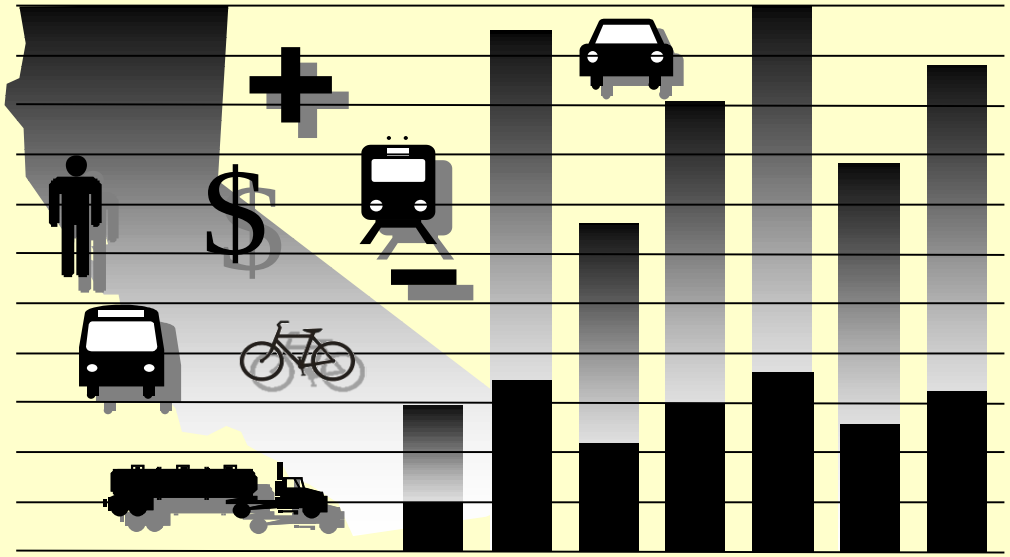
California Department Of Transportation

California Life-Cycle Benefit/Cost Analysis Model (Cal-B/C Sketch) Version 7.2



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CALIFORNIA LIFE-CYCLE BENEFIT/COST ANALYSIS MODEL (CAL-B/C)

INTRODUCTION

This spreadsheet model provides a method for preparing a simple economic analysis of both highway and transit projects. Given certain input data for a project, the model calculates its life-cycle costs, life-cycle benefits, net present value, benefit/cost ratio, internal rate of return, and payback period. Annual benefits are also calculated.

The model is arranged by worksheets and contains the following information, data, and results:

Worksheets	Contents
Instructions	General model description and assumptions
1) Project Information	Project input data
2) Model Inputs	Highway speed, volume, accident data, and trips estimated by model
3) Results	Summary results of analysis
Travel Time	Calculation of travel time and induced demand impacts
Vehicle Operating Costs	Calculation of highway vehicle operating cost impacts
Accident Costs	Calculation of accident cost impacts
Emissions	Calculation of emission impacts
Final Calculations	Calculation of net present value, internal rate of return, and payback period
Parameters	Economic assumptions, lookup tables, and other model parameters

The model is designed so that the user generally needs to enter data only in the green boxes on the Project Information worksheet. The model estimates detailed highway speed, volume, and accident data for the user to review on the Model Inputs worksheet. Highway speeds are estimated from volumes using relationships found in the Highway Capacity Manual. Other adjustments are made for weaving and pavement conditions. An option is also available to conduct a simple queuing analysis. Accidents are estimated from statewide averages and recent data for the facility. If available, inputs from regional planning or traffic simulation models can be entered to override model calculations. Summary results are shown in Results worksheet.

The remaining worksheets are provided for the user to see, but model performs calculations automatically. Some projects (i.e., truck only lanes, bypasses, intersections, and connectors) require the user to enter two sets of highway data, since two roads are involved. The model calculates benefits for the first road before the user enters information about the second road. The user clicks a button and the model clears the Project Information worksheet to receive information on other road.

In the process of economic analysis, some generally accepted economic assumptions are necessary. These assumptions include: the real and nominal discount rates, unit user costs (e.g., value of time), consumption rates (e.g., fuel consumption and vehicle emissions), and accident rates. These assumptions are given in the Parameters worksheet and should not be changed by the user.

After reading the instructions in this worksheet, the user should proceed to the Project Information worksheet and input data for the specific project in the green boxes (light gray when printed). The model provides default values in the red boxes (medium gray when printed). These values can be changed by the user, if information specific to the project is available. The model calculates some values based on relationships or assumptions, with results shown in the blue boxes (dark gray when printed). These values can be changed by the user.

INSTRUCTIONS

The user can analyze most projects simply by entering limited data on the Project Information Sheet and getting results on the Results page. The Model Inputs page allows the user to enter more detailed data adjust estimated speeds, volumes, and accidents rates, and check the number of trips estimated for projects that affect vehicle occupancy.

The user should account for induced demand, if applicable, in the inputs provided since Cal-B/C does not estimate it automatically. Induced demand is an unintended effect that may occur if a project alleviates traffic congestion by increasing roadway capacity (e.g., building new roadways or adding lane miles). With induced demand, the roadway network experiences an increase in vehicle-miles traveled (VMT) because the added roadway capacity reduces travel delay or the "price" of travel, enticing motorists to drive more. If there is enough extra demand, congestion relief may be temporary as VMT increases. Cal-B/C users can account for the effects of induced demand by making sure the extra travel is included in the ADT for the Build scenario, located in cell H38 of the Project Information tab.

PROJECT DATA (Box 1A)

This section provides general information about the project and is used for highway, rail, and transit projects. At the top of the sheet, the user can enter information about the project, such as the project name, Caltrans district, and funding information.

Type of Project

1. Please select the appropriate type of highway, rail, or transit project from the pull-down menu. The menu appears if user clicks on the green box next to the project type.

   For a truck only lane, bypass or intersection project, model reminds user that information must be entered for both roads impacted by project. After entering information for the first road, the user clicks a button at bottom of the worksheet to prepare model for data on the bypass or intersecting road. The user may also enter information for connector projects involving two roads.

Project Location

2. Insert a 1, 2, or 3 for the appropriate region of California. This information is used to estimate peak traffic and emissions benefits.

Length of Construction Period

3. Insert the number of construction years before benefits begin. This must be a whole number (round to next higher integer).

One- or Two-Way Data

4. Indicate whether Highway Design and Traffic Data to be entered in Box 1B is for a single direction or both directions of highway.

Length of Peak Period(s)

5. Insert the number of peak period hours per typical day. The model provides a default of 5 hours (statewide average). Model estimates total % daily traffic occurring during peak period using a lookup table developed from Traffic Census data. Model does not distinguish between weekdays and weekends.

   To model a 24-hour HOV or HOT lane, enter 24 hours so peak is 100% of ADT. To model a ramp metering project, user should enter the number of hours per day that metering is operational.

HIGHWAY DESIGN AND TRAFFIC DATA (Box 1B)

Highway design and traffic data must be entered for highway projects. Enter data consistent with one- or two-way answer in Box 1A. Statewide default values are provided for some inputs.

Highway Design

6. **Roadway Type:** Indicate if the road is a freeway, expressway, or conventional highway in build and no build cases.
7. **Number of General Traffic Lanes:** Insert number of general purpose (not HOV or bus) lanes in both directions for build and no build cases. Enter data consistent with Box 1A.
8. **Number of HOV Lanes:** Insert number of HOV lanes in both directions for the build and no build cases. A value must be provided if an HOV restriction is entered on the next row.
9. **HOV Restriction:** If highway facility has/will have HOV lanes, enter the HOV restriction (e.g., 2 means 2 people per vehicle). Must be entered for an HOV project. Enter for a non-HOV project, if facility has HOV lanes. Changes in HOV restrictions are special project types and handled automatically by model.
10. **Exclusive ROW for Buses:** If bus project, indicate (with "Y" or "N") whether buses have exclusive right-of-way. This information is used to estimate emissions.
11. **Highway Free-Flow Speed:** Insert free-flow speed for build and no build cases. Model assumes build is same as no build, if not entered.
12. **Ramp Design Speed:** If auxiliary lane or off-ramp project, enter the design speed of the appropriate on- or off-ramp. This is used to estimate the speed of traffic affected by weaving.
13. **Highway Segment:** Insert segment length for build and no build cases. Model assumes build is same as no build, if not entered.
14. **Impacted Length:** The model estimates an area affected by the project. In most cases, this equals the segment length. For passing lane projects, the default affected area is 3 miles longer than the project area. For auxiliary lane and off-ramp projects, the default affected area is 1500 feet. For connectors and HOV drop ramps, default affected area is 3250 feet. User can change these lengths.

Average Daily Traffic (ADT)

15. **Current**: For most projects, insert current two-way ADT on facility. For operational improvements, enter only the one-way ADT applicable to the project. Enter data consistent with one-way or two-way answer in Box 1A.
16. **Forecast (Year 20)**: Insert projected ADT for 20 years after construction completion for build and no build cases. Make sure to account for induced demand, if applicable. The model assumes build is same as no build, if not entered.

    The model uses the current and forecasted ADT to estimate annual traffic for 20 years after construction, assuming a linear trend. User can change base (Year 1) forecasts.

Average Hourly HOV/HOT Lane Traffic

17. Insert hourly HOV/HOT volumes for build and no build cases in a typical peak hour.

Percent Traffic in Weave

18. For operational improvements, insert % traffic affected by weaving. Model suggests a % based on the type of project (2 right lanes for auxiliary lanes, 3 right lanes for off-ramps, 2.5% of all traffic for freeway connectors, and 4% of HOV traffic for HOV connectors and drop ramps). The user can change values for project conditions.

Percent Trucks

19. Insert estimated % of ADT comprised of trucks in build and no build cases. Model provides a default value (statewide average).

Truck Speed

20. If passing lane project, enter estimated speed (in MPH) for slow vehicles (trucks, recreational vehicles, etc.). Values must be entered for passing lane projects.

On-Ramp Volume

21. **Hourly Ramp Volume**: If auxiliary lane or on-ramp widening project, insert average hourly ramp volume to estimate traffic affected by weaving for auxiliary lanes and metering effectiveness for on-ramp widening. No entry needed for ramp metering projects.
22. **Metering Strategy**: If on-ramp widening project, enter 1, 2, or 3 for vehicles allowed per green signal. Enter "D" for dual metering. No entry should be made for ramp metering projects.

Queue Formation

23. **Arrival Rate**: For queuing and rail grade crossing projects, enter vehicles per hour contributing to queue. Arrival rate should be estimated only for time queue grows. Model estimates queue dissipation automatically.
24. **Departure Rate**: For queuing and rail crossing projects, enter vehicles per hour leaving queue.

Pavement Condition (for Pavement Rehab. Projects)

25. If pavement rehabilitation project, enter base (Year 1) International Roughness Index (IRI) for build and no build. Model will calculate Year 20 values using standard parameters unless entered by user.

Average Vehicle Occupancy (AVO)

26. Model provides default values. The figures change automatically, depending on presence of HOV lanes. Adjust if project-specific data are available.

HIGHWAY ACCIDENT DATA (Box 1C)

Statewide default values are provided for transit projects. The model uses information provided to calculate accident rates for each accident type in the Model Inputs worksheet.

Actual 3-Year Accident Data (from Table B)

27. Insert the total number of fatal, injury, and property damage only accidents on the segment over the 3 most recent years. For rail grade crossing projects, enter 10-year accident data from FRA WBAPS in fatal and injury rows and collision prediction in total accident row.

Statewide Basic Average Accident Rate

28. Insert statewide average accident rates per million vehicle-miles (or million vehicles, as appropriate) for build and no build highway rate groups. Include Base Rate and ADT Factor where applicable.
29. Insert statewide % of accidents that are fatal and injury accidents for road classifications similar to build and no build facilities.

    The model uses adjustment factors (the ratio of actual rates to statewide rates for existing facility) to estimate accident rates by accident type for the new road classification. Additional adjustments (accident savings) are made for highway TMS projects. Results are presented in the Model Inputs worksheet and can be changed by the user.

RAIL AND TRANSIT DATA (Box 1D)

This section is used for rail and transit projects only.

Annual Person-Trips

30. **Base (Year 1)**: Insert estimated annual transit person-trips for first year after construction completion in build and no build cases. For a transit TMS project, enter only person-trips on routes affected. If the routes are substantially different, the benefits analysis should be split into pieces.
31. **Forecast (Year 20)**: Insert forecasted annual transit person-trips for 20 years after construction completion in build and no build cases.

Percent Trips during Peak Period

32. Insert % annual person-trips that occur during peak period.

Percent New Trips from Parallel Highway

33. Insert % new transit person-trips originating on parallel highway.

Annual Vehicle-Miles

34. **Base (Year 1)**: Insert estimated annual vehicle-miles for first year after construction completion in build and no build cases. For passenger rail projects, multiply the number of train-miles by the average number of rail cars per train consist.
35. **Forecast (Year 20)**: Insert forecasted annual vehicle-miles for 20 years after construction completion in build and no build cases.

Average Vehicles per Train

36. If passenger rail project, insert the average number of rail cars per train consist. This is used to calculate emissions.

Reduction in Transit Accidents

37. If project affects transit/rail safety, insert estimated percent accident reduction due to project. Increases should be entered as negative %.

Average Transit Travel Time

38. **In-Vehicle**: Insert average in-vehicle transit travel time in minutes during peak and non-peak periods in build and no build cases. For TMS Projects, insert the average for all transit routes impacted. Model assumes build is same as no build for most projects. Signal priority and bus rapid transit projects reduce time. User can adjust build travel times.
39. **Out-of-Vehicle**: Insert average out-of-vehicle transit travel time in minutes during peak and non-peak periods. Model monetizes out-of-vehicle travel time at a higher value.

Highway Grade Crossing

40. **Annual Number of Trains**: Insert annual number of passenger and freight trains entering highway-rail crossing.
41. **Average Gate Down Time**: Insert average time per train that crossing gate is down for passenger and freight trains.

Transit Agency Costs (for Transit TMS Projects

42. **Annual Capital Expenditure**: If transit TMS project, insert annual agency capital expenditures for routes impacted by project. Model calculates cost reductions for expenditures in build case due to transit TMS. Agency cost savings are entered automatically as a negative cost in Box 1E.
43. **Annual Ops. and Maintenance Expenditure**: If transit TMS project, insert the annual average operating and maintenance costs for routes impacted by project. Model calculates cost reductions for expenditures in build case due to transit TMS. Agency cost savings are entered automatically as a negative cost in Box 1E.

PROJECT COSTS (Box 1E)

Net project costs should be entered in the years they are expected to occur. Costs should be entered for construction period and for twenty years after construction completion. Construction Year 1 is the first year that costs are incurred. All costs should be entered in thousands of dollars.

44. Insert project's initial costs in constant (Year 2016) dollars for project development, right-of-way, and construction. The number of construction years with costs should equal the length of the construction period (Box 1A, Input 5).
45. Insert estimated future incremental maintenance/operating and rehabilitation costs in constant (Year 2016) dollars. These figures should be entered in the years after the project opens.
46. Insert estimated mitigation costs (e.g., wetlands, community, and sound walls) in constant (Year 2016) dollars during construction and for 20 years after construction completion.
47. Model adds agency cost savings due to transit TMS automatically.
48. Insert any other costs not already included.

HIGHWAY SPEED AND VOLUME INPUTS (Box 2A)

This section allows user to review detailed speed and volume data estimated by the model. These values are estimated from the inputs provided in the Project Information sheet.

49. User may enter new speed and volume data for the highway in the green boxes to override model calculations, if detailed data are available from a travel demand or micro-simulation model. The model estimates speeds and volumes on highway for HOVs, non-HOVs, weaving vehicles, and trucks during the peak and non-peak periods in Year 1 and Year 20 in build and no build cases. Speeds are estimated using a BPR curve (or queuing analysis). Adjustments are made to speed and volumes to account for weaving, transit mode shifts, pavement condition, and TMS.
50. If TMS project and detailed simulation data are available, the highway results should be inputted in the green cells. Model will use the data in place of figures estimated by the model.

HIGHWAY ACCIDENT RATES (Box 2B)

User may adjust accident rates calculated by the model. User may also enter TASAS highway accident data for rail grade crossing projects in this box.

51. **No Build**: Fatality, injury and PDO accident rates for no build facility are estimated using inputs from Box 1C of the Project Information sheet. User may change these rates in green boxes.
52. **Highway Safety or Weaving Improvement**: Model assumes an overall safety improvement for off-ramp and ramp metering projects. User may adjust this percentage. For safety projects, user should enter collision reduction factor from HSIP Guidelines.
53. **Adjustment Factor**: User may change the ratios of facility accident rates to statewide averages used in calculating rates for the build facility. These factors are also adjusted by the collision reduction factor.
54. **Build Facility**: User may modify the fatality, injury, and PDO accident rates for build facility. Model estimates these accident rates using statewide average rates and the adjustment factors.

RAMP AND ARTERIAL INPUTS (Box 2C)

This section allows users to enter detailed arterial information for an arterial signal management project or detailed ramp and arterial data for a highway TMS project.

55. Detailed Information Available: Input "Y" if detailed arterial and/or ramp data are available. Model automatically selects "Y" if other data are inputted. User should enter detailed ramp and arterial data for TMS highway project if detailed highway data are entered in Box 2A.
56. Aggregate Segment Length: Input the total segment lengths for the ramps and arterials. These can be estimated from travel demand or micro-simulation model data as VMT/total trips.
57. User may enter speeds and volumes on ramps and arterials during peak and non-peak periods in Year 1 and Year 20 in build and no build cases. If arterial signal management project, user must enter arterial data. Benefits are estimated assuming all vehicles are automobiles.

ANNUAL PERSON-TRIPS (Box 2D)

This section is for information purposes only. It allows user to examine number trips estimated for projects that affect AVO (e.g., HOT lane and HOV conversions).

NEXT STEPS

58. For bypass, intersection, and connector projects, click button on Project Information page after data are verified for the first road. Enter data for the second road in Boxes 1B and 1C. As with the first road, detailed data may be verified on Model Inputs page. Model prompts user to save interim version of analysis before proceeding.
59. Summary results are available immediately in the Results worksheet.

District: 6

PROJECT: Commercial IC

EA: 06-0U880
PPNO: 6940

1A PROJECT DATA

Type of Project	Check percent traffic in weave in section 1B	
Select project type from list	Freeway Connector	
Project Location (enter 1 for So. Cal., 2 for No. Cal., or 3 for rural)	3	
Length of Construction Period	3	years
One- or Two-Way Data	2	enter 1 or 2
	Current	
Length of Peak Period(s) (up to 24 hrs)	5	hours

1B HIGHWAY DESIGN AND TRAFFIC DATA

Highway Design		No Build	Build
Roadway Type (Fwy, Exp, Conv Hwy)		F	F
Number of General Traffic Lanes		4	4
Number of HOV/HOT Lanes			
HOV Restriction (2 or 3)			
Exclusive ROW for Buses (y/n)		N	
Highway Free-Flow Speed		70	70
Ramp Design Speed (if aux. lane/off-ramp proj.)		35	35
Length (in miles)	Highway Segment	3.5	3.5
	Impacted Length	3.5	3.5

Average Daily Traffic			
	Current	59,433	
		No Build	Build
	Base (Year 1)	65,283	65,283
	Forecast (Year 20)	102,336	102,336
Average Hourly HOV/HOT Lane Traffic			0
Percent of Induced Trips in HOV (if HOT or 2-to-3 conv.)			100%
Percent Traffic in Weave		2.5%	0.0%
Percent Trucks (include RVs, if applicable)		25%	25%
Truck Speed		55	55

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	1.30	1.30
	Peak	1.15	1.15
High Occupancy Vehicle (if HOV/HOT lanes)		2.15	2.15

1C HIGHWAY ACCIDENT DATA

Actual 3-Year Accident Data (from Table B)	Count (No.)	Rate
Total Accidents (Tot)	181	2.78
Fatal Accidents (Fat)	2	0.031
Injury Accidents (Inj)	35	0.54
Property Damage Only (PDO) Accidents	144	2.21

Statewide Basic Average Accident Rate	No Build	Build
Rate Group	H 63	H 64
Accident Rate (per million vehicle-miles)	1.26	0.81
Percent Fatal Accidents (Pct Fat)	0.7%	0.5%
Percent Injury Accidents (Pct Inj)	32.9%	32.0%

1D RAIL AND TRANSIT DATA

Annual Person-Trips		No Build	Build
	Base (Year 1)		
	Forecast (Year 20)		
Percent Trips during Peak Period		40%	
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					Mitigation	Transit Agency Cost Savings	TOTAL COSTS (in dollars)	
	INITIAL COSTS			SUBSEQUENT COSTS				Constant Dollars	Present Value
	Project Support	R / W	Construction	Maint./ Op.	Rehab.				
Construction Period									
1	$7,180	$5,500	$17,667					$30,346,667	$30,346,667
2			17,667					17,666,667	16,987,179
3			17,667					17,666,667	16,333,826
4								0	0
5								0	0
6								0	0
7								0	0
8								0	0
Project Open									
1				$50				$50,000	$44,450
2				50				50,000	42,740
3				50				50,000	41,096
4				50				50,000	39,516
5				50				50,000	37,996
6				50				50,000	36,535
7				50				50,000	35,129
8				50				50,000	33,778
9				50				50,000	32,479
10				50				50,000	31,230
11				50				50,000	30,029
12				50				50,000	28,874
13				50				50,000	27,763
14				50				50,000	26,695
15				50				50,000	25,669
16				50				50,000	24,681
17				50				50,000	23,732
18				50				50,000	22,819
19				50				50,000	21,942
20				50				50,000	21,098
Total	$7,180	$5,500	$53,000	$1,000	$0	$0	$0	$66,680,000	$64,295,924

Present Value = Future Value (in Constant Dollars) / (1 + Real Discount Rate) ^ Year

2A

HIGHWAY SPEED AND VOLUME INPUTS

	Calculated by Model	Changed by User	Used for Proj. Eval.	Reason for Change
No Build				
Year 1				
Peak Period				
HOV Volume	0		0	
Non-HOV Volume	19,732		19,732	
Weaving Volume	0		0	
Truck Volume	6,577		6,577	
HOV Speed	55.0		55.0	
Non-HOV Speed	49.3		49.3	
Weaving Speed	55.0		55.0	
Truck Speed	49.3		49.3	
Non-Peak Period				
Non-HOV Volume	29,231		29,231	
Weaving Volume	0		0	
Truck Volume	9,744		9,744	
Non-HOV Speed	49.4		49.4	
Weaving Speed	55.0		55.0	
Truck Speed	49.4		49.4	
Year 20				
Peak Period				
HOV Volume	0		0	
Non-HOV Volume	30,931		30,931	
Weaving Volume	0		0	
Truck Volume	10,310		10,310	
HOV Speed	55.0		55.0	
Non-HOV Speed	38.9		38.9	
Weaving Speed	55.0		55.0	
Truck Speed	38.9		38.9	
Non-Peak Period				
Non-HOV Volume	45,821		45,821	
Weaving Volume	0		0	
Truck Volume	15,274		15,274	
Non-HOV Speed	49.4		49.4	
Weaving Speed	55.0		55.0	
Truck Speed	49.4		49.4	
Build				
Year 1				
Peak Period				
HOV Volume	0		0	
Non-HOV Volume	19,732		19,732	
Weaving Volume	0		0	
Truck Volume	6,577		6,577	
HOV Speed	55.0		55.0	
Non-HOV Speed	69.8		69.8	
Weaving Speed	55.0		55.0	
Truck Speed	55.0		55.0	
Non-Peak Period				
Non-HOV Volume	29,231		29,231	
Weaving Volume	0		0	
Truck Volume	9,744		9,744	
Non-HOV Speed	70.0		70.0	
Weaving Speed	55.0		55.0	
Truck Speed	55.0		55.0	
Year 20				
Peak Period				
HOV Volume	0		0	
Non-HOV Volume	30,931		30,931	
Weaving Volume	0		0	
Truck Volume	10,310		10,310	
HOV Speed	55.0		55.0	
Non-HOV Speed	55.1		55.1	
Weaving Speed	55.0		55.0	
Truck Speed	55.0		55.0	
Non-Peak Period				
Non-HOV Volume	45,821		45,821	
Weaving Volume	0		0	
Truck Volume	15,274		15,274	
Non-HOV Speed	70.0		70.0	
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	0.031		0.031	
Injury Accidents	0.54		0.54	
PDO Accidents	2.21		2.21	
Total Accidents	2.781			

Hwy Safety or Weaving Improvement 0% collision reduction factor (per HSIP Guidelines)

Adjustment Factor (Actual/Statewide Avg. Existing)

Fatal Accidents	3.5054		3.5054	
Injury Accidents	1.2992		1.2992	
PDO Accidents	2.6345		2.6345	

Build				
Fatal Accidents	0.014		0.014	
Injury Accidents	0.34		0.34	
PDO Accidents	1.45		1.45	
Total Accidents	1.798			

2C

RAMP AND ARTERIAL INPUTS

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

Detailed Information Available? (y/n) 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	8,282,469	8,282,469	0
Truck Trips	2,400,716	2,400,716	0
Non-Peak Period			
Non-HOV Trips	13,869,942	13,869,942	0
Truck Trips	3,556,395	3,556,395	0
Total Trips	28,109,522	28,109,522	0
Year 20			
Peak Period			
HOV Trips	0	0	
Non-HOV Trips	12,983,311	12,983,311	0
Truck Trips	3,763,278	3,763,278	0
Non-Peak Period			
Non-HOV Trips	21,742,038	21,742,038	0
Truck Trips	5,574,882	5,574,882	0
Total Trips	44,063,509	44,063,509	0

District: 6

PROJECT: Commercial IC

EA: 06-0U880
PPNO: 6940

3

INVESTMENT ANALYSIS

SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$64.3
Life-Cycle Benefits (mil. $)	$193.9
Net Present Value (mil. $)	$129.6
Benefit / Cost Ratio:	3.0
Rate of Return on Investment:	16.4%
Payback Period:	6 years

ITEMIZED BENEFITS (mil. $)	Passenger Benefits	Freight Benefits	Total Over 20 Years	Average Annual
Travel Time Savings	$103.0	$31.0	$134.0	$6.7
Veh. Op. Cost Savings	-$18.2	-$3.3	-$21.4	-$1.1
Accident Cost Savings	$63.5	$21.2	$84.6	$4.2
Emission Cost Savings	-$1.8	-$1.5	-$3.3	-$0.2
TOTAL BENEFITS	$146.5	$47.4	$193.9	$9.7
Person-Hours of Time Saved			14,159,496	707,975

Should benefit-cost results include:

1) Induced Travel? (y/n)	Y	Default = Y
2) Vehicle Operating Costs? (y/n)	Y	Default = Y
3) Accident Costs? (y/n)	Y	Default = Y
4) Vehicle Emissions? (y/n) includes value for CO_2e	Y	Default = Y

EMISSIONS REDUCTION	Tons: Total Over 20 Years	Tons: Average Annual	Value (mil. $): Total Over 20 Years	Value (mil. $): Average Annual
CO Emissions Saved	124	6	$0.0	$0.0
CO_2 Emissions Saved	-74,125	-3,706	-$2.3	-$0.1
NO_X Emissions Saved	-42	-2	-$0.5	-$0.0
PM_{10} Emissions Saved	-6	0	-$0.4	-$0.0
$PM_{2.5}$ Emissions Saved	-6	0		
SO_X Emissions Saved	-1	0	-$0.0	-$0.0
VOC Emissions Saved	-10	-1	-$0.0	-$0.0

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	$2,095,618	$0	$493,064	$0	$0	$3,509,276	$0	$716,153
20	$0	$1,978,183	$0	$1,313,240	$0	$0	$2,611,017	$0	$532,842
2	$0	$2,098,603	$0	$541,159	$0	$0	$3,475,101	$0	$709,179
3	$0	$2,100,091	$0	$588,963	$0	$0	$3,438,363	$0	$701,682
4	$0	$2,100,184	$0	$636,407	$0	$0	$3,399,310	$0	$693,712
5	$0	$2,098,977	$0	$683,426	$0	$0	$3,358,176	$0	$685,318
6	$0	$2,096,563	$0	$729,965	$0	$0	$3,315,176	$0	$676,543
7	$0	$2,093,029	$0	$775,975	$0	$0	$3,270,517	$0	$667,429
8	$0	$2,088,458	$0	$821,411	$0	$0	$3,224,389	$0	$658,015
9	$0	$2,082,929	$0	$866,237	$0	$0	$3,176,971	$0	$648,339
10	$0	$2,076,518	$0	$910,421	$0	$0	$3,128,431	$0	$638,433
11	$0	$2,069,298	$0	$953,935	$0	$0	$3,078,926	$0	$628,330
12	$0	$2,061,336	$0	$996,759	$0	$0	$3,028,600	$0	$618,060
13	$0	$2,052,698	$0	$1,038,874	$0	$0	$2,977,591	$0	$607,650
14	$0	$2,043,446	$0	$1,080,269	$0	$0	$2,926,026	$0	$597,127
15	$0	$2,033,639	$0	$1,120,933	$0	$0	$2,874,022	$0	$586,514
16	$0	$2,023,335	$0	$1,160,862	$0	$0	$2,821,690	$0	$575,835
17	$0	$2,012,587	$0	$1,200,054	$0	$0	$2,769,133	$0	$565,109
18	$0	$2,001,446	$0	$1,238,510	$0	$0	$2,716,444	$0	$554,357
19	$0	$1,989,963	$0	$1,276,237	$0	$0	$2,663,711	$0	$543,595
Total	**$0**	**$41,196,900**	**$0**	**$18,426,700**	**$0**	**$0**	**$61,762,871**	**$0**	**$12,604,221**

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	$6,814,112	$7,664,949	505,205
20	$0	$0	$0	$0	$6,435,282	$15,251,096	936,112
2	$0	$0	$0	$0	$6,824,042	$7,983,163	524,272
3	$0	$0	$0	$0	$6,829,099	$8,308,643	543,662
4	$0	$0	$0	$0	$6,829,613	$8,641,640	563,388
5	$0	$0	$0	$0	$6,825,897	$8,982,415	583,460
6	$0	$0	$0	$0	$6,818,248	$9,331,243	603,892
7	$0	$0	$0	$0	$6,806,950	$9,688,412	624,694
8	$0	$0	$0	$0	$6,792,273	$10,054,224	645,882
9	$0	$0	$0	$0	$6,774,476	$10,428,994	667,470
10	$0	$0	$0	$0	$6,753,803	$10,813,056	689,471
11	$0	$0	$0	$0	$6,730,488	$11,206,758	711,902
12	$0	$0	$0	$0	$6,704,754	$11,610,465	734,779
13	$0	$0	$0	$0	$6,676,813	$12,024,563	758,119
14	$0	$0	$0	$0	$6,646,867	$12,449,457	781,940
15	$0	$0	$0	$0	$6,615,108	$12,885,573	806,261
16	$0	$0	$0	$0	$6,581,722	$13,333,361	831,103
17	$0	$0	$0	$0	$6,546,882	$13,793,294	856,486
18	$0	$0	$0	$0	$6,510,757	$14,265,871	882,432
19	$0	$0	$0	$0	$6,473,506	$14,751,619	908,966
Total	**$0**	**$0**	**$0**	**$0**	**$133,990,692**	**$223,468,795**	**14,159,496**

C

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	($498,833)	$0	($69,917)	$0	($791,749)	$0	($103,575)	-	-	($1,464,074)	($1,646,885)
20	$0	$39,766	$0	($88,035)	$0	($589,088)	$0	($77,063)	-	-	($714,420)	($1,693,117)
2	$0	($493,975)	$0	($65,686)	$0	($784,039)	$0	($102,566)	-	-	($1,446,266)	($1,691,926)
3	$0	($448,023)	$0	($64,991)	$0	($775,750)	$0	($101,482)	-	-	($1,390,247)	($1,691,448)
4	$0	($408,420)	$0	($59,044)	$0	($766,939)	$0	($100,329)	-	-	($1,334,732)	($1,688,862)
5	$0	($369,381)	$0	($58,329)	$0	($757,659)	$0	($99,115)	-	-	($1,284,484)	($1,690,294)
6	$0	($330,992)	$0	($54,195)	$0	($747,957)	$0	($97,846)	-	-	($1,230,990)	($1,684,695)
7	$0	($326,533)	$0	($53,465)	$0	($737,881)	$0	($96,528)	-	-	($1,214,407)	($1,728,480)
8	$0	($289,189)	$0	($49,416)	$0	($727,474)	$0	($95,166)	-	-	($1,161,246)	($1,718,928)
9	$0	($236,551)	$0	($61,674)	$0	($716,776)	$0	($93,767)	-	-	($1,108,767)	($1,706,896)
10	$0	($201,172)	$0	($60,731)	$0	($705,825)	$0	($92,334)	-	-	($1,060,063)	($1,697,195)
11	$0	($187,569)	$0	($72,353)	$0	($694,655)	$0	($90,873)	-	-	($1,045,450)	($1,740,752)
12	$0	($153,752)	$0	($71,171)	$0	($683,301)	$0	($89,388)	-	-	($997,612)	($1,727,541)
13	$0	($105,814)	$0	($82,141)	$0	($671,793)	$0	($87,882)	-	-	($947,630)	($1,706,628)
14	$0	($89,127)	$0	($80,719)	$0	($660,159)	$0	($86,360)	-	-	($916,365)	($1,716,334)
15	$0	($58,362)	$0	($91,030)	$0	($648,426)	$0	($84,826)	-	-	($882,643)	($1,719,301)
16	$0	($57,299)	$0	($89,372)	$0	($636,619)	$0	($83,281)	-	-	($866,571)	($1,755,515)
17	$0	($32,802)	$0	($99,025)	$0	($624,761)	$0	($81,730)	-	-	($838,318)	($1,766,209)
18	$0	$4,597	$0	($94,365)	$0	($612,874)	$0	($80,175)	-	-	($782,817)	($1,715,248)
19	$0	$22,538	$0	($92,533)	$0	($600,976)	$0	($78,618)	-	-	($749,590)	($1,708,142)
Total	**$0**	**($4,220,894)**	**$0**	**($1,458,194)**	**$0**	**($13,934,700)**	**$0**	**($1,822,904)**	**-**	**-**	**($21,436,692)**	**($34,194,393)**

C

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	$1,453,700	$0	$484,567	$0	$2,153,496	$0	$717,832	$0	$4,809,594	$5,410,139
20	$0	$1,081,601	$0	$360,534	$0	$1,602,272	$0	$534,091	$0	$3,578,496	$8,480,746
2	$0	$1,439,543	$0	$479,848	$0	$2,132,524	$0	$710,841	$0	$4,762,755	$5,571,750
3	$0	$1,424,324	$0	$474,775	$0	$2,109,979	$0	$703,326	$0	$4,712,405	$5,733,361
4	$0	$1,408,147	$0	$469,382	$0	$2,086,014	$0	$695,338	$0	$4,658,882	$5,894,972
5	$0	$1,391,107	$0	$463,702	$0	$2,060,772	$0	$686,924	$0	$4,602,505	$6,056,583
6	$0	$1,373,295	$0	$457,765	$0	$2,034,385	$0	$678,128	$0	$4,543,573	$6,218,194
7	$0	$1,354,795	$0	$451,598	$0	$2,006,979	$0	$668,993	$0	$4,482,366	$6,379,804
8	$0	$1,335,687	$0	$445,229	$0	$1,978,673	$0	$659,558	$0	$4,419,146	$6,541,415
9	$0	$1,316,044	$0	$438,681	$0	$1,949,574	$0	$649,858	$0	$4,354,158	$6,703,026
10	$0	$1,295,937	$0	$431,979	$0	$1,919,787	$0	$639,929	$0	$4,287,632	$6,864,637
11	$0	$1,275,429	$0	$425,143	$0	$1,889,408	$0	$629,803	$0	$4,219,782	$7,026,248
12	$0	$1,254,582	$0	$418,194	$0	$1,858,525	$0	$619,508	$0	$4,150,809	$7,187,859
13	$0	$1,233,452	$0	$411,151	$0	$1,827,223	$0	$609,074	$0	$4,080,900	$7,349,470
14	$0	$1,212,091	$0	$404,030	$0	$1,795,579	$0	$598,526	$0	$4,010,227	$7,511,081
15	$0	$1,190,549	$0	$396,850	$0	$1,763,667	$0	$587,889	$0	$3,938,955	$7,672,691
16	$0	$1,168,871	$0	$389,624	$0	$1,731,553	$0	$577,184	$0	$3,867,232	$7,834,302
17	$0	$1,147,099	$0	$382,366	$0	$1,699,301	$0	$566,434	$0	$3,795,200	$7,995,913
18	$0	$1,125,273	$0	$375,091	$0	$1,666,968	$0	$555,656	$0	$3,722,988	$8,157,524
19	$0	$1,103,429	$0	$367,810	$0	$1,634,608	$0	$544,869	$0	$3,650,716	$8,319,135
Total	**$0**	**$25,584,955**	**$0**	**$8,528,318**	**$0**	**$37,901,286**	**$0**	**$12,633,762**	**$0**	**$84,648,321**	**$138,908,850**

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	($50,307)	$0	($81,186)	$0	$0	($80,313)	$0	($120,268)
20	$0	($12,856)	$0	$39,298	$0	$0	($46,649)	$0	($38,908)
2	$0	($52,569)	$0	($68,660)	$0	$0	($80,898)	$0	($119,940)
3	$0	($48,883)	$0	($68,353)	$0	$0	($81,423)	$0	($119,524)
4	$0	($46,630)	$0	($55,654)	$0	$0	($81,890)	$0	($119,025)
5	$0	($42,970)	$0	($55,248)	$0	$0	($82,301)	$0	($118,449)
6	$0	($41,207)	$0	($42,455)	$0	$0	($82,659)	$0	($117,804)
7	$0	($41,422)	$0	($41,994)	$0	$0	($82,966)	$0	($117,093)
8	$0	($27,205)	$0	$2,359	$0	$0	($45,873)	$0	($41,889)
9	$0	($26,057)	$0	$8,413	$0	$0	($46,061)	$0	($41,725)
10	$0	($24,825)	$0	$8,308	$0	$0	($46,223)	$0	($41,542)
11	$0	($25,133)	$0	$14,154	$0	$0	($46,361)	$0	($41,341)
12	$0	($23,865)	$0	$13,985	$0	$0	($46,475)	$0	($41,123)
13	$0	($22,770)	$0	$19,675	$0	$0	($46,567)	$0	($40,890)
14	$0	($21,303)	$0	$19,436	$0	$0	($46,637)	$0	($40,642)
15	$0	($20,044)	$0	$24,975	$0	$0	($46,686)	$0	($40,380)
16	$0	($20,069)	$0	$24,662	$0	$0	($46,715)	$0	($40,107)
17	$0	($18,790)	$0	$29,889	$0	$0	($46,726)	$0	($39,822)
18	$0	($15,891)	$0	$34,926	$0	$0	($46,717)	$0	($39,527)
19	$0	($14,271)	$0	$34,462	$0	$0	($46,692)	$0	($39,222)
Total	**$0**	**($597,065)**	**$0**	**($139,010)**	**$0**	**$0**	**($1,176,831)**	**$0**	**($1,359,222)**

C

SUMMARY OF EMISSION REDUCTION BENEFITS (continued)

Year	TRANSIT				Present Value of Emission Benefits	Constant Dollars
	Peak Bus	Non-Peak Bus	Passenger Rail	Light Rail		
1	$0	$0	$0	$0	($332,075)	($373,539)
20	$0	$0	$0	$0	($59,115)	($140,097)
2	$0	$0	$0	$0	($322,068)	($376,774)
3	$0	$0	$0	$0	($318,183)	($387,118)
4	$0	$0	$0	$0	($303,198)	($383,642)
5	$0	$0	$0	$0	($298,968)	($393,422)
6	$0	$0	$0	$0	($284,124)	($388,844)
7	$0	$0	$0	$0	($283,475)	($403,474)
8	$0	$0	$0	$0	($112,608)	($166,687)
9	$0	$0	$0	$0	($105,430)	($162,304)
10	$0	$0	$0	$0	($104,282)	($166,960)
11	$0	$0	$0	$0	($98,681)	($164,311)
12	$0	$0	$0	$0	($97,478)	($168,801)
13	$0	$0	$0	$0	($90,551)	($163,078)
14	$0	$0	$0	$0	($89,145)	($166,967)
15	$0	$0	$0	$0	($82,135)	($159,991)
16	$0	$0	$0	$0	($82,230)	($166,582)
17	$0	$0	$0	$0	($75,449)	($158,959)
18	$0	$0	$0	$0	($67,210)	($147,265)
19	$0	$0	$0	$0	($65,722)	($149,766)
Total	**$0**	**$0**	**$0**	**$0**	**($3,272,128)**	**($4,788,581)**

C

SUMMARY OF EMISSION REDUCTION BENEFITS (continued)

Year	TONS EMISSIONS SAVED (tons/yr)						
	CO	CO_2	NO_X	PM_{10}	SO_X	VOC	$PM_{2.5}$
1	3	(5,134)	(8)	(0)	(0)	(1)	(0)
20	8	(2,781)	3	(0)	(0)	(0)	(0)
2	4	(5,116)	(8)	(0)	(0)	(1)	(0)
3	5	(5,178)	(8)	(0)	(0)	(1)	(0)
4	6	(5,054)	(8)	(0)	(0)	(1)	(0)
5	7	(5,101)	(8)	(1)	(0)	(1)	(0)
6	8	(4,952)	(8)	(1)	(0)	(1)	(1)
7	8	(5,081)	(8)	(1)	(0)	(1)	(1)
8	5	(3,002)	(1)	(0)	(0)	(0)	(0)
9	5	(2,978)	(0)	(0)	(0)	(0)	(0)
10	5	(3,008)	(0)	(0)	(0)	(0)	(0)
11	6	(3,019)	0	(0)	(0)	(0)	(0)
12	6	(3,045)	0	(0)	(0)	(0)	(0)
13	6	(3,006)	1	(0)	(0)	(0)	(0)
14	6	(3,019)	1	(0)	(0)	(0)	(0)
15	7	(2,964)	1	(0)	(0)	(0)	(0)
16	7	(3,027)	1	(0)	(0)	(0)	(0)
17	7	(2,965)	2	(0)	(0)	(0)	(0)
18	8	(2,850)	3	(0)	(0)	(0)	(0)
19	8	(2,847)	3	(0)	(0)	(0)	(0)
Total	**124**	**(74,125)**	**(42)**	**(6)**	**(1)**	**(10)**	**(6)**

C

SUMMARY OF EMISSION REDUCTION BENEFITS (continued)

Year	DOLLARS EMISSIONS SAVED (PV $/yr)					
	CO	CO_2	NO_X	PM_{10}	SO_X	VOC
1	$229	($184,046)	($99,701)	($45,110)	($2,556)	($890)
20	$264	($68,929)	$20,153	($9,902)	($610)	($91)
2	$242	($179,884)	($94,797)	($44,320)	($2,443)	($866)
3	$283	($178,553)	($92,954)	($43,851)	($2,285)	($822)
4	$338	($170,920)	($87,186)	($42,494)	($2,173)	($762)
5	$376	($169,191)	($85,310)	($41,980)	($2,146)	($717)
6	$428	($161,096)	($79,655)	($41,107)	($2,034)	($660)
7	$422	($162,104)	($78,582)	($40,554)	($2,007)	($651)
8	$246	($93,928)	($7,061)	($10,517)	($1,123)	($224)
9	$256	($91,401)	($2,491)	($10,603)	($985)	($205)
10	$252	($90,539)	($2,392)	($10,441)	($970)	($193)
11	$262	($89,138)	$1,883	($10,587)	($916)	($185)
12	$257	($88,159)	$1,912	($10,414)	($901)	($174)
13	$266	($85,368)	$6,056	($10,464)	($885)	($156)
14	$256	($84,079)	$5,979	($10,283)	($870)	($149)
15	$259	($80,977)	$9,857	($10,318)	($818)	($138)
16	$254	($81,092)	$9,677	($10,130)	($803)	($135)
17	$256	($77,906)	$13,335	($10,221)	($788)	($125)
18	$263	($73,440)	$17,015	($10,164)	($773)	($111)
19	$252	($71,958)	$16,711	($9,967)	($656)	($105)
Total	**$5,660**	**($2,282,708)**	**($527,550)**	**($433,429)**	**($26,742)**	**($7,357)**

A

NET PRESENT VALUE CALCULATION

Year	PRESENT VALUE OF USER BENEFITS: Travel Time Savings	Vehicle Op. Cost Savings	Accident Reductions	Vehicle Emission Reductions	PRESENT VALUE OF USER BENEFITS (road 2): 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	$6,814,112	($1,464,074)	$4,809,594	($332,075)				
2	$6,824,042	($1,446,266)	$4,762,755	($322,068)				
3	$6,829,099	($1,390,247)	$4,712,405	($318,183)				
4	$6,829,613	($1,334,732)	$4,658,882	($303,198)				
5	$6,825,897	($1,284,484)	$4,602,505	($298,968)				
6	$6,818,248	($1,230,990)	$4,543,573	($284,124)				
7	$6,806,950	($1,214,407)	$4,482,366	($283,475)				
8	$6,792,273	($1,161,246)	$4,419,146	($112,608)				
9	$6,774,476	($1,108,767)	$4,354,158	($105,430)				
10	$6,753,803	($1,060,063)	$4,287,632	($104,282)				
11	$6,730,488	($1,045,450)	$4,219,782	($98,681)				
12	$6,704,754	($997,612)	$4,150,809	($97,478)				
13	$6,676,813	($947,630)	$4,080,900	($90,551)				
14	$6,646,867	($916,365)	$4,010,227	($89,145)				
15	$6,615,108	($882,643)	$3,938,955	($82,135)				
16	$6,581,722	($866,571)	$3,867,232	($82,230)				
17	$6,546,882	($838,318)	$3,795,200	($75,449)				
18	$6,510,757	($782,817)	$3,722,988	($67,210)				
19	$6,473,506	($749,590)	$3,650,716	($65,722)				
20	$6,435,282	($714,420)	$3,578,496	($59,115)				
Total	$133,990,692	($21,436,692)	$84,648,321	($3,272,128)	$0	$0	$0	$0

14,159,496	Person-Hours of Time Saved		
tons	$ PV		
124	$5,660	CO Saved	
(74,125)	($2,282,708)	CO_2 Saved	
(42)	($527,550)	NO_X Saved	
(6)	($433,429)	PM_{10} Saved	
(6)		$PM_{2.5}$ Saved	
(1)	($26,742)	SO_X Saved	
(10)	($7,357)	VOC Saved	
$31,030,922	($3,281,098)	$21,162,080	($1,498,232)

	Person-Hours of Time Saved	
tons	$ PV	
		CO Saved
		CO_2 Saved
		NO_X Saved
		PM_{10} Saved
		$PM_{2.5}$ Saved
		SO_X Saved
		VOC Saved

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	$30,346,667	($30,346,667)
				$0	$16,987,179	($16,987,179)
				$0	$16,333,826	($16,333,826)
				$0	$0	$0
				$0	$0	$0
				$0	$0	$0
				$0	$0	$0
				$0	$0	$0
				$9,827,556	$44,450	$9,783,107
				$9,818,463	$42,740	$9,775,723
				$9,833,074	$41,096	$9,791,978
				$9,850,565	$39,516	$9,811,049
				$9,844,950	$37,996	$9,806,954
				$9,846,707	$36,535	$9,810,172
				$9,791,433	$35,129	$9,756,304
				$9,937,565	$33,778	$9,903,787
				$9,914,437	$32,479	$9,881,958
				$9,877,090	$31,230	$9,845,860
				$9,806,139	$30,029	$9,776,111
				$9,760,473	$28,874	$9,731,600
				$9,719,531	$27,763	$9,691,768
				$9,651,584	$26,695	$9,624,889
				$9,589,285	$25,669	$9,563,616
				$9,500,153	$24,681	$9,475,471
				$9,428,316	$23,732	$9,404,583
				$9,383,718	$22,819	$9,360,899
				$9,308,910	$21,942	$9,286,968
				$9,240,244	$21,098	$9,219,146
$0	$0	$0	$0	**$193,930,193**	**$64,295,924**	**$129,634,270**

Person-Hours of Time Saved

tons	$ PV	
		CO Saved
		CO_2 Saved
		NO_X Saved
		PM_{10} Saved
		$PM_{2.5}$ Saved
		SO_X Saved
		VOC Saved

Freight Benefits Only

B

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	$7,664,949	($1,646,885)	$5,410,139	($373,539)				
2	$7,983,163	($1,691,926)	$5,571,750	($376,774)				
3	$8,308,643	($1,691,448)	$5,733,361	($387,118)				
4	$8,641,640	($1,688,862)	$5,894,972	($383,642)				
5	$8,982,415	($1,690,294)	$6,056,583	($393,422)				
6	$9,331,243	($1,684,695)	$6,218,194	($388,844)				
7	$9,688,412	($1,728,480)	$6,379,804	($403,474)				
8	$10,054,224	($1,718,928)	$6,541,415	($166,687)				
9	$10,428,994	($1,706,896)	$6,703,026	($162,304)				
10	$10,813,056	($1,697,195)	$6,864,637	($166,960)				
11	$11,206,758	($1,740,752)	$7,026,248	($164,311)				
12	$11,610,465	($1,727,541)	$7,187,859	($168,801)				
13	$12,024,563	($1,706,628)	$7,349,470	($163,078)				
14	$12,449,457	($1,716,334)	$7,511,081	($166,967)				
15	$12,885,573	($1,719,301)	$7,672,691	($159,991)				
16	$13,333,361	($1,755,515)	$7,834,302	($166,582)				
17	$13,793,294	($1,766,209)	$7,995,913	($158,959)				
18	$14,265,871	($1,715,248)	$8,157,524	($147,265)				
19	$14,751,619	($1,708,142)	$8,319,135	($149,766)				
20	$15,251,096	($1,693,117)	$8,480,746	($140,097)				
Total	$223,468,795	($34,194,393)	$138,908,850	($4,788,581)	$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	$30,346,667	($30,346,667)	
				$0	$17,666,667	($17,666,667)	
				$0	$17,666,667	($17,666,667)	
				$0	$0	$0	
				$0	$0	$0	
				$0	$0	$0	
				$0	$0	$0	
				$0	$0	$0	
				$11,054,664	$50,000	$11,004,664	$11,004,664
				$11,486,213	$50,000	$11,436,213	$22,440,877
				$11,963,438	$50,000	$11,913,438	$34,354,316
				$12,464,107	$50,000	$12,414,107	$46,768,423
				$12,955,282	$50,000	$12,905,282	$59,673,705
				$13,475,898	$50,000	$13,425,898	$73,099,603
				$13,936,263	$50,000	$13,886,263	$86,985,866
				$14,710,024	$50,000	$14,660,024	$101,645,890
				$15,262,820	$50,000	$15,212,820	$116,858,709
				$15,813,539	$50,000	$15,763,539	$132,622,249
				$16,327,943	$50,000	$16,277,943	$148,900,191
				$16,901,982	$50,000	$16,851,982	$165,752,173
				$17,504,326	$50,000	$17,454,326	$183,206,500
				$18,077,236	$50,000	$18,027,236	$201,233,736
				$18,678,972	$50,000	$18,628,972	$219,862,708
				$19,245,566	$50,000	$19,195,566	$239,058,274
				$19,864,039	$50,000	$19,814,039	$258,872,313
				$20,560,883	$50,000	$20,510,883	$279,383,196
				$21,212,846	$50,000	$21,162,846	$300,546,042
				$21,898,628	$50,000	$21,848,628	$322,394,671
$0	$0	$0	$0	**$323,394,671**	**$66,680,000**	**$256,714,671**	

Total Construction Costs **$65,680,000**

Years After Construction Begins	ANNUAL RETURNS ON INVESTMENT
1	($30,346,667)
2	($17,666,667)
3	($17,666,667)
4	$11,004,664
5	$11,436,213
6	$11,913,438
7	$12,414,107
8	$12,905,282
9	$13,425,898
10	$13,886,263
11	$14,660,024
12	$15,212,820
13	$15,763,539
14	$16,277,943
15	$16,851,982
16	$17,454,326
17	$18,027,236
18	$18,628,972
19	$19,195,566
20	$19,814,039
21	$20,510,883
22	$21,162,846
23	$21,848,628
24	$0
25	$0
26	$0
27	$0
28	$0

Internal Rate of Return **16.36%**

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.

Payback Period **6 years**

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	2016	
Economic Update Factor (Using GDP Deflator)	1.00	1
Real Discount Rate	4.0%	2

Travel Time Parameters

	Value	Units	
Statewide Average Hourly Wage	$ 27.34	$/hr	3
Heavy and Light Truck Drivers			
Average Hourly Wage	$ 20.44	$/hr	3
Benefits and Costs	$ 10.97	$/hr	4
Value of Time			
Automobile	$ 13.65	$/hr/per	5
Truck	$ 31.40	$/hr/veh	5
Auto & Truck Composite	$ 18.95	$/hr/veh	6
Transit	$ 13.65	$/hr/per	5
Out-of-Vehicle Travel	2	times	5
Incident-Related Travel	3	times	7
Travel Time Uprater	0.0%	annual incr	

Vehicle Operating Cost Parameters

Average Fuel Price			
Automobile (regular unleaded)	$ 3.18	$/gal	8
Truck (diesel)	$ 3.00	$/gal	8
Sales and Fuel Taxes			
State Sales Tax (gasoline)	2.25%	%	9
State Sales Tax (diesel)	7.50%	%	9
Average Local Sales Tax	0.50%	%	9
Federal Fuel Excise Tax (gasoline)	$ 0.184	$/gal	9
Federal Fuel Excise Tax (diesel)	$ 0.244	$/gal	9
State Fuel Excise Tax (gasoline)	$ 0.278	$/gal	9
State Fuel Excise Tax (diesel)	$ 0.160	$/gal	9
Fuel Cost Per Gallon (Exclude Taxes)			
Automobile	$ 2.65	$/gal	
Truck	$ 2.40	$/gal	
Non-Fuel Cost Per Mile			
Automobile	$ 0.313	$/mi	10
Truck	$ 0.429	$/mi	11
Idling Speed for Op. Costs and Emissions	5	mph	

Accident Cost Parameters

Cost of a Fatality	$ 9,800,000	$/event	12
Cost of an Injury			
Level A (Severe)	$ 466,400	$/event	12
Level B (Moderate)	$ 127,000	$/event	12
Level C (Minor)	$ 64,900	$/event	12
Cost of Property Damage	$ 2,700	$/event	13
Cost of Highway Accident			
Fatal Accident	$ 11,300,000	$/accident	
Injury Accident	$ 154,200	$/accident	
PDO Accident	$ 8,600	$/accident	
Average Cost	$ 281,100	$/accident	
Statewide Highway Accident Rates			
Fatal Accident	0.006	per mil veh-mi	14
Injury Accident	0.29	per mil veh-mi	14
PDO Accident	0.55	per mil veh-mi	14
Non-Freeway	1.05	per mil veh-mi	15

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) USDOT VSL, 13) NHTSA, 14) TASAS summary 2013, 15) TASAS summary 2009

Highway Operations Parameters

	Value	Units	
Maximum V/C Ratio	1.56	-	16
Percent ADT in Peak Period	40.3%	%	
Percent ADT in Average Peak Hour	8.1%	%	
Annualization Factor	365	days/yr	

	Alpha	Beta	Capacity (vphpl)	Dep. Rate (vphpl)	
Freeway	0.20	10	2,000	1,800	16, 17
Expressway	0.20	10	2,000	1,800	16, 17
Conventional Highway	0.05	10	800	1,400	17
HOV Lanes	0.55	8	1,600		18

Non-HOV Lanes	Alpha	Beta	Capacity (vphpl)
No Build	0.20	10	2,000
Build	0.20	10	2,000

Sources: 16) Highway Capacity Manual, 17) NCHRP 387, 18) PeMS data

Active Transportation Parameters

General Travel Activity Characteristics Parameters	Value	Units	
Cycling Days per Year	365	days	
Walking Days per Year	365	days	
School Days per Year	180	days	
Vehicle Statistics			
Average Vehicle Speed	25	mph	
Average Vehicle Occupancy	1.25	persons / veh	*19*
Active Transportation User Characteristics			
Average Cycling Speed	11.80	mph	*20*
Average Walking Speed	3.00	mph	*21*
Number of Unlinked Cycling Trips per Day	1.93	trips	*19*
Number of Unlinked Pedestrian Trips per Day	2.38	trips	*19*
Diversion of Cyclists from Personal Vehicles	50%	assumption	
Diversion of Pedestrians from Personal Vehicles	50%	assumption	
Value of Travel Time			
Adults	$ 13.65	$/hr/per	
Children	$ 13.65	$/hr/per	
Cycling Journey Quality - Facility Preference Factors as Function of Distance by Facility Class			
Class I	0.57	-	*20*
Class II	0.49	-	*20*
Class III	0.92	-	*20*
Class IV	0.49	-	*20*
Note: Class IV assumed to be the same as Class II			
Walking Journey Quality Values per Mile by Amentity			
Street Lighting	$0.110	$/mi	*22*
Curb Level	$0.078	$/mi	*22*
Crowding	$0.055	$/mi	*22*
Pavement Evenness	$0.026	$/mi	*22*
Information Panels	$0.026	$/mi	*22*
Benches	$0.017	$/mi	*22*
Directional Signage	$0.017	$/mi	*22*
Health (Absenteeism Reduction)			
Average Absence of Employees	3.60	days/yr	*23*
Percentage Covered by Short-Term Sick Leave	95%	%	*24*
Percentage of Sick Days Reduced When Active at Least 30 Minutes per Day	6%	%	*25*
Health (Mortality Reduction)			
Percentage of Cyclists Aged 16-64	66.0%	%	*26*
Percentage of Pedestrians Aged 16-74	70.0%	%	*26*
Percentage Reduction in Mortality per 365 Annual Cycling Miles	4.5%	%	*27*
Percentage Reduction in Mortality per 365 Annual Walking Miles	9.0%	%	*27*
Morality Rate - All Causes (Aged 20-64)	266	#/100,000 people	*28*
Morality Rate - All Causes (Aged 20-74)	395	#/100,000 people	*28*

Sources: 19) 2000-2001 California Statewide Travel Survey, 20) Hood et al., 2011, 21) WHO HEAT Model, 2012, 22) Heuman et al., 2005, 23) CDC, 2007, 24) UK TAG, 2014, 25) WHO, 2003, 26) 2010-2012 California Household Transporation Survey, 27) WHO HEAT Model, 2016, 28) California Department of Health, 2010-2014 Death Rates, Table 5.2

Travel Demand Tables

Project Types

Highway Capacity Expansion			Please select a type of highway project
General Highway	FALSE	GenHwy	
HOV Lane Addition	FALSE	HOV	Enter HOV restriction in section 1B
HOT Lane Addition	FALSE	HOT	Include toll payers as HOVs & check AVOs
Passing Lane	FALSE	Passing	Enter a truck speed in section 1B
Intersection	FALSE	Intersect	Remember to run model for both roads
Truck Only Lane	FALSE	TruckLane	Remember to run macro for truck lane
Bypass	FALSE	Bypass	Remember to run model for both roads
Queuing	FALSE	Queuing	Add arrival rate & check departure rate in 1B
Pavement	FALSE	Pavement	Enter pavement condition in section 1B
Rail or Transit Cap Expansion			Please select a type of rail or transit project
Passenger Rail	FALSE	PassRail	Enter data in both sections 1B & 1E
Light-Rail (LRT)	FALSE	LRT	Enter data in both sections 1B & 1E
Bus	FALSE	Bus	Enter data in both sections 1B & 1E
Hwy-Rail Grade Crossing	FALSE	HwyRail	Put hwy design in 1B, safety in 1C & crossing in 1D
Hwy Operational Improvement			Please select a type of op. improvement
Auxiliary Lane	FALSE	AuxLane	Enter ramp design speed & on-ramp volume
Freeway Connector	TRUE	FreeConn	Check percent traffic in weave in section 1B
HOV Connector	FALSE	HOVConn	Check percent traffic in weave in section 1B
HOV Drop Ramp	FALSE	HOVDrop	Check percent traffic in weave in section 1B
Off-Ramp Widening	FALSE	OffRamp	Check percent traffic in weave in section 1B
On-Ramp Widening	FALSE	OnRamp	Enter on-ramp volume & metering strategy
HOV-2 to HOV-3 Conv	FALSE	HOV2to3	Check AVOs & trips in sections 1B & 2D
HOT Lane Conversion	FALSE	HOTConv	Check AVOs & trips in sections 1B & 2D
Transp Mgmt Systems (TMS)			Please select a type of TMS project
Ramp Metering	FALSE	RM	Enter model data, if avail, in sections 2A & 2C
Ramp Metering Signal Coord	FALSE	AM	Enter model data, if avail, in sections 2A & 2C
Incident Management	FALSE	IM	Enter model data, if avail, in sections 2A & 2C
Traveler Information	FALSE	TI	Enter model data, if avail, in sections 2A & 2C
Arterial Signal Management	FALSE	ASM	Complete only sections 1A, 1E & 2C
Transit Vehicle Location (AVL)	FALSE	AVL	Enter transit agency costs in section 1D
Transit Vehicle Signal Priority	FALSE	SigPriority	Check travel time in section 1D
Bus Rapid Transit (BRT)	FALSE	BRT	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
1	8.5%	8.5%	8.5%	8.5%	8.5%	8.5%
2	16.8%	16.8%	16.8%	16.8%	16.8%	16.8%
3	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%
4	32.8%	32.8%	32.8%	32.8%	32.8%	32.8%
5	40.3%	40.3%	40.3%	40.3%	40.3%	40.3%
6	47.4%	47.4%	47.4%	47.4%	47.4%	47.4%
7	54.2%	54.2%	54.2%	54.2%	54.2%	54.2%
8	60.8%	60.8%	60.8%	60.8%	60.8%	60.8%
9	67.1%	67.1%	67.1%	67.1%	67.1%	67.1%
10	73.4%	73.4%	73.4%	73.4%	73.4%	73.4%
11	79.0%	79.0%	79.0%	79.0%	79.0%	79.0%
12	84.3%	84.3%	84.3%	84.3%	84.3%	84.3%
13	88.6%	88.6%	88.6%	88.6%	88.6%	88.6%
14	91.6%	91.6%	91.6%	91.6%	91.6%	91.6%
15	94.3%	94.3%	94.3%	94.3%	94.3%	94.3%
16	96.4%	96.4%	96.4%	96.4%	96.4%	96.4%
17	97.6%	97.6%	97.6%	97.6%	97.6%	97.6%
18	98.5%	98.5%	98.5%	98.5%	98.5%	98.5%
19	99.1%	99.1%	99.1%	99.1%	99.1%	99.1%
20	99.4%	99.4%	99.4%	99.4%	99.4%	99.4%
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, 2010-2012 California Household Travel Survey, Final Report Appendix, June 2013

AGE COHORTS FOR MORTALITY RISK REDUCTION

(percent of population)

Mode	Age Cohort	Urban		Rural
		South	North	
Cycling	Age 16-64	70.5%	73.4%	66.0%
Walking	Age 16-74	76.2%	80.7%	70.0%

AVERAGE DISTANCE PER ACTIVE TRANSPORTATION TRIP

(miles/trip)

Mode	Age Cohort	Urban		Rural
		South	North	
Cycling	Adults	1.83	1.85	2.91
	Children <16	0.88	1.03	1.66
Walking	Adults	0.52	0.66	0.29
	Children <16	0.46	0.58	0.42

TRIP PURPOSE FOR ACTIVE TRANSPORTATION TRIPS

(percent of trips)

Mode	Trip Purpose	Urban		Rural
		South	North	
Cycling	Commuting	8%	11%	7%
	Recreation	15%	13%	15%
	Other Destination	77%	76%	78%
Walking	Commuting	5%	9%	4%
	Recreation	10%	10%	15%
	Other Destination	85%	81%	81%

Source: California Department of Transportation, 2010-2012 California Household Travel Survey database, 2012

Operating Cost Tables

FUEL CONSUMPTION RATES

(gal/veh-mi)

Speed	Auto*	Truck
5	0.1024	0.2112
6	0.0971	0.2056
7	0.0919	0.2000
8	0.0867	0.1944
9	0.0815	0.1888
10	0.0763	0.1832
11	0.0727	0.1707
12	0.0691	0.1583
13	0.0656	0.1459
14	0.0620	0.1335
15	0.0584	0.1211
16	0.0560	0.1181
17	0.0536	0.1150
18	0.0513	0.1120
19	0.0489	0.1089
20	0.0465	0.1059
21	0.0449	0.1011
22	0.0433	0.0963
23	0.0417	0.0916
24	0.0401	0.0868
25	0.0384	0.0821
26	0.0374	0.0804
27	0.0363	0.0788
28	0.0352	0.0771
29	0.0341	0.0755
30	0.0330	0.0738
31	0.0323	0.0750
32	0.0316	0.0763
33	0.0310	0.0774
34	0.0303	0.0786
35	0.0296	0.0799
36	0.0292	0.0796
37	0.0288	0.0794
38	0.0284	0.0792
39	0.0280	0.0790
40	0.0276	0.0788
41	0.0274	0.0796
42	0.0272	0.0804
43	0.0270	0.0812
44	0.0268	0.0820
45	0.0266	0.0828
46	0.0266	0.0826
47	0.0266	0.0824
48	0.0266	0.0821
49	0.0266	0.0819
50	0.0266	0.0817
51	0.0268	0.0826
52	0.0270	0.0834
53	0.0272	0.0842
54	0.0274	0.0850
55	0.0275	0.0858
56	0.0279	0.0839
57	0.0283	0.0820
58	0.0286	0.0802
59	0.0290	0.0783
60	0.0293	0.0764
61	0.0300	0.0756
62	0.0306	0.0749
63	0.0312	0.0741
64	0.0319	0.0734
65	0.0325	0.0726
66	0.0331	0.0765
67	0.0337	0.0804
68	0.0343	0.0842
69	0.0350	0.0881
70	0.0356	0.0920

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

Source: California Air Resources Board, EMFAC2014, 2016 & 2036 average

Accident Tables

HIGHWAY INJURY SEVERITY FREQUENCY
(percent of injuries)

Event	Urban	Suburban	Rural	Average
Severe Injury (A)	4.78%	4.78%	4.78%	4.78%
Other Visible Injury (B)	25.54%	25.54%	25.54%	25.54%
Complaint of Pain (C)	69.68%	69.68%	69.68%	69.68%

Source: 2013 SWITRS Annual Report, Table 8C

RATES FOR NON-HIGHWAY ACCIDENT EVENTS
(events/million veh-mi)

Event	Pass Train	Light Rail	Bus	Freight Rail
Fatality	0.0555	0.2480	0.0349	0.9917
Injury	0.2519	3.9469	3.6535	7.7862
All Accidents	0.2775	5.3817	2.6733	13.5424

Sources: USDOT,Transportation Statistics Annual Report, Table 2-33, 2003 to 2012 average
FRA, Office of Safety Analysis, Table 1.13, 2008 to 2017 YTD average.

NUMBER OF FATALITIES
(events/accident)

Accident Type	Urban	Suburban	Rural	Average
Fatal Accident	1.09	1.08	1.14	1.11

NUMBER OF INJURIES
(events/accident)

Accident Type	Urban	Suburban	Rural	Average
Fatal Accident	0.81	0.82	1.12	0.95
Injury Accident	1.44	1.43	1.50	1.44

NUMBER OF VEHICLES INVOLVED
(events/accident)

Accident Type	Urban	Suburban	Rural	Average
Fatal Accident	1.51	1.69	1.58	1.63
Injury Accident	1.82	2.10	1.59	1.99
PDO Accident	1.80	2.03	1.59	1.96

DISTRIBUTION OF ACCIDENT TYPES
(percent of accidents)

Accident Type	Urban	Suburban	Rural	Average
Fatal Accident	1.18%	0.45%	1.92%	0.71%
Injury Accident	34.93%	33.09%	38.25%	33.98%
PDO Accident	63.89%	66.45%	59.83%	65.31%

Source: California Department of Transportation,TASAS Unit, 2010 to 2013 average

COST OF NON-HIGHWAY ACCIDENT EVENTS
($/event)

Event	Pass Train	Light Rail	Bus	Freight Rail
Fatality	$9,800,000	$9,800,000	$9,800,000	$9,800,000
Injury	$180,500	$180,500	$180,500	$180,500
Prop Damage	$78,800	$12,400	$3,800	$147,600

Sources: FTA, Transit Safety & Security Statistics, 2002 to 2011 average
FRA, Office of Safety Analysis, Table 3.16, 2014 to 2016 average.

COSTS OF NON-HIGHWAY ACCIDENTS
($/million veh-mi)

Value	Pass Train	Light Rail	Bus	Freight Rail
Cost	$611,200	$3,209,500	$1,011,600	$13,122,900

Source: Combination of above two tables

HIGHWAY-RAIL GRADE CROSSING INCIDENTS
(units in table)

Value	Incident	Fatality	Injury
Total Events	799	94	515
Avg per Incident		0.1176	0.6446
Cost per Event		$9,800,000	$180,500

Source: FRA, Office of Safety Analysis, 5.10 - Hwy/Rail Incidents Summary
Table, California, Motor Vehicles, Public Crossings, Jan 2007 to Dec 2016

COST OF HIGHWAY ACCIDENTS
($/accident)

Accident Type	Urban	Suburban	Rural	Average
Fatal Accident	$10,800,000	$10,700,000	$11,300,000	$11,000,000
Injury Accident	$148,800	$148,600	$154,200	$149,300
PDO Accident	$9,700	$11,000	$8,600	$10,600
All Types	$185,600	$104,600	$281,100	$135,800

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

Emissions Tables

HIGHWAY EMISSIONS FACTORS (g/mi)

Model Year 2020

Mode	Speed	CO	CO2	NOX	PM10	SOX	VOC	PM2.5
Auto	0	2.7812	66.6818	0.2922	0.0022	0.0007	0.3837	0.0020
	5	2.4569	766.8891	0.1849	0.0119	0.0076	0.2149	0.0110
	6	2.3624	736.4937	0.1767	0.0110	0.0073	0.1979	0.0102
	7	2.2679	706.0983	0.1684	0.0101	0.0070	0.1809	0.0093
	8	2.1734	675.7028	0.1602	0.0092	0.0067	0.1639	0.0085
	9	2.0789	645.3074	0.1519	0.0084	0.0064	0.1469	0.0077
	10	1.9844	614.9120	0.1436	0.0075	0.0061	0.1299	0.0069
	11	1.9452	593.4537	0.1408	0.0070	0.0059	0.1221	0.0064
	12	1.9060	571.9954	0.1380	0.0065	0.0057	0.1142	0.0060
	13	1.8667	550.5371	0.1352	0.0060	0.0054	0.1064	0.0055
	14	1.8275	529.0788	0.1323	0.0055	0.0052	0.0986	0.0051
	15	1.7883	507.6205	0.1295	0.0050	0.0050	0.0908	0.0046
	16	1.7449	490.1154	0.1262	0.0047	0.0048	0.0853	0.0044
	17	1.7015	472.6104	0.1230	0.0044	0.0047	0.0797	0.0041
	18	1.6580	455.1053	0.1197	0.0041	0.0045	0.0742	0.0038
	19	1.6146	437.6003	0.1165	0.0038	0.0043	0.0687	0.0035
	20	1.5712	420.0952	0.1132	0.0036	0.0042	0.0632	0.0033
	21	1.5324	407.5672	0.1102	0.0034	0.0040	0.0598	0.0031
	22	1.4935	395.0392	0.1073	0.0032	0.0039	0.0563	0.0029
	23	1.4547	382.5112	0.1043	0.0030	0.0038	0.0529	0.0028
	24	1.4159	369.9831	0.1013	0.0028	0.0037	0.0495	0.0026
	25	1.3770	357.4551	0.0984	0.0026	0.0035	0.0461	0.0024
	26	1.3526	349.3782	0.0970	0.0025	0.0035	0.0442	0.0023
	27	1.3282	341.3012	0.0957	0.0024	0.0034	0.0424	0.0022
	28	1.3037	333.2243	0.0943	0.0023	0.0033	0.0405	0.0021
	29	1.2793	325.1474	0.0929	0.0022	0.0032	0.0387	0.0020
	30	1.2549	317.0704	0.0916	0.0020	0.0031	0.0369	0.0019
	31	1.2403	312.8750	0.0911	0.0020	0.0031	0.0358	0.0018
	32	1.2258	308.6796	0.0907	0.0019	0.0031	0.0348	0.0018
	33	1.2112	304.4842	0.0903	0.0018	0.0030	0.0337	0.0017
	34	1.1966	300.2888	0.0898	0.0018	0.0030	0.0327	0.0016
	35	1.1821	296.0934	0.0894	0.0017	0.0029	0.0316	0.0016
	36	1.1699	294.5019	0.0892	0.0017	0.0029	0.0310	0.0015
	37	1.1576	292.9105	0.0890	0.0016	0.0029	0.0303	0.0015
	38	1.1454	291.3191	0.0889	0.0016	0.0029	0.0297	0.0014
	39	1.1332	289.7276	0.0887	0.0015	0.0029	0.0291	0.0014
	40	1.1209	288.1362	0.0885	0.0015	0.0029	0.0284	0.0014
	41	1.1115	288.4709	0.0887	0.0015	0.0029	0.0282	0.0013
	42	1.1021	288.8057	0.0889	0.0014	0.0029	0.0280	0.0013
	43	1.0927	289.1404	0.0890	0.0014	0.0029	0.0278	0.0013
	44	1.0833	289.4751	0.0892	0.0014	0.0029	0.0275	0.0013
	45	1.0739	289.8098	0.0893	0.0014	0.0029	0.0273	0.0013
	46	1.0644	291.6375	0.0895	0.0014	0.0029	0.0272	0.0013
	47	1.0549	293.4651	0.0897	0.0014	0.0029	0.0271	0.0012
	48	1.0454	295.2927	0.0898	0.0013	0.0029	0.0270	0.0012
	49	1.0359	297.1204	0.0900	0.0013	0.0029	0.0269	0.0012
	50	1.0264	298.9480	0.0901	0.0013	0.0030	0.0268	0.0012
	51	1.0176	301.2656	0.0905	0.0013	0.0030	0.0269	0.0012
	52	1.0088	303.5831	0.0908	0.0013	0.0030	0.0271	0.0012
	53	0.9999	305.9006	0.0912	0.0013	0.0030	0.0272	0.0012
	54	0.9911	308.2182	0.0915	0.0013	0.0030	0.0273	0.0012
	55	0.9822	310.5357	0.0919	0.0013	0.0031	0.0274	0.0012
	56	0.9679	312.2601	0.0915	0.0014	0.0031	0.0275	0.0013
	57	0.9535	313.9844	0.0912	0.0014	0.0031	0.0276	0.0013
	58	0.9391	315.7088	0.0908	0.0014	0.0031	0.0277	0.0013
	59	0.9248	317.4331	0.0904	0.0014	0.0031	0.0278	0.0013
	60	0.9104	319.1575	0.0901	0.0014	0.0032	0.0279	0.0013
	61	0.9102	321.1627	0.0908	0.0015	0.0032	0.0288	0.0013
	62	0.9099	323.1679	0.0915	0.0015	0.0032	0.0298	0.0014
	63	0.9096	325.1730	0.0922	0.0015	0.0032	0.0307	0.0014
	64	0.9093	327.1782	0.0929	0.0016	0.0032	0.0316	0.0014
	65	0.9090	329.1834	0.0936	0.0016	0.0033	0.0326	0.0015
	66	0.9328	332.1274	0.0961	0.0016	0.0033	0.0340	0.0015
	67	0.9566	335.0713	0.0986	0.0016	0.0033	0.0355	0.0015
	68	0.9804	338.0152	0.1011	0.0017	0.0033	0.0370	0.0015
	69	1.0041	340.9592	0.1036	0.0017	0.0034	0.0384	0.0016
	70	1.0279	343.9031	0.1062	0.0017	0.0034	0.0399	0.0016

HIGHWAY EMISSIONS FACTORS (g/mi)

Model Year 2040

Mode	Speed	CO	CO2	NOX	PM10	SOX	VOC	PM2.5
Auto	0	1.6243	41.5134	0.1182	0.0008	0.0004	0.1038	0.0007
	5	1.0375	512.1914	0.0448	0.0042	0.0051	0.0871	0.0038
	6	1.0103	492.7973	0.0435	0.0039	0.0049	0.0810	0.0035
	7	0.9831	473.4032	0.0422	0.0035	0.0047	0.0749	0.0033
	8	0.9559	454.0092	0.0409	0.0032	0.0045	0.0688	0.0030
	9	0.9286	434.6151	0.0396	0.0029	0.0043	0.0627	0.0027
	10	0.9014	415.2211	0.0383	0.0026	0.0041	0.0566	0.0024
	11	0.8807	400.2645	0.0375	0.0024	0.0040	0.0531	0.0022
	12	0.8600	385.3079	0.0366	0.0023	0.0038	0.0495	0.0021
	13	0.8392	370.3513	0.0358	0.0021	0.0037	0.0460	0.0019
	14	0.8185	355.3947	0.0349	0.0019	0.0035	0.0424	0.0018
	15	0.7977	340.4381	0.0341	0.0017	0.0034	0.0389	0.0016
	16	0.7797	328.9303	0.0333	0.0016	0.0033	0.0365	0.0015
	17	0.7616	317.4224	0.0326	0.0015	0.0031	0.0342	0.0014
	18	0.7435	305.9146	0.0318	0.0014	0.0030	0.0318	0.0013
	19	0.7254	294.4067	0.0311	0.0013	0.0029	0.0295	0.0012
	20	0.7073	282.8989	0.0303	0.0012	0.0028	0.0272	0.0011
	21	0.6937	274.6096	0.0298	0.0012	0.0027	0.0258	0.0011
	22	0.6802	266.3204	0.0293	0.0011	0.0026	0.0245	0.0010
	23	0.6666	258.0312	0.0287	0.0010	0.0026	0.0231	0.0010
	24	0.6530	249.7419	0.0282	0.0010	0.0025	0.0218	0.0009
	25	0.6394	241.4527	0.0276	0.0009	0.0024	0.0204	0.0008
	26	0.6287	235.9199	0.0273	0.0009	0.0023	0.0196	0.0008
	27	0.6180	230.3871	0.0270	0.0008	0.0023	0.0188	0.0008
	28	0.6072	224.8543	0.0266	0.0008	0.0022	0.0180	0.0007
	29	0.5965	219.3215	0.0263	0.0007	0.0022	0.0172	0.0007
	30	0.5858	213.7887	0.0260	0.0007	0.0021	0.0164	0.0007
	31	0.5769	210.7272	0.0257	0.0007	0.0021	0.0158	0.0006
	32	0.5681	207.6656	0.0254	0.0007	0.0021	0.0152	0.0006
	33	0.5592	204.6041	0.0252	0.0006	0.0020	0.0147	0.0006
	34	0.5504	201.5426	0.0249	0.0006	0.0020	0.0141	0.0006
	35	0.5415	198.4811	0.0246	0.0006	0.0020	0.0135	0.0005
	36	0.5339	197.2354	0.0244	0.0006	0.0020	0.0131	0.0005
	37	0.5263	195.9898	0.0243	0.0006	0.0019	0.0128	0.0005
	38	0.5188	194.7441	0.0241	0.0005	0.0019	0.0124	0.0005
	39	0.5112	193.4985	0.0239	0.0005	0.0019	0.0120	0.0005
	40	0.5036	192.2529	0.0237	0.0005	0.0019	0.0117	0.0005
	41	0.4983	192.4698	0.0237	0.0005	0.0019	0.0116	0.0005
	42	0.4930	192.6867	0.0237	0.0005	0.0019	0.0115	0.0005
	43	0.4876	192.9036	0.0236	0.0005	0.0019	0.0114	0.0004
	44	0.4823	193.1206	0.0236	0.0005	0.0019	0.0113	0.0004
	45	0.4770	193.3375	0.0235	0.0005	0.0019	0.0112	0.0004
	46	0.4717	194.4847	0.0235	0.0005	0.0019	0.0112	0.0004
	47	0.4664	195.6319	0.0235	0.0005	0.0019	0.0111	0.0004
	48	0.4611	196.7791	0.0234	0.0005	0.0019	0.0110	0.0004
	49	0.4558	197.9263	0.0234	0.0005	0.0020	0.0109	0.0004
	50	0.4506	199.0735	0.0234	0.0005	0.0020	0.0109	0.0004
	51	0.4463	200.6160	0.0234	0.0005	0.0020	0.0110	0.0004
	52	0.4420	202.1586	0.0235	0.0005	0.0020	0.0110	0.0004
	53	0.4377	203.7011	0.0235	0.0005	0.0020	0.0111	0.0004
	54	0.4334	205.2437	0.0236	0.0005	0.0020	0.0112	0.0004
	55	0.4291	206.7862	0.0237	0.0005	0.0020	0.0113	0.0004
	56	0.4253	208.1718	0.0238	0.0005	0.0021	0.0115	0.0004
	57	0.4216	209.5573	0.0238	0.0005	0.0021	0.0116	0.0004
	58	0.4179	210.9429	0.0239	0.0005	0.0021	0.0118	0.0004
	59	0.4142	212.3284	0.0240	0.0005	0.0021	0.0120	0.0004
	60	0.4105	213.7139	0.0241	0.0005	0.0021	0.0122	0.0005
	61	0.4105	214.9073	0.0243	0.0005	0.0021	0.0127	0.0005
	62	0.4104	216.1006	0.0245	0.0005	0.0021	0.0131	0.0005
	63	0.4104	217.2939	0.0247	0.0005	0.0021	0.0135	0.0005
	64	0.4103	218.4873	0.0249	0.0005	0.0022	0.0140	0.0005
	65	0.4103	219.6806	0.0251	0.0006	0.0022	0.0144	0.0005
	66	0.4137	220.9470	0.0254	0.0006	0.0022	0.0147	0.0005
	67	0.4171	222.2134	0.0256	0.0006	0.0022	0.0149	0.0005
	68	0.4205	223.4798	0.0258	0.0006	0.0022	0.0152	0.0005
	69	0.4238	224.7463	0.0260	0.0006	0.0022	0.0155	0.0005
	70	0.4272	226.0127	0.0262	0.0006	0.0022	0.0157	0.0006

Emissions Tables

HIGHWAY EMISSIONS FACTORS (g/mi)

Model Year 2020

Mode	Speed	CO	CO2	NOX	PM10	SOX	VOC	PM2.5
Auto	0	2.7812	66.6818	0.2922	0.0022	0.0007	0.3837	0.0020
	5	2.4569	766.8891	0.1849	0.0119	0.0076	0.2149	0.0110
	6	2.3624	736.4937	0.1767	0.0110	0.0073	0.1979	0.0102
	7	2.2679	706.0983	0.1684	0.0101	0.0070	0.1809	0.0093
	8	2.1734	675.7028	0.1602	0.0092	0.0067	0.1639	0.0085
Truck	0	0.9305	9.0247	0.6741	0.0002	0.0002	0.0657	0.0002
	5	3.6942	2632.6795	8.9241	0.1305	0.0246	1.0958	0.1248
	6	3.5195	2514.9122	8.2937	0.1206	0.0235	1.0078	0.1153
	7	3.3449	2397.1449	7.6633	0.1107	0.0223	0.9199	0.1059
	8	3.1702	2279.3775	7.0329	0.1009	0.0212	0.8319	0.0965
	9	2.9956	2161.6102	6.4026	0.0910	0.0201	0.7440	0.0870
	10	2.8209	2043.8428	5.7722	0.0812	0.0190	0.6560	0.0776
	11	2.6205	1905.7080	5.2310	0.0737	0.0178	0.5864	0.0705
	12	2.4202	1767.5732	4.6898	0.0663	0.0165	0.5169	0.0633
	13	2.2198	1629.4383	4.1485	0.0588	0.0153	0.4474	0.0562
	14	2.0195	1491.3035	3.6073	0.0514	0.0141	0.3778	0.0491
	15	1.8191	1353.1687	3.0661	0.0440	0.0129	0.3083	0.0420
	16	1.7210	1328.7488	3.0671	0.0432	0.0126	0.2863	0.0413
	17	1.6228	1304.3289	3.0681	0.0424	0.0124	0.2644	0.0405
	18	1.5246	1279.9090	3.0692	0.0416	0.0122	0.2424	0.0398
	19	1.4265	1255.4891	3.0702	0.0409	0.0120	0.2205	0.0391
	20	1.3283	1231.0692	3.0712	0.0401	0.0117	0.1986	0.0383
	21	1.2704	1198.9333	3.0121	0.0388	0.0114	0.1880	0.0371
	22	1.2124	1166.7975	2.9531	0.0376	0.0111	0.1775	0.0359
	23	1.1545	1134.6616	2.8940	0.0363	0.0108	0.1669	0.0347
	24	1.0965	1102.5258	2.8350	0.0350	0.0105	0.1564	0.0335
	25	1.0386	1070.3899	2.7759	0.0338	0.0102	0.1458	0.0323
	26	1.0089	1057.3247	2.7566	0.0337	0.0100	0.1414	0.0322
	27	0.9792	1044.2595	2.7373	0.0336	0.0099	0.1371	0.0321
	28	0.9495	1031.1942	2.7180	0.0335	0.0098	0.1327	0.0320
	29	0.9198	1018.1290	2.6988	0.0334	0.0097	0.1283	0.0319
	30	0.8902	1005.0638	2.6795	0.0333	0.0095	0.1239	0.0318
	31	0.8697	1009.5733	2.6973	0.0337	0.0095	0.1210	0.0322
	32	0.8493	1014.0828	2.7152	0.0341	0.0095	0.1181	0.0326
	33	0.8289	1018.5923	2.7331	0.0345	0.0096	0.1152	0.0330
	34	0.8084	1023.1018	2.7509	0.0349	0.0096	0.1123	0.0333
	35	0.7880	1027.6114	2.7688	0.0353	0.0096	0.1094	0.0337
	36	0.7707	1026.1846	2.7470	0.0355	0.0096	0.1065	0.0340
	37	0.7534	1024.7579	2.7253	0.0358	0.0096	0.1035	0.0342
	38	0.7362	1023.3312	2.7036	0.0360	0.0095	0.1006	0.0345
	39	0.7189	1021.9044	2.6818	0.0363	0.0095	0.0977	0.0347
	40	0.7016	1020.4777	2.6601	0.0366	0.0095	0.0947	0.0350
	41	0.6870	1013.9423	2.6305	0.0369	0.0095	0.0923	0.0353
	42	0.6725	1007.4069	2.6010	0.0372	0.0094	0.0898	0.0356
	43	0.6579	1000.8716	2.5715	0.0376	0.0094	0.0873	0.0359
	44	0.6434	994.3362	2.5419	0.0379	0.0093	0.0849	0.0363
	45	0.6288	987.8008	2.5124	0.0382	0.0093	0.0824	0.0366
	46	0.6314	964.3856	2.4771	0.0378	0.0091	0.0810	0.0362
	47	0.6340	940.9704	2.4418	0.0374	0.0089	0.0795	0.0358
	48	0.6366	917.5552	2.4065	0.0370	0.0087	0.0781	0.0354
	49	0.6392	894.1400	2.3712	0.0366	0.0085	0.0766	0.0350
	50	0.6419	870.7248	2.3359	0.0362	0.0083	0.0752	0.0346
	51	0.6220	892.7249	2.4040	0.0401	0.0085	0.0765	0.0384
	52	0.6022	914.7250	2.4722	0.0441	0.0087	0.0779	0.0422
	53	0.5824	936.7252	2.5404	0.0480	0.0089	0.0792	0.0459
	54	0.5626	958.7253	2.6086	0.0520	0.0091	0.0805	0.0497
	55	0.5428	980.7255	2.6768	0.0559	0.0093	0.0819	0.0535
	56	0.5271	1009.3233	2.7048	0.0580	0.0096	0.0817	0.0555
	57	0.5115	1037.9211	2.7329	0.0600	0.0098	0.0816	0.0574
	58	0.4958	1066.5189	2.7610	0.0621	0.0101	0.0814	0.0594
	59	0.4802	1095.1167	2.7891	0.0641	0.0104	0.0813	0.0613
	60	0.4645	1123.7146	2.8172	0.0661	0.0106	0.0811	0.0633
	61	0.4591	1143.6798	2.8456	0.0659	0.0108	0.0798	0.0631
	62	0.4537	1163.6450	2.8741	0.0657	0.0110	0.0785	0.0629
	63	0.4483	1183.6103	2.9025	0.0655	0.0112	0.0772	0.0627
	64	0.4429	1203.5755	2.9309	0.0653	0.0114	0.0759	0.0625
	65	0.4374	1223.5407	2.9594	0.0651	0.0116	0.0745	0.0623
	66	0.4579	1221.1740	2.9982	0.0648	0.0116	0.0762	0.0620
	67	0.4784	1218.8073	3.0370	0.0646	0.0115	0.0778	0.0618
	68	0.4989	1216.4406	3.0758	0.0643	0.0115	0.0795	0.0615
	69	0.5193	1214.0739	3.1146	0.0641	0.0115	0.0811	0.0613
	70	0.5398	1211.7072	3.1534	0.0638	0.0115	0.0828	0.0610

HIGHWAY EMISSIONS FACTORS (g/mi)

Model Year 2040

Mode	Speed	CO	CO2	NOX	PM10	SOX	VOC	PM2.5
Auto	0	1.6243	41.5134	0.1182	0.0008	0.0004	0.1038	0.0007
	5	1.0375	512.1914	0.0448	0.0042	0.0051	0.0871	0.0038
	6	1.0103	492.7973	0.0435	0.0039	0.0049	0.0810	0.0035
	7	0.9831	473.4032	0.0422	0.0035	0.0047	0.0749	0.0033
	8	0.9559	454.0092	0.0409	0.0032	0.0045	0.0688	0.0030
Truck	0	0.5426	6.2184	0.8784	0.0001	0.0001	0.0216	0.0001
	5	2.2343	2133.8128	7.8220	0.0104	0.0197	0.1694	0.0099
	6	2.1544	2037.2309	7.2086	0.0103	0.0188	0.1668	0.0098
	7	2.0745	1940.6489	6.5953	0.0101	0.0178	0.1643	0.0096
	8	1.9946	1844.0670	5.9819	0.0100	0.0169	0.1617	0.0095
	9	1.9147	1747.4850	5.3685	0.0099	0.0160	0.1591	0.0094
	10	1.8348	1650.9031	4.7551	0.0097	0.0150	0.1566	0.0093
	11	1.6377	1541.7983	4.2323	0.0095	0.0141	0.1456	0.0090
	12	1.4405	1432.6935	3.7096	0.0092	0.0132	0.1347	0.0088
	13	1.2434	1323.5888	3.1868	0.0090	0.0123	0.1237	0.0086
	14	1.0462	1214.4840	2.6640	0.0087	0.0113	0.1128	0.0083
	15	0.8490	1105.3793	2.1412	0.0085	0.0104	0.1018	0.0081
	16	0.7673	1083.3925	2.1164	0.0081	0.0102	0.0899	0.0077
	17	0.6856	1061.4058	2.0917	0.0077	0.0100	0.0780	0.0073
	18	0.6039	1039.4190	2.0669	0.0073	0.0098	0.0661	0.0070
	19	0.5221	1017.4323	2.0422	0.0069	0.0096	0.0542	0.0066
	20	0.4404	995.4456	2.0174	0.0065	0.0094	0.0423	0.0062
	21	0.4190	964.9603	1.9304	0.0064	0.0091	0.0397	0.0061
	22	0.3975	934.4750	1.8433	0.0062	0.0088	0.0370	0.0059
	23	0.3761	903.9897	1.7562	0.0061	0.0085	0.0344	0.0058
	24	0.3546	873.5044	1.6692	0.0059	0.0082	0.0317	0.0057
	25	0.3332	843.0192	1.5821	0.0058	0.0079	0.0290	0.0055
	26	0.3186	829.3296	1.5318	0.0057	0.0078	0.0275	0.0054
	27	0.3039	815.6399	1.4814	0.0056	0.0077	0.0259	0.0054
	28	0.2893	801.9503	1.4311	0.0055	0.0075	0.0244	0.0053
	29	0.2747	788.2607	1.3808	0.0054	0.0074	0.0228	0.0052
	30	0.2601	774.5711	1.3305	0.0053	0.0073	0.0213	0.0051
	31	0.2617	772.3339	1.2970	0.0054	0.0072	0.0204	0.0052
	32	0.2634	770.0966	1.2636	0.0055	0.0072	0.0195	0.0052
	33	0.2650	767.8594	1.2302	0.0056	0.0071	0.0186	0.0053
	34	0.2667	765.6222	1.1968	0.0056	0.0070	0.0177	0.0054
	35	0.2683	763.3850	1.1634	0.0057	0.0070	0.0168	0.0054
	36	0.2556	758.7409	1.1196	0.0059	0.0070	0.0162	0.0057
	37	0.2429	754.0968	1.0759	0.0062	0.0069	0.0156	0.0059
	38	0.2301	749.4527	1.0322	0.0064	0.0069	0.0150	0.0061
	39	0.2174	744.8086	0.9885	0.0066	0.0068	0.0143	0.0063
	40	0.2047	740.1645	0.9447	0.0068	0.0068	0.0137	0.0065
	41	0.1954	734.5862	0.9025	0.0072	0.0068	0.0134	0.0069
	42	0.1861	729.0080	0.8603	0.0075	0.0067	0.0131	0.0072
	43	0.1768	723.4298	0.8182	0.0078	0.0067	0.0128	0.0075
	44	0.1675	717.8516	0.7760	0.0082	0.0066	0.0125	0.0078
	45	0.1582	712.2733	0.7338	0.0085	0.0066	0.0122	0.0081
	46	0.1501	701.7716	0.6947	0.0087	0.0065	0.0123	0.0083
	47	0.1420	691.2700	0.6557	0.0089	0.0064	0.0123	0.0085
	48	0.1339	680.7683	0.6166	0.0091	0.0064	0.0124	0.0087
	49	0.1258	670.2666	0.5776	0.0093	0.0063	0.0124	0.0089
	50	0.1177	659.7649	0.5385	0.0095	0.0062	0.0125	0.0091
	51	0.1134	670.7116	0.5630	0.0104	0.0063	0.0124	0.0099
	52	0.1091	681.6584	0.5874	0.0113	0.0064	0.0123	0.0108
	53	0.1048	692.6052	0.6119	0.0122	0.0066	0.0122	0.0117
	54	0.1005	703.5520	0.6364	0.0131	0.0067	0.0121	0.0125
	55	0.0962	714.4987	0.6609	0.0140	0.0068	0.0120	0.0134
	56	0.0964	730.3835	0.7136	0.0153	0.0069	0.0124	0.0146
	57	0.0966	746.2682	0.7663	0.0166	0.0071	0.0127	0.0158
	58	0.0969	762.1530	0.8191	0.0178	0.0072	0.0130	0.0171
	59	0.0971	778.0378	0.8718	0.0191	0.0074	0.0134	0.0183
	60	0.0973	793.9225	0.9245	0.0204	0.0075	0.0137	0.0195
	61	0.1018	810.7058	1.0126	0.0218	0.0077	0.0144	0.0209
	62	0.1064	827.4890	1.1007	0.0233	0.0078	0.0151	0.0222
	63	0.1109	844.2722	1.1888	0.0247	0.0080	0.0157	0.0236
	64	0.1154	861.0555	1.2769	0.0261	0.0081	0.0164	0.0250
	65	0.1200	877.8387	1.3650	0.0275	0.0083	0.0171	0.0263
	66	0.1280	880.4223	1.3757	0.0277	0.0083	0.0180	0.0265
	67	0.1361	883.0060	1.3865	0.0279	0.0084	0.0189	0.0267
	68	0.1442	885.5896	1.3972	0.0281	0.0084	0.0198	0.0269
	69	0.1522	888.1732	1.4080	0.0283	0.0084	0.0207	0.0271
	70	0.1603	890.7569	1.4187	0.0285	0.0084	0.0216	0.0272

Emissions Tables

HIGHWAY EMISSIONS FACTORS (g/mi)

Model Year 2020

Mode	Speed	CO	CO2	NOX	PM10	SOX	VOC	PM2.5
Auto	0	2.7812	66.6818	0.2922	0.0022	0.0007	0.3837	0.0020
	5	2.4569	766.8891	0.1849	0.0119	0.0076	0.2149	0.0110
	6	2.3624	736.4937	0.1767	0.0110	0.0073	0.1979	0.0102
	7	2.2679	706.0983	0.1684	0.0101	0.0070	0.1809	0.0093
	8	2.1734	675.7028	0.1602	0.0092	0.0067	0.1639	0.0085
Bus	0	1.7052	12.7834	0.6062	0.0001	0.0001	0.0807	0.0001
	5	20.7553	2860.2247	6.9105	0.0597	0.0186	0.4993	0.0570
	6	20.2836	2782.8803	6.5264	0.0560	0.0182	0.4690	0.0535
	7	19.8120	2705.5358	6.1422	0.0523	0.0177	0.4387	0.0500
	8	19.3403	2628.1913	5.7580	0.0486	0.0172	0.4084	0.0465
	9	18.8686	2550.8469	5.3739	0.0449	0.0167	0.3781	0.0429
	10	18.3970	2473.5024	4.9897	0.0412	0.0162	0.3478	0.0394
	11	18.2626	2387.8333	4.6778	0.0381	0.0155	0.3189	0.0364
	12	18.1282	2302.1641	4.3659	0.0349	0.0147	0.2901	0.0334
	13	17.9938	2216.4950	4.0539	0.0318	0.0140	0.2612	0.0304
	14	17.8595	2130.8259	3.7420	0.0286	0.0132	0.2324	0.0274
	15	17.7251	2045.1567	3.4300	0.0255	0.0125	0.2035	0.0243
	16	19.5028	2013.8706	3.1042	0.0219	0.0114	0.1854	0.0209
	17	21.2804	1982.5846	2.7783	0.0184	0.0103	0.1672	0.0175
	18	23.0581	1951.2985	2.4524	0.0148	0.0092	0.1490	0.0141
	19	24.8358	1920.0124	2.1265	0.0112	0.0081	0.1308	0.0108
	20	26.6134	1888.7263	1.8007	0.0077	0.0070	0.1126	0.0074
	21	22.0537	1802.6822	2.1964	0.0114	0.0082	0.1152	0.0109
	22	17.4940	1716.6380	2.5921	0.0151	0.0095	0.1178	0.0144
	23	12.9342	1630.5938	2.9878	0.0188	0.0107	0.1203	0.0180
	24	8.3745	1544.5496	3.3835	0.0225	0.0119	0.1229	0.0215
	25	3.8147	1458.5055	3.7792	0.0262	0.0131	0.1255	0.0251
	26	3.7714	1430.8138	3.7304	0.0255	0.0128	0.1204	0.0243
	27	3.7280	1403.1221	3.6817	0.0247	0.0126	0.1153	0.0236
	28	3.6846	1375.4304	3.6330	0.0239	0.0123	0.1102	0.0229
	29	3.6413	1347.7387	3.5842	0.0232	0.0120	0.1051	0.0222
	30	3.5979	1320.0470	3.5355	0.0224	0.0118	0.1000	0.0214
	31	3.5389	1302.9919	3.4890	0.0218	0.0116	0.0965	0.0209
	32	3.4800	1285.9368	3.4425	0.0212	0.0115	0.0930	0.0203
	33	3.4210	1268.8817	3.3960	0.0206	0.0114	0.0894	0.0197
	34	3.3621	1251.8266	3.3495	0.0200	0.0112	0.0859	0.0192
	35	3.3031	1234.7715	3.3030	0.0194	0.0111	0.0824	0.0186
	36	3.3885	1237.8678	3.1905	0.0188	0.0111	0.0802	0.0180
	37	3.4738	1240.9642	3.0780	0.0181	0.0111	0.0780	0.0173
	38	3.5592	1244.0606	2.9655	0.0175	0.0111	0.0757	0.0167
	39	3.6446	1247.1569	2.8529	0.0168	0.0111	0.0735	0.0161
	40	3.7300	1250.2533	2.7404	0.0162	0.0111	0.0713	0.0155
	41	3.7750	1258.8091	2.6699	0.0161	0.0112	0.0702	0.0154
	42	3.8200	1267.3650	2.5995	0.0161	0.0113	0.0691	0.0154
	43	3.8651	1275.9208	2.5290	0.0160	0.0113	0.0680	0.0153
	44	3.9101	1284.4766	2.4585	0.0160	0.0114	0.0669	0.0153
	45	3.9551	1293.0324	2.3880	0.0159	0.0115	0.0658	0.0152
	46	3.8713	1292.4992	2.4237	0.0165	0.0115	0.0648	0.0158
	47	3.7875	1291.9659	2.4595	0.0171	0.0115	0.0639	0.0164
	48	3.7037	1291.4326	2.4952	0.0177	0.0115	0.0629	0.0170
	49	3.6199	1290.8994	2.5309	0.0184	0.0115	0.0620	0.0175
	50	3.5361	1290.3661	2.5666	0.0190	0.0115	0.0610	0.0181
	51	3.3966	1282.7008	2.7690	0.0208	0.0115	0.0615	0.0198
	52	3.2572	1275.0355	2.9713	0.0226	0.0114	0.0620	0.0216
	53	3.1177	1267.3703	3.1736	0.0244	0.0114	0.0625	0.0233
	54	2.9782	1259.7050	3.3759	0.0261	0.0114	0.0629	0.0250
	55	2.8388	1252.0397	3.5783	0.0279	0.0113	0.0634	0.0267
	56	2.9208	1268.5531	3.5566	0.0303	0.0114	0.0664	0.0290
	57	3.0029	1285.0664	3.5349	0.0326	0.0116	0.0693	0.0312
	58	3.0850	1301.5798	3.5132	0.0349	0.0117	0.0723	0.0334
	59	3.1671	1318.0932	3.4915	0.0372	0.0118	0.0753	0.0356
	60	3.2492	1334.6065	3.4698	0.0396	0.0119	0.0782	0.0378
	61	3.1376	1357.3126	3.5254	0.0452	0.0122	0.0847	0.0432
	62	3.0260	1380.0187	3.5809	0.0508	0.0124	0.0911	0.0486
	63	2.9145	1402.7247	3.6365	0.0564	0.0126	0.0976	0.0539
	64	2.8029	1425.4308	3.6920	0.0620	0.0129	0.1040	0.0593
	65	2.6914	1448.1369	3.7475	0.0676	0.0131	0.1105	0.0646
	66	2.7330	1459.9054	3.4083	0.0593	0.0132	0.1036	0.0567
	67	2.7747	1471.6740	3.0692	0.0510	0.0133	0.0968	0.0487
	68	2.8163	1483.4425	2.7300	0.0427	0.0135	0.0899	0.0408
	69	2.8579	1495.2110	2.3908	0.0344	0.0136	0.0831	0.0329
	70	2.8996	1506.9796	2.0516	0.0261	0.0137	0.0762	0.0249

HIGHWAY EMISSIONS FACTORS (g/mi)

Model Year 2040

Mode	Speed	CO	CO2	NOX	PM10	SOX	VOC	PM2.5
Auto	0	1.6243	41.5134	0.1182	0.0008	0.0004	0.1038	0.0007
	5	1.0375	512.1914	0.0448	0.0042	0.0051	0.0871	0.0038
	6	1.0103	492.7973	0.0435	0.0039	0.0049	0.0810	0.0035
	7	0.9831	473.4032	0.0422	0.0035	0.0047	0.0749	0.0033
	8	0.9559	454.0092	0.0409	0.0032	0.0045	0.0688	0.0030
Bus	0	1.3037	10.4247	1.2376	0.0001	0.0001	0.0639	0.0001
	5	23.9976	2501.4118	2.6218	0.0074	0.0141	0.1044	0.0070
	6	23.4637	2424.4382	2.4492	0.0071	0.0136	0.0990	0.0067
	7	22.9297	2347.4646	2.2765	0.0068	0.0131	0.0936	0.0064
	8	22.3957	2270.4910	2.1038	0.0064	0.0127	0.0881	0.0061
	9	21.8617	2193.5175	1.9311	0.0061	0.0122	0.0827	0.0058
	10	21.3278	2116.5439	1.7584	0.0058	0.0118	0.0773	0.0055
	11	21.1073	2047.5775	1.6420	0.0055	0.0112	0.0736	0.0052
	12	20.8868	1978.6110	1.5255	0.0052	0.0107	0.0699	0.0050
	13	20.6662	1909.6446	1.4091	0.0050	0.0101	0.0662	0.0047
	14	20.4457	1840.6782	1.2926	0.0047	0.0096	0.0625	0.0045
	15	20.2252	1771.7118	1.1762	0.0045	0.0090	0.0588	0.0042
	16	22.3237	1775.9215	1.0665	0.0043	0.0083	0.0594	0.0040
	17	24.4222	1780.1312	0.9569	0.0041	0.0075	0.0601	0.0039
	18	26.5207	1784.3409	0.8473	0.0039	0.0067	0.0607	0.0037
	19	28.6192	1788.5505	0.7377	0.0037	0.0060	0.0613	0.0035
	20	30.7177	1792.7602	0.6280	0.0035	0.0052	0.0620	0.0033
	21	25.2049	1655.9515	0.7462	0.0034	0.0061	0.0542	0.0033
	22	19.6922	1519.1428	0.8643	0.0034	0.0070	0.0465	0.0032
	23	14.1794	1382.3341	0.9825	0.0033	0.0078	0.0388	0.0032
	24	8.6666	1245.5254	1.1006	0.0033	0.0087	0.0311	0.0031
	25	3.1538	1108.7167	1.2188	0.0032	0.0096	0.0234	0.0031
	26	3.1149	1084.9049	1.1651	0.0032	0.0094	0.0225	0.0030
	27	3.0759	1061.0931	1.1114	0.0032	0.0092	0.0216	0.0030
	28	3.0370	1037.2814	1.0577	0.0031	0.0089	0.0207	0.0030
	29	2.9981	1013.4696	1.0040	0.0031	0.0087	0.0199	0.0029
	30	2.9591	989.6578	0.9503	0.0031	0.0085	0.0190	0.0029
	31	2.9189	974.6062	0.9043	0.0031	0.0084	0.0184	0.0029
	32	2.8788	959.5545	0.8584	0.0031	0.0083	0.0177	0.0029
	33	2.8386	944.5029	0.8125	0.0031	0.0081	0.0171	0.0029
	34	2.7984	929.4513	0.7666	0.0031	0.0080	0.0164	0.0029
	35	2.7582	914.3996	0.7207	0.0031	0.0079	0.0158	0.0030
	36	2.8909	917.8025	0.6824	0.0032	0.0079	0.0156	0.0030
	37	3.0237	921.2055	0.6441	0.0032	0.0079	0.0155	0.0030
	38	3.1565	924.6084	0.6058	0.0033	0.0078	0.0153	0.0031
	39	3.2892	928.0113	0.5676	0.0033	0.0078	0.0152	0.0031
	40	3.4220	931.4142	0.5293	0.0033	0.0078	0.0150	0.0032
	41	3.5398	941.3220	0.5092	0.0035	0.0079	0.0150	0.0033
	42	3.6575	951.2298	0.4890	0.0036	0.0079	0.0150	0.0034
	43	3.7753	961.1377	0.4689	0.0037	0.0080	0.0150	0.0035
	44	3.8931	971.0455	0.4488	0.0038	0.0081	0.0150	0.0036
	45	4.0108	980.9533	0.4287	0.0039	0.0081	0.0150	0.0038
	46	3.9266	980.8062	0.4258	0.0042	0.0081	0.0148	0.0040
	47	3.8424	980.6590	0.4230	0.0045	0.0082	0.0146	0.0043
	48	3.7582	980.5119	0.4202	0.0047	0.0082	0.0144	0.0045
	49	3.6739	980.3647	0.4173	0.0050	0.0082	0.0142	0.0048
	50	3.5897	980.2176	0.4145	0.0053	0.0082	0.0140	0.0050
	51	3.5005	975.8673	0.4381	0.0059	0.0082	0.0139	0.0056
	52	3.4112	971.5171	0.4617	0.0065	0.0082	0.0138	0.0062
	53	3.3220	967.1668	0.4852	0.0070	0.0082	0.0138	0.0067
	54	3.2327	962.8166	0.5088	0.0076	0.0082	0.0137	0.0073
	55	3.1435	958.4663	0.5324	0.0082	0.0082	0.0137	0.0078
	56	3.2439	976.2456	0.5594	0.0089	0.0083	0.0141	0.0085
	57	3.3442	994.0250	0.5864	0.0096	0.0084	0.0144	0.0092
	58	3.4446	1011.8043	0.6133	0.0104	0.0086	0.0148	0.0099
	59	3.5449	1029.5836	0.6403	0.0111	0.0087	0.0152	0.0106
	60	3.6453	1047.3629	0.6673	0.0118	0.0088	0.0156	0.0113
	61	3.3385	1067.0328	0.7561	0.0135	0.0091	0.0159	0.0129
	62	3.0317	1086.7026	0.8449	0.0152	0.0094	0.0163	0.0145
	63	2.7248	1106.3724	0.9338	0.0169	0.0097	0.0166	0.0162
	64	2.4180	1126.0422	1.0226	0.0186	0.0099	0.0169	0.0178
	65	2.1112	1145.7121	1.1114	0.0203	0.0102	0.0173	0.0194
	66	2.0966	1149.4634	1.0159	0.0184	0.0103	0.0172	0.0176
	67	2.0819	1153.2148	0.9203	0.0164	0.0103	0.0170	0.0157
	68	2.0673	1156.9661	0.8248	0.0145	0.0104	0.0169	0.0139
	69	2.0527	1160.7175	0.7292	0.0126	0.0104	0.0168	0.0120
	70	2.0380	1164.4688	0.6337	0.0107	0.0105	0.0167	0.0102

Source: California Air Resources Board, EMFAC 2017

Notes: 1) Zero mph corresponds to starts, 2) Other emissions factors include idling emissions and exclude diurnal and evaporative emissions, 3) Five mph is best estimate for idling

HEALTH COST OF TRANSPORTATION EMISSIONS

($/ton)

Area	Proj Loc	CO	CO_2e	NO_x	PM_{10}	SO_x	VOC
LA/South Coast	1	$160	$38	$63,900	$523,300	$196,600	$3,970
CA Urban Area	2	$80	$38	$18,700	$151,100	$75,500	$1,305
CA Rural Area	3	$75	$38	$13,900	$107,700	$54,400	$1,025

CO_2e Uprater 2.0% 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, 2016 for CO2e

PASSENGER TRAIN EMISSIONS FACTORS

(g/train-mile)

Mode	Year	CO	CO_2	NO_x	PM_{10}	SO_x	VOC	$PM_{2.5}$
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	$PM_{2.5}$
Light Rail	2002	0.14		1.13	0.17		0.06	
	2022	0.14		1.14	0.17		0.06	

FREIGHT LOCOMOTIVE EMISSIONS FACTORS

(g/gal)

Mode	Year	CO	CO_2	NO_x	PM_{10}	SO_x	VOC	$PM_{2.5}$
Freight Rail	2030		10,206	28.10	0.43			
	2030		10,206	28.10	0.43			

Freight Rail Fuel Efficiency 468 ton-miles/gal
Fuel Burned at Idle 4 gal/hr

Sources: California Air Resources Board
Association of American Railroads, The Environmental Benefits of Moving Freight by Rail, June 2017
California Environmental Protection Agency / Air Resources Board, Technology Assessment: Freight Locomotives, November 2016

Pavement Adjustments (used only for pavement projects)

PAVEMENT DETERIORATION
(IRI in inches/mile)

	Year 20, By Loading		
Year 0	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	1.000	1.025
25	1.000	1.025
50	1.000	1.025
75	1.000	1.025
100	1.000	1.025
125	1.000	1.025
150	1.000	1.013
175	1.000	1.000
200	1.000	0.980
225	1.000	0.949
250	1.000	0.919
275	0.991	0.890
300	0.981	0.862
325	0.971	0.834
350	0.961	0.808
375	0.952	0.782
400	0.942	0.758
425	0.932	0.734
450	0.923	0.709

Source: Botterill, 1996 and 1997

FUEL CONSUMPTION
(percent adjustment)

IRI	Auto	Truck
0	0.971	0.961
25	0.977	0.965
50	0.980	0.970
75	0.982	0.975
100	0.985	0.980
125	0.990	0.986
150	0.995	0.993
175	1.000	1.000
200	1.005	1.007
225	1.012	1.017
250	1.019	1.026
275	1.027	1.036
300	1.034	1.047
325	1.041	1.058
350	1.050	1.070
375	1.061	1.085
400	1.072	1.100
425	1.082	1.114
450	1.093	1.129

Source: Texas Transportation Institute, 1994

NON-FUEL COSTS
(percent adjustment)

IRI	Auto	Truck
0	1.000	1.000
25	1.000	1.000
50	1.000	1.000
75	1.000	1.000
100	1.000	1.000
125	1.000	1.000
150	1.017	1.018
175	1.034	1.038
200	1.052	1.058
225	1.070	1.078
250	1.088	1.097
275	1.105	1.117
300	1.123	1.137
325	1.141	1.156
350	1.159	1.176
375	1.176	1.196
400	1.194	1.216
425	1.212	1.235
450	1.230	1.255

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	1.000	1.000
0.002	0.982	0.988
0.004	0.964	0.976
0.006	0.945	0.964
0.008	0.927	0.952
0.010	0.909	0.939
0.012	0.891	0.927
0.014	0.873	0.915
0.016	0.855	0.903
0.018	0.836	0.891
0.020	0.789	0.879
0.022	0.747	0.867
0.024	0.706	0.855
0.026	0.664	0.842
0.028	0.623	0.817
0.030	0.581	0.789
0.032	0.540	0.761
0.034	0.498	0.734
0.036	0.476	0.706
0.038	0.473	0.678
0.040	0.471	0.650
0.042	0.468	0.623
0.044	0.466	0.595
0.046	0.463	0.567
0.048	0.460	0.540
0.050	0.458	0.512
0.052	0.455	0.484
0.054	0.453	0.476
0.056	0.453	0.474
0.058	0.453	0.473
0.060	0.453	0.471
0.062	0.453	0.469
0.064	0.453	0.467
0.066	0.453	0.466
0.068	0.453	0.464
0.070	0.453	0.462
0.072	0.453	0.460
0.074	0.453	0.459
0.076	0.453	0.457
0.078	0.453	0.455
0.080	0.453	0.453

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	Without		With		Non-Highway Benefits			Total
Strategy	Speed	Volume	Speed	Volume	TT	VOC	Em	Benefit
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
TIoth	1.00	1.00	1.02	0.97	-0.11	-0.12	-0.35	1.00
TIsev	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
29) Chaudhary and Messer, 2000

TRANSIT TRAVEL TIME AND AGENCY COST SAVINGS
(percent savings)

	Travel	Agency Costs	
TMS Strategy	Time	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