Traffic Study

Epps Mill Road @ Interstate 24
Rutherford County

The purpose of this study is to analyze the operation of the interchange at Epps Mill Road and Interstate 24 (I-24) in Rutherford County. The following sources were used to develop the relevant traffic data:

- 2-12 hour turning movement counts (February 2015)
  - I-24 Eastbound Ramps @ Epps Mill Road
  - I-24 Westbound Ramps @ Epps Mill Road
- Nearby cycle and ramp count stations
- A growth rate derived from the Nashville MPO travel demand model

Level of Service and Delay calculations are summarized in Tables 1 and 2. Supporting documentation is attached in the appendix.

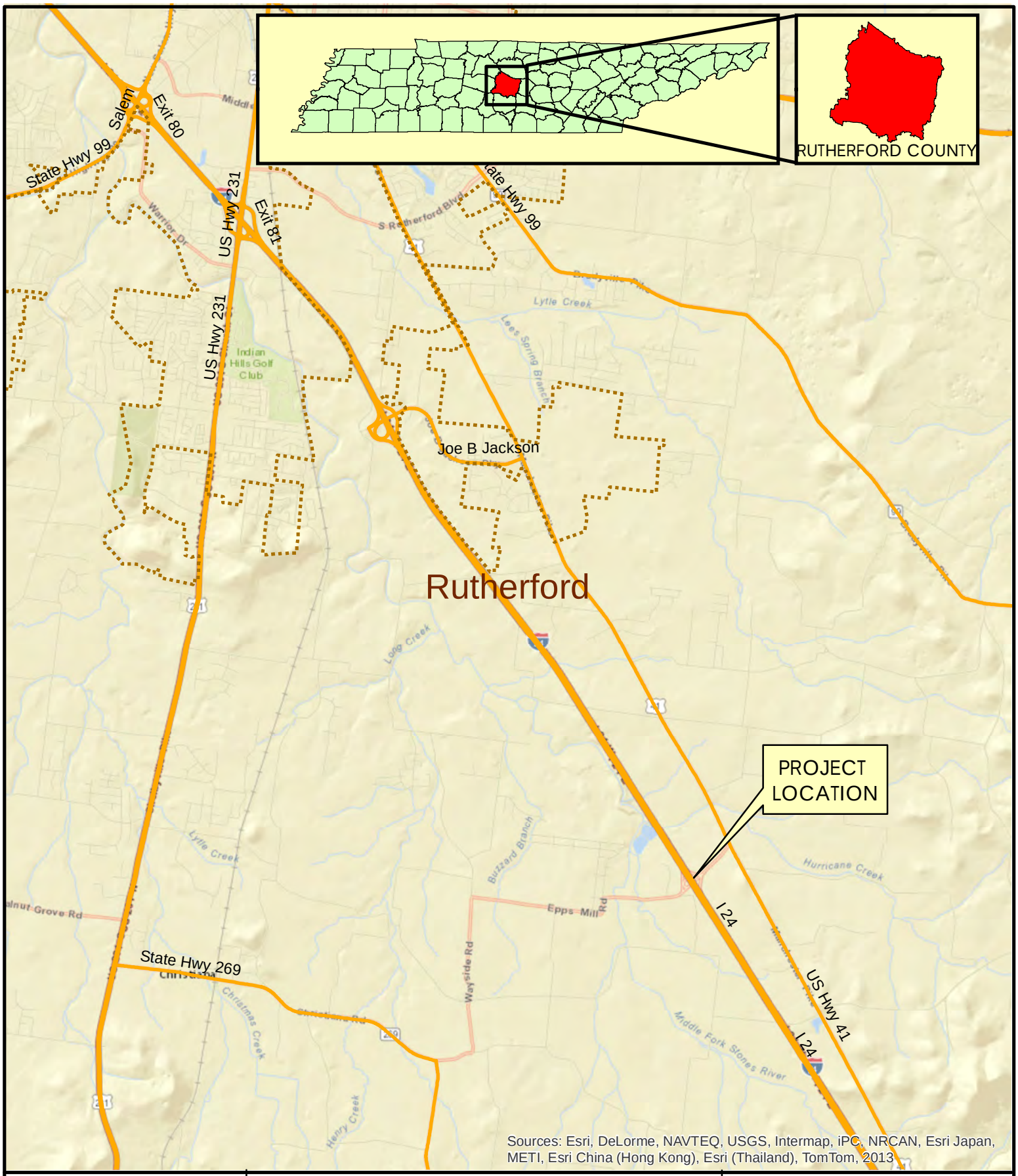
Table 1: Eastbound I-24 Level of Service & Delay

Location	Level of Service & Delay (s/veh)			
	2015		2035	
	AM	PM	AM	PM
I-24 Eastbound @ Epps Mill Rd.	**B** **14.7**	**B** **13.5**	**D** **26.4**	**C** **21.4**
I-24 Off Ramp - Eastbound Left Turn	C 17.6	C 16.3	E 35.3	D 31.1
I-24 Off Ramp - Eastbound Right Turn	A 9.4	B 11.5	A 9.9	B 14.2
Epps Mill Rd. - Northbound Left Turn	A 7.7	A 8	A 7.9	A 8.3
I-24 Eastbound Off Ramp	**C**	**C**	**D**	**E**
I-24 Eastbound On Ramp	**B**	**B**	**B**	**B**

Table 2: Westbound I-24 Level of Service & Delay

Location	Level of Service & Delay (s/veh)			
	2015		2035	
	AM	PM	AM	PM
I-24 Westbound @ Epps Mill Rd.	**B** **13.4**	**B** **12.9**	**C** **20**	**C** **17.4**
I-24 Off Ramp - Westbound Left Turn	D 27.9	C 18.3	F 64.8	D 30.7
I-24 Off Ramp - Westbound Right Turn	B 11.0	B 11.0	B 12.7	B 12.7
Epps Mill Rd. - Northbound Left Turn	A 8.4	A 8.2	A 9.1	A 8.6
I-24 Westbound Off Ramp	**C**	**C**	**D**	**D**
I-24 Westbound On Ramp	**B**	**B**	**C**	**C**

Appendix



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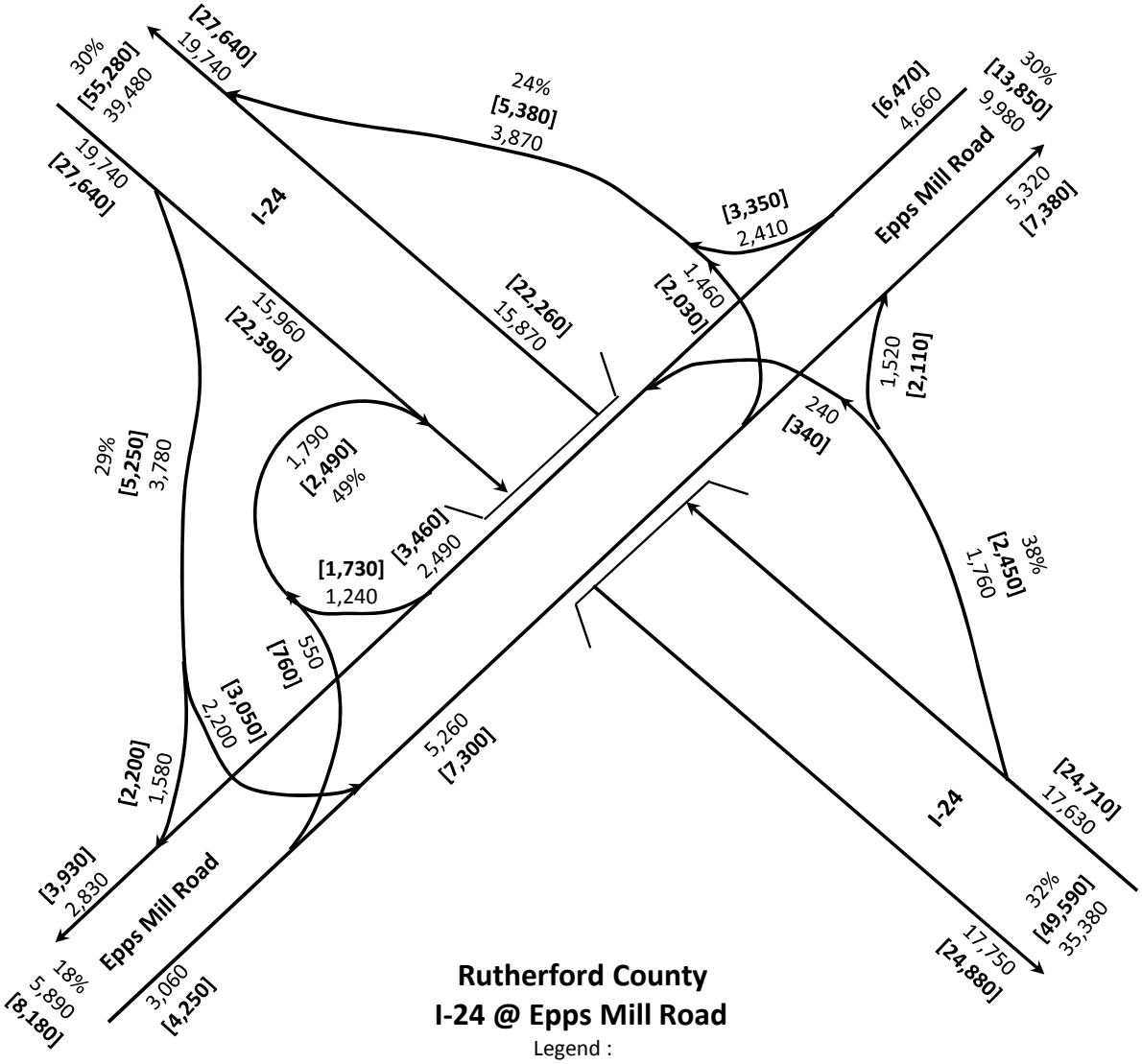
AREA MAP
INTERSTATE 24 @ EPPS MILL ROAD
RUTHERFORD COUNTY



Rutherford County

I-24 @ Epps Mill Road

Legend :

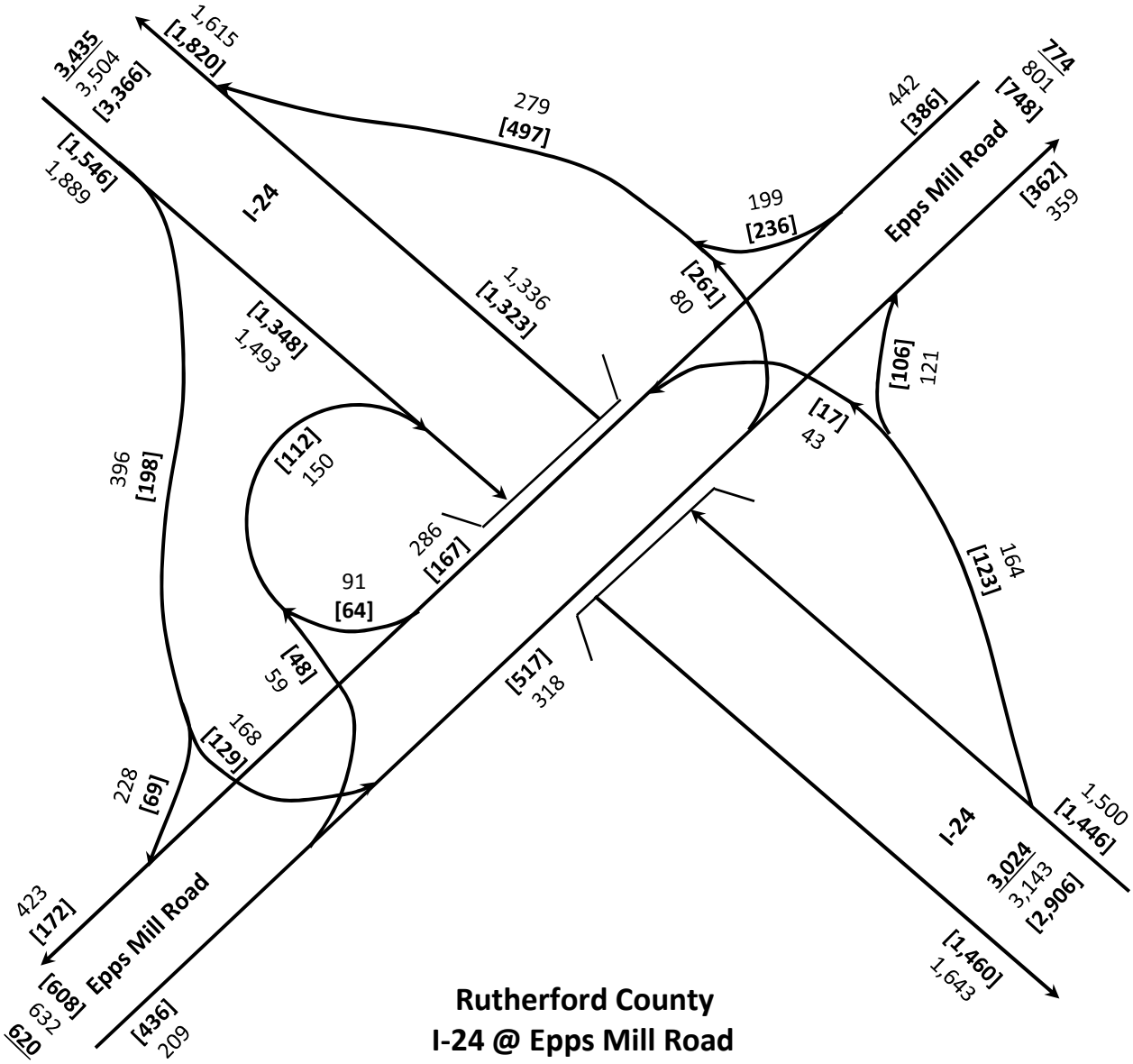
2015 AADT - 000

2035 AADT - [000]

AADT Truck % - 0%

Date : February 12, 2015

TA



Rutherford County

I-24 @ Epps Mill Road

Legend :

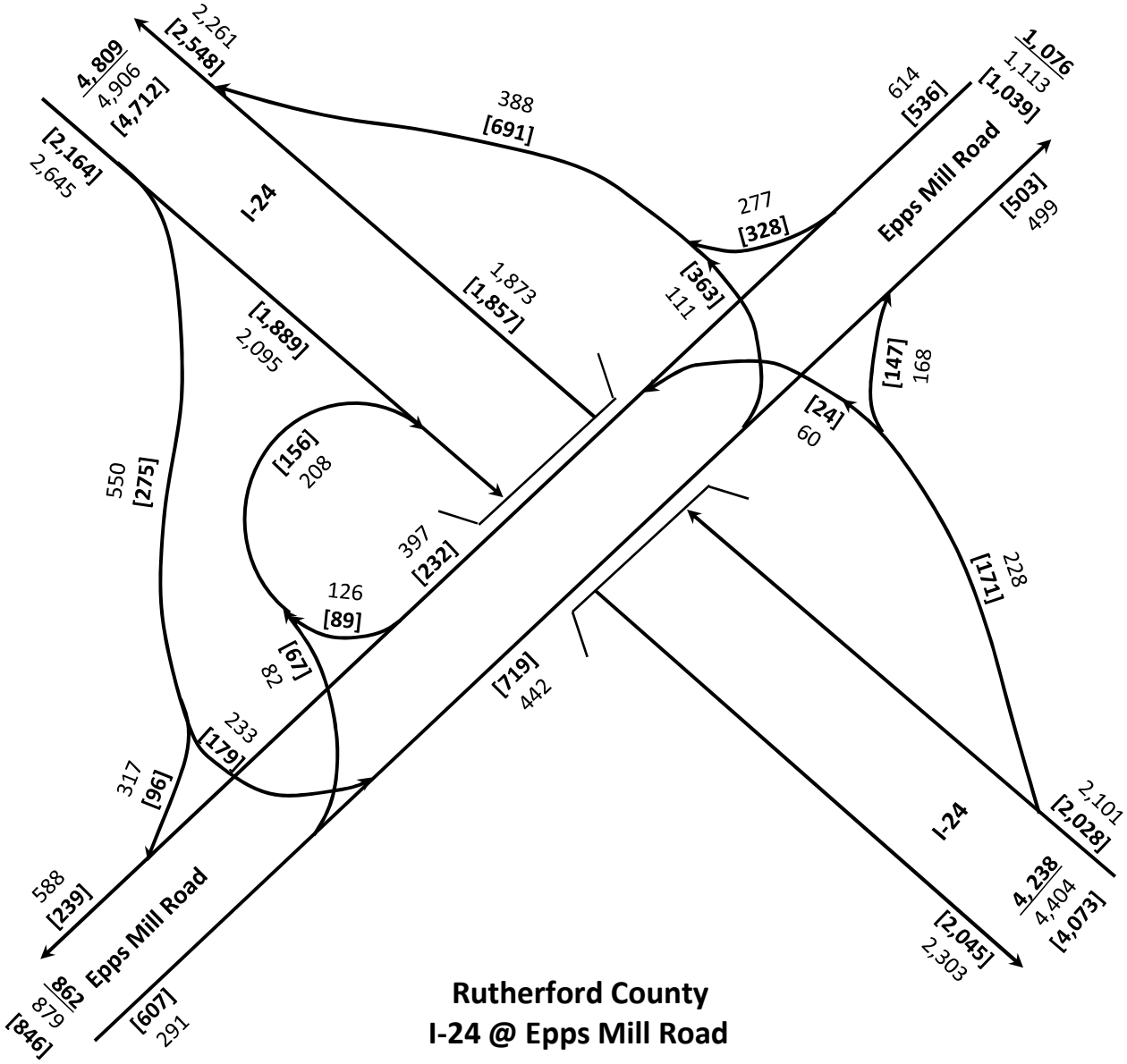
2015 DHV

PM

[AM]

Date : February 12, 2015

TA



Rutherford County
I-24 @ Epps Mill Road

2035 DHV
PM
[AM]

Date : February 12, 2015
TA

TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	GKD	Intersection	I-24 EB @ Epps Mill Rd
Agency/Co.	TDOT	Jurisdiction	Rutherford County
Date Performed	2/19/2015	Analysis Year	2015
Analysis Time Period	AM Peak Hour		

Project Description

East/West Street: *I-24 EB* | North/South Street: *Epps Mill Rd*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	48	388			103	64
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	48	388	0	0	103	64
Percent Heavy Vehicles	24	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			1
Lanes	0	1	0	0	1	1
Configuration	LT				T	R
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	129		69			
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	129	0	69	0	0	0
Percent Heavy Vehicles	29	0	29	0	0	0
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			1			0
Lanes	1	0	1	0	0	0
Configuration	L		R			

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LT					L		R
v (veh/h)	48					129		69
C (m) (veh/h)	1362					415		883
v/c	0.04					0.31		0.08
95% queue length	0.11					1.34		0.25
Control Delay (s/veh)	7.7					17.6		9.4
LOS	A					C		A
Approach Delay (s/veh)	--	--				14.7		
Approach LOS	--	--				B		

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*GKD*	Intersection	*I-24 EB @ Epps Mill Rd*
Agency/Co.	*TDOT*	Jurisdiction	*Rutherford County*
Date Performed	*2/19/2015*	Analysis Year	*2015*
Analysis Time Period	*PM Peak Hour*		

Project Description

East/West Street: *I-24 EB* | North/South Street: *Epps Mill Rd*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*59*	*150*			*195*	*91*
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*59*	*150*	*0*	*0*	*195*	*91*
Percent Heavy Vehicles	*24*	--	--	*0*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*1*
Lanes	*0*	*1*	*0*	*0*	*1*	*1*
Configuration	*LT*				*T*	*R*
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*168*		*228*			
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*168*	*0*	*228*	*0*	*0*	*0*
Percent Heavy Vehicles	*29*	*0*	*29*	*0*	*0*	*0*
Percent Grade (%)	*0*			*0*		
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*1*			*0*
Lanes	*1*	*0*	*1*	*0*	*0*	*0*
Configuration	*L*		*R*			

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*LT*					*L*		*R*
v (veh/h)	*59*					*168*		*228*
C (m) (veh/h)	*1257*					*487*		*782*
v/c	*0.05*					*0.34*		*0.29*
95% queue length	*0.15*					*1.56*		*1.23*
Control Delay (s/veh)	*8.0*					*16.3*		*11.5*
LOS	*A*					*C*		*B*
Approach Delay (s/veh)	--	--				*13.5*		
Approach LOS	--	--				*B*		

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*GKD*	Intersection	*I-24 EB @ Epps Mill Rd*
Agency/Co.	*TDOT*	Jurisdiction	*Rutherford County*
Date Performed	*2/19/2015*	Analysis Year	*2035*
Analysis Time Period	*AM Peak Hour*		

Project Description

East/West Street: *I-24 EB* | North/South Street: *Epps Mill Rd*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*67*	*540*			*143*	*89*
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*67*	*540*	*0*	*0*	*143*	*89*
Percent Heavy Vehicles	*24*	--	--	*0*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*1*
Lanes	*0*	*1*	*0*	*0*	*1*	*1*
Configuration	*LT*				*T*	*R*
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*179*		*96*			
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*179*	*0*	*96*	*0*	*0*	*0*
Percent Heavy Vehicles	*29*	*0*	*29*	*0*	*0*	*0*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*1*			*0*
Lanes	*1*	*0*	*1*	*0*	*0*	*0*
Configuration	*L*		*R*			

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*LT*					*L*		*R*
v (veh/h)	*67*					*179*		*96*
C (m) (veh/h)	*1315*					*296*		*838*
v/c	*0.05*					*0.60*		*0.11*
95% queue length	*0.16*					*4.28*		*0.39*
Control Delay (s/veh)	*7.9*					*35.3*		*9.9*
LOS	*A*					*E*		*A*
Approach Delay (s/veh)	--	--				*26.4*		
Approach LOS	--	--				*D*		

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*GKD*	Intersection	*I-24 EB @ Epps Mill Rd*
Agency/Co.	*TDOT*	Jurisdiction	*Rutherford County*
Date Performed	*2/19/2015*	Analysis Year	*2035*
Analysis Time Period	*PM Peak Hour*		

Project Description

East/West Street: *I-24 EB* | North/South Street: *Epps Mill Rd*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*82*	*209*			*271*	*126*
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*82*	*209*	*0*	*0*	*271*	*126*
Percent Heavy Vehicles	*24*	--	--	*0*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*1*
Lanes	*0*	*1*	*0*	*0*	*1*	*1*
Configuration	*LT*				*T*	*R*
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*233*		*317*			
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*233*	*0*	*317*	*0*	*0*	*0*
Percent Heavy Vehicles	*29*	*0*	*29*	*0*	*0*	*0*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*1*			*0*
Lanes	*1*	*0*	*1*	*0*	*0*	*0*
Configuration	*L*		*R*			

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*LT*					*L*		*R*
v (veh/h)	*82*					*233*		*317*
C (m) (veh/h)	*1175*					*369*		*707*
v/c	*0.07*					*0.63*		*0.45*
95% queue length	*0.22*					*4.80*		*2.41*
Control Delay (s/veh)	*8.3*					*31.1*		*14.2*
LOS	*A*					*D*		*B*
Approach Delay (s/veh)	--	--				*21.4*		
Approach LOS	--	--				*C*		

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	GKD	Freeway/Dir of Travel	I-24 EB
Agency or Company	TDOT	Junction	I-24 EB @ Epps Mill Rd
Date Performed	2/19/2015	Jurisdiction	Rutherford County
Analysis Time Period	AM Peak	Analysis Year	2015

Project Description

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	280
Freeway Volume, V_F	1546
Ramp Volume, V_R	198
Freeway Free-Flow Speed, S_{FF}	75.0
Ramp Free-Flow Speed, S_{FR}	40.0

Downstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{down} = 850 ft

V_D = 112 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	1546	0.94	Rolling	30	0	0.690	1.00	2385
Ramp	198	0.94	Rolling	29	0	0.697	1.00	302
UpStream								
DownStream	112	0.94	Rolling	49	0	0.576	1.00	207

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} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2385 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{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	2385	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	2083	Exhibit 13-8	4800	No
V_R	302	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2385	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 = 22.2 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.390 (Exhibit 13-12)

S_R= 62.1 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 62.1 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	GKD	Freeway/Dir of Travel	I-24 EB
Agency or Company	TDOT	Junction	I-24 EB @ Epps Mill Rd
Date Performed	2/19/2015	Jurisdiction	Rutherford County
Analysis Time Period	PM Peak	Analysis Year	2015

Project Description

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	280
Freeway Volume, V_F	1889
Ramp Volume, V_R	396
Freeway Free-Flow Speed, S_{FF}	75.0
Ramp Free-Flow Speed, S_{FR}	40.0

Downstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{down} = 850 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	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1889	0.94	Rolling	30	0	0.690	1.00	2914
Ramp	396	0.94	Rolling	29	0	0.697	1.00	605
UpStream								
DownStream	150	0.94	Rolling	49	0	0.576	1.00	277

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} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2914 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{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	2914	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	2309	Exhibit 13-8	4800	No
V_R	605	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2914	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 = 26.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.417 (Exhibit 13-12)

S_R= 61.2 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 61.2 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	GKD	Freeway/Dir of Travel	I-24 EB
Agency or Company	TDOT	Junction	I-24 EB @ Epps Mill Rd
Date Performed	2/19/2015	Jurisdiction	Rutherford County
Analysis Time Period	AM Peak	Analysis Year	2035

Project Description

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	280
Freeway Volume, V_F	2164
Ramp Volume, V_R	275
Freeway Free-Flow Speed, S_{FF}	75.0
Ramp Free-Flow Speed, S_{FR}	40.0

Downstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{down} = 850 ft

V_D = 156 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	2164	0.94	Rolling	30	0	0.690	1.00	3338
Ramp	275	0.94	Rolling	29	0	0.697	1.00	420
UpStream								
DownStream	156	0.94	Rolling	49	0	0.576	1.00	288

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} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3338 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{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	3338	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	2918	Exhibit 13-8	4800	No
V_R	420	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3338	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 = 30.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.401 (Exhibit 13-12)

S_R= 61.8 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 61.8 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	GKD	Freeway/Dir of Travel	I-24 EB
Agency or Company	TDOT	Junction	I-24 EB @ Epps Mill Rd
Date Performed	2/19/2015	Jurisdiction	Rutherford County
Analysis Time Period	PM Peak	Analysis Year	2035

Project Description

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	280
Freeway Volume, V_F	2645
Ramp Volume, V_R	550
Freeway Free-Flow Speed, S_{FF}	75.0
Ramp Free-Flow Speed, S_{FR}	40.0

Downstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{down} = 850 ft

V_D = 208 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	2645	0.94	Rolling	30	0	0.690	1.00	4080
Ramp	550	0.94	Rolling	29	0	0.697	1.00	840
UpStream								
DownStream	208	0.94	Rolling	49	0	0.576	1.00	384

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} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4080 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{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	4080	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	3240	Exhibit 13-8	4800	No
V_R	840	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4080	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 = 36.8 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.439 (Exhibit 13-12)

S_R= 60.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 60.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	GKD	Freeway/Dir of Travel	I-24 EB
Agency or Company	TDOT	Junction	I-24 EB @ Epps Mill Rd
Date Performed	2/23/2015	Jurisdiction	Rutherford County
Analysis Time Period	AM Peak	Analysis Year	2015

Project Description

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☐ No ☑ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = 850 ft	Acceleration Lane Length, L_A: 950	L_{down} = ft
V_u = 198 veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 1348	
	Ramp Volume, V_R: 112	
	Freeway Free-Flow Speed, S_{FF}: 75.0	
	Ramp Free-Flow Speed, S_{FR}: 35.0	

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	1348	0.94	Rolling	0	0	1.000	1.00	1434
Ramp	112	0.94	Rolling	0	0	1.000	1.00	119
UpStream	198	0.94	Rolling	0	0	1.000	1.00	211
DownStream								

Merge Areas

Estimation of v_{12}

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

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

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1434 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{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}	1553	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1553	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 = 11.6 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.273 (Exibit 13-11)

S_R= 66.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 66.0 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)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	GKD	Freeway/Dir of Travel	I-24 EB
Agency or Company	TDOT	Junction	I-24 EB @ Epps Mill Rd
Date Performed	2/23/2015	Jurisdiction	Rutherford County
Analysis Time Period	PM Peak	Analysis Year	2015

Project Description

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☐ No ☑ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = 850 ft	Acceleration Lane Length, L_A: 950	L_{down} = ft
V_u = 396 veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 1493	
	Ramp Volume, V_R: 150	
	Freeway Free-Flow Speed, S_{FF}: 75.0	
	Ramp Free-Flow Speed, S_{FR}: 35.0	

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	1493	0.94	Rolling	0	0	1.000	1.00	1588
Ramp	150	0.94	Rolling	0	0	1.000	1.00	160
UpStream	396	0.94	Rolling	0	0	1.000	1.00	421
DownStream								

Merge Areas

Estimation of v_{12}

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

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

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1588 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{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}	1748	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1748	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 = 13.1 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.277 (Exibit 13-11)

S_R= 65.9 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 65.9 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)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	GKD	Freeway/Dir of Travel	I-24 EB
Agency or Company	TDOT	Junction	I-24 EB @ Epps Mill Rd
Date Performed	2/23/2015	Jurisdiction	Rutherford County
Analysis Time Period	AM Peak	Analysis Year	2035

Project Description

Inputs

Upstream Adj Ramp

☑ Yes ☐ On

☐ No ☑ Off

L_{up} = 850 ft

V_u = 275 veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	950
Deceleration Lane Length L_D	
Freeway Volume, V_F	1889
Ramp Volume, V_R	156
Freeway Free-Flow Speed, S_{FF}	75.0
Ramp Free-Flow Speed, S_{FR}	35.0

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	1889	0.94	Rolling	0	0	1.000	1.00	2010
Ramp	156	0.94	Rolling	0	0	1.000	1.00	166
UpStream	275	0.94	Rolling	0	0	1.000	1.00	293
DownStream								

Merge Areas

Estimation of v_{12}

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

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

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2010 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{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}	2176	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2176	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 = 16.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.289 (Exibit 13-11)

S_R= 65.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 65.5 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)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	GKD	Freeway/Dir of Travel	I-24 EB
Agency or Company	TDOT	Junction	I-24 EB @ Epps Mill Rd
Date Performed	2/23/2015	Jurisdiction	Rutherford County
Analysis Time Period	PM Peak	Analysis Year	2035

Project Description

Inputs

Upstream Adj Ramp

☑ Yes ☐ On

☐ No ☑ Off

L_{up} = 850 ft

V_u = 550 veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	950
Deceleration Lane Length L_D	
Freeway Volume, V_F	2095
Ramp Volume, V_R	208
Freeway Free-Flow Speed, S_{FF}	75.0
Ramp Free-Flow Speed, S_{FR}	35.0

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	2095	0.94	Rolling	0	0	1.000	1.00	2229
Ramp	208	0.94	Rolling	0	0	1.000	1.00	221
UpStream	550	0.94	Rolling	0	0	1.000	1.00	585
DownStream								

Merge Areas

Estimation of v_{12}

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

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

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2229 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{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}	2450	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2450	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 = 18.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.300 (Exibit 13-11)

S_R= 65.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 65.1 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)

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	GKD	Intersection	I-24 WB @ Epps Mill Rd
Agency/Co.	TDOT	Jurisdiction	Rutherford County
Date Performed	2/19/2015	Analysis Year	2015
Analysis Time Period	AM Peak Hour		

Project Description

East/West Street: *I-24 WB Ramps* North/South Street: *Epps Mill Rd*

Intersection Orientation: *North-South* Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	261	256			150	236
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	261	256	0	0	150	236
Percent Heavy Vehicles	24	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			1
Lanes	0	1	0	0	1	1
Configuration	LT				T	R
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				17		106
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	0	0	0	17	0	106
Percent Heavy Vehicles	0	0	0	38	0	38
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			1			1
Lanes	0	0	0	1	0	1
Configuration				L		R

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LT		L		R			
v (veh/h)	261		17		106			
C (m) (veh/h)	1307		174		703			
v/c	0.20		0.10		0.15			
95% queue length	0.75		0.32		0.53			
Control Delay (s/veh)	8.4		27.9		11.0			
LOS	A		D		B			
Approach Delay (s/veh)	--	--	13.4					
Approach LOS	--	--	B					

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*GKD*	Intersection	*I-24 WB @ Epps Mill Rd*
Agency/Co.	*TDOT*	Jurisdiction	*Rutherford County*
Date Performed	*2/19/2015*	Analysis Year	*2015*
Analysis Time Period	*PM Peak Hour*		

Project Description

East/West Street: *I-24 WB Ramps* | North/South Street: *Epps Mill Rd*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*80*	*238*			*243*	*199*
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*80*	*238*	*0*	*0*	*243*	*199*
Percent Heavy Vehicles	*24*	--	--	*0*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*1*
Lanes	*0*	*1*	*0*	*0*	*1*	*1*
Configuration	*LT*				*T*	*R*
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*43*		*121*
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*0*	*0*	*0*	*43*	*0*	*121*
Percent Heavy Vehicles	*0*	*0*	*0*	*38*	*0*	*38*
Percent Grade (%)	*0*			*0*		
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*1*			*1*
Lanes	*0*	*0*	*0*	*1*	*0*	*1*
Configuration				*L*		*R*

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*LT*		*L*		*R*			
v (veh/h)	*80*		*43*		*121*			
C (m) (veh/h)	*1205*		*314*		*720*			
v/c	*0.07*		*0.14*		*0.17*			
95% queue length	*0.21*		*0.47*		*0.60*			
Control Delay (s/veh)	*8.2*		*18.3*		*11.0*			
LOS	*A*		*C*		*B*			
Approach Delay (s/veh)	--	--	*12.9*					
Approach LOS	--	--	*B*					

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	GKD	Intersection	I-24 WB @ Epps Mill Rd
Agency/Co.	TDOT	Jurisdiction	Rutherford County
Date Performed	2/19/2015	Analysis Year	2035
Analysis Time Period	AM Peak Hour		

Project Description

East/West Street: *I-24 WB Ramps* | North/South Street: *Epps Mill Rd*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	363	356			208	328
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	363	356	0	0	208	328
Percent Heavy Vehicles	24	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			1
Lanes	0	1	0	0	1	1
Configuration	LT				T	R
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				24		147
Peak-Hour Factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Hourly Flow Rate, HFR (veh/h)	0	0	0	24	0	147
Percent Heavy Vehicles	0	0	0	38	0	38
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			1			1
Lanes	0	0	0	1	0	1
Configuration				L		R

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LT		L		R			
v (veh/h)	363		24		147			
C (m) (veh/h)	1242		84		614			
v/c	0.29		0.29		0.24			
95% queue length	1.24		1.16		0.94			
Control Delay (s/veh)	9.1		64.8		12.7			
LOS	A		F		B			
Approach Delay (s/veh)	--	--	20.0					
Approach LOS	--	--	C					

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*GKD*	Intersection	*I-24 WB @ Epps Mill Rd*
Agency/Co.	*TDOT*	Jurisdiction	*Rutherford County*
Date Performed	*2/19/2015*	Analysis Year	*2035*
Analysis Time Period	*PM Peak Hour*		

Project Description

East/West Street: *I-24 WB Ramps* | North/South Street: *Epps Mill Rd*

Intersection Orientation: *North-South* | Study Period (hrs): *1.00*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*111*	*331*			*337*	*277*
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*111*	*331*	*0*	*0*	*337*	*277*
Percent Heavy Vehicles	*24*	--	--	*0*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*1*
Lanes	*0*	*1*	*0*	*0*	*1*	*1*
Configuration	*LT*				*T*	*R*
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*60*		*168*
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*0*	*0*	*0*	*60*	*0*	*168*
Percent Heavy Vehicles	*0*	*0*	*0*	*38*	*0*	*38*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*1*			*1*
Lanes	*0*	*0*	*0*	*1*	*0*	*1*
Configuration				*L*		*R*

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*LT*		*L*		*R*			
v (veh/h)	*111*		*60*		*168*			
C (m) (veh/h)	*1109*		*200*		*635*			
v/c	*0.10*		*0.30*		*0.26*			
95% queue length	*0.33*		*1.26*		*1.07*			
Control Delay (s/veh)	*8.6*		*30.7*		*12.7*			
LOS	*A*		*D*		*B*			
Approach Delay (s/veh)	--	--	*17.4*					
Approach LOS	--	--	*C*					

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	GKD	Freeway/Dir of Travel	I-24 WB
Agency or Company	TDOT	Junction	I-24 WB @ Epps Mill Rd
Date Performed	2/19/2015	Jurisdiction	Rutherford County
Analysis Time Period	AM Peak Hour	Analysis Year	2015

Project Description

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	200
Freeway Volume, V_F	1446
Ramp Volume, V_R	123
Freeway Free-Flow Speed, S_{FF}	75.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{down} = 1800 ft

V_D = 497 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	1446	0.94	Rolling	30	0	0.690	1.00	2231
Ramp	123	0.94	Rolling	38	0	0.637	1.00	205
UpStream								
DownStream	497	0.94	Rolling	24	0	0.735	1.00	719

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} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2231 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{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	2231	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	2026	Exhibit 13-8	4800	No
V_R	205	Exhibit 13-10	2000	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2231	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 = 21.6 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.446 (Exhibit 13-12)

S_R= 60.3 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 60.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	GKD	Freeway/Dir of Travel	I-24 WB
Agency or Company	TDOT	Junction	I-24 WB @ Epps Mill Rd
Date Performed	2/19/2015	Jurisdiction	Rutherford County
Analysis Time Period	PM Peak Hour	Analysis Year	2015

Project Description

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	200
Freeway Volume, V_F	1500
Ramp Volume, V_R	164
Freeway Free-Flow Speed, S_{FF}	75.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{down} = 1800 ft

V_D = 279 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	1500	0.94	Rolling	30	0	0.690	1.00	2314
Ramp	164	0.94	Rolling	38	0	0.637	1.00	274
UpStream								
DownStream	279	0.94	Rolling	24	0	0.735	1.00	404

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} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2314 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{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	2314	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	2040	Exhibit 13-8	4800	No
V_R	274	Exhibit 13-10	2000	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2314	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 = 22.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.453 (Exhibit 13-12)

S_R= 60.1 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 60.1 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	GKD	Freeway/Dir of Travel	I-24 WB
Agency or Company	TDOT	Junction	I-24 WB @ Epps Mill Rd
Date Performed	2/19/2015	Jurisdiction	Rutherford County
Analysis Time Period	AM Peak Hour	Analysis Year	2035

Project Description

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	200
Freeway Volume, V_F	2028
Ramp Volume, V_R	171
Freeway Free-Flow Speed, S_{FF}	75.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{down} = 1800 ft

V_D = 691 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	2028	0.94	Rolling	30	0	0.690	1.00	3128
Ramp	171	0.94	Rolling	38	0	0.637	1.00	286
UpStream								
DownStream	691	0.94	Rolling	24	0	0.735	1.00	1000

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} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3128 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{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	3128	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	2842	Exhibit 13-8	4800	No
V_R	286	Exhibit 13-10	2000	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3128	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 = 29.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.454 (Exhibit 13-12)

S_R= 60.0 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 60.0 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	GKD	Freeway/Dir of Travel	I-24 WB
Agency or Company	TDOT	Junction	I-24 WB @ Epps Mill Rd
Date Performed	2/19/2015	Jurisdiction	Rutherford County
Analysis Time Period	PM Peak Hour	Analysis Year	2035

Project Description

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	200
Freeway Volume, V_F	2101
Ramp Volume, V_R	228
Freeway Free-Flow Speed, S_{FF}	75.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{down} = 1800 ft

V_D = 388 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	2101	0.94	Rolling	30	0	0.690	1.00	3241
Ramp	228	0.94	Rolling	38	0	0.637	1.00	381
UpStream								
DownStream	388	0.94	Rolling	24	0	0.735	1.00	561

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} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3241 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{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	3241	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	2860	Exhibit 13-8	4800	No
V_R	381	Exhibit 13-10	2000	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3241	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 = 30.3 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.462 (Exhibit 13-12)

S_R= 59.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 59.7 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	GKD	Freeway/Dir of Travel	I-24 WB
Agency or Company	TDOT	Junction	I-24 WB @ Epps Mill Rd
Date Performed	2/19/2015	Jurisdiction	Rutherford County
Analysis Time Period	AM Peak Hour	Analysis Year	2015

Project Description

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☐ No ☑ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = 1800 ft	Acceleration Lane Length, L_A: 1190	L_{down} = ft
V_u = 123 veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 1323	
	Ramp Volume, V_R: 497	
	Freeway Free-Flow Speed, S_{FF}: 75.0	
	Ramp Free-Flow Speed, S_{FR}: 40.0	

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	1323	0.94	Rolling	30	0	0.690	1.00	2041
Ramp	497	0.94	Rolling	24	0	0.735	1.00	719
UpStream	123	0.94	Rolling	38	0	0.637	1.00	205
DownStream								

Merge Areas

Estimation of v_{12}

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

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

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2041 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{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}	2760	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2760	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 = 19.2 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.287 (Exibit 13-11)

S_R= 65.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 65.5 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)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	GKD	Freeway/Dir of Travel	I-24 WB
Agency or Company	TDOT	Junction	I-24 WB @ Epps Mill Rd
Date Performed	2/19/2015	Jurisdiction	Rutherford County
Analysis Time Period	PM Peak Hour	Analysis Year	2015

Project Description

Inputs

Upstream Adj Ramp

☑ Yes ☐ On

☐ No ☑ Off

L_{up} = 1800 ft

V_u = 164 veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	1190
Deceleration Lane Length L_D	
Freeway Volume, V_F	1336
Ramp Volume, V_R	279
Freeway Free-Flow Speed, S_{FF}	75.0
Ramp Free-Flow Speed, S_{FR}	40.0

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	1336	0.94	Rolling	30	0	0.690	1.00	2061
Ramp	279	0.94	Rolling	24	0	0.735	1.00	404
UpStream	164	0.94	Rolling	38	0	0.637	1.00	274
DownStream								

Merge Areas

Estimation of v_{12}

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

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

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2061 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{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}	2465	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2465	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 = 17.1 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.272 (Exibit 13-11)

S_R= 66.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 66.0 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)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	GKD	Freeway/Dir of Travel	I-24 WB
Agency or Company	TDOT	Junction	I-24 WB @ Epps Mill Rd
Date Performed	2/19/2015	Jurisdiction	Rutherford County
Analysis Time Period	AM Peak Hour	Analysis Year	2035

Project Description

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☐ No ☑ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = 1800 ft	Acceleration Lane Length, L_A: 1190	L_{down} = ft
V_u = 171 veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 1857	
	Ramp Volume, V_R: 691	
	Freeway Free-Flow Speed, S_{FF}: 75.0	
	Ramp Free-Flow Speed, S_{FR}: 40.0	

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	1857	0.94	Rolling	30	0	0.690	1.00	2865
Ramp	691	0.94	Rolling	24	0	0.735	1.00	1000
UpStream	171	0.94	Rolling	38	0	0.637	1.00	286
DownStream								

Merge Areas

Estimation of v_{12}

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

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

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2865 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{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}	3865	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3865	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 = 27.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.412 (Exibit 13-11)

S_R= 61.4 mph (Exhibit 13-11)

S_0= N/A 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)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	GKD	Freeway/Dir of Travel	I-24 WB
Agency or Company	TDOT	Junction	I-24 WB @ Epps Mill Rd
Date Performed	2/19/2015	Jurisdiction	Rutherford County
Analysis Time Period	PM Peak Hour	Analysis Year	2035

Project Description

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☐ No ☑ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = 1800 ft	Acceleration Lane Length, L_A: 1190	L_{down} = ft
V_u = 228 veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 1873	
	Ramp Volume, V_R: 388	
	Freeway Free-Flow Speed, S_{FF}: 75.0	
	Ramp Free-Flow Speed, S_{FR}: 40.0	

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	1873	0.94	Rolling	30	0	0.690	1.00	2889
Ramp	388	0.94	Rolling	24	0	0.735	1.00	561
UpStream	228	0.94	Rolling	38	0	0.637	1.00	381
DownStream								

Merge Areas

Estimation of v_{12}

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

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

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2889 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{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}	3450	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3450	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 = 24.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.349 (Exibit 13-11)

S_R= 63.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 63.5 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)

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