph
Weaving segment density, D	9.0 pc/mi/ln	Average non-weaving speed, S_{NW}	59.3 mph
Level of Service, LOS	A	Maximum weaving length, L_{MAX}	4623 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 3/28/2018 3:31 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information

Analyst	XL
Agency/Company	HDR Engineering Inc.
Date Performed	12/29/2017
Analysis Time Period	PM

Site Information

Freeway/Dir of Travel	83rd Ave to 91st Ave
Weaving Segment Location	
Analysis Year	2035

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	C-D Roadway/ Multilane Highways
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2220ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	7175	0.95	10	0	1.5	1.2	0.952	1.00	7930
V_{RF}	1050	0.95	10	0	1.5	1.2	0.952	1.00	1161
V_{FR}	175	0.95	10	0	1.5	1.2	0.952	1.00	193
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	7930
V_{NW}	7930							V =	9284
V_W	1354								
VR	0.146								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	193 lc/h
Interchange density, ID	0.66 int/mi	Weaving lane changes, LC_W	834 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1874 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	2708 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.264

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	9284 pc/h	Weaving intensity factor, W	0.264
Weaving segment capacity, c_w	10548 veh/h	Weaving segment speed, S	54.7 mph
Weaving segment v/c ratio	0.838	Average weaving speed, S_W	54.5 mph
Weaving segment density, D	34.0 pc/mi/ln	Average non-weaving speed, S_{NW}	54.7 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	3990 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 1/4/2018 10:52 AM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	107th Ave to Avondale Blvd
Agency/Company	HDR Engineering Inc.	Weaving Segment Location	
Date Performed	12/29/2017	Analysis Year	2035
Analysis Time Period	PM		

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1675ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	6200	0.95	10	0	1.5	1.2	0.952	1.00	6853
V_{RF}	900	0.95	10	0	1.5	1.2	0.952	1.00	995
V_{FR}	100	0.95	10	0	1.5	1.2	0.952	1.00	111
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	6853
V_{NW}	6853							V =	7959
V_W	1106								
VR	0.139								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1106 lc/h
Interchange density, ID	0.83 int/mi	Weaving lane changes, LC_W	1481 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1549 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	3030 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.361

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	7959 pc/h	Weaving intensity factor, W	0.361
Weaving segment capacity, c_w	8297 veh/h	Weaving segment speed, S	48.0 mph
Weaving segment v/c ratio	0.914	Average weaving speed, S_W	51.7 mph
Weaving segment density, D	41.4 pc/mi/ln	Average non-weaving speed, S_{NW}	47.5 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	3922 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Bullard Ave to Estrella Pkwy
Agency/Company	HDR Engineering Inc.	Weaving Segment Location	
Date Performed	12/27/2017	Analysis Year	2035
Analysis Time Period	PM		

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2085ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	5100	0.95	10	0	1.5	1.2	0.952	1.00	5637
V_{RF}	925	0.95	10	0	1.5	1.2	0.952	1.00	1022
V_{FR}	450	0.95	10	0	1.5	1.2	0.952	1.00	497
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	5637
V_{NW}	5637							V =	7156
V_W	1519								
VR	0.212								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1022 lc/h
Interchange density, ID	0.83 int/mi	Weaving lane changes, LC_W	1690 lc/h
Minimum RF lane changes, LC_{RF}	0 lc/pc	Non-weaving lane changes, LC_{NW}	1328 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	3018 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.303

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	7156 pc/h	Weaving intensity factor, W	0.303
Weaving segment capacity, c_w	10252 veh/h	Weaving segment speed, S	51.3 mph
Weaving segment v/c ratio	0.665	Average weaving speed, S_W	53.4 mph
Weaving segment density, D	27.9 pc/mi/ln	Average non-weaving speed, S_{NW}	50.8 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	4662 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information

Analyst	XL
Agency/Company	HDR Engineering Inc.
Date Performed	12/26/2017
Analysis Time Period	PM

Site Information

Freeway/Dir of Travel	Estrella Pkwy to Sarival Ave
Weaving Segment Location	
Analysis Year	2035

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	5
Weaving segment length, L_S	2225ft
Freeway free-flow speed, FFS	65 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2350
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	4775	0.95	10	0	1.5	1.2	0.952	1.00	5278
V_{RF}	775	0.95	10	0	1.5	1.2	0.952	1.00	857
V_{FR}	50	0.95	10	0	1.5	1.2	0.952	1.00	55
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	5278
V_{NW}	5278							V =	6190
V_W	912								
VR	0.147								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc
Interchange density, ID	0.83 int/mi
Minimum RF lane changes, LC_{RF}	0 lc/pc
Minimum FR lane changes, LC_{FR}	0 lc/pc
Minimum RR lane changes, LC_{RR}	lc/pc
Minimum weaving lane changes, LC_{MIN}	0 lc/h
Weaving lane changes, LC_W	694 lc/h
Non-weaving lane changes, LC_{NW}	1330 lc/h
Total lane changes, LC_{ALL}	2024 lc/h
Non-weaving vehicle index, I_{NW}	0.210

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	6190 pc/h
Weaving segment capacity, c_w	10543 veh/h
Weaving segment v/c ratio	0.559
Weaving segment density, D	21.1 pc/mi/ln
Level of Service, LOS	C
Weaving intensity factor, W	0.210
Weaving segment speed, S	58.6 mph
Average weaving speed, S_W	56.3 mph
Average non-weaving speed, S_{NW}	59.1 mph
Maximum weaving length, L_{MAX}	4005 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information

Analyst	XL
Agency/Company	HDR Engineering Inc.
Date Performed	12/29/2017
Analysis Time Period	PM

Site Information

Freeway/Dir of Travel	91st Ave to 83rd Ave
Weaving Segment Location	
Analysis Year	2035

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	2055ft
Freeway free-flow speed, FFS	65 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2350
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3375	0.95	10	0	1.5	1.2	0.952	1.00	3730
V_{RF}	125	0.95	10	0	1.5	1.2	0.952	1.00	138
V_{FR}	600	0.95	10	0	1.5	1.2	0.952	1.00	663
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	3730
V_{NW}	3730							V =	4531
V_W	801								
VR	0.177								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc
Interchange density, ID	0.66 int/mi
Minimum RF lane changes, LC_{RF}	0 lc/pc
Minimum FR lane changes, LC_{FR}	1 lc/pc
Minimum RR lane changes, LC_{RR}	lc/pc
Minimum weaving lane changes, LC_{MIN}	138 lc/h
Weaving lane changes, LC_W	530 lc/h
Non-weaving lane changes, LC_{NW}	1112 lc/h
Total lane changes, LC_{ALL}	1642 lc/h
Non-weaving vehicle index, I_{NW}	0.189

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4531 pc/h
Weaving segment capacity, c_w	8297 veh/h
Weaving segment v/c ratio	0.520
Weaving segment density, D	19.4 pc/mi/ln
Level of Service, LOS	B
Weaving intensity factor, W	0.189
Weaving segment speed, S	58.3 mph
Average weaving speed, S_W	57.0 mph
Average non-weaving speed, S_{NW}	58.6 mph
Maximum weaving length, L_{MAX}	4300 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Avondale Blvd to 107th Ave
Agency/Company	HDR Engineering Inc.	Weaving Segment Location	
Date Performed	12/27/2017	Analysis Year	2035
Analysis Time Period	PM		

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1620ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2875	0.95	10	0	1.5	1.2	0.952	1.00	3178
V_{RF}	150	0.95	10	0	1.5	1.2	0.952	1.00	166
V_{FR}	500	0.95	10	0	1.5	1.2	0.952	1.00	553
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	3178
V_{NW}	3178							V =	3897
V_W	719								
VR	0.185								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	719 lc/h
Interchange density, ID	0.83 int/mi	Weaving lane changes, LC_W	1087 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	762 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1849 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.251

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3897 pc/h	Weaving intensity factor, W	0.251
Weaving segment capacity, c_w	8149 veh/h	Weaving segment speed, S	55.1 mph
Weaving segment v/c ratio	0.455	Average weaving speed, S_W	55.0 mph
Weaving segment density, D	17.7 pc/mi/ln	Average non-weaving speed, S_{NW}	55.1 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	4378 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 3/28/2018 3:29 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Estrella Pkwy to Bullard Ave
Agency/Company	HDR Engineering Inc.	Weaving Segment Location	
Date Performed	12/27/2017	Analysis Year	2035
Analysis Time Period	PM		

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2100ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2200	0.95	10	0	1.5	1.2	0.952	1.00	2432
V_{RF}	100	0.95	10	0	1.5	1.2	0.952	1.00	111
V_{FR}	750	0.95	10	0	1.5	1.2	0.952	1.00	829
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	2432
V_{NW}	2432							V =	3372
V_W	940								
VR	0.279								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	829 lc/h
Interchange density, ID	0.83 int/mi	Weaving lane changes, LC_W	1500 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	676 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	2176 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.232

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3372 pc/h	Weaving intensity factor, W	0.232
Weaving segment capacity, c_w	8199 veh/h	Weaving segment speed, S	55.7 mph
Weaving segment v/c ratio	0.392	Average weaving speed, S_W	55.6 mph
Weaving segment density, D	12.1 pc/mi/ln	Average non-weaving speed, S_{NW}	55.8 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	5357 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 1/3/2018 4:18 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At 75th Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*10625*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*5*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2349*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*52.2*	mph	S	mph
D = v_p / S	*45.0*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*E*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 12:49 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At 83rd Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*9625*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*4*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2660*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*42.5*	mph	S	mph
D = v_p / S	*62.6*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*F*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 11:12 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At 91st Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*8650*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*3187*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*19.7*	mph	S	mph
D = v_p / S	*161.6*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*F*		Required Number of Lanes, N	

Glossary

N - Number of lanes
S - Speed
V - Hourly volume
D - Density
v_p - Flow rate
FFS - Free-flow speed
LOS - Level of service
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13
f_{LC} - Exhibit 11-9
f_p - Page 11-18
TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 1/2/2018 10:58 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At 99th Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*9050*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*3334*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*12.0*	mph	S	mph
D = v_p / S	*278.7*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*F*		Required Number of Lanes, N	

Glossary

N - Number of lanes
S - Speed
V - Hourly volume
D - Density
v_p - Flow rate
FFS - Free-flow speed
LOS - Level of service
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13
f_{LC} - Exhibit 11-9
f_p - Page 11-18
TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 1/2/2018 10:48 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	From/To	At 107th Ave
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	8350	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	3		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	65.0	mph
FFS (measured)	65.0	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	3076	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	25.2	mph	S	mph
D = v_p / S	122.2	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	F		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 10:39 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	From/To	At Avondale Blvd
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	7350	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	3		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	65.0	mph
FFS (measured)	65.0	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2708	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	40.7	mph	S	mph
D = v_p / S	66.5	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	F		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 10:29 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Bullard Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*7275*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*4*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2010*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*59.7*	mph	S	mph
D = v_p / S	*33.7*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 9:12 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Dysart Rd*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*7075*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2607*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*44.3*	mph	S	mph
D = v_p / S	*58.8*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*F*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 9:51 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Estrella Pkwy*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*7025*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 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)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
			Design (N)	
Operational (LOS)			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1941*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*60.8*	mph	S	mph
D = v_p / S	*31.9*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 9:01 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Sarival Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*6375*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*5*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
			Design (N)	
Operational (LOS)			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1409*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*21.7*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/3/2018 4:26 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*East of Agua Fria River*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*7625*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2809*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*36.8*	mph	S	mph
D = v_p / S	*76.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*F*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 9:29 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*East of Sarival Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*6375*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*4*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1762*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*63.1*	mph	S	mph
D = v_p / S	*27.9*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/3/2018 4:27 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*El Mirage Rd*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs				
Volume, V	*7375*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments			
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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2717*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*40.4*	mph	S	mph
D = v_p / S	*67.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*F*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 10:05 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*West of 67th Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs				
Volume, V	*9800*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments			
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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*5*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2166*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*56.7*	mph	S	mph
D = v_p / S	*38.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*E*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 1:12 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst: *XL*
Agency or Company: *HDR Engineering Inc.*
Date Performed: *1/2/2018*
Analysis Time Period: *AM*

Site Information

Highway/Direction of Travel: *Eastbound*
From/To: *West of Agua Fria River*
Jurisdiction: *ADOT*
Analysis Year: *2040*

Project Description: *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*7625*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*4*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2107*	pc/h/ln
S	*57.9*	mph
D = v_p / S	*36.4*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

 HCS 2010™ Version 6.1 Generated: 1/2/2018 9:28 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst: *XL*
Agency or Company: *HDR Engineering Inc.*
Date Performed: *1/2/2018*
Analysis Time Period: *AM*

Site Information

Highway/Direction of Travel: *Westbound*
From/To: *83rd Ave major Diverge*
Jurisdiction: *ADOT*
Analysis Year: *2040*

Project Description: *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*325*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*180*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*3.0*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

 HCS 2010™ Version 6.1 Generated: 1/2/2018 12:46 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At 75th Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3000*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*5*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*663*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*10.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 12:50 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At 83rd Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2675*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*4*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*739*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*11.4*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 11:20 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*XL*
Agency or Company	*HDR Engineering Inc.*
Date Performed	*1/2/2018*
Analysis Time Period	*AM*

Site Information

Highway/Direction of Travel	*Westbound*
From/To	*At 99th Ave*
Jurisdiction	*ADOT*
Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2425*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*893*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*13.7*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	mph
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

 HCS 2010[TM] Version 6.1 Generated: 1/2/2018 10:49 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*XL*
Agency or Company	*HDR Engineering Inc.*
Date Performed	*1/2/2018*
Analysis Time Period	*AM*

Site Information

Highway/Direction of Travel	*Westbound*
From/To	*At 107th Ave*
Jurisdiction	*ADOT*
Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2225*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*820*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*12.6*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	mph
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

 HCS 2010[TM] Version 6.1 Generated: 1/2/2018 10:40 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Avondale Blvd*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1975*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*728*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*11.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 10:30 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Bullard Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1950*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*4*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*539*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*8.3*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 9:14 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Westbound
Agency or Company	HDR Engineering Inc.	From/To	At Dysart Rd
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	1900	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	3		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	65.0	mph
FFS (measured)	65.0	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	700	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	65.0	mph	S		mph
D = v_p / S	10.8	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	A		Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 9:52 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Westbound
Agency or Company	HDR Engineering Inc.	From/To	At Estrella Pkwy
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	1450	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	5		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	65.0	mph
FFS (measured)	65.0	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	321	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	65.0	mph	S		mph
D = v_p / S	4.9	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	A		Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 9:03 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Sarival Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs				
Volume, V	*1200* veh/h		Peak-Hour Factor, PHF	*0.95*
AADT	veh/day		%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments			
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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*5*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*265*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*4.1*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/3/2018 4:36 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*East of 91st Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs				
Volume, V	*2300* veh/h		Peak-Hour Factor, PHF	*0.95*
AADT	veh/day		%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments			
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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*4*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*636*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*9.8*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 11:00 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Westbound
Agency or Company	HDR Engineering Inc.	From/To	East of Agua Fria River
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	1975	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	3		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	65.0	mph
FFS (measured)	65.0	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	728	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	65.0	mph	S	mph
D = v_p / S	11.2	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	B		Required Number of Lanes, N	

Glossary

N - Number of lanes; S - Speed
V - Hourly volume; D - Density
v_p - Flow rate; FFS - Free-flow speed
LOS - Level of service; BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12; f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13; f_{LC} - Exhibit 11-9
f_p - Page 11-18; TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 1/2/2018 9:32 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Westbound
Agency or Company	HDR Engineering Inc.	From/To	El Mirage Rd
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	2050	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
Peak-Hr Prop. of AADT, K			%RVs, P_R	0
Peak-Hr Direction Prop, D			General Terrain:	Grade
DDHV = AADT x K x D		veh/h	Grade 0.00% Length	0.00mi
			Up/Down %	0.00

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	3		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	65.0	mph
FFS (measured)	65.0	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	755	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	65.0	mph	S	mph
D = v_p / S	11.6	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	B		Required Number of Lanes, N	

Glossary

N - Number of lanes; S - Speed
V - Hourly volume; D - Density
v_p - Flow rate; FFS - Free-flow speed
LOS - Level of service; BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12; f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13; f_{LC} - Exhibit 11-9
f_p - Page 11-18; TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 1/2/2018 10:06 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*West of 67th Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2675*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*5*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*591*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	*65.0*	mph	S		mph
D = v_p / S	*9.1*	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	*A*		Required Number of Lanes, N		

Glossary

N - Number of lanes; S - Speed
V - Hourly volume; D - Density
v_p - Flow rate; FFS - Free-flow speed
LOS - Level of service; BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12; f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13; f_{LC} - Exhibit 11-9
f_p - Page 11-18; TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 1/2/2018 1:13 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*West of 91st Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2300*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*847*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	*65.0*	mph	S		mph
D = v_p / S	*13.0*	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	*B*		Required Number of Lanes, N		

Glossary

N - Number of lanes; S - Speed
V - Hourly volume; D - Density
v_p - Flow rate; FFS - Free-flow speed
LOS - Level of service; BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12; f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13; f_{LC} - Exhibit 11-9
f_p - Page 11-18; TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 1/2/2018 10:59 AM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*West of Agua Fria River*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*AM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1975*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Adjustments

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

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*4*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*546*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*8.4*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

 HCS 2010™ Version 6.1 Generated: 1/2/2018 9:32 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	83rd ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp
☑ Yes ☑ On
☐ No ☐ Off
L_{up} = 4300 ft
V_u = 50 veh/h

Number of Lanes, N	4
Acceleration Lane Length, L_A	1500
Deceleration Lane Length L_D	
Freeway Volume, V_F	9625
Ramp Volume, V_R	1000
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} = ft
V_D = veh/h

Conversion to pc/h Under 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	9625	0.95	Level	10	0	0.952	1.00	10638
Ramp	1000	0.95	Level	10	0	0.952	1.00	1105
UpStream	50	0.95	Level	10	0	0.952	1.00	55
DownStream								

Merge Areas

Estimation of v_{12}

$$V_{12} = V_F\,(P_{FM})$$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = 0.080 using Equation (Exhibit 13-6)
V_{12} = 848 pc/h
V_3 or V_{av34} 4895 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No
If Yes, V_{12a} = 4255 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	11743	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	5360	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$$

D_R = 37.4 (pc/mi/ln)
LOS = F (Exhibit 13-2)

Speed Determination

M_S = 0.986 (Exibit 13-11)
S_R= 42.3 mph (Exhibit 13-11)
S_0= 53.1 mph (Exhibit 13-11)
S = 47.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = using Equation (Exhibit 13-7)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)
S_R= mph (Exhibit 13-12)
S_0= mph (Exhibit 13-12)
S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/4/2018 1:05 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	83rd ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	4	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	1500	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D		L_{down} = 6200 ft
V_u = veh/h	Freeway Volume, V_F	9625	V_D = 850 veh/h
	Ramp Volume, V_R	1000	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	55.0	

Conversion to pc/h Under 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	9625	0.95	Level	10	0	0.952	1.00	10638
Ramp	1000	0.95	Level	10	0	0.952	1.00	1105
UpStream								
DownStream	850	0.95	Level	10	0	0.952	1.00	939

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.080 using Equation (Exhibit 13-6)

V_{12} = 848 pc/h

V_3 or V_{av34} 4895 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No

If Yes,V_{12a} = 4255 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	11743	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	5360	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 37.4 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 0.986 (Exibit 13-11)

S_R= 42.3 mph (Exhibit 13-11)

S_0= 53.1 mph (Exhibit 13-11)

S = 47.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/4/2018 1:06 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	91st Ave OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N	3	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D	700	L_{down} = ft
V_u = 700 veh/h	Freeway Volume, V_F	9050	V_D = veh/h
	Ramp Volume, V_R	425	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under 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	9050	0.95	Level	10	0	0.952	1.00	10003
Ramp	425	0.95	Level	10	0	0.952	1.00	470
UpStream	700	0.95	Level	10	0	0.952	1.00	774
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 2916.91 (Equation 13-12 or 13-13)

P_{FD} = 0.488 using Equation (Exhibit 13-7)

V_{12} = 5125 pc/h

V_3 or V_{av34} 4878 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = 7303 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	10003	Exhibit 13-8	7050	Yes
$V_{FO} = V_F - V_R$	9533	Exhibit 13-8	7050	Yes
V_R	470	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	5125	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 60.8 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.145 (Exhibit 13-12)

S_R= 61.7 mph (Exhibit 13-12)

S_0= 64.7 mph (Exhibit 13-12)

S = 62.4 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 10:50 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	91st Ave OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{up} = ft; V_u = veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	700
Freeway Volume, V_F	9050
Ramp Volume, V_R	425
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	60.0

Downstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off; L_{down} = 2600 ft; V_D = 1025 veh/h

Conversion to pc/h Under 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	9050	0.95	Level	10	0	0.952	1.00	10003
Ramp	425	0.95	Level	10	0	0.952	1.00	470
UpStream								
DownStream	1025	0.95	Level	10	0	0.952	1.00	1133

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.488 using Equation (Exhibit 13-7)

V_{12} = 5125 pc/h

V_3 or V_{av34} 4878 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = 7303 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	10003	Exhibit 13-8	7050	Yes
$V_{FO} = V_F - V_R$	9533	Exhibit 13-8	7050	Yes
V_R	470	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	5125	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 60.8 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.145 (Exhibit 13-12)

S_R= 61.7 mph (Exhibit 13-12)

S_0= 64.7 mph (Exhibit 13-12)

S = 62.4 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 10:51 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	107th Ave ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☑ Yes ☐ On ☐ No ☑ Off; L_{up} = 2600 ft; V_u = 75 veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	1300
Deceleration Lane Length L_D	
Freeway Volume, V_F	8350
Ramp Volume, V_R	700
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{down} = ft; V_D = veh/h

Conversion to pc/h Under 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	8350	0.95	Level	10	0	0.952	1.00	9229
Ramp	700	0.95	Level	10	0	0.952	1.00	774
UpStream	75	0.95	Level	10	0	0.952	1.00	83
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = 3192.44 (Equation 13-6 or 13-7)

P_{FM} = 0.576 using Equation (Exhibit 13-6)

V_{12} = 5319 pc/h

V_3 or V_{av34} 3910 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = 6529 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	10003	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	7303	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 53.9 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 5.969 (Exibit 13-11)

S_R= -72.3 mph (Exhibit 13-11)

S_0= 56.1 mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 10:41 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	107th Ave ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1300	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = 9100 ft
V_u = veh/h	Freeway Volume, V_F: 8350	V_D = 425 veh/h
	Ramp Volume, V_R: 700	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under 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	8350	0.95	Level	10	0	0.952	1.00	9229
Ramp	700	0.95	Level	10	0	0.952	1.00	774
UpStream								
DownStream	425	0.95	Level	10	0	0.952	1.00	470

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

- L_{EQ} = 1889.83 (Equation 13-6 or 13-7)
- P_{FM} = 0.614 using Equation (Exhibit 13-6)
- V_{12} = 5666 pc/h
- V_3 or V_{av34} = 3563 pc/h (Equation 13-14 or 13-17)
- Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No
- Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
- If Yes, V_{12a} = 6529 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	10003	Exhibit 13-8	Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	7303	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

- D_R = 53.9 (pc/mi/ln)
- LOS = F (Exhibit 13-2)

Speed Determination

- M_S = 5.969 (Exibit 13-11)
- S_R= -72.3 mph (Exhibit 13-11)
- S_0= 56.1 mph (Exhibit 13-11)
- S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

- L_{EQ} = (Equation 13-12 or 13-13)
- P_{FD} = using Equation (Exhibit 13-7)
- V_{12} = pc/h
- V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
- Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
- Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
- If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

- D_R = (pc/mi/ln)
- LOS = (Exhibit 13-2)

Speed Determination

- D_s = (Exhibit 13-12)
- S_R= mph (Exhibit 13-12)
- S_0= mph (Exhibit 13-12)
- S = mph (Exhibit 13-13)

 HCS2010[TM] Version 6.1 Generated: 1/2/2018 10:43 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Avondale Blvd OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N: 3	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D: 700	L_{down} = ft
V_u = 300 veh/h	Freeway Volume, V_F: 7375	V_D = veh/h
	Ramp Volume, V_R: 25	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under 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	7375	0.95	Level	10	0	0.952	1.00	8151
Ramp	25	0.95	Level	10	0	0.952	1.00	28
UpStream	300	0.95	Level	10	0	0.952	1.00	332
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

- L_{EQ} = (Equation 13-6 or 13-7)
- P_{FM} = using Equation (Exhibit 13-6)
- V_{12} = pc/h
- V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
- Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
- Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
- If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

- D_R = (pc/mi/ln)
- LOS = (Exhibit 13-2)

Speed Determination

- M_S = (Exibit 13-11)
- S_R= mph (Exhibit 13-11)
- S_0= mph (Exhibit 13-11)
- S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

- L_{EQ} = 1295.13 (Equation 13-12 or 13-13)
- P_{FD} = 0.555 using Equation (Exhibit 13-7)
- V_{12} = 4536 pc/h
- V_3 or V_{av34} 3615 pc/h (Equation 13-14 or 13-17)
- Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No
- Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
- If Yes, V_{12a} = 5451 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	8151	Exhibit 13-8	7050	Yes
$V_{FO} = V_F - V_R$	8123	Exhibit 13-8	7050	Yes
V_R	28	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4536	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

- D_R = 44.8 (pc/mi/ln)
- LOS = F (Exhibit 13-2)

Speed Determination

- D_s = 0.106 (Exhibit 13-12)
- S_R= 62.6 mph (Exhibit 13-12)
- S_0= 64.7 mph (Exhibit 13-12)
- S = 63.3 mph (Exhibit 13-13)

 HCS2010[TM] Version 6.1 Generated: 1/2/2018 10:14 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / **Site Information**

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Avondale Blvd OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{up} = ft; V_u = veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	700
Freeway Volume, V_F	7375
Ramp Volume, V_R	25
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	60.0

Downstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off; L_{down} = 3000 ft; V_D = 1075 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	7375	0.95	Level	10	0	0.952	1.00	8151
Ramp	25	0.95	Level	10	0	0.952	1.00	28
UpStream								
DownStream	1075	0.95	Level	10	0	0.952	1.00	1188

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.555 using Equation (Exhibit 13-7)

V_{12} = 4536 pc/h

V_3 or V_{av34} 3615 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = 5451 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	8151	Exhibit 13-8	7050	Yes
$V_{FO} = V_F - V_R$	8123	Exhibit 13-8	7050	Yes
V_R	28	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4536	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 44.8 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.106 (Exhibit 13-12)

S_R= 62.6 mph (Exhibit 13-12)

S_0= 64.7 mph (Exhibit 13-12)

S = 63.3 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 10:15 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / **Site Information**

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Bullard Ave ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☑ Yes ☐ On ☐ No ☑ Off; L_{up} = 2600 ft; V_u = 650 veh/h

Number of Lanes, N	4
Acceleration Lane Length, L_A	1300
Deceleration Lane Length L_D	
Freeway Volume, V_F	7275
Ramp Volume, V_R	375
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{down} = ft; V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	7275	0.95	Level	10	0	0.952	1.00	8041
Ramp	375	0.95	Level	10	0	0.952	1.00	414
UpStream	650	0.95	Level	10	0	0.952	1.00	718
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.166 using Equation (Exhibit 13-6)

V_{12} = 1335 pc/h

V_3 or V_{av34} 3353 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No

If Yes,V_{12a} = 3216 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	8455	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3630	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 25.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.325 (Exibit 13-11)

S_R= 57.5 mph (Exhibit 13-11)

S_0= 57.8 mph (Exhibit 13-11)

S = 57.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 9:17 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Bullard Ave ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{up} = ft; V_u = veh/h

Number of Lanes, N	4
Acceleration Lane Length, L_A	1300
Deceleration Lane Length L_D	
Freeway Volume, V_F	7275
Ramp Volume, V_R	375
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☑ Yes ☐ On ☐ No ☑ Off; L_{down} = 9100 ft; V_D = 550 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	7275	0.95	Level	10	0	0.952	1.00	8041
Ramp	375	0.95	Level	10	0	0.952	1.00	414
UpStream								
DownStream	550	0.95	Level	10	0	0.952	1.00	608

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = 0.166 using Equation (Exhibit 13-6)
V_{12} = 1335 pc/h
V_3 or V_{av34} 3353 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No
If Yes,V_{12a} = 3216 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	8455	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3630	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\,v_R + 0.0078\,V_{12} - 0.00627\,L_A$

D_R = 25.4 (pc/mi/ln)
LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.325 (Exibit 13-11)
S_R= 57.5 mph (Exhibit 13-11)
S_0= 57.8 mph (Exhibit 13-11)
S = 57.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = using Equation (Exhibit 13-7)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\,V_{12} - 0.009\,L_D$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)
S_R= mph (Exhibit 13-12)
S_0= mph (Exhibit 13-12)
S = mph (Exhibit 13-13)

 HCS2010TM Version 6.1 Generated: 1/2/2018 9:21 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off; L_{up} = 9100 ft; V_u = 375 veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	700
Freeway Volume, V_F	7625
Ramp Volume, V_R	550
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	60.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{down} = ft; V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	7625	0.95	Level	10	0	0.952	1.00	8428
Ramp	550	0.95	Level	10	0	0.952	1.00	608
UpStream	375	0.95	Level	10	0	0.952	1.00	414
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\,v_R + 0.0078\,V_{12} - 0.00627\,L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 1893.56 (Equation 13-12 or 13-13)
P_{FD} = 0.521 using Equation (Exhibit 13-7)
V_{12} = 4685 pc/h
V_3 or V_{av34} 3743 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = 5728 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	8428	Exhibit 13-8	7050	Yes
$V_{FO} = V_F - V_R$	7820	Exhibit 13-8	7050	Yes
V_R	608	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4685	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\,V_{12} - 0.009\,L_D$

D_R = 47.2 (pc/mi/ln)
LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.158 (Exhibit 13-12)
S_R= 61.4 mph (Exhibit 13-12)
S_0= 64.7 mph (Exhibit 13-12)
S = 62.4 mph (Exhibit 13-13)

 HCS2010TM Version 6.1 Generated: 1/2/2018 9:34 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On; ☑ No ☐ Off; L_{up} = ft; V_u = veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	700
Freeway Volume, V_F	7625
Ramp Volume, V_R	550
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	60.0

Downstream Adj Ramp: ☑ Yes ☑ On; ☐ No ☐ Off; L_{down} = 2600 ft; V_D = 300 veh/h

Conversion to pc/h Under 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	7625	0.95	Level	10	0	0.952	1.00	8428
Ramp	550	0.95	Level	10	0	0.952	1.00	608
UpStream								
DownStream	300	0.95	Level	10	0	0.952	1.00	332

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.521 using Equation (Exhibit 13-7)

V_{12} = 4685 pc/h

V_3 or V_{av34} 3743 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = 5728 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	8428	Exhibit 13-8	7050	Yes
$V_{FO} = V_F - V_R$	7820	Exhibit 13-8	7050	Yes
V_R	608	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4685	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 47.2 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.158 (Exhibit 13-12)

S_R= 61.4 mph (Exhibit 13-12)

S_0= 64.7 mph (Exhibit 13-12)

S = 62.4 mph (Exhibit 13-13)

HCS2010TM Version 6.1 Generated: 1/2/2018 9:37 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☑ Yes ☐ On; ☐ No ☑ Off; L_{up} = 2600 ft; V_u = 550 veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	1300
Deceleration Lane Length L_D	
Freeway Volume, V_F	7075
Ramp Volume, V_R	300
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☐ Yes ☐ On; ☑ No ☐ Off; L_{down} = ft; V_D = veh/h

Conversion to pc/h Under 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	7075	0.95	Level	10	0	0.952	1.00	7820
Ramp	300	0.95	Level	10	0	0.952	1.00	332
UpStream	550	0.95	Level	10	0	0.952	1.00	608
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = 2796.33 (Equation 13-6 or 13-7)

P_{FM} = 0.601 using Equation (Exhibit 13-6)

V_{12} = 4703 pc/h

V_3 or V_{av34} 3117 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = 5120 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	8152	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	5452	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 39.7 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 1.088 (Exibit 13-11)

S_R= 40.0 mph (Exhibit 13-11)

S_0= 56.1 mph (Exhibit 13-11)

S = 44.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010TM Version 6.1 Generated: 1/2/2018 9:54 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1300	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = 9100 ft
V_u = veh/h	Freeway Volume, V_F: 7075	V_D = 25 veh/h
	Ramp Volume, V_R: 300	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under 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	7075	0.95	Level	10	0	0.952	1.00	7820
Ramp	300	0.95	Level	10	0	0.952	1.00	332
UpStream								
DownStream	25	0.95	Level	10	0	0.952	1.00	28

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = 112.59 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 4801 pc/h

V_3 or V_{av34} 3019 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = 5120 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	8152	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	5452	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 39.7 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 1.088 (Exibit 13-11)

S_R= 40.0 mph (Exhibit 13-11)

S_0= 56.1 mph (Exhibit 13-11)

S = 44.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 1/2/2018 9:55 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☐ On	Number of Lanes, N: 4	☐ Yes ☐ On
☐ No ☑ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = 600 ft	Deceleration Lane Length L_D: 1500	L_{down} = ft
V_u = 175 veh/h	Freeway Volume, V_F: 1700	V_D = veh/h
	Ramp Volume, V_R: 250	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under 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	1700	0.95	Level	10	0	0.952	1.00	1879
Ramp	250	0.95	Level	10	0	0.952	1.00	276
UpStream	175	0.95	Level	10	0	0.952	1.00	193
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 975 pc/h

V_3 or V_{av34} 452 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1879	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	1603	Exhibit 13-8	9400	No
V_R	276	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	975	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = -0.9 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

D_s = 0.128 (Exhibit 13-12)

S_R= 62.1 mph (Exhibit 13-12)

S_0= 71.3 mph (Exhibit 13-12)

S = 66.2 mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 1/4/2018 2:18 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{up} = ft; V_u = veh/h

Number of Lanes, N	4
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	1500
Freeway Volume, V_F	1700
Ramp Volume, V_R	250
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	60.0

Downstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off; L_{down} = 5400 ft; V_D = 150 veh/h

Conversion to pc/h Under 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	1700	0.95	Level	10	0	0.952	1.00	1879
Ramp	250	0.95	Level	10	0	0.952	1.00	276
UpStream								
DownStream	150	0.95	Level	10	0	0.952	1.00	166

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 0.436 using Equation (Exhibit 13-7)
V_{12} = 975 pc/h
V_3 or V_{av34} 452 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1879	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	1603	Exhibit 13-8	9400	No
V_R	276	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	975	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = -0.9 (pc/mi/ln)
LOS = A (Exhibit 13-2)

Speed Determination

D_s = 0.128 (Exhibit 13-12)
S_R= 62.1 mph (Exhibit 13-12)
S_0= 71.3 mph (Exhibit 13-12)
S = 66.2 mph (Exhibit 13-13)

HCS2010[TM] Version 6.1 Generated: 1/4/2018 2:20 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off; L_{up} = 2000 ft; V_u = 1100 veh/h

Number of Lanes, N	5
Acceleration Lane Length, L_A	1300
Deceleration Lane Length L_D	
Freeway Volume, V_F	2675
Ramp Volume, V_R	325
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{down} = ft; V_D = veh/h

Conversion to pc/h Under 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	2675	0.95	Level	10	0	0.952	1.00	2957
Ramp	325	0.95	Level	10	0	0.952	1.00	359
UpStream	1100	0.95	Level	10	0	0.952	1.00	1216
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = 0.436 using Equation (Exhibit 13-6)
V_{12} = 1007 pc/h
V_3 or V_{av34} 650 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2666	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1366	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 7.8 (pc/mi/ln)
LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.193 (Exhibit 13-11)
S_R= 60.6 mph (Exhibit 13-11)
S_0= 64.5 mph (Exhibit 13-11)
S = 62.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = using Equation (Exhibit 13-7)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)
S_R= mph (Exhibit 13-12)
S_0= mph (Exhibit 13-12)
S = mph (Exhibit 13-13)

HCS2010[TM] Version 6.1 Generated: 1/2/2018 1:09 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 5	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1300	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = 9100 ft
V_u = veh/h	Freeway Volume, V_F: 2675	V_D = 325 veh/h
	Ramp Volume, V_R: 325	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under 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	2675	0.95	Level	10	0	0.952	1.00	2957
Ramp	325	0.95	Level	10	0	0.952	1.00	359
UpStream								
DownStream	325	0.95	Level	10	0	0.952	1.00	359

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.436 using Equation (Exhibit 13-6)

V_{12} = 1007 pc/h

V_3 or V_{av34} 650 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2666	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1366	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 7.8 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.193 (Exibit 13-11)

S_R= 60.6 mph (Exhibit 13-11)

S_0= 64.5 mph (Exhibit 13-11)

S = 62.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010[TM] Version 6.1 Generated: 1/2/2018 1:10 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	83rd Ave OFF Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N: 5	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D: 700	L_{down} = ft
V_u = 325 veh/h	Freeway Volume, V_F: 3000	V_D = veh/h
	Ramp Volume, V_R: 325	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under 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	3000	0.95	Level	10	0	0.952	1.00	3316
Ramp	325	0.95	Level	10	0	0.952	1.00	359
UpStream	325	0.95	Level	10	0	0.952	1.00	359
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.260 using Equation (Exhibit 13-7)

V_{12} = 1128 pc/h

V_3 or V_{av34} 1094 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No

If Yes,V_{12a} = 1326 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3316	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	2957	Exhibit 13-8	9400	No
V_R	359	Exhibit 13-10	4400	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1128	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = -3.2 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

D_s = 0.135 (Exhibit 13-12)

S_R= 61.9 mph (Exhibit 13-12)

S_0= 71.3 mph (Exhibit 13-12)

S = 67.2 mph (Exhibit 13-13)

HCS2010[TM] Version 6.1 Generated: 3/28/2018 3:06 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	91st Ave ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☐ On	Number of Lanes, N	3	☐ Yes ☐ On
☐ No ☑ Off	Acceleration Lane Length, L_A	1300	☑ No ☐ Off
	Deceleration Lane Length L_D		
L_{up} = 2600 ft	Freeway Volume, V_F	2300	L_{down} = ft
	Ramp Volume, V_R	125	
	Freeway Free-Flow Speed, S_{FF}	65.0	
V_u = 450 veh/h	Ramp Free-Flow Speed, S_{FR}	55.0	V_D = veh/h

Conversion to pc/h Under 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	2300	0.95	Level	10	0	0.952	1.00	2542
Ramp	125	0.95	Level	10	0	0.952	1.00	138
UpStream	450	0.95	Level	10	0	0.952	1.00	497
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = 1625.32 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 1561 pc/h

V_3 or V_{av34} 981 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2680	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1699	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\,v_R + 0.0078\,V_{12} - 0.00627\,L_A$

D_R = 10.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.199 (Exibit 13-11)

S_R= 60.4 mph (Exhibit 13-11)

S_0= 63.3 mph (Exhibit 13-11)

S = 61.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\,V_{12} - 0.009\,L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 10:54 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	91st Ave ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	1300	☐ No ☑ Off
	Deceleration Lane Length L_D		
L_{up} = ft	Freeway Volume, V_F	2300	L_{down} = 9100 ft
	Ramp Volume, V_R	125	
	Freeway Free-Flow Speed, S_{FF}	65.0	
V_u = veh/h	Ramp Free-Flow Speed, S_{FR}	55.0	V_D = 200 veh/h

Conversion to pc/h Under 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	2300	0.95	Level	10	0	0.952	1.00	2542
Ramp	125	0.95	Level	10	0	0.952	1.00	138
UpStream								
DownStream	200	0.95	Level	10	0	0.952	1.00	221

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = 888.62 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 1561 pc/h

V_3 or V_{av34} 981 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2680	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1699	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\,v_R + 0.0078\,V_{12} - 0.00627\,L_A$

D_R = 10.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.199 (Exibit 13-11)

S_R= 60.4 mph (Exhibit 13-11)

S_0= 63.3 mph (Exhibit 13-11)

S = 61.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\,V_{12} - 0.009\,L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 10:55 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	107th Ave OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N	3	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D	700	L_{down} = ft
V_u = 125 veh/h	Freeway Volume, V_F	2425	V_D = veh/h
	Ramp Volume, V_R	200	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under 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	2425	0.95	Level	10	0	0.952	1.00	2680
Ramp	200	0.95	Level	10	0	0.952	1.00	221
UpStream	125	0.95	Level	10	0	0.952	1.00	138
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 1191.26 (Equation 13-12 or 13-13)
P_{FD} = 0.683 using Equation (Exhibit 13-7)
V_{12} = 1900 pc/h
V_3 or V_{av34} 780 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2680	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	2459	Exhibit 13-8	7050	No
V_R	221	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1900	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 14.3 (pc/mi/ln)
LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.123 (Exhibit 13-12)
S_R= 62.2 mph (Exhibit 13-12)
S_0= 71.3 mph (Exhibit 13-12)
S = 64.6 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 10:45 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	107th Ave OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	3	☑ Yes ☑ On
☑ No ☐ Off	Acceleration Lane Length, L_A		☐ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D	700	L_{down} = 2600 ft
V_u = veh/h	Freeway Volume, V_F	2425	V_D = 175 veh/h
	Ramp Volume, V_R	200	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under 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	2425	0.95	Level	10	0	0.952	1.00	2680
Ramp	200	0.95	Level	10	0	0.952	1.00	221
UpStream								
DownStream	175	0.95	Level	10	0	0.952	1.00	193

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 0.683 using Equation (Exhibit 13-7)
V_{12} = 1900 pc/h
V_3 or V_{av34} 780 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2680	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	2459	Exhibit 13-8	7050	No
V_R	221	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1900	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 14.3 (pc/mi/ln)
LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.123 (Exhibit 13-12)
S_R= 62.2 mph (Exhibit 13-12)
S_0= 71.3 mph (Exhibit 13-12)
S = 64.6 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 10:46 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Avondale Blvd ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☑ Yes ☐ On ☐ No ☑ Off; L_{up} = 2600 ft; V_u = 425 veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	1300
Deceleration Lane Length L_D	
Freeway Volume, V_F	1975
Ramp Volume, V_R	75
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{down} = ft; V_D = veh/h

Conversion to pc/h Under 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	1975	0.95	Level	10	0	0.952	1.00	2183
Ramp	75	0.95	Level	10	0	0.952	1.00	83
UpStream	425	0.95	Level	10	0	0.952	1.00	470
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 1536.72 (Equation 13-6 or 13-7)
P_{FM} = 0.614 using Equation (Exhibit 13-6)
V_{12} = 1340 pc/h
V_3 or V_{av34} 843 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2266	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1423	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$
D_R = 8.4 (pc/mi/ln)
LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.194 (Exibit 13-11)
S_R= 60.5 mph (Exhibit 13-11)
S_0= 63.8 mph (Exhibit 13-11)
S = 61.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = using Equation (Exhibit 13-7)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$
D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)
S_R= mph (Exhibit 13-12)
S_0= mph (Exhibit 13-12)
S = mph (Exhibit 13-13)

 HCS2010[TM] Version 6.1 Generated: 1/2/2018 10:17 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Avondale Blvd ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{up} = ft; V_u = veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	1300
Deceleration Lane Length L_D	
Freeway Volume, V_F	1975
Ramp Volume, V_R	75
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☑ Yes ☐ On ☐ No ☑ Off; L_{down} = 9100 ft; V_D = 175 veh/h

Conversion to pc/h Under 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	1975	0.95	Level	10	0	0.952	1.00	2183
Ramp	75	0.95	Level	10	0	0.952	1.00	83
UpStream								
DownStream	175	0.95	Level	10	0	0.952	1.00	193

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 776.04 (Equation 13-6 or 13-7)
P_{FM} = 0.614 using Equation (Exhibit 13-6)
V_{12} = 1340 pc/h
V_3 or V_{av34} 843 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2266	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1423	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$
D_R = 8.4 (pc/mi/ln)
LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.194 (Exibit 13-11)
S_R= 60.5 mph (Exhibit 13-11)
S_0= 63.8 mph (Exhibit 13-11)
S = 61.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = using Equation (Exhibit 13-7)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$
D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)
S_R= mph (Exhibit 13-12)
S_0= mph (Exhibit 13-12)
S = mph (Exhibit 13-13)

 HCS2010[TM] Version 6.1 Generated: 1/2/2018 10:18 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Bullard Ave OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N	4	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D	700	L_{down} = ft
V_u = 75 veh/h	Freeway Volume, V_F	1975	V_D = veh/h
	Ramp Volume, V_R	50	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1975	0.95	Level	10	0	0.952	1.00	2183
Ramp	50	0.95	Level	10	0	0.952	1.00	55
UpStream	75	0.95	Level	10	0	0.952	1.00	83
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 983 pc/h

V_3 or V_{av34} 600 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2183	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	2128	Exhibit 13-8	9400	No
V_R	55	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	983	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 6.4 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

D_s = 0.108 (Exhibit 13-12)

S_R= 62.5 mph (Exhibit 13-12)

S_0= 71.3 mph (Exhibit 13-12)

S = 67.1 mph (Exhibit 13-13)

HCS2010TM Version 6.1 Generated: 1/2/2018 9:24 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Bullard Ave OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	4	☑ Yes ☑ On
☑ No ☐ Off	Acceleration Lane Length, L_A		☐ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D	700	L_{down} = 2600 ft
V_u = veh/h	Freeway Volume, V_F	1975	V_D = 125 veh/h
	Ramp Volume, V_R	50	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1975	0.95	Level	10	0	0.952	1.00	2183
Ramp	50	0.95	Level	10	0	0.952	1.00	55
UpStream								
DownStream	125	0.95	Level	10	0	0.952	1.00	138

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 983 pc/h

V_3 or V_{av34} 600 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2183	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	2128	Exhibit 13-8	9400	No
V_R	55	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	983	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 6.4 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

D_s = 0.108 (Exhibit 13-12)

S_R= 62.5 mph (Exhibit 13-12)

S_0= 71.3 mph (Exhibit 13-12)

S = 67.1 mph (Exhibit 13-13)

HCS2010TM Version 6.1 Generated: 1/2/2018 9:26 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N	3	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D	700	L_{down} = ft
V_u = 75 veh/h	Freeway Volume, V_F	2050	V_D = veh/h
	Ramp Volume, V_R	175	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under 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	2050	0.95	Level	10	0	0.952	1.00	2266
Ramp	175	0.95	Level	10	0	0.952	1.00	193
UpStream	75	0.95	Level	10	0	0.952	1.00	83
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 765.33 (Equation 13-12 or 13-13)

P_{FD} = 0.694 using Equation (Exhibit 13-7)

V_{12} = 1633 pc/h

V_3 or V_{av34} 633 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2266	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	2073	Exhibit 13-8	7050	No
V_R	193	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1633	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 12.0 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.120 (Exhibit 13-12)

S_R= 62.2 mph (Exhibit 13-12)

S_0= 71.3 mph (Exhibit 13-12)

S = 64.5 mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 1/2/2018 9:58 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	3	☑ Yes ☑ On
☑ No ☐ Off	Acceleration Lane Length, L_A		☐ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D	700	L_{down} = 2600 ft
V_u = veh/h	Freeway Volume, V_F	2050	V_D = 75 veh/h
	Ramp Volume, V_R	175	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under 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	2050	0.95	Level	10	0	0.952	1.00	2266
Ramp	175	0.95	Level	10	0	0.952	1.00	193
UpStream								
DownStream	75	0.95	Level	10	0	0.952	1.00	83

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.694 using Equation (Exhibit 13-7)

V_{12} = 1633 pc/h

V_3 or V_{av34} 633 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2266	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	2073	Exhibit 13-8	7050	No
V_R	193	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1633	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 12.0 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.120 (Exhibit 13-12)

S_R= 62.2 mph (Exhibit 13-12)

S_0= 71.3 mph (Exhibit 13-12)

S = 64.5 mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 1/2/2018 9:59 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☐ On	Number of Lanes, N	3	☐ Yes ☐ On
☐ No ☑ Off	Acceleration Lane Length, L_A	1300	☑ No ☐ Off
	Deceleration Lane Length L_D		
L_{up} = 2600 ft	Freeway Volume, V_F	1900	L_{down} = ft
	Ramp Volume, V_R	75	
	Freeway Free-Flow Speed, S_{FF}	65.0	
V_u = 175 veh/h	Ramp Free-Flow Speed, S_{FR}	55.0	V_D = veh/h

Conversion to pc/h Under 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	1900	0.95	Level	10	0	0.952	1.00	2100
Ramp	75	0.95	Level	10	0	0.952	1.00	83
UpStream	175	0.95	Level	10	0	0.952	1.00	193
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 1518.96 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 1289 pc/h

V_3 or V_{av34} 811 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2183	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1372	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 8.0 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.193 (Exibit 13-11)

S_R= 60.6 mph (Exhibit 13-11)

S_0= 63.9 mph (Exhibit 13-11)

S = 61.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 9:41 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	1300	☐ No ☑ Off
	Deceleration Lane Length L_D		
L_{up} = ft	Freeway Volume, V_F	1900	L_{down} = 9100 ft
	Ramp Volume, V_R	75	
	Freeway Free-Flow Speed, S_{FF}	65.0	
V_u = veh/h	Ramp Free-Flow Speed, S_{FR}	55.0	V_D = 50 veh/h

Conversion to pc/h Under 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	1900	0.95	Level	10	0	0.952	1.00	2100
Ramp	75	0.95	Level	10	0	0.952	1.00	83
UpStream								
DownStream	50	0.95	Level	10	0	0.952	1.00	55

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 221.15 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 1289 pc/h

V_3 or V_{av34} 811 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2183	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1372	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 8.0 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.193 (Exibit 13-11)

S_R= 60.6 mph (Exhibit 13-11)

S_0= 63.9 mph (Exhibit 13-11)

S = 61.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 9:46 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N	5	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D	170	L_{down} = ft
V_u = 1000 veh/h	Freeway Volume, V_F	10625	V_D = veh/h
	Ramp Volume, V_R	850	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under 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	10625	0.95	Level	10	0	0.952	1.00	11743
Ramp	850	0.95	Level	10	0	0.952	1.00	939
UpStream	1000	0.95	Level	10	0	0.952	1.00	1105
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 4626 pc/h

V_3 or V_{av34} 2384 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	9395	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	8456	Exhibit 13-8	9400	No
V_R	939	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4626	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 42.5 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.188 (Exhibit 13-12)

S_R= 60.7 mph (Exhibit 13-12)

S_0= 65.9 mph (Exhibit 13-12)

S = 63.2 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 12:54 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	5	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A		☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D	170	L_{down} = 1700 ft
V_u = veh/h	Freeway Volume, V_F	10625	V_D = 650 veh/h
	Ramp Volume, V_R	850	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under 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	10625	0.95	Level	10	0	0.952	1.00	11743
Ramp	850	0.95	Level	10	0	0.952	1.00	939
UpStream								
DownStream	650	0.95	Level	10	0	0.952	1.00	718

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 4626 pc/h

V_3 or V_{av34} 2384 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	9395	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	8456	Exhibit 13-8	9400	No
V_R	939	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4626	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 42.5 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.188 (Exhibit 13-12)

S_R= 60.7 mph (Exhibit 13-12)

S_0= 65.9 mph (Exhibit 13-12)

S = 63.2 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 1:02 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave on Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☐ On	Number of Lanes, N	3	☐ Yes ☐ On
☐ No ☑ Off	Acceleration Lane Length, L_A	800	☑ No ☐ Off
L_{up} = 2200 ft	Deceleration Lane Length L_D		L_{down} = ft
V_u = 3225 veh/h	Freeway Volume, V_F	5925	V_D = veh/h
	Ramp Volume, V_R	650	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	55.0	

Conversion to pc/h Under 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	5925	0.95	Level	10	0	0.952	1.00	6549
Ramp	650	0.95	Level	10	0	0.952	1.00	718
UpStream	3225	0.95	Level	10	0	0.952	1.00	3564
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = 2384.94 (Equation 13-6 or 13-7)

P_{FM} = 0.588 using Equation (Exhibit 13-6)

V_{12} = 3852 pc/h

V_3 or V_{av34} 2697 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	7267	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4570	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 35.8 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 0.610 (Exibit 13-11)

S_R= 51.0 mph (Exhibit 13-11)

S_0= 56.1 mph (Exhibit 13-11)

S = 52.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/4/2018 2:15 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave on Ramp
Date Performed	1/3/2018	Jurisdiction	ADOT
Analysis Time Period	AM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	3	☑ Yes ☑ On
☑ No ☐ Off	Acceleration Lane Length, L_A	800	☐ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D		L_{down} = 1400 ft
V_u = veh/h	Freeway Volume, V_F	5925	V_D = 450 veh/h
	Ramp Volume, V_R	650	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	55.0	

Conversion to pc/h Under 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	5925	0.95	Level	10	0	0.952	1.00	6549
Ramp	650	0.95	Level	10	0	0.952	1.00	718
UpStream								
DownStream	450	0.95	Level	10	0	0.952	1.00	497

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.600 using Equation (Exhibit 13-6)

V_{12} = 3929 pc/h

V_3 or V_{av34} 2620 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	7267	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4647	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 36.4 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 0.640 (Exibit 13-11)

S_R= 50.3 mph (Exhibit 13-11)

S_0= 56.5 mph (Exhibit 13-11)

S = 52.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/4/2018 2:17 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Avondale Blvd to 107th Ave
Agency/Company	HDR Engineering Inc.	Weaving Segment Location	
Date Performed	1/2/2018	Analysis Year	2040
Analysis Time Period	AM		

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1620ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	7275	0.95	10	0	1.5	1.2	0.952	1.00	8041
V_{RF}	75	0.95	10	0	1.5	1.2	0.952	1.00	83
V_{FR}	1075	0.95	10	0	1.5	1.2	0.952	1.00	1188
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	8041
V_{NW}	8041							V =	9312
V_W	1271								
VR	0.136								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.83 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	9312 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	8290 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.070	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	3897 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 3/28/2018 3:39 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Estrella Pkwy to Bullard Ave
Agency/Company	HDR Engineering Inc.	Weaving Segment Location	
Date Performed	1/2/2018	Analysis Year	2040
Analysis Time Period	AM		

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2100ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	6350	0.95	10	0	1.5	1.2	0.952	1.00	7018
V_{RF}	650	0.95	10	0	1.5	1.2	0.952	1.00	718
V_{FR}	900	0.95	10	0	1.5	1.2	0.952	1.00	995
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	7018
V_{NW}	7018							V =	8731
V_W	1713								
VR	0.196								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	995 lc/h
Interchange density, ID	0.83 int/mi	Weaving lane changes, LC_W	1666 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1621 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	3287 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.322

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	8731 pc/h	Weaving intensity factor, W	0.322
Weaving segment capacity, c_w	10319 veh/h	Weaving segment speed, S	50.1 mph
Weaving segment v/c ratio	0.806	Average weaving speed, S_W	52.8 mph
Weaving segment density, D	34.9 pc/mi/ln	Average non-weaving speed, S_{NW}	49.5 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	4497 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 3/28/2018 3:40 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Sarival Ave to Estrella Pkwy
Agency/Company	HDR Engineering Inc.	Weaving Segment Location	
Date Performed	1/2/2018	Analysis Year	2040
Analysis Time Period	AM		

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2200ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	6300	0.95	10	0	1.5	1.2	0.952	1.00	6963
V_{RF}	50	0.95	10	0	1.5	1.2	0.952	1.00	55
V_{FR}	700	0.95	10	0	1.5	1.2	0.952	1.00	774
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	6963
V_{NW}	6963							V =	7792
V_W	829								
VR	0.106								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	774 lc/h
Interchange density, ID	0.83 int/mi	Weaving lane changes, LC_W	1463 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1664 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	3127 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.298

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	7792 pc/h	Weaving intensity factor, W	0.298
Weaving segment capacity, c_w	10681 veh/h	Weaving segment speed, S	52.1 mph
Weaving segment v/c ratio	0.695	Average weaving speed, S_W	53.5 mph
Weaving segment density, D	29.9 pc/mi/ln	Average non-weaving speed, S_{NW}	51.9 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	3602 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 3/28/2018 3:41 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	83rd Ave to 91st Ave
Agency/Company	HDR Engineering Inc.	Weaving Segment Location	
Date Performed	1/2/2018	Analysis Year	2040
Analysis Time Period	AM		

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	C-D Roadway/ Multilane Highways
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2220ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2225	0.95	10	0	1.5	1.2	0.952	1.00	2459
V_{RF}	450	0.95	10	0	1.5	1.2	0.952	1.00	497
V_{FR}	75	0.95	10	0	1.5	1.2	0.952	1.00	83
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	2459
V_{NW}	2459							V =	3039
V_W	580								
VR	0.191								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	83 lc/h
Interchange density, ID	0.66 int/mi	Weaving lane changes, LC_W	724 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	747 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	1471 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.163

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3039 pc/h	Weaving intensity factor, W	0.163
Weaving segment capacity, c_w	10381 veh/h	Weaving segment speed, S	60.8 mph
Weaving segment v/c ratio	0.279	Average weaving speed, S_W	58.0 mph
Weaving segment density, D	10.0 pc/mi/ln	Average non-weaving speed, S_{NW}	61.5 mph
Level of Service, LOS	A	Maximum weaving length, L_{MAX}	4443 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 1/5/2018 9:40 AM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information

Analyst	XL
Agency/Company	HDR Engineering Inc.
Date Performed	1/2/2018
Analysis Time Period	AM

Site Information

Freeway/Dir of Travel	107th Ave to Avondale Blvd
Weaving Segment Location	
Analysis Year	2040

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1675ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1800	0.95	10	0	1.5	1.2	0.952	1.00	1989
V_{RF}	425	0.95	10	0	1.5	1.2	0.952	1.00	470
V_{FR}	175	0.95	10	0	1.5	1.2	0.952	1.00	193
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	1989
V_{NW}	1989							V =	2652
V_W	663								
VR	0.250								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	663 lc/h
Interchange density, ID	0.83 int/mi	Weaving lane changes, LC_W	1038 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	547 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1585 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.216

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2652 pc/h	Weaving intensity factor, W	0.216
Weaving segment capacity, c_w	7970 veh/h	Weaving segment speed, S	56.8 mph
Weaving segment v/c ratio	0.317	Average weaving speed, S_W	56.1 mph
Weaving segment density, D	11.7 pc/mi/ln	Average non-weaving speed, S_{NW}	57.0 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	5054 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 1/3/2018 4:42 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information

Analyst	XL
Agency/Company	HDR Engineering Inc.
Date Performed	1/2/2018
Analysis Time Period	AM

Site Information

Freeway/Dir of Travel	Bullard Ave to Estrella Pkwy
Weaving Segment Location	
Analysis Year	2040

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2085ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1325	0.95	10	0	1.5	1.2	0.952	1.00	1464
V_{RF}	600	0.95	10	0	1.5	1.2	0.952	1.00	663
V_{FR}	125	0.95	10	0	1.5	1.2	0.952	1.00	138
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	1464
V_{NW}	1464							V =	2265
V_W	801								
VR	0.354								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	663 lc/h
Interchange density, ID	0.83 int/mi	Weaving lane changes, LC_W	1331 lc/h
Minimum RF lane changes, LC_{RF}	0 lc/pc	Non-weaving lane changes, LC_{NW}	469 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1800 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.201

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2265 pc/h	Weaving intensity factor, W	0.201
Weaving segment capacity, c_w	6463 veh/h	Weaving segment speed, S	57.5 mph
Weaving segment v/c ratio	0.334	Average weaving speed, S_W	56.6 mph
Weaving segment density, D	7.9 pc/mi/ln	Average non-weaving speed, S_{NW}	58.1 mph
Level of Service, LOS	A	Maximum weaving length, L_{MAX}	6166 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 3/28/2018 3:45 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Estrella Pkwy to Sarival Ave
Agency/Company	HDR Engineering Inc.	Weaving Segment Location	
Date Performed	1/2/2018	Analysis Year	2040
Analysis Time Period	AM		

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2225ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1075	0.95	10	0	1.5	1.2	0.952	1.00	1188
V_{RF}	375	0.95	10	0	1.5	1.2	0.952	1.00	414
V_{FR}	100	0.95	10	0	1.5	1.2	0.952	1.00	111
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	1188
V_{NW}	1188							V =	1713
V_W	525								
VR	0.306								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	0 lc/h
Interchange density, ID	0.83 int/mi	Weaving lane changes, LC_W	694 lc/h
Minimum RF lane changes, LC_{RF}	0 lc/pc	Non-weaving lane changes, LC_{NW}	488 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	1182 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.137

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1713 pc/h	Weaving intensity factor, W	0.137
Weaving segment capacity, c_w	7458 veh/h	Weaving segment speed, S	61.9 mph
Weaving segment v/c ratio	0.219	Average weaving speed, S_W	59.0 mph
Weaving segment density, D	5.5 pc/mi/ln	Average non-weaving speed, S_{NW}	63.4 mph
Level of Service, LOS	A	Maximum weaving length, L_{MAX}	5654 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 1/3/2018 4:38 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	91st Ave to 83rd Ave
Agency/Company	HDR Engineering Inc.	Weaving Segment Location	
Date Performed	1/2/2018	Analysis Year	2040
Analysis Time Period	AM		

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2055ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	8575	0.95	10	0	1.5	1.2	0.952	1.00	9478
V_{RF}	50	0.95	10	0	1.5	1.2	0.952	1.00	55
V_{FR}	1025	0.95	10	0	1.5	1.2	0.952	1.00	1133
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	9478
V_{NW}	9478							V =	10666
V_W	1188								
VR	0.111								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.66 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	0 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	10666 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	8488 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.197	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	3650 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 3/28/2018 3:35 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Dysart Rd*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3425* veh/h	Peak-Hour Factor, PHF	*0.95*	
AADT	veh/day	%Trucks and Buses, P_T	*10*	
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 Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1262*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*19.4*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 2:05 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Estrella Pkwy*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2750* veh/h	Peak-Hour Factor, PHF	*0.95*	
AADT	veh/day	%Trucks and Buses, P_T	*10*	
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 Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*4*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*760*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*11.7*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 1:38 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*XL*
Agency or Company	*HDR Engineering Inc.*
Date Performed	*1/2/2018*
Analysis Time Period	*PM*

Site Information

Highway/Direction of Travel	*Eastbound*
From/To	*At Sarival Ave*
Jurisdiction	*ADOT*
Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2400*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*5*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*531*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*8.2*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

 HCS 2010™ Version 6.1 Generated: 1/3/2018 4:53 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*XL*
Agency or Company	*HDR Engineering Inc.*
Date Performed	*1/2/2018*
Analysis Time Period	*PM*

Site Information

Highway/Direction of Travel	*Eastbound*
From/To	*East of Agua Fria River*
Jurisdiction	*ADOT*
Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3500*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1289*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*19.8*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

 HCS 2010™ Version 6.1 Generated: 1/2/2018 1:54 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*East of Sarival Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2400*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 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)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
			Design (N)	
Operational (LOS)			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*663*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*10.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/3/2018 4:55 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*El Mirage Rd*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3625*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 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)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
			Design (N)	
Operational (LOS)			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1336*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*20.6*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 2:13 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*West of 67th Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4475*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*5*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*989*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*15.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 3:18 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*West of Agua Fria River*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3500*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*4*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*967*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*14.9*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 1:53 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Westbound
Agency or Company	HDR Engineering Inc.	From/To	83rd Ave major Diverge
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	800	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 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)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	442	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	60.0	mph	S	mph
D = v_p / S	7.4	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	A		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 3:04 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Westbound
Agency or Company	HDR Engineering Inc.	From/To	At 75th Ave
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	10025	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	5		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	65.0	mph	FFS	65.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2216	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	55.6	mph	S	mph
D = v_p / S	39.9	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	E		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 3:09 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At 83rd Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*9225* veh/h		Peak-Hour Factor, PHF	*0.95*
AADT	veh/day		%Trucks and Buses, P_T	*10*
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*4*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2549*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*46.3*	mph	S	mph
D = v_p / S	*55.1*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*F*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 3:03 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At 99th Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*8575* veh/h		Peak-Hour Factor, PHF	*0.95*
AADT	veh/day		%Trucks and Buses, P_T	*10*
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*3*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*3159*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*21.1*	mph	S	mph
D = v_p / S	*149.5*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*F*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 2:43 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*XL*
Agency or Company	*HDR Engineering Inc.*
Date Performed	*1/2/2018*
Analysis Time Period	*PM*

Site Information

Highway/Direction of Travel	*Westbound*
From/To	*At 107th Ave*
Jurisdiction	*ADOT*
Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*7975*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2938*	pc/h/ln
S	*31.5*	mph
D = v_p / S	*93.4*	pc/mi/ln
LOS	*F*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

 HCS 2010™ Version 6.1 Generated: 1/2/2018 2:33 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*XL*
Agency or Company	*HDR Engineering Inc.*
Date Performed	*1/2/2018*
Analysis Time Period	*PM*

Site Information

Highway/Direction of Travel	*Westbound*
From/To	*At Avondale Blvd*
Jurisdiction	*ADOT*
Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*7100*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2616*	pc/h/ln
S	*44.0*	mph
D = v_p / S	*59.4*	pc/mi/ln
LOS	*F*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

 HCS 2010™ Version 6.1 Generated: 1/2/2018 2:26 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	XL
Agency or Company	HDR Engineering Inc.
Date Performed	1/2/2018
Analysis Time Period	PM

Site Information

Highway/Direction of Travel	Westbound
From/To	At Bullard Ave
Jurisdiction	ADOT
Analysis Year	2040

Project Description SR 30 East HA (3+0)

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	7000	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	4	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	65.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	65.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1934	pc/h/ln
S	61.0	mph
D = v_p / S	31.7	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

 HCS 2010™ Version 6.1 Generated: 1/2/2018 1:46 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	XL
Agency or Company	HDR Engineering Inc.
Date Performed	1/2/2018
Analysis Time Period	PM

Site Information

Highway/Direction of Travel	Westbound
From/To	At Dysart Rd
Jurisdiction	ADOT
Analysis Year	2040

Project Description SR 30 East HA (3+0)

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	6775	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	3	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	65.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	65.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2496	pc/h/ln
S	48.0	mph
D = v_p / S	52.0	pc/mi/ln
LOS	F	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

 HCS 2010™ Version 6.1 Generated: 1/2/2018 2:06 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Estrella Pkwy*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*6775*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*5*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1498*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*64.9*	mph	S	mph
D = v_p / S	*23.1*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 1:39 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At Sarival Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*6050*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*5*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1337*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*20.6*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/3/2018 5:09 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Westbound
Agency or Company	HDR Engineering Inc.	From/To	East of 91st Ave
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	8225	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	4		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	65.0	mph
FFS (measured)	65.0	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2273	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	54.2	mph	S		mph
D = v_p / S	41.9	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	E		Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 2:56 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Westbound
Agency or Company	HDR Engineering Inc.	From/To	East of Agua Fria River
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	7300	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	3		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	65.0	mph
FFS (measured)	65.0	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2689	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	41.4	mph	S		mph
D = v_p / S	64.9	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	F		Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 1:56 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*El Mirage Rd*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*7125*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Adjustments

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 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)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
			Design (N)		
Operational (LOS)			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2625*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	*43.7*	mph	S		mph
D = v_p / S	*60.0*	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	*F*		Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 2:15 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*XL*	Highway/Direction of Travel	*Westbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*West of 67th Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*9225*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Adjustments

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 FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*5*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
			Design (N)		
Operational (LOS)			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2039*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	*59.2*	mph	S		mph
D = v_p / S	*34.4*	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	*D*		Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 3:22 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Westbound
Agency or Company	HDR Engineering Inc.	From/To	West of 91st Ave
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	8225	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	3	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	65.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	65.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	3030	pc/h/ln
S	27.3	mph
D = v_p / S	110.9	pc/mi/ln
LOS	F	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes S - Speed
V - Hourly volume D - Density
v_p - Flow rate FFS - Free-flow speed
LOS - Level of service BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18 TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 1/2/2018 2:55 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Westbound
Agency or Company	HDR Engineering Inc.	From/To	West of Agua Fria River
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	7300	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	4	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	65.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	65.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2017	pc/h/ln
S	59.6	mph
D = v_p / S	33.8	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes S - Speed
V - Hourly volume D - Density
v_p - Flow rate FFS - Free-flow speed
LOS - Level of service BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18 TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 1/2/2018 1:55 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At 75th Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4975*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*5*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1100*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*16.9*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 3:10 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*XL*	Highway/Direction of Travel	*Eastbound*
Agency or Company	*HDR Engineering Inc.*	From/To	*At 83rd Ave*
Date Performed	*1/2/2018*	Jurisdiction	*ADOT*
Analysis Time Period	*PM*	Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4525*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Up/Down %	*mi*

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	*4*		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	*65.0*	mph
FFS (measured)	*65.0*	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1250*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*19.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 3:02 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	From/To	At 91st Ave
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	4075	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	3		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	65.0	mph
FFS (measured)	65.0	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1501	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	64.9	mph	S	mph
D = v_p / S	23.1	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	C		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 2:51 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	From/To	At 99th Ave
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	4250	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	3		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	65.0	mph
FFS (measured)	65.0	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1566	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	64.6	mph	S	mph
D = v_p / S	24.2	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	C		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

 HCS 2010™ Version 6.1 Generated: 1/2/2018 2:42 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	From/To	At 107th Ave
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	3950	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	3		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	65.0	mph
FFS (measured)	65.0	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1455	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	65.0	mph	S	mph
D = v_p / S	22.4	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	C		Required Number of Lanes, N	

Glossary

N - Number of lanes; S - Speed
V - Hourly volume; D - Density
v_p - Flow rate; FFS - Free-flow speed
LOS - Level of service; BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12; f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13; f_{LC} - Exhibit 11-9
f_p - Page 11-18; TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 1/2/2018 2:30 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	XL	Highway/Direction of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	From/To	At Avondale Blvd
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	3550	veh/h	Peak-Hour Factor, PHF	0.95
AADT		veh/day	%Trucks and Buses, P_T	10
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 Up/Down %	mi

Calculate Flow Adjustments

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 FFS		
Lane Width		ft	f_{LW}		mph
Rt-Side Lat. Clearance		ft	f_{LC}		mph
Number of Lanes, N	3		TRD Adjustment		mph
Total Ramp Density, TRD		ramps/mi	FFS	65.0	mph
FFS (measured)	65.0	mph			
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1308	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	65.0	mph	S	mph
D = v_p / S	20.1	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	C		Required Number of Lanes, N	

Glossary

N - Number of lanes; S - Speed
V - Hourly volume; D - Density
v_p - Flow rate; FFS - Free-flow speed
LOS - Level of service; BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12; f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13; f_{LC} - Exhibit 11-9
f_p - Page 11-18; TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

 HCS 2010™ Version 6.1 Generated: 1/2/2018 2:25 PM

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*XL*
Agency or Company	*HDR Engineering Inc.*
Date Performed	*1/2/2018*
Analysis Time Period	*PM*

Site Information

Highway/Direction of Travel	*Eastbound*
From/To	*At Bullard Ave*
Jurisdiction	*ADOT*
Analysis Year	*2040*

Project Description *SR 30 East HA (3+0)*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3400*	veh/h	Peak-Hour Factor, PHF	*0.95*
AADT		veh/day	%Trucks and Buses, P_T	*10*
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 Adjustments

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

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*4*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*939*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*14.4*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010™ Version 6.1 Generated: 1/2/2018 1:45 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Bullard Ave ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{up} = ft; V_u = veh/h

Number of Lanes, N	4
Acceleration Lane Length, L_A	1300
Deceleration Lane Length L_D	
Freeway Volume, V_F	3400
Ramp Volume, V_R	125
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☑ Yes ☐ On ☐ No ☑ Off; L_{down} = 9100 ft; V_D = 100 veh/h

Conversion to pc/h Under 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	3400	0.95	Level	10	0	0.952	1.00	3758
Ramp	125	0.95	Level	10	0	0.952	1.00	138
UpStream								
DownStream	100	0.95	Level	10	0	0.952	1.00	111

Merge Areas

Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.464 using Equation (Exhibit 13-6)

V_{12} = 1744 pc/h

V_3 or V_{av34} 1007 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3896	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1882	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$$

D_R = 11.9 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.204 (Exibit 13-11)

S_R= 60.3 mph (Exhibit 13-11)

S_0= 63.2 mph (Exhibit 13-11)

S = 61.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 1/2/2018 1:49 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N	3	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D	700	L_{down} = ft
V_u = 125 veh/h	Freeway Volume, V_F	3500	V_D = veh/h
	Ramp Volume, V_R	100	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under 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	3500	0.95	Level	10	0	0.952	1.00	3868
Ramp	100	0.95	Level	10	0	0.952	1.00	111
UpStream	125	0.95	Level	10	0	0.952	1.00	138
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 910.72 (Equation 13-12 or 13-13)
P_{FD} = 0.658 using Equation (Exhibit 13-7)
V_{12} = 2584 pc/h
V_3 or V_{av34} 1284 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3868	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	3757	Exhibit 13-8	7050	No
V_R	111	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2584	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 20.2 (pc/mi/ln)
LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.113 (Exhibit 13-12)
S_R= 62.4 mph (Exhibit 13-12)
S_0= 70.2 mph (Exhibit 13-12)
S = 64.8 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 1:58 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	3	☑ Yes ☑ On
☑ No ☐ Off	Acceleration Lane Length, L_A		☐ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D	700	L_{down} = 2600 ft
V_u = veh/h	Freeway Volume, V_F	3500	V_D = 225 veh/h
	Ramp Volume, V_R	100	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under 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	3500	0.95	Level	10	0	0.952	1.00	3868
Ramp	100	0.95	Level	10	0	0.952	1.00	111
UpStream								
DownStream	225	0.95	Level	10	0	0.952	1.00	249

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 0.658 using Equation (Exhibit 13-7)
V_{12} = 2584 pc/h
V_3 or V_{av34} 1284 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3868	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	3757	Exhibit 13-8	7050	No
V_R	111	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2584	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 20.2 (pc/mi/ln)
LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.113 (Exhibit 13-12)
S_R= 62.4 mph (Exhibit 13-12)
S_0= 70.2 mph (Exhibit 13-12)
S = 64.8 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 2:00 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☐ On	Number of Lanes, N	3	☐ Yes ☐ On
☐ No ☑ Off	Acceleration Lane Length, L_A	1300	☑ No ☐ Off
	Deceleration Lane Length L_D		
L_{up} = 2600 ft	Freeway Volume, V_F	3425	L_{down} = ft
V_u = 100 veh/h	Ramp Volume, V_R	225	V_D = veh/h
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	55.0	

Conversion to pc/h Under 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	3425	0.95	Level	10	0	0.952	1.00	3786
Ramp	225	0.95	Level	10	0	0.952	1.00	249
UpStream	100	0.95	Level	10	0	0.952	1.00	111
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 1915.29 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 2324 pc/h

V_3 or V_{av34} 1462 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4035	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2573	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R = 17.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.229 (Exibit 13-11)

S_R= 59.7 mph (Exhibit 13-11)

S_0= 61.5 mph (Exhibit 13-11)

S = 60.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 2:08 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	1300	☐ No ☑ Off
	Deceleration Lane Length L_D		
L_{up} = ft	Freeway Volume, V_F	3425	L_{down} = 9100 ft
V_u = veh/h	Ramp Volume, V_R	225	V_D = 75 veh/h
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	55.0	

Conversion to pc/h Under 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	3425	0.95	Level	10	0	0.952	1.00	3786
Ramp	225	0.95	Level	10	0	0.952	1.00	249
UpStream								
DownStream	75	0.95	Level	10	0	0.952	1.00	83

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 333.74 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 2324 pc/h

V_3 or V_{av34} 1462 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4035	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2573	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R = 17.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.229 (Exibit 13-11)

S_R= 59.7 mph (Exhibit 13-11)

S_0= 61.5 mph (Exhibit 13-11)

S = 60.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 2:09 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑Yes ☑On	Number of Lanes, N	4	☐Yes ☐On
☐No ☐Off	Acceleration Lane Length, L_A		☑No ☐Off
L_{up} = 600 ft	Deceleration Lane Length L_D	1500	L_{down} = ft
V_u = 350 veh/h	Freeway Volume, V_F	5850	V_D = veh/h
	Ramp Volume, V_R	475	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under 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	5850	0.95	Level	10	0	0.952	1.00	6466
Ramp	475	0.95	Level	10	0	0.952	1.00	525
UpStream	350	0.95	Level	10	0	0.952	1.00	387
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☐No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☐No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 3115 pc/h

V_3 or V_{av34} 1675 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☑No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☑No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6466	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	5941	Exhibit 13-8	9400	No
V_R	525	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3115	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 17.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.150 (Exhibit 13-12)

S_R= 61.5 mph (Exhibit 13-12)

S_0= 68.7 mph (Exhibit 13-12)

S = 65.0 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/4/2018 2:28 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐Yes ☐On	Number of Lanes, N	4	☑Yes ☑On
☑No ☐Off	Acceleration Lane Length, L_A		☐No ☐Off
L_{up} = ft	Deceleration Lane Length L_D	1500	L_{down} = 5400 ft
V_u = veh/h	Freeway Volume, V_F	5850	V_D = 650 veh/h
	Ramp Volume, V_R	475	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under 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	5850	0.95	Level	10	0	0.952	1.00	6466
Ramp	475	0.95	Level	10	0	0.952	1.00	525
UpStream								
DownStream	650	0.95	Level	10	0	0.952	1.00	718

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☐No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☐No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 3115 pc/h

V_3 or V_{av34} 1675 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☑No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☑No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6466	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	5941	Exhibit 13-8	9400	No
V_R	525	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3115	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 17.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.150 (Exhibit 13-12)

S_R= 61.5 mph (Exhibit 13-12)

S_0= 68.7 mph (Exhibit 13-12)

S = 65.0 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/4/2018 2:30 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off; L_{up} = 2000 ft; V_u = 3225 veh/h

Number of Lanes, N	5
Acceleration Lane Length, L_A	1300
Deceleration Lane Length L_D	
Freeway Volume, V_F	9225
Ramp Volume, V_R	800
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{down} = ft; V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	9225	0.95	Level	10	0	0.952	1.00	10196
Ramp	800	0.95	Level	10	0	0.952	1.00	884
UpStream	3225	0.95	Level	10	0	0.952	1.00	3564
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.107 using Equation (Exhibit 13-6)

V_{12} = 826 pc/h

V_3 or V_{av34} 3435 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No

If Yes,V_{12a} = 3078 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	8580	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3962	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 27.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.383 (Exibit 13-11)

S_R= 56.2 mph (Exhibit 13-11)

S_0= 58.4 mph (Exhibit 13-11)

S = 57.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/4/2018 2:29 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{up} = ft; V_u = veh/h

Number of Lanes, N	5
Acceleration Lane Length, L_A	1300
Deceleration Lane Length L_D	
Freeway Volume, V_F	9225
Ramp Volume, V_R	800
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☑ Yes ☐ On ☐ No ☑ Off; L_{down} = 9100 ft; V_D = 800 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	9225	0.95	Level	10	0	0.952	1.00	10196
Ramp	800	0.95	Level	10	0	0.952	1.00	884
UpStream								
DownStream	800	0.95	Level	10	0	0.952	1.00	884

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.107 using Equation (Exhibit 13-6)

V_{12} = 826 pc/h

V_3 or V_{av34} 3435 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No

If Yes,V_{12a} = 3078 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	8580	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3962	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 27.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.383 (Exibit 13-11)

S_R= 56.2 mph (Exhibit 13-11)

S_0= 58.4 mph (Exhibit 13-11)

S = 57.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 3:17 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	83rd Ave OFF Ramp
Date Performed	12/27/2017	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N: 5	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D: 700	L_{down} = ft
V_u = 800 veh/h	Freeway Volume, V_F: 10025	V_D = veh/h
	Ramp Volume, V_R: 800	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under 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	10025	0.95	Level	10	0	0.952	1.00	11080
Ramp	800	0.95	Level	10	0	0.952	1.00	884
UpStream	800	0.95	Level	10	0	0.952	1.00	884
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 0.260 using Equation (Exhibit 13-7)
V_{12} = 2959 pc/h
V_3 or V_{av34} 2952 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No
If Yes,V_{12a} = 3545 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	8864	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	7980	Exhibit 13-8	9400	No
V_R	884	Exhibit 13-10	4400	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2959	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 15.8 (pc/mi/ln)
LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.183 (Exhibit 13-12)
S_R= 60.8 mph (Exhibit 13-12)
S_0= 64.8 mph (Exhibit 13-12)
S = 63.2 mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 3/28/2018 3:07 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	91st Ave ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☐ No ☑ Off	Acceleration Lane Length, L_A: 1300	☑ No ☐ Off
L_{up} = 2600 ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = 1125 veh/h	Freeway Volume, V_F: 8225	V_D = veh/h
	Ramp Volume, V_R: 375	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under 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	8225	0.95	Level	10	0	0.952	1.00	9091
Ramp	375	0.95	Level	10	0	0.952	1.00	414
UpStream	1125	0.95	Level	10	0	0.952	1.00	1243
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 3085.87 (Equation 13-6 or 13-7)
P_{FM} = 0.583 using Equation (Exhibit 13-6)
V_{12} = 5301 pc/h
V_3 or V_{av34} 3790 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = 6391 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	9505	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	6805	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 50.2 (pc/mi/ln)
LOS = F (Exhibit 13-2)

Speed Determination

M_S = 3.697 (Exibit 13-11)
S_R= -20.0 mph (Exhibit 13-11)
S_0= 56.1 mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = using Equation (Exhibit 13-7)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)
S_R= mph (Exhibit 13-12)
S_0= mph (Exhibit 13-12)
S = mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 1/2/2018 2:48 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	91st Ave ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1300	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = 9100 ft
V_u = veh/h	Freeway Volume, V_F: 8225	V_D = 625 veh/h
	Ramp Volume, V_R: 375	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	8225	0.95	Level	10	0	0.952	1.00	9091
Ramp	375	0.95	Level	10	0	0.952	1.00	414
UpStream								
DownStream	625	0.95	Level	10	0	0.952	1.00	691

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = 2778.45 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 5581 pc/h

V_3 or V_{av34} 3510 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = 6391 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	9505	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	6805	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\,v_R + 0.0078\,V_{12} - 0.00627\,L_A$

D_R = 50.2 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 3.697 (Exibit 13-11)

S_R= -20.0 mph (Exhibit 13-11)

S_0= 56.1 mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\,V_{12} - 0.009\,L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 2:49 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	107th Ave OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N: 3	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D: 700	L_{down} = ft
V_u = 375 veh/h	Freeway Volume, V_F: 8575	V_D = veh/h
	Ramp Volume, V_R: 625	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	8575	0.95	Level	10	0	0.952	1.00	9478
Ramp	625	0.95	Level	10	0	0.952	1.00	691
UpStream	375	0.95	Level	10	0	0.952	1.00	414
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\,v_R + 0.0078\,V_{12} - 0.00627\,L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 1750.69 (Equation 13-12 or 13-13)

P_{FD} = 0.491 using Equation (Exhibit 13-7)

V_{12} = 5008 pc/h

V_3 or V_{av34} 4470 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = 6778 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	9478	Exhibit 13-8	7050	Yes
$V_{FO} = V_F - V_R$	8787	Exhibit 13-8	7050	Yes
V_R	691	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	5008	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\,V_{12} - 0.009\,L_D$

D_R = 56.2 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.165 (Exhibit 13-12)

S_R= 61.2 mph (Exhibit 13-12)

S_0= 64.7 mph (Exhibit 13-12)

S = 62.2 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 2:39 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	107th Ave OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{up} = ft; V_u = veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	700
Freeway Volume, V_F	8575
Ramp Volume, V_R	625
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	60.0

Downstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off; L_{down} = 2600 ft; V_D = 100 veh/h

Conversion to pc/h Under 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	8575	0.95	Level	10	0	0.952	1.00	9478
Ramp	625	0.95	Level	10	0	0.952	1.00	691
UpStream								
DownStream	100	0.95	Level	10	0	0.952	1.00	111

Merge Areas

Estimation of v_{12}

$V_{12} = V_F$ (P_{FM})

- L_{EQ} = (Equation 13-6 or 13-7)
- P_{FM} = using Equation (Exhibit 13-6)
- V_{12} = pc/h
- V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
- Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
- Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
- If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

- D_R = (pc/mi/ln)
- LOS = (Exhibit 13-2)

Speed Determination

- M_S = (Exibit 13-11)
- S_R= mph (Exhibit 13-11)
- S_0= mph (Exhibit 13-11)
- S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

- L_{EQ} = (Equation 13-12 or 13-13)
- P_{FD} = 0.491 using Equation (Exhibit 13-7)
- V_{12} = 5008 pc/h
- V_3 or V_{av34} 4470 pc/h (Equation 13-14 or 13-17)
- Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No
- Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
- If Yes,V_{12a} = 6778 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	9478	Exhibit 13-8	7050	Yes
$V_{FO} = V_F - V_R$	8787	Exhibit 13-8	7050	Yes
V_R	691	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	5008	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

- D_R = 56.2 (pc/mi/ln)
- LOS = F (Exhibit 13-2)

Speed Determination

- D_s = 0.165 (Exhibit 13-12)
- S_R= 61.2 mph (Exhibit 13-12)
- S_0= 64.7 mph (Exhibit 13-12)
- S = 62.2 mph (Exhibit 13-13)

 HCS2010[TM] Version 6.1 Generated: 1/2/2018 2:41 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Avondale Blvd ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☑ Yes ☐ On ☐ No ☑ Off; L_{up} = 2600 ft; V_u = 975 veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	1300
Deceleration Lane Length L_D	
Freeway Volume, V_F	7100
Ramp Volume, V_R	25
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{down} = ft; V_D = veh/h

Conversion to pc/h Under 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	7100	0.95	Level	10	0	0.952	1.00	7847
Ramp	25	0.95	Level	10	0	0.952	1.00	28
UpStream	975	0.95	Level	10	0	0.952	1.00	1078
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F$ (P_{FM})

- L_{EQ} = 2737.05 (Equation 13-6 or 13-7)
- P_{FM} = 0.605 using Equation (Exhibit 13-6)
- V_{12} = 4748 pc/h
- V_3 or V_{av34} 3099 pc/h (Equation 13-14 or 13-17)
- Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No
- Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
- If Yes,V_{12a} = 5147 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	7875	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	5175	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

- D_R = 37.7 (pc/mi/ln)
- LOS = F (Exhibit 13-2)

Speed Determination

- M_S = 0.868 (Exibit 13-11)
- S_R= 45.0 mph (Exhibit 13-11)
- S_0= 56.1 mph (Exhibit 13-11)
- S = 48.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

- L_{EQ} = (Equation 13-12 or 13-13)
- P_{FD} = using Equation (Exhibit 13-7)
- V_{12} = pc/h
- V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
- Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
- Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
- If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

- D_R = (pc/mi/ln)
- LOS = (Exhibit 13-2)

Speed Determination

- D_s = (Exhibit 13-12)
- S_R= mph (Exhibit 13-12)
- S_0= mph (Exhibit 13-12)
- S = mph (Exhibit 13-13)

 HCS2010[TM] Version 6.1 Generated: 1/2/2018 2:21 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Avondale Blvd ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1300	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = 9100 ft
V_u = veh/h	Freeway Volume, V_F: 7100	V_D = 350 veh/h
	Ramp Volume, V_R: 25	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under 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	7100	0.95	Level	10	0	0.952	1.00	7847
Ramp	25	0.95	Level	10	0	0.952	1.00	28
UpStream								
DownStream	350	0.95	Level	10	0	0.952	1.00	387

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = 1556.09 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 4817 pc/h

V_3 or V_{av34} 3030 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = 5147 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	7875	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	5175	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 37.7 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 0.868 (Exibit 13-11)

S_R= 45.0 mph (Exhibit 13-11)

S_0= 56.1 mph (Exhibit 13-11)

S = 48.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010[TM] Version 6.1 Generated: 1/2/2018 2:22 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Bullard Ave OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N: 4	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D: 700	L_{down} = ft
V_u = 525 veh/h	Freeway Volume, V_F: 7300	V_D = veh/h
	Ramp Volume, V_R: 300	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under 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	7300	0.95	Level	10	0	0.952	1.00	8068
Ramp	300	0.95	Level	10	0	0.952	1.00	332
UpStream	525	0.95	Level	10	0	0.952	1.00	580
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 3705 pc/h

V_3 or V_{av34} 2181 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	8068	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	7736	Exhibit 13-8	9400	No
V_R	332	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3705	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 29.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.133 (Exhibit 13-12)

S_R= 61.9 mph (Exhibit 13-12)

S_0= 66.7 mph (Exhibit 13-12)

S = 64.4 mph (Exhibit 13-13)

HCS2010[TM] Version 6.1 Generated: 1/2/2018 1:51 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Bullard Ave OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	4	☑ Yes ☑ On
☑ No ☐ Off	Acceleration Lane Length, L_A		☐ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D	700	L_{down} = 2600 ft
V_u = veh/h	Freeway Volume, V_F	7300	V_D = 650 veh/h
	Ramp Volume, V_R	300	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	7300	0.95	Level	10	0	0.952	1.00	8068
Ramp	300	0.95	Level	10	0	0.952	1.00	332
UpStream								
DownStream	650	0.95	Level	10	0	0.952	1.00	718

Merge Areas	Diverge Areas
Estimation of v_{12}	**Estimation of v_{12}**
$V_{12} = V_F\,(P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
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} = 0.436 using Equation (Exhibit 13-7)
V_{12} = pc/h	V_{12} = 3705 pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} 2181 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

	Actual	Capacity		LOS F?
V_F	8068	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	7736	Exhibit 13-8	9400	No
V_R	332	Exhibit 13-10	2200	No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3705	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

Merge: $D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Diverge: $D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 29.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

Merge:

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge:

D_s = 0.133 (Exhibit 13-12)

S_R= 61.9 mph (Exhibit 13-12)

S_0= 66.7 mph (Exhibit 13-12)

S = 64.4 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 1:52 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N	3	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D	700	L_{down} = ft
V_u = 25 veh/h	Freeway Volume, V_F	7125	V_D = veh/h
	Ramp Volume, V_R	350	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	7125	0.95	Level	10	0	0.952	1.00	7875
Ramp	350	0.95	Level	10	0	0.952	1.00	387
UpStream	25	0.95	Level	10	0	0.952	1.00	28
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	**Estimation of v_{12}**
$V_{12} = V_F\,(P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = 125.72 (Equation 13-12 or 13-13)
P_{FM} = using Equation (Exhibit 13-6)	P_{FD} = 0.545 using Equation (Exhibit 13-7)
V_{12} = pc/h	V_{12} = 4470 pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} 3405 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No	Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes, V_{12a} = 5175 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

	Actual	Capacity		LOS F?
V_F	7875	Exhibit 13-8	7050	Yes
$V_{FO} = V_F - V_R$	7488	Exhibit 13-8	7050	Yes
V_R	387	Exhibit 13-10	2200	No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4470	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

Merge: $D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Diverge: $D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 42.5 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

Merge:

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge:

D_s = 0.138 (Exhibit 13-12)

S_R= 61.8 mph (Exhibit 13-12)

S_0= 64.7 mph (Exhibit 13-12)

S = 62.8 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 2:10 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{up} = ft; V_u = veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	700
Freeway Volume, V_F	7125
Ramp Volume, V_R	350
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	60.0

Downstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off; L_{down} = 2600 ft; V_D = 525 veh/h

Conversion to pc/h Under 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	7125	0.95	Level	10	0	0.952	1.00	7875
Ramp	350	0.95	Level	10	0	0.952	1.00	387
UpStream								
DownStream	525	0.95	Level	10	0	0.952	1.00	580

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 0.545 using Equation (Exhibit 13-7)
V_{12} = 4470 pc/h
V_3 or V_{av34} 3405 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = 5175 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	7875	Exhibit 13-8	7050	Yes
$V_{FO} = V_F - V_R$	7488	Exhibit 13-8	7050	Yes
V_R	387	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4470	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 42.5 (pc/mi/ln)
LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.138 (Exhibit 13-12)
S_R= 61.8 mph (Exhibit 13-12)
S_0= 64.7 mph (Exhibit 13-12)
S = 62.8 mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 1/2/2018 2:11 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☑ Yes ☐ On ☐ No ☑ Off; L_{up} = 2600 ft; V_u = 350 veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	1300
Deceleration Lane Length L_D	
Freeway Volume, V_F	6775
Ramp Volume, V_R	525
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{down} = ft; V_D = veh/h

Conversion to pc/h Under 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	6775	0.95	Level	10	0	0.952	1.00	7488
Ramp	525	0.95	Level	10	0	0.952	1.00	580
UpStream	350	0.95	Level	10	0	0.952	1.00	387
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = 2778.35 (Equation 13-6 or 13-7)
P_{FM} = 0.603 using Equation (Exhibit 13-6)
V_{12} = 4512 pc/h
V_3 or V_{av34} 2976 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = 4788 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	8068	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	5368	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 38.9 (pc/mi/ln)
LOS = F (Exhibit 13-2)

Speed Determination

M_S = 1.014 (Exibit 13-11)
S_R= 41.7 mph (Exhibit 13-11)
S_0= 56.1 mph (Exhibit 13-11)
S = 45.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = using Equation (Exhibit 13-7)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)
S_R= mph (Exhibit 13-12)
S_0= mph (Exhibit 13-12)
S = mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 1/2/2018 2:02 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Westbound
Agency or Company	HDR Engineering Inc.	Junction	Dysart Rd ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On; ☑ No ☐ Off; L_{up} = ft; V_u = veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	1300
Deceleration Lane Length L_D	
Freeway Volume, V_F	6775
Ramp Volume, V_R	525
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☑ Yes ☐ On; ☐ No ☑ Off; L_{down} = 9100 ft; V_D = 300 veh/h

Conversion to pc/h Under 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	6775	0.95	Level	10	0	0.952	1.00	7488
Ramp	525	0.95	Level	10	0	0.952	1.00	580
UpStream								
DownStream	300	0.95	Level	10	0	0.952	1.00	332

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = 1334.94 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 4597 pc/h

V_3 or V_{av34} 2891 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = 4788 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	8068	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	5368	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 38.9 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 1.014 (Exibit 13-11)

S_R= 41.7 mph (Exhibit 13-11)

S_0= 56.1 mph (Exhibit 13-11)

S = 45.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010[TM] Version 6.1 Generated: 1/2/2018 2:03 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☑ Yes ☑ On; ☐ No ☐ Off; L_{up} = 9100 ft; V_u = 475 veh/h

Number of Lanes, N	5
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	170
Freeway Volume, V_F	4975
Ramp Volume, V_R	525
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	60.0

Downstream Adj Ramp: ☐ Yes ☐ On; ☑ No ☐ Off; L_{down} = ft; V_D = veh/h

Conversion to pc/h Under 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	4975	0.95	Level	10	0	0.952	1.00	5499
Ramp	525	0.95	Level	10	0	0.952	1.00	580
UpStream	475	0.95	Level	10	0	0.952	1.00	525
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 2485 pc/h

V_3 or V_{av34} 1232 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4950	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	4370	Exhibit 13-8	9400	No
V_R	580	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2485	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 24.1 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.155 (Exhibit 13-12)

S_R= 61.4 mph (Exhibit 13-12)

S_0= 70.4 mph (Exhibit 13-12)

S = 65.6 mph (Exhibit 13-13)

 HCS2010[TM] Version 6.1 Generated: 1/3/2018 5:04 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{up} = ft; V_u = veh/h

Number of Lanes, N	5
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	170
Freeway Volume, V_F	4975
Ramp Volume, V_R	525
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	60.0

Downstream Adj Ramp: ☑ Yes ☐ On ☐ No ☑ Off; L_{down} = 1700 ft; V_D = 250 veh/h

Conversion to pc/h Under 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	4975	0.95	Level	10	0	0.952	1.00	5499
Ramp	525	0.95	Level	10	0	0.952	1.00	580
UpStream								
DownStream	250	0.95	Level	10	0	0.952	1.00	276

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 2485 pc/h

V_3 or V_{av34} 1232 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4950	Exhibit 13-8	9400	No
$V_{FO} = V_F - V_R$	4370	Exhibit 13-8	9400	No
V_R	580	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2485	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 24.1 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.155 (Exhibit 13-12)

S_R= 61.4 mph (Exhibit 13-12)

S_0= 70.4 mph (Exhibit 13-12)

S = 65.6 mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 1/3/2018 5:05 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave on Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☑ Yes ☐ On ☐ No ☑ Off; L_{up} = 2200 ft; V_u = 1975 veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	800
Deceleration Lane Length L_D	
Freeway Volume, V_F	2275
Ramp Volume, V_R	400
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{down} = ft; V_D = veh/h

Conversion to pc/h Under 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	2275	0.95	Level	10	0	0.952	1.00	2514
Ramp	400	0.95	Level	10	0	0.952	1.00	442
UpStream	1975	0.95	Level	10	0	0.952	1.00	2183
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = 1462.38 (Equation 13-6 or 13-7)

P_{FM} = 0.600 using Equation (Exhibit 13-6)

V_{12} = 1508 pc/h

V_3 or V_{av34} 1006 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2956	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1950	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 15.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.260 (Exhibit 13-11)

S_R= 59.0 mph (Exhibit 13-11)

S_0= 63.2 mph (Exhibit 13-11)

S = 60.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 1/4/2018 2:22 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	67th Ave on Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{up} = ft; V_u = veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	800
Deceleration Lane Length L_D	
Freeway Volume, V_F	2275
Ramp Volume, V_R	400
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off; L_{down} = 1400 ft; V_D = 400 veh/h

Conversion to pc/h Under 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	2275	0.95	Level	10	0	0.952	1.00	2514
Ramp	400	0.95	Level	10	0	0.952	1.00	442
UpStream								
DownStream	400	0.95	Level	10	0	0.952	1.00	442

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.600 using Equation (Exhibit 13-6)

V_{12} = 1508 pc/h

V_3 or V_{av34} 1006 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2956	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1950	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\,v_R + 0.0078\,V_{12} - 0.00627\,L_A$

D_R = 15.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.260 (Exibit 13-11)

S_R= 59.0 mph (Exhibit 13-11)

S_0= 63.2 mph (Exhibit 13-11)

S = 60.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\,V_{12} - 0.009\,L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/4/2018 2:25 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	83rd ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off; L_{up} = 4300 ft; V_u = 125 veh/h

Number of Lanes, N	4
Acceleration Lane Length, L_A	1500
Deceleration Lane Length L_D	
Freeway Volume, V_F	4525
Ramp Volume, V_R	475
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{down} = ft; V_D = veh/h

Conversion to pc/h Under 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	4525	0.95	Level	10	0	0.952	1.00	5001
Ramp	475	0.95	Level	10	0	0.952	1.00	525
UpStream	125	0.95	Level	10	0	0.952	1.00	138
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.152 using Equation (Exhibit 13-6)

V_{12} = 761 pc/h

V_3 or V_{av34} 2120 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No

If Yes,V_{12a} = 2000 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5526	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2525	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\,v_R + 0.0078\,V_{12} - 0.00627\,L_A$

D_R = 15.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.205 (Exibit 13-11)

S_R= 60.3 mph (Exhibit 13-11)

S_0= 61.4 mph (Exhibit 13-11)

S = 60.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\,V_{12} - 0.009\,L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/4/2018 1:07 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	83rd ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	4	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	1500	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D		L_{down} = 6200 ft
V_u = veh/h	Freeway Volume, V_F	4525	V_D = 525 veh/h
	Ramp Volume, V_R	475	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	55.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4525	0.95	Level	10	0	0.952	1.00	5001
Ramp	475	0.95	Level	10	0	0.952	1.00	525
UpStream								
DownStream	525	0.95	Level	10	0	0.952	1.00	580

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.152 using Equation (Exhibit 13-6)

V_{12} = 761 pc/h

V_3 or V_{av34} 2120 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No

If Yes,V_{12a} = 2000 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5526	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2525	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 15.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.205 (Exibit 13-11)

S_R= 60.3 mph (Exhibit 13-11)

S_0= 61.4 mph (Exhibit 13-11)

S = 60.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 1/4/2018 1:08 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	91st Ave OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N	3	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D	700	L_{down} = ft
V_u = 325 veh/h	Freeway Volume, V_F	4250	V_D = veh/h
	Ramp Volume, V_R	200	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4250	0.95	Level	10	0	0.952	1.00	4697
Ramp	200	0.95	Level	10	0	0.952	1.00	221
UpStream	325	0.95	Level	10	0	0.952	1.00	359
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 2212.84 (Equation 13-12 or 13-13)

P_{FD} = 0.632 using Equation (Exhibit 13-7)

V_{12} = 3052 pc/h

V_3 or V_{av34} 1645 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4697	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	4476	Exhibit 13-8	7050	No
V_R	221	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3052	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 24.2 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.123 (Exhibit 13-12)

S_R= 62.2 mph (Exhibit 13-12)

S_0= 68.8 mph (Exhibit 13-12)

S = 64.3 mph (Exhibit 13-13)

HCS2010™ Version 6.1 Generated: 1/2/2018 2:45 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	91st Ave OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{up} = ft; V_u = veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	700
Freeway Volume, V_F	4250
Ramp Volume, V_R	200
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	60.0

Downstream Adj Ramp: ☑ Yes ☑ On ☐ No ☐ Off; L_{down} = 2600 ft; V_D = 575 veh/h

Conversion to pc/h Under 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	4250	0.95	Level	10	0	0.952	1.00	4697
Ramp	200	0.95	Level	10	0	0.952	1.00	221
UpStream								
DownStream	575	0.95	Level	10	0	0.952	1.00	636

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 3920.24 (Equation 13-12 or 13-13)
P_{FD} = 0.632 using Equation (Exhibit 13-7)
V_{12} = 3052 pc/h
V_3 or V_{av34} 1645 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4697	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	4476	Exhibit 13-8	7050	No
V_R	221	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3052	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 24.2 (pc/mi/ln)
LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.123 (Exhibit 13-12)
S_R= 62.2 mph (Exhibit 13-12)
S_0= 68.8 mph (Exhibit 13-12)
S = 64.3 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 2:46 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	107th Ave ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp: ☑ Yes ☐ On ☐ No ☑ Off; L_{up} = 2600 ft; V_u = 200 veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	1300
Deceleration Lane Length L_D	
Freeway Volume, V_F	3950
Ramp Volume, V_R	325
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off; L_{down} = ft; V_D = veh/h

Conversion to pc/h Under 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	3950	0.95	Level	10	0	0.952	1.00	4366
Ramp	325	0.95	Level	10	0	0.952	1.00	359
UpStream	200	0.95	Level	10	0	0.952	1.00	221
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\ (P_{FM})$

L_{EQ} = 2062.95 (Equation 13-6 or 13-7)
P_{FM} = 0.614 using Equation (Exhibit 13-6)
V_{12} = 2680 pc/h
V_3 or V_{av34} 1686 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4725	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3039	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 20.9 (pc/mi/ln)
LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.259 (Exhibit 13-11)
S_R= 59.0 mph (Exhibit 13-11)
S_0= 60.7 mph (Exhibit 13-11)
S = 59.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = using Equation (Exhibit 13-7)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)
S_R= mph (Exhibit 13-12)
S_0= mph (Exhibit 13-12)
S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 2:34 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	107th Ave ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1300	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = 9100 ft
V_u = veh/h	Freeway Volume, V_F: 3950	V_D = 200 veh/h
	Ramp Volume, V_R: 325	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under 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	3950	0.95	Level	10	0	0.952	1.00	4366
Ramp	325	0.95	Level	10	0	0.952	1.00	359
UpStream								
DownStream	200	0.95	Level	10	0	0.952	1.00	221

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = 888.62 (Equation 13-6 or 13-7)

P_{FM} = 0.614 using Equation (Exhibit 13-6)

V_{12} = 2680 pc/h

V_3 or V_{av34} 1686 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4725	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3039	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 20.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.259 (Exibit 13-11)

S_R= 59.0 mph (Exhibit 13-11)

S_0= 60.7 mph (Exhibit 13-11)

S = 59.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010[TM] Version 6.1 Generated: 1/2/2018 2:36 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Avondale Blvd OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N: 3	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = 9100 ft	Deceleration Lane Length L_D: 700	L_{down} = ft
V_u = 225 veh/h	Freeway Volume, V_F: 3625	V_D = veh/h
	Ramp Volume, V_R: 75	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 60.0	

Conversion to pc/h Under 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	3625	0.95	Level	10	0	0.952	1.00	4007
Ramp	75	0.95	Level	10	0	0.952	1.00	83
UpStream	225	0.95	Level	10	0	0.952	1.00	249
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 1587.47 (Equation 13-12 or 13-13)

P_{FD} = 0.656 using Equation (Exhibit 13-7)

V_{12} = 2657 pc/h

V_3 or V_{av34} 1350 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4007	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	3924	Exhibit 13-8	7050	No
V_R	83	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2657	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 20.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.110 (Exhibit 13-12)

S_R= 62.5 mph (Exhibit 13-12)

S_0= 69.9 mph (Exhibit 13-12)

S = 64.8 mph (Exhibit 13-13)

 HCS2010[TM] Version 6.1 Generated: 1/2/2018 2:18 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Avondale Blvd OFF Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐Yes ☐On	Number of Lanes, N	3	☑Yes ☑On
☑No ☐Off	Acceleration Lane Length, L_A		☐No ☐Off
L_{up} = ft	Deceleration Lane Length L_D	700	L_{down} = 3000 ft
V_u = veh/h	Freeway Volume, V_F	3625	V_D = 575 veh/h
	Ramp Volume, V_R	75	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	60.0	

Conversion to pc/h Under 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	3625	0.95	Level	10	0	0.952	1.00	4007
Ramp	75	0.95	Level	10	0	0.952	1.00	83
UpStream								
DownStream	575	0.95	Level	10	0	0.952	1.00	636

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☐No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☐No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.656 using Equation (Exhibit 13-7)

V_{12} = 2657 pc/h

V_3 or V_{av34} 1350 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☑No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☑No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4007	Exhibit 13-8	7050	No
$V_{FO} = V_F - V_R$	3924	Exhibit 13-8	7050	No
V_R	83	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2657	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = 20.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.110 (Exhibit 13-12)

S_R= 62.5 mph (Exhibit 13-12)

S_0= 69.9 mph (Exhibit 13-12)

S = 64.8 mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 2:20 PM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	XL	Freeway/Dir of Travel	Eastbound
Agency or Company	HDR Engineering Inc.	Junction	Bullard Ave ON Ramp
Date Performed	1/2/2018	Jurisdiction	ADOT
Analysis Time Period	PM	Analysis Year	2040

Project Description SR 30 East HA (3+0)

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☑Yes ☐On	Number of Lanes, N	4	☐Yes ☐On
☐No ☑Off	Acceleration Lane Length, L_A	1300	☑No ☐Off
L_{up} = 2600 ft	Deceleration Lane Length L_D		L_{down} = ft
V_u = 150 veh/h	Freeway Volume, V_F	3400	V_D = veh/h
	Ramp Volume, V_R	125	
	Freeway Free-Flow Speed, S_{FF}	65.0	
	Ramp Free-Flow Speed, S_{FR}	55.0	

Conversion to pc/h Under 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	3400	0.95	Level	10	0	0.952	1.00	3758
Ramp	125	0.95	Level	10	0	0.952	1.00	138
UpStream	150	0.95	Level	10	0	0.952	1.00	166
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F\,(P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.464 using Equation (Exhibit 13-6)

V_{12} = 1744 pc/h

V_3 or V_{av34} 1007 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☑No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☑No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3896	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1882	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

D_R = 11.9 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.204 (Exibit 13-11)

S_R= 60.3 mph (Exhibit 13-11)

S_0= 63.2 mph (Exhibit 13-11)

S = 61.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☐No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☐No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

 HCS2010™ Version 6.1 Generated: 1/2/2018 1:48 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information

Analyst	XL
Agency/Company	HDR Engineering Inc.
Date Performed	1/2/2018
Analysis Time Period	PM

Site Information

Freeway/Dir of Travel	Sarival Ave to Estrella Pkwy
Weaving Segment Location	
Analysis Year	2040

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	5
Weaving segment length, L_S	2200ft
Freeway free-flow speed, FFS	65 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2350
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2250	0.95	10	0	1.5	1.2	0.952	1.00	2487
V_{RF}	125	0.95	10	0	1.5	1.2	0.952	1.00	138
V_{FR}	500	0.95	10	0	1.5	1.2	0.952	1.00	553
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	2487
V_{NW}	2487							V =	3178
V_W	691								
VR	0.217								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc
Interchange density, ID	0.83 int/mi
Minimum RF lane changes, LC_{RF}	1 lc/pc
Minimum FR lane changes, LC_{FR}	0 lc/pc
Minimum RR lane changes, LC_{RR}	lc/pc
Minimum weaving lane changes, LC_{MIN}	553 lc/h
Weaving lane changes, LC_W	1242 lc/h
Non-weaving lane changes, LC_{NW}	742 lc/h
Total lane changes, LC_{ALL}	1984 lc/h
Non-weaving vehicle index, I_{NW}	0.208

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3178 pc/h
Weaving segment capacity, c_w	10276 veh/h
Weaving segment v/c ratio	0.295
Weaving segment density, D	11.0 pc/mi/ln
Level of Service, LOS	B
Weaving intensity factor, W	0.208
Weaving segment speed, S	57.6 mph
Average weaving speed, S_W	56.4 mph
Average non-weaving speed, S_{NW}	58.0 mph
Maximum weaving length, L_{MAX}	4715 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 *HCS 2010*TM Version 6.1 Generated: 3/28/2018 3:51 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information

Analyst	XL
Agency/Company	HDR Engineering Inc.
Date Performed	1/2/2018
Analysis Time Period	PM

Site Information

Freeway/Dir of Travel	Estrella Pkwy to Sarival Ave
Weaving Segment Location	
Analysis Year	2040

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	5
Weaving segment length, L_S	2225ft
Freeway free-flow speed, FFS	65 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2350
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	5950	0.95	10	0	1.5	1.2	0.952	1.00	6576
V_{RF}	800	0.95	10	0	1.5	1.2	0.952	1.00	884
V_{FR}	75	0.95	10	0	1.5	1.2	0.952	1.00	83
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	6576
V_{NW}	6576							V =	7543
V_W	967								
VR	0.128								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc
Interchange density, ID	0.83 int/mi
Minimum RF lane changes, LC_{RF}	0 lc/pc
Minimum FR lane changes, LC_{FR}	0 lc/pc
Minimum RR lane changes, LC_{RR}	lc/pc
Minimum weaving lane changes, LC_{MIN}	0 lc/h
Weaving lane changes, LC_W	694 lc/h
Non-weaving lane changes, LC_{NW}	1598 lc/h
Total lane changes, LC_{ALL}	2292 lc/h
Non-weaving vehicle index, I_{NW}	0.231

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	7543 pc/h
Weaving segment capacity, c_w	10610 veh/h
Weaving segment v/c ratio	0.677
Weaving segment density, D	26.2 pc/mi/ln
Level of Service, LOS	C
Weaving intensity factor, W	0.231
Weaving segment speed, S	57.5 mph
Average weaving speed, S_W	55.6 mph
Average non-weaving speed, S_{NW}	57.8 mph
Maximum weaving length, L_{MAX}	3815 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 *HCS 2010*TM Version 6.1 Generated: 3/28/2018 3:52 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information

Analyst	XL
Agency/Company	HDR Engineering Inc.
Date Performed	1/2/2018
Analysis Time Period	PM

Site Information

Freeway/Dir of Travel	83rd Ave to 91st Ave
Weaving Segment Location	
Analysis Year	2040

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	5
Weaving segment length, L_S	2220ft
Freeway free-flow speed, FFS	65 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2350
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	8100	0.95	10	0	1.5	1.2	0.952	1.00	8953
V_{RF}	1125	0.95	10	0	1.5	1.2	0.952	1.00	1243
V_{FR}	100	0.95	10	0	1.5	1.2	0.952	1.00	111
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	8953
V_{NW}	8953							V =	10307
V_W	1354								
VR	0.131								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	111 lc/h
Interchange density, ID	0.83 int/mi	Weaving lane changes, LC_W	804 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	2946 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	3750 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.342

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	10307 pc/h	Weaving intensity factor, W	0.342
Weaving segment capacity, c_w	10600 veh/h	Weaving segment speed, S	54.0 mph
Weaving segment v/c ratio	0.926	Average weaving speed, S_W	52.3 mph
Weaving segment density, D	38.2 pc/mi/ln	Average non-weaving speed, S_{NW}	54.3 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	3847 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 *HCS 2010*TM Version 6.1 Generated: 1/4/2018 10:55 AM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information

Analyst	XL
Agency/Company	HDR Engineering Inc.
Date Performed	1/2/2018
Analysis Time Period	PM

Site Information

Freeway/Dir of Travel	107th Ave to Avondale Blvd
Weaving Segment Location	
Analysis Year	2040

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	1675ft
Freeway free-flow speed, FFS	65 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2350
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	7000	0.95	10	0	1.5	1.2	0.952	1.00	7737
V_{RF}	975	0.95	10	0	1.5	1.2	0.952	1.00	1078
V_{FR}	100	0.95	10	0	1.5	1.2	0.952	1.00	111
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	7737
V_{NW}	7737							V =	8926
V_W	1189								
VR	0.133								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.83 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	8926 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	8312 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.023	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	3865 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 *HCS 2010*TM Version 6.1 Generated: 1/3/2018 5:16 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	Bullard Ave to Estrella Pkwy
Agency/Company	HDR Engineering Inc.	Weaving Segment Location	
Date Performed	1/2/2018	Analysis Year	2040
Analysis Time Period	PM		

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2085ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	6100	0.95	10	0	1.5	1.2	0.952	1.00	6742
V_{RF}	875	0.95	10	0	1.5	1.2	0.952	1.00	967
V_{FR}	650	0.95	10	0	1.5	1.2	0.952	1.00	718
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	6742
V_{NW}	6742							V =	8427
V_W	1685								
VR	0.200								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	967 lc/h
Interchange density, ID	0.83 int/mi	Weaving lane changes, LC_W	1635 lc/h
Minimum RF lane changes, LC_{RF}	0 lc/pc	Non-weaving lane changes, LC_{NW}	1556 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	3191 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.316

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	8427 pc/h	Weaving intensity factor, W	0.316
Weaving segment capacity, c_w	10300 veh/h	Weaving segment speed, S	50.5 mph
Weaving segment v/c ratio	0.779	Average weaving speed, S_W	53.0 mph
Weaving segment density, D	33.4 pc/mi/ln	Average non-weaving speed, S_{NW}	49.9 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	4536 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 3/28/2018 3:53 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	XL	Freeway/Dir of Travel	91st Ave to 83rd Ave
Agency/Company	HDR Engineering Inc.	Weaving Segment Location	
Date Performed	1/2/2018	Analysis Year	2040
Analysis Time Period	PM		

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2055ft	Freeway maximum capacity, C_{IFL}	2350
Freeway free-flow speed, FFS	65 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3925	0.95	10	0	1.5	1.2	0.952	1.00	4338
V_{RF}	125	0.95	10	0	1.5	1.2	0.952	1.00	138
V_{FR}	575	0.95	10	0	1.5	1.2	0.952	1.00	636
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	4338
V_{NW}	4338							V =	5112
V_W	774								
VR	0.151								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	138 lc/h
Interchange density, ID	0.66 int/mi	Weaving lane changes, LC_W	530 lc/h
Minimum RF lane changes, LC_{RF}	0 lc/pc	Non-weaving lane changes, LC_{NW}	1237 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1767 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0.201

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5112 pc/h	Weaving intensity factor, W	0.201
Weaving segment capacity, c_w	8373 veh/h	Weaving segment speed, S	57.7 mph
Weaving segment v/c ratio	0.581	Average weaving speed, S_W	56.6 mph
Weaving segment density, D	22.2 pc/mi/ln	Average non-weaving speed, S_{NW}	57.9 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	4045 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 3/28/2018 3:48 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information

Analyst XL
Agency/Company HDR Engineering Inc.
Date Performed 1/2/2018
Analysis Time Period PM

Site Information

Freeway/Dir of Travel Avondale Blvd to 107th Ave
Weaving Segment Location
Analysis Year 2040

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration One-Sided
Weaving number of lanes, N 4
Weaving segment length, L_S 1620ft
Freeway free-flow speed, FFS 65 mph

Segment type Freeway
Freeway minimum speed, S_{MIN} 15
Freeway maximum capacity, C_{IFL} 2350
Terrain type Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3350	0.95	10	0	1.5	1.2	0.952	1.00	3703
V_{RF}	200	0.95	10	0	1.5	1.2	0.952	1.00	221
V_{FR}	575	0.95	10	0	1.5	1.2	0.952	1.00	636
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	3703
V_{NW}	3703							V =	4560
V_W	857								
VR	0.188								

Configuration Characteristics

Minimum maneuver lanes, N_{WL} 2 lc
Interchange density, ID 0.83 int/mi
Minimum RF lane changes, LC_{RF} 1 lc/pc
Minimum FR lane changes, LC_{FR} 1 lc/pc
Minimum RR lane changes, LC_{RR} lc/pc

Minimum weaving lane changes, LC_{MIN} 857 lc/h
Weaving lane changes, LC_W 1225 lc/h
Non-weaving lane changes, LC_{NW} 870 lc/h
Total lane changes, LC_{ALL} 2095 lc/h
Non-weaving vehicle index, I_{NW} 0.277

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v 4560 pc/h
Weaving segment capacity, c_w 8137 veh/h
Weaving segment v/c ratio 0.534
Weaving segment density, D 21.3 pc/mi/ln
Level of Service, LOS C

Weaving intensity factor, W 0.277
Weaving segment speed, S 53.5 mph
Average weaving speed, S_W 54.2 mph
Average non-weaving speed, S_{NW} 53.4 mph
Maximum weaving length, L_{MAX} 4413 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 3/28/2018 3:50 PM

SR 30 East HA (3+0)

FREEWAY WEAVING WORKSHEET

General Information

Analyst XL
Agency/Company HDR Engineering Inc.
Date Performed 1/2/2018
Analysis Time Period PM

Site Information

Freeway/Dir of Travel Estrella Pkwy to Bullard Ave
Weaving Segment Location
Analysis Year 2040

Project Description *SR 30 East HA (3+0)*

Inputs

Weaving configuration One-Sided
Weaving number of lanes, N 5
Weaving segment length, L_S 2100ft
Freeway free-flow speed, FFS 65 mph

Segment type Freeway
Freeway minimum speed, S_{MIN} 15
Freeway maximum capacity, C_{IFL} 2350
Terrain type Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2600	0.95	10	0	1.5	1.2	0.952	1.00	2874
V_{RF}	150	0.95	10	0	1.5	1.2	0.952	1.00	166
V_{FR}	800	0.95	10	0	1.5	1.2	0.952	1.00	884
V_{RR}	0	0.95	10	0	1.5	1.2	0.952	1.00	2874
V_{NW}	2874							V =	3924
V_W	1050								
VR	0.268								

Configuration Characteristics

Minimum maneuver lanes, N_{WL} 2 lc
Interchange density, ID 0.83 int/mi
Minimum RF lane changes, LC_{RF} 1 lc/pc
Minimum FR lane changes, LC_{FR} 0 lc/pc
Minimum RR lane changes, LC_{RR} lc/pc

Minimum weaving lane changes, LC_{MIN} 884 lc/h
Weaving lane changes, LC_W 1555 lc/h
Non-weaving lane changes, LC_{NW} 767 lc/h
Total lane changes, LC_{ALL} 2322 lc/h
Non-weaving vehicle index, I_{NW} 0.245

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v 3924 pc/h
Weaving segment capacity, c_w 8542 veh/h
Weaving segment v/c ratio 0.438
Weaving segment density, D 14.3 pc/mi/ln
Level of Service, LOS B

Weaving intensity factor, W 0.245
Weaving segment speed, S 54.9 mph
Average weaving speed, S_W 55.2 mph
Average non-weaving speed, S_{NW} 54.9 mph
Maximum weaving length, L_{MAX} 5239 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

 HCS 2010™ Version 6.1 Generated: 1/3/2018 4:58 PM

Appendix B

Synchro Analysis Reports

This page is intentionally left blank.

HCM Signalized Intersection Capacity Analysis
1: 67th Ave & WB On Ramp

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	135	0	80	255	530	0	0	485	60
Future Volume (vph)	0	0	0	135	0	80	255	530	0	0	485	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0	5.0	5.0	4.0	4.0			4.0	4.0
Lane Util. Factor				0.95	0.91	0.95	0.97	0.91			0.91	1.00
Frt				1.00	0.97	0.85	1.00	1.00			1.00	0.85
Flt Protected				0.95	0.96	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)				1559	1471	1395	3183	4715			4715	1468
Flt Permitted				0.95	0.96	1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)				1559	1471	1395	3183	4715			4715	1468
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	142	0	84	268	558	0	0	511	63
RTOR Reduction (vph)	0	0	0	0	61	56	0	0	0	0	0	35
Lane Group Flow (vph)	0	0	0	78	16	15	268	558	0	0	511	28
Turn Type				Perm	NA	Perm	Prot	NA			NA	Perm
Protected Phases					8		5	2			6	
Permitted Phases				8		8						6
Actuated Green, G (s)				14.7	14.7	14.7	10.2	31.8			30.1	30.1
Effective Green, g (s)				14.7	14.7	14.7	11.2	32.8			31.1	31.1
Actuated g/C Ratio				0.21	0.21	0.21	0.16	0.47			0.44	0.44
Clearance Time (s)				5.0	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	3.0
Lane Grp Cap (vph)				327	308	292	509	2209			2094	652
v/s Ratio Prot							c0.08	c0.12			0.11	
v/s Ratio Perm				c0.05	0.01	0.01						0.02
v/c Ratio				0.24	0.05	0.05	0.53	0.25			0.24	0.04
Uniform Delay, d1				23.0	22.1	22.1	27.0	11.2			12.1	11.0
Progression Factor				1.00	1.00	1.00	1.32	0.60			1.00	1.00
Incremental Delay, d2				0.4	0.1	0.1	1.0	0.3			0.3	0.1
Delay (s)				23.4	22.2	22.2	36.7	7.0			12.4	11.1
Level of Service				C	C	C	D	A			B	B
Approach Delay (s)		0.0			22.6			16.7			12.3	
Approach LOS		A			C			B			B	

Intersection Summary			
HCM 2000 Control Delay	15.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.31		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	70.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
2: 67th Ave & EB Off Ramp

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	135	0	780	0	0	0	0	645	670	180	440	0
Future Volume (vph)	135	0	780	0	0	0	0	645	670	180	440	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	5.0	4.0					4.0	5.0	5.0	4.0	
Lane Util. Factor	0.95	0.91	0.95					0.86	1.00	0.97	0.91	
Frt	1.00	0.86	0.85					1.00	0.85	1.00	1.00	
Flt Protected	0.95	1.00	1.00					1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1559	1342	1395					5942	1468	3183	4715	
Flt Permitted	0.95	1.00	1.00					1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1559	1342	1395					5942	1468	3183	4715	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	142	0	821	0	0	0	0	679	705	189	463	0
RTOR Reduction (vph)	0	292	286	0	0	0	0	0	385	0	0	0
Lane Group Flow (vph)	128	124	133	0	0	0	0	679	320	189	463	0
Turn Type	Split	NA	Perm					NA	Perm	Prot	NA	
Protected Phases	4	4						2		1	6	
Permitted Phases			4						2			
Actuated Green, G (s)	14.7	14.7	14.7					31.8	31.8	8.5	30.1	
Effective Green, g (s)	15.7	14.7	15.7					32.8	31.8	8.5	31.1	
Actuated g/C Ratio	0.22	0.21	0.22					0.47	0.45	0.12	0.44	
Clearance Time (s)	5.0	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	3.0	
Lane Grp Cap (vph)	349	281	312					2784	666	386	2094	
v/s Ratio Prot	0.08	0.09						0.11		c0.06	0.10	
v/s Ratio Perm			c0.10						c0.22			
v/c Ratio	0.37	0.44	0.43					0.24	0.48	0.49	0.22	
Uniform Delay, d1	22.9	24.1	23.3					11.2	13.3	28.7	12.0	
Progression Factor	1.00	1.00	1.00					1.00	1.00	1.23	0.60	
Incremental Delay, d2	0.7	1.1	0.9					0.2	2.5	1.0	0.2	
Delay (s)	23.6	25.2	24.2					11.4	15.8	36.2	7.5	
Level of Service	C	C	C					B	B	D	A	
Approach Delay (s)		24.6			0.0			13.6			15.8	
Approach LOS		C			A			B			B	

Intersection Summary			
HCM 2000 Control Delay	17.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	70.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
3: 83rd Ave & WB On Ramp/WB Off Ramp

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	15	0	345	15	150	0	0	1000	70
Future Volume (vph)	0	0	0	15	0	345	15	150	0	0	1000	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0	4.0	4.0			4.0	
Lane Util. Factor				0.95	0.91	0.95	1.00	0.95			0.95	
Frt				1.00	0.85	0.85	1.00	1.00			0.99	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1559	1338	1395	1641	3282			3249	
Flt Permitted				0.95	1.00	1.00	0.15	1.00			1.00	
Satd. Flow (perm)				1559	1338	1395	252	3282			3249	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	16	0	363	16	158	0	0	1053	74
RTOR Reduction (vph)	0	0	0	0	161	160	0	0	0	0	4	0
Lane Group Flow (vph)	0	0	0	14	23	21	16	158	0	0	1123	0
Turn Type				Perm	NA	Perm	Perm	NA			NA	
Protected Phases					8			2 5			6	
Permitted Phases				8		8	2 5					
Actuated Green, G (s)				9.5	9.5	9.5	26.4	26.4			54.5	
Effective Green, g (s)				10.5	10.5	10.5	27.4	27.4			55.5	
Actuated g/C Ratio				0.12	0.12	0.12	0.30	0.30			0.62	
Clearance Time (s)				5.0	5.0	5.0					5.0	
Vehicle Extension (s)				3.0	3.0	3.0					3.0	
Lane Grp Cap (vph)				181	156	162	76	999			2003	
v/s Ratio Prot								0.05			c0.35	
v/s Ratio Perm				0.01	0.02	0.02	c0.06					
v/c Ratio				0.08	0.15	0.13	0.21	0.16			0.56	
Uniform Delay, d1				35.4	35.7	35.7	23.3	22.9			10.1	
Progression Factor				1.00	1.00	1.00	0.57	0.56			1.00	
Incremental Delay, d2				0.2	0.4	0.4	1.4	0.1			1.1	
Delay (s)				35.6	36.2	36.0	14.7	13.0			11.2	
Level of Service				D	D	D	B	B			B	
Approach Delay (s)		0.0			36.1			13.1			11.2	
Approach LOS		A			D			B			B	

Intersection Summary			
HCM 2000 Control Delay	17.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	47.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
4: 83rd Ave & EB Off Ramp/EB On Ramp

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	130	0	10	0	0	0	0	30	25	980	35	0
Future Volume (vph)	130	0	10	0	0	0	0	30	25	980	35	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0					4.0		4.0	4.0	
Lane Util. Factor	0.95	0.91	0.95					0.95		0.97	0.95	
Frt	1.00	1.00	0.85					0.93		1.00	1.00	
Flt Protected	0.95	0.95	1.00					1.00		0.95	1.00	
Satd. Flow (prot)	1559	1495	1395					3061		3183	3282	
Flt Permitted	0.95	0.95	1.00					1.00		0.95	1.00	
Satd. Flow (perm)	1559	1495	1395					3061		3183	3282	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	0	11	0	0	0	0	32	26	1032	37	0
RTOR Reduction (vph)	0	62	9	0	0	0	0	18	0	0	0	0
Lane Group Flow (vph)	68	8	1	0	0	0	0	40	0	1032	37	0
Turn Type	Perm	NA	Perm					NA		Prot	NA	
Protected Phases		4						2		1	1 6	
Permitted Phases	4		4									
Actuated Green, G (s)	9.5	9.5	9.5					26.4		39.1	54.5	
Effective Green, g (s)	10.5	10.5	10.5					27.4		40.1	55.5	
Actuated g/C Ratio	0.12	0.12	0.12					0.30		0.45	0.62	
Clearance Time (s)	5.0	5.0	5.0					5.0		5.0		
Vehicle Extension (s)	3.0	3.0	3.0					3.0		3.0		
Lane Grp Cap (vph)	181	174	162					931		1418	2023	
v/s Ratio Prot								c0.01		c0.32	0.01	
v/s Ratio Perm	c0.04	0.01	0.00									
v/c Ratio	0.38	0.05	0.01					0.04		0.73	0.02	
Uniform Delay, d1	36.7	35.3	35.1					22.1		20.5	6.7	
Progression Factor	1.00	1.00	1.00					1.00		0.57	0.58	
Incremental Delay, d2	1.3	0.1	0.0					0.1		1.6	0.0	
Delay (s)	38.0	35.4	35.2					22.1		13.3	3.9	
Level of Service	D	D	D					C		B	A	
Approach Delay (s)		36.6			0.0			22.1			13.0	
Approach LOS		D			A			C			B	

Intersection Summary			
HCM 2000 Control Delay	16.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	47.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	20	0	510	85	135	0	0	1105	45
Future Volume (vph)	0	0	0	20	0	510	85	135	0	0	1105	45
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0	4.0	4.0			4.0	
Lane Util. Factor				0.95	0.91	0.95	0.97	0.95			0.86	
Frt				1.00	0.85	0.85	1.00	1.00			0.99	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1559	1337	1395	3183	3282			5907	
Flt Permitted				0.95	1.00	1.00	0.20	1.00			1.00	
Satd. Flow (perm)				1559	1337	1395	676	3282			5907	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	21	0	537	89	142	0	0	1163	47
RTOR Reduction (vph)	0	0	0	0	238	237	0	0	0	0	4	0
Lane Group Flow (vph)	0	0	0	19	33	31	89	142	0	0	1206	0
Turn Type				Perm	NA	Perm	Perm	NA			NA	
Protected Phases					8			2			6	
Permitted Phases				8		8	2					
Actuated Green, G (s)				9.4	9.4	9.4	31.3	31.3			70.6	
Effective Green, g (s)				10.4	10.4	10.4	32.3	32.3			71.6	
Actuated g/C Ratio				0.12	0.12	0.12	0.36	0.36			0.80	
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)				180	154	161	242	1177			4699	
v/s Ratio Prot								0.04			c0.20	
v/s Ratio Perm				0.01	0.02	0.02	c0.13					
v/c Ratio				0.11	0.21	0.19	0.37	0.12			0.26	
Uniform Delay, d1				35.6	36.1	36.0	21.3	19.3			2.4	
Progression Factor				1.00	1.00	1.00	0.47	0.46			1.00	
Incremental Delay, d2				0.3	0.7	0.6	4.3	0.2			0.1	
Delay (s)				35.9	36.8	36.6	14.2	9.0			2.5	
Level of Service				D	D	D	B	A			A	
Approach Delay (s)		0.0			36.7			11.0			2.5	
Approach LOS		A			D			B			A	

Intersection Summary			
HCM 2000 Control Delay	13.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.31		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	46.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	40	0	255	0	0	0	0	180	75	1010	110	0
Future Volume (vph)	40	0	255	0	0	0	0	180	75	1010	110	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0					4.0		4.0	4.0	
Lane Util. Factor	0.95	0.91	0.95					0.86		0.97	0.95	
Frt	1.00	0.85	0.85					0.96		1.00	1.00	
Flt Protected	0.95	1.00	1.00					1.00		0.95	1.00	
Satd. Flow (prot)	1559	1341	1395					5679		3183	3282	
Flt Permitted	0.95	1.00	1.00					1.00		0.95	1.00	
Satd. Flow (perm)	1559	1341	1395					5679		3183	3282	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	42	0	268	0	0	0	0	189	79	1063	116	0
RTOR Reduction (vph)	0	116	121	0	0	0	0	51	0	0	0	0
Lane Group Flow (vph)	38	19	16	0	0	0	0	217	0	1063	116	0
Turn Type	Perm	NA	Perm					NA		Prot	NA	
Protected Phases		4						2		1	6	
Permitted Phases	4		4									
Actuated Green, G (s)	9.4	9.4	9.4					31.3		34.3	70.6	
Effective Green, g (s)	10.4	10.4	10.4					32.3		35.3	71.6	
Actuated g/C Ratio	0.12	0.12	0.12					0.36		0.39	0.80	
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)	180	154	161					2038		1248	2611	
v/s Ratio Prot								c0.04		c0.33	0.04	
v/s Ratio Perm	c0.02	0.01	0.01									
v/c Ratio	0.21	0.12	0.10					0.11		0.85	0.04	
Uniform Delay, d1	36.1	35.7	35.6					19.2		25.0	1.9	
Progression Factor	1.00	1.00	1.00					1.00		0.92	0.65	
Incremental Delay, d2	0.6	0.4	0.3					0.1		5.7	0.0	
Delay (s)	36.7	36.1	35.9					19.3		28.5	1.3	
Level of Service	D	D	D					B		C	A	
Approach Delay (s)		36.1			0.0			19.3			25.9	
Approach LOS		D			A			B			C	

Intersection Summary			
HCM 2000 Control Delay	26.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	46.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
7: 107th & WB Off Ramp/WB On Ramp

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	30	0	180	45	150	0	0	505	110
Future Volume (vph)	0	0	0	30	0	180	45	150	0	0	505	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0	4.0	4.0			4.0	5.0
Lane Util. Factor				0.95	0.91	0.95	1.00	0.95			0.91	1.00
Frt				1.00	0.85	0.85	1.00	1.00			1.00	0.85
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)				1559	1341	1395	1641	3282			4715	1468
Flt Permitted				0.95	1.00	1.00	0.44	1.00			1.00	1.00
Satd. Flow (perm)				1559	1341	1395	767	3282			4715	1468
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	32	0	189	47	158	0	0	532	116
RTOR Reduction (vph)	0	0	0	0	82	84	0	0	0	0	0	31
Lane Group Flow (vph)	0	0	0	29	14	12	47	158	0	0	532	85
Turn Type				Perm	NA	Perm	Perm	NA			NA	Perm
Protected Phases					8			2			6	
Permitted Phases				8		8	2					6
Actuated Green, G (s)				6.2	6.2	6.2	43.8	43.8			43.8	43.8
Effective Green, g (s)				7.2	7.2	7.2	44.8	44.8			44.8	43.8
Actuated g/C Ratio				0.12	0.12	0.12	0.75	0.75			0.75	0.73
Clearance Time (s)				5.0	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	3.0
Lane Grp Cap (vph)				187	160	167	572	2450			3520	1071
v/s Ratio Prot								0.05			c0.11	
v/s Ratio Perm				c0.02	0.01	0.01	0.06					0.06
v/c Ratio				0.16	0.09	0.07	0.08	0.06			0.15	0.08
Uniform Delay, d1				23.7	23.5	23.4	2.1	2.0			2.2	2.3
Progression Factor				1.00	1.00	1.00	0.91	0.86			1.00	1.00
Incremental Delay, d2				0.4	0.2	0.2	0.3	0.1			0.1	0.1
Delay (s)				24.1	23.7	23.6	2.2	1.8			2.3	2.5
Level of Service				C	C	C	A	A			A	A
Approach Delay (s)		0.0			23.7			1.9			2.3	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM 2000 Control Delay	6.6	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.15		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	48.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
8: EB Off Ramp/EB On Ramp & 107th

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	80	0	10	0	0	0	0	115	220	480	55	0
Future Volume (vph)	80	0	10	0	0	0	0	115	220	480	55	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	5.0					5.0	5.0	4.0	5.0	
Lane Util. Factor	0.95	0.91	0.95					0.95	1.00	1.00	0.95	
Frt	1.00	1.00	0.85					1.00	0.85	1.00	1.00	
Flt Protected	0.95	0.95	1.00					1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1559	1493	1395					3282	1468	1641	3282	
Flt Permitted	0.95	0.95	1.00					1.00	1.00	0.68	1.00	
Satd. Flow (perm)	1559	1493	1395					3282	1468	1167	3282	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	84	0	11	0	0	0	0	121	232	505	58	0
RTOR Reduction (vph)	0	32	9	0	0	0	0	0	63	0	0	0
Lane Group Flow (vph)	43	10	1	0	0	0	0	121	169	505	58	0
Turn Type	Perm	NA	Perm					NA	Perm	Perm	NA	
Protected Phases		4						2			6	
Permitted Phases	4		4						2	6		
Actuated Green, G (s)	6.2	6.2	6.2					43.8	43.8	43.8	43.8	
Effective Green, g (s)	7.2	7.2	6.2					43.8	43.8	44.8	43.8	
Actuated g/C Ratio	0.12	0.12	0.10					0.73	0.73	0.75	0.73	
Clearance Time (s)	5.0	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	3.0	
Lane Grp Cap (vph)	187	179	144					2395	1071	871	2395	
v/s Ratio Prot								0.04			0.02	
v/s Ratio Perm	c0.03	0.01	0.00						0.12	c0.43		
v/c Ratio	0.23	0.06	0.01					0.05	0.16	0.58	0.02	
Uniform Delay, d1	23.9	23.4	24.1					2.3	2.5	3.4	2.2	
Progression Factor	1.00	1.00	1.00					1.00	1.00	0.89	0.83	
Incremental Delay, d2	0.6	0.1	0.0					0.0	0.3	2.8	0.0	
Delay (s)	24.5	23.5	24.2					2.3	2.8	5.8	1.9	
Level of Service	C	C	C					A	A	A	A	
Approach Delay (s)		24.0			0.0			2.6			5.4	
Approach LOS		C			A			A			A	

Intersection Summary			
HCM 2000 Control Delay	6.2	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	48.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
9: Avondale Blvd & WB On Ramp/WB Off Ramp

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	85	0	320	20	110	0	0	1125	60
Future Volume (vph)	0	0	0	85	0	320	20	110	0	0	1125	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0	4.0	4.0			4.0	5.0
Lane Util. Factor				0.95	0.91	0.95	1.00	0.91			0.81	0.81
Frt				1.00	0.86	0.85	1.00	1.00			1.00	0.85
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)				1559	1345	1395	1641	4715			5592	1189
Flt Permitted				0.95	1.00	1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)				1559	1345	1395	1641	4715			5592	1189
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	89	0	337	21	116	0	0	1184	63
RTOR Reduction (vph)	0	0	0	0	145	151	0	0	0	0	1	18
Lane Group Flow (vph)	0	0	0	80	29	21	21	116	0	0	1189	39
Turn Type				Perm	NA	Perm	Prot	NA			NA	Perm
Protected Phases					8		5	2			6	
Permitted Phases				8		8						6
Actuated Green, G (s)				10.1	10.1	10.1	3.2	19.1			61.7	61.7
Effective Green, g (s)				11.1	11.1	11.1	4.2	20.1			62.7	61.7
Actuated g/C Ratio				0.12	0.12	0.12	0.05	0.22			0.70	0.69
Clearance Time (s)				5.0	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	3.0
Lane Grp Cap (vph)				192	165	172	76	1053			3895	815
v/s Ratio Prot							c0.01	0.02			c0.21	
v/s Ratio Perm				c0.05	0.02	0.02						0.03
v/c Ratio				0.42	0.18	0.12	0.28	0.11			0.31	0.05
Uniform Delay, d1				36.5	35.4	35.1	41.4	27.8			5.3	4.6
Progression Factor				1.00	1.00	1.00	0.79	0.56			1.00	1.00
Incremental Delay, d2				1.5	0.5	0.3	2.0	0.2			0.2	0.1
Delay (s)				37.9	35.9	35.4	34.7	15.8			5.5	4.7
Level of Service				D	D	D	C	B			A	A
Approach Delay (s)		0.0			36.1			18.7			5.4	
Approach LOS		A			D			B			A	

Intersection Summary			
HCM 2000 Control Delay	13.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.33		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	44.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
10: Avondale Blvd & EB Off Ramp/EB On Ramp

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	15	0	0	0	0	0	0	120	15	1065	145	0
Future Volume (vph)	15	0	0	0	0	0	0	120	15	1065	145	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0						5.0	5.0	5.0	5.0	
Lane Util. Factor	0.95	0.91						0.81	0.81	0.97	0.91	
Frt	1.00	1.00						1.00	0.85	1.00	1.00	
Flt Protected	0.95	0.95						1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1559	1493						5583	1189	3183	4715	
Flt Permitted	0.95	0.95						1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1559	1493						5583	1189	3183	4715	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	16	0	0	0	0	0	0	126	16	1121	153	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	2	11	0	0	0
Lane Group Flow (vph)	8	8	0	0	0	0	0	126	3	1121	153	0
Turn Type	Perm	NA	Perm					NA	Perm	Prot	NA	
Protected Phases		4						2		1	6	
Permitted Phases	4		4						2			
Actuated Green, G (s)	10.1	10.1						19.1	19.1	45.8	61.7	
Effective Green, g (s)	10.1	10.1						19.1	19.1	45.8	61.7	
Actuated g/C Ratio	0.11	0.11						0.21	0.21	0.51	0.69	
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)	174	167						1184	252	1619	3232	
v/s Ratio Prot								c0.02		c0.35	0.03	
v/s Ratio Perm	0.01	0.01							0.00			
v/c Ratio	0.05	0.05						0.11	0.01	0.69	0.05	
Uniform Delay, d1	35.7	35.7						28.6	28.0	16.8	4.6	
Progression Factor	1.00	1.00						1.00	1.00	0.98	0.65	
Incremental Delay, d2	0.1	0.1						0.2	0.1	1.3	0.0	
Delay (s)	35.8	35.8						28.8	28.1	17.8	3.0	
Level of Service	D	D						C	C	B	A	
Approach Delay (s)		35.8			0.0			28.7			16.0	
Approach LOS		D			A			C			B	

Intersection Summary			
HCM 2000 Control Delay	17.5	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	46.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	20	20	150	15	20	0	0	55	10
Future Volume (vph)	0	0	0	20	20	150	15	20	0	0	55	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0	5.0	5.0	4.0	4.0			4.0	
Lane Util. Factor				0.95	0.91	0.95	1.00	0.91			0.81	
Frt				1.00	0.89	0.85	1.00	1.00			0.98	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1559	1393	1395	1641	4715			6828	
Flt Permitted				0.95	1.00	1.00	0.70	1.00			1.00	
Satd. Flow (perm)				1559	1393	1395	1212	4715			6828	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	21	21	158	16	21	0	0	58	11
RTOR Reduction (vph)	0	0	0	0	48	60	0	0	0	0	5	0
Lane Group Flow (vph)	0	0	0	19	45	28	16	21	0	0	64	0
Turn Type				Perm	NA	Perm	Perm	NA			NA	
Protected Phases					8			2			6	
Permitted Phases				8		8	2					
Actuated Green, G (s)				22.3	22.3	22.3	28.4	28.4			37.7	
Effective Green, g (s)				22.3	22.3	22.3	29.4	29.4			38.7	
Actuated g/C Ratio				0.32	0.32	0.32	0.42	0.42			0.55	
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)				496	443	444	509	1980			3774	
v/s Ratio Prot								0.00			c0.01	
v/s Ratio Perm				0.01	0.03	0.02	c0.01					
v/c Ratio				0.04	0.10	0.06	0.03	0.01			0.02	
Uniform Delay, d1				16.5	16.8	16.6	11.9	11.8			7.1	
Progression Factor				1.00	1.00	1.00	0.74	0.75			1.00	
Incremental Delay, d2				0.0	0.1	0.1	0.1	0.0			0.0	
Delay (s)				16.5	16.9	16.6	9.0	8.8			7.1	
Level of Service				B	B	B	A	A			A	
Approach Delay (s)		0.0			16.7			8.9			7.1	
Approach LOS		A			B			A			A	

Intersection Summary			
HCM 2000 Control Delay	13.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.06		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	28.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	5	370	5	0	0	0	0	25	5	50	20	0
Future Volume (vph)	5	370	5	0	0	0	0	25	5	50	20	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0					4.0		5.0	4.0	
Lane Util. Factor	0.95	0.91	0.95					0.86		0.97	0.91	
Frt	1.00	1.00	0.85					0.98		1.00	1.00	
Flt Protected	0.95	1.00	1.00					1.00		0.95	1.00	
Satd. Flow (prot)	1559	1571	1395					5798		3183	4715	
Flt Permitted	0.95	1.00	1.00					1.00		0.95	1.00	
Satd. Flow (perm)	1559	1571	1395					5798		3183	4715	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	5	389	5	0	0	0	0	26	5	53	21	0
RTOR Reduction (vph)	0	0	3	0	0	0	0	3	0	0	0	0
Lane Group Flow (vph)	4	391	1	0	0	0	0	28	0	53	21	0
Turn Type	Perm	NA	Perm					NA		Prot	NA	
Protected Phases		4						2		1	6	
Permitted Phases	4		4									
Actuated Green, G (s)	22.3	22.3	22.3					28.4		4.3	37.7	
Effective Green, g (s)	22.3	22.3	22.3					29.4		4.3	38.7	
Actuated g/C Ratio	0.32	0.32	0.32					0.42		0.06	0.55	
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)	496	500	444					2435		195	2606	
v/s Ratio Prot								c0.00		c0.02	0.00	
v/s Ratio Perm	0.00	0.25	0.00									
v/c Ratio	0.01	0.78	0.00					0.01		0.27	0.01	
Uniform Delay, d1	16.3	21.6	16.3					11.8		31.4	7.0	
Progression Factor	1.00	1.00	1.00					1.00		1.41	0.89	
Incremental Delay, d2	0.0	7.8	0.0					0.0		0.8	0.0	
Delay (s)	16.3	29.4	16.3					11.8		45.0	6.2	
Level of Service	B	C	B					B		D	A	
Approach Delay (s)		29.2			0.0			11.8			34.0	
Approach LOS		C			A			B			C	

Intersection Summary			
HCM 2000 Control Delay	28.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.34		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	28.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
13: Bullard Ave & WB On Ramp/WB Off Ramp

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	25	0	0	25	635	0	0	60	70
Future Volume (vph)	0	0	0	25	0	0	25	635	0	0	60	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0		4.0	4.0			4.0	5.0
Lane Util. Factor				0.95	0.91		1.00	0.95			0.86	0.86
Frt				1.00	1.00		1.00	1.00			0.94	0.85
Flt Protected				0.95	0.95		0.95	1.00			1.00	1.00
Satd. Flow (prot)				1559	1493		1641	3282			4209	1263
Flt Permitted				0.95	0.95		0.68	1.00			1.00	1.00
Satd. Flow (perm)				1559	1493		1178	3282			4209	1263
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	26	0	0	26	668	0	0	63	74
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	19	19
Lane Group Flow (vph)	0	0	0	13	13	0	26	668	0	0	81	18
Turn Type				Prot	NA	Perm	Perm	NA			NA	Perm
Protected Phases				3	8			2			6	
Permitted Phases						8	2					6
Actuated Green, G (s)				0.8	26.7		33.3	33.3			33.3	33.3
Effective Green, g (s)				1.8	27.7		34.3	34.3			34.3	33.3
Actuated g/C Ratio				0.03	0.40		0.49	0.49			0.49	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)				40	590		577	1608			2062	600
v/s Ratio Prot				c0.01	c0.00			c0.20			0.02	
v/s Ratio Perm					0.01		0.02					0.01
v/c Ratio				0.33	0.02		0.05	0.42			0.04	0.03
Uniform Delay, d1				33.5	12.9		9.3	11.4			9.3	9.8
Progression Factor				1.00	1.00		0.86	0.90			1.00	1.00
Incremental Delay, d2				4.7	0.0		0.1	0.8			0.0	0.1
Delay (s)				38.2	12.9		8.1	11.1			9.3	9.8
Level of Service				D	B		A	B			A	A
Approach Delay (s)		0.0			25.6			11.0			9.5	
Approach LOS		A			C			B			A	

Intersection Summary			
HCM 2000 Control Delay	11.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.27		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	52.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
14: Bullard Ave & EB Off Ramp/EB On Ramp

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	380	0	70	0	0	0	0	275	440	0	85	0
Future Volume (vph)	380	0	70	0	0	0	0	275	440	0	85	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0					4.0	5.0		4.0	
Lane Util. Factor	0.95	0.91	0.95					0.91	1.00		0.95	
Frt	1.00	0.99	0.85					1.00	0.85		1.00	
Flt Protected	0.95	0.95	1.00					1.00	1.00		1.00	
Satd. Flow (prot)	1559	1492	1395					4715	1468		3282	
Flt Permitted	0.95	0.95	1.00					1.00	1.00		1.00	
Satd. Flow (perm)	1559	1492	1395					4715	1468		3282	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	400	0	74	0	0	0	0	289	463	0	89	0
RTOR Reduction (vph)	0	75	46	0	0	0	0	0	243	0	0	0
Lane Group Flow (vph)	204	128	21	0	0	0	0	289	220	0	89	0
Turn Type	Perm	NA	Perm					NA	Perm	Perm	NA	
Protected Phases		4						2			6	
Permitted Phases	4		4						2	6		
Actuated Green, G (s)	20.9	20.9	20.9					33.3	33.3		33.3	
Effective Green, g (s)	21.9	21.9	21.9					34.3	33.3		34.3	
Actuated g/C Ratio	0.31	0.31	0.31					0.49	0.48		0.49	
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)	487	466	436					2310	698		1608	
v/s Ratio Prot								0.06			0.03	
v/s Ratio Perm	c0.13	0.09	0.02						c0.15			
v/c Ratio	0.42	0.27	0.05					0.13	0.32		0.06	
Uniform Delay, d1	19.0	18.1	16.8					9.7	11.3		9.4	
Progression Factor	1.00	1.00	1.00					1.00	1.00		0.96	
Incremental Delay, d2	0.6	0.3	0.0					0.1	1.2		0.1	
Delay (s)	19.6	18.4	16.8					9.8	12.5		9.1	
Level of Service	B	B	B					A	B		A	
Approach Delay (s)		18.7			0.0			11.5			9.1	
Approach LOS		B			A			B			A	

Intersection Summary			
HCM 2000 Control Delay	13.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.34		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	52.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
15: Estrella Pkwy & WB On Ramp/WB Off Ramp

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	475	0	115	10	870	0	0	685	70
Future Volume (vph)	0	0	0	475	0	115	10	870	0	0	685	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0	4.0	4.0			4.0	
Lane Util. Factor				0.95	0.91	0.95	1.00	0.91			0.81	
Frt				1.00	0.99	0.85	1.00	1.00			0.99	
Flt Protected				0.95	0.95	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1559	1490	1395	1641	4715			6898	
Flt Permitted				0.95	0.95	1.00	0.31	1.00			1.00	
Satd. Flow (perm)				1559	1490	1395	529	4715			6898	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	500	0	121	11	916	0	0	721	74
RTOR Reduction (vph)	0	0	0	0	86	80	0	0	0	0	23	0
Lane Group Flow (vph)	0	0	0	255	171	29	11	916	0	0	772	0
Turn Type				Perm	NA	Perm	Perm	NA			NA	
Protected Phases					8			2			6	
Permitted Phases				8		8	2					
Actuated Green, G (s)				16.0	16.0	16.0	23.5	23.5			39.0	
Effective Green, g (s)				17.0	17.0	17.0	24.5	24.5			40.0	
Actuated g/C Ratio				0.26	0.26	0.26	0.38	0.38			0.62	
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)				407	389	364	199	1777			4244	
v/s Ratio Prot								c0.19			c0.11	
v/s Ratio Perm				c0.16	0.11	0.02	0.02					
v/c Ratio				0.63	0.44	0.08	0.06	0.52			0.18	
Uniform Delay, d1				21.2	20.0	18.1	12.9	15.7			5.4	
Progression Factor				1.00	1.00	1.00	0.93	0.67			1.00	
Incremental Delay, d2				3.0	0.8	0.1	0.4	0.8			0.1	
Delay (s)				24.2	20.8	18.2	12.4	11.3			5.5	
Level of Service				C	C	B	B	B			A	
Approach Delay (s)		0.0			21.7			11.3			5.5	
Approach LOS		A			C			B			A	

Intersection Summary			
HCM 2000 Control Delay	12.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	55.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
16: Estrella Pkwy & EB Off Ramp/EB On Ramp

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	10	0	20	0	0	0	0	870	790	335	825	0
Future Volume (vph)	10	0	20	0	0	0	0	870	790	335	825	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0					4.0	4.0	4.0	4.0	
Lane Util. Factor	0.95	0.91	0.95					0.81	0.81	0.97	0.91	
Frt	1.00	0.86	0.85					0.95	0.85	1.00	1.00	
Flt Protected	0.95	1.00	1.00					1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1559	1351	1395					5334	1189	3183	4715	
Flt Permitted	0.95	1.00	1.00					1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1559	1351	1395					5334	1189	3183	4715	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	11	0	21	0	0	0	0	916	832	353	868	0
RTOR Reduction (vph)	0	8	8	0	0	0	0	116	259	0	0	0
Lane Group Flow (vph)	10	3	3	0	0	0	0	1216	157	353	868	0
Turn Type	Perm	NA	Perm					NA	Perm	Prot	NA	
Protected Phases		4						2		1	6	
Permitted Phases	4		4						2			
Actuated Green, G (s)	16.0	16.0	16.0					23.5	23.5	10.5	39.0	
Effective Green, g (s)	17.0	17.0	17.0					24.5	24.5	11.5	40.0	
Actuated g/C Ratio	0.26	0.26	0.26					0.38	0.38	0.18	0.62	
Clearance Time (s)	5.0	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	3.0	
Lane Grp Cap (vph)	407	353	364					2010	448	563	2901	
v/s Ratio Prot								c0.23		c0.11	0.18	
v/s Ratio Perm	c0.01	0.00	0.00						0.13			
v/c Ratio	0.02	0.01	0.01					0.61	0.35	0.63	0.30	
Uniform Delay, d1	17.8	17.8	17.8					16.3	14.5	24.8	5.9	
Progression Factor	1.00	1.00	1.00					1.00	1.00	0.98	0.87	
Incremental Delay, d2	0.0	0.0	0.0					1.4	2.1	2.1	0.3	
Delay (s)	17.9	17.8	17.8					17.7	16.7	26.3	5.4	
Level of Service	B	B	B					B	B	C	A	
Approach Delay (s)		17.8			0.0			17.5			11.5	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM 2000 Control Delay	15.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	55.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
17: Sarival Ave & WB Off Ramp

05/02/2018

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	20	410	0	0	0	795
Future Volume (Veh/h)	20	410	0	0	0	795
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	432	0	0	0	837
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	418	0			0	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	418	0			0	
tC, single (s)	7.0	7.1			4.3	
tC, 2 stage (s)						
tF (s)	3.6	3.4			2.3	
p0 queue free %	96	59			100	
cM capacity (veh/h)	542	1059			1565	

Direction, Lane #	WB 1	WB 2	WB 3	NB 1	SB 1	SB 2
Volume Total	21	216	216	0	418	418
Volume Left	21	0	0	0	0	0
Volume Right	0	216	216	0	0	0
cSH	542	1059	1059	1700	1700	1700
Volume to Capacity	0.04	0.20	0.20	0.00	0.25	0.25
Queue Length 95th (ft)	3	19	19	0	0	0
Control Delay (s)	11.9	9.3	9.3	0.0	0.0	0.0
Lane LOS	B	A	A			
Approach Delay (s)	9.4			0.0	0.0	
Approach LOS	A					

Intersection Summary			
Average Delay	3.3		
Intersection Capacity Utilization	32.0%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
1: 67th Ave & WB On Ramp

05/10/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	375	0	95	605	420	0	0	510	115
Future Volume (vph)	0	0	0	375	0	95	605	420	0	0	510	115
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.5		4.5	4.0	4.0			4.0	4.0
Lane Util. Factor				1.00		1.00	0.97	0.91			0.91	1.00
Frt				1.00		0.85	1.00	1.00			1.00	0.85
Flt Protected				0.95		1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)				1641		1468	3183	4715			4715	1468
Flt Permitted				0.95		1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)				1641		1468	3183	4715			4715	1468
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	395	0	100	637	442	0	0	537	121
RTOR Reduction (vph)	0	0	0	0	0	71	0	0	0	0	0	82
Lane Group Flow (vph)	0	0	0	395	0	29	637	442	0	0	537	39
Turn Type				Perm		Perm	Prot	NA			NA	Perm
Protected Phases					8		5	2			6	
Permitted Phases				8		8						6
Actuated Green, G (s)				20.3		20.3	13.4	40.2			21.8	21.8
Effective Green, g (s)				20.3		20.3	14.4	41.2			22.8	22.8
Actuated g/C Ratio				0.29		0.29	0.21	0.59			0.33	0.33
Clearance Time (s)				4.5		4.5	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)				475		425	654	2775			1535	478
v/s Ratio Prot							c0.20	0.09			c0.11	
v/s Ratio Perm				c0.24		0.02						0.03
v/c Ratio				0.83		0.07	0.97	0.16			0.35	0.08
Uniform Delay, d1				23.3		18.0	27.6	6.5			18.0	16.4
Progression Factor				1.00		1.00	0.78	0.58			1.00	1.00
Incremental Delay, d2				11.8		0.1	28.1	0.1			0.6	0.3
Delay (s)				35.0		18.1	49.6	3.9			18.6	16.7
Level of Service				D		B	D	A			B	B
Approach Delay (s)		0.0			31.6			30.9			18.2	
Approach LOS		A			C			C			B	

Intersection Summary			
HCM 2000 Control Delay	27.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	58.3%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	65	0	460	0	0	0	0	960	300	115	770	0
Future Volume (vph)	65	0	460	0	0	0	0	960	300	115	770	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	5.0	4.0					4.0	5.0	5.0	4.0	
Lane Util. Factor	1.00	0.95	0.95					0.86	1.00	0.97	0.91	
Frt	1.00	0.85	0.85					1.00	0.85	1.00	1.00	
Flt Protected	0.95	1.00	1.00					1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1641	1395	1395					5942	1468	3183	4715	
Flt Permitted	0.95	1.00	1.00					1.00	1.00	0.24	1.00	
Satd. Flow (perm)	1641	1395	1395					5942	1468	791	4715	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	68	0	484	0	0	0	0	1011	316	121	811	0
RTOR Reduction (vph)	0	174	170	0	0	0	0	0	135	0	0	0
Lane Group Flow (vph)	68	68	72	0	0	0	0	1011	181	121	811	0
Turn Type	Split	NA	Perm					NA	Perm	Perm	NA	
Protected Phases	4	4						2			6	
Permitted Phases			4						2	6		
Actuated Green, G (s)	19.8	19.8	19.8					40.2	40.2	21.8	21.8	
Effective Green, g (s)	20.8	19.8	20.8					41.2	40.2	21.8	22.8	
Actuated g/C Ratio	0.30	0.28	0.30					0.59	0.57	0.31	0.33	
Clearance Time (s)	5.0	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	3.0	
Lane Grp Cap (vph)	487	394	414					3497	843	246	1535	
v/s Ratio Prot	0.04	0.05						c0.17			c0.17	
v/s Ratio Perm			c0.05						0.12	0.15		
v/c Ratio	0.14	0.17	0.17					0.29	0.22	0.49	0.53	
Uniform Delay, d1	18.0	18.9	18.2					7.1	7.2	19.6	19.2	
Progression Factor	1.00	1.00	1.00					1.00	1.00	0.42	0.41	
Incremental Delay, d2	0.1	0.2	0.2					0.2	0.6	6.0	1.1	
Delay (s)	18.2	19.1	18.4					7.3	7.8	14.1	8.9	
Level of Service	B	B	B					A	A	B	A	
Approach Delay (s)		18.7			0.0			7.5			9.6	
Approach LOS		B			A			A			A	

Intersection Summary			
HCM 2000 Control Delay	10.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.37		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	58.3%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	25	0	680	20	120	0	0	495	165
Future Volume (vph)	0	0	0	25	0	680	20	120	0	0	495	165
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0	4.0	4.0			4.0	
Lane Util. Factor				0.95	0.91	0.95	1.00	0.95			0.95	
Frt				1.00	0.85	0.85	1.00	1.00			0.96	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1559	1337	1395	1641	3282			3159	
Flt Permitted				0.95	1.00	1.00	0.17	1.00			1.00	
Satd. Flow (perm)				1559	1337	1395	285	3282			3159	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	26	0	716	21	126	0	0	521	174
RTOR Reduction (vph)	0	0	0	0	311	311	0	0	0	0	24	0
Lane Group Flow (vph)	0	0	0	23	50	47	21	126	0	0	671	0
Turn Type				Perm	NA	Perm	Perm	NA			NA	
Protected Phases					8			2 5			6	
Permitted Phases				8		8	2 5					
Actuated Green, G (s)				10.9	10.9	10.9	38.7	38.7			51.8	
Effective Green, g (s)				11.9	11.9	11.9	39.7	39.7			52.8	
Actuated g/C Ratio				0.13	0.13	0.13	0.44	0.44			0.59	
Clearance Time (s)				5.0	5.0	5.0					5.0	
Vehicle Extension (s)				3.0	3.0	3.0					3.0	
Lane Grp Cap (vph)				206	176	184	125	1447			1853	
v/s Ratio Prot								0.04			c0.21	
v/s Ratio Perm				0.01	0.04	0.03	c0.07					
v/c Ratio				0.11	0.29	0.26	0.17	0.09			0.36	
Uniform Delay, d1				34.4	35.2	35.1	15.2	14.6			9.8	
Progression Factor				1.00	1.00	1.00	0.72	0.67			1.00	
Incremental Delay, d2				0.2	0.9	0.7	0.6	0.0			0.5	
Delay (s)				34.6	36.1	35.8	11.5	9.8			10.3	
Level of Service				C	D	D	B	A			B	
Approach Delay (s)		0.0			35.9			10.1			10.3	
Approach LOS		A			D			B			B	

Intersection Summary			
HCM 2000 Control Delay	22.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.33		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	40.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	100	0	15	0	0	0	0	35	15	470	50	0
Future Volume (vph)	100	0	15	0	0	0	0	35	15	470	50	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0					4.0		4.0	4.0	
Lane Util. Factor	0.95	0.91	0.95					0.95		0.97	0.95	
Frt	1.00	0.99	0.85					0.95		1.00	1.00	
Flt Protected	0.95	0.95	1.00					1.00		0.95	1.00	
Satd. Flow (prot)	1559	1491	1395					3133		3183	3282	
Flt Permitted	0.95	0.95	1.00					1.00		0.95	1.00	
Satd. Flow (perm)	1559	1491	1395					3133		3183	3282	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	105	0	16	0	0	0	0	37	16	495	53	0
RTOR Reduction (vph)	0	46	12	0	0	0	0	9	0	0	0	0
Lane Group Flow (vph)	54	7	2	0	0	0	0	44	0	495	53	0
Turn Type	Perm	NA	Perm					NA		Prot	NA	
Protected Phases		4						2		1	1 6	
Permitted Phases	4		4									
Actuated Green, G (s)	10.9	10.9	10.9					38.7		25.4	51.8	
Effective Green, g (s)	11.9	11.9	11.9					39.7		26.4	52.8	
Actuated g/C Ratio	0.13	0.13	0.13					0.44		0.29	0.59	
Clearance Time (s)	5.0	5.0	5.0					5.0		5.0		
Vehicle Extension (s)	3.0	3.0	3.0					3.0		3.0		
Lane Grp Cap (vph)	206	197	184					1382		933	1925	
v/s Ratio Prot								c0.01		c0.16	0.02	
v/s Ratio Perm	c0.03	0.00	0.00									
v/c Ratio	0.26	0.04	0.01					0.03		0.53	0.03	
Uniform Delay, d1	35.1	34.0	33.9					14.3		26.6	7.8	
Progression Factor	1.00	1.00	1.00					1.00		0.64	0.51	
Incremental Delay, d2	0.7	0.1	0.0					0.0		0.6	0.0	
Delay (s)	35.8	34.1	34.0					14.3		17.5	4.0	
Level of Service	D	C	C					B		B	A	
Approach Delay (s)		34.8			0.0			14.3			16.2	
Approach LOS		C			A			B			B	

Intersection Summary			
HCM 2000 Control Delay	19.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.24		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	40.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	70	0	1040	230	155	0	0	665	40
Future Volume (vph)	0	0	0	70	0	1040	230	155	0	0	665	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0	4.0	4.0			4.0	
Lane Util. Factor				0.95	0.91	0.95	0.97	0.95			0.86	
Frt				1.00	0.85	0.85	1.00	1.00			0.99	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1559	1338	1395	3183	3282			5891	
Flt Permitted				0.95	1.00	1.00	0.34	1.00			1.00	
Satd. Flow (perm)				1559	1338	1395	1148	3282			5891	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	74	0	1095	242	163	0	0	700	42
RTOR Reduction (vph)	0	0	0	0	462	461	0	0	0	0	7	0
Lane Group Flow (vph)	0	0	0	67	93	86	242	163	0	0	735	0
Turn Type				Perm	NA	Perm	Perm	NA			NA	
Protected Phases					8			2			6	
Permitted Phases				8		8	2					
Actuated Green, G (s)				13.1	13.1	13.1	36.2	36.2			66.9	
Effective Green, g (s)				14.1	14.1	14.1	37.2	37.2			67.9	
Actuated g/C Ratio				0.16	0.16	0.16	0.41	0.41			0.75	
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)				244	209	218	474	1356			4444	
v/s Ratio Prot								0.05			c0.12	
v/s Ratio Perm				0.04	0.07	0.06	c0.21					
v/c Ratio				0.27	0.44	0.39	0.51	0.12			0.17	
Uniform Delay, d1				33.4	34.4	34.1	19.6	16.3			3.1	
Progression Factor				1.00	1.00	1.00	0.42	0.37			1.00	
Incremental Delay, d2				0.6	1.5	1.2	3.9	0.2			0.1	
Delay (s)				34.1	35.9	35.3	12.1	6.3			3.2	
Level of Service				C	D	D	B	A			A	
Approach Delay (s)		0.0			35.5			9.8			3.2	
Approach LOS		A			D			A			A	

Intersection Summary			
HCM 2000 Control Delay	20.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	53.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	50	0	120	0	0	0	0	330	30	585	150	0
Future Volume (vph)	50	0	120	0	0	0	0	330	30	585	150	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0					4.0		4.0	4.0	
Lane Util. Factor	0.95	0.91	0.95					0.91		0.97	0.95	
Frt	1.00	0.86	0.85					0.99		1.00	1.00	
Flt Protected	0.95	1.00	1.00					1.00		0.95	1.00	
Satd. Flow (prot)	1559	1349	1395					4656		3183	3282	
Flt Permitted	0.95	1.00	1.00					1.00		0.95	1.00	
Satd. Flow (perm)	1559	1349	1395					4656		3183	3282	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	53	0	126	0	0	0	0	347	32	616	158	0
RTOR Reduction (vph)	0	55	56	0	0	0	0	13	0	0	0	0
Lane Group Flow (vph)	48	10	10	0	0	0	0	366	0	616	158	0
Turn Type	Perm	NA	Perm					NA		Prot	NA	
Protected Phases		4						2		1	6	
Permitted Phases	4		4									
Actuated Green, G (s)	13.1	13.1	13.1					36.2		25.7	66.9	
Effective Green, g (s)	14.1	14.1	14.1					37.2		26.7	67.9	
Actuated g/C Ratio	0.16	0.16	0.16					0.41		0.30	0.75	
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)	244	211	218					1924		944	2476	
v/s Ratio Prot								c0.08		c0.19	0.05	
v/s Ratio Perm	c0.03	0.01	0.01									
v/c Ratio	0.20	0.05	0.05					0.19		0.65	0.06	
Uniform Delay, d1	33.0	32.2	32.2					16.8		27.6	2.9	
Progression Factor	1.00	1.00	1.00					1.00		0.97	0.73	
Incremental Delay, d2	0.4	0.1	0.1					0.2		1.6	0.0	
Delay (s)	33.4	32.3	32.3					17.0		28.3	2.1	
Level of Service	C	C	C					B		C	A	
Approach Delay (s)		32.6			0.0			17.0			23.0	
Approach LOS		C			A			B			C	

Intersection Summary			
HCM 2000 Control Delay	22.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	53.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	160	0	365	15	145	0	0	305	95
Future Volume (vph)	0	0	0	160	0	365	15	145	0	0	305	95
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0	4.0	4.0			4.0	5.0
Lane Util. Factor				0.95	0.91	0.95	1.00	0.95			0.91	1.00
Frt				1.00	0.86	0.85	1.00	1.00			1.00	0.85
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)				1559	1350	1395	1641	3282			4715	1468
Flt Permitted				0.95	1.00	1.00	0.55	1.00			1.00	1.00
Satd. Flow (perm)				1559	1350	1395	950	3282			4715	1468
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	168	0	384	16	153	0	0	321	100
RTOR Reduction (vph)	0	0	0	0	145	158	0	0	0	0	0	36
Lane Group Flow (vph)	0	0	0	151	56	42	16	153	0	0	321	64
Turn Type				Perm	NA	Perm	Perm	NA			NA	Perm
Protected Phases					8			2			6	
Permitted Phases				8		8	2					6
Actuated Green, G (s)				11.6	11.6	11.6	38.4	38.4			38.4	38.4
Effective Green, g (s)				12.6	12.6	12.6	39.4	39.4			39.4	38.4
Actuated g/C Ratio				0.21	0.21	0.21	0.66	0.66			0.66	0.64
Clearance Time (s)				5.0	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	3.0
Lane Grp Cap (vph)				327	283	292	623	2155			3096	939
v/s Ratio Prot								0.05			c0.07	
v/s Ratio Perm				c0.10	0.04	0.03	0.02					0.04
v/c Ratio				0.46	0.20	0.14	0.03	0.07			0.10	0.07
Uniform Delay, d1				20.7	19.5	19.3	3.6	3.7			3.8	4.1
Progression Factor				1.00	1.00	1.00	1.20	1.19			1.00	1.00
Incremental Delay, d2				1.0	0.3	0.2	0.1	0.1			0.1	0.1
Delay (s)				21.8	19.9	19.5	4.4	4.5			3.9	4.2
Level of Service				C	B	B	A	A			A	A
Approach Delay (s)		0.0			20.3			4.5			3.9	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM 2000 Control Delay	11.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.19		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	32.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
8: EB Off Ramp/EB On Ramp & 107th

05/10/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	110	0	45	0	0	0	0	45	80	240	230	0
Future Volume (vph)	110	0	45	0	0	0	0	45	80	240	230	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	5.0					5.0	5.0	4.0	5.0	
Lane Util. Factor	0.95	0.91	0.95					0.95	1.00	1.00	0.95	
Frt	1.00	0.99	0.85					1.00	0.85	1.00	1.00	
Flt Protected	0.95	0.96	1.00					1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1559	1484	1395					3282	1468	1641	3282	
Flt Permitted	0.95	0.96	1.00					1.00	1.00	0.72	1.00	
Satd. Flow (perm)	1559	1484	1395					3282	1468	1252	3282	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	116	0	47	0	0	0	0	47	84	253	242	0
RTOR Reduction (vph)	0	28	34	0	0	0	0	0	30	0	0	0
Lane Group Flow (vph)	60	33	8	0	0	0	0	47	54	253	242	0
Turn Type	Perm	NA	Perm					NA	Perm	Perm	NA	
Protected Phases		4						2			6	
Permitted Phases	4		4						2	6		
Actuated Green, G (s)	11.6	11.6	11.6					38.4	38.4	38.4	38.4	
Effective Green, g (s)	12.6	12.6	11.6					38.4	38.4	39.4	38.4	
Actuated g/C Ratio	0.21	0.21	0.19					0.64	0.64	0.66	0.64	
Clearance Time (s)	5.0	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	3.0	
Lane Grp Cap (vph)	327	311	269					2100	939	822	2100	
v/s Ratio Prot								0.01			0.07	
v/s Ratio Perm	c0.04	0.02	0.01						0.04	c0.20		
v/c Ratio	0.18	0.10	0.03					0.02	0.06	0.31	0.12	
Uniform Delay, d1	19.5	19.1	19.6					3.9	4.0	4.4	4.2	
Progression Factor	1.00	1.00	1.00					1.00	1.00	0.88	0.82	
Incremental Delay, d2	0.3	0.1	0.0					0.0	0.1	1.0	0.1	
Delay (s)	19.7	19.3	19.7					4.0	4.2	4.8	3.5	
Level of Service	B	B	B					A	A	A	A	
Approach Delay (s)		19.6			0.0			4.1			4.2	
Approach LOS		B			A			A			A	

Intersection Summary			
HCM 2000 Control Delay	7.4	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.29		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	32.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
9: Avondale Blvd & WB On Ramp/WB Off Ramp

05/10/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	90	0	860	0	135	0	0	480	35
Future Volume (vph)	0	0	0	90	0	860	0	135	0	0	480	35
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0		4.0			4.0	5.0
Lane Util. Factor				0.95	0.91	0.95		0.91			0.76	0.76
Frt				1.00	0.85	0.85		1.00			1.00	0.85
Flt Protected				0.95	1.00	1.00		1.00			1.00	1.00
Satd. Flow (prot)				1559	1340	1395		4715			6556	1116
Flt Permitted				0.95	1.00	1.00		1.00			1.00	1.00
Satd. Flow (perm)				1559	1340	1395		4715			6556	1116
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	95	0	905	0	142	0	0	505	37
RTOR Reduction (vph)	0	0	0	0	353	353	0	0	0	0	1	12
Lane Group Flow (vph)	0	0	0	85	110	99	0	142	0	0	508	21
Turn Type				Perm	NA	Perm	Prot	NA			NA	Perm
Protected Phases					8		5	2			6	
Permitted Phases				8		8						6
Actuated Green, G (s)				12.2	12.2	12.2		14.5			37.8	37.8
Effective Green, g (s)				13.2	13.2	13.2		15.5			38.8	37.8
Actuated g/C Ratio				0.22	0.22	0.22		0.26			0.65	0.63
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)				342	294	306		1218			4239	703
v/s Ratio Prot								0.03			c0.08	
v/s Ratio Perm				0.05	0.08	0.07						0.02
v/c Ratio				0.25	0.37	0.32		0.12			0.12	0.03
Uniform Delay, d1				19.3	19.9	19.7		17.0			4.1	4.2
Progression Factor				1.00	1.00	1.00		0.87			1.00	1.00
Incremental Delay, d2				0.4	0.8	0.6		0.2			0.1	0.1
Delay (s)				19.7	20.7	20.3		15.0			4.1	4.3
Level of Service				B	C	C		B			A	A
Approach Delay (s)		0.0			20.4			15.0			4.1	
Approach LOS		A			C			B			A	

Intersection Summary			
HCM 2000 Control Delay	14.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.21		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	45.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
10: Avondale Blvd & EB Off Ramp/EB On Ramp

05/10/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	50	0	25	0	0	0	0	85	110	400	175	0
Future Volume (vph)	50	0	25	0	0	0	0	85	110	400	175	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0					5.0	5.0	5.0	5.0	
Lane Util. Factor	0.95	0.91	0.95					0.81	0.81	0.97	0.91	
Frt	1.00	0.98	0.85					0.94	0.85	1.00	1.00	
Flt Protected	0.95	0.96	1.00					1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1559	1480	1395					5265	1189	3183	4715	
Flt Permitted	0.95	0.96	1.00					1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1559	1480	1395					5265	1189	3183	4715	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	53	0	26	0	0	0	0	89	116	421	184	0
RTOR Reduction (vph)	0	22	18	0	0	0	0	44	44	0	0	0
Lane Group Flow (vph)	28	6	5	0	0	0	0	103	14	421	184	0
Turn Type	Perm	NA	Perm					NA	Perm	Prot	NA	
Protected Phases		4						2		1	6	
Permitted Phases	4		4						2			
Actuated Green, G (s)	12.2	12.2	12.2					14.5	14.5	18.3	37.8	
Effective Green, g (s)	12.2	12.2	12.2					14.5	14.5	18.3	37.8	
Actuated g/C Ratio	0.20	0.20	0.20					0.24	0.24	0.31	0.63	
Clearance Time (s)	5.0	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	3.0	
Lane Grp Cap (vph)	316	300	283					1272	287	970	2970	
v/s Ratio Prot								c0.02		c0.13	0.04	
v/s Ratio Perm	c0.02	0.00	0.00						0.01			
v/c Ratio	0.09	0.02	0.02					0.08	0.05	0.43	0.06	
Uniform Delay, d1	19.4	19.1	19.1					17.6	17.5	16.7	4.3	
Progression Factor	1.00	1.00	1.00					1.00	1.00	1.12	0.73	
Incremental Delay, d2	0.1	0.0	0.0					0.1	0.3	0.3	0.0	
Delay (s)	19.5	19.1	19.1					17.7	17.8	19.1	3.2	
Level of Service	B	B	B					B	B	B	A	
Approach Delay (s)		19.3			0.0			17.7			14.2	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM 2000 Control Delay	15.5	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.23		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	45.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
11: Dysart Rd & WB On Ramp

05/10/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	5	355	25	40	20	0	0	230	5
Future Volume (vph)	0	0	0	5	355	25	40	20	0	0	230	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0	5.0	5.0	4.0	4.0			4.0	
Lane Util. Factor				0.95	0.91	0.95	1.00	0.91			0.81	
Frt				1.00	1.00	0.85	1.00	1.00			1.00	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1559	1570	1395	1641	4715			6974	
Flt Permitted				0.95	1.00	1.00	0.57	1.00			1.00	
Satd. Flow (perm)				1559	1570	1395	992	4715			6974	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	5	374	26	42	21	0	0	242	5
RTOR Reduction (vph)	0	0	0	0	1	16	0	0	0	0	2	0
Lane Group Flow (vph)	0	0	0	4	377	7	42	21	0	0	245	0
Turn Type				Perm	NA	Perm	Perm	NA			NA	
Protected Phases					8			2			6	
Permitted Phases				8		8	2					
Actuated Green, G (s)				19.5	19.5	19.5	15.2	15.2			30.5	
Effective Green, g (s)				19.5	19.5	19.5	16.2	16.2			31.5	
Actuated g/C Ratio				0.32	0.32	0.32	0.27	0.27			0.52	
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)				506	510	453	267	1273			3661	
v/s Ratio Prot								0.00			c0.04	
v/s Ratio Perm				0.00	0.24	0.01	c0.04					
v/c Ratio				0.01	0.74	0.02	0.16	0.02			0.07	
Uniform Delay, d1				13.7	18.0	13.7	16.7	16.1			7.0	
Progression Factor				1.00	1.00	1.00	0.97	0.65			1.00	
Incremental Delay, d2				0.0	5.6	0.0	1.3	0.0			0.0	
Delay (s)				13.7	23.6	13.8	17.4	10.5			7.1	
Level of Service				B	C	B	B	B			A	
Approach Delay (s)		0.0			22.9			15.1			7.1	
Approach LOS		A			C			B			A	

Intersection Summary			
HCM 2000 Control Delay	16.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.39		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	27.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
12: Dysart Rd

05/10/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	5	55	5	0	0	0	0	50	25	215	20	0
Future Volume (vph)	5	55	5	0	0	0	0	50	25	215	20	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0					4.0		5.0	4.0	
Lane Util. Factor	0.95	0.91	0.95					0.86		0.97	0.91	
Frt	1.00	1.00	0.85					0.95		1.00	1.00	
Flt Protected	0.95	1.00	1.00					1.00		0.95	1.00	
Satd. Flow (prot)	1559	1567	1395					5648		3183	4715	
Flt Permitted	0.95	1.00	1.00					1.00		0.95	1.00	
Satd. Flow (perm)	1559	1567	1395					5648		3183	4715	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	5	58	5	0	0	0	0	53	26	226	21	0
RTOR Reduction (vph)	0	1	3	0	0	0	0	19	0	0	0	0
Lane Group Flow (vph)	4	59	1	0	0	0	0	60	0	226	21	0
Turn Type	Perm	NA	Perm					NA		Prot	NA	
Protected Phases		4						2		1	6	
Permitted Phases	4		4									
Actuated Green, G (s)	19.5	19.5	19.5					15.2		10.3	30.5	
Effective Green, g (s)	19.5	19.5	19.5					16.2		10.3	31.5	
Actuated g/C Ratio	0.32	0.32	0.32					0.27		0.17	0.52	
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)	506	509	453					1524		546	2475	
v/s Ratio Prot								c0.01		c0.07	0.00	
v/s Ratio Perm	0.00	0.04	0.00									
v/c Ratio	0.01	0.12	0.00					0.04		0.41	0.01	
Uniform Delay, d1	13.7	14.2	13.7					16.2		22.2	6.8	
Progression Factor	1.00	1.00	1.00					1.00		1.58	0.56	
Incremental Delay, d2	0.0	0.1	0.0					0.0		0.5	0.0	
Delay (s)	13.7	14.3	13.7					16.2		35.6	3.8	
Level of Service	B	B	B					B		D	A	
Approach Delay (s)		14.2			0.0			16.2			32.9	
Approach LOS		B			A			B			C	

Intersection Summary			
HCM 2000 Control Delay	26.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.16		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	27.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
13: Bullard Ave & WB On Ramp/WB Off Ramp

05/10/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	440	0	0	80	180	0	0	230	380
Future Volume (vph)	0	0	0	440	0	0	80	180	0	0	230	380
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0		4.0	4.0			4.0	5.0
Lane Util. Factor				0.95	0.91		1.00	0.95			0.86	0.86
Frt				1.00	1.00		1.00	1.00			0.93	0.85
Flt Protected				0.95	0.95		0.95	1.00			1.00	1.00
Satd. Flow (prot)				1559	1493		1641	3282			4154	1263
Flt Permitted				0.95	0.95		0.46	1.00			1.00	1.00
Satd. Flow (perm)				1559	1493		795	3282			4154	1263
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	463	0	0	84	189	0	0	242	400
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	123	125
Lane Group Flow (vph)	0	0	0	231	232	0	84	189	0	0	319	75
Turn Type				Prot	NA	Perm	Perm	NA			NA	Perm
Protected Phases				3	8			2			6	
Permitted Phases						8	2					6
Actuated Green, G (s)				14.4	37.0		28.0	28.0			28.0	28.0
Effective Green, g (s)				15.4	38.0		29.0	29.0			29.0	28.0
Actuated g/C Ratio				0.21	0.51		0.39	0.39			0.39	0.37
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)				320	756		307	1269			1606	471
v/s Ratio Prot				c0.15	c0.06			0.06			0.08	
v/s Ratio Perm					0.09		c0.11					0.06
v/c Ratio				0.72	0.31		0.27	0.15			0.20	0.16
Uniform Delay, d1				27.8	10.8		15.8	15.0			15.3	15.7
Progression Factor				1.00	1.00		0.54	0.53			1.00	1.00
Incremental Delay, d2				7.8	0.2		2.2	0.2			0.3	0.7
Delay (s)				35.6	11.0		10.8	8.2			15.6	16.4
Level of Service				D	B		B	A			B	B
Approach Delay (s)		0.0			23.3			9.0			15.8	
Approach LOS		A			C			A			B	

Intersection Summary			
HCM 2000 Control Delay	17.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	43.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

14: Bullard Ave & EB Off Ramp/EB On Ramp

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	65	0	45	0	0	0	0	195	30	0	665	0
Future Volume (vph)	65	0	45	0	0	0	0	195	30	0	665	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0					4.0	5.0		4.0	
Lane Util. Factor	0.95	0.91	0.95					0.91	1.00		0.95	
Frt	1.00	0.96	0.85					1.00	0.85		1.00	
Flt Protected	0.95	0.96	1.00					1.00	1.00		1.00	
Satd. Flow (prot)	1559	1457	1395					4715	1468		3282	
Flt Permitted	0.95	0.96	1.00					1.00	1.00		1.00	
Satd. Flow (perm)	1559	1457	1395					4715	1468		3282	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	68	0	47	0	0	0	0	205	32	0	700	0
RTOR Reduction (vph)	0	29	28	0	0	0	0	0	20	0	0	0
Lane Group Flow (vph)	39	10	9	0	0	0	0	205	12	0	700	0
Turn Type	Perm	NA	Perm					NA	Perm	Perm	NA	
Protected Phases		4						2			6	
Permitted Phases	4		4						2	6		
Actuated Green, G (s)	17.6	17.6	17.6					28.0	28.0		28.0	
Effective Green, g (s)	18.6	18.6	18.6					29.0	28.0		29.0	
Actuated g/C Ratio	0.25	0.25	0.25					0.39	0.37		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)	386	361	345					1823	548		1269	
v/s Ratio Prot								0.04			c0.21	
v/s Ratio Perm	c0.03	0.01	0.01						0.01			
v/c Ratio	0.10	0.03	0.03					0.11	0.02		0.55	
Uniform Delay, d1	21.8	21.3	21.3					14.7	14.8		17.9	
Progression Factor	1.00	1.00	1.00					1.00	1.00		1.45	
Incremental Delay, d2	0.1	0.0	0.0					0.1	0.1		1.4	
Delay (s)	21.9	21.4	21.4					14.9	14.9		27.5	
Level of Service	C	C	C					B	B		C	
Approach Delay (s)		21.5			0.0			14.9			27.5	
Approach LOS		C			A			B			C	

Intersection Summary			
HCM 2000 Control Delay	24.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.29		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	43.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

15: Estrella Pkwy & WB On Ramp/WB Off Ramp

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	655	0	310	20	570	0	0	1025	30
Future Volume (vph)	0	0	0	655	0	310	20	570	0	0	1025	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0	4.0	4.0			4.0	
Lane Util. Factor				0.95	0.91	0.95	1.00	0.91			0.81	
Frt				1.00	0.99	0.85	1.00	1.00			1.00	
Flt Protected				0.95	0.96	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1559	1483	1395	1641	4715			6965	
Flt Permitted				0.95	0.96	1.00	0.21	1.00			1.00	
Satd. Flow (perm)				1559	1483	1395	366	4715			6965	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	689	0	326	21	600	0	0	1079	32
RTOR Reduction (vph)	0	0	0	0	79	197	0	0	0	0	6	0
Lane Group Flow (vph)	0	0	0	365	278	96	21	600	0	0	1105	0
Turn Type				Perm	NA	Perm	Perm	NA			NA	
Protected Phases					8			2			6	
Permitted Phases				8		8	2					
Actuated Green, G (s)				20.2	20.2	20.2	24.2	24.2			34.8	
Effective Green, g (s)				21.2	21.2	21.2	25.2	25.2			35.8	
Actuated g/C Ratio				0.33	0.33	0.33	0.39	0.39			0.55	
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	483	454	141	1827			3836	
v/s Ratio Prot								c0.13			c0.16	
v/s Ratio Perm				c0.23	0.19	0.07	0.06					
v/c Ratio				0.72	0.58	0.21	0.15	0.33			0.29	
Uniform Delay, d1				19.3	18.2	15.8	12.9	14.0			7.8	
Progression Factor				1.00	1.00	1.00	0.62	0.63			1.00	
Incremental Delay, d2				4.8	1.7	0.2	2.1	0.5			0.2	
Delay (s)				24.1	19.8	16.1	10.2	9.3			8.0	
Level of Service				C	B	B	B	A			A	
Approach Delay (s)		0.0			20.3			9.3			8.0	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM 2000 Control Delay	12.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	46.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
16: Estrella Pkwy & EB Off Ramp/EB On Ramp

05/10/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	90	0	15	0	0	0	0	505	635	150	1530	0
Future Volume (vph)	90	0	15	0	0	0	0	505	635	150	1530	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0					4.0	4.0	4.0	4.0	
Lane Util. Factor	0.95	0.91	0.95					0.81	0.81	0.97	0.91	
Frt	1.00	0.99	0.85					0.94	0.85	1.00	1.00	
Flt Protected	0.95	0.95	1.00					1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1559	1491	1395					5273	1189	3183	4715	
Flt Permitted	0.95	0.95	1.00					1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1559	1491	1395					5273	1189	3183	4715	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	95	0	16	0	0	0	0	532	668	158	1611	0
RTOR Reduction (vph)	0	33	9	0	0	0	0	158	205	0	0	0
Lane Group Flow (vph)	48	16	5	0	0	0	0	708	129	158	1611	0
Turn Type	Perm	NA	Perm					NA	Perm	Prot	NA	
Protected Phases		4						2		1	6	
Permitted Phases	4		4						2			
Actuated Green, G (s)	20.2	20.2	20.2					24.2	24.2	5.6	34.8	
Effective Green, g (s)	21.2	21.2	21.2					25.2	25.2	6.6	35.8	
Actuated g/C Ratio	0.33	0.33	0.33					0.39	0.39	0.10	0.55	
Clearance Time (s)	5.0	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	3.0	
Lane Grp Cap (vph)	508	486	454					2044	460	323	2596	
v/s Ratio Prot								0.13		0.05	c0.34	
v/s Ratio Perm	c0.03	0.01	0.00						0.11			
v/c Ratio	0.09	0.03	0.01					0.35	0.28	0.49	0.62	
Uniform Delay, d1	15.2	14.9	14.8					14.1	13.7	27.6	10.0	
Progression Factor	1.00	1.00	1.00					1.00	1.00	1.24	0.79	
Incremental Delay, d2	0.1	0.0	0.0					0.5	1.5	1.1	1.1	
Delay (s)	15.3	14.9	14.8					14.5	15.2	35.4	8.9	
Level of Service	B	B	B					B	B	D	A	
Approach Delay (s)		15.1			0.0			14.7			11.3	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM 2000 Control Delay	12.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	46.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
17: Sarival Ave & WB Off Ramp

05/10/2018

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	40	780	110	0	0	475
Future Volume (Veh/h)	40	780	110	0	0	475
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	42	821	116	0	0	500
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	366	116			116	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	366	116			116	
tC, single (s)	7.0	7.1			4.3	
tC, 2 stage (s)						
tF (s)	3.6	3.4			2.3	
p0 queue free %	93	8			100	
cM capacity (veh/h)	586	889			1414	

Direction, Lane #	WB 1	WB 2	WB 3	NB 1	SB 1	SB 2
Volume Total	42	410	410	116	250	250
Volume Left	42	0	0	0	0	0
Volume Right	0	410	410	0	0	0
cSH	586	889	889	1700	1700	1700
Volume to Capacity	0.07	0.46	0.46	0.07	0.15	0.15
Queue Length 95th (ft)	6	62	62	0	0	0
Control Delay (s)	11.6	12.5	12.5	0.0	0.0	0.0
Lane LOS	B	B	B			
Approach Delay (s)	12.4			0.0	0.0	
Approach LOS	B					

Intersection Summary			
Average Delay	7.3		
Intersection Capacity Utilization	39.7%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
1: 67th Ave & WB On Ramp

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	190	0	85	285	480	0	0	530	65
Future Volume (vph)	0	0	0	190	0	85	285	480	0	0	530	65
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.5	4.5	4.5	4.0	4.0			4.0	4.0
Lane Util. Factor				0.95	0.91	0.95	0.97	0.91			0.91	1.00
Frt				1.00	0.99	0.85	1.00	1.00			1.00	0.85
Flt Protected				0.95	0.96	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)				1559	1484	1395	3183	4715			4715	1468
Flt Permitted				0.95	0.96	1.00	0.95	1.00			1.00	1.00
Satd. Flow (perm)				1559	1484	1395	3183	4715			4715	1468
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	200	0	89	300	505	0	0	558	68
RTOR Reduction (vph)	0	0	0	0	83	64	0	0	0	0	0	37
Lane Group Flow (vph)	0	0	0	106	20	16	300	505	0	0	558	31
Turn Type				Perm	NA	Perm	Prot	NA			NA	Perm
Protected Phases					8		5	2			6	
Permitted Phases				8		8						6
Actuated Green, G (s)				13.9	13.9	13.9	10.9	46.6			30.7	30.7
Effective Green, g (s)				13.9	13.9	13.9	11.9	47.6			31.7	31.7
Actuated g/C Ratio				0.20	0.20	0.20	0.17	0.68			0.45	0.45
Clearance Time (s)				4.5	4.5	4.5	5.0	5.0			5.0	5.0
Vehicle Extension (s)				3.0	3.0	3.0	3.0	3.0			3.0	3.0
Lane Grp Cap (vph)				309	294	277	541	3206			2135	664
v/s Ratio Prot							c0.09	0.11			c0.12	
v/s Ratio Perm				c0.07	0.01	0.01						0.02
v/c Ratio				0.34	0.07	0.06	0.55	0.16			0.26	0.05
Uniform Delay, d1				24.1	22.8	22.7	26.6	4.0			11.9	10.7
Progression Factor				1.00	1.00	1.00	1.08	0.67			1.00	1.00
Incremental Delay, d2				0.7	0.1	0.1	1.2	0.1			0.3	0.1
Delay (s)				24.8	22.9	22.8	29.9	2.8			12.2	10.8
Level of Service				C	C	C	C	A			B	B
Approach Delay (s)		0.0			23.6			12.9			12.0	
Approach LOS		A			C			B			B	

Intersection Summary			
HCM 2000 Control Delay	14.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.34		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	64.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
2: 67th Ave & EB Off Ramp

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	85	0	875	0	0	0	0	680	595	145	580	0
Future Volume (vph)	85	0	875	0	0	0	0	680	595	145	580	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	5.0	4.0					4.0	5.0	5.0	4.0	
Lane Util. Factor	0.95	0.91	0.95					0.86	1.00	0.97	0.91	
Frt	1.00	0.85	0.85					1.00	0.85	1.00	1.00	
Flt Protected	0.95	1.00	1.00					1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1559	1339	1395					5942	1468	3183	4715	
Flt Permitted	0.95	1.00	1.00					1.00	1.00	0.35	1.00	
Satd. Flow (perm)	1559	1339	1395					5942	1468	1181	4715	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	89	0	921	0	0	0	0	716	626	153	611	0
RTOR Reduction (vph)	0	344	338	0	0	0	0	0	209	0	0	0
Lane Group Flow (vph)	80	126	122	0	0	0	0	716	417	153	611	0
Turn Type	Split	NA	Perm					NA	Perm	Perm	NA	
Protected Phases	4	4						2			6	
Permitted Phases			4						2	6		
Actuated Green, G (s)	13.4	13.4	13.4					46.6	46.6	30.7	30.7	
Effective Green, g (s)	14.4	13.4	14.4					47.6	46.6	30.7	31.7	
Actuated g/C Ratio	0.21	0.19	0.21					0.68	0.67	0.44	0.45	
Clearance Time (s)	5.0	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	3.0	
Lane Grp Cap (vph)	320	256	286					4040	977	517	2135	
v/s Ratio Prot	0.05	c0.09						0.12			0.13	
v/s Ratio Perm			0.09						c0.28	0.13		
v/c Ratio	0.25	0.49	0.43					0.18	0.43	0.30	0.29	
Uniform Delay, d1	23.3	25.3	24.2					4.1	5.5	12.7	12.0	
Progression Factor	1.00	1.00	1.00					1.00	1.00	0.64	0.66	
Incremental Delay, d2	0.4	1.5	1.0					0.1	1.4	1.4	0.3	
Delay (s)	23.7	26.8	25.2					4.2	6.8	9.5	8.3	
Level of Service	C	C	C					A	A	A	A	
Approach Delay (s)		25.8			0.0			5.4			8.5	
Approach LOS		C			A			A			A	

Intersection Summary			
HCM 2000 Control Delay	12.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	64.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
3: 83rd Ave & WB On Ramp/WB Off Ramp

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	15	0	350	15	50	0	0	1130	75
Future Volume (vph)	0	0	0	15	0	350	15	50	0	0	1130	75
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0	4.0	4.0			4.0	
Lane Util. Factor				0.95	0.91	0.95	1.00	0.95			0.95	
Frt				1.00	0.85	0.85	1.00	1.00			0.99	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1559	1338	1395	1641	3282			3251	
Flt Permitted				0.95	1.00	1.00	0.15	1.00			1.00	
Satd. Flow (perm)				1559	1338	1395	262	3282			3251	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	16	0	368	16	53	0	0	1189	79
RTOR Reduction (vph)	0	0	0	0	165	165	0	0	0	0	3	0
Lane Group Flow (vph)	0	0	0	14	21	19	16	53	0	0	1265	0
Turn Type				Perm	NA	Perm	Perm	NA			NA	
Protected Phases					8			2 5			6	
Permitted Phases				8		8	2 5					
Actuated Green, G (s)				8.1	8.1	8.1	25.4	25.4			56.1	
Effective Green, g (s)				9.1	9.1	9.1	26.4	26.4			57.1	
Actuated g/C Ratio				0.10	0.10	0.10	0.29	0.29			0.63	
Clearance Time (s)				5.0	5.0	5.0					5.0	
Vehicle Extension (s)				3.0	3.0	3.0					3.0	
Lane Grp Cap (vph)				157	135	141	76	962			2062	
v/s Ratio Prot								0.02			c0.39	
v/s Ratio Perm				0.01	0.02	0.01	c0.06					
v/c Ratio				0.09	0.15	0.13	0.21	0.06			0.61	
Uniform Delay, d1				36.7	36.9	36.9	24.0	22.8			9.8	
Progression Factor				1.00	1.00	1.00	0.56	0.55			1.00	
Incremental Delay, d2				0.2	0.5	0.4	1.4	0.0			1.4	
Delay (s)				36.9	37.5	37.3	14.9	12.7			11.2	
Level of Service				D	D	D	B	B			B	
Approach Delay (s)		0.0			37.4			13.2			11.2	
Approach LOS		A			D			B			B	

Intersection Summary			
HCM 2000 Control Delay	17.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	51.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
4: 83rd Ave & EB Off Ramp/EB On Ramp

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	25	0	10	0	0	0	0	35	25	1110	35	0
Future Volume (vph)	25	0	10	0	0	0	0	35	25	1110	35	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0					4.0		4.0	4.0	
Lane Util. Factor	0.95	0.91	0.95					0.95		0.97	0.95	
Frt	1.00	0.99	0.85					0.94		1.00	1.00	
Flt Protected	0.95	0.96	1.00					1.00		0.95	1.00	
Satd. Flow (prot)	1559	1485	1395					3079		3183	3282	
Flt Permitted	0.95	0.96	1.00					1.00		0.95	1.00	
Satd. Flow (perm)	1559	1485	1395					3079		3183	3282	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	26	0	11	0	0	0	0	37	26	1168	37	0
RTOR Reduction (vph)	0	12	9	0	0	0	0	18	0	0	0	0
Lane Group Flow (vph)	14	1	1	0	0	0	0	45	0	1168	37	0
Turn Type	Perm	NA	Perm					NA		Prot	NA	
Protected Phases		4						2		1	1 6	
Permitted Phases	4		4									
Actuated Green, G (s)	8.1	8.1	8.1					25.4		41.5	56.1	
Effective Green, g (s)	9.1	9.1	9.1					26.4		42.5	57.1	
Actuated g/C Ratio	0.10	0.10	0.10					0.29		0.47	0.63	
Clearance Time (s)	5.0	5.0	5.0					5.0		5.0		
Vehicle Extension (s)	3.0	3.0	3.0					3.0		3.0		
Lane Grp Cap (vph)	157	150	141					903		1503	2082	
v/s Ratio Prot								c0.01		c0.37	0.01	
v/s Ratio Perm	c0.01	0.00	0.00									
v/c Ratio	0.09	0.01	0.01					0.05		0.78	0.02	
Uniform Delay, d1	36.7	36.4	36.4					22.8		19.8	6.1	
Progression Factor	1.00	1.00	1.00					1.00		0.63	0.75	
Incremental Delay, d2	0.2	0.0	0.0					0.1		2.1	0.0	
Delay (s)	36.9	36.4	36.4					22.9		14.6	4.5	
Level of Service	D	D	D					C		B	A	
Approach Delay (s)		36.6			0.0			22.9			14.3	
Approach LOS		D			A			C			B	

Intersection Summary			
HCM 2000 Control Delay	15.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	51.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
5: 91st Ave & WB On Ramp/WB Off Ramp

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	25	0	490	95	110	0	0	1190	45
Future Volume (vph)	0	0	0	25	0	490	95	110	0	0	1190	45
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0	3.5	4.0			4.0	
Lane Util. Factor				0.95	0.91	0.95	0.97	0.95			0.86	
Frt				1.00	0.85	0.85	1.00	1.00			0.99	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1559	1338	1395	3183	3282			5910	
Flt Permitted				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (perm)				1559	1338	1395	3183	3282			5910	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	26	0	516	100	116	0	0	1253	47
RTOR Reduction (vph)	0	0	0	0	229	229	0	0	0	0	4	0
Lane Group Flow (vph)	0	0	0	23	32	29	100	116	0	0	1296	0
Turn Type				Perm	NA	Perm	Prot	NA			NA	
Protected Phases					8		5	2			6	
Permitted Phases				8		8						
Actuated Green, G (s)				9.1	9.1	9.1	6.7	26.9			59.7	
Effective Green, g (s)				10.1	10.1	10.1	7.7	27.9			60.7	
Actuated g/C Ratio				0.11	0.11	0.11	0.09	0.31			0.67	
Clearance Time (s)				5.0	5.0	5.0	4.5	5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)				174	150	156	272	1017			3985	
v/s Ratio Prot							c0.03	0.04			c0.22	
v/s Ratio Perm				0.01	0.02	0.02						
v/c Ratio				0.13	0.21	0.19	0.37	0.11			0.33	
Uniform Delay, d1				36.0	36.3	36.2	38.9	22.2			6.1	
Progression Factor				1.00	1.00	1.00	1.42	0.44			1.00	
Incremental Delay, d2				0.3	0.7	0.6	0.8	0.2			0.2	
Delay (s)				36.3	37.0	36.8	55.9	10.0			6.3	
Level of Service				D	D	D	E	B			A	
Approach Delay (s)		0.0			36.9			31.2			6.3	
Approach LOS		A			D			C			A	

Intersection Summary			
HCM 2000 Control Delay	17.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.33		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	49.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
6: 91st Ave & EB Off Ramp/EB On Ramp

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	10	0	450	0	0	0	0	195	90	1070	145	0
Future Volume (vph)	10	0	450	0	0	0	0	195	90	1070	145	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0					4.0		4.0	4.0	
Lane Util. Factor	0.95	0.91	0.95					0.86		0.97	0.95	
Frt	1.00	0.85	0.85					0.95		1.00	1.00	
Flt Protected	0.95	1.00	1.00					1.00		0.95	1.00	
Satd. Flow (prot)	1559	1337	1395					5660		3183	3282	
Flt Permitted	0.95	1.00	1.00					1.00		0.95	1.00	
Satd. Flow (perm)	1559	1337	1395					5660		3183	3282	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	11	0	474	0	0	0	0	205	95	1126	153	0
RTOR Reduction (vph)	0	210	210	0	0	0	0	66	0	0	0	0
Lane Group Flow (vph)	10	28	27	0	0	0	0	234	0	1126	153	0
Turn Type	Perm	NA	Perm					NA		Prot	NA	
Protected Phases		4						2		1	6	
Permitted Phases	4		4									
Actuated Green, G (s)	9.1	9.1	9.1					26.9		39.0	59.7	
Effective Green, g (s)	10.1	10.1	10.1					27.9		40.0	60.7	
Actuated g/C Ratio	0.11	0.11	0.11					0.31		0.44	0.67	
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)	174	150	156					1754		1414	2213	
v/s Ratio Prot								c0.04		c0.35	0.05	
v/s Ratio Perm	0.01	0.02	0.02									
v/c Ratio	0.06	0.18	0.17					0.13		0.80	0.07	
Uniform Delay, d1	35.7	36.2	36.2					22.4		21.5	5.0	
Progression Factor	1.00	1.00	1.00					1.00		0.72	0.48	
Incremental Delay, d2	0.1	0.6	0.5					0.2		3.1	0.1	
Delay (s)	35.8	36.8	36.7					22.5		18.5	2.5	
Level of Service	D	D	D					C		B	A	
Approach Delay (s)		36.7			0.0			22.5			16.6	
Approach LOS		D			A			C			B	

Intersection Summary			
HCM 2000 Control Delay	22.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	13.5
Intersection Capacity Utilization	49.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
7: 107th & WB Off Ramp/WB On Ramp

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	30	0	180	60	145	0	0	430	125
Future Volume (vph)	0	0	0	30	0	180	60	145	0	0	430	125
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0	4.0	4.0			4.0	5.0
Lane Util. Factor				0.95	0.91	0.95	1.00	0.95			0.91	1.00
Frt				1.00	0.85	0.85	1.00	1.00			1.00	0.85
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)				1559	1341	1395	1641	3282			4715	1468
Flt Permitted				0.95	1.00	1.00	0.48	1.00			1.00	1.00
Satd. Flow (perm)				1559	1341	1395	831	3282			4715	1468
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	32	0	189	63	153	0	0	453	132
RTOR Reduction (vph)	0	0	0	0	82	85	0	0	0	0	0	35
Lane Group Flow (vph)	0	0	0	29	14	11	63	153	0	0	453	97
Turn Type				Perm	NA	Perm	Perm	NA			NA	Perm
Protected Phases					8			2			6	
Permitted Phases				8		8	2					6
Actuated Green, G (s)				6.0	6.0	6.0	44.0	44.0			44.0	44.0
Effective Green, g (s)				7.0	7.0	7.0	45.0	45.0			45.0	44.0
Actuated g/C Ratio				0.12	0.12	0.12	0.75	0.75			0.75	0.73
Clearance Time (s)				5.0	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	3.0
Lane Grp Cap (vph)				181	156	162	623	2461			3536	1076
v/s Ratio Prot								0.05			c0.10	
v/s Ratio Perm				c0.02	0.01	0.01	0.08					0.07
v/c Ratio				0.16	0.09	0.07	0.10	0.06			0.13	0.09
Uniform Delay, d1				23.9	23.7	23.6	2.0	2.0			2.1	2.3
Progression Factor				1.00	1.00	1.00	0.88	0.84			1.00	1.00
Incremental Delay, d2				0.4	0.2	0.2	0.3	0.0			0.1	0.2
Delay (s)				24.3	23.9	23.8	2.1	1.7			2.1	2.4
Level of Service				C	C	C	A	A			A	A
Approach Delay (s)		0.0			23.9			1.8			2.2	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM 2000 Control Delay	6.8	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.13		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	58.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
8: EB Off Ramp/EB On Ramp & 107th

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	60	0	15	0	0	0	0	140	400	395	65	0
Future Volume (vph)	60	0	15	0	0	0	0	140	400	395	65	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	5.0					5.0	5.0	4.0	5.0	
Lane Util. Factor	0.95	0.91	0.95					0.91	1.00	1.00	0.95	
Frt	1.00	0.99	0.85					1.00	0.85	1.00	1.00	
Flt Protected	0.95	0.96	1.00					1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1559	1487	1395					4715	1468	1641	3282	
Flt Permitted	0.95	0.96	1.00					1.00	1.00	0.65	1.00	
Satd. Flow (perm)	1559	1487	1395					4715	1468	1131	3282	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	63	0	16	0	0	0	0	147	421	416	68	0
RTOR Reduction (vph)	0	28	13	0	0	0	0	0	112	0	0	0
Lane Group Flow (vph)	33	4	1	0	0	0	0	147	309	416	68	0
Turn Type	Perm	NA	Perm					NA	Perm	Perm	NA	
Protected Phases		4						2			6	
Permitted Phases	4		4						2	6		
Actuated Green, G (s)	6.0	6.0	6.0					44.0	44.0	44.0	44.0	
Effective Green, g (s)	7.0	7.0	6.0					44.0	44.0	45.0	44.0	
Actuated g/C Ratio	0.12	0.12	0.10					0.73	0.73	0.75	0.73	
Clearance Time (s)	5.0	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	3.0	
Lane Grp Cap (vph)	181	173	139					3457	1076	848	2406	
v/s Ratio Prot								0.03			0.02	
v/s Ratio Perm	c0.02	0.00	0.00						0.21	c0.37		
v/c Ratio	0.18	0.02	0.01					0.04	0.29	0.49	0.03	
Uniform Delay, d1	23.9	23.5	24.3					2.2	2.7	3.0	2.2	
Progression Factor	1.00	1.00	1.00					1.00	1.00	0.90	0.83	
Incremental Delay, d2	0.5	0.1	0.0					0.0	0.7	2.0	0.0	
Delay (s)	24.4	23.5	24.4					2.2	3.4	4.7	1.8	
Level of Service	C	C	C					A	A	A	A	
Approach Delay (s)		24.0			0.0			3.1			4.3	
Approach LOS		C			A			A			A	

Intersection Summary			
HCM 2000 Control Delay	5.1	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	58.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	110	0	365	25	130	0	0	990	65
Future Volume (vph)	0	0	0	110	0	365	25	130	0	0	990	65
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0	4.0	4.0			4.0	5.0
Lane Util. Factor				0.95	0.91	0.95	1.00	0.91			0.76	0.76
Frt				1.00	0.86	0.85	1.00	1.00			1.00	0.85
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)				1559	1346	1395	1641	4715			6557	1116
Flt Permitted				0.95	1.00	1.00	0.21	1.00			1.00	1.00
Satd. Flow (perm)				1559	1346	1395	363	4715			6557	1116
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	116	0	384	26	137	0	0	1042	68
RTOR Reduction (vph)	0	0	0	0	160	167	0	0	0	0	1	16
Lane Group Flow (vph)	0	0	0	104	40	29	26	137	0	0	1048	45
Turn Type				Perm	NA	Perm	Perm	NA			NA	Perm
Protected Phases					8			2			6	
Permitted Phases				8		8	2					6
Actuated Green, G (s)				10.8	10.8	10.8	23.3	23.3			59.2	59.2
Effective Green, g (s)				11.8	11.8	11.8	24.3	24.3			60.2	59.2
Actuated g/C Ratio				0.15	0.15	0.15	0.30	0.30			0.75	0.74
Clearance Time (s)				5.0	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	3.0
Lane Grp Cap (vph)				229	198	205	110	1432			4934	825
v/s Ratio Prot								0.03			c0.16	
v/s Ratio Perm				c0.07	0.03	0.02	c0.07					0.04
v/c Ratio				0.45	0.20	0.14	0.24	0.10			0.21	0.05
Uniform Delay, d1				31.2	30.0	29.7	20.9	20.0			2.9	2.8
Progression Factor				1.00	1.00	1.00	0.69	0.74			1.00	1.00
Incremental Delay, d2				1.4	0.5	0.3	5.0	0.1			0.1	0.1
Delay (s)				32.6	30.5	30.0	19.4	14.8			3.0	2.9
Level of Service				C	C	C	B	B			A	A
Approach Delay (s)		0.0			30.7			15.6			3.0	
Approach LOS		A			C			B			A	

Intersection Summary			
HCM 2000 Control Delay	12.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.28		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	49.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	15	0	0	0	0	0	0	140	280	920	175	0
Future Volume (vph)	15	0	0	0	0	0	0	140	280	920	175	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0						5.0	5.0	5.0	5.0	
Lane Util. Factor	0.95	0.91						0.81	0.81	0.97	0.91	
Frt	1.00	1.00						0.92	0.85	1.00	1.00	
Flt Protected	0.95	0.95						1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1559	1493						5175	1189	3183	4715	
Flt Permitted	0.95	0.95						1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1559	1493						5175	1189	3183	4715	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	16	0	0	0	0	0	0	147	295	968	184	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	105	104	0	0	0
Lane Group Flow (vph)	8	8	0	0	0	0	0	190	43	968	184	0
Turn Type	Perm	NA	Perm					NA	Perm	Prot	NA	
Protected Phases		4						2		1	6	
Permitted Phases	4		4						2			
Actuated Green, G (s)	10.8	10.8						23.3	23.3	30.9	59.2	
Effective Green, g (s)	10.8	10.8						23.3	23.3	30.9	59.2	
Actuated g/C Ratio	0.14	0.14						0.29	0.29	0.39	0.74	
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	201						1507	346	1229	3489	
v/s Ratio Prot								c0.04		c0.30	0.04	
v/s Ratio Perm	0.01	0.01							0.04			
v/c Ratio	0.04	0.04						0.13	0.12	0.79	0.05	
Uniform Delay, d1	30.1	30.1						20.9	20.8	21.7	2.8	
Progression Factor	1.00	1.00						1.00	1.00	0.84	0.77	
Incremental Delay, d2	0.1	0.1						0.2	0.7	3.4	0.0	
Delay (s)	30.2	30.2						21.0	21.6	21.6	2.2	
Level of Service	C	C						C	C	C	A	
Approach Delay (s)		30.2			0.0			21.2			18.5	
Approach LOS		C			A			C			B	

Intersection Summary			
HCM 2000 Control Delay	19.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	49.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
11: Dysart Rd & WB On Ramp

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	20	40	155	25	20	0	0	60	15
Future Volume (vph)	0	0	0	20	40	155	25	20	0	0	60	15
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0	5.0	5.0	4.0	4.0			4.0	
Lane Util. Factor				0.95	0.91	0.95	1.00	0.91			0.81	
Frt				1.00	0.91	0.85	1.00	1.00			0.97	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1559	1431	1395	1641	4715			6783	
Flt Permitted				0.95	1.00	1.00	0.69	1.00			1.00	
Satd. Flow (perm)				1559	1431	1395	1199	4715			6783	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	21	42	163	26	21	0	0	63	16
RTOR Reduction (vph)	0	0	0	0	32	50	0	0	0	0	10	0
Lane Group Flow (vph)	0	0	0	19	76	49	26	21	0	0	69	0
Turn Type				Perm	NA	Perm	Perm	NA			NA	
Protected Phases					8			2			6	
Permitted Phases				8		8	2					
Actuated Green, G (s)				34.7	34.7	34.7	16.7	16.7			25.3	
Effective Green, g (s)				34.7	34.7	34.7	17.7	17.7			26.3	
Actuated g/C Ratio				0.50	0.50	0.50	0.25	0.25			0.38	
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)				772	709	691	303	1192			2548	
v/s Ratio Prot								0.00			c0.01	
v/s Ratio Perm				0.01	0.05	0.04	c0.02					
v/c Ratio				0.02	0.11	0.07	0.09	0.02			0.03	
Uniform Delay, d1				9.0	9.4	9.2	20.0	19.6			13.8	
Progression Factor				1.00	1.00	1.00	1.55	1.28			1.00	
Incremental Delay, d2				0.0	0.1	0.0	0.6	0.0			0.0	
Delay (s)				9.0	9.5	9.3	31.5	25.2			13.8	
Level of Service				A	A	A	C	C			B	
Approach Delay (s)		0.0			9.3			28.7			13.8	
Approach LOS		A			A			C			B	

Intersection Summary			
HCM 2000 Control Delay	12.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.10		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	34.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
12: Dysart Rd

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	10	610	5	0	0	0	0	35	10	55	25	0
Future Volume (vph)	10	610	5	0	0	0	0	35	10	55	25	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0					4.0		5.0	4.0	
Lane Util. Factor	0.95	0.91	0.95					0.86		0.97	0.91	
Frt	1.00	1.00	0.85					0.97		1.00	1.00	
Flt Protected	0.95	1.00	1.00					1.00		0.95	1.00	
Satd. Flow (prot)	1559	1571	1395					5738		3183	4715	
Flt Permitted	0.95	1.00	1.00					1.00		0.95	1.00	
Satd. Flow (perm)	1559	1571	1395					5738		3183	4715	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	11	642	5	0	0	0	0	37	11	58	26	0
RTOR Reduction (vph)	0	0	2	0	0	0	0	8	0	0	0	0
Lane Group Flow (vph)	10	644	2	0	0	0	0	40	0	58	26	0
Turn Type	Perm	NA	Perm					NA		Prot	NA	
Protected Phases		4						2		1	6	
Permitted Phases	4		4									
Actuated Green, G (s)	34.7	34.7	34.7					16.7		3.6	25.3	
Effective Green, g (s)	34.7	34.7	34.7					17.7		3.6	26.3	
Actuated g/C Ratio	0.50	0.50	0.50					0.25		0.05	0.38	
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)	772	778	691					1450		163	1771	
v/s Ratio Prot								c0.01		c0.02	0.01	
v/s Ratio Perm	0.01	0.41	0.00									
v/c Ratio	0.01	0.83	0.00					0.03		0.36	0.01	
Uniform Delay, d1	9.0	15.1	8.9					19.7		32.1	13.7	
Progression Factor	1.00	1.00	1.00					1.00		1.48	0.70	
Incremental Delay, d2	0.0	7.2	0.0					0.0		1.3	0.0	
Delay (s)	9.0	22.3	8.9					19.7		48.8	9.6	
Level of Service	A	C	A					B		D	A	
Approach Delay (s)		22.1			0.0			19.7			36.6	
Approach LOS		C			A			B			D	

Intersection Summary			
HCM 2000 Control Delay	23.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	34.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

13: Bullard Ave & WB On Ramp/WB Off Ramp

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	35	0	0	40	865	0	0	145	80
Future Volume (vph)	0	0	0	35	0	0	40	865	0	0	145	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0		4.0	4.0			4.0	5.0
Lane Util. Factor				0.95	0.91		1.00	0.95			0.86	0.86
Frt				1.00	1.00		1.00	1.00			0.98	0.85
Flt Protected				0.95	0.95		0.95	1.00			1.00	1.00
Satd. Flow (prot)				1559	1493		1641	3282			4347	1263
Flt Permitted				0.95	0.95		0.62	1.00			1.00	1.00
Satd. Flow (perm)				1559	1493		1079	3282			4347	1263
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	37	0	0	42	911	0	0	153	84
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	17	32
Lane Group Flow (vph)	0	0	0	18	19	0	42	911	0	0	166	22
Turn Type				Prot	NA	Perm	Perm	NA			NA	Perm
Protected Phases				3	8			2			6	
Permitted Phases						8	2					6
Actuated Green, G (s)				0.8	31.2		28.8	28.8			28.8	28.8
Effective Green, g (s)				1.8	32.2		29.8	29.8			29.8	28.8
Actuated g/C Ratio				0.03	0.46		0.43	0.43			0.43	0.41
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)				40	686		459	1397			1850	519
v/s Ratio Prot				c0.01	c0.00			c0.28			0.04	
v/s Ratio Perm					0.01		0.04					0.02
v/c Ratio				0.45	0.03		0.09	0.65			0.09	0.04
Uniform Delay, d1				33.6	10.3		12.0	16.0			12.0	12.3
Progression Factor				1.00	1.00		0.85	0.99			1.00	1.00
Incremental Delay, d2				7.9	0.0		0.4	2.3			0.1	0.2
Delay (s)				41.5	10.4		10.6	18.0			12.1	12.5
Level of Service				D	B		B	B			B	B
Approach Delay (s)		0.0			25.5			17.7			12.2	
Approach LOS		A			C			B			B	

Intersection Summary			
HCM 2000 Control Delay	16.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.37		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	53.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

14: Bullard Ave & EB Off Ramp/EB On Ramp

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	590	0	140	0	0	0	0	315	335	80	100	0
Future Volume (vph)	590	0	140	0	0	0	0	315	335	80	100	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0					4.0	5.0	4.0	4.0	
Lane Util. Factor	0.95	0.91	0.95					0.91	1.00	1.00	0.95	
Frt	1.00	0.99	0.85					1.00	0.85	1.00	1.00	
Flt Protected	0.95	0.95	1.00					1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1559	1490	1395					4715	1468	1641	3282	
Flt Permitted	0.95	0.95	1.00					1.00	1.00	0.54	1.00	
Satd. Flow (perm)	1559	1490	1395					4715	1468	939	3282	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	621	0	147	0	0	0	0	332	353	84	105	0
RTOR Reduction (vph)	0	68	82	0	0	0	0	0	208	0	0	0
Lane Group Flow (vph)	317	251	50	0	0	0	0	332	145	84	105	0
Turn Type	Perm	NA	Perm					NA	Perm	Perm	NA	
Protected Phases		4						2			6	
Permitted Phases	4		4						2	6		
Actuated Green, G (s)	25.4	25.4	25.4					28.8	28.8	28.8	28.8	
Effective Green, g (s)	26.4	26.4	26.4					29.8	28.8	29.8	29.8	
Actuated g/C Ratio	0.38	0.38	0.38					0.43	0.41	0.43	0.43	
Clearance Time (s)	5.0	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	3.0	
Lane Grp Cap (vph)	587	561	526					2007	603	399	1397	
v/s Ratio Prot								0.07			0.03	
v/s Ratio Perm	c0.20	0.17	0.04						c0.10	0.09		
v/c Ratio	0.54	0.45	0.09					0.17	0.24	0.21	0.08	
Uniform Delay, d1	17.1	16.3	14.1					12.4	13.5	12.7	11.9	
Progression Factor	1.00	1.00	1.00					1.00	1.00	0.74	0.75	
Incremental Delay, d2	1.0	0.6	0.1					0.2	0.9	1.2	0.1	
Delay (s)	18.1	16.9	14.2					12.6	14.4	10.6	9.1	
Level of Service	B	B	B					B	B	B	A	
Approach Delay (s)		16.9			0.0			13.5			9.8	
Approach LOS		B			A			B			A	

Intersection Summary			
HCM 2000 Control Delay	14.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.37		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	53.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

15: Estrella Pkwy & WB On Ramp/WB Off Ramp

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	550	0	125	10	1010	0	0	645	100
Future Volume (vph)	0	0	0	550	0	125	10	1010	0	0	645	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0	4.0	4.0			4.0	
Lane Util. Factor				0.95	0.91	0.95	1.00	0.91			0.81	
Frt				1.00	0.99	0.85	1.00	1.00			0.98	
Flt Protected				0.95	0.95	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1559	1490	1395	1641	4715			6855	
Flt Permitted				0.95	0.95	1.00	0.95	1.00			1.00	
Satd. Flow (perm)				1559	1490	1395	1641	4715			6855	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	579	0	132	11	1063	0	0	679	105
RTOR Reduction (vph)	0	0	0	0	84	85	0	0	0	0	35	0
Lane Group Flow (vph)	0	0	0	295	213	34	11	1063	0	0	749	0
Turn Type				Perm	NA	Perm	Prot	NA			NA	
Protected Phases					8		5	2			6	
Permitted Phases				8		8						
Actuated Green, G (s)				17.3	17.3	17.3	0.8	24.0			31.9	
Effective Green, g (s)				18.3	18.3	18.3	1.8	25.0			32.9	
Actuated g/C Ratio				0.28	0.28	0.28	0.03	0.38			0.51	
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)				438	419	392	45	1813			3469	
v/s Ratio Prot							c0.01	c0.23			c0.11	
v/s Ratio Perm				c0.19	0.14	0.02						
v/c Ratio				0.67	0.51	0.09	0.24	0.59			0.22	
Uniform Delay, d1				20.7	19.6	17.2	30.9	15.9			8.9	
Progression Factor				1.00	1.00	1.00	1.21	0.69			1.00	
Incremental Delay, d2				4.1	1.0	0.1	2.1	1.0			0.1	
Delay (s)				24.8	20.5	17.3	39.4	12.1			9.0	
Level of Service				C	C	B	D	B			A	
Approach Delay (s)		0.0			21.8			12.4			9.0	
Approach LOS		A			C			B			A	

Intersection Summary			
HCM 2000 Control Delay	14.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	51.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

16: Estrella Pkwy & EB Off Ramp/EB On Ramp

05/02/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	25	0	25	0	0	0	0	1000	755	255	940	0
Future Volume (vph)	25	0	25	0	0	0	0	1000	755	255	940	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0					4.0	4.0	4.0	4.0	
Lane Util. Factor	0.95	0.91	0.95					0.81	0.81	0.97	0.91	
Frt	1.00	0.92	0.85					0.96	0.85	1.00	1.00	
Flt Protected	0.95	0.98	1.00					1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1559	1414	1395					5366	1189	3183	4715	
Flt Permitted	0.95	0.98	1.00					1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1559	1414	1395					5366	1189	3183	4715	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	26	0	26	0	0	0	0	1053	795	268	989	0
RTOR Reduction (vph)	0	12	12	0	0	0	0	98	244	0	0	0
Lane Group Flow (vph)	18	5	5	0	0	0	0	1353	153	268	989	0
Turn Type	Perm	NA	Perm					NA	Perm	Prot	NA	
Protected Phases		4						2		1	6	
Permitted Phases	4		4						2			
Actuated Green, G (s)	17.3	17.3	17.3					24.0	24.0	8.7	31.9	
Effective Green, g (s)	18.3	18.3	18.3					25.0	25.0	9.7	32.9	
Actuated g/C Ratio	0.28	0.28	0.28					0.38	0.38	0.15	0.51	
Clearance Time (s)	5.0	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	3.0	
Lane Grp Cap (vph)	438	398	392					2063	457	475	2386	
v/s Ratio Prot								c0.25		c0.08	0.21	
v/s Ratio Perm	c0.01	0.00	0.00						0.13			
v/c Ratio	0.04	0.01	0.01					0.66	0.33	0.56	0.41	
Uniform Delay, d1	17.0	16.8	16.8					16.5	14.1	25.7	10.0	
Progression Factor	1.00	1.00	1.00					1.00	1.00	1.04	0.87	
Incremental Delay, d2	0.0	0.0	0.0					1.6	2.0	1.5	0.5	
Delay (s)	17.0	16.8	16.8					18.1	16.1	28.2	9.3	
Level of Service	B	B	B					B	B	C	A	
Approach Delay (s)		16.9			0.0			17.7			13.3	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM 2000 Control Delay	15.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	51.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
17: Sarival Ave & WB Off Ramp

05/02/2018

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	20	385	0	0	0	855
Future Volume (Veh/h)	20	385	0	0	0	855
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	405	0	0	0	900
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	450	0			0	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	450	0			0	
tC, single (s)	7.0	7.1			4.3	
tC, 2 stage (s)						
tF (s)	3.6	3.4			2.3	
p0 queue free %	96	62			100	
cM capacity (veh/h)	518	1059			1565	

Direction, Lane #	WB 1	WB 2	WB 3	NB 1	SB 1	SB 2
Volume Total	21	202	202	0	450	450
Volume Left	21	0	0	0	0	0
Volume Right	0	202	202	0	0	0
cSH	518	1059	1059	1700	1700	1700
Volume to Capacity	0.04	0.19	0.19	0.00	0.26	0.26
Queue Length 95th (ft)	3	18	18	0	0	0
Control Delay (s)	12.2	9.2	9.2	0.0	0.0	0.0
Lane LOS	B	A	A			
Approach Delay (s)	9.4			0.0	0.0	
Approach LOS	A					

Intersection Summary			
Average Delay	3.0		
Intersection Capacity Utilization	33.6%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
1: 67th Ave & WB On Ramp

05/10/2018

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	0	0	560	670	105	215
Future Volume (vph)	0	0	560	670	105	215
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)			4.0	4.0	4.0	4.0
Lane Util. Factor			0.97	0.91	0.91	1.00
Frt			1.00	1.00	1.00	0.85
Flt Protected			0.95	1.00	1.00	1.00
Satd. Flow (prot)			3183	4715	4715	1468
Flt Permitted			0.95	1.00	1.00	1.00
Satd. Flow (perm)			3183	4715	4715	1468
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	589	705	111	226
RTOR Reduction (vph)	0	0	0	0	0	184
Lane Group Flow (vph)	0	0	589	705	111	42
Turn Type			Prot	NA	NA	Perm
Protected Phases			5	2	6	
Permitted Phases						6
Actuated Green, G (s)			18.5	35.6	12.1	12.1
Effective Green, g (s)			19.5	36.6	13.1	13.1
Actuated g/C Ratio			0.28	0.52	0.19	0.19
Clearance Time (s)			5.0	5.0	5.0	5.0
Vehicle Extension (s)			3.0	3.0	3.0	3.0
Lane Grp Cap (vph)			886	2465	882	274
v/s Ratio Prot			c0.19	c0.15	0.02	
v/s Ratio Perm						0.03
v/c Ratio			0.66	0.29	0.13	0.15
Uniform Delay, d1			22.4	9.4	23.7	23.8
Progression Factor			0.85	0.75	1.00	1.00
Incremental Delay, d2			1.7	0.3	0.3	1.2
Delay (s)			20.8	7.3	24.0	25.0
Level of Service			C	A	C	C
Approach Delay (s)	0.0			13.4	24.7	
Approach LOS	A			B	C	

Intersection Summary			
HCM 2000 Control Delay	15.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.31		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	45.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
2: 67th Ave & EB Off Ramp

05/10/2018

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	515	860	0	715	105	0
Future Volume (vph)	515	860	0	715	105	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	
Lane Util. Factor	0.97	0.91		0.86	0.91	
Frt	0.93	0.85		1.00	1.00	
Flt Protected	0.97	1.00		1.00	1.00	
Satd. Flow (prot)	3041	1336		5942	4715	
Flt Permitted	0.97	1.00		1.00	1.00	
Satd. Flow (perm)	3041	1336		5942	4715	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	542	905	0	753	111	0
RTOR Reduction (vph)	200	294	0	0	0	0
Lane Group Flow (vph)	785	168	0	753	111	0
Turn Type	Prot	Perm		NA	NA	
Protected Phases	4			2	6	
Permitted Phases		4				
Actuated Green, G (s)	24.4	24.4		35.6	12.1	
Effective Green, g (s)	25.4	25.4		36.6	13.1	
Actuated g/C Ratio	0.36	0.36		0.52	0.19	
Clearance Time (s)	5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	1103	484		3106	882	
v/s Ratio Prot	c0.26			c0.13	0.02	
v/s Ratio Perm		0.13				
v/c Ratio	0.71	0.35		0.24	0.13	
Uniform Delay, d1	19.2	16.3		9.1	23.7	
Progression Factor	1.00	1.00		1.00	1.14	
Incremental Delay, d2	2.2	0.4		0.2	0.3	
Delay (s)	21.3	16.7		9.3	27.2	
Level of Service	C	B		A	C	
Approach Delay (s)	19.9			9.3	27.2	
Approach LOS	B			A	C	

Intersection Summary			
HCM 2000 Control Delay	16.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	45.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
3: 83rd Ave & WB On Ramp/WB Off Ramp

05/10/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	25	0	175	0	325	0	0	90	100
Future Volume (vph)	0	0	0	25	0	175	0	325	0	0	90	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0		4.0		4.0			4.0	
Lane Util. Factor				1.00		0.88		0.95			0.95	
Frt				1.00		0.85		1.00			0.92	
Flt Protected				0.95		1.00		1.00			1.00	
Satd. Flow (prot)				1641		2584		3282			3023	
Flt Permitted				0.95		1.00		1.00			1.00	
Satd. Flow (perm)				1641		2584		3282			3023	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	26	0	184	0	342	0	0	95	105
RTOR Reduction (vph)	0	0	0	0	0	153	0	0	0	0	46	0
Lane Group Flow (vph)	0	0	0	26	0	31	0	342	0	0	154	0
Turn Type				Perm		Perm	Perm	NA			NA	
Protected Phases								2 5			6	
Permitted Phases				8		8	2 5					
Actuated Green, G (s)				14.3		14.3		44.4			49.9	
Effective Green, g (s)				15.3		15.3		45.4			50.9	
Actuated g/C Ratio				0.17		0.17		0.50			0.57	
Clearance Time (s)				5.0		5.0					5.0	
Vehicle Extension (s)				3.0		3.0					3.0	
Lane Grp Cap (vph)				278		439		1655			1709	
v/s Ratio Prot								c0.10			c0.05	
v/s Ratio Perm				c0.02		0.01						
v/c Ratio				0.09		0.07		0.21			0.09	
Uniform Delay, d1				31.5		31.4		12.3			9.0	
Progression Factor				1.00		1.00		0.74			1.00	
Incremental Delay, d2				0.1		0.1		0.1			0.1	
Delay (s)				31.6		31.4		9.2			9.1	
Level of Service				C		C		A			A	
Approach Delay (s)		0.0			31.5			9.2			9.1	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM 2000 Control Delay	15.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.17		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	26.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

4: 83rd Ave & EB Off Ramp/EB On Ramp

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	300	0	0	0	0	0	0	25	75	75	40	0
Future Volume (vph)	300	0	0	0	0	0	0	25	75	75	40	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0							4.0		4.0	4.0	
Lane Util. Factor	0.97							0.95		1.00	0.95	
Frt	1.00							0.89		1.00	1.00	
Flt Protected	0.95							1.00		0.95	1.00	
Satd. Flow (prot)	3183							2911		1641	3282	
Flt Permitted	0.95							1.00		0.69	1.00	
Satd. Flow (perm)	3183							2911		1184	3282	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	316	0	0	0	0	0	0	26	79	79	42	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	39	0	0	0	0
Lane Group Flow (vph)	316	0	0	0	0	0	0	66	0	79	42	0
Turn Type	Perm		Perm					NA		pm+pt	NA	
Protected Phases								2		1	1 6	
Permitted Phases	4		4							1 6		
Actuated Green, G (s)	14.3							44.4		49.9	49.9	
Effective Green, g (s)	15.3							45.4		50.9	50.9	
Actuated g/C Ratio	0.17							0.50		0.57	0.57	
Clearance Time (s)	5.0							5.0		5.0		
Vehicle Extension (s)	3.0							3.0		3.0		
Lane Grp Cap (vph)	541							1468		757	1856	
v/s Ratio Prot								c0.02		c0.02	0.01	
v/s Ratio Perm	c0.10									c0.04		
v/c Ratio	0.58							0.04		0.10	0.02	
Uniform Delay, d1	34.4							11.3		9.1	8.6	
Progression Factor	1.00							1.00		1.05	1.07	
Incremental Delay, d2	1.6							0.1		0.1	0.0	
Delay (s)	36.0							11.4		9.6	9.2	
Level of Service	D							B		A	A	
Approach Delay (s)		36.0			0.0			11.4			9.5	
Approach LOS		D			A			B			A	

Intersection Summary			
HCM 2000 Control Delay	25.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.19		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	26.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

5: 91st Ave & WB On Ramp/WB Off Ramp

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	0	0	425	185	290	0	0	485	65
Future Volume (vph)	0	0	0	0	0	425	185	290	0	0	485	65
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)					4.0	4.0	4.0	4.0			4.0	
Lane Util. Factor					0.91	0.95	0.97	0.95			0.86	
Frt					0.85	0.85	1.00	1.00			0.98	
Flt Protected					1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)					1336	1395	3183	3282			5837	
Flt Permitted					1.00	1.00	0.41	1.00			1.00	
Satd. Flow (perm)					1336	1395	1370	3282			5837	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	0	0	447	195	305	0	0	511	68
RTOR Reduction (vph)	0	0	0	0	189	189	0	0	0	0	18	0
Lane Group Flow (vph)	0	0	0	0	35	34	195	305	0	0	561	0
Turn Type				Perm	NA	Perm	Perm	NA			NA	
Protected Phases					8			2			6	
Permitted Phases				8		8	2					
Actuated Green, G (s)					9.8	9.8	31.7	31.7			50.2	
Effective Green, g (s)					10.8	10.8	32.7	32.7			51.2	
Actuated g/C Ratio					0.15	0.15	0.47	0.47			0.73	
Clearance Time (s)					5.0	5.0	5.0	5.0			5.0	
Vehicle Extension (s)					3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)					206	215	639	1533			4269	
v/s Ratio Prot					c0.03			0.09			c0.10	
v/s Ratio Perm						0.02	c0.14					
v/c Ratio					0.17	0.16	0.31	0.20			0.13	
Uniform Delay, d1					25.7	25.7	11.6	11.0			2.8	
Progression Factor					1.00	1.00	0.51	0.49			1.00	
Incremental Delay, d2					0.4	0.4	1.2	0.3			0.1	
Delay (s)					26.1	26.0	7.1	5.7			2.9	
Level of Service					C	C	A	A			A	
Approach Delay (s)		0.0			26.1			6.2			2.9	
Approach LOS		A			C			A			A	

Intersection Summary			
HCM 2000 Control Delay	10.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.25		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	32.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	185	0	65	0	0	0	0	290	0	400	85	0
Future Volume (vph)	185	0	65	0	0	0	0	290	0	400	85	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0					4.0		4.0	4.0	
Lane Util. Factor	0.95	0.91	0.95					0.86		0.97	0.95	
Frt	1.00	0.99	0.85					1.00		1.00	1.00	
Flt Protected	0.95	0.96	1.00					1.00		0.95	1.00	
Satd. Flow (prot)	1559	1486	1395					5942		3183	3282	
Flt Permitted	0.95	0.96	1.00					1.00		0.95	1.00	
Satd. Flow (perm)	1559	1486	1395					5942		3183	3282	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	195	0	68	0	0	0	0	305	0	421	89	0
RTOR Reduction (vph)	0	85	52	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	101	16	9	0	0	0	0	305	0	421	89	0
Turn Type	Perm	NA	Perm					NA		Prot	NA	
Protected Phases		4						2		1	6	
Permitted Phases	4		4									
Actuated Green, G (s)	9.8	9.8	9.8					31.7		13.5	50.2	
Effective Green, g (s)	10.8	10.8	10.8					32.7		14.5	51.2	
Actuated g/C Ratio	0.15	0.15	0.15					0.47		0.21	0.73	
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)	240	229	215					2775		659	2400	
v/s Ratio Prot								c0.05		c0.13	0.03	
v/s Ratio Perm	c0.06	0.01	0.01									
v/c Ratio	0.42	0.07	0.04					0.11		0.64	0.04	
Uniform Delay, d1	26.8	25.3	25.2					10.5		25.4	2.6	
Progression Factor	1.00	1.00	1.00					1.00		0.89	0.68	
Incremental Delay, d2	1.2	0.1	0.1					0.1		2.0	0.0	
Delay (s)	28.0	25.4	25.3					10.6		24.6	1.8	
Level of Service	C	C	C					B		C	A	
Approach Delay (s)		26.4			0.0			10.6			20.6	
Approach LOS		C			A			B			C	

Intersection Summary			
HCM 2000 Control Delay	19.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.31		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	32.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	10	0	150	10	400	0	0	300	200
Future Volume (vph)	0	0	0	10	0	150	10	400	0	0	300	200
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0		4.0	4.0	4.0			4.0	5.0
Lane Util. Factor				1.00		0.88	1.00	0.95			0.91	1.00
Frt				1.00		0.85	1.00	1.00			1.00	0.85
Flt Protected				0.95		1.00	0.95	1.00			1.00	1.00
Satd. Flow (prot)				1641		2584	1641	3282			4715	1468
Flt Permitted				0.95		1.00	0.55	1.00			1.00	1.00
Satd. Flow (perm)				1641		2584	954	3282			4715	1468
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	11	0	158	11	421	0	0	316	211
RTOR Reduction (vph)	0	0	0	0	0	120	0	0	0	0	0	82
Lane Group Flow (vph)	0	0	0	11	0	38	11	421	0	0	316	129
Turn Type				Perm		Perm	Perm	NA			NA	Perm
Protected Phases								2			6	
Permitted Phases				8		8	2					6
Actuated Green, G (s)				13.3		13.3	36.7	36.7			36.7	36.7
Effective Green, g (s)				14.3		14.3	37.7	37.7			37.7	36.7
Actuated g/C Ratio				0.24		0.24	0.63	0.63			0.63	0.61
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)				391		615	599	2062			2962	897
v/s Ratio Prot								c0.13			0.07	
v/s Ratio Perm				0.01		c0.01	0.01					0.09
v/c Ratio				0.03		0.06	0.02	0.20			0.11	0.14
Uniform Delay, d1				17.5		17.7	4.2	4.8			4.4	5.0
Progression Factor				1.00		1.00	1.15	1.54			1.00	1.00
Incremental Delay, d2				0.0		0.0	0.1	0.2			0.1	0.3
Delay (s)				17.6		17.7	4.9	7.5			4.5	5.3
Level of Service				B		B	A	A			A	A
Approach Delay (s)		0.0			17.7			7.5			4.8	
Approach LOS		A			B			A			A	

Intersection Summary			
HCM 2000 Control Delay	7.8	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.17		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	41.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	400	0	10	0	0	0	0	10	10	300	10	0
Future Volume (vph)	400	0	10	0	0	0	0	10	10	300	10	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		5.0					5.0		4.0	5.0	
Lane Util. Factor	0.97		1.00					0.95		1.00	0.95	
Frt	1.00		0.85					0.93		1.00	1.00	
Flt Protected	0.95		1.00					1.00		0.95	1.00	
Satd. Flow (prot)	3183		1468					3036		1641	3282	
Flt Permitted	0.95		1.00					1.00		0.74	1.00	
Satd. Flow (perm)	3183		1468					3036		1282	3282	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	421	0	11	0	0	0	0	11	11	316	11	0
RTOR Reduction (vph)	0	0	9	0	0	0	0	4	0	0	0	0
Lane Group Flow (vph)	421	0	2	0	0	0	0	18	0	316	11	0
Turn Type	Perm		Perm					NA		Perm	NA	
Protected Phases								2			6	
Permitted Phases	4		4							6		
Actuated Green, G (s)	13.3		13.3					36.7		36.7	36.7	
Effective Green, g (s)	14.3		13.3					36.7		37.7	36.7	
Actuated g/C Ratio	0.24		0.22					0.61		0.63	0.61	
Clearance Time (s)	5.0		5.0					5.0		5.0	5.0	
Vehicle Extension (s)	3.0		3.0					3.0		3.0	3.0	
Lane Grp Cap (vph)	758		325					1857		805	2007	
v/s Ratio Prot								0.01			0.00	
v/s Ratio Perm	c0.13		0.00							c0.25		
v/c Ratio	0.56		0.01					0.01		0.39	0.01	
Uniform Delay, d1	20.1		18.2					4.6		5.5	4.5	
Progression Factor	1.00		1.00					1.00		0.76	0.72	
Incremental Delay, d2	0.9		0.0					0.0		1.4	0.0	
Delay (s)	20.9		18.2					4.6		5.6	3.3	
Level of Service	C		B					A		A	A	
Approach Delay (s)		20.9			0.0			4.6			5.6	
Approach LOS		C			A			A			A	

Intersection Summary			
HCM 2000 Control Delay	14.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	42.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	50	0	300	0	150	0	0	145	100
Future Volume (vph)	0	0	0	50	0	300	0	150	0	0	145	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0		4.0			4.0	
Lane Util. Factor				0.95	0.91	0.95		0.91			0.86	
Frt				1.00	0.85	0.85		1.00			0.94	
Flt Protected				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (prot)				1559	1341	1395		4715			5579	
Flt Permitted				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (perm)				1559	1341	1395		4715			5579	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	53	0	316	0	158	0	0	153	105
RTOR Reduction (vph)	0	0	0	0	130	136	0	0	0	0	31	0
Lane Group Flow (vph)	0	0	0	48	30	25	0	158	0	0	227	0
Turn Type				Perm	NA	Perm	Prot	NA			NA	
Protected Phases					8		5	2			6	
Permitted Phases				8		8						
Actuated Green, G (s)				8.5	8.5	8.5		30.5			41.5	
Effective Green, g (s)				9.5	9.5	9.5		31.5			42.5	
Actuated g/C Ratio				0.16	0.16	0.16		0.52			0.71	
Clearance Time (s)				5.0	5.0	5.0		5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				246	212	220		2475			3951	
v/s Ratio Prot								c0.03			c0.04	
v/s Ratio Perm				c0.03	0.02	0.02						
v/c Ratio				0.20	0.14	0.12		0.06			0.06	
Uniform Delay, d1				21.9	21.7	21.6		7.0			2.7	
Progression Factor				1.00	1.00	1.00		1.67			1.00	
Incremental Delay, d2				0.4	0.3	0.2		0.0			0.0	
Delay (s)				22.3	22.0	21.9		11.8			2.7	
Level of Service				C	C	C		B			A	
Approach Delay (s)		0.0			22.0			11.8			2.7	
Approach LOS		A			C			B			A	

Intersection Summary			
HCM 2000 Control Delay	13.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.09		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	35.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
10: Avondale Blvd & EB Off Ramp/EB On Ramp

05/10/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	125	0	0	0	0	0	0	25	310	115	80	0
Future Volume (vph)	125	0	0	0	0	0	0	25	310	115	80	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0						5.0	5.0	5.0	5.0	
Lane Util. Factor	0.95	0.91						0.76	0.76	1.00	0.91	
Frt	1.00	1.00						0.87	0.85	1.00	1.00	
Flt Protected	0.95	0.95						1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1559	1493						5715	1116	1641	4715	
Flt Permitted	0.95	0.95						1.00	1.00	0.52	1.00	
Satd. Flow (perm)	1559	1493						5715	1116	897	4715	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	132	0	0	0	0	0	0	26	326	121	84	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	80	80	0	0	0
Lane Group Flow (vph)	66	66	0	0	0	0	0	109	83	121	84	0
Turn Type	Perm	NA	Perm					NA	Perm	pm+pt	NA	
Protected Phases		4						2		1	6	
Permitted Phases	4		4						2	6		
Actuated Green, G (s)	8.5	8.5						30.5	30.5	41.5	41.5	
Effective Green, g (s)	8.5	8.5						30.5	30.5	41.5	41.5	
Actuated g/C Ratio	0.14	0.14						0.51	0.51	0.69	0.69	
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)	220	211						2905	567	694	3261	
v/s Ratio Prot								0.02		c0.02	0.02	
v/s Ratio Perm	0.04	0.04							0.07	c0.10		
v/c Ratio	0.30	0.31						0.04	0.15	0.17	0.03	
Uniform Delay, d1	23.1	23.1						7.4	7.8	3.3	2.9	
Progression Factor	1.00	1.00						1.00	1.00	0.95	0.89	
Incremental Delay, d2	0.8	0.9						0.0	0.5	0.1	0.0	
Delay (s)	23.9	24.0						7.4	8.4	3.3	2.6	
Level of Service	C	C						A	A	A	A	
Approach Delay (s)		23.9			0.0			7.9			3.0	
Approach LOS		C			A			A			A	

Intersection Summary			
HCM 2000 Control Delay	9.5	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.22		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	35.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
11: Dysart Rd & WB On Ramp

05/10/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	150	25	5	165	280	0	0	85	85
Future Volume (vph)	0	0	0	150	25	5	165	280	0	0	85	85
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0	5.0	5.0	4.0	4.0			4.0	
Lane Util. Factor				1.00	1.00	1.00	0.97	0.91			0.81	
Frt				1.00	1.00	0.85	1.00	1.00			0.93	
Flt Protected				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (prot)				1641	1727	1468	3183	4715			6471	
Flt Permitted				0.95	1.00	1.00	0.95	1.00			1.00	
Satd. Flow (perm)				1641	1727	1468	3183	4715			6471	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	158	26	5	174	295	0	0	89	89
RTOR Reduction (vph)	0	0	0	0	0	4	0	0	0	0	48	0
Lane Group Flow (vph)	0	0	0	158	26	1	174	295	0	0	130	0
Turn Type				Perm	NA	Perm	Prot	NA			NA	
Protected Phases					8		5	2			6	
Permitted Phases				8		8						
Actuated Green, G (s)				14.8	14.8	14.8	9.1	39.0			31.1	
Effective Green, g (s)				14.8	14.8	14.8	10.1	40.0			32.1	
Actuated g/C Ratio				0.21	0.21	0.21	0.14	0.57			0.46	
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)				346	365	310	459	2694			2967	
v/s Ratio Prot					0.02		c0.05	c0.06			0.02	
v/s Ratio Perm				c0.10		0.00						
v/c Ratio				0.46	0.07	0.00	0.38	0.11			0.04	
Uniform Delay, d1				24.1	22.1	21.8	27.1	6.9			10.5	
Progression Factor				1.00	1.00	1.00	0.95	1.00			1.00	
Incremental Delay, d2				1.0	0.1	0.0	0.5	0.1			0.0	
Delay (s)				25.0	22.2	21.8	26.4	6.9			10.5	
Level of Service				C	C	C	C	A			B	
Approach Delay (s)		0.0			24.6			14.1			10.5	
Approach LOS		A			C			B			B	

Intersection Summary			
HCM 2000 Control Delay	15.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.26		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	29.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
12: Dysart Rd

05/10/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	190	170	140	0	0	0	0	255	75	5	230	0
Future Volume (vph)	190	170	140	0	0	0	0	255	75	5	230	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0					4.0		5.0	4.0	
Lane Util. Factor	1.00	1.00	1.00					0.81		0.97	0.91	
Frt	1.00	1.00	0.85					0.97		1.00	1.00	
Flt Protected	0.95	1.00	1.00					1.00		0.95	1.00	
Satd. Flow (prot)	1641	1727	1468					6757		3183	4715	
Flt Permitted	0.95	1.00	1.00					1.00		0.95	1.00	
Satd. Flow (perm)	1641	1727	1468					6757		3183	4715	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	200	179	147	0	0	0	0	268	79	5	242	0
RTOR Reduction (vph)	0	0	116	0	0	0	0	34	0	0	0	0
Lane Group Flow (vph)	200	179	31	0	0	0	0	313	0	5	242	0
Turn Type	Perm	NA	Perm					NA		Prot	NA	
Protected Phases		4						2		1	6	
Permitted Phases	4		4									
Actuated Green, G (s)	14.8	14.8	14.8					39.0		1.2	31.1	
Effective Green, g (s)	14.8	14.8	14.8					40.0		1.2	32.1	
Actuated g/C Ratio	0.21	0.21	0.21					0.57		0.02	0.46	
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)	346	365	310					3861		54	2162	
v/s Ratio Prot		0.10						c0.05		c0.00	c0.05	
v/s Ratio Perm	c0.12		0.02									
v/c Ratio	0.58	0.49	0.10					0.08		0.09	0.11	
Uniform Delay, d1	24.8	24.3	22.2					6.7		33.9	10.8	
Progression Factor	1.00	1.00	1.00					1.00		0.64	1.41	
Incremental Delay, d2	2.3	1.0	0.1					0.0		0.7	0.1	
Delay (s)	27.1	25.3	22.4					6.8		22.3	15.3	
Level of Service	C	C	C					A		C	B	
Approach Delay (s)		25.2			0.0			6.8			15.5	
Approach LOS		C			A			A			B	

Intersection Summary			
HCM 2000 Control Delay	17.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.23		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	29.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
13: Bullard Ave & WB On Ramp/WB Off Ramp

05/10/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	0	0	275	0	1215	0	0	95	125
Future Volume (vph)	0	0	0	0	0	275	0	1215	0	0	95	125
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)						4.0		4.0			4.0	5.0
Lane Util. Factor						1.00		0.95			0.86	1.00
Frt						0.85		1.00			1.00	0.85
Flt Protected						1.00		1.00			1.00	1.00
Satd. Flow (prot)						1468		3282			5942	1468
Flt Permitted						1.00		1.00			1.00	1.00
Satd. Flow (perm)						1468		3282			5942	1468
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	0	0	289	0	1279	0	0	100	132
RTOR Reduction (vph)	0	0	0	0	0	97	0	0	0	0	0	40
Lane Group Flow (vph)	0	0	0	0	0	192	0	1279	0	0	100	92
Turn Type				Prot		Perm	Prot	NA			NA	Perm
Protected Phases				3			5	2			6	
Permitted Phases						8						6
Actuated Green, G (s)						17.0		53.9			63.0	63.0
Effective Green, g (s)						18.0		54.9			64.0	63.0
Actuated g/C Ratio						0.20		0.61			0.71	0.70
Clearance Time (s)						5.0		5.0			5.0	5.0
Vehicle Extension (s)						3.0		3.0			3.0	3.0
Lane Grp Cap (vph)						293		2002			4225	1027
v/s Ratio Prot								c0.39			0.02	
v/s Ratio Perm						c0.13						c0.06
v/c Ratio						0.66		0.64			0.02	0.09
Uniform Delay, d1						33.1		11.2			3.8	4.3
Progression Factor						1.00		0.79			1.00	1.00
Incremental Delay, d2						5.2		1.5			0.0	0.2
Delay (s)						38.4		10.4			3.8	4.5
Level of Service						D		B			A	A
Approach Delay (s)		0.0			38.4			10.4			4.2	
Approach LOS		A			D			B			A	

Intersection Summary			
HCM 2000 Control Delay	14.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	52.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	275	0	0	0	0	0	0	940	470	30	65	0
Future Volume (vph)	275	0	0	0	0	0	0	940	470	30	65	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0							4.0	5.0	4.0	4.0	
Lane Util. Factor	0.97							0.86	0.88	0.97	0.95	
Frt	1.00							1.00	0.85	1.00	1.00	
Flt Protected	0.95							1.00	1.00	0.95	1.00	
Satd. Flow (prot)	3183							5942	2584	3183	3282	
Flt Permitted	0.95							1.00	1.00	0.95	1.00	
Satd. Flow (perm)	3183							5942	2584	3183	3282	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	289	0	0	0	0	0	0	989	495	32	68	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	199	0	0	0
Lane Group Flow (vph)	289	0	0	0	0	0	0	989	296	32	68	0
Turn Type	Perm		Perm					NA	Perm	Prot	NA	
Protected Phases								2		1	6	
Permitted Phases	4		4						2			
Actuated Green, G (s)	17.0							53.9	53.9	4.1	63.0	
Effective Green, g (s)	18.0							54.9	53.9	5.1	64.0	
Actuated g/C Ratio	0.20							0.61	0.60	0.06	0.71	
Clearance Time (s)	5.0							5.0	5.0	5.0	5.0	
Vehicle Extension (s)	3.0							3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	636							3624	1547	180	2333	
v/s Ratio Prot								c0.17		c0.01	0.02	
v/s Ratio Perm	c0.09								0.11			
v/c Ratio	0.45							0.27	0.19	0.18	0.03	
Uniform Delay, d1	31.7							8.2	8.2	40.5	3.8	
Progression Factor	1.00							1.00	1.00	1.58	0.58	
Incremental Delay, d2	0.5							0.2	0.3	0.5	0.0	
Delay (s)	32.2							8.4	8.5	64.5	2.2	
Level of Service	C							A	A	E	A	
Approach Delay (s)		32.2			0.0			8.4			22.2	
Approach LOS		C			A			A			C	

Intersection Summary			
HCM 2000 Control Delay	12.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.34		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	19.0
Intersection Capacity Utilization	52.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	955	0	70	210	1335	0	0	655	15
Future Volume (vph)	0	0	0	955	0	70	210	1335	0	0	655	15
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0		4.0	4.0	4.0			4.0	
Lane Util. Factor				0.97		1.00	0.97	0.91			0.81	
Frt				1.00		0.85	1.00	1.00			1.00	
Flt Protected				0.95		1.00	0.95	1.00			1.00	
Satd. Flow (prot)				3183		1468	3183	4715			6972	
Flt Permitted				0.95		1.00	0.95	1.00			1.00	
Satd. Flow (perm)				3183		1468	3183	4715			6972	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	1005	0	74	221	1405	0	0	689	16
RTOR Reduction (vph)	0	0	0	0	0	49	0	0	0	0	5	0
Lane Group Flow (vph)	0	0	0	1005	0	25	221	1405	0	0	700	0
Turn Type				Perm		Perm	Prot	NA			NA	
Protected Phases							5	2			6	
Permitted Phases				8		8						
Actuated Green, G (s)				23.0		23.0	5.0	31.2			27.0	
Effective Green, g (s)				24.0		24.0	6.0	32.2			28.0	
Actuated g/C Ratio				0.34		0.34	0.09	0.46			0.40	
Clearance Time (s)				5.0		5.0	5.0	5.0			5.0	
Vehicle Extension (s)				3.0		3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)				1091		503	272	2168			2788	
v/s Ratio Prot							c0.07	c0.30			0.10	
v/s Ratio Perm				c0.32		0.02						
v/c Ratio				0.92		0.05	0.81	0.65			0.25	
Uniform Delay, d1				22.1		15.4	31.4	14.5			14.0	
Progression Factor				1.00		1.00	1.53	0.55			1.00	
Incremental Delay, d2				12.4		0.0	15.4	1.4			0.2	
Delay (s)				34.5		15.4	63.5	9.4			14.2	
Level of Service				C		B	E	A			B	
Approach Delay (s)		0.0			33.2			16.7			14.2	
Approach LOS		A			C			B			B	

Intersection Summary			
HCM 2000 Control Delay	21.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	59.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
16: Estrella Pkwy & EB Off Ramp/EB On Ramp

05/10/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	15	0	210	0	0	0	0	1530	1195	5	1605	0
Future Volume (vph)	15	0	210	0	0	0	0	1530	1195	5	1605	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0					4.0	4.0	4.0	4.0	
Lane Util. Factor	0.95	0.91	0.95					0.81	0.88	0.97	0.91	
Frt	1.00	0.85	0.85					1.00	0.85	1.00	1.00	
Flt Protected	0.95	1.00	1.00					1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1559	1339	1395					6995	2584	3183	4715	
Flt Permitted	0.95	1.00	1.00					1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1559	1339	1395					6995	2584	3183	4715	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	16	0	221	0	0	0	0	1611	1258	5	1689	0
RTOR Reduction (vph)	0	73	72	0	0	0	0	0	679	0	0	0
Lane Group Flow (vph)	14	40	38	0	0	0	0	1611	579	5	1689	0
Turn Type	Perm	NA	Perm					NA	Perm	Prot	NA	
Protected Phases		4						2		1	6	
Permitted Phases	4		4						2			
Actuated Green, G (s)	23.0	23.0	23.0					31.2	31.2	0.8	27.0	
Effective Green, g (s)	24.0	24.0	24.0					32.2	32.2	1.8	28.0	
Actuated g/C Ratio	0.34	0.34	0.34					0.46	0.46	0.03	0.40	
Clearance Time (s)	5.0	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	3.0	
Lane Grp Cap (vph)	534	459	478					3217	1188	81	1886	
v/s Ratio Prot								c0.23		c0.00	c0.36	
v/s Ratio Perm	0.01	0.03	0.03						0.22			
v/c Ratio	0.03	0.09	0.08					0.50	0.49	0.06	0.90	
Uniform Delay, d1	15.3	15.6	15.5					13.3	13.2	33.3	19.6	
Progression Factor	1.00	1.00	1.00					1.00	1.00	0.76	1.02	
Incremental Delay, d2	0.0	0.1	0.1					0.6	1.4	0.2	5.5	
Delay (s)	15.3	15.7	15.6					13.8	14.6	25.7	25.6	
Level of Service	B	B	B					B	B	C	C	
Approach Delay (s)		15.6			0.0			14.2			25.6	
Approach LOS		B			A			B			C	

Intersection Summary			
HCM 2000 Control Delay	18.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	59.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
17: Sarival Ave & WB Off Ramp

05/10/2018

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	0	1165	0	0	0	900
Future Volume (Veh/h)	0	1165	0	0	0	900
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	0	1226	0	0	0	947
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	474	0			0	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	474	0			0	
tC, single (s)	7.0	7.1			4.3	
tC, 2 stage (s)						
tF (s)	3.6	3.4			2.3	
p0 queue free %	100	0			100	
cM capacity (veh/h)	500	1059			1565	

Direction, Lane #	WB 1	WB 2	WB 3	NB 1	SB 1	SB 2
Volume Total	0	613	613	0	474	474
Volume Left	0	0	0	0	0	0
Volume Right	0	613	613	0	0	0
cSH	1700	1059	1059	1700	1700	1700
Volume to Capacity	0.00	0.58	0.58	0.00	0.28	0.28
Queue Length 95th (ft)	0	96	96	0	0	0
Control Delay (s)	0.0	13.0	13.0	0.0	0.0	0.0
Lane LOS	A	B	B			
Approach Delay (s)	13.0			0.0	0.0	
Approach LOS	B					

Intersection Summary			
Average Delay	7.3		
Intersection Capacity Utilization	44.1%	ICU Level of Service	A
Analysis Period (min)	15		