

District: **TxDOT Houston**

PROJECT: **FM 1488 from FM 1774 to W of FM 149**

EA:	Arterial
PPNO:	0523-09-009

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INVESTMENT ANALYSIS

SUMMARY RESULTS

Life-Cycle Costs (mil. \$)	\$39.5
Life-Cycle Benefits (mil. \$)	\$380.7
Net Present Value (mil. \$)	\$341.2
Benefit / Cost Ratio:	9.6
Rate of Return on Investment:	29.9%
Payback Period:	4 years

ITEMIZED BENEFITS (mil. \$)	Average Annual	Total Over 20 Years
Travel Time Savings	\$11.7	\$233.8
Veh. Op. Cost Savings	\$1.1	\$22.5
Accident Cost Savings	\$6.1	\$121.7
Emission Cost Savings	\$0.1	\$2.7
TOTAL BENEFITS	\$19.0	\$380.7
Person-Hours of Time Saved	986,049	19,720,972
CO₂ Emissions Saved (tons)	5,631	112,614
CO₂ Emissions Saved (mil. \$)	\$0.1	\$2.3

Should benefit-cost results include:

- 1) Induced Travel? (y/n)**

Default = Y
- 2) Vehicle Operating Costs? (y/n)**

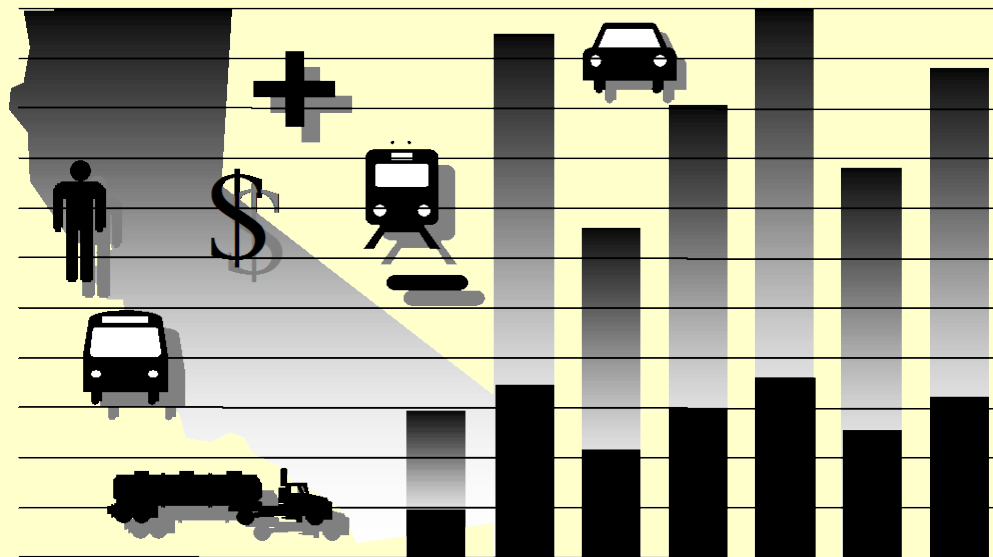
Default = Y
- 3) Accident Costs? (y/n)**

Default = Y
- 4) Vehicle Emissions? (y/n)**
includes value for CO₂e

Default = Y



California Life-Cycle Benefit/Cost Analysis Model (Version 5.0) TIGER Benefit-Cost Analysis



Office of Transportation Economics
Division of Transportation Planning
2014 TIGER Grant Applications

For questions and comments, please contact:

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District: **TxDOT Houston**

PROJECT: **FM 1488 from FM 1774 to W of FM 149**

Facility Type: **Arterial T**
 CSJ #: **0523-09-009**

1A PROJECT DATA

Type of Project
 Select project type from list: **General Highway**

Project Location (enter 1 for So. Cal., 2 for No. Cal., or 3 for rural): **1**

Length of Construction Period: **2** years
 One- or Two-Way Data: **2** enter 1 or 2

Length of Peak Period(s) (up to 24 hrs): **7** hours (Current)

1C HIGHWAY ACCIDENT DATA

Actual 3-Year Accident Data (from Table B)

	Count (No.)	Rate
Total Accidents (Tot)	94	1.49
Fatal Accidents (Fat)	2	0.032
Injury Accidents (Inj)	22	0.35
Property Damage Only (PDO) Accidents	70	1.11

Statewide Basic Average Accident Rate

	No Build	Build
Rate Group		
Accident Rate (per million vehicle-miles)	0.46	0.29
Percent Fatal Accidents (Pct Fat)	1.0%	0.5%
Percent Injury Accidents (Pct Inj)	49.2%	27.0%

1B HIGHWAY DESIGN AND TRAFFIC DATA

Highway Design

	No Build	Build
Roadway Type (Fwy, Exp, Conv Hwy)	C	C
Number of General Traffic Lanes	2	4
Number of HOV/HOT Lanes		
HOV Restriction (2 or 3)		
Exclusive ROW for Buses (y/n)	N	
Highway Free-Flow Speed	40	55
Ramp Design Speed (if aux. lane/off-ramp proj.)	35	35
Length (in miles) Highway Segment	4.0	4.0
Impacted Length	4.0	4.0

Average Daily Traffic

	No Build	Build
Current	20,157	
Base (Year 1)	21,916	21,916
Forecast (Year 20)	38,623	38,623

Average Hourly HOV/HOT Lane Traffic

	No Build	Build
Percent of Induced Trips in HOV (if HOT or 2-to-3 conv.)		100%

Percent Traffic in Weave: 0.0%

Percent Trucks (include RVs, if applicable): 5%

Truck Speed

On-Ramp Volume

	Peak	Non-Peak
Hourly Ramp Volume (if aux. lane/on-ramp proj.)	0	0
Metering Strategy (1, 2, 3, or D, if on-ramp proj.)		

Queue Formation (if queuing or grade crossing project)

	Year 1	Year 20
Arrival Rate (in vehicles per hour)	0	0
Departure Rate (in vehicles per hour)	0	0

Pavement Condition (if pavement project)

	No Build	Build
IRI (inches/mile) Base (Year 1)		
Forecast (Year 20)		

Average Vehicle Occupancy (AVO)

	No Build	Build
General Traffic Non-Peak	1.32	1.32
Peak	1.25	1.25
High Occupancy Vehicle (if HOV/HOT lanes)	2.15	2.15

1D RAIL AND TRANSIT DATA

Annual Person-Trips

	No Build	Build
Base (Year 1)		
Forecast (Year 20)		

Percent Trips during Peak Period: 54%

Percent New Trips from Parallel Highway: 100%

Annual Vehicle-Miles

	No Build	Build
Base (Year 1)		
Forecast (Year 20)		

Average Vehicles/Train (if rail project)

Reduction in Transit Accidents

Percent Reduction (if safety project)

Average Transit Travel Time

	No Build	Build
In-Vehicle Non-Peak (in minutes)		0.0
Peak (in minutes)		0.0
Out-of-Vehicle Non-Peak (in minutes)	0.0	0.0
Peak (in minutes)	0.0	0.0

Highway Grade Crossing

	Current	Year 1	Year 20
Annual Number of Trains		0	
Avg. Gate Down Time (in min.)		0.0	

Transit Agency Costs (if TMS project)

	No Build	Build
Annual Capital Expenditure		\$0
Annual Ops. and Maintenance Expenditure		\$0

Model should be run for both roads for intersection or bypass highway projects, and may be run twice for connectors. Press button below to prepare model to enter data for second road. After data are entered, results reflect total project benefits.

Prepare Model for Second Road

Enter all project costs (in today's dollars) in columns 1 to 7. Costs during construction should be entered in the first eight rows. Project costs (including maintenance and operating costs) should be net of costs without project.

1E PROJECT COSTS (enter costs in thousands of dollars)									
Col. no.	(1)	(2)	(3)	(4)	(5)	(6)	(7)		
Year	DIRECT PROJECT COSTS			SUBSEQUENT COSTS		Mitigation	Transit Agency Cost Savings	TOTAL COSTS (in dollars)	
	Project Support	R / W	Construction	Maint./ Op.	Rehab.			Constant Dollars	Present Value
Construction Period									
1			\$20,050					\$20,050,000	\$20,050,000
2			20,050					20,050,000	19,466,019
3								0	0
4								0	0
5								0	0
6								0	0
7								0	0
8								0	0
Project Open									
1								\$0	\$0
2								0	0
3								0	0
4								0	0
5								0	0
6								0	0
7								0	0
8								0	0
9								0	0
10								0	0
11								0	0
12								0	0
13								0	0
14								0	0
15								0	0
16								0	0
17								0	0
18								0	0
19								0	0
20								0	0
Total	\$0	\$0	\$40,100	\$0	\$0	\$0	\$0	\$40,100,000	\$39,516,019

$$\text{Present Value} = \frac{\text{Future Value (in Constant Dollars)}}{(1 + \text{Real Discount Rate})^{\text{Year}}}$$

HIGHWAY SPEED AND VOLUME INPUTS

	Calculated by Model	Changed by User	Used for Proj. Eval.	Reason for Change
No Build				
Year 1				
<u>Peak Period</u>				
HOV Volume	0		0	
Non-HOV Volume	11,139		11,139	
Weaving Volume	0		0	
Truck Volume	586		586	
HOV Speed	55.0		55.0	
Non-HOV Speed	37.1		37.1	
Weaving Speed	55.0		55.0	
Truck Speed	37.1		37.1	
<u>Non-Peak Period</u>				
Non-HOV Volume	9,681		9,681	
Weaving Volume	0		0	
Truck Volume	510		510	
Non-HOV Speed	40.0		40.0	
Weaving Speed	55.0		55.0	
Truck Speed	40.0		40.0	
Year 20				
<u>Peak Period</u>				
HOV Volume	0		0	
Non-HOV Volume	19,630		19,630	
Weaving Volume	0		0	
Truck Volume	1,033		1,033	
HOV Speed	55.0		55.0	
Non-HOV Speed	7.6		7.6	
Weaving Speed	55.0		55.0	
Truck Speed	7.6		7.6	
<u>Non-Peak Period</u>				
Non-HOV Volume	17,062		17,062	
Weaving Volume	0		0	
Truck Volume	898		898	
Non-HOV Speed	40.0		40.0	
Weaving Speed	55.0		55.0	
Truck Speed	40.0		40.0	

Build				
Year 1				
<u>Peak Period</u>				
HOV Volume	0		0	
Non-HOV Volume	11,139		11,139	
Weaving Volume	0		0	
Truck Volume	586		586	
HOV Speed	55.0		55.0	
Non-HOV Speed	55.0		55.0	
Weaving Speed	55.0		55.0	
Truck Speed	55.0		55.0	
<u>Non-Peak Period</u>				
Non-HOV Volume	9,681		9,681	
Weaving Volume	0		0	
Truck Volume	510		510	
Non-HOV Speed	55.0		55.0	
Weaving Speed	55.0		55.0	
Truck Speed	55.0		55.0	
Year 20				
<u>Peak Period</u>				
HOV Volume	0		0	
Non-HOV Volume	19,630		19,630	
Weaving Volume	0		0	
Truck Volume	1,033		1,033	
HOV Speed	55.0		55.0	
Non-HOV Speed	53.8		53.8	
Weaving Speed	55.0		55.0	
Truck Speed	53.8		53.8	
<u>Non-Peak Period</u>				
Non-HOV Volume	17,062		17,062	
Weaving Volume	0		0	
Truck Volume	898		898	
Non-HOV Speed	55.0		55.0	
Weaving Speed	55.0		55.0	
Truck Speed	55.0		55.0	

Model speed estimates based on Highway Capacity Manual, pavement research, and research on weaving impacts

2B

HIGHWAY ACCIDENT RATES

	Calculated by Model	Changed by User	Used for Proj. Eval.	Reason for Change
No Build				
Fatal Accidents	0.032		0.032	
Injury Accidents	0.35		0.35	
PDO Accidents	1.11		1.11	
Total Accidents	1.492			
Hwy Safety or Weaving Improvement				
		0%	collision reduction factor (per HSIP Guidelines)	
Adjustment Factor (Actual/Statewide Avg. Existing)				
Fatal Accidents	7.1598		7.1598	
Injury Accidents	1.5614		1.5614	
PDO Accidents	4.8805		4.8805	
Build				
Fatal Accidents	0.011		0.011	
Injury Accidents	0.12		0.12	
PDO Accidents	1.01		1.01	
Total Accidents	1.142			

2C

RAMP AND ARTERIAL INPUTS

(if detailed information is available for a TMS or an arterial signal management project)

Detailed Information Available? (y/n)

Aggregate Segment Length (estimate as VMT/total volume)

All Ramps miles

Arterials miles

	Entered by User	Used for Proj. Eval.	Source/Notes
No Build (Peak Period Only)			
Year 1			
Aggregate Ramp Volume		0	
Aggregate Arterial Volume		0	
Average Ramp Speed		5.0	
Average Arterial Speed		5.0	
Year 20			
Aggregate Ramp Volume		0	
Aggregate Arterial Volume		0	
Average Ramp Speed		5.0	
Average Arterial Speed		5.0	
Build (Peak Period Only)			
Year 1			
Aggregate Ramp Volume		0	
Aggregate Arterial Volume		0	
Average Ramp Speed		5.0	
Average Arterial Speed		5.0	
Year 20			
Aggregate Ramp Volume		0	
Aggregate Arterial Volume		0	
Average Ramp Speed		5.0	
Average Arterial Speed		5.0	

2D

ANNUAL PERSON-TRIPS

(for HOV and HOT lane projects that affect average vehicle occupancy)

	No Build	Build	Induced
Year 1			
Peak Period			
HOV Trips	0	0	
Non-HOV Trips	3,620,057	3,620,057	0
Truck Trips	152,423	152,423	0
Non-Peak Period			
Non-HOV Trips	3,322,604	3,322,604	0
Truck Trips	132,480	132,480	0
Total Trips	7,227,564	7,227,564	0

Year 20			
Peak Period			
HOV Trips	0	0	
Non-HOV Trips	6,379,795	6,379,795	0
Truck Trips	268,623	268,623	0
Non-Peak Period			
Non-HOV Trips	5,855,579	5,855,579	0
Truck Trips	233,476	233,476	0
Total Trips	12,737,473	12,737,473	0

C

SUMMARY OF TRAVEL TIME BENEFITS

Year	HIGHWAY								
	Peak HOV	Peak Non-HOV	Peak Weaving	Peak Truck	Peak Ramp	Peak Arterial	Non-Peak Non-HOV	Non-Peak Weaving	Non-Peak Truck
1	\$0	\$1,855,314	\$0	\$136,152	\$0	\$0	\$1,323,526	\$0	\$91,976
20	\$0	\$30,127,342	\$0	\$2,210,896	\$0	\$0	\$1,668,577	\$0	\$115,955
2	\$0	\$2,145,972	\$0	\$157,482	\$0	\$0	\$1,352,573	\$0	\$93,995
3	\$0	\$2,468,558	\$0	\$181,155	\$0	\$0	\$1,380,201	\$0	\$95,915
4	\$0	\$2,827,189	\$0	\$207,473	\$0	\$0	\$1,406,449	\$0	\$97,739
5	\$0	\$3,226,825	\$0	\$236,801	\$0	\$0	\$1,431,359	\$0	\$99,470
6	\$0	\$3,673,496	\$0	\$269,580	\$0	\$0	\$1,454,969	\$0	\$101,111
7	\$0	\$4,174,602	\$0	\$306,353	\$0	\$0	\$1,477,316	\$0	\$102,664
8	\$0	\$4,739,311	\$0	\$347,795	\$0	\$0	\$1,498,438	\$0	\$104,132
9	\$0	\$5,379,120	\$0	\$394,747	\$0	\$0	\$1,518,371	\$0	\$105,517
10	\$0	\$6,108,635	\$0	\$448,283	\$0	\$0	\$1,537,149	\$0	\$106,822
11	\$0	\$6,946,690	\$0	\$509,783	\$0	\$0	\$1,554,807	\$0	\$108,049
12	\$0	\$7,917,981	\$0	\$581,061	\$0	\$0	\$1,571,378	\$0	\$109,200
13	\$0	\$9,055,536	\$0	\$664,541	\$0	\$0	\$1,586,896	\$0	\$110,279
14	\$0	\$10,404,533	\$0	\$763,537	\$0	\$0	\$1,601,391	\$0	\$111,286
15	\$0	\$12,028,441	\$0	\$882,708	\$0	\$0	\$1,614,895	\$0	\$112,225
16	\$0	\$14,019,302	\$0	\$1,028,807	\$0	\$0	\$1,627,438	\$0	\$113,096
17	\$0	\$16,515,822	\$0	\$1,212,014	\$0	\$0	\$1,639,049	\$0	\$113,903
18	\$0	\$19,737,210	\$0	\$1,448,416	\$0	\$0	\$1,649,758	\$0	\$114,647
19	\$0	\$24,051,463	\$0	\$1,765,018	\$0	\$0	\$1,659,591	\$0	\$115,331
Total	\$0	\$187,403,342	\$0	\$13,752,603	\$0	\$0	\$30,554,133	\$0	\$2,123,311

C

SUMMARY OF TRAVEL TIME BENEFITS (continued)

Year	TRANSIT				Present Value of Travel Time Benefits	Constant Dollars	Total Per-Hrs of Time Saved
	Peak In-Vehicle	Peak Out-of-Veh	Non-Peak In-Vehicle	Non-Peak Out-of-Veh			
1	\$0	\$0	\$0	\$0	\$3,406,969	\$3,614,453	226,604
20	\$0	\$0	\$0	\$0	\$34,122,772	\$63,478,407	3,170,927
2	\$0	\$0	\$0	\$0	\$3,750,022	\$4,097,750	253,846
3	\$0	\$0	\$0	\$0	\$4,125,829	\$4,643,657	284,241
4	\$0	\$0	\$0	\$0	\$4,538,850	\$5,261,772	318,244
5	\$0	\$0	\$0	\$0	\$4,994,454	\$5,963,640	356,405
6	\$0	\$0	\$0	\$0	\$5,499,156	\$6,763,268	399,386
7	\$0	\$0	\$0	\$0	\$6,060,935	\$7,677,812	448,001
8	\$0	\$0	\$0	\$0	\$6,689,675	\$8,728,509	503,254
9	\$0	\$0	\$0	\$0	\$7,397,754	\$9,941,963	566,404
10	\$0	\$0	\$0	\$0	\$8,200,888	\$11,351,948	639,045
11	\$0	\$0	\$0	\$0	\$9,119,329	\$13,001,982	723,233
12	\$0	\$0	\$0	\$0	\$10,179,621	\$14,949,117	821,661
13	\$0	\$0	\$0	\$0	\$11,417,251	\$17,269,617	937,926
14	\$0	\$0	\$0	\$0	\$12,880,747	\$20,067,784	1,076,948
15	\$0	\$0	\$0	\$0	\$14,638,269	\$23,490,124	1,245,634
16	\$0	\$0	\$0	\$0	\$16,788,644	\$27,749,070	1,453,998
17	\$0	\$0	\$0	\$0	\$19,480,789	\$33,164,739	1,717,128
18	\$0	\$0	\$0	\$0	\$22,950,031	\$40,243,019	2,058,864
19	\$0	\$0	\$0	\$0	\$27,591,403	\$49,833,143	2,519,224
Total	\$0	\$0	\$0	\$0	\$233,833,389	\$371,291,773	19,720,972

SUMMARY OF VEHICLE OPERATING COST BENEFITS

Year	HIGHWAY									TRANSIT		Present Value of Veh Op Cost Benefits	Constant Dollars
	Peak HOV	Peak Non-HOV	Peak Weaving	Peak Truck	Peak Arterial	Non-Peak Non-HOV	Non-Peak Weaving	Non-Peak Truck	Peak Period	Non-Peak Period			
1	\$0	\$62,239	\$0	\$5,310	\$0	\$2,847	\$0	\$0	-	-	\$70,397	\$74,684	
20	\$0	\$2,943,295	\$0	\$270,279	\$0	\$2,862	\$0	\$0	-	-	\$3,216,435	\$5,983,517	
2	\$0	\$112,471	\$0	\$9,767	\$0	\$2,875	\$0	\$0	-	-	\$125,113	\$136,714	
3	\$0	\$180,117	\$0	\$15,642	\$0	\$2,899	\$0	\$0	-	-	\$198,658	\$223,591	
4	\$0	\$214,952	\$0	\$18,667	\$0	\$2,919	\$0	\$0	-	-	\$236,538	\$274,213	
5	\$0	\$283,717	\$0	\$24,639	\$0	\$2,936	\$0	\$0	-	-	\$311,291	\$371,698	
6	\$0	\$335,866	\$0	\$29,462	\$0	\$2,949	\$0	\$0	-	-	\$368,277	\$452,934	
7	\$0	\$435,692	\$0	\$38,822	\$0	\$2,958	\$0	\$0	-	-	\$477,473	\$604,848	
8	\$0	\$487,855	\$0	\$43,453	\$0	\$2,965	\$0	\$0	-	-	\$534,273	\$697,105	
9	\$0	\$614,874	\$0	\$55,177	\$0	\$2,969	\$0	\$0	-	-	\$673,019	\$904,482	
10	\$0	\$690,275	\$0	\$62,121	\$0	\$2,970	\$0	\$0	-	-	\$755,366	\$1,045,604	
11	\$0	\$843,622	\$0	\$76,129	\$0	\$2,969	\$0	\$0	-	-	\$922,720	\$1,315,578	
12	\$0	\$917,544	\$0	\$82,940	\$0	\$2,965	\$0	\$0	-	-	\$1,003,449	\$1,473,598	
13	\$0	\$1,136,864	\$0	\$103,851	\$0	\$2,958	\$0	\$0	-	-	\$1,243,673	\$1,881,167	
14	\$0	\$1,354,264	\$0	\$124,779	\$0	\$2,950	\$0	\$0	-	-	\$1,481,993	\$2,308,897	
15	\$0	\$1,457,720	\$0	\$134,718	\$0	\$2,940	\$0	\$0	-	-	\$1,595,377	\$2,560,112	
16	\$0	\$1,778,322	\$0	\$166,523	\$0	\$2,927	\$0	\$0	-	-	\$1,947,772	\$3,219,370	
17	\$0	\$1,937,364	\$0	\$182,411	\$0	\$2,913	\$0	\$0	-	-	\$2,122,688	\$3,613,735	
18	\$0	\$2,250,271	\$0	\$213,464	\$0	\$2,898	\$0	\$0	-	-	\$2,466,633	\$4,325,256	
19	\$0	\$2,478,753	\$0	\$232,143	\$0	\$2,880	\$0	\$0	-	-	\$2,713,776	\$4,901,381	
Total	\$0	\$20,516,077	\$0	\$1,890,296	\$0	\$58,549	\$0	\$0	-	-	\$22,464,922	\$36,368,484	

SUMMARY OF ACCIDENT REDUCTION BENEFITS

Year	HIGHWAY									TRANSIT	Present Value of Accident Benefits	Constant Dollars
	Peak HOV	Peak Non-HOV	Peak Weaving	Peak Truck	Peak Arterial	Non-Peak Non-HOV	Non-Peak Weaving	Non-Peak Truck	All Periods			
1	\$0	\$3,006,873	\$0	\$158,256	\$0	\$2,613,450	\$0	\$137,550	\$0	\$5,916,130	\$6,276,422	
20	\$0	\$3,022,033	\$0	\$159,054	\$0	\$2,626,627	\$0	\$138,244	\$0	\$5,945,957	\$11,061,232	
2	\$0	\$3,036,427	\$0	\$159,812	\$0	\$2,639,137	\$0	\$138,902	\$0	\$5,974,278	\$6,528,255	
3	\$0	\$3,061,708	\$0	\$161,143	\$0	\$2,661,110	\$0	\$140,058	\$0	\$6,024,019	\$6,780,087	
4	\$0	\$3,082,940	\$0	\$162,260	\$0	\$2,679,565	\$0	\$141,030	\$0	\$6,065,795	\$7,031,919	
5	\$0	\$3,100,338	\$0	\$163,176	\$0	\$2,694,687	\$0	\$141,826	\$0	\$6,100,027	\$7,283,751	
6	\$0	\$3,114,108	\$0	\$163,900	\$0	\$2,706,655	\$0	\$142,456	\$0	\$6,127,118	\$7,535,583	
7	\$0	\$3,124,445	\$0	\$164,444	\$0	\$2,715,639	\$0	\$142,928	\$0	\$6,147,457	\$7,787,415	
8	\$0	\$3,131,538	\$0	\$164,818	\$0	\$2,721,804	\$0	\$143,253	\$0	\$6,161,413	\$8,039,247	
9	\$0	\$3,135,568	\$0	\$165,030	\$0	\$2,725,307	\$0	\$143,437	\$0	\$6,169,341	\$8,291,079	
10	\$0	\$3,136,706	\$0	\$165,090	\$0	\$2,726,296	\$0	\$143,489	\$0	\$6,171,581	\$8,542,911	
11	\$0	\$3,135,118	\$0	\$165,006	\$0	\$2,724,915	\$0	\$143,417	\$0	\$6,168,456	\$8,794,743	
12	\$0	\$3,130,961	\$0	\$164,787	\$0	\$2,721,303	\$0	\$143,226	\$0	\$6,160,277	\$9,046,575	
13	\$0	\$3,124,387	\$0	\$164,441	\$0	\$2,715,589	\$0	\$142,926	\$0	\$6,147,343	\$9,298,407	
14	\$0	\$3,115,540	\$0	\$163,976	\$0	\$2,707,899	\$0	\$142,521	\$0	\$6,129,935	\$9,550,239	
15	\$0	\$3,104,557	\$0	\$163,398	\$0	\$2,698,353	\$0	\$142,019	\$0	\$6,108,327	\$9,802,071	
16	\$0	\$3,091,571	\$0	\$162,714	\$0	\$2,687,067	\$0	\$141,425	\$0	\$6,082,777	\$10,053,903	
17	\$0	\$3,076,708	\$0	\$161,932	\$0	\$2,674,148	\$0	\$140,745	\$0	\$6,053,533	\$10,305,735	
18	\$0	\$3,060,088	\$0	\$161,057	\$0	\$2,659,703	\$0	\$139,984	\$0	\$6,020,833	\$10,557,567	
19	\$0	\$3,041,827	\$0	\$160,096	\$0	\$2,643,831	\$0	\$139,149	\$0	\$5,984,902	\$10,809,400	
Total	\$0	\$61,833,441	\$0	\$3,254,392	\$0	\$53,743,084	\$0	\$2,828,583	\$0	\$121,659,500	\$173,376,541	

C

SUMMARY OF EMISSION REDUCTION BENEFITS

Year	HIGHWAY								
	Peak HOV	Peak Non-HOV	Peak Weaving	Peak Truck	Peak Ramp	Peak Arterial	Non-Peak Non-HOV	Non-Peak Weaving	Non-Peak Truck
1	\$0	\$7,016	\$0	\$76	\$0	\$0	\$831	\$0	(\$371)
20	\$0	\$390,394	\$0	\$31,712	\$0	\$0	\$1,027	\$0	(\$20)
2	\$0	\$12,447	\$0	\$534	\$0	\$0	\$844	\$0	(\$374)
3	\$0	\$19,625	\$0	\$1,169	\$0	\$0	\$857	\$0	(\$377)
4	\$0	\$24,019	\$0	\$1,502	\$0	\$0	\$868	\$0	(\$380)
5	\$0	\$31,636	\$0	\$2,156	\$0	\$0	\$879	\$0	(\$382)
6	\$0	\$38,068	\$0	\$2,699	\$0	\$0	\$888	\$0	(\$384)
7	\$0	\$50,510	\$0	\$3,787	\$0	\$0	\$897	\$0	(\$385)
8	\$0	\$51,991	\$0	\$4,087	\$0	\$0	\$1,001	\$0	(\$20)
9	\$0	\$66,368	\$0	\$5,310	\$0	\$0	\$1,007	\$0	(\$20)
10	\$0	\$75,775	\$0	\$6,080	\$0	\$0	\$1,013	\$0	(\$20)
11	\$0	\$93,812	\$0	\$7,583	\$0	\$0	\$1,017	\$0	(\$20)
12	\$0	\$103,812	\$0	\$8,428	\$0	\$0	\$1,021	\$0	(\$20)
13	\$0	\$131,285	\$0	\$10,755	\$0	\$0	\$1,023	\$0	(\$20)
14	\$0	\$159,495	\$0	\$13,143	\$0	\$0	\$1,026	\$0	(\$20)
15	\$0	\$174,769	\$0	\$14,454	\$0	\$0	\$1,027	\$0	(\$20)
16	\$0	\$217,844	\$0	\$18,193	\$0	\$0	\$1,028	\$0	(\$20)
17	\$0	\$242,166	\$0	\$20,307	\$0	\$0	\$1,029	\$0	(\$20)
18	\$0	\$286,323	\$0	\$24,183	\$0	\$0	\$1,029	\$0	(\$20)
19	\$0	\$321,767	\$0	\$26,757	\$0	\$0	\$1,028	\$0	(\$20)
Total	\$0	\$2,499,120	\$0	\$202,915	\$0	\$0	\$19,339	\$0	(\$2,917)

C

SUMMARY OF EMISSION REDUCTION BENEFITS (continued)

Year	TRANSIT				Present Value of Emission Benefits	Constant Dollars	CO ₂ EMISSIONS SAVED	
	Peak Bus	Non-Peak Bus	Passenger Rail	Light Rail			tons/yr	PV \$/yr
1	\$0	\$0	\$0	\$0	\$7,552	\$8,012	234	\$5,497
20	\$0	\$0	\$0	\$0	\$423,112	\$787,113	18,567	\$363,061
2	\$0	\$0	\$0	\$0	\$13,451	\$14,698	421	\$9,819
3	\$0	\$0	\$0	\$0	\$21,273	\$23,943	685	\$15,821
4	\$0	\$0	\$0	\$0	\$26,009	\$30,152	839	\$19,189
5	\$0	\$0	\$0	\$0	\$34,288	\$40,942	1,136	\$25,712
6	\$0	\$0	\$0	\$0	\$41,271	\$50,758	1,385	\$31,035
7	\$0	\$0	\$0	\$0	\$54,810	\$69,431	1,863	\$41,366
8	\$0	\$0	\$0	\$0	\$57,059	\$74,449	2,154	\$47,343
9	\$0	\$0	\$0	\$0	\$72,665	\$97,656	2,797	\$60,880
10	\$0	\$0	\$0	\$0	\$82,847	\$114,680	3,235	\$69,749
11	\$0	\$0	\$0	\$0	\$102,392	\$145,986	4,060	\$86,665
12	\$0	\$0	\$0	\$0	\$113,240	\$166,297	4,551	\$96,204
13	\$0	\$0	\$0	\$0	\$143,043	\$216,365	5,815	\$121,749
14	\$0	\$0	\$0	\$0	\$173,643	\$270,531	7,142	\$148,067
15	\$0	\$0	\$0	\$0	\$190,230	\$305,263	7,930	\$162,812
16	\$0	\$0	\$0	\$0	\$237,045	\$391,798	9,969	\$202,695
17	\$0	\$0	\$0	\$0	\$263,481	\$448,560	11,213	\$225,763
18	\$0	\$0	\$0	\$0	\$311,515	\$546,243	13,414	\$267,468
19	\$0	\$0	\$0	\$0	\$349,532	\$631,293	15,204	\$300,217
Total	\$0	\$0	\$0	\$0	\$2,718,457	\$4,434,170	112,614	\$2,301,112

A

NET PRESENT VALUE CALCULATION

Year	PRESENT VALUE OF USER BENEFITS				PRESENT VALUE OF USER BENEFITS (road 2)			
	Travel Time Savings	Vehicle Op. Cost Savings	Accident Reductions	Vehicle Emission Reductions	Travel Time Savings	Vehicle Op. Cost Savings	Accident Reductions	Vehicle Emission Reductions
Construction Period								
1								
2								
3								
4								
5								
6								
7								
8								
Project Open								
1	\$3,406,969	\$70,397	\$5,916,130	\$7,552				
2	\$3,750,022	\$125,113	\$5,974,278	\$13,451				
3	\$4,125,829	\$198,658	\$6,024,019	\$21,273				
4	\$4,538,850	\$236,538	\$6,065,795	\$26,009				
5	\$4,994,454	\$311,291	\$6,100,027	\$34,288				
6	\$5,499,156	\$368,277	\$6,127,118	\$41,271				
7	\$6,060,935	\$477,473	\$6,147,457	\$54,810				
8	\$6,689,675	\$534,273	\$6,161,413	\$57,059				
9	\$7,397,754	\$673,019	\$6,169,341	\$72,665				
10	\$8,200,888	\$755,366	\$6,171,581	\$82,847				
11	\$9,119,329	\$922,720	\$6,168,456	\$102,392				
12	\$10,179,621	\$1,003,449	\$6,160,277	\$113,240				
13	\$11,417,251	\$1,243,673	\$6,147,343	\$143,043				
14	\$12,880,747	\$1,481,993	\$6,129,935	\$173,643				
15	\$14,638,269	\$1,595,377	\$6,108,327	\$190,230				
16	\$16,788,644	\$1,947,772	\$6,082,777	\$237,045				
17	\$19,480,789	\$2,122,688	\$6,053,533	\$263,481				
18	\$22,950,031	\$2,466,633	\$6,020,833	\$311,515				
19	\$27,591,403	\$2,713,776	\$5,984,902	\$349,532				
20	\$34,122,772	\$3,216,435	\$5,945,957	\$423,112				
Total	\$233,833,389	\$22,464,922	\$121,659,500	\$2,718,457	\$0	\$0	\$0	\$0

19,720,972	Person-Hours of Time Saved
112,614	CO ₂ Emissions Saved (tons)
\$2,301,112	CO ₂ Emissions Saved (\$ PV)

	Person-Hours of Time Saved
	CO ₂ Emissions Saved (tons)
	CO ₂ Emissions Saved (\$ PV)

PRESENT VALUE OF USER BENEFITS (road 3)				Present Value of Total User Benefits	Present Value of Total Project Costs	NET PRESENT VALUE
Travel Time Savings	Vehicle Op. Cost Savings	Accident Reductions	Vehicle Emission Reductions			
				\$0	\$20,050,000	(\$20,050,000)
				\$0	\$19,466,019	(\$19,466,019)
				\$0	\$0	\$0
				\$0	\$0	\$0
				\$0	\$0	\$0
				\$0	\$0	\$0
				\$0	\$0	\$0
				\$0	\$0	\$0
				\$9,401,048	\$0	\$9,401,048
				\$9,862,863	\$0	\$9,862,863
				\$10,369,779	\$0	\$10,369,779
				\$10,867,193	\$0	\$10,867,193
				\$11,440,061	\$0	\$11,440,061
				\$12,035,822	\$0	\$12,035,822
				\$12,740,675	\$0	\$12,740,675
				\$13,442,421	\$0	\$13,442,421
				\$14,312,780	\$0	\$14,312,780
				\$15,210,683	\$0	\$15,210,683
				\$16,312,896	\$0	\$16,312,896
				\$17,456,587	\$0	\$17,456,587
				\$18,951,310	\$0	\$18,951,310
				\$20,666,319	\$0	\$20,666,319
				\$22,532,202	\$0	\$22,532,202
				\$25,056,237	\$0	\$25,056,237
				\$27,920,492	\$0	\$27,920,492
				\$31,749,012	\$0	\$31,749,012
				\$36,639,613	\$0	\$36,639,613
				\$43,708,276	\$0	\$43,708,276
\$0	\$0	\$0	\$0	\$380,676,268	\$39,516,019	\$341,160,249

	Person-Hours of Time Saved
	CO ₂ Emissions Saved (tons)
	CO ₂ Emissions Saved (\$ PV)

INTERNAL RATE OF RETURN ON INVESTMENT AND PAYBACK PERIOD

Year	USER BENEFITS IN CONSTANT DOLLARS				USER BENEFITS IN CONSTANT DOLLARS (road 2)			
	Travel Time Savings	Vehicle Op. Cost Savings	Accident Reductions	Vehicle Emission Reductions	Travel Time Savings	Vehicle Op. Cost Savings	Accident Reductions	Vehicle Emission Reductions
Construction Period								
1								
2								
3								
4								
5								
6								
7								
8								
Project Open								
1	\$3,614,453	\$74,684	\$6,276,422	\$8,012				
2	\$4,097,750	\$136,714	\$6,528,255	\$14,698				
3	\$4,643,657	\$223,591	\$6,780,087	\$23,943				
4	\$5,261,772	\$274,213	\$7,031,919	\$30,152				
5	\$5,963,640	\$371,698	\$7,283,751	\$40,942				
6	\$6,763,268	\$452,934	\$7,535,583	\$50,758				
7	\$7,677,812	\$604,848	\$7,787,415	\$69,431				
8	\$8,728,509	\$697,105	\$8,039,247	\$74,449				
9	\$9,941,963	\$904,482	\$8,291,079	\$97,656				
10	\$11,351,948	\$1,045,604	\$8,542,911	\$114,680				
11	\$13,001,982	\$1,315,578	\$8,794,743	\$145,986				
12	\$14,949,117	\$1,473,598	\$9,046,575	\$166,297				
13	\$17,269,617	\$1,881,167	\$9,298,407	\$216,365				
14	\$20,067,784	\$2,308,897	\$9,550,239	\$270,531				
15	\$23,490,124	\$2,560,112	\$9,802,071	\$305,263				
16	\$27,749,070	\$3,219,370	\$10,053,903	\$391,798				
17	\$33,164,739	\$3,613,735	\$10,305,735	\$448,560				
18	\$40,243,019	\$4,325,256	\$10,557,567	\$546,243				
19	\$49,833,143	\$4,901,381	\$10,809,400	\$631,293				
20	\$63,478,407	\$5,983,517	\$11,061,232	\$787,113				
Total	\$371,291,773	\$36,368,484	\$173,376,541	\$4,434,170	\$0	\$0	\$0	\$0

USER BENEFITS IN CONSTANT DOLLARS (road 3)				Total User Benefits in Constant Dollars	Total Project Costs in Constant Dollars	ANNUAL RETURNS ON INVESTMENT	CUMULATIVE RETURNS AFTER PROJ OPENS
Travel Time Savings	Vehicle Op. Cost Savings	Accident Reductions	Vehicle Emission Reductions				
				\$0	\$20,050,000	(\$20,050,000)	
				\$0	\$20,050,000	(\$20,050,000)	
				\$0	\$0	\$0	
				\$0	\$0	\$0	
				\$0	\$0	\$0	
				\$0	\$0	\$0	
				\$0	\$0	\$0	
				\$0	\$0	\$0	
				\$9,973,571	\$0	\$9,973,571	\$9,973,571
				\$10,777,417	\$0	\$10,777,417	\$20,750,989
				\$11,671,277	\$0	\$11,671,277	\$32,422,266
				\$12,598,055	\$0	\$12,598,055	\$45,020,321
				\$13,660,031	\$0	\$13,660,031	\$58,680,352
				\$14,802,543	\$0	\$14,802,543	\$73,482,894
				\$16,139,506	\$0	\$16,139,506	\$89,622,400
				\$17,539,310	\$0	\$17,539,310	\$107,161,710
				\$19,235,180	\$0	\$19,235,180	\$126,396,889
				\$21,055,142	\$0	\$21,055,142	\$147,452,032
				\$23,258,289	\$0	\$23,258,289	\$170,710,321
				\$25,635,587	\$0	\$25,635,587	\$196,345,908
				\$28,665,557	\$0	\$28,665,557	\$225,011,464
				\$32,197,451	\$0	\$32,197,451	\$257,208,916
				\$36,157,570	\$0	\$36,157,570	\$293,366,486
				\$41,414,142	\$0	\$41,414,142	\$334,780,628
				\$47,532,768	\$0	\$47,532,768	\$382,313,396
				\$55,672,085	\$0	\$55,672,085	\$437,985,482
				\$66,175,217	\$0	\$66,175,217	\$504,160,699
				\$81,310,268	\$0	\$81,310,268	\$585,470,967
\$0	\$0	\$0	\$0	\$585,470,967	\$40,100,000	\$545,370,967	

Total Construction Costs

\$40,100,000

Years After Construction Begins	ANNUAL RETURNS ON INVESTMENT
1	(\$20,050,000)
2	(\$20,050,000)
3	\$9,973,571
4	\$10,777,417
5	\$11,671,277
6	\$12,598,055
7	\$13,660,031
8	\$14,802,543
9	\$16,139,506
10	\$17,539,310
11	\$19,235,180
12	\$21,055,142
13	\$23,258,289
14	\$25,635,587
15	\$28,665,557
16	\$32,197,451
17	\$36,157,570
18	\$41,414,142
19	\$47,532,768
20	\$55,672,085
21	\$66,175,217
22	\$81,310,268
23	\$0
24	\$0
25	\$0
26	\$0
27	\$0
28	\$0

Internal Rate of Return

29.95%

Payback Period

4 years

The INTERNAL RATE OF RETURN (IRR) is the discount rate at which benefits and costs break even (are equal). For a project with an IRR greater than the Discount Rate, benefits are greater than costs, and the project has a positive economic value. The IRR allows projects with different costs, different benefit flows, and different time periods to be compared.

The PAYBACK PERIOD is the number of years it takes for the net benefits (benefits minus costs) to equal, or payback, the initial construction costs. For a project with a Payback Period longer than the life-cycle of the project, initial construction costs are not recovered. The Payback Period varies inversely with the Benefit-Cost Ratio: shorter Payback Period yields higher Benefit-Cost.

Parameters

This page contains all economic values and rate tables.

To update economic values automatically, change "Economic Update Factor."

General Economic Parameters	
Year of Current Dollars for Model	2015
Economic Update Factor (Using GDP Deflator)	1.02
Real Discount Rate	3.0%

Travel Time Parameters		Value	Units	
Statewide Average Hourly Wage	\$	30.26	\$/hr	3
Heavy and Light Truck Drivers				
Average Hourly Wage	\$	17.69	\$/hr	3
Benefits and Costs	\$	8.68	\$/hr	4
Value of Time				
Automobile	\$	15.13	\$/hr/per	5
Truck	\$	26.37	\$/hr/veh	5
Auto & Truck Composite	\$	20.27	\$/hr/veh	6
Transit	\$	15.13	\$/hr/per	5
Out-of-Vehicle Travel		2	times	5
Incident-Related Travel		3	times	7
Travel Time Updater		1.2%	annual incr	
Vehicle Operating Cost Parameters				
Average Fuel Price				
Automobile (regular unleaded)	\$	3.37	\$/gal	8
Truck (diesel)	\$	3.74	\$/gal	8
Sales and Fuel Taxes				
State Sales Tax (gasoline)		0.00%	%	9
State Sales Tax (diesel)		0.00%	%	9
Average Local Sales Tax		0.00%	%	9
Federal Fuel Excise Tax (gasoline)	\$	0.184	\$/gal	9
Federal Fuel Excise Tax (diesel)	\$	0.244	\$/gal	9
State Fuel Excise Tax (gasoline)	\$	0.200	\$/gal	9
State Fuel Excise Tax (diesel)	\$	0.200	\$/gal	9
Fuel Cost Per Gallon (Exclude Taxes)				
Automobile	\$	3.00	\$/gal	
Truck	\$	3.30	\$/gal	
Non-Fuel Cost Per Mile				
Automobile	\$	0.324	\$/mi	10
Truck	\$	0.447	\$/mi	11
Idling Speed for Op. Costs and Emissions		5	mph	
Accident Cost Parameters				
Cost of a Fatality	\$	9,200,000	\$/event	12
Cost of an Injury				
Level A (Severe)	\$	966,000	\$/event	12
Level B (Moderate)	\$	432,400	\$/event	12
Level C (Minor)	\$	27,600	\$/event	12
Cost of Property Damage	\$	3,927	\$/event	12
Cost of Highway Accident				
Fatal Accident	\$	10,200,000	\$/accident	
Injury Accident	\$	261,100	\$/accident	
PDO Accident	\$	15,900	\$/accident	
Average Cost	\$	145,400	\$/accident	
Statewide Highway Accident Rates				
Fatal Accident		0.007	per mil veh-mi	13
Injury Accident		0.27	per mil veh-mi	13
PDO Accident		0.53	per mil veh-mi	13
Non-Freeway		1.05	per mil veh-mi	13

Highway Operations Parameters		Value	Units	
Maximum V/C Ratio		1.56	-	15
Percent ADT in Peak Period		53.5%	%	
Percent ADT in Average Peak Hour		7.6%	%	
Annualization Factor		260	days/yr	
Freeway				
	Alpha	Beta	Capacity (vphpl)	Dep. Rate (vphpl)
Freeway	0.20	10	2,000	1,800
Expressway	0.20	10	2,000	1,800
Conventional Highway	0.05	10	800	1,400
HOV Lanes	0.55	8	1,600	
Non-HOV Lanes				
	Alpha	Beta	Capacity (vphpl)	
No Build	0.05	10	800	
Build	0.05	10	800	

Sources: 15) Highway Capacity Manual, 16) NCHRP 387, 17) PeMS data

Sources: 1) Office of Management and Budget (OMB), 2) Review of OMB and State Treasurer's Office data, 3) Bureau of Labor Statistics (BLS) OES, 4) BLS Employment Cost Index, 5) USDOT Department Guidance, 6) California Department of Transportation TSI and Traffic Operations, 7) IDAS model, 8) AAA Daily Fuel Gauge Report, 9) California Board of Equalization, 10) AAA Your Driving Costs, 11) American Transportation Research Institute, 12) National Safety Council, 13) TASAS summary 2009

TIGER Sources: 1) OMB GDP and Deflators Used in Historical Tables 1940-2019 (Table 10.1), 2) TIG

Travel Demand Tables

Project Types		
Highway Capacity Expansion		
General Highway	TRUE	GenHwy
HOV Lane Addition	FALSE	HOV
HOT Lane Addition	FALSE	HOT
Passing Lane	FALSE	Passing
Intersection	FALSE	Intersect
Bypass	FALSE	Bypass
Queueing	FALSE	Queueing
Pavement	FALSE	Pavement
Please select a type of highway project		
Enter HOV restriction in section 1B		
Include toll payers as HOVs & check AVOs		
Enter a truck speed in section 1B		
Remember to run model for both roads		
Remember to run model for both roads		
Add arrival rate & check departure rate in 1B		
Enter pavement condition in section 1B		
Rail or Transit Cap Expansion		
Passenger Rail	FALSE	PassRail
Light-Rail (LRT)	FALSE	LRT
Bus	FALSE	Bus
Hwy-Rail Grade Crossing	FALSE	HwyRail
Please select a type of rail or transit project		
Enter data in both sections 1B & 1E		
Enter data in both sections 1B & 1E		
Enter data in both sections 1B & 1E		
Put hwy design in 1B, safety in 1C & crossing in 1D		
Hwy Operational Improvement		
Auxiliary Lane	FALSE	AuxLane
Freeway Connector	FALSE	FreeConn
HOV Connector	FALSE	HOVConn
HOV Drop Ramp	FALSE	HOVDrop
Off-Ramp Widening	FALSE	OffRamp
On-Ramp Widening	FALSE	OnRamp
HOV-2 to HOV-3 Conv	FALSE	HOV2to3
HOT Lane Conversion	FALSE	HOTConv
Please select a type of op. improvement		
Enter ramp design speed & on-ramp volume		
Check percent traffic in weave in section 1B		
Check percent traffic in weave in section 1B		
Check percent traffic in weave in section 1B		
Check percent traffic in weave in section 1B		
Enter on-ramp volume & metering strategy		
Check AVOs & trips in sections 1B & 2D		
Check AVOs & trips in sections 1B & 2D		
Transp Mgmt Systems (TMS)		
Ramp Metering	FALSE	RM
Ramp Metering Signal Coord	FALSE	AM
Incident Management	FALSE	IM
Traveler Information	FALSE	TI
Arterial Signal Management	FALSE	ASM
Transit Vehicle Location (AVL)	FALSE	AVL
Transit Vehicle Signal Priority	FALSE	SigPriority
Bus Rapid Transit (BRT)	FALSE	BRT
Please select a type of TMS project		
Enter model data, if avail, in sections 2A & 2C		
Enter model data, if avail, in sections 2A & 2C		
Enter model data, if avail, in sections 2A & 2C		
Enter model data, if avail, in sections 2A & 2C		
Complete only sections 1A, 1E & 2C		
Enter transit agency costs in section 1D		
Check travel time in section 1D		
Enter free-flow bus lane speed in section 1B		
TMS Lookup Code	NoAdj	TMSLookup
User Modified Inputs	FALSE	UserAdjInputs

DEMAND FOR TRAVEL IN PEAK PERIOD (percent of total daily travel)						
Number of Hours in Peak Period	Urban				Rural	
	So. California		No. California		Fwy/Exp	Other
	Fwy/Exp	Other	Fwy/Exp	Other	Fwy/Exp	Other
1	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%
2	17.2%	17.2%	17.2%	17.2%	17.2%	17.2%
3	25.8%	25.8%	25.8%	25.8%	25.8%	25.8%
4	34.1%	34.1%	34.1%	34.1%	34.1%	34.1%
5	41.0%	41.0%	41.0%	41.0%	41.0%	41.0%
6	47.3%	47.3%	47.3%	47.3%	47.3%	47.3%
7	53.5%	53.5%	53.5%	53.5%	53.5%	53.5%
8	59.6%	59.6%	59.6%	59.6%	59.6%	59.6%
9	65.6%	65.6%	65.6%	65.6%	65.6%	65.6%
10	71.1%	71.1%	71.1%	71.1%	71.1%	71.1%
11	76.5%	76.5%	76.5%	76.5%	76.5%	76.5%
12	81.7%	81.7%	81.7%	81.7%	81.7%	81.7%
13	86.9%	86.9%	86.9%	86.9%	86.9%	86.9%
14	89.9%	89.9%	89.9%	89.9%	89.9%	89.9%
15	92.7%	92.7%	92.7%	92.7%	92.7%	92.7%
16	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%
17	96.7%	96.7%	96.7%	96.7%	96.7%	96.7%
18	97.9%	97.9%	97.9%	97.9%	97.9%	97.9%
19	98.9%	98.9%	98.9%	98.9%	98.9%	98.9%
20	99.5%	99.5%	99.5%	99.5%	99.5%	99.5%
21	99.7%	99.7%	99.7%	99.7%	99.7%	99.7%
22	99.8%	99.8%	99.8%	99.8%	99.8%	99.8%
23	99.9%	99.9%	99.9%	99.9%	99.9%	99.9%
24	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: California Department of Transportation, 2000-2001 California Statewide Travel Survey
Weekday Travel Report, June 2003

Operating Cost Tables

FUEL CONSUMPTION RATES		
<small>(gal/veh-mi)</small>		
Speed	Auto*	Truck
5	0.1439	0.2234
6	0.1366	0.2130
7	0.1293	0.2026
8	0.1220	0.1922
9	0.1147	0.1818
10	0.1074	0.1714
11	0.1025	0.1631
12	0.0977	0.1548
13	0.0929	0.1466
14	0.0880	0.1383
15	0.0832	0.1300
16	0.0800	0.1247
17	0.0767	0.1193
18	0.0735	0.1139
19	0.0702	0.1086
20	0.0670	0.1032
21	0.0648	0.0997
22	0.0626	0.0962
23	0.0603	0.0926
24	0.0581	0.0891
25	0.0559	0.0856
26	0.0544	0.0832
27	0.0529	0.0809
28	0.0515	0.0785
29	0.0500	0.0762
30	0.0485	0.0738
31	0.0475	0.0723
32	0.0465	0.0708
33	0.0455	0.0693
34	0.0445	0.0678
35	0.0435	0.0663
36	0.0429	0.0654
37	0.0423	0.0645
38	0.0417	0.0635
39	0.0411	0.0626
40	0.0405	0.0617
41	0.0402	0.0613
42	0.0400	0.0609
43	0.0397	0.0604
44	0.0394	0.0600
45	0.0391	0.0596
46	0.0391	0.0596
47	0.0391	0.0596
48	0.0391	0.0596
49	0.0391	0.0596
50	0.0390	0.0596
51	0.0393	0.0600
52	0.0396	0.0604
53	0.0399	0.0608
54	0.0401	0.0612
55	0.0404	0.0617
56	0.0410	0.0626
57	0.0416	0.0635
58	0.0422	0.0644
59	0.0428	0.0653
60	0.0433	0.0662
61	0.0443	0.0677
62	0.0453	0.0692
63	0.0462	0.0708
64	0.0472	0.0723
65	0.0482	0.0738
66	0.0488	0.0752
67	0.0495	0.0767
68	0.0502	0.0781
69	0.0509	0.0796
70	0.0515	0.0810
71	0.0516	0.0821
72	0.0516	0.0831
73	0.0516	0.0842
74	0.0517	0.0854
75	0.0517	0.0865
76	0.0518	0.0882
77	0.0518	0.0900
78	0.0519	0.0918
79	0.0519	0.0936
80	0.0520	0.0953

* Includes motorcycles & motorhomes
Note: Five mph is best estimate for idling

Source: California Air Resources Board,
EMFAC2011, 2011 & 2031 average

Accident Tables

HIGHWAY INJURY SEVERITY FREQUENCY (percent of injuries)				
Event	Urban	Suburban	Rural	Average
Severe Injury (A)	4.70%	4.70%	4.70%	4.70%
Other Visible Injury (B)	26.28%	26.28%	26.28%	26.28%
Complaint of Pain (C)	69.02%	69.02%	69.02%	69.02%

Source: 2009 SWITRS Annual Report, Table 8C

RATES FOR TRANSIT ACCIDENT EVENTS (events/million veh-mi)			
Event	Pass Train	Light Rail	Bus
Fatality	0.0428	0.1897	0.0351
Injury	0.2517	3.6283	3.8909
All Accidents	0.2519	7.4952	3.8924

Source: USDOT, Transportation Statistics Annual Report, Table 2-33, 2002 to 2008 average

NUMBER OF FATALITIES (events/accident)				
Accident Type	Urban	Suburban	Rural	Average
Fatal Accident	1.09	1.11	1.16	1.13

NUMBER OF INJURIES (events/accident)				
Accident Type	Urban	Suburban	Rural	Average
Fatal Accident	0.84	1.02	1.26	1.06
Injury Accident	1.42	1.43	1.51	1.44

NUMBER OF VEHICLES INVOLVED (events/accident)				
Accident Type	Urban	Suburban	Rural	Average
Fatal Accident	1.69	1.63	1.61	1.65
Injury Accident	2.08	1.97	1.58	1.96
PDO Accident	2.03	1.94	1.62	1.95

DISTRIBUTION OF ACCIDENT TYPES (percent of accidents)				
Accident Type	Urban	Suburban	Rural	Average
Fatal Accident	0.50%	0.74%	2.11%	0.83%
Injury Accident	32.08%	32.90%	37.91%	33.27%
PDO Accident	67.42%	66.37%	59.98%	65.90%

Source: California Department of Transportation, TASAS Unit, 2007 to 2009 average

COST OF TRANSIT ACCIDENT EVENTS (\$/event)			
Event	Pass Train	Light Rail	Bus
Fatality	\$9,200,000	\$9,200,000	\$9,200,000
Injury	\$513,400	\$513,400	\$513,400
Prop Damage	\$82,000	\$5,800	\$2,800

Source: FTA, Transit Safety & Security Statistics, 2002 to 2007 average

COSTS OF TRANSIT ACCIDENTS (\$/million veh-mi)			
Value	Pass Train	Light Rail	Bus
Cost	\$543,600	\$3,651,500	\$2,331,400

Source: Combination of above two tables

HIGHWAY-RAIL GRADE CROSSING INCIDENTS (units in table)			
Value	Incident	Fatality	Injury
Total Events	1,500	332	608
Avg per Incident		0.2213	0.4053
Cost per Event		\$9,200,000	\$513,400

Source: FRA, Office of Safety Analysis, 5.11 - Hwy/Rail Incidents Summary Tables, California, Jan 2001 to Dec 2010

COST OF HIGHWAY ACCIDENTS (\$/accident)				
Accident Type	Urban	Suburban	Rural	Average
Fatal Accident	\$10,200,000	\$10,400,000	\$10,900,000	\$10,600,000
Injury Accident	\$261,100	\$262,400	\$275,100	\$264,100
PDO Accident	\$15,900	\$15,200	\$12,700	\$15,300
All Types	\$145,400	\$172,900	\$342,100	\$185,700

Source: Combination of above four tables

PASSING LANE ACCIDENT REDUCTION FACTORS (rate with passing lane/rate without passing lane)			
Minimum ADT	Fatality	Injury	PDO
0	25.0%	69.4%	92.6%
5,000	19.2%	80.3%	96.5%
10,000	84.0%	57.7%	97.8%

Source: Taylor and Jain, 1991

HEALTH COST OF TRANSPORTATION EMISSIONS
(\$/ton)

Area	Proj Loc	CO	CO ₂ e	NO _x	PM ₁₀	SO _x	VOC
LA/South Coast	1	\$0	\$24	\$8,209	\$360,383	\$46,561	\$2,083
CA Urban Area	2	\$0	\$24	\$7,877	\$360,383	\$46,561	\$1,999
CA Rural Area	3	\$0	\$24	\$7,877	\$360,383	\$46,561	\$1,999

CO₂e Uprater increase in value per year

Sources: McCubbin and Delucchi, 1996 for emissions other than CO₂e
Interagency Working Group on Social Cost of Carbon, United States Government, 2010 for CO₂e

PASSENGER TRAIN EMISSIONS FACTORS
(g/train-mile)

Mode	Year	CO	CO ₂	NO _x	PM ₁₀	SO _x	VOC
Passenger Train	2002	45.67		583.58	62.02		19.73
	2022	45.67		250.11	31.01		19.73

LIGHT RAIL EMISSIONS FACTORS
(g/veh-mile)

Mode	Year	CO	CO ₂	NO _x	PM ₁₀	SO _x	VOC
Light Rail	2002	0.14		1.13	0.17		0.06
	2022	0.14		1.14	0.17		0.06

Source: California Air Resources Board

Pavement Adjustments (used only for pavement projects)

PAVEMENT DETERIORATION (IRI in inches/mile)			
Year 0	Year 20, By Loading		
	Light	Medium	Heavy
0	125	150	350
25	150	200	500
50	175	250	675
75	200	300	750
100	275	400	750
125	325	475	750
150	400	575	750
175	500	700	750
200	575	750	750
225	650	750	750
250	750	750	750
275	750	750	750
300	750	750	750
325	750	750	750
350	750	750	750
375	750	750	750
400	750	750	750
425	750	750	750
450	750	750	750

Source: Paterson, 1987

VEHICLE OPERATING SPEED (percent adjustment)		
IRI	Auto	Truck
0	1.00	1.02
25	1.00	1.02
50	1.00	1.02
75	1.00	1.02
100	1.00	1.02
125	1.00	1.02
150	1.00	1.01
175	1.00	1.00
200	1.00	0.98
225	1.00	0.95
250	1.00	0.92
275	0.99	0.89
300	0.98	0.86
325	0.97	0.83
350	0.96	0.81
375	0.95	0.78
400	0.94	0.76
425	0.93	0.73
450	0.92	0.71

Source: Botterill, 1996 and 1997

FUEL CONSUMPTION (percent adjustment)		
IRI	Auto	Truck
0	0.97	0.96
25	0.98	0.97
50	0.98	0.97
75	0.98	0.98
100	0.98	0.98
125	0.99	0.99
150	1.00	0.99
175	1.00	1.00
200	1.01	1.01
225	1.01	1.02
250	1.02	1.03
275	1.03	1.04
300	1.03	1.05
325	1.04	1.06
350	1.05	1.07
375	1.06	1.08
400	1.07	1.10
425	1.08	1.11
450	1.09	1.13

Source: Texas Transportation Institute, 1994

NON-FUEL COSTS (percent adjustment)		
IRI	Auto	Truck
0	1.00	1.00
25	1.00	1.00
50	1.00	1.00
75	1.00	1.00
100	1.00	1.00
125	1.00	1.00
150	1.02	1.02
175	1.03	1.04
200	1.05	1.06
225	1.07	1.08
250	1.09	1.10
275	1.11	1.12
300	1.12	1.14
325	1.14	1.16
350	1.16	1.18
375	1.18	1.20
400	1.19	1.22
425	1.21	1.24
450	1.23	1.26

Source: ARRB Research Board TR VOC Model

Weaving Adjustments (used only for freeway connector, HOV connector, and HOV drop ramp projects)

VEHICLE OPERATING SPEED (percent adjustment)		
Percent Weaving	Freeway Conn	HOV Project
0.000	1.00	1.00
0.002	0.98	0.99
0.004	0.96	0.98
0.006	0.95	0.96
0.008	0.93	0.95
0.010	0.91	0.94
0.012	0.89	0.93
0.014	0.87	0.92
0.016	0.85	0.90
0.018	0.84	0.89
0.020	0.79	0.88
0.022	0.75	0.87
0.024	0.71	0.85
0.026	0.66	0.84
0.028	0.62	0.82
0.030	0.58	0.79
0.032	0.54	0.76
0.034	0.50	0.73
0.036	0.48	0.71
0.038	0.47	0.68
0.040	0.47	0.65
0.042	0.47	0.62
0.044	0.47	0.60
0.046	0.46	0.57
0.048	0.46	0.54
0.050	0.46	0.51
0.052	0.46	0.48
0.054	0.45	0.48
0.056	0.45	0.47
0.058	0.45	0.47
0.060	0.45	0.47
0.062	0.45	0.47
0.064	0.45	0.47
0.066	0.45	0.47
0.068	0.45	0.46
0.070	0.45	0.46
0.072	0.45	0.46
0.074	0.45	0.46
0.076	0.45	0.46
0.078	0.45	0.46
0.080	0.45	0.45

Source: Fitzpatrick, Brewer, and Venglar, 2003

TMS Adjustments (used only for ramp metering, ramp metering signal coordination, incident management, traveler information projects, AVL, transit priority, and BRT projects)

PEAK PERIOD SPEED, VOLUME, AND NON-HIGHWAY BENEFITS (percent adjustment)								
TMS Strategy	Without		With		Non-Highway Benefits			Total Benefit
	Speed	Volume	Speed	Volume	TT	VOC	Em	
AMoth	1.02	0.95	1.02	0.95	-5.05	12.81	1.37	0.74
AMsev	1.53	0.94	1.53	0.94	1.21	1.38	-0.37	1.00
IMoth	0.88	1.18	0.98	0.96	0.51	0.15	0.06	0.74
IMsev	1.01	0.97	1.01	0.95	0.30	0.31	0.30	1.00
NoAdj	1.00	1.00	1.00	1.00	0.00	0.00	0.00	1.00
ORoth	0.98	1.03	1.00	1.00	-0.07	-0.03	-0.07	0.00
ORsev	0.95	1.03	1.00	1.00	0.00	0.00	5.67	0.00
RMoth	1.00	1.00	1.03	0.97	-0.07	-0.03	-0.07	1.00
RMsev	1.00	1.00	1.05	0.97	0.00	0.00	5.67	1.00
Tloth	1.00	1.00	1.02	0.97	-0.11	-0.12	-0.35	1.00
Tlsev	1.00	1.00	1.01	0.97	-0.39	-0.39	-0.35	1.00

Source: California Department of Transportation TMS Master Plan, 2003
18) Chaudhary and Messer, 2000

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TRANSIT TRAVEL TIME AND AGENCY COST SAVINGS (percent savings)			
TMS Strategy	Travel Time	Agency Costs	
		Capital	O&M
Transit Vehicle Location (AVL)	15%	2%	8%
Transit Vehicle Signal Priority	10%	-	-
Bus Rapid Transit (BRT)	29%	-	-

Sources: FHWA ITS Deployment Analysis System (IDAS), California PATH