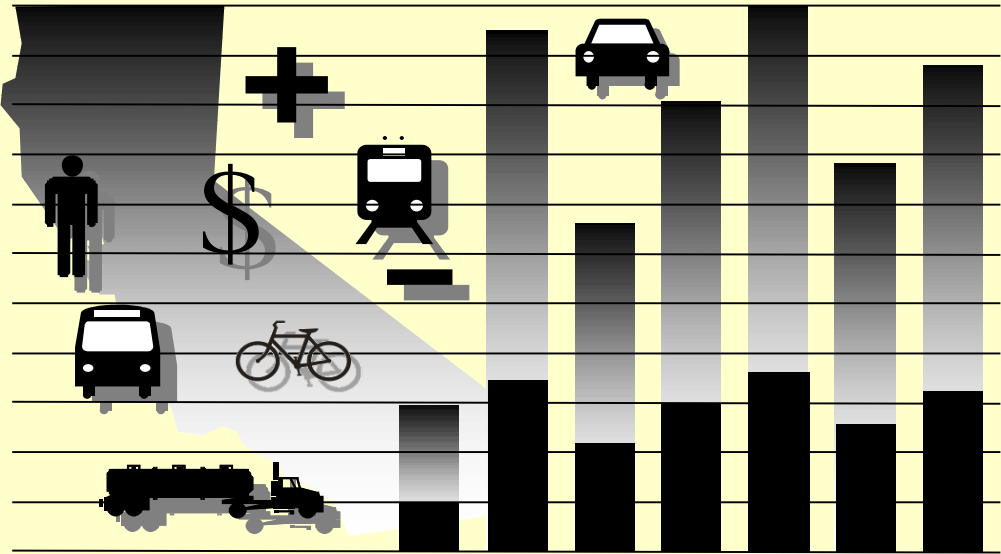




# California Life-Cycle Benefit/Cost Analysis Model (Cal-B/C Sketch) Version 7.2



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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:

<u>Worksheets</u>	<u>Contents</u>
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:

PROJECT:

EA:   
PPNO:

**1A PROJECT DATA**

**Type of Project** Check percent traffic in weave in section 1B  
Select project type from list

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

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

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

**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%

**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**

	No Build	Build
Current	59,433	
Base (Year 1)	65,283	65,283
Forecast (Year 20)	102,336	102,336

**Average Hourly HOV/HOT Lane Traffic**

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

**Percent Traffic in Weave**

	No Build	Build
Percent Trucks (include RVs, if applicable)	25%	25%

**Truck Speed**

	No Build	Build
	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

**1D RAIL AND TRANSIT DATA**

**Annual Person-Trips**

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

**Percent Trips during Peak Period**

	No Build	Build
	40%	

**Percent New Trips from Parallel Highway**

	No Build	Build
		100%

**Annual Vehicle-Miles**

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

**Average Vehicles/Train** (if rail project)

	No Build	Build

**Reduction in Transit Accidents**

	No Build	Build
Percent Reduction (if safety project)		

**Average Transit Travel Time**

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

**Highway Grade Crossing**

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

**Transit Agency Costs** (if TMS project)

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

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

Prepare Model for Second Road

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

1E PROJECT COSTS (enter costs in thousands of dollars)									
Col. no.	(1)	(2)	(3)	(4)	(5)	(6)	(7)		
Year	DIRECT PROJECT COSTS			SUBSEQUENT COSTS		Mitigation	Transit Agency Cost Savings	TOTAL COSTS (in dollars)	
	Project Support	R / W	Construction	Maint./ Op.	Rehab.			Constant Dollars	Present Value
<b>Construction Period</b>									
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
<b>Project Open</b>									
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
<b>Total</b>	\$7,180	\$5,500	\$53,000	\$1,000	\$0	\$0	\$0	\$66,680,000	\$64,295,924

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

**HIGHWAY SPEED AND VOLUME INPUTS**

Calculated by Model      Changed by User      Used for Proj. Eval.      Reason for Change

**No Build**

**Year 1**

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
<b>No Build</b>				
Fatal Accidents	0.031		0.031	
Injury Accidents	0.54		0.54	
PDO Accidents	2.21		2.21	
Total Accidents	2.781			
<b>Hwy Safety or Weaving Improvement</b>		0%	collision reduction factor (per HSIP Guidelines)	
<b>Adjustment Factor (Actual/Statewide Avg. Existing)</b>				
Fatal Accidents	3.5054		3.5054	
Injury Accidents	1.2992		1.2992	
PDO Accidents	2.6345		2.6345	
<b>Build</b>				
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)

Aggregate Segment Length (estimate as VMT/total volume)

All Ramps  miles

Arterials  miles

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

<b>Year 1</b>			
<b>Peak Period</b>			
HOV Trips	0	0	
Non-HOV Trips	8,282,469	8,282,469	0
Truck Trips	2,400,716	2,400,716	0
<b>Non-Peak Period</b>			
Non-HOV Trips	13,869,942	13,869,942	0
Truck Trips	3,556,395	3,556,395	0
<b>Total Trips</b>	<b>28,109,522</b>	<b>28,109,522</b>	<b>0</b>

<b>Year 20</b>			
<b>Peak Period</b>			
HOV Trips	0	0	
Non-HOV Trips	12,983,311	12,983,311	0
Truck Trips	3,763,278	3,763,278	0
<b>Non-Peak Period</b>			
Non-HOV Trips	21,742,038	21,742,038	0
Truck Trips	5,574,882	5,574,882	0
<b>Total Trips</b>	<b>44,063,509</b>	<b>44,063,509</b>	<b>0</b>

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. \$)	Tons		Value (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
<b>TOTAL BENEFITS</b>	<b>\$146.5</b>	<b>\$47.4</b>	<b>\$193.9</b>	<b>\$9.7</b>
Person-Hours of Time Saved			14,159,496	707,975

**Should benefit-cost results include:**

1) Induced Travel? (y/n)	<input type="text" value="Y"/> <small>Default = Y</small>
2) Vehicle Operating Costs? (y/n)	<input type="text" value="Y"/> <small>Default = Y</small>
3) Accident Costs? (y/n)	<input type="text" value="Y"/> <small>Default = Y</small>
4) Vehicle Emissions? (y/n) <small>includes value for CO<sub>2</sub>e</small>	<input type="text" value="Y"/> <small>Default = Y</small>

EMISSIONS REDUCTION	Tons		Value (mil. \$)	
	Total Over 20 Years	Average Annual	Total Over 20 Years	Average Annual
CO Emissions Saved	124	6	\$0.0	\$0.0
CO <sub>2</sub> Emissions Saved	-74,125	-3,706	-\$2.3	-\$0.1
NO <sub>x</sub> Emissions Saved	-42	-2	-\$0.5	-\$0.0
PM <sub>10</sub> Emissions Saved	-6	0	-\$0.4	-\$0.0
PM <sub>2.5</sub> Emissions Saved	-6	0		
SO <sub>x</sub> Emissions Saved	-1	0	-\$0.0	-\$0.0
VOC Emissions Saved	-10	-1	-\$0.0	-\$0.0

**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
<b>Total</b>	<b>\$0</b>	<b>\$41,196,900</b>	<b>\$0</b>	<b>\$18,426,700</b>	<b>\$0</b>	<b>\$0</b>	<b>\$61,762,871</b>	<b>\$0</b>	<b>\$12,604,221</b>

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
<b>Total</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$133,990,692</b>	<b>\$223,468,795</b>	<b>14,159,496</b>

**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)
<b>Total</b>	<b>\$0</b>	<b>(\$4,220,894)</b>	<b>\$0</b>	<b>(\$1,458,194)</b>	<b>\$0</b>	<b>(\$13,934,700)</b>	<b>\$0</b>	<b>(\$1,822,904)</b>	<b>-</b>	<b>-</b>	<b>(\$21,436,692)</b>	<b>(\$34,194,393)</b>

**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	
<b>Total</b>	<b>\$0</b>	<b>\$25,584,955</b>	<b>\$0</b>	<b>\$8,528,318</b>	<b>\$0</b>	<b>\$37,901,286</b>	<b>\$0</b>	<b>\$12,633,762</b>	<b>\$0</b>	<b>\$84,648,321</b>	<b>\$138,908,850</b>	

## 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)
<b>Total</b>	<b>\$0</b>	<b>(\$597,065)</b>	<b>\$0</b>	<b>(\$139,010)</b>	<b>\$0</b>	<b>\$0</b>	<b>(\$1,176,831)</b>	<b>\$0</b>	<b>(\$1,359,222)</b>



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**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)
<b>Total</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>(\$3,272,128)</b>	<b>(\$4,788,581)</b>

## SUMMARY OF EMISSION REDUCTION BENEFITS (continued)

Year	TONS EMISSIONS SAVED (tons/yr)						
	CO	CO <sub>2</sub>	NO <sub>x</sub>	PM <sub>10</sub>	SO <sub>x</sub>	VOC	PM <sub>2.5</sub>
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)
<b>Total</b>	<b>124</b>	<b>(74,125)</b>	<b>(42)</b>	<b>(6)</b>	<b>(1)</b>	<b>(10)</b>	<b>(6)</b>

C

**SUMMARY OF EMISSION REDUCTION BENEFITS (continued)**

Year	DOLLARS EMISSIONS SAVED (PV \$/yr)					
	CO	CO <sub>2</sub>	NO <sub>x</sub>	PM <sub>10</sub>	SO <sub>x</sub>	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)
<b>Total</b>	<b>\$5,660</b>	<b>(\$2,282,708)</b>	<b>(\$527,550)</b>	<b>(\$433,429)</b>	<b>(\$26,742)</b>	<b>(\$7,357)</b>

A

**NET PRESENT VALUE CALCULATION**

Year	PRESENT VALUE OF USER BENEFITS				PRESENT VALUE OF USER BENEFITS (road 2)			
	Travel Time Savings	Vehicle Op. Cost Savings	Accident Reductions	Vehicle Emission Reductions	Travel Time Savings	Vehicle Op. Cost Savings	Accident Reductions	Vehicle Emission Reductions
<b>Construction Period</b>								
1								
2								
3								
4								
5								
6								
7								
8								
<b>Project Open</b>								
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)				
<b>Total</b>	<b>\$133,990,692</b>	<b>(\$21,436,692)</b>	<b>\$84,648,321</b>	<b>(\$3,272,128)</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>

14,159,496	Person-Hours of Time Saved		Person-Hours of Time Saved
tons	\$ PV	tons	\$ PV
124	\$5,660		CO Saved
(74,125)	(\$2,282,708)		CO <sub>2</sub> Saved
(42)	(\$527,550)		NO <sub>x</sub> Saved
(6)	(\$433,429)		PM <sub>10</sub> Saved
(6)			PM <sub>2.5</sub> Saved
(1)	(\$26,742)		SO <sub>x</sub> Saved
(10)	(\$7,357)		VOC Saved
<b>\$31,030,922</b>	<b>(\$3,281,098)</b>	<b>\$21,162,080</b>	<b>(\$1,498,232)</b>

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 <sub>2</sub> Saved
	NO <sub>x</sub> Saved
	PM <sub>10</sub> Saved
	PM <sub>2.5</sub> Saved
	SO <sub>x</sub> 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
<b>Construction Period</b>								
1								
2								
3								
4								
5								
6								
7								
8								
<b>Project Open</b>								
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)				
<b>Total</b>	\$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	<b>\$323,394,671</b>	<b>\$66,680,000</b>	<b>\$256,714,671</b>	

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%

**Payback Period** 6 years

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

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



**Parameters**

This page contains all economic values and rate tables.  
To update economic values automatically, change "Economic Update Factor."

General Economic Parameters	
Year of Current Dollars for Model	2016
Economic Update Factor (Using GDP Deflator)	1.00
Real Discount Rate	4.0%

Travel Time Parameters		Value	Units
Statewide Average Hourly Wage	\$	27.34	\$/hr
<b>Heavy and Light Truck Drivers</b>			
Average Hourly Wage	\$	20.44	\$/hr
Benefits and Costs	\$	10.97	\$/hr
<b>Value of Time</b>			
Automobile	\$	13.65	\$/hr/rip
Truck	\$	31.40	\$/hr/veh
Auto & Truck Composite	\$	18.95	\$/hr/veh
Transit	\$	13.65	\$/hr/rip
Out-of-Vehicle Travel		2	times
Incident-Related Travel		3	times
Travel Time Uprater		0.0%	annual incr
<b>Vehicle Operating Cost Parameters</b>			
<b>Average Fuel Price</b>			
Automobile (regular unleaded)	\$	3.18	\$/gal
Truck (diesel)	\$	3.00	\$/gal
<b>Sales and Fuel Taxes</b>			
State Sales Tax (gasoline)		2.25%	%
State Sales Tax (diesel)		7.50%	%
Average Local Sales Tax		0.50%	%
Federal Fuel Excise Tax (gasoline)	\$	0.184	\$/gal
Federal Fuel Excise Tax (diesel)	\$	0.244	\$/gal
State Fuel Excise Tax (gasoline)	\$	0.278	\$/gal
State Fuel Excise Tax (diesel)	\$	0.160	\$/gal
<b>Fuel Cost Per Gallon (Exclude Taxes)</b>			
Automobile	\$	2.65	\$/gal
Truck	\$	2.40	\$/gal
<b>Non-Fuel Cost Per Mile</b>			
Automobile	\$	0.313	\$/mi
Truck	\$	0.429	\$/mi
Idling Speed for Op. Costs and Emissions		5	mph
<b>Accident Cost Parameters</b>			
Cost of a Fatality	\$	9,800,000	\$/event
<b>Cost of an Injury</b>			
Level A (Severe)	\$	466,400	\$/event
Level B (Moderate)	\$	127,000	\$/event
Level C (Minor)	\$	64,900	\$/event
Cost of Property Damage	\$	2,700	\$/event
<b>Cost of Highway Accident</b>			
Fatal Accident	\$	11,300,000	\$/accident
Injury Accident	\$	154,200	\$/accident
PDO Accident	\$	8,600	\$/accident
Average Cost	\$	281,100	\$/accident
<b>Statewide Highway Accident Rates</b>			
Fatal Accident		0.006	per mil veh-mi
Injury Accident		0.29	per mil veh-mi
PDO Accident		0.55	per mil veh-mi
Non-Freeway		1.05	per mil veh-mi

Highway Operations Parameters		Value	Units
Maximum V/C Ratio		1.56	-
Percent ADT in Peak Period		40.3%	%
Percent ADT in Average Peak Hour		8.1%	%
Annualization Factor		365	days/yr
<b>Capacity and Dep. Rate</b>			
	Alpha	Beta	Capacity (vphpl) Dep. Rate (vphpl)
Freeway	0.20	10	2,000 1,800
Expressway	0.20	10	2,000 1,800
Conventional Highway	0.05	10	800 1,400
HOV Lanes	0.55	8	1,600
<b>Non-HOV Lanes</b>			
	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

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

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

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 Transportation Survey, 27) WHO HEAT Model, 2016, 28) California Department of Health, 2010-2014 Death Rates, Table 5.2

**Travel Demand Tables**

Project Types		
<b>Highway Capacity Expansion</b>		
General Highway	<input type="checkbox"/> FALSE	GenHwy
HOV Lane Addition	<input type="checkbox"/> FALSE	HOV
HOT Lane Addition	<input type="checkbox"/> FALSE	HOT
Passing Lane	<input type="checkbox"/> FALSE	Passing
Intersection	<input type="checkbox"/> FALSE	Intersect
Truck Only Lane	<input type="checkbox"/> FALSE	TruckLane
Bypass	<input type="checkbox"/> FALSE	Bypass
Queueing	<input type="checkbox"/> FALSE	Queueing
Pavement	<input type="checkbox"/> FALSE	Pavement
Please select a type of highway project		
		Enter HOV restriction in section 1B
		Include toll payers as HOV's & check AVOs
		Enter a truck speed in section 1B
		Remember to run model for both roads
		Remember to run macro for truck lane
		Remember to run model for both roads
		Add arrival rate & check departure rate in 1B
		Enter pavement condition in section 1B
<b>Rail or Transit Cap Expansion</b>		
Passenger Rail	<input type="checkbox"/> FALSE	PassRail
Light-Rail (LRT)	<input type="checkbox"/> FALSE	LRT
Bus	<input type="checkbox"/> FALSE	Bus
Hwy-Rail Grade Crossing	<input type="checkbox"/> FALSE	HwyRail
Please select a type of rail or transit project		
		Enter data in both sections 1B & 1E
		Enter data in both sections 1B & 1E
		Enter data in both sections 1B & 1E
		Put hwy design in 1B, safety in 1C & crossing in 1D
<b>Hwy Operational Improvement</b>		
Auxiliary Lane	<input type="checkbox"/> FALSE	AuxLane
Freeway Connector	<input type="checkbox"/> TRUE	FreConn
HOV Connector	<input type="checkbox"/> FALSE	HOVConn
HOV Drop Ramp	<input type="checkbox"/> FALSE	HOVDrop
Off-Ramp Widening	<input type="checkbox"/> FALSE	OffRamp
On-Ramp Widening	<input type="checkbox"/> FALSE	OnRamp
HOV-2 to HOV-3 Conv	<input type="checkbox"/> FALSE	HOVto3
HOT Lane Conversion	<input type="checkbox"/> FALSE	HOTConv
Please select a type of op. improvement		
		Enter ramp design speed & on-ramp volume
		Check percent traffic in weave in section 1B
		Check percent traffic in weave in section 1B
		Check percent traffic in weave in section 1B
		Check percent traffic in weave in section 1B
		Enter on-ramp volume & metering strategy
		Check AVOs & trips in sections 1B & 2D
		Check AVOs & trips in sections 1B & 2D
<b>Transp Mgmt Systems (TMS)</b>		
Ramp Metering	<input type="checkbox"/> FALSE	RM
Ramp Metering Signal Coord	<input type="checkbox"/> FALSE	AM
Incident Management	<input type="checkbox"/> FALSE	IM
Traveler Information	<input type="checkbox"/> FALSE	TI
Arterial Signal Management	<input type="checkbox"/> FALSE	ASM
Transit Vehicle Location (AVL)	<input type="checkbox"/> FALSE	AVL
Transit Vehicle Signal Priority	<input type="checkbox"/> FALSE	SigPriority
Bus Rapid Transit (BRT)	<input type="checkbox"/> FALSE	BRT
Please select a type of TMS project		
		Enter model data, if avail., in sections 2A & 2C
		Enter model data, if avail., in sections 2A & 2C
		Enter model data, if avail., in sections 2A & 2C
		Enter model data, if avail., in sections 2A & 2C
		Complete only sections 1A, 1E & 2C
		Enter transit agency costs in section 1D
		Check travel time in section 1D
		Enter free-flow bus lane speed in section 1B
TMS Lookup Code	<input type="checkbox"/> NoAdj	TMSLookup
User Modified Inputs	<input type="checkbox"/> 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
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**

<b>FUEL CONSUMPTION RATES</b>		
(gal/veh-mi)		
<b>Speed</b>	<b>Auto*</b>	<b>Truck</b>
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	0.0499	0.1089
20	0.0485	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









**HEALTH COST OF TRANSPORTATION EMISSIONS**  
(\$/ton)

Area	Proj Loc	CO	CO <sub>2e</sub>	NO <sub>x</sub>	PM <sub>10</sub>	SO <sub>x</sub>	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<sub>2e</sub> Uprater = 2.0% Increase in value per year

Sources: McCubbin and Delucchi, 1996 for emissions other than CO<sub>2e</sub>  
Interagency Working Group on Social Cost of Carbon, United States Government, 2016 for CO<sub>2e</sub>

**PASSENGER TRAIN EMISSIONS FACTORS**  
(g/train-mile)

Mode	Year	CO	CO <sub>2</sub>	NO <sub>x</sub>	PM <sub>10</sub>	SO <sub>x</sub>	VOC	PM <sub>2.5</sub>
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 <sub>2</sub>	NO <sub>x</sub>	PM <sub>10</sub>	SO <sub>x</sub>	VOC	PM <sub>2.5</sub>
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 <sub>2</sub>	NO <sub>x</sub>	PM <sub>10</sub>	SO <sub>x</sub>	VOC	PM <sub>2.5</sub>
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 0	Year 20, By Loading		
	Light	Medium	Heavy
0	125	150	350
25	150	200	500
50	175	250	675
75	200	300	750
100	275	400	750
125	325	475	750
150	400	575	750
175	500	700	750
200	575	750	750
225	650	750	750
250	750	750	750
275	750	750	750
300	750	750	750
325	750	750	750
350	750	750	750
375	750	750	750
400	750	750	750
425	750	750	750
450	750	750	750

Source: Paterson, 1987

VEHICLE OPERATING SPEED (percent adjustment)		
IRI	Auto	Truck
0	1.000	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	0.806
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 Strategy	Without		With		Non-Highway Benefits			Total Benefit
	Speed	Volume	Speed	Volume	TT	VOC	Em	
AMoth	1.02	0.95	1.02	0.95	-5.06	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)			
TMS Strategy	Travel Time	Agency Costs	
		Capital	O&M
Transit Vehicle Location (AVL)	15%	2%	8%
Transit Vehicle Signal Priority	10%	-	-
Bus Rapid Transit (BRT)	29%	-	-

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