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Dowling Associates, Inc.

Memorandum

Date: February 16, 2009

To: Paul Hom, El Dorado County DOT

cc: Christine Zdunkiewicz, Caltrans D-3

From: Jim Damkowitch & Chirag Safi

Reference #: P07033

Subject: US 50 EB Weaving Analysis between El Dorado Hills and Silva Valley
Ramp Metering Analysis for US 50 EB On-Ramp at Latrobe Road

Weaving Analysis

Dowling Associates, Inc. has completed evaluation of a weave section along US 50 EB from El Dorado Hills to Silva Valley. Weaving analysis for 2010 opening year and 2030 design year peak hour volumes was performed using the methodology described in *Highway Capacity Manual* updated in 2000, Transportation Research Board, 3rd Edition, Washington DC.

The lane configuration on mainline US 50 EB was assumed to be consisting of five lanes (an HOV, 2 mixed flow, a truck climbing and an auxiliary lane) for both analysis years. Since vehicles utilizing HOV lane would not perform weaving maneuvers, total mainline volumes were reduced by 11.5% to control for HOV traffic.

Highway Capacity Manual (HCM) Methodology

Table 1 shows the results of weaving analysis. The study weave section is estimated to operate at highly acceptable LOS B or better for the opening year (2010) peak hour traffic volumes. In the design year (2030), the weave section would function at acceptable LOS D or better during both peak hours. With the installation of ramp metering and assuming discharge rate of 900 vehicles per hour (vph), the study weave section is anticipated to operate at the same LOS but with better density during the PM peak hours.

HCS worksheets for weaving analysis are provided in **Attachment A**.

Table 1. Weaving Analysis Results

Analysis Year	Control	HCM Method [1]			
		AM Peak		PM Peak	
		Density pc/mi/ln	LOS	Density pc/mi/ln	LOS
2010	Unmetered	10.43	B	18.56	B
2030	Unmetered	20.11	C	34.67	D
2030	Metered [2]	19.6	B	30.59	D

[1] - Based on HCM 2000 Type 'B' Weave Section

[2] - Assuming discharge rate of 900 vph

Highway Design Manual (HDM) Methodology

HDM is insensitive to the ramp design features such as dual off-ramp lanes. It characterizes weave sections as either balanced or unbalanced based on number of lanes upstream and downstream of an off-ramp. Given that this analysis is being applied to a dual off-ramp design, the HCM methodology is considered more appropriate/representative approach for determining operational performance.

Ramp Metering Analysis

Based on the methodology described in Caltrans publication Highway Design Manual (HDM), Sixth Edition, ramp metering analysis was performed for US 50 EB on-ramp at Latrobe for 2030 peak hour conditions. Based on the preliminary concept plan prepared by Quincy Engineering[1], Inc., the on-ramp is estimated to provide storage capacity of 1,000 feet per lane. The EB on-ramp is proposed to accommodate two mixed flow and an HOV lane for US 50 EB on-ramp at Latrobe. The preliminary ramp design is shown in **Figure 1**.

Discharge rate for ramp meters varies from 240 to 900 vph per lane. Since the study ramp consists of two lanes, assumptions must be made about lane utilization. To provide a range, three different scenarios with varying discharge capacities were evaluated. Scenario 'A' studies the most conservative situation where the discharge rate for two-lane on-ramp was assumed to be 900 vph. Scenario 'B' uses both upper and lower limits of discharge, i.e. discharge rate for one lane is assumed to be 900 vph and the second is 240 vph (total of 1140 vph). Scenario 'C' is based on the assumption that both on-ramp lanes would operate at their maximum capacity i.e. 900 vph.

Ramp meter analysis procedure and results for 2030 forecasted peak hour traffic volumes are presented in **Table 2**. As recommended in HDM, the peak 15-min and 5-min arrival and departure rates were computed and any queue spillback was estimated. Overall, the PM peak hour is more critical than the AM peak hour. Major findings are discussed below:

- **Scenario 'A'**: The arrival rates for peak 15-min traffic volumes during both peak hours were found to be higher than the corresponding discharge rates, which would result in queues. The queue length for peak 15-min volumes during the PM peak hour is estimated to be 2,173 ft which exceeds the storage capacity of 2,000 ft. Therefore, net

[1] Not based on final GAD.

difference of 173 ft i.e.7 vehicles would spillback from the ramp. Hence, this scenario is likely to negatively impact operation of the upstream intersection.

- **Scenario 'B':** The assumed discharge rate and calculated arrival rate would not result in queues during the AM peak hour. The estimated queue length during the PM peak hour was 673 ft which could be easily accommodated by the proposed storage length of ramp. In this case, ramp metering operation will not impede that of upstream intersection.

- **Scenario 'C':** The assumed discharge rate and calculated arrival rate will not result in any queues during both peak hours. Discharge rate in this case is higher than the arrival rate. The higher discharge rate assumed under this scenario will possibly create greater turbulence on the mainline.

- In case of queues spillback, left-turn movement towards the study on-ramp of the upstream intersection will have major impact than the right-turn movement.

- Downstream merge and mainline sections affect/limit the discharge capacities of the ramp. This analysis assumed that the freeway would have sufficient capacity to accommodate ramp meter discharge of up to 1,800 vph.

Conclusion

Based on the HCS weaving analysis and with the unmetered on-ramp, US 50 EB section from El Dorado Hills to Silva Valley section is projected to operate at acceptable LOS B or better for the opening year (2010) and at LOS D or better for the design year (2030) peak hour traffic volumes. It was determined that this weave section would continue to operate at the same LOS during the PM peak hour if it's metered with discharge rate of 900 vph. In addition, the weave section would continue to operate at the same LOS D during the PM peak hour if the discharge rate of meter was kept as low as 500 mph. Therefore, metering at US 50 EB on-ramp at Latrobe is not anticipated to change operation of the weave section during the study peak hours.

Ramp metering analysis for US 50 EB on-ramp at Latrobe reveals that under Scenario 'A' (combined discharge rate is 900 vph) the arrival rate would produce queues that may exceed the available storage capacity during the PM peak hour. Under Scenario 'B' where capacity of one lane is fully utilized while the second is minimally used, queues will exist but are not shown to exceed the available storage length. Under Scenario 'C', the departure rate will be higher than the arrival rate, and therefore, queues will not be present.

For more comprehensive and detailed analysis of the effect of metering on weave section, ramps and intersection queue spillback operations, micro-simulation is the most appropriate approach.

Figure 1. US 50 EB Interchange with El Dorado Hills/Latrobe

Table 2. Ramp Metering Analysis Procedure and Results

Description	Scenario 'A'		Scenario 'B'		Scenario 'C'	
	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
Arrival Rate:						
Forecasted Traffic Volumes	968	1,297	968	1,297	968	1,297
Adjusted Traffic Volumes [1]	857	1,148	857	1,148	857	1,148
Number of On-Ramp Lanes	2					
Peak Hour Factor (PHF)	0.92					
Flow Rate (vph) [2]	931	1,248	931	1,248	931	1,248
Average Arrival Rate (vps)	0.26	0.35	0.26	0.35	0.26	0.35
Peak 15-min Arrival Rate	233	312	233	312	233	312
Peak 5-min Arrival Rate	78	104	78	104	78	104
Discharge Rate:						
Maximum Capacity or Discharge Rate (vph) [3]	900	900	1,140	1,140	1,800	1,800
Average Discharge Rate (vps)	0.25	0.25	0.32	0.32	0.50	0.50
Peak 15-min Discharge Rate	225	225	285	285	450	450
Peak 5-min Discharge Rate	75	75	95	95	150	150
Results:						
Average Car Length (ft)	25					
Approx. Storage Length (ft per lane) [4]	1,000					
Approx Total Storage Capacity (ft)	2,000					
Residual Peak 15-min Queue Length (veh) [5]	8	87	0	27	0	0
Residual Peak 15-min Queue Length (ft)	195	2,173	0	673	0	0
Resultant Peak 15-min Queue Spillback (ft) [6]	0	173	0	0	0	0
Resultant Peak 15-min Queue Spillback (veh)	0	7	0	0	0	0
Residual Peak 5-min Queue Length (veh) [5]	3	29	0	9	0	0
Residual Peak 5-min Queue Length (ft)	65	724	0	224	0	0
Resultant Peak 5-min Queue Spillback (ft) [6]	0	0	0	0	0	0
Resultant Peak 5-min Queue Spillback (veh)	0	0	0	0	0	0

[1] - Forecasted traffic volumes were reduced by 11.5% to exclude HOV-lane traffic

[2] - Computed as traffic volumes divided by a PHF

[3] - Based on Highway Design Manual (HDM), Sixth Edition.

[4] - Based on the preliminary concept plan prepared by Quincy Engineering, Inc.

[5] - Difference of corresponding arrival rate and departure rate

[6] - Queues in feet exceeding the available storage capacity

vph - vehicles per hour, vps - vehicles per second

Attachment A
HCS Weaving Analysis Worksheets

FREEWAY WEAVING WORKSHEET

General Information

Analyst	CS
Agency/Company	Dowling Associates, Inc.
Date Performed	1/09
Analysis Time Period	AM Peak Hour

Site Information

Freeway/Dir of Travel	US 50 EB
Weaving Seg Location	El Dorado Hills/Silva Valley
Jurisdiction	El Dorado County
Analysis Year	2010

Inputs

Freeway free-flow speed, S_{FF} (mi/h)	65	Weaving type	A
Weaving number of lanes, N	4	Volume ratio, VR	0.46
Weaving seg length, L (ft)	2150	Weaving ratio, R	0.25
Terrain	Grade		

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	f_{HV}	f_p	v
V_{o1}	1173	1.00	6	0	2.0	2.5	0.943	1.00	1243
V_{o2}	41	1.00	6	0	2.0	2.5	0.943	1.00	43
V_{w1}	785	1.00	6	0	2.0	2.5	0.943	1.00	832
V_{w2}	261	1.00	6	0	2.0	2.5	0.943	1.00	276
V_w				1108	V_{nw}				1286
V									2394

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)			0.35	0.0020
b (Exhibit 24-6)			2.20	4.00
c (Exhibit 24-6)			0.97	1.30
d (Exhibit 24-6)			0.80	0.75
Weaving intensity factor, Wi			0.86	0.12
Weaving and non-weaving speeds, Si (mi/h)			44.54	64.19

Number of lanes required for unconstrained operation, Nw 1.98
Maximum number of lanes, Nw (max) 1.40

☐ If Nw < Nw(max) unconstrained operation ☑ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	53.31
Weaving segment density, D (pc/mi/ln)	11.23
Level of service, LOS	B
Capacity of base condition, c_b (pc/h)	7557
Capacity as a 15-minute flow rate, c (veh/h)	7129
Capacity as a full-hour volume, c_h (veh/h)	7129

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

FREEWAY WEAVING WORKSHEET

General Information

Analyst	CS
Agency/Company	Dowling Associates, Inc.
Date Performed	1/09
Analysis Time Period	PM Peak Hour

Site Information

Freeway/Dir of Travel	US 50 EB
Weaving Seg Location	El Dorado Hills/Silva Valley
Jurisdiction	El Dorado County
Analysis Year	2010

Inputs

Freeway free-flow speed, S_{FF} (mi/h)	65	Weaving type	A
Weaving number of lanes, N	4	Volume ratio, VR	0.39
Weaving seg length, L (ft)	2150	Weaving ratio, R	0.31
Terrain	Grade		

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	f_{HV}	f_p	v
V_{o1}	2263	1.00	6	0	2.0	2.5	0.943	1.00	2398
V_{o2}	55	1.00	6	0	2.0	2.5	0.943	1.00	58
V_{w1}	1036	1.00	6	0	2.0	2.5	0.943	1.00	1098
V_{w2}	470	1.00	6	0	2.0	2.5	0.943	1.00	498
V_w				1596	V_{nw}				2456
V									4052

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)			0.35	0.0020
b (Exhibit 24-6)			2.20	4.00
c (Exhibit 24-6)			0.97	1.30
d (Exhibit 24-6)			0.80	0.75
Weaving intensity factor, Wi			1.29	0.19
Weaving and non-weaving speeds, Si (mi/h)			39.01	61.10

Number of lanes required for unconstrained operation, Nw 1.88
Maximum number of lanes, Nw (max) 1.40

☐ If Nw < Nw(max) unconstrained operation ☑ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	49.96
Weaving segment density, D (pc/mi/ln)	20.28
Level of service, LOS	C
Capacity of base condition, c_b (pc/h)	7557
Capacity as a 15-minute flow rate, c (veh/h)	7129
Capacity as a full-hour volume, c_h (veh/h)	7129

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

FREEWAY WEAVING WORKSHEET

General Information

Analyst	CS
Agency/Company	DAI
Date Performed	2/13/2009
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	US 50 EB
Weaving Seg Location	El Dorado Hills/Silva Valley
Jurisdiction	El Dorado County
Analysis Year	2030

Inputs

Freeway free-flow speed, S_{FF} (mi/h)	65	Weaving type	B
Weaving number of lanes, N	4	Volume ratio, VR	0.38
Weaving seg length, L (ft)	2150	Weaving ratio, R	0.42
Terrain	Grade		

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	f_{HV}	f_p	v
V_{o1}	2506	1.00	6	0	2.0	2.5	0.943	1.00	2656
V_{o2}	48	1.00	6	0	2.0	2.5	0.943	1.00	50
V_{w1}	920	1.00	6	0	2.0	2.5	0.943	1.00	975
V_{w2}	675	1.00	6	0	2.0	2.5	0.943	1.00	715
V_w				1690	V_{nw}				2706
V									4396

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)	0.08	0.0020		
b (Exhibit 24-6)	2.20	6.00		
c (Exhibit 24-6)	0.70	1.00		
d (Exhibit 24-6)	0.50	0.50		
Weaving intensity factor, Wi	0.47	0.33		
Weaving and non-weaving speeds, Si (mi/h)	52.30	56.24		

Number of lanes required for unconstrained operation, Nw 1.57
Maximum number of lanes, Nw (max) 3.50

☑ If Nw < Nw(max) unconstrained operation ☐ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	54.65
Weaving segment density, D (pc/mi/ln)	20.11
Level of service, LOS	C
Capacity of base condition, c_b (pc/h)	8253
Capacity as a 15-minute flow rate, c (veh/h)	7786
Capacity as a full-hour volume, c_h (veh/h)	7786

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

FREEWAY WEAVING WORKSHEET

General Information

Analyst	CS
Agency/Company	DAI
Date Performed	2/13/2009
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	US 50 EB
Weaving Seg Location	El Dorado Hills/Silva Valley
Jurisdiction	El Dorado County
Analysis Year	2030

Inputs

Freeway free-flow speed, S_{FF} (mi/h)	65	Weaving type	B
Weaving number of lanes, N	4	Volume ratio, VR	0.38
Weaving seg length, L (ft)	2150	Weaving ratio, R	0.44
Terrain	Grade		

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	f_{HV}	f_p	v
V_{o1}	2503	1.00	6	0	2.0	2.5	0.943	1.00	2653
V_{o2}	45	1.00	6	0	2.0	2.5	0.943	1.00	47
V_{w1}	855	1.00	6	0	2.0	2.5	0.943	1.00	906
V_{w2}	678	1.00	6	0	2.0	2.5	0.943	1.00	718
V_w				1624	V_{nw}				2700
V									4324

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)	0.08	0.0020		
b (Exhibit 24-6)	2.20	6.00		
c (Exhibit 24-6)	0.70	1.00		
d (Exhibit 24-6)	0.50	0.50		
Weaving intensity factor, Wi	0.46	0.32		
Weaving and non-weaving speeds, Si (mi/h)	52.60	56.80		

Number of lanes required for unconstrained operation, Nw 1.53
Maximum number of lanes, Nw (max) 3.50

☑ If Nw < Nw(max) unconstrained operation ☐ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	55.15
Weaving segment density, D (pc/mi/ln)	19.60
Level of service, LOS	B
Capacity of base condition, c_b (pc/h)	8310
Capacity as a 15-minute flow rate, c (veh/h)	7840
Capacity as a full-hour volume, c_h (veh/h)	7840

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

FREEWAY WEAVING WORKSHEET

General Information

Analyst	CS
Agency/Company	DAI
Date Performed	2/13/2009
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	US 50 EB
Weaving Seg Location	El Dorado Hills/Silva Valley
Jurisdiction	El Dorado County
Analysis Year	2030

Inputs

Freeway free-flow speed, S_{FF} (mi/h)	65	Weaving type	B
Weaving number of lanes, N	4	Volume ratio, VR	0.29
Weaving seg length, L (ft)	2150	Weaving ratio, R	0.39
Terrain	Grade		

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	f_{HV}	f_p	v
V_{o1}	4905	1.00	6	0	2.0	2.5	0.943	1.00	5199
V_{o2}	65	1.00	6	0	2.0	2.5	0.943	1.00	68
V_{w1}	1232	1.00	6	0	2.0	2.5	0.943	1.00	1305
V_{w2}	797	1.00	6	0	2.0	2.5	0.943	1.00	844
V_w				2149	V_{nw}				5267
V									7416

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)	0.08	0.0020		
b (Exhibit 24-6)	2.20	6.00		
c (Exhibit 24-6)	0.70	1.00		
d (Exhibit 24-6)	0.50	0.50		
Weaving intensity factor, Wi	0.59	0.37		
Weaving and non-weaving speeds, Si (mi/h)	49.68	55.20		

Number of lanes required for unconstrained operation, Nw 1.19
Maximum number of lanes, Nw (max) 3.50

☑ If Nw < Nw(max) unconstrained operation ☐ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	53.48
Weaving segment density, D (pc/mi/ln)	34.67
Level of service, LOS	D
Capacity of base condition, c_b (pc/h)	8859
Capacity as a 15-minute flow rate, c (veh/h)	8358
Capacity as a full-hour volume, c_h (veh/h)	8358

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

FREEWAY WEAVING WORKSHEET

General Information

Analyst	CS
Agency/Company	DAI
Date Performed	2/13/2009
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	US 50 EB
Weaving Seg Location	El Dorado Hills/Silva Valley
Jurisdiction	El Dorado County
Analysis Year	2030

Inputs

Freeway free-flow speed, S_{FF} (mi/h)	65	Weaving type	B
Weaving number of lanes, N	4	Volume ratio, VR	0.25
Weaving seg length, L (ft)	2150	Weaving ratio, R	0.49
Terrain	Grade		

Conversions to pc/h Under Base Conditions

(pc/h)	V	PHF	Truck %	RV %	E_T	E_R	f_{HV}	f_p	v
V_{o1}	4887	1.00	6	0	2.0	2.5	0.943	1.00	5180
V_{o2}	45	1.00	6	0	2.0	2.5	0.943	1.00	47
V_{w1}	855	1.00	6	0	2.0	2.5	0.943	1.00	906
V_{w2}	817	1.00	6	0	2.0	2.5	0.943	1.00	866
V_w				1772	V_{nw}				5227
V									6999

Weaving and Non-Weaving Speeds

	Unconstrained		Constrained	
	Weaving (i = w)	Non-Weaving (i = nw)	Weaving (i = w)	Non-Weaving (= nw)
a (Exhibit 24-6)	0.08	0.0020		
b (Exhibit 24-6)	2.20	6.00		
c (Exhibit 24-6)	0.70	1.00		
d (Exhibit 24-6)	0.50	0.50		
Weaving intensity factor, Wi	0.53	0.29		
Weaving and non-weaving speeds, Si (mi/h)	51.00	57.56		

Number of lanes required for unconstrained operation, Nw 1.02
Maximum number of lanes, Nw (max) 3.50

☑ If Nw < Nw(max) unconstrained operation ☐ if Nw > Nw (max) constrained operation

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment speed, S (mi/h)	55.74
Weaving segment density, D (pc/mi/ln)	31.39
Level of service, LOS	D
Capacity of base condition, c_b (pc/h)	9079
Capacity as a 15-minute flow rate, c (veh/h)	8565
Capacity as a full-hour volume, c_h (veh/h)	8565

Notes

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.