



California
Department
Of
Transportation



Cal-B/C

Active Transportation

Version 7.1

User's Guide and Technical Documentation

November 2019

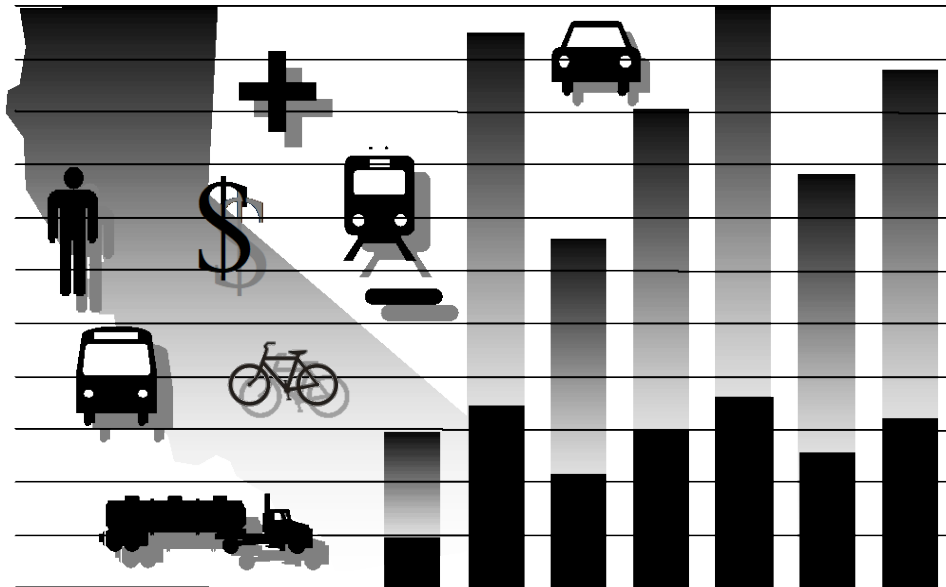


TABLE OF CONTENTS

1. Overview of Cal-B/C	3
2. Introduction to User Guide	4
3. User Requirements	5
4. Operating System and Software Requirements	5
5. Model Overview	5
6. Worksheet Details and Project Analysis.....	10
Project Information Worksheets	10
Project Information Worksheet	10
Non-Infrastructure Program Information Worksheet	21
Model Inputs Worksheet.....	22
Results Worksheet	25
Appendix A: Project Example	28
Upgrade Existing Facility and Construct New Multi-Use Trail	28
Appendix B: Technical Documentation.....	41
Background and Scope of Analysis	41
Benefit Categories by Facility Type	43
Benefit Estimation	44
Journey Quality	44
Intersection Safety – Active Transportation Users	47
Intersection Delay – Active Transportation Users	48
Health – Reduced Absenteeism	49
Health – Reduced Mortality	50
Safety Benefits – Road Users.....	52
Emissions Benefits	53
Cost-Effectiveness Assessment of Non-Infrastructure Programs	54

LIST OF EXHIBITS

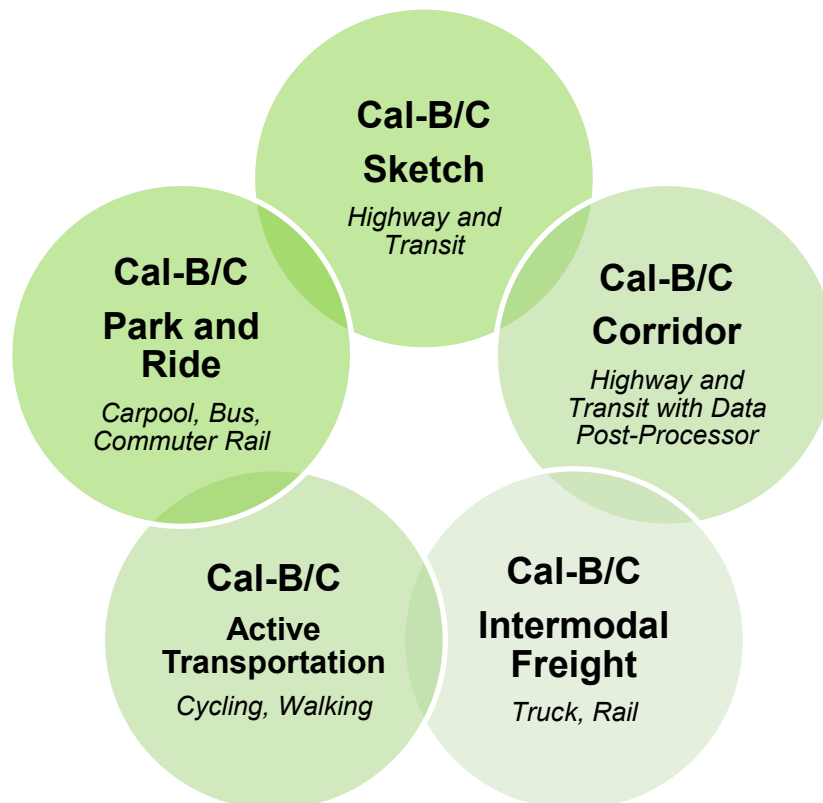
Exhibit 1: Suite of Tools in Cal-B/C Framework.....	3
Exhibit 2: Cal-B/C Graphical User Interface	6
Exhibit 3: Results Worksheet	8
Exhibit 4: Project Information Data Entry Boxes	10
Exhibit 5: Project Information Data Entry Section Locations	11
Exhibit 6: Project Information (Box 1A).....	12
Exhibit 7: Project Information (Box 1d).....	13
Exhibit 8: Existing/New Improvements and Trip Volumes (Boxes 1B/1E).....	15
Exhibit 9: Daily Trip Growth Rate Estimation.....	16
Exhibit 10: Intersection Improvements (Box 1C).....	17
Exhibit 11: Project Costs (Box 1F/1G).....	19
Exhibit 12: Data Checks (Box 1h).....	21
Exhibit 13: Non-Infrastructure Project Information Worksheet (Box 1i).....	22
Exhibit 14: Model Input Worksheet.....	23
Exhibit 15: Model Input Boxes.....	23
Exhibit 16: Results Worksheet - Final Model Output	25
Exhibit 17: Project and Site Characteristics	29
Exhibit 18: Existing and New Facility Improvements and Trip Volumes	30
Exhibit 19: Intersection Improvements - Time Savings and Accident Reduction Data	33
Exhibit 20: General User Characteristics.....	34
Exhibit 21: Infrastructure Project Costs	35
Exhibit 22: Non-Infrastructure Program Costs	36
Exhibit 23: Data Checks.....	37
Exhibit 24: Non-Infrastructure Program Characteristics (Part 1).....	38
Exhibit 25: Non-Infrastructure Program Characteristics (Part 2).....	39
Exhibit 26: Final Results.....	40

1. Overview of Cal-B/C

Welcome to California Department of Transportation (Caltrans) California Life-Cycle Benefit/Cost Analysis suite of tools. Caltrans uses this set of spreadsheet-based tools to conduct investment analyses of projects proposed for the interregional portion of the State Transportation Improvement Program (STIP), the State Highway Operations and Protection Program (SHOPP), applications to the Active Transportation Program (ATP), Senate Bill (SB) 1 programs, and other ad hoc analyses requiring benefit-cost analysis.

The original Cal-B/C model focused on highway and transit modes. This model has been updated several times and ultimately renamed as the **Cal-B/C Sketch** model. This model now covers a wide variety of highway and transit physical and operational improvements. Closely related to the Cal-B/C Sketch model is **Cal-B/C Corridor**, which is based on the same platform, but allows the user to post-process travel demand and micro-simulation model data. In addition, several relatively new sketch planning models have been tailored to evaluate active transportation (**Cal-B/C AT**) projects (e.g., biking and walking facilities), park-and-ride (**Cal-B/C PnR**) programs (e.g., commuter parking and ride-sharing facilities), and intermodal freight (**Cal-B/C IF**) improvements (e.g., freight network expansion and terminal efficiency). Exhibit 1 shows all five tools in the Cal-B/C framework, which allows users to consider many different types of projects.

Exhibit 1: Suite of Tools in Cal-B/C Framework



All of the tools in the Cal-B/C framework use consistent methods, rely on the same parameters, and produce comparable results. Together, these tools cover multi-modal analyses of highway, transit, bicycle, pedestrian, Intelligent Transportation System (ITS), operational improvement, and passenger rail projects. In addition, there are other versions of the Cal-B/C model available for more experienced analysts. One version incorporates the additional benefits of improved reliability, beyond those of predictable time savings alone, and could be used if the proposed project warrants it. A separate version of Cal-B/C has been developed to enable users to assess the degree to which uncertainty influences project outcomes. Risk analysis is performed on the same model, but with an Excel add-in module called Risk Analyzer that is used to perform Monte Carlo simulation on user-specified parameters.

2. Introduction to User Guide

Welcome to the User's Guide for the *California Life-Cycle Benefit/Cost Analysis Model (Cal-B/C) Active Transportation (AT)*, Version 7.1. Cal-B/C AT is part of a suite of similarly designed Cal-B/C Microsoft Excel spreadsheet-based tools that can evaluate multi-modal analyses of highway, transit, bicycle, pedestrian, Intelligent Transportation System (ITS), operational improvement, and passenger rail projects. The California Department of Transportation (Caltrans) uses Cal-B/C to conduct benefit-cost analyses (BCAs) of projects proposed for the interregional portion of the State Transportation Improvement Program (STIP), the State Highway Operations and Protection Program (SHOPP), applications to the Active Transportation Program (ATP), and other ad hoc analyses requiring BCAs.

Cal-B/C AT performs basic economic analyses of active transportation projects that improve travel options and conditions for cyclists and pedestrians. The user enters data into the tool, which computes lifecycle costs, annual and total benefits in several key categories, net present value, benefit-cost ratio, internal rate of return, and payback period. Benefits are also estimated for children as part of Safe Route to School (SRTS) initiatives.

In addition to the benefit-cost tool, a data entry form is provided to assess non-infrastructure initiatives. The tool uses attributes of these initiatives in a multi-criteria scoring system to provide a common basis of comparison. Results of this scoring system are presented alongside the monetized benefits computed in the Cal-B/C AT.

The Cal-B/C AT represents Caltrans' commitment to active transportation. This version of the model reflects updates to a first-generation BCA model that Caltrans developed in 2014. Refinements to the original model have been developed through a comprehensive literature review and in coordination with several organizations, including the Caltrans Economic Analysis Branch, Caltrans Sustainable Community Planning, Caltrans Multi-Modal System Planning, the Division of Traffic Operations, and the California Department of Public Health.

Cal-B/C AT provides several features including estimates for changes in:

- Journey quality impacts for cyclists and pedestrians from facility improvements

- Additional travel time savings where bike facilities cross improved intersections
- User accident risks at improved intersections on existing facilities
- Auto accident costs due to diversions to active transportation
- Health benefits for employers due to reduced absenteeism based on increased productivity
- User benefits associated with reduced risks of mortality
- Highway emissions costs from diversions to active transportation.

This quick-start manual introduces the user to important features of Cal-B/C AT and leads the user through the analysis of a hypothetical project. The Technical Discussion in Appendix B provides details of the methodologies and analytical framework used for the model.

3. User Requirements

At a minimum, the user of Cal-B/C AT should have a working knowledge of spreadsheets, particularly Microsoft Excel. To use Cal-B/C AT, the reader of this User's Guide must be able to navigate through a multiple-sheet workbook and understand basic principles, functions, and the terminology used when discussing spreadsheets.

The user should also understand lifecycle benefit-cost analysis and be able to interpret the results in a transportation planning context. The reader can also refer to the Cal-B/C Resource Guide for additional information, as needed.

4. Operating System and Software Requirements

Cal-B/C AT is a Microsoft Excel macro-enabled workbook (.xlsm) called *Cal-BC 71 AT*. The file is approximately 600 kilobytes (KB) in size. Although designed for a Windows environment, Cal-B/C AT should work on all computer platforms running Excel.

5. Model Overview

Cal-B/C AT provides economic benefit-cost analysis for a range of active transportation projects. The model provides constant dollar economic impacts for five benefit categories:

- **Journey Quality** due to an enhanced quality of the trip for pedestrians and cyclists that arise from a greater feeling of safety, comfort, aesthetics, and other types of improvements.

- **Additional Delay Savings** due to improvements to existing facility intersections (e.g., lights, bridges, etc.) that lead to time savings for trips by reducing waiting time at intersections.
- **Additional Safety Benefits** due to improvements to existing facility intersections (e.g., lights, bridges, etc.) that can reduce accident risk at those intersections.
- **Health Benefits** that include both improved long-term health and reduced risk of disease and early death, and a reduction in absenteeism are realized by new users.
- **Auto Accident Costs and Auto Emissions** due to reduced auto use and associated externalities from such use.

Benefits are computed separately for different types of users. Projects are differentiated by being either new, improved existing facilities, or some combination. Users include existing and induced cyclists and pedestrians. In addition, Cal-B/C AT reports a subset of benefits specific to SRTS in three categories: (1) Journey Quality; (2) Additional Delay Savings; and (3) Additional Safety Benefits.

The Cal-B/C AT model consists of a cover page and 15 worksheets in an Excel workbook. Exhibit 2 shows where these sheets are located in Cal-B/C AT.

Exhibit 2: Cal-B/C Graphical User Interface

The screenshot shows the Excel interface for the Cal-B/C AT model. The worksheet tabs at the bottom are: Title, Instructions, Definitions, 1a) Project Info, 1b) Non-Inf Program Info, 2) Model Inputs, 3) Results, Journey Quality, Intersection Delay, Intersection Safety, Auto Accident Costs, Health, and Parameters. Three callout boxes categorize these worksheets:

- Introduction Worksheets** (purple box):
 - Title
 - Instructions
 - Definitions
- Project Inputs & Results Worksheets** (green box):
 - 1a) Project Information
 - 1b) Non-Infrastructure Program Info.
 - 2) Model Inputs
 - 3) Results
- Analysis Worksheets** (red box):
 - Journey Quality
 - Intersection Delay
 - Intersection Safety
 - Auto Accident Costs
 - Health – Absenteeism
 - Health – Reduced Mortality
 - Emissions
 - Final Calculations
 - Parameters

The first three pages include the cover page, a worksheet with concise instructions for how to use Cal-B/C AT, and a sheet with key active transportation and tool definitions.

The next four sheets are data entry and summary results sheets. **These are generally the only worksheets that the user will need to use to produce results.** The final nine worksheets perform calculations or store defaults and economic parameters. These last worksheets should be used by advanced users only.

Cal-B/C AT requires few user inputs, but allows the user to enter many more when project details are available. Cells in the worksheets are color-coded. **Green** cells indicate required data (i.e., the user must input values for the model to work). **Red** cells provide default values, such as bicycle facility classification, that the user can change if needed. **Blue** cells contain values calculated by the model, which can be changed if more detailed data are available.

The first worksheet after the cover page provides *Instructions*. The instructions include short descriptions of the steps in performing a basic analysis and hints on how to avoid potential pitfalls.

The *Definitions* worksheet clarifies several key terms used to evaluate active transportation facility use with respect to trip types and user types. In addition, not all users benefit from projects in the same way, so benefit category definitions are also provided in this worksheet.

The *Project Information* and *Non-Infrastructure Program Information* worksheets are the main data-entry locations. The user enters descriptive information such as:

- Project and site characteristics
- Existing/future segment improvements and trip volumes
- Intersection improvements - time savings and accident reduction data
- General user characteristics
- Project and program costs and requested funds
- Non-infrastructure program characteristics (e.g., target audience and messaging impacts).

The *Model Inputs* worksheet is where the user enters bicycle and pedestrian daily trips for existing facilities, new segments, and SRTS projects. This worksheet will need updating only if the user has better active transportation annual trip volumes, data on facility users, and annual mileage.

The *Results* worksheet, shown in Exhibit 3 presents the final investment costs as well as annualized and life-cycle benefits. It also includes the impacts of non-infrastructure (e.g., outreach and messaging) programs.

Exhibit 3: Results Worksheet

3		INVESTMENT ANALYSIS			
SUMMARY RESULTS					
Life-Cycle Costs (mil. \$) <input type="text" value="\$0.0"/> Life-Cycle Benefits (mil. \$) <input type="text" value="\$0.0"/> Net Present Value (mil. \$) <input type="text" value="\$0.0"/>		ITEMIZED BENEFITS (mil. \$)		Total Over	Average
Benefit / Cost Ratio: <input type="text" value="N/A"/> Rate of Return on Investment: <input type="text" value="N/A"/> Payback Period: <input type="text" value="N/A"/>		Journey Quality <input type="text" value="\$0.0"/> <input type="text" value="\$0.0"/> Additional Delay Savings <input type="text" value="\$0.0"/> <input type="text" value="\$0.0"/> Additional Safety Benefits <input type="text" value="\$0.0"/> <input type="text" value="\$0.0"/> Health Benefits <input type="text" value="\$0.0"/> <input type="text" value="\$0.0"/> Emission Cost Savings <input type="text" value="\$0.0"/> <input type="text" value="\$0.0"/> TOTAL BENEFITS <input type="text" value="\$0.0"/> <input type="text" value="\$0.0"/>		20 Years	Annual
NON-INFRASTRUCTURE IMPLEMENTATION COST Per Bike Program Impact Score <input type="text" value="N/A"/> Per Ped Program Impact Score <input type="text" value="N/A"/>		SRTS-SPECIFIC BENEFITS (mil. \$)			
		Journey Quality <input type="text" value="N/A"/> <input type="text" value="N/A"/> Additional Delay Savings <input type="text" value="N/A"/> <input type="text" value="N/A"/> Additional Safety Benefits <input type="text" value="N/A"/> <input type="text" value="N/A"/> TOTAL SRTS BENEFITS <input type="text" value="N/A"/> <input type="text" value="N/A"/>			
Factors that Differentiate Benefits and Performance Measures					
Safe Route to School <input type="text" value="No"/> Intersection Improvements on SRTS <input type="text" value="No"/> Programmatic Initiatives <input type="text" value="No"/> Recreational Benefits <input type="text" value="0"/> <small>(enter 1 for Yes, 0 for No)</small>					
		EMISSIONS REDUCTION			
		Tons		Value (mil. \$)	
		Total Over	Average	Total Over	Average
		20 Years	Annual	20 Years	Annual
		CO Emissions Saved <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="\$0.0"/> <input type="text" value="\$0.0"/> CO₂ Emissions Saved <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="\$0.0"/> <input type="text" value="\$0.0"/> NO_x Emissions Saved <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="\$0.0"/> <input type="text" value="\$0.0"/> PM₁₀ Emissions Saved <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="\$0.0"/> <input type="text" value="\$0.0"/> PM_{2.5} Emissions Saved <input type="text" value="0"/> <input type="text" value="0"/> SO_x Emissions Saved <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="\$0.0"/> <input type="text" value="\$0.0"/> VOC Emissions Saved <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="\$0.0"/> <input type="text" value="\$0.0"/>			

An experienced user can override default parameters in the *Parameters* or other calculation worksheets to produce tailored results if detailed information is available for specific projects. Cal-B/C AT requires user inputs only on the *Project Information*, *Non-Infrastructure Program Information*, and *Model Inputs* worksheets, but the parameters and detailed calculation sheets can be accessed to change default values as needed.

The *Parameters* worksheet (i.e., the last sheet in Cal-B/C AT) contains all of the economic values and rate tables used for the entire suite of Cal-B/C products. This worksheet contains several parameters specific to active transportation projects:

- General Travel Activity Characteristics (cycling, walking, and school days per year)
- Active Transportation User Characteristics (cycling and walking speed, auto diversion rates)
- Journey Quality parameters for cycling and walking by bike facility classification and other roadway characteristics (e.g., curb height, crowding)
- Health (Absenteeism and Mortality Reduction).

Adjusting the economic update factor using the Gross Domestic Product (GDP) deflator changes the economic values in the model.

The *Parameters* worksheet includes the following parameters:

General Economic Values

- Year of current dollars for model¹
- Economic update factor
- Real discount rate

Highway Operations Measures

- Maximum volume-capacity (v/c) ratio
- Percent ADT in peak period
- Capacity per lane by road type
- Parameters for speed estimation
- Queue departure rates
- Annualization factor

Active Transportation Parameters

- Travel activity characteristics
- User characteristics
- Trip characteristics
- Journey quality
- Health impacts

Travel Time Values

- Automobile, truck, and transit
- Out-of-vehicle; incident-related travel

User Operating Costs

- Fuel cost per gallon
- Non-fuel cost per mile (automobile and truck)

Highway Accident Costs

- Cost of a fatality
- Cost of an injury (Level A Severe, Level B Moderate, Level C Minor)
- Cost of a highway accident (fatal, injury, PDO)
- Statewide highway accident rates (fatal, injury, PDO)

Accident Rates and Transit Costs

- Highway injury severity frequency
- Highway accident type distribution
- Light rail and bus accident rates and costs
- Passenger train accident rates and costs
- Highway-rail grade crossing incidents

- Passing lane accident reduction factors

Highway Emissions Rates

- CO, CO₂, NO_x, PM₁₀, SO_x, and VOC
- Automobile, truck, and bus

Rail Emissions Rates

- CO, NO_x, PM₁₀, and VOC
- Passenger train, light rail, and freight locomotive

Emissions Health Costs

- Urban Southern California, urban Northern California, and rural California
- CO, CO_{2e}, NO_x, PM₁₀, SO_x, and VOC
- Automobile, truck, and bus

Other Values

- Demand for travel in peak period
- Fuel consumption rates for autos, trucks, and buses
- Pavement adjustment factors
- Weaving adjustment factors
- Transportation Management System (TMS) adjustment factors

¹ Measured in real (constant) dollars, which are a measure of monetary value adjusted for inflation.

6. Worksheet Details and Project Analysis

The following sections describe the four primary Cal-B/C AT worksheets and walk the user through a hypothetical project. The main text in each section introduces the user to an element of the model and the project examples provide details on how to enter data.

PROJECT INFORMATION WORKSHEETS

The user enters data primarily on the *Project Information* or *Non-Infrastructure Program Information* worksheets, depending on project type. The *Project Information* worksheet is where the user provides information for infrastructure projects (e.g., bicycle lane expansions) and cost/funding information for infrastructure projects and non-infrastructure programs. The *Non-Infrastructure Program Information* worksheet is where the user enters information (beyond program costs) for programs intended to reach target audiences through a variety of outreach and training mechanisms. Both worksheets are discussed in detail in the following sections.

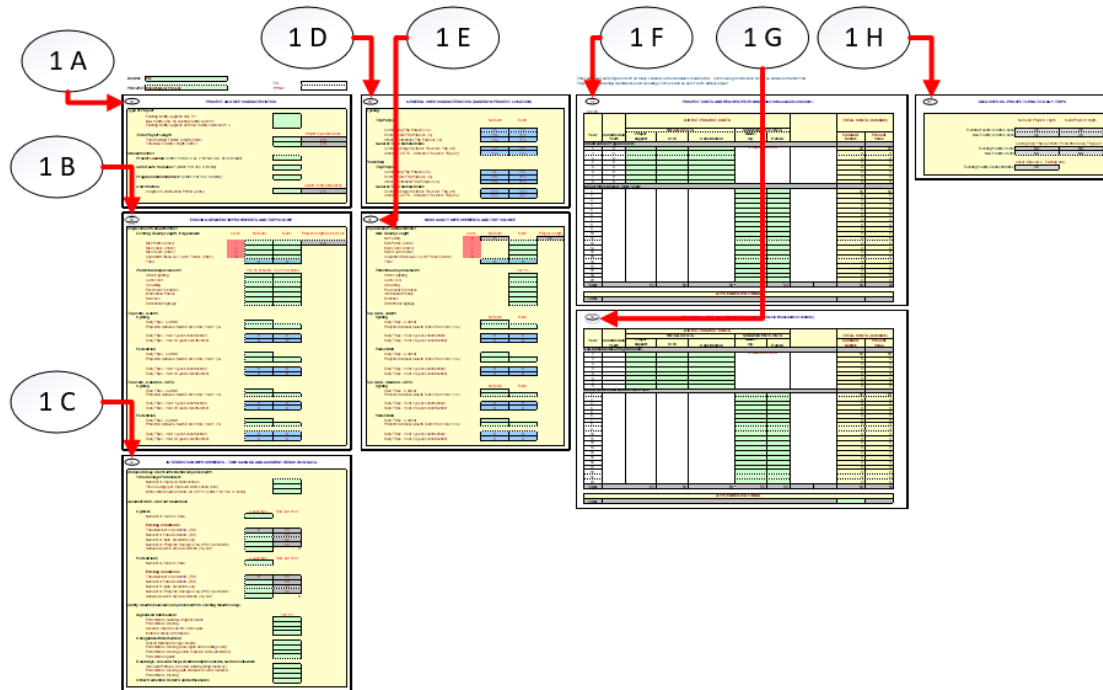
Project Information Worksheet

The user can analyze most projects by entering limited data on the *Project Information* worksheet. There are several sections of the worksheet called “boxes” where information pertaining to specific project elements are entered. Exhibit 4 summarizes the eight boxes in the worksheet while Exhibit 5 illustrates where these boxes are found in the worksheet.

Exhibit 4: Project Information Data Entry Boxes

Data Entry Boxes		Location/ Cell Range
1A/(1D)	Project and Site/(General User) Characteristics	B6:J27/ (L6:T27)
1B/(1E)	Existing/(New) Segment Improvements and Trip Volume	B29:J80 / (L29:T80)
1C	Intersection Improvements - Time Savings and Accident Reduction Data	B80:J132
1F/(1G)	Project/(Program) Costs and Requested Funds	V6:AH48 / (V50:AH92)
1H	Data Checks - Project Length, Daily Trips	AJ6:AR21

Exhibit 5: Project Information Data Entry Section Locations



At the top of the worksheet, the user can provide the Caltrans District where the project is located, a descriptive name for the project, an Expenditure Authorization (EA), or a Caltrans project planning number (PPNO).²

The subsections that follow provide data entry instructions for each of the boxes described above. Project and user characteristics (1A and 1D) are presented together since these two boxes are closely related. This approach also applies to the existing and new segment information and trip volume boxes (1B and 1E) and for the two cost and funds boxes (1F and 1E) since these boxes require similar information.

Project and Site Characteristics (Box 1A), General User Characteristics (Box 1D)

Box 1A is where the user inputs basic information about the type of project proposed for implementation and is shown in Exhibit 6. Box 1B, discussed below, presents information calculated by Cal-B/C AT based on inputs from Box 1A.

² Expenditure Authorization (EA) is a unique, 5-digit number assigned by Caltrans for projects. A Project Planning Number (PPNO) is an identification number assigned by Caltrans District offices for all STIP and bond projects.

Exhibit 6: Project Information (Box 1A)

1A PROJECT AND SITE CHARACTERISTICS	
Type of Project	
Existing facility upgrade only = 1	<input type="text"/>
New facility only, no existing facility work = 2	<input type="text"/>
Existing facility upgrade and new facility extension = 3	<input type="text"/>
Total Project Length	
Total Existing Facility Length (miles)	<input type="text"/>
Total New Facility Length (miles)	<input type="text"/>
	Project Type Data Check
	OK
	OK
Characteristics	
Project Location (enter 1 for So. Cal., 2 for No. Cal., or 3 for rural)	<input type="text"/>
Safe Route to School? (enter 1 for Yes, 0 for No)	<input type="text"/>
Programmatic Initiatives? (enter 1 for Yes, 0 for No)	<input type="text"/>
Construction	
Length of Construction Period (years)	<input type="text"/>
	Constr. Years Data Check
	OK

Type of Project

Identify the general type of project by entering a “1”, “2”, or “3” in this cell, where:

- 1 = Existing facility upgrade only
- 2 = New facility only, no existing facility work
- 3 = Existing facility upgrade and new facility extension

The project type is primarily used by Cal-B/C AT to estimate the number of users for a facility given improvements or expansion.

Total Project Length

Enter total mileage for existing and new facilities. If the project type matches the project lengths entered, the “Project Type Data Check” will show “OK” in the **gray** cells to the right of the **green** data entry cells. If not, then the data check cells will say “Not OK.” For example, if the project is an existing facility upgrade only (i.e., project type “1” from above), and if the user enters a “Total New Facility Length” that is greater than 0 miles, then an error will be returned.

Note that for improvements to an existing bike facility (e.g., pavement rehabilitation) that covers only a portion of the total facility length (e.g., only two miles of a five-mile facility are being rehabilitated), enter the mileage of the facility that is receiving the improvement (i.e., two miles in this example).

Project Location

Enter a “1”, “2”, or “3” for the appropriate region of California, where:

- 1 = Southern California (urbanized area)



- 2 = Northern California (urbanized area)
- 3 = Rural (non-urbanized area)

This information is used to estimate the percent of daily bicycle and pedestrian trips taken for different trip purposes (i.e., commute, recreational, other) in Box 1D for the “No Build” scenario. The “No Build” scenario is the base case under which no project is implemented. [Note: Benefits calculated by Cal-B/C AT are the differences in impacts for a future time which the project is built (i.e., the “Build” scenario) and the No Build scenario.]

The project location is also used by Box 1D to estimate the average distance per trip for SRTS and other trips for both cyclists and pedestrians. Box 1D reports on mode-specific trip characteristics for walking and cycling for a new or existing facility. Reported default values on trip purpose by percentage of total and average distance traveled per trip are provided. Separate trip distances are provided for children and can be used as default values for SRTS initiatives. Other default values (e.g., ages of users, diversion of riders from personal vehicles, and traveling speeds) are included in the *Parameters* worksheet.

Exhibit 7 illustrates how the No Build Box 1D is updated by referencing the data input in the Project Location cell. In that exhibit, if the user enters a “2” for a project in an urbanized area of Northern California, the appropriate cell in Box 1D looks up the appropriate value in the *Parameters* worksheet (see Cal-B/C Resource Guide for more information).

Exhibit 7: Project Information (Box 1d)

Box 1A

User types in “2” for urban Northern California in Box 1A

AVERAGE DISTANCE PER ACTIVE TRANSPORTATION TRIP
(miles/trip)

Mode	Age Cohort	Urban		
		South	North	Rural
Cycling	Adults	2.51	2.21	2.48
	Children <16	1.57	1.10	1.12
				69
				57

Urban Northern California is referenced in the parameters worksheet (see cell range AG58:A176)

TRIP PURPOSE FOR ACTIVE TRANSPORTATION TRIPS
(percent of trips)

Mode	Trip Purpose	Urban		
		South	North	Rural
Cycling	Commuting	8%	11%	7%
	Recreation	16%	13%	15%
	Other Destination	77%	76%	78%
Walking	Commuting	5%	9%	4%
	Recreation	10%	10%	15%
	Other Destination	85%	81%	81%

Box 1D

Appropriate cell is updated in Box 1D in the No Build scenario

Note that the **blue** cells in Box 1D indicate cells that can be manually overwritten by the user if data better than the default values provided in the *Parameters* worksheet are available. However, if the user changes the percentages, they must total to 100 percent.

As a default, the “Build” or with project values are assumed to be the same as the “No Build” values. However, the user is free to override any values in this box should better estimates be available for the project under analysis.

Safe Route to School

Enter either a “0” or a “1” to indicate if the project involves a Safe Route to School, where

- 0 = No, the project does not involve a SRTS
- 1 = Yes, the project does involve a SRTS

This information is used to evaluate the journey quality and intersection delay impacts of projects.

Programmatic Initiatives

Enter either a “0” or a “1” to indicate whether the project includes any non-infrastructure, programmatic initiatives, where

- 0 = No, the project does not involve non-infrastructure, programmatic initiatives
- 1 = Yes, the project does involve these additional initiatives.

This information is used to activate the features of the *Non-Infrastructure Program Information* worksheet that reports non-infrastructure program implementation impact scores for cyclists and pedestrians. That worksheet and its results are discussed in sections below.

Construction

Insert the number of construction years before benefits begin. This must be a whole number (round to the next higher integer for a conservative estimate of the years). The number of years should correspond with the cost data entered in Boxes 1F and 1G. For example, if the construction of a bike facility is expected to take two years, there should be two years of construction cost data in Boxes 1F and 1G.

As with the mileage entered above, the “Construction Years Data Check” will return “OK” in the **gray** cells to the right of the **green** data entry cells if the construction years equal the number of years with construction cost data in Boxes 1F and 1G.

Existing Segment Improvements and Trip Volume (Box 1B)/New Facility Improvements and Trip Volume (Box 1E)

Box 1B is where the user enters information about improvements to an existing facility. Box 1E is similar to Box 1B. However, Box 1E is where data is entered for a newly constructed facility. Exhibit 8 shows boxes 1B and 1E.



Exhibit 8: Existing/New Improvements and Trip Volumes (Boxes 1B/1E)

EXISTING SEGMENT IMPROVEMENTS AND TRIP VOLUME					NEW TRAIL IMPROVEMENTS AND TRIP VOLUME				
Improvement Characteristics					Improvement Characteristics				
<i>Existing Trail Length, if Applicable</i>					<i>New Trail Length</i>				
	Class	No Build	Build	Project Length Data Check		No Build	Build	Project Length	
Bike Paths (miles)	I			OK	No Trail	0			OK
Bike Lanes (miles)	II				Bike Paths (miles)				
Bike Route (miles)	III				Bike Lanes (miles)				
Separated Bikeways, Cycle Tracks (miles)	IV				Bike Route (miles)				
Total		0	0		Separated Bikeways, Cycle Tracks (miles)				
Pedestrian Improvements					Pedestrian Improvements				
		Yes =1 or No=0	Yes =1 or No=0				Yes =1		
Street Lighting					Street Lighting				
Curb Level					Curb Level				
Crowding					Crowding				
Pavement Evenness					Pavement Evenness				
Information Panels					Information Panels				
Benches					Benches				
Directional Signage					Directional Signage				
Trip Data - Adults					Trip Data - Adults				
Cycling					Cycling				
Daily Trips - Current					Daily Trips - Current	No Build	Build		
Projected Annual Growth Rates from Year 1 [%]					Projected Annual Growth Rates from Year 1 [%]				
Daily Trips - Year 1 (post-construction)		0	0		Daily Trips - Year 1 (post-construction)	0	0		
Daily Trips - Year 20 (post-construction)		0	0		Daily Trips - Year 20 (post-construction)	0	0		
Pedestrian					Pedestrian				
Daily Trips - Current					Daily Trips - Current				
Projected Annual Growth Rates from Year 1 [%]					Projected Annual Growth Rates from Year 1 [%]				
Daily Trips - Year 1 (post-construction)		0	0		Daily Trips - Year 1 (post-construction)	0	0		
Daily Trips - Year 20 (post-construction)		0	0		Daily Trips - Year 20 (post-construction)	0	0		
Trip Data - Children - SRTS					Trip Data - Children - SRTS				
Cycling					Cycling				
Daily Trips - Current					Daily Trips - Current	No Build	Build		
Projected Annual Growth Rates from Year 1 [%]					Projected Annual Growth Rates from Year 1 [%]				
Daily Trips - Year 1 (post-construction)		0	0		Daily Trips - Year 1 (post-construction)	0	0		
Daily Trips - Year 20 (post-construction)		0	0		Daily Trips - Year 20 (post-construction)	0	0		
Pedestrian					Pedestrian				
Daily Trips - Current					Daily Trips - Current				
Projected Annual Growth Rates from Year 1 [%]					Projected Annual Growth Rates from Year 1 [%]				
Daily Trips - Year 1 (post-construction)		0	0		Daily Trips - Year 1 (post-construction)	0	0		
Daily Trips - Year 20 (post-construction)		0	0		Daily Trips - Year 20 (post-construction)	0	0		

Existing Facility Length

Enter lengths for each class of bike facility, where appropriate, for the existing segment (Box 1B) and for any improvements (Box 1E). Note that Box 1E does not have a location to enter “No Build” values since this box is for entering information for a proposed facility to be constructed in the future.

Cal-B/C AT recognizes the four classes of bicycle facilities:

- I. Bike Paths
- II. Bike Lanes
- III. Bike Routes
- IV. Separated Bikeways/Cycle Tracks

The sums of the facility lengths in the No Build and Build scenarios should equal the total length of existing facility in Box 1A. If the total miles are entered correctly, and match mileage of potentially different bike facility classes, the data entry indicators will read “OK.” Otherwise, the adjacent gray cell will read “Not OK.”

Note bicycle classifications in the Red colored cells cannot be changed.

Pedestrian Improvements

Indicate if the project design includes one or more pedestrian elements by entering a “1” in the appropriate locations. These features are assumed to be located throughout the bike facility so all facility users will have the opportunity to use them.

The elements or features of the existing segment include:

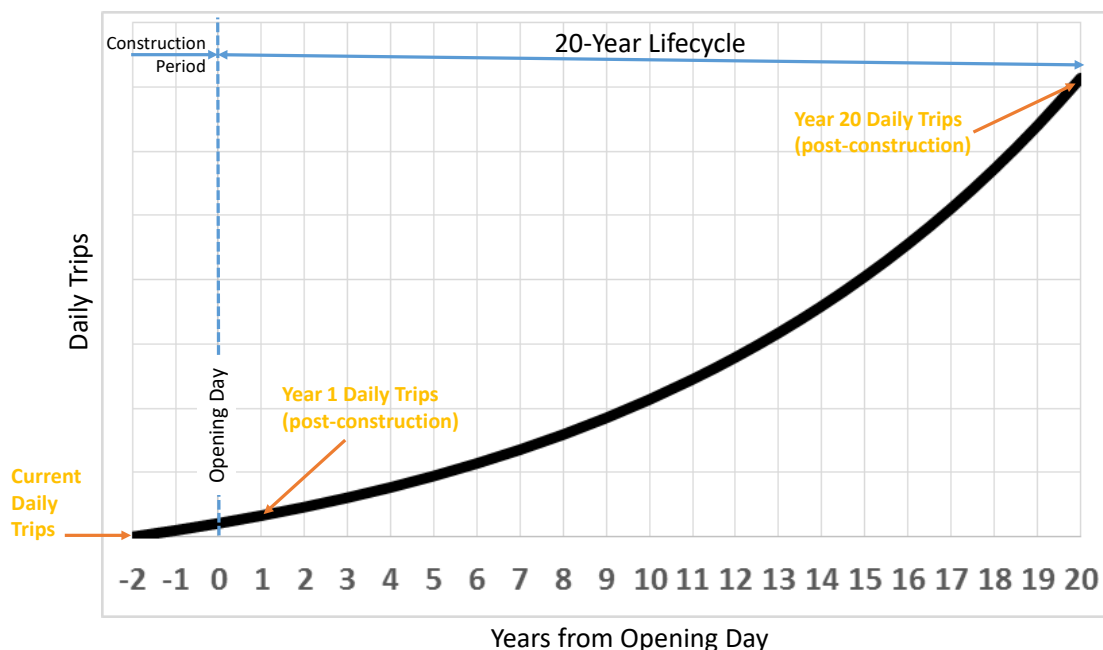
- Street lighting
- Curb level
- Crowding
- Pavement evenness
- Information panels
- Benches
- Directional signage.

Trip Data

Enter the current number of one-way trips and the expected annual growth rate in trips in the No Build and Build scenarios for both cyclists and pedestrians. These parameters are used to estimate trips in the first year after construction (depending on the expected number of years until construction is completed) and 20 years after construction. Growth rates are calculated using the compound annual growth rate (CAGR) formula. This growth rate is illustrated in Exhibit 9.

Blue cells can be overwritten if better data are available (e.g., an expectation that demand jumps in the first year of operations).

Exhibit 9: Daily Trip Growth Rate Estimation



Intersections Improvements – Time Savings, Accident Reduction (Box 1C)

Improvements at existing intersections between bike facilities and roadways can generate benefits from time savings by avoiding delays and from reduced crashes. This section allows the user to enter the data required to estimate these benefits. Box 1C is shown in Exhibit 10.



Exhibit 10: Intersection Improvements (Box 1C)

1C
INTERSECTION IMPROVEMENTS - TIME SAVINGS AND ACCIDENT REDUCTION DATA

Reduced Delay Due to Intersection Improvements

Time Savings Parameters

Number of Improved Intersections	<input style="width: 90%;" type="text"/>
Time Savings per Improved Intersection (min.)	<input style="width: 90%;" type="text"/>
Intersection improvements on SRTS? (enter 1 for Yes, 0 for No)	<input style="width: 90%;" type="text"/>

Accident Rate - Current Conditions

Cyclists

	Count (No.)	Rate per Year
Number of Years of Data	<input style="width: 90%;" type="text"/>	
Existing Conditions		
Total Number of Accidents (Tot)	0	0.0
Number of Fatal Accidents (Fat)	<input style="width: 90%;" type="text"/>	0.0
Number of Injury Accidents (Inj)	<input style="width: 90%;" type="text"/>	0.0
Number of Property Damage Only (PDO) Accidents	<input style="width: 90%;" type="text"/>	0.0
Annual Growth Rate in Accidents (%/year)	<input style="width: 90%;" type="text"/>	0

Pedestrians

	Count (No.)	Rate per Year
Number of Years of Data	<input style="width: 90%;" type="text"/>	
Existing Conditions		
Total Number of Accidents (Tot)	0	0.0
Number of Fatal Accidents (Fat)	<input style="width: 90%;" type="text"/>	0.0
Number of Injury Accidents (Inj)	<input style="width: 90%;" type="text"/>	0.0
Number of Property Damage Only (PDO) Accidents	<input style="width: 90%;" type="text"/>	0.0
Annual Growth Rate in Accidents (%/year)	<input style="width: 90%;" type="text"/>	0

Safety Countermeasures (improvements to existing facilities only)

Signalized Intersection Yes = 1

Pedestrian Countdown Signal Heads	<input style="width: 90%;" type="text"/>
Pedestrian Crossing	<input style="width: 90%;" type="text"/>
Advance Stop Bar before Crosswalk	<input style="width: 90%;" type="text"/>
Install Overpass/Underpass	<input style="width: 90%;" type="text"/>

Unsignalized Intersection

Raised Medians/Refuge Islands	<input style="width: 90%;" type="text"/>
Pedestrian Crossing (new signs and markings only)	<input style="width: 90%;" type="text"/>
Pedestrian Crossing (safety features/curb extensions)	<input style="width: 90%;" type="text"/>
Pedestrian Signals	<input style="width: 90%;" type="text"/>

Roadways - relevant for pedestrian improvements, such as sidewalks

Sidewalk/Pathway (to avoid walking along roadway)	<input style="width: 90%;" type="text"/>
Pedestrian Crossing (with enhanced safety features)	<input style="width: 90%;" type="text"/>
Pedestrian Crossing	<input style="width: 90%;" type="text"/>

Other Reduction Factor Countermeasures

<input style="width: 90%;" type="text"/>	
<input style="width: 90%;" type="text"/>	
<input style="width: 90%;" type="text"/>	

Reduced Delay Due to Intersection Improvements

These data are used to compute the number of intersections crossed by users (based on average trip lengths discussed in Box 1D) and the reduced delay at intersections.

Improvements can include signals for users as well as bridges for bike facilities over roadways. The average number of intersections crossed is computed from the number of intersections improved and average distance per trip.

First, enter the number of improved intersections along the bike facility.

Then, estimate the time savings in minutes at each improved intersection. This analysis will need to be performed outside of Cal-B/C AT and based on intersection traffic conditions and the crossing characteristics of the existing bike facility.

Finally, indicate if the intersection improvements occur for children as part of an SRTS initiative.

Accident Rates – Current Conditions

For existing facilities with explicit safety improvements, enter five-year average data for accidents involving cyclists or pedestrians. Baseline data should indicate the number of fatalities, injuries, and property damage only (PDO) accidents.

If available, data on the annual percent growth in accidents should be provided. Annual accident rates are determined based on the years available, if other than five years.

Improvements at intersections can take several forms (e.g., signals and lane markings). Each improvement provides a different accident reduction rate. The three most effective measures are used to estimate reductions in accidents and the associated monetized benefits.

Provide baseline accident rates for crashes involving cyclists and pedestrians in terms of:

- a. Number of Years of Data
- b. Fatal Accidents (Fat) (#)
- c. Injury Accidents (Inj) (#)
- d. PDO Accidents (#)
- e. Annual Growth Rate in Accidents (%)

Safety Countermeasures (improvements to existing facilities only)

Indicate which countermeasures are included in the facility improvement by entering a “1” in each green cell with that particular countermeasure. The available countermeasures include:

- Signalized Intersection
 - Pedestrian Countdown Signal Heads
 - Pedestrian Crossing
 - Advance Stop Bar before Crosswalk
 - Install Overpass/Underpass
- Unsignalized Intersection
 - Raised Medians/Refuge Islands
 - Pedestrian Crossing (new signs and markings only)
 - Pedestrian Crossing (safety features/curb extensions)
 - Pedestrian Signals
- Roadways – relevant for pedestrian improvements, such as sidewalks
 - Sidewalk/Pathway (to avoid walking along roadway)
 - Pedestrian Crossing (with enhanced safety features)
 - Pedestrian Crossing
- Other Reduction Factor Countermeasures



Infrastructure Project Costs (Box 1F)/Non-Infrastructure Program Costs (Box 1G)

These boxes allow the user to input costs for infrastructure projects and non-infrastructure programs and is shown in Exhibit 11.

Exhibit 11: Project Costs (Box 1F/1G)

1F		PROJECT COSTS AND REQUESTED FUNDS (enter in thousands of dollars)								
Col. no.										
Year	Construction Years	DIRECT PROJECT COSTS					TOTAL COSTS (in dollars)			
		Project Support	INITIAL COSTS		SUBSEQUENT COSTS		Constant Dollars	Present Value		
			R / W	Construction	Maint./ Op.	Rehab.				
Infrastructure Program Costs										
1	0							\$0	\$0	
2	0							0	0	
3	0							0	0	
4	0							0	0	
5	0							0	0	
6	0							0	0	
7	0							0	0	
8	0							0	0	
Annual Infrastructure O&M Costs										
1								\$0	\$0	
2								0	0	
3								0	0	
4								0	0	
5								0	0	
6								0	0	
7								0	0	
8								0	0	
9								0	0	
10								0	0	
11								0	0	
12								0	0	
13								0	0	
14								0	0	
15								0	0	
16								0	0	
17								0	0	
18								0	0	
19								0	0	
20								0	0	
Total		\$0	\$0	\$0	\$0	\$0		\$0	\$0	
ATP REQUESTED FUNDS										
Total										

1G		PROGRAM COSTS AND REQUESTED FUNDS (enter in thousands of dollars)								
Col. no.										
Year	Construction Years	DIRECT PROJECT COSTS					TOTAL COSTS (in dollars)			
		Project Support	INITIAL COSTS		SUBSEQUENT COSTS		Constant Dollars	Present Value		
			R / W	Construction	Maint./ Op.	Rehab.				
Non-Infrastructure Program Costs										
1								\$0	\$0	
2								0	0	
3								0	0	
4								0	0	
5								0	0	
6								0	0	
7								0	0	
8								0	0	
Annual Non-Infrastructure O&M Costs										
1								\$0	\$0	
2								0	0	
3								0	0	
4								0	0	
5								0	0	
6								0	0	
7								0	0	
8								0	0	
9								0	0	
10								0	0	
11								0	0	
12								0	0	
13								0	0	
14								0	0	
15								0	0	
16								0	0	
17								0	0	
18								0	0	
19								0	0	
20								0	0	
Total		\$0	\$0	\$0	\$0	\$0		\$0	\$0	
ATP REQUESTED FUNDS										
Total										

All costs should be entered as incremental rather than total costs. Costs already incurred are sunk costs and should not be included in the benefit-cost analysis.³ Incremental costs are estimated as the difference between the Build costs and the No Build costs.

The project costs tables contain seven columns for users to enter cost information in thousands of dollars, as shown in Exhibit 11. All cost values should be in the year of current dollars for the model (as shown in the *Parameters* worksheet) to ensure consistency. For instance, if the year of current dollars for model is 2016, all cost values should be in 2016 dollars to ensure consistency with the benefit calculations. The model automatically calculates the sum and present value of all costs inputted by the user.

The leftmost column of the project costs tables indicate the years throughout the lifecycle separating the construction or implementation period and project lifecycle years. Cal-B/C AT can handle up to eight years of construction or implementation, where the number of years is determined in the *Project Data* section. For each year of construction or implementation where cost data are missing, the message “Must enter a cost” appears in red under the Subsequent Cost section. As well for each year beyond the construction period, if a construction cost is entered, the message “Adjust Construction Period” appears in red under the Subsequent Cost section.

Direct Project Costs (In Thousands of Dollars)

The direct project costs are broken down into *Initial Costs* and *Subsequent Costs*. Their respective composition is as follows:

- *Initial Costs* include:
 - Project support (e.g., engineering design and management costs)
 - Right-of-way acquisition costs
 - Construction costs.
- *Subsequent Costs* include:
 - Maintenance and operating costs
 - Rehabilitation costs (e.g., pavement overlay, truck, track, or station refurbishment).

The *Initial Costs* should reflect the net capital costs required to complete the project, while the *Subsequent Costs* indicate the estimate future incremental maintenance, operating and rehabilitation costs in constant dollars. Costs should be entered in the years they are expected to occur. As previously indicated, these costs should be entered in thousands of dollars.

Mitigation (In Thousands of Dollars)

Mitigation costs include costs to protect communities and the environment from negative impacts. These costs include wetland and community preservation, as well as sound walls to reduce noise.

³ Sunk costs are included as part of the BCA for federal grant application, but not as part of the amount requested.

The user enters these costs in constant dollars during construction and for 20 years after construction has been completed.

Total Costs (In Dollars)

The model calculates the total costs automatically, and presents the total cost in constant dollars and present value for each year. It should be noted that since total costs are denoted in dollars, the model multiplies the previous columns by 1,000 to convert the values from thousands of dollars to actual values. The project cost table also summarizes the total constant dollar of cost element at the bottom in dollars. Using the *Real Discount Rate* defined in the *Parameters* worksheet and the *Current Year* defined in the *Project Data* section, the following formula is used to calculate the present value:

$$\text{Present Value} = \frac{\text{Future Value (in constant dollars)}}{(1 + \text{Real Discount Rate})^{\text{Future Year} - \text{Current Year}}}$$

Data Checks - Project Length, Daily Trips (Box 1H)

This section provides data checks to make sure that data are entered correctly. An example is shown in Exhibit 12. The user does not need to enter anything in this table. The data checks evaluate No Build and Build project lengths for each type of relevant project (e.g., new and existing facilities). All of these cells should read “OK.” Errors indicate that prior inputs should be modified.

Exhibit 12: Data Checks (Box 1h)

1H		DATA CHECKS - PROJECT LENGTH, DAILY TRIPS	
		No Build Project Length	Build Project Length
Existing Facility Length Check		OK	OK
New Facility Length Check		OK	OK
		Cycling Daily Trips per Mile	Pedestrian Daily Trips per
Existing Facility Users		NA	NA
New Facility Users		NA	NA
		Safety Measures - Existing only	
Existing Facility Characteristics		OK	

Non-Infrastructure Program Information Worksheet

Non-infrastructure programs are intended to reach target audiences through a variety of outreach and training mechanisms. The Non-Infrastructure Program Information sheet collects information about the proposed initiative and applies a scoring framework to determine the overall program score per cost. This worksheet is shown in Exhibit 13.

Exhibit 13: Non-Infrastructure Project Information Worksheet (Box 1i)

NON-INFRASTRUCTURE PROGRAM CHARACTERISTICS			
Programmatic Initiatives?	No		
Scale of Initiative			
Participants / Beneficiaries			Date Check on Initiative
Numbers of People Reached per Year		OK	
Average Percentage of Current Active Bicyclists Reached per Year			
Average Percentage of Current Active Pedestrians Reached per Year			
Scoring Criteria			
Total Number of Criteria	4		
Total Criteria Weight Sum	100%		
1) Target Audience			
			Criteria Weight
			25%
Indicators (mark as %; sum must equal 100%)			
Younger than 10		Indicator Weight	10%
10-12			20%
13-24			25%
25-55			15%
55+			5%
Indicator-Weighted Score	Sum must equal 100%		
2) Characteristics Promotional Effort			
			Criteria Weight
			25%
Indicators (enter 1 for Yes on all that apply)			
Effort Targets 5 E's or 5 P's		Indicator Weight	5%
Knowledgeable Staff/Educator			5%
Partnership/Volunteers			5%
Creates Community Ownership/Relationship			5%
Part of Bigger Effort (e.g., political support)			5%
Indicator-Weighted Score	0		
3) Type of Impact and Messaging			
			Criteria Weight
			25%
Indicators (enter 1 for Yes on all that apply)			
Outreach is Hands-on (self-efficacy)		Indicator Weight	5%
Overcome Barriers (e.g., dist., time, etc.)			5%
Eliminates Hazards/Treats (speed, crime, etc.)			5%
Connected or Addresses Connectivity Challenges			5%
Creating Value in Using Active Transportation			5%
Indicator-Weighted Score	0		
4) Frequency of Outreach Effort			
			Criteria Weight
			25%
Indicators (enter 1 for Yes for only one option)			
One Day		Indicator Weight	5%
One Month			10%
One Year			15%
Multiple Years			20%
Continuous Effort			25%
Indicator-Weighted Score	0		
Projected New Active Transportation Cyclists			
Number of Potential New Trail Users	0		
Weighted Impact Score of Outreach	0		
Program Impact Score	0.0		
Years of Outreach	0		
Multi-year Program Impact Score	0		
Cost Effectiveness			
Total Discounted Cost	\$0		
Cost per Program Impact Score	\$0		
Projected New Active Transportation Pedestrians			
Number of Potential New Trail Users	0		
Weighted Impact Score of Outreach	0		
Program Impact Score	0.0		
Years of Outreach	0		
Multi-year Program Impact Score	0		
Cost Effectiveness			
Total Discounted Cost	\$0		
Cost per Program Impact Score	\$0		

The impact score is based on the number of people reached who are not currently using active transportation. The model uses four criteria to assess the effectiveness of the initiative, each with a different measure of relative value. The criteria have equal weights. The scoring system is designed to provide a maximum potential score of 1.0, with values ranging as percentages from 0% to 100%. The percentage is applied to the number of currently non-active transportation mode users, to develop a total program impact score.

Program costs should be entered in Box 1G the *Project Information* worksheet (discussed above). If a proposed program does not include capital investments, the anticipated impact on user demand from the program can be entered as trip volumes in Box 1B. If the program is combined with an infrastructure project, it is assumed that the demand impact is already captured by the infrastructure project.

To avoid overestimating demand, no additional demand from the program alone should be included in the *Project Information* worksheet. Non-infrastructure initiatives are assumed to stimulate demand and safety for 20 years. If this is not the case, adjustments should be made for the appropriate number of years in each benefit calculation worksheet. In this case, the project type should be set to “1” to reflect the use of existing facilities only.

MODEL INPUTS WORKSHEET

The *Model Inputs* worksheet contains information about cycling and pedestrian annual trips, number of facility users, and annual mileage. This worksheet allows users to check the data estimated by the model and override those values if better data are available. The user does not have to make any changes in this worksheet for Cal-B/C AT to produce results. Exhibit 14

illustrates some of the key features of the *Model Inputs* worksheet. Exhibit 15 summarizes the boxes used to input information in the worksheet.

Exhibit 14: Model Input Worksheet

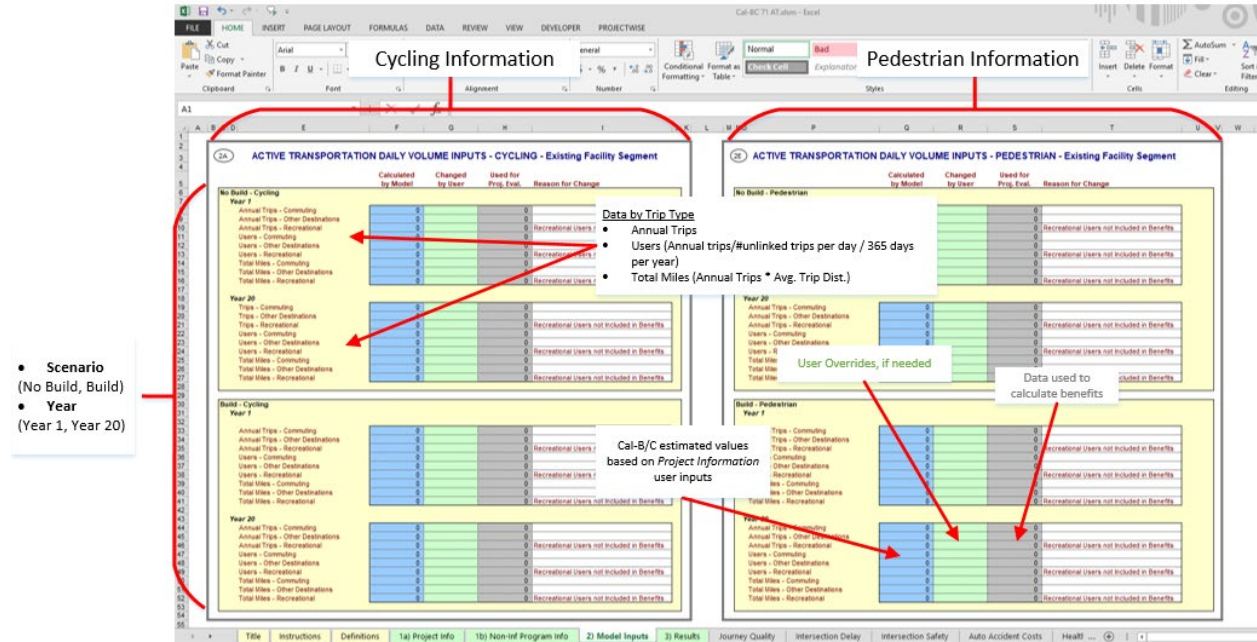


Exhibit 15: Model Input Boxes

Data Entry Boxes		Location/ Cell Range
2A/(2E)	Existing Facility Segment - Cycling/(Pedestrian)	B2:K54/ (M2:V54)
2B/(2F)	New Facility Segment - Cycling/(Pedestrian)	B57:K109 / (M57:V109)
2C/(2G)	New Safe Routes To School - Cycling/(Pedestrian)	B111:K137/ M111:V137
2D/(2H)	Existing Safe Routes To School - Cycling/(Pedestrian)	V139:K168/ (M139:V168)

Although this worksheet contains a lot of information, it is structured to facilitate updates. The left columns in the worksheet (columns “B” through “K”) are used to modify data about cyclists and the columns “M” through “V” are for entering information about pedestrian travel.

Each box allows information to be entered for one of three bike facility types: Existing Segments, New Facilities, and SRTS Facilities. Within each box the inputs are arranged according to scenario (i.e., “No Build”, or “Build”), and then by model year (i.e., Year 1 after project opening, and Year 20 after project opening).

The **blue** cells in columns “F” and “Q” are calculated by Cal-B/C AT. The **green** cells (columns “G” and “R”) can be edited by the user if better data are available, and the **gray** un-editable cells (columns “H” and “S”) are the values used by Cal-B/C to calculate benefits. The gray cells are updated by default using the value in the blue cells unless the user makes a change in the green cells.

Data are provided for each of the three user trip types: Commuter, Recreational, and Other. The data that can be updated in the *Model Inputs* worksheet are:

Annual Trips are the total number of cycling or walking trips per year by user trip type. Annual trips are based on the current daily trips input by the user in the *Project Information* worksheet. In that worksheet, current trips are projected to Year 1 and Year 20 daily trips by using the projected annual growth rate (see Exhibit 9 and related discussion for an illustration of this growth).

These new total daily projections are then multiplied by the percent of each trip type (e.g., commute) from the *Project Information* worksheet in Box 1D. They are also multiplied by the average number of days cycling, walking or number of school days per year. The average days can be found in the Active Transportation Parameters section of the *Parameters* worksheet (cell range R17:W22).

Annual Users are the total number of users of a facility per year, including either pedestrians or cyclists. Since users often make a number of separate unlinked trips in one journey, it is necessary to divide the number of trips by the number of unlinked trips to estimate the number of users. In addition, annual trips represents a single person’s trips over an annual period, so it is necessary to divide annual trips by the number of days per year. As such, Cal-B/C AT calculates the number of users by dividing annual trips by the number of unlinked trips and 365, for the number of days per year (and corresponds ultimately to the CA Statewide Travel Survey data on user characteristics). The number of unlinked trips for cyclists and pedestrians can also be found in the *Parameters* worksheet (cell range T31:U32).

Annual Miles are the total annual miles ridden or walked by trip-makers. This value is calculated in the *Model Inputs* worksheet by taking the total annual trips described above and multiplying that value by the average trip distance taken. The average trip distance can be found in Box 1D of the *Project Information* worksheet.



RESULTS WORKSHEET

The final worksheet covered in this User's Guide is the *Results Worksheet*. This is where Cal-B/C outputs the results of the benefit-cost assessment. Exhibit 16 shows an example of this output.

Exhibit 16: Results Worksheet - Final Model Output

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1																				
2		District:			HQ															
3																	EA:			
4		PROJECT:			Hypothetical Project												PPND:			
5																				
6																				
7																				
8																				
9																				
10																				
11																				
12																				
13																				
14																				
15																				
16																				
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30																				
31																				
32																				
33																				
34																				
35																				
36																				
37																				
38																				
39																				
40																				
41																				

The bottom of the *Results* worksheet includes a toggle to select whether benefits for recreational users are included in the analysis. A more detailed breakdown of the results by year and benefit type is available on the Final Calculations sheet.

Cal-B/C provides several summary results, which highlight different aspects of an AT infrastructure project:

- **Life-Cycle Costs** are the present values of all net project costs, including initial and subsequent costs in real current dollars.
- **Life-Cycle Benefits** are the sum of the present value of benefits for the project.

- **Net Present Value** equals the lifecycle benefits minus the lifecycle costs. The value of benefits exceeds the value of costs for a project with a positive net present value.
- **Benefit/Cost Ratio** shows the benefits relative to the costs of a project. A project with a benefit-cost ratio greater than one has a positive economic value.
- **Rate of Return on Investment** is the discount rate at which benefits and costs are equal. For a project with a rate of return greater than the discount rate, the benefits are greater than costs and the project has a positive economic value. The user can use rate of return to compare projects with different costs and different benefit flows over different time periods. This is particularly useful for project staging.
- **Payback Period** is the number of years it takes for the undiscounted net benefits (lifecycle benefits minus lifecycle costs) to equal the initial construction costs. For a project with a payback period longer than the project lifecycle, initial construction costs are not recovered. The payback period varies inversely with the benefit-cost ratio. A shorter payback period yields a higher benefit-cost ratio.

At present, methods and data are not sufficiently developed to accurately estimate the economic value of AT non-infrastructure programs, so Cal-B/C AT includes non-infrastructure program implementation impact scores for bicycle and pedestrian programs.

The effectiveness of these programs depends on many characteristics, such as the knowledge of staff, extent of outreach effort, duration of program, and direct linkage to specific AT facilities or networks. Cal-B/C AT assumes that projects with accompanying AT non-infrastructure programs have a qualitatively higher level of value than a similar project without such programs, but Cal-B/C AT does not monetize these as benefits.

The impact scores are influenced by the number of people reached who are not currently using active transportation. In addition, four program performance criteria are established to assess the effectiveness of the initiative, each with different measures of relative value that are reported in the *Non-Infrastructure Project Information* worksheet.

For infrastructure benefits that can be monetized, Cal-B/C AT provides five itemized benefits:

- **Journey Quality** represents the primary value of mobility gained by active transportation users and can be derived from their sense of journey ambiance, ease of use, and feeling of safety (from vehicles). Higher values are observed for active transportation facilities with greater separation from conflicting modes, safety features, and aesthetic value. Journey quality can be associated with different trip purposes, including users with a specific destination (e.g., work or school) and those with a purely recreational purpose whose trips begin and end in the same place – so-called “loop” trips.
- **Additional Delay Savings** represent the reductions in travel time for cyclists or pedestrians where a bike facility crosses improved highway intersections. These delay savings are in addition to those included in the journey quality measure.

- **Additional Safety Benefits** occur when accident rates decline because drivers shift to cycling or walking simply because there are fewer cars on the road. Other safety benefits occur when accident risks are reduced at improved highway intersections. Developing reasonable estimates of these benefits depends on the availability of local data on accident rates in the corridor where an active transportation project is implemented. The economic value of a change in accident rates is estimated with an average cost per accident severity.

To estimate the impact of a transportation project on accident costs, Cal-B/C AT compares accident costs under two scenarios: with the project and without the project. Accident costs are compared over the lifetime of the project, which is assumed to be 20 years. Accident benefits are summed over the twenty-year period to derive the total impact. Individual projects may improve or adversely impact vehicle accidents, so the net result may be positive or negative.

- **Health Benefits** present the benefits from reduced absenteeism and mortality due to physical activity that can reduce short-term sick leave by at least six percent. Mortality benefits represent a reduction in the relative risk of death for users due to improved health conditions. The estimated reduction in risk for cycling and walking activity has been parameterized in a simplified form that is based on the distance traveled by mode. For cycling, there is a 4.5% reduction in risk for every 365 miles traveled per year. For walking, the annual risk reduction per 365 miles traveled is 9%. In addition, risk reduction is maximized at 30% for cycling and 45% for walking.
- **Emission Cost Savings** report the public benefits of reduced vehicle use due to shifts of travelers to active transportation that reduces the externalities of air emissions. Cal-B/C AT applies methods consistent with other Cal-B/C tools to measure these benefits.

Below the itemized project benefits, Cal-B/C AT displays:

- **Person-Hours of Time Saved** shows the reduction in person-hours of travel time due to the project. A positive value indicates a net benefit.
- **Emissions Reduction** shows the itemized change in emissions for CO, CO₂, NO_x, PM₁₀, PM_{2.5}, SO_x, and VOC. A positive value indicates a reduction in emissions, while a negative value indicates an increase in emissions. The change in emissions are reported in tons and millions of dollars. PM_{2.5} is reported only in tons because a generally accepted economic value was not available at the time of the model update.

Cal-B/C AT also lists benefits specific to safe routes to school (SRTS) projects. These benefits are a subset of the itemized benefits and included in the total benefits for the project:

- Journey Quality
- Additional Delay Savings
- Additional Safety Benefits.

Appendix A: Project Example

UPGRADE EXISTING FACILITY AND CONSTRUCT NEW MULTI-USE TRAIL

For this example, let's assume that we want to upgrade an existing 4-mile Class III bike route in Santa Barbara in Southern California to a Class II bike lane, but we also want to connect this lane with a new 2-mile to a fully-separated, paved multi-use Class I facility to better integrate an elementary school to the local neighborhood as part of a larger Safe Routes to School (SRTS) program.

As part of this program, we are going to add amenities to the existing location (e.g., lighting, pavement improvements, signage) to improve the quality of travel along the facility. We are also going to improve an arterial intersection along the path. Finally, as part of the overall program, we will provide two years of outreach to the school and to the general community.

STEP 1: Input Project Data into Infrastructure Project Information Worksheet

All data entry for project analysis begins in the *Project Info* worksheets. There are two worksheets: *1a) Project Info*, and *1b) Non-Inf Program Info*. The first worksheet is where infrastructure construction information, existing user volumes and future forecasts, user characteristics, and accident information is input. Project construction and on-going program related costs are also entered into this worksheet.

The second worksheet is where non-infrastructure related information is inputted to evaluate the potential effectiveness of community outreach to encourage the use of active transportation modes and to inform the school-age children, university students, and the general public about - the benefits of using the multi-use facilities. The information inputted is used to calculate a "Cost per Program Impact" score. The project data entry can be done in the following steps:

(1) Project and Site Characteristics (Box 1A). Enter the information as shown in Exhibit 17. In our example, we are upgrading a 4-mile existing facility, and constructing a new 2-mile facility. Therefore, type a "3" in the **green**-colored *Type of Project* cell to indicate an "existing facility upgrade and new facility extension". Remember that **green** cells are for user data entry, but you can leave a **green** cell empty and Cal-B/C AT will interpret that empty cell as a "0".

In the *Total Project Length* cells, type in the existing and new mileage as shown in the exhibit. The **gray** boxes provide a quality control check to ensure that distances entered are consistent throughout Cal-B/C. This box will initially indicate "Not OK", until you enter in the project lengths in the "No Build" and "Build" facility improvement location in boxes 1B and 1E. These boxes will be discussed as part of the next step below. Once all project data are inputted, you should review these data check boxes to make sure they give you the "OK".

This project takes place in Southern California, so type a "1" in the *Project Location* cell. This will be used to calculate the emissions benefits of the project given that air pollution differs by region of California due to different ambient air conditions.



Since this is a SRTS project, type a “1” in the *Safe Routes to School* box. This will be used to calculate the benefits of that program to school-age children using the facility to commute to school.

We will include public outreach as part of this program, so type a “1” in the *Programmatic Initiatives* box.

Finally, enter the total construction period in whole years. Round up to the next nearest year. For example, if the construction period is actually going to take 18 months, or 1½ years, then round up to two years. This is used to estimate the Year 1 and Year 20 forecasts for user volumes, which will be used to estimate user benefits in future years. Please refer to Exhibit 9 in the User’s Guide above to see an illustration of how the construction year is used in forecasting volumes.

Exhibit 17: Project and Site Characteristics

Row	Column	Content	
2	D	District: District 5 (Santa Barbara)	
4	D	PROJECT: Elementary School / College Multiuse Plan	
4	F	EA:	
5	F	PPNO:	
7	1A PROJECT AND SITE CHARACTERISTICS		
9	Type of Project		
10	Existing facility upgrade only = 1	3	
11	New facility only, no existing facility work = 2		
12	Existing facility upgrade and new facility extension = 3		
12	Total Project Length		
13	Total Existing Facility Length (miles)	4	Project Type Data Check
14	Total New Facility Length (miles)	2	OK
16	Characteristics		
17	Project Location (enter 1 for So. Cal., 2 for No. Cal., or 3 for rural)	1	
18	Safe Route to School? (enter 1 for Yes, 0 for No)	1	
21	Programmatic Initiatives? (enter 1 for Yes, 0 for No)	1	
24	Construction		
25	Length of Construction Period (years)	2	Constr. Years Data Check
26			OK

(2) **Existing and New Facility Improvements and Trip Volumes.** These two boxes, 1B and 1E, are where you enter the existing facility and new facility distances under the “No Build” (i.e., no new project will be constructed) and the “Build” (i.e., future improvements will be implemented) scenarios.

You also input a “1” to indicate if any pedestrian amenities, safety features, or journey quality enhancements will be included in the project. Finally, you enter existing and future volumes for adult/children pedestrians and bicyclists.



In our project, we are going to improve the existing one-mile Class I facility. Therefore, in the *Existing Facility Length* cell input a “1” for both the “No Build” and the “Build” cases. As mentioned above, the gray box will tell you if the distances are consistent.

Exhibit 18: Existing and New Facility Improvements and Trip Volumes

EXISTING SEGMENT IMPROVEMENTS AND TRIP VOLUME					NEW FACILITY IMPROVEMENTS AND TRIP VOLUME				
Improvement Characteristics	Class	No Build	Build	Project Length Data Check	Improvement Characteristics	Class	No Build	Build	Project Length
Existing Facility Length, if Applicable					New Facility Length				
Bike Paths (miles)	I		4	OK	No Facility	0	2	2	OK
Bike Lanes (miles)	II				Bike Paths (miles)	I		2	
Bike Route (miles)	III	4			Bike Lanes (miles)	II			
Separated Bikeways, Cycle Tracks (miles)	IV		4		Bike Route (miles)	III			
Total		4	4		Separated Bikeways, Cycle Tracks (miles)	IV		2	
					Total		2	2	
Pedestrian Improvements					Pedestrian Improvements				
Street Lighting			1		Street Lighting			1	
Curb Level					Curb Level				
Crowding					Crowding				
Pavement Evenness			1		Pavement Evenness			1	
Information Panels					Information Panels				
Benches					Benches			1	
Directional Signage			1		Directional Signage			1	
Trip Data - Adults					Trip Data - Adults				
Cycling					Cycling				
Daily Trips - Current		151			Daily Trips - Current		100	106	
Projected Annual Growth Rates from Year 1(%)		0.5%	2.0%		Projected Annual Growth Rates from Year 1(%)		0.5%	3.0%	
Daily Trips - Year 1(post-construction)		153	157		Daily Trips - Year 1(post-construction)		101	106	
Daily Trips - Year 20(post-construction)		159	233		Daily Trips - Year 20(post-construction)		112	152	
Pedestrian					Pedestrian				
Daily Trips - Current					Daily Trips - Current		75	80	
Projected Annual Growth Rates from Year 1(%)					Projected Annual Growth Rates from Year 1(%)		0.5%	3.0%	
Daily Trips - Year 1(post-construction)		0	0		Daily Trips - Year 1(post-construction)		76	80	
Daily Trips - Year 20(post-construction)		0	0		Daily Trips - Year 20(post-construction)		84	144	
Trip Data - Children - SRFS					Trip Data - Children - SRFS				
Cycling					Cycling				
Daily Trips - Current		18			Daily Trips - Current		18	19	
Projected Annual Growth Rates from Year 1(%)		0.5%	2.0%		Projected Annual Growth Rates from Year 1(%)		0.5%	3.0%	
Daily Trips - Year 1(post-construction)		18	19		Daily Trips - Year 1(post-construction)		18	19	
Daily Trips - Year 20(post-construction)		20	28		Daily Trips - Year 20(post-construction)		20	34	
Pedestrian					Pedestrian				
Daily Trips - Current		24			Daily Trips - Current		24	25	
Projected Annual Growth Rates from Year 1(%)		0.5%	2.0%		Projected Annual Growth Rates from Year 1(%)		0.5%	2.0%	
Daily Trips - Year 1(post-construction)		24	25		Daily Trips - Year 1(post-construction)		24	25	
Daily Trips - Year 20(post-construction)		27	37		Daily Trips - Year 20(post-construction)		27	37	

Existing Segment (Box 1B)

For our project, let’s assume that we are going to repave the path as part of the upgrade to improve the pavement evenness on our existing facility. We will also add lighting and directional signage as additional amenities. Type a “1” in the appropriate cells in the “Build” scenario column as shown in Exhibit 18. Do not put anything in the “No Build” column since we will not be making any improvements under a “No Build” or base case.

We will need to break out existing bicycle and pedestrian demand into “adults” and “children”. Unless existing data are available, this step will require manual counts to be performed as part of the analysis.

In our case, we counted 151 current adult bicyclists and 18 children using the bike lane on an average day. Since this is a bike lane, we didn’t count any adult pedestrians. However, we did find 24 intrepid elementary school students who walked to school adjacent to the bike lane.

For the existing segment (box 1B), we expect low growth to occur under the “No Build” scenario, on the order of 0.5% per year since the facility is currently not conducive to growth in users. However, let’s assume that if we upgrade the existing location from a Class III to a Class II bike lane, this will encourage more cyclists to use the facility, particularly school children whose parents believe that the new improvements will make them safer (in our example we will also make safety improvements to an intersection that may also enhance

safety, which will be discussed below). Type the growth percentages in the appropriate cells (Exhibit 9 above shows how growth is forecasted in Cal-BC AT).

Note that the **blue** cells are calculated cells, but these can be overwritten if you have better growth forecasts from another source. Say, for example, you performed a more detailed user forecast outside Cal-B/C and have estimates of pedestrian and bicycle volumes. Also, if you have more detailed results you can also enter those existing and forecast volumes in the *Model Inputs* worksheet.

New Segment (Box 1E)

For our newly constructed segment, we are going to build 2 miles of Class I multi-use facility, so type that in the appropriate cell under the *Bike Paths (miles)* section as shown in Exhibit 18 above. Note that the **gray** cell will show an “OK” if the lengths are consistent between Box 1E and Box 1A as illustrated in above.

For our project, let’s assume that our bike/pedestrian counts indicate that 100 adult cyclists traverse arterials along this segment. Also, let’s assume the same number of children ride and walk (18 and 24, respectively) along this new segment on their way to school. However, along the new 2-mile segment we also estimated that 75 adult pedestrians would potentially use the new facility if it were available today.

On our new “Build” facility, we estimate that annual growth in path use will be around 3% per year because of its improved condition. Type “3%” in the appropriate cells. As discussed above, if you have better forecast volumes, you can type them in the **blue** cells as needed.

- (3) Intersection Improvements - Time Savings and Accident Reduction.** Box 1C is used to address any intersection improvements that may be done as part of the project. The data to be entered are shown in Exhibit 19 on the following page.

For our project, we are going to improve a single intersection, so type a “1” in the appropriate cell in the *Number of Improved Intersections* location. To be conservative, assume that there will be no time savings due to the intersection improvements (since we will not be adjusting signal timings), so type a “0” in the *Time Savings...* cell. Since this intersection improvement is on a Safe Route to School type a “1” in the *SRTS* cell.

Cal-B/C uses existing accident data and estimates future accident reductions depending on the type of intersection improvement being implemented. Bicycle and pedestrian accident data can be readily obtained from local sources or from the California Highway Patrol (CHP) Statewide Integrated Traffic Records System (SWITRS) website⁴ or University of California Berkeley Transportation Injury Mapping System (TIMS).⁵

⁴ See <https://www.chp.ca.gov/programs-services/services-information/switrs-internet-statewide-integrated-traffic-records-system>

⁵ See <https://tims.berkeley.edu/>

Regardless of the source of incident data, enter the number of years of accident data available in the appropriate cells. In our example, let's assume that we downloaded five years of bicycle and pedestrian accident data from SWITRS or TIMS.

In our case, let's say there were 8 cyclists injured in accidents at our intersection over the past five years (a rate of 1.6 per year, which is shown in the calculated **gray** cell to the right of the **green** input cell). Fortunately, we did not experience any pedestrian incidents at our intersection over the past five years.

To mitigate against future accidents, let's add pedestrian crossing and countdown signal heads and pedestrian crossing (new signs and markings only) as safety countermeasures, so input a "1" in the appropriate places in *Signalized Intersection* and a "1" in the *Unsignalized Intersection* sections of Box 1C.

Exhibit 19: Intersection Improvements - Time Savings and Accident Reduction Data

	A	B	C	D	E	F	G	H	I	J	K
80											
81											
82											
83	1C INTERSECTION IMPROVEMENTS - TIME SAVINGS AND ACCIDENT REDUCTION DATA										
84											
85	<i>Reduced Delay Due to Intersection Improvements</i>										
86	Time Savings Parameters										
87	Number of Improved Intersections						2				
88	Time Savings per Improved Intersection (min.)						1				
89	Intersection improvements on SRTS? (enter 1 for Yes, 0 for No)						1				
90											
91	<i>Accident Rate - Current Conditions</i>										
92											
93	Cyclists										
94					Count (No.)		Rate per Year				
95	Number of Years of Data				5.00						
96	Existing Conditions										
97	Total Number of Accidents (Tot)				8		1.6				
98	Number of Fatal Accidents (Fat)						0.0				
99	Number of Injury Accidents (Inj)				8		1.6				
100	Number of Property Damage Only (PDD) Accidents						0.0				
101	Annual Growth Rate in Accidents (%/year)										
102											
103	Pedestrians										
104					Count (No.)		Rate per Year				
105	Number of Years of Data				5.00						
106	Existing Conditions										
107	Total Number of Accidents (Tot)				0		0.0				
108	Number of Fatal Accidents (Fat)						0.0				
109	Number of Injury Accidents (Inj)						0.0				
110	Number of Property Damage Only (PDD) Accidents						0.0				
111	Annual Growth Rate in Accidents (%/year)										
112											
113	<i>Safety Countermeasures (improvements to existing facilities only)</i>										
114											
115	Signalized Intersection										
116	Pedestrian Countdown Signal Heads						Yes = 1				
117	Pedestrian Crossing						1				
118	Advance Stop Bar before Crosswalk										
119	Install Overpass/Underpass										
120	Unsignalized Intersection										
121	Raised Medians/Refuge Islands										
122	Pedestrian Crossing (new signs and markings only)						1				
123	Pedestrian Crossing (safety features/curb extensions)										
124	Pedestrian Signals										
125	Roadways - relevant for pedestrian improvements, such as sidewalks										
126	Sidewalk/Pathway (to avoid walking along roadway)										
127	Pedestrian Crossing (with enhanced safety features)										
128	Pedestrian Crossing										
129	Other Reduction Factor Countermeasures										
130											
131											
132											
133											

(4) **General User Characteristics (Box 1D).** We will be using the defaults values from Cal-B/C AT for our analysis that are shown in Exhibit 20, so no action will be needed for this step. Exhibit 7, above in the User's Guide, illustrates how these estimates are referenced in the *Parameters* worksheet based on the project location. Since our project is in Southern California, the user travel characteristics for that region are presented in Box 1D. However, if you have better traveler characteristics, you can overwrite any of the blue cells in the example.

Exhibit 20: General User Characteristics

1D GENERAL USER CHARACTERISTICS (BASED ON PROJECT LOCATION)			
Cycling			
Trip Purpose	No Build	Build	
Commuting Trip Purpose (%)	8%	8%	
Recreational Trip Purpose (%)	15%	15%	
Other Destinations Trip Purpose (%)	77%	77%	
General Trip Characteristics			
Overall Average Distance Traveled / Trip (mi)	1.83	1.83	
Children - SRTS - Distance Traveled / Trip (mi)	0.88	0.88	
Pedestrian			
Trip Purpose			
Commuting Trip Purpose (%)	5%	5%	
Recreational Trip Purpose (%)	10%	10%	
Other Destination Trip Purpose (%)	85%	85%	
General Trip Characteristics			
Overall Average Distance Traveled / Trip (mi)	0.52	0.52	
Children - SRTS - Distance Traveled / Trip (mi)	0.46	0.46	

(5) Infrastructure Project Costs (Box 1F). Initial project construction and subsequent on-going maintenance and operating costs are inputted in this location of the worksheet. Cal-B/C AT will automatically calculate the constant dollars and net present value for you. Note that costs must be entered in thousands (i.e., \$3,000,000 will be entered as \$3,000). Also note that project support, right of way, and construction costs must be entered for each year of the construction period and must match the number entered in Box 1A discussed above. For example, since we indicated earlier that our project would take two years to construct, we must include construction costs for Years 1 and 2 as shown in Exhibit 21.

For our project, input \$500 in the R/W cost cell for construction Year 1. We are also going to spend \$2,000,000 on construction in Year 1 and in Year 2, so type a “2000” in each of the appropriate cells.

We anticipate spending approximately \$5,000 per year over the next twenty years to maintain our 2.2 miles of active transportation facility as shown by entering a “5” in each year of the *Subsequent Costs* section of Box 1F. Our total constant dollars to build, operate and maintain this project will be \$4.6 million with a present value total cost of \$4.5 million shown in the calculated totals at the bottom.



Exhibit 21: Infrastructure Project Costs

PROJECT COSTS AND REQUESTED FUNDS (enter in thousands of dollars)									
Year	Construction Years	DIRECT PROJECT COSTS					TOTAL COSTS (in dollars)		
		Project Support	INITIAL COSTS		SUBSEQUENT COSTS		Constant Dollars	Present Value	
			R / W	Construction	Maint./Op.	Rehab.			
Infrastructure Program Costs									
1	1		\$500.0	\$2,000.0	<-- Must enter a cost		\$2,500,000	\$2,500,000	
2	1			\$2,000.0			2,000,000	1,923,077	
3	0						0	0	
4	0						0	0	
5	0						0	0	
6	0						0	0	
7	0						0	0	
8	0						0	0	
Annual Infrastructure O&M Costs									
1					\$5		\$5,000	\$4,623	
2					\$5		5,000	4,445	
3					\$5		5,000	4,274	
4					\$5		5,000	4,110	
5					\$5		5,000	3,952	
6					\$5		5,000	3,800	
7					\$5		5,000	3,653	
8					\$5		5,000	3,513	
9					\$5		5,000	3,378	
10					\$5		5,000	3,248	
11					\$5		5,000	3,123	
12					\$5		5,000	3,003	
13					\$5		5,000	2,887	
14					\$5		5,000	2,776	
15					\$5		5,000	2,670	
16					\$5		5,000	2,567	
17					\$5		5,000	2,468	
18					\$5		5,000	2,373	
19					\$5		5,000	2,282	
20					\$5		5,000	2,194	
Total		\$0	\$500	\$4,000	\$100	\$0	\$4,600,000	\$4,488,416	
ATP REQUESTED FUNDS									
Total									

(6) Non-Infrastructure Program Costs (Box 1G). If we are going to include additional program support through community outreach to educate the public on the benefits of active transportation and to encourage use of the newly upgraded and built facility, then include the costs in the box shown in Exhibit 22, below. These costs will be used by the “Non-Infrastructure Program Information” worksheet tab to calculate the cost effectiveness of the program.

For our project, let’s assume that we will need \$1,000 in Year 1 for program support to initiate the program, so enter a “1” in the appropriate Year 1 cell under “Project Support”. It will cost \$5,000 per year for the two-year outreach program. Under subsequent costs type a “5” in each of the Year 1 and Year 2 cells under “Maint./Op.” since these costs will be incurred after the project opens.



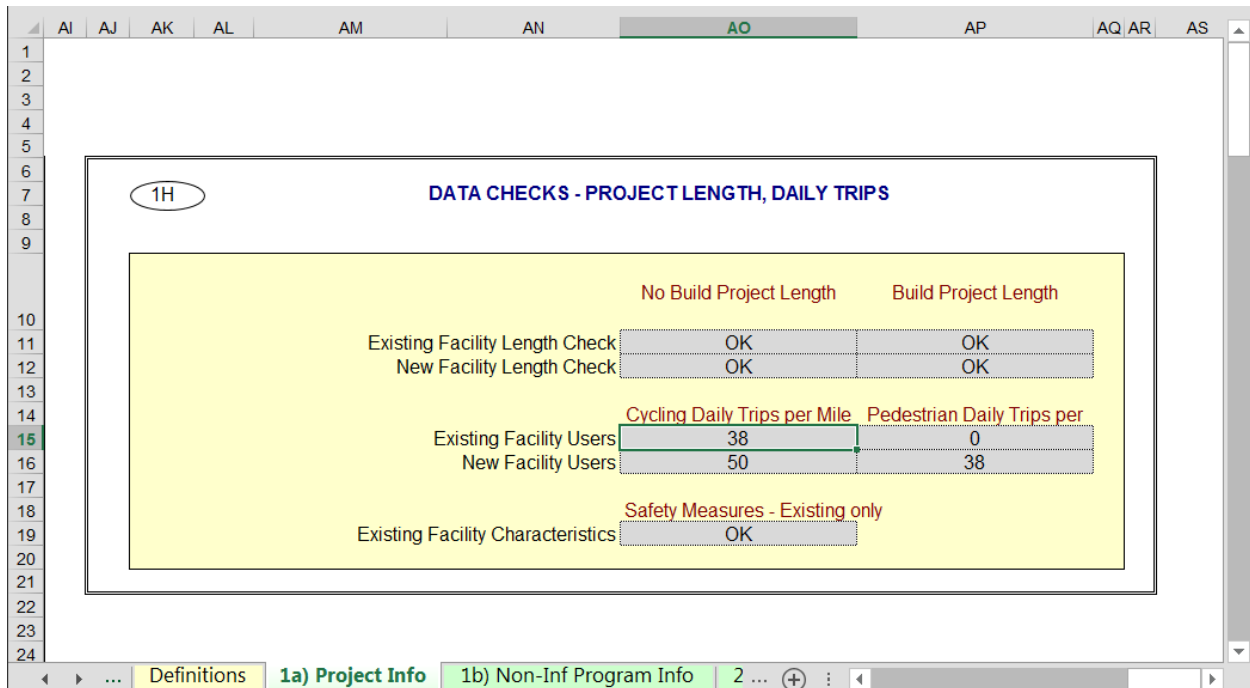
Exhibit 22: Non-Infrastructure Program Costs

PROGRAM COSTS AND REQUESTED FUNDS (enter in thousands of dollars)									
Year	Construction Years	Project Support	DIRECT PROJECT COSTS			SUBSEQUENT COSTS		TOTAL COSTS (in dollars)	
			R / W	Construction		Maint./ Op.	Rehab.	Constant Dollars	Present Value
Non-Infrastructure Program Costs									
1		1				← Must enter a cost		\$1,000	\$1,000
2								0	0
3								0	0
4								0	0
5								0	0
6								0	0
7								0	0
8								0	0
Annual Non-Infrastructure O&M Costs									
1						\$5		\$5,000	\$5,000
2						\$5		5,000	4,808
3								0	0
4								0	0
5								0	0
6								0	0
7								0	0
8								0	0
9								0	0
10								0	0
11								0	0
12								0	0
13								0	0
14								0	0
15								0	0
16								0	0
17								0	0
18								0	0
19								0	0
20								0	0
Total			\$1	\$0	\$0	\$10	\$0	\$11,000	\$10,808
ATP REQUESTED FUNDS									
Total									

This concludes the activities needed to set up infrastructure and total program costs. It is important to verify any data that has been input. A quick quality summary is provided in Cal-B/C AT to ensure that inputs have been accurately entered. Exhibit 23 shows the data check for our project.

For most active transportation projects this may be the only worksheet that requires data entry. If you have better forecast or model data, the *Model Inputs* worksheet can be used to make any edits for existing or future users. In our example, we will not be discussing the *Model Inputs* worksheet, but we will be using the *1b) Non-Inf Program Info* worksheet to evaluate the cost effectiveness of our outreach program. This will be discussed in the following section.

Exhibit 23: Data Checks



STEP 2: Input Non-Infrastructure Program Information

Worksheet *1b) Non-Inf Program Info* is used to evaluate the effectiveness of our outreach program. The information entered in Box 1G described above provides program costs, and this worksheet will be used to input specific program features and anticipated target audiences to identify cost effectiveness impact. Exhibit 24 shows the inputs for our example for the first three elements of this worksheet. Exhibit 25 is a continuation of the worksheet and shows the lower part of the worksheet.

- 1) For our example, assume that we expect to reach 2,500 people during our outreach effort. We expect that through focused targeting we'll reach around 5% of bicyclists in the area, and around 1% of potential pedestrians.
- 2) We will focus our efforts on two target audiences: elementary school children and young adults at the local university, so input 45% and 44%, respectively. Enter the other percentages as shown in the exhibit. Make sure that the totals equal 100%.
- 3) Our messaging efforts will focus on three areas, so input a "1" for the following target promotional areas:
 - 5 E's (**E**ducation, **E**nforcement, **E**ncouragement, **E**ngineering, **E**valuation) and the 5P's (**P**reparation, **P**romotion, **P**rograms, **P**olicy, and **P**hysical **P**rojects)
 - Knowledgeable Staff/Educator (to better reach the elementary school students and parents in our example project)
 - Creates Community Ownership/Relationship (emphasizing the integration of the local community).



Exhibit 24: Non-Infrastructure Program Characteristics (Part 1)

	A	B	C	D	E	F	G	H	I	J	K	L	M
1													
2					District:	District 5 (Santa Barbara)							
3								EA:					0
4					PROJECT:	Elementary School / College Multiuse Plan			PPNO:				0
5													
6					NON-INFRASTRUCTURE PROGRAM CHARACTERISTICS								
7					1								
8					Programmatic Initiatives?								
9					Yes								
10					Scale of Initiative								
11					Participants / Beneficiaries								
12					Data Check on Initiative								
13					Numbers of People Reached per Year	2500							OK
14					Average Percentage of Current Active Bicyclists Reached per Year	5%							
15					Average Percentage of Current Active Pedestrians Reached per Year	1%							
16					Scoring Criteria								
17					Total Number of Criteria								
18					4								
19					Total Criteria Weight Sum								
20					100%								
21					1) Target Audience								
22					Criteria Weight								
23					25%								
24					Indicators								
25					(mark as %; sum must equal 100%)								
26					Younger than 10	5%							Indicator Weight
27					10-12	45%							10%
28					13-24	44%							20%
29					25-55	5%							25%
30					55+	1%							15%
31					Indicator-Weighted Score								
32					0.21								
33					2) Characteristics Promotional Effort								
34					Criteria Weight								
35					25%								
36					Indicators								
37					(enter 1 for Yes on all that apply)								
38					Effort Targets 5 E's or 5 P's	1							Indicator Weight
39					Knowledgeable Staff/Educator	1							5%
40					Partnership/Volunteers								5%
41					Creates Community Ownership/Relationship	1							5%
42					Part of Bigger Effort (e.g., political support)								5%
43					Indicator-Weighted Score								
44					0.15								

- 4) Exhibit 24 shows the last input section for the worksheet. As indicated in the non-infrastructure program cost input box from the discussion above, we will provide two years of outreach. Therefore, enter a "1" for the cell corresponding to the *Multiple Years* option.
- 5) The results are presented at the bottom of the worksheet. For our \$10,808 investment, we receive an impact score of 2,674 for reaching cyclists and 2,787 for pedestrians, which results in a \$4 per impact point.



Exhibit 25: Non-Infrastructure Program Characteristics (Part 2)

	A	B	C	D	E	F	G	H	I	J	K	L	M
55									Criteria Weight				
56									25%				
57													
58					4) Frequency of Outreach Effort								
59					Indicators			(enter 1 for Yes for only one option)	Indicator Weight				
60					One Day				5%				
61					One Month				10%				
62					One Year				15%				
63					Multiple Years			1	20%				
64					Continuous Effort				25%				
65					Indicator-Weighted Score			0.2					
66					Projected New Active Transportation Cyclists								
67					Number of Potential New Facility Users			2,375					
68					Weighted Impact Score of Outreach			0.56					
69					Program Impact Score			1,337					
70					Years of Outreach			2.0					
71					Multi-year Program Impact Score			2,674					
72													
73					Cost Effectiveness								
74					Total Discounted Cost			\$10,808					
75					Cost per Program Impact Score			\$4					
76													
77					Projected New Active Transportation Pedestrians								
78					Number of Potential New Facility Users			2,475					
79					Weighted Impact Score of Outreach			56%					
80					Program Impact Score			1,393					
81					Years of Outreach			2.0					
82					Multi-year Program Impact Score			2,787					
83													
84					Cost Effectiveness								
85					Total Discounted Cost			\$10,808					
86					Cost per Program Impact Score			\$4					
87													
88													
89													
90													
91													
92													
93													

STEP 3: Review Final Results

The 3) *Results* worksheet provides the final benefit-cost results and summarizes the benefits for the project. Exhibit 26 shows the results for our project. For our \$4.5 million investment, we receive \$5.5 million in benefits that result in a benefit to cost ratio of 1.2. The largest benefit categories include journey quality, safety, and health benefits for users.

Appendix B: Technical Documentation

BACKGROUND AND SCOPE OF ANALYSIS

The scope of analysis differentiates benefits by trip purpose and type of project (improvements to existing facility, or new facility construction). An overview of these benefits is discussed below. First, to clarify concepts on bike facility use, several definitions cover terms that are used throughout the tool with respect to “trip types” and “user types”. Also, since not all users benefit from projects in the same way, definitions that map users to benefit categories are provided.

<u>Trip Types</u>	<u>Definitions</u>
Trips	One-way daily volumes of trips for commuting, or other purposes. Estimated numbers of trips should be obtained from facility count data and then scaled to estimate daily trips, assuming that the annualization factor is 365 days for regular facility use. Trips for children as part of a Safe Route to School assessment would be annualized with 180 days, based on the school year duration.
Roundtrips	Most trips have a return journey of the same mode and some trips include other unlinked side trips. “Roundtrips” are generalized here for cyclists and pedestrians as including the number of unlinked trips per day. A roundtrip as defined here is used to identify the number of users that are taking trips.
Existing Trips	Baseline trips, either on an existing facility or unmarked street, where the project will create a new facility with specific improvements.
Induced Trips	Additional trips above the baseline that arise because of the improvements to existing or new bike facilities.
Trip Forecasts	Forecasts are developed for existing and new facility locations (if applicable). Model users determine numbers of current and induced trips, and other characteristics (e.g., roundtrip probability, purpose, distance, etc.).

<u>Trip Purposes</u>	<u>Definitions</u>
Commute to Work	Users who are taking the bike facility to or from work. These users are primarily adult or young-adult aged. Facility use by college students would be classified under "other destinations".
Other Destinations	Users who are taking the facility to reach a variety of other destinations besides work, such as shopping, meeting friends, college classes, etc. These are trips that would be otherwise taken by some type of motor vehicle.

Recreational Users who are taking the facility purely as a loop-trip for exercise purposes. These trips would not be otherwise taken by motor vehicle since the purpose is for fitness and recreation.

Safe Route to School Users who are school-aged, i.e. 18 or under years old, and taking the facility to or from school. These estimated trips may be obtained from local schools who can survey the more well-defined population of children walking or riding to school.

Benefit Categories

Definitions

Journey Quality Improvements in the quality of the trip for pedestrians and cyclists that arise from a greater feeling of safety, comfort, aesthetics, and other types of improvements. Improvements to existing and new bike facilities can generate benefits for current trips and induced trips. Benefits to induced users are estimated using "rule of half" approximation. Journey quality is assumed to have a zero value for existing users along routes where there is no existing facility. The value of journey quality includes the perception of safety improvement and thus, to avoid double counting, additional accident reduction value along the routes is excluded. However, safety improvements at intersections along existing bike facilities generate additional benefits that are discussed below.

Intersection Delay (Time Savings from Improved Intersections on Existing Facilities) Improvements to existing facility intersections (e.g., lights, bridges, etc.) can lead to time savings for trips by reducing waiting time at intersections, for say a break in vehicular traffic. Time savings benefits can arise for existing and induced pedestrians and cyclists at each intersection that they cross. The number of intersections crossed by users of a facility on each trip is determined by the total length of the existing facility, the average distance traveled per user type, and the number of intersections with improvements. Benefits to induced users are estimated using "rule of half" approximation.

Health Benefits - Reduced Absenteeism of Commuters Health benefits related to a reduction in absenteeism are generated by induced walking and cycling commuters. The benefits are monetized by higher productivity due to fewer sick days. Benefits to these induced users are not estimated using "rule of half" approximation since the value is observed by the employer.

Health Benefits - Reduced Mortality Risk Health benefits related to improved long-term health and reduced risk of disease and early death. These benefits are derived from parameters established by the World Health Organization (WHO) and formalized in their online HEAT tool and documentation. Benefits are derived from reduced mortality risk in populations that range from 20-64 for cyclists and 20-74 for pedestrians. Reduced mortality risk depends on the amount of cycling (average distance) undertaken over a one year period.



**Intersection Safety
(Accident Reduction at
Improved
Intersections of
Existing Facilities)**

Improvements to existing facility intersections (e.g., lights, bridges, etc.) can lead to reduced accidents at intersections. Benefits can arise for existing and induced pedestrians and cyclists at each intersection crossed. The number of intersections crossed per trip is determined by the total length of the existing facility, the average distance traveled per user type, and the number of intersections with improvements. The magnitude of impacts is determined by the percent reduction in existing accidents due to specific safety measures. Induced trips benefits apply "rule of half" approximation.

**Auto Accident Costs
and Auto Emissions
(Diverted Auto Trips
only)**

Some of the induced pedestrian and cycling trips entail diversions from auto use. Benefits from reduced auto use include reduced frequency of accidents and level of auto emissions. Benefits are estimated for each diverted auto trip by using standard methods and data for estimating the value of auto use externalities.

BENEFIT CATEGORIES BY FACILITY TYPE

The matrix below indicates the applicability of benefits to different types of trips and facility projects. Facility projects include existing facility improvements and new facility construction. Trips differ between: (a) existing trips already being taken, or which would be taken in the future given expected growth rates; and, (b) new, induced trips that arise because of the facility improvement.

	<u>Existing Facility Improvement</u>		<u>New Facility Construction</u>	
	<u>Existing Trips</u>	<u>Induced Trips</u>	<u>Existing Trips</u>	<u>Induced Trips</u>
Journey Quality	Yes	Yes	Yes	Yes
Intersection Delay (Time Savings from Improved, Existing Facilities)	Yes	Yes		
Intersection Safety (Accident Reduction at Improved, Existing Facilities)	Yes	Yes		
Health Benefits - Reduced Absenteeism of Commuters (Commuters, only)		Yes		Yes
Health Benefits - Reduced Mortality Risk (Age dependent)		Yes		Yes
Auto Accident Costs and Auto Emissions		Yes		Yes

BENEFIT ESTIMATION

Journey Quality

Journey Quality benefits are estimated for both cyclists and pedestrians with different trip purposes. Different methodologies are however applied for each type of mode. The tool also distinguishes between destination-oriented (including commuting and other purposes) and recreational trips. This distinction is necessary because U.S. DOT BCA guidelines exclude consideration of recreational trips (i.e. trips defined as 'loop trips' for only exercise purposes) in estimating journey quality benefits for mobility to a destination. However, Caltrans may wish to depart from these guidelines to consider benefits for recreational users for several reasons. First, recreational cyclists certainly share the road with other vehicles if no bike facility exists. New projects would enable them to adjust their route of travel to facilities that would in turn improve performance and travel speeds for vehicular road users. Moreover, recreational trip purposes can be considered as valid as any other trip purpose, even if very few vehicular users of a road drive for recreational purposes. Because of these alternative perspectives, the tool is established to permit users to determine if recreational users are included in journey quality benefits.

Cyclists

Journey quality benefits for cycling are driven primarily by revealed preference research on cyclist route that assumes that when cyclists make choices between routes, they make these choices based on their values on the attributes of the route (e.g., the route is Bike Class II). By comparing cyclists' choices within a set of reasonable route options, the value of the route attributes to the cyclist can be determined. Note that in consideration of the above perspectives on recreational purpose cycling, no information is available on trip purpose.

These values capture the preference for a designated bike route in comparison with a basic roadway. Analytically, the term that quantifies the preference for a bike facility is the *marginal rate of substitution* (MRS), in which the distance that a user travels on a bike facility is compared against 1 mile traveled on a normal road. Each type of Bike Class for Caltrans has a different MRS value. To interpret the MRS value, consider a rider's choice between a Class II facility and a road, the MRS is 0.49. This value means that riding one mile on a Bike Class II facility is equivalent to *saving* 0.51 miles from a journey that would be otherwise taken on a road without bike facilities. Thus, for every mile traveled on a Bike Class II facility, there is a corresponding 0.51 mile-savings equivalent for each mile of a journey on the bike facility. MRS values that are closer to 1 generate a lower value per mile and vice versa. The monetary value of these mile-equivalent savings is determined from additional information on the time it takes to travel this distance and the value of time.

The estimation of the value of journey quality is presented below in three parts: Scale of Impact, Impact Factors, and Impact Value per Unit. Total benefits equals the difference in value between No Build and Build scenarios. See Cal-B/C Resource Guide for more information on methods and the Cal-B/C Parameters Guide for a discussion on data and sources.

Scale of Impact	Impact Factors	Impact Value per Unit
Annual existing and induced trips of cyclists	<ul style="list-style-type: none"> • Time spent on bike facility, based on average travel distance and travel speed • Preference for bike facility versus road, as a <i>marginal rate of substitution</i> where riders express preference for riding on bike facility versus road • Average travel distance varies regionally in based on data from the CA Household Travel Survey (2012) 	<ul style="list-style-type: none"> • Value of time (hourly) • Estimation of value for induced riders (from other modes) applies “rule of half”

Scale of Impact: $N \cdot AF$

Where:

- N = Number of daily one-way journeys for existing or induced users
- AF = Annualization Factor, equals 365 days with a standardized definition of a daily trip

Impact Factors: $Dist \cdot (1 - MRS) \cdot (1/ MPH_c)$

Where:

- $Dist$ = Mean distance traveled per trip for cyclists in CA, varies by location
- MRS = Marginal rate of substitution for *not* taking a route with a bike facility versus taking one with a facility
- MPH_c = Mean cycling speed, in miles per hour, per trip per user in California
- $(1/ MPH_c)$ = Inverse of MPH is the pace or mean cycling travel time for a given distance

Impact Value per Unit: VOT

Where

- VOT = Value of Time, in dollars per hour.

Total Value of Journey Quality – Cyclists:

$$VJQC = [N \cdot AF] \cdot [Dist \cdot (1 - MRS) \cdot (1/ MPH_c)] \cdot VOT$$

Pedestrians

The Journey Quality benefits of pedestrian infrastructure are based on the results of stated preference surveys. This methodology focused on the monetized benefit per mile-traveled.

The estimation of the value of journey quality for pedestrians is presented below in three parts: Scale of Impact, Impact Factors, and Impact Value per Unit. Total benefits equals the difference in value between No Build and Build scenarios. See Cal-B/C Resource Guide for more information on methods and the Cal-B/C Parameters Guide.

Scale of Impact	Impact Factors	Impact Value per Unit
Annual existing and induced trips of pedestrians	<ul style="list-style-type: none"> Average travel distance per trip, varies regionally by project location Type of amenity found on route 	<ul style="list-style-type: none"> Willingness to pay per amenity Estimation of value for induced riders (from other modes) applies "rule of half"

Scale of Impact: N • AF

Where:

- N = Number of daily one-way journeys by existing or induced pedestrians
- AF = Annualization Factor, equals 365 days with a standardized definition of a daily trip

Impact Factors: Dist

Where:

- Dist = Mean distance traveled per trip for pedestrians in CA, varies by location

Impact Value per Unit: VPM

Where:

- VPM = Value of journey quality per amenity per mile of travel

Total Value of Journey Quality – Pedestrians:

$$VJQP = [N \cdot AF] \cdot Dist \cdot VPM$$

Intersection Safety – Active Transportation Users

Cal-B/C AT estimates safety benefits if changes at intersections of existing facilities reduce risk of accidents. Data on three types of crash are considered: (a) Fatality collisions; (b) Injury collisions; and (c) PDO collisions. Ideally, at least 5 years of historical accident data should be collected, aggregated and averaged across all such intersections along the existing facility. In this case, the user metric is captured by the annual average number of collisions that have occurred among existing facility users, independent of trip purpose. The number of accidents reflects the actual risk that all users face. Reducing this risk leads to benefits for all users. Note that several crash reduction improvements are applicable only for estimating benefits for pedestrians from avoided accidents. These include: (1) Install sidewalk/pathway (to avoid walking along roadways); (2) Install pedestrian crossing (with enhanced safety measures); and (3) Install pedestrian crossing. The installation of sidewalks and other safety measures is assumed to be located in areas with a history of high accident risks.

The estimation of the value of intersection safety is presented below in three parts: Scale of impact, Impact factors, and Value of Impact per unit. Total benefits equals the difference in value between No Build and Build scenarios. See Cal-B/C Resource Guide for more information on methods and the Cal-B/C Parameters Guide.

Scale of Impact	Impact Factors	Impact Value per Unit
Historical rate and severity of accidents at intersections, including all users	Impact of safety countermeasures for reducing frequency of accidents	Monetary value of life, injury and property damage per event

Scale of Impact: C

Where:

- C = Annual average crash rate by crash type

Impact Factors: CR

Where:

- CR = Crash reduction factors as a percentage reduction in the crash rate by crash type
- $CR = 1 - (1 - CR1) \cdot (1 - CR2) \cdot (1 - CR3)$, where CR1, CR2, and CR3 are the three largest single crash reduction factors in percentage terms

Impact Value per Unit: ACC

Where:

- ACC = Sum product of accident frequencies and costs per accident by severity per mile

$$ACC = (FatalAcc \cdot CostFatal + InjAcc \cdot CostInj + PDAcc \cdot CostPD)$$

ACC, accident costs per-mile is derived using incident rates by accident severity (e.g., FatalAcc) and the respective cost by severity (e.g., CostFatal).

Total Value of Intersection Safety Enhancements:

$$VIS = C \cdot CR \cdot ACC$$

Intersection Delay – Active Transportation Users

Some projects that improve intersections to make them safer, also generate benefits for users based on a potential reduction in delay while waiting to cross an intersection. As an example, a bridge for active mode users to avoid a roadway provides a complete safety improvement and can save users time since they no longer have to slow, stop and wait to cross.

Cal-B/C AT estimates delay reduction benefits for each mode where applicable using standard valuation methods for the value of time savings. Time savings would be estimated for each improved intersection along an existing facility. Then, depending on the average length of a cycling or walking trip, it can be determined how many intersections would be crossed by an average trip. The total average time savings per trip would then be valued using ½ of the median wage rate, following standard practice.

The estimation of the value of intersection delay is presented below in three parts: scale of impact, Impact factors, and Impact value per unit. Total benefits equals the difference in value between No Build and Build scenarios. See Cal-B/C Resource Guide for more information on methods and the Cal-B/C Parameters Guide.

Scale of Impact	Impact Factors	Impact Value per Unit
Number of trips per year	<ul style="list-style-type: none"> Time savings per intersection; Number of improved intersections crossed per trip 	Value of time (hourly)

Scale of Impact: $N \cdot AF$

Where:

- N = Number of daily one-way journeys for existing or induced users
- AF = Annualization Factor, equals 365 days with a standardized definition of a daily trip

Impact Factors: $Dist \cdot N / L \cdot S$

Where:

- Dist = Mean distance traveled per trip by mode, varies by location
- N = Number of improved intersection along entire facility
- L = Facility length
- S = Average delay reduction per intersection, in minutes

Impact Value per Unit: VOT

Where

- VOT = Value of Time, in dollars per hour

Total Value of Intersection Delay Reductions:

$$VID = [N \cdot AF] \cdot [Dist \cdot N / L \cdot S] \cdot VOT$$

Health – Reduced Absenteeism

The methodology and some of the data to estimate health benefits from reduced absenteeism is derived from the World Health Organization (WHO) model, called HEAT. The study from WHO indicates that workplace physical activity programs in the U.S. involving 30 minutes of daily exercise can reduce short-term sick leave by between 6 percent and 32 percent. This analysis uses 6 percent as a conservative estimate.

The estimation of the value of reduced absenteeism is presented below in three parts: Scale of impact, Impact factors, and Impact value per unit. Total benefits equals the difference in value between No Build and Build scenarios. See Cal-B/C Resource Guide for more information on methods and the Cal-B/C Parameters Guide.

Scale of Impact	Impact Factors	Impact Value per Unit
Induced roundtrips by cyclists and pedestrians who are commuters	<ul style="list-style-type: none"> Average absence per employee (sick days taken) Proportion accounted by short-term sick leave Proportion of sick days reduced for being active for at least 30 minutes a day 	Average daily wage per worker

Scale of Impact: $N_i \cdot P_C / R \cdot AF$

Where:

- N_i = Number of daily one-way journeys of induced users
- P_C = Proportion of induced trips made by commuters
- R = Number of unlinked trips
- AF = Annualization Factor, equals 365 days with a standardized definition of a daily trip

Note that the model requests data in terms of number of new daily trips from the applicant. The tool converts new daily trips to new daily users using a roundtrip factor.

Impact Factors: $S \cdot P_{SL} \cdot P_{SR}$

Where:

- S = Average absence at work of typical employees(days per year)
- P_{SL} = Percentage of absences accounted for by short-term sick leave
- P_{SR} = Percentage reduction in sick days by being active

Impact Value per Unit: VOD

Where

- VOD = Average daily wage of new user

Total Value of Health - Reduced Absenteeism:

$$VHRA = [N_i \cdot P_C / R \cdot AF] \cdot [S \cdot P_{SL} \cdot P_{SR}] \cdot VOD$$

Health – Reduced Mortality

Cal-B/C AT adapts the method and data applied in the WHO HEAT model to estimate benefits of reduced mortality.⁶ The HEAT approach determines benefits as a reduction in the relative risk of death for bike facility users due to improved health conditions. The estimated reduction in risk for cycling and walking activity has been parameterized in a simplified form that is based on the distance traveled by mode. For cycling, there is a 4.5% reduction in risk for every 365 miles traveled per year (equal also to a 1 mile travel distance per day, every day). For walking, the annual risk reduction per 365 miles traveled is 9%. In addition, risk reduction is maximized at 30% for cycling and 45% for walking.⁷

The Cal-B/C AT model applies the HEAT model's risk reduction rate to estimate reduced deaths among users of a specific age group. Baseline risk of death for people in specific cohorts (e.g., from 20-64 for cycling and 20-74 for walking) are obtained from the CA Department of Public Health. Data from the California Household Transportation Survey are used to estimate proportions of cyclists and pedestrians in these age groups whose risk would be lowered.

The estimation of the value of reduced mortality is presented below in three parts: Scale of impact, Impact factors, and Impact value per unit. Total benefits equals the difference in value between No Build and Build scenarios. See Cal-B/C Resource Guide for more information on methods and the Cal-B/C Parameters Guide.

Scale of Impact	Impact Factors	Impact Value per Unit
Annual existing and induced roundtrips of cyclists and pedestrians	<ul style="list-style-type: none"> Average distance traveled per user by mode Existing proportion of deaths in an age cohort who die each year from any cause; age cohorts are defined as ages 20-64 (for cycling) and ages 20-74 (for walking) Risk reduction in expected deaths and among cyclists and pedestrians 	Value of a prevented fatality

Scale of Impact: $N_i \cdot P_A / R \cdot AF$

Where:

- N_i = Number of daily one-way journeys of induced users
- P_A = Percentage of users in age cohort: Cyclists: Ages 20-64, Pedestrians: Ages 20-74
- R = Roundtrip factor
- AF = Annualization Factor, equals 365 days with a standardized definition of a daily trip

Note that the model requests data in terms of number of new daily trips from the applicant. The tool converts daily trips to daily users using a roundtrip factor.

⁶ See: <http://www.heatwalkingcycling.org>

⁷ For trips lasting longer than this maximum value, no appreciable improvement in health is observable.

Impact Factors: $\text{Dist} \cdot \text{M} \cdot (1\text{-RR})$

Where:

- Dist = Mean distance traveled per trip for users in CA, varies by location
- M = Numbers of people per 100,000 who die each year from all causes in California
- 1-RR = Percentage mortality risk reduction for induced active travelers compared to baseline, non-active population

Impact Value per Unit: VSL

Where:

- VSL = Value of a Statistical Life - (2014 dollars)

Total Value of Health - Reduced Mortality:

$$\text{VHRM} = [N_i \cdot P_A / R \cdot \text{AF}] \cdot [\text{Dist} \cdot \text{M} \cdot (1\text{-RR})] \cdot \text{VSL}$$

Safety Benefits – Road Users

Accident rates may decline for road users when drivers shift to cycling or walking from motor vehicles simply because there are fewer cars on the road. Developing reasonable estimates of these benefits depends ideally on the availability of local data on accident rates in the corridor where an active transportation project is implemented. Relevant data would include numbers of motorized vehicle accidents per year by level of severity and total annual VMT. A ratio of annual accidents to annual VMT, when multiplied with the reduced VMT of diverted drivers, generates an estimate of the reduced number of accidents by level of severity. The economic value of a change in accident rates is estimated with an average cost per accident severity.

Cal-B/C AT compares accident costs with the project and without the project. Accident costs are summed over the lifetime of the project to derive the total impact. Individual projects may improve or adversely impact vehicle accidents, so the net result may be positive or negative. The estimation of the value of reduced accidents is presented below in three parts: Scale of impact, Impact factors, and Impact Value per unit. Total benefits equals the difference in value between No Build and Build scenarios. See Cal-B/C Resource Guide for more information on methods and the Cal-B/C Parameters Guide.

Scale of Impact	Impact Factors	Impact Value per Unit
<ul style="list-style-type: none"> Annual induced trips of cyclists and pedestrians Average vehicle occupancy 	Average travel distance	<ul style="list-style-type: none"> Cost of an accident, by severity Average accident rate, by severity

Scale of Impact: $N_i \cdot P_D / AVO \cdot AF$

Where:

- N_i = Number of daily one-way journeys for induced users
- P_D = Percentage of induced riders that divert from a passenger vehicle
- AVO = Average vehicle occupancy
- AF = Annualization Factor, equals 365 days with a standardized definition of a daily trip

Impact Factors: $Dist$

Where:

- $Dist$ = Mean distance traveled per trip (California) for induced users, varies by location

Impact Value per Unit: ACC

Where:

- ACC = Sum product of accident frequencies per mile and costs per accident, by severity
 $ACC = (FatalAcc \cdot CostFatal + InjAcc \cdot CostInj + PDAcc \cdot CostPD)$

ACC , accident costs per-mile is derived using incident rates by accident severity (e.g., $FatalAcc$) and the respective cost by severity (e.g., $CostFatal$).

Total Value of Accident Risk Reduction:

$$VAR = [N_i \cdot P_D / AVO \cdot AF] \cdot Dist \cdot ACC$$

Emissions Benefits

Reduced vehicle use, due to a shift of travelers to active transportation, creates public benefits by reducing the externalities of air emissions from auto use. Changes in the value of air emissions would be associated with differences in VMT or vehicle speed. Emissions rates per mile are determined by using look-up tables that depend on vehicle speed. Pollutants evaluated include carbon monoxide (CO), oxides of nitrogen (NO_x), volatile organic compounds (VOC), particulate matter (PM), and oxides of sulfur (SO_x) and greenhouse gases (CO₂). The value of pollutant emissions per mile are combined with VMT to determine a total value of emissions. Any benefits would be determined from the difference in total values between No Build and Build scenarios.

The value of reduced emissions is presented below in three parts: Scale of impact, Impact factors, and Value of impact per unit. Additional discussion on data and methods can be found in the Cal-B/C Resource Guide. See also the discussion in the Cal-B/C Parameters Guide.

Scale of Impact	Impact Factors	Impact Value per Unit
<ul style="list-style-type: none"> Annual induced trips of cyclists and pedestrians Average Vehicle Occupancy 	Average Travel Distance	<ul style="list-style-type: none"> Valuation per unit of emissions, by pollutant Emissions rates per vehicle, by pollutant Average speed of passenger vehicle

Scale of Impact: $N_i \cdot P_D / AVO \cdot AF$

Where:

- N_i = Number of daily one-way journeys for induced users
- P_D = Percentage of induced riders who divert from a passenger vehicle
- AVO = Average Vehicle Occupancy
- AF = Annualization Factor, equals 365 days with a standardized definition of a “daily” trip

Impact Factors: Dist

Where:

- Dist = Mean distance traveled per trip for users, varies by location

Impact Value per Unit: EC

Where:

- EC = Emissions cost equals the sum product of each pollutant's emissions (*pollutant^m*) rate per mile by mode (m), and costs per pollutant ($VPP_{pollutant}$).⁸ The equation is:

$$EC = (CO \cdot VPP_{CO} + CO_2 \cdot VPP_{CO_2} + NO_x \cdot VPP_{NO} + PM_{10} \cdot VPP_{PM_{10}} + SO_x \cdot VPP_{SO} + VOC \cdot VPP_{VOC})$$

Total Value of Emissions Reduction:

$$VER = [N_i \cdot P_D / AVO \cdot AF] \cdot Dist \cdot EC$$

⁸ Emissions rates are a function of vehicle speed, which is a user input.

COST-EFFECTIVENESS ASSESSMENT OF NON-INFRASTRUCTURE PROGRAMS

At present, methods and data are not sufficiently developed to accurately estimate the economic value of AT non-infrastructure programs. The effectiveness of AT non-infrastructure programs depends on many characteristics of the programs (e.g., knowledge of staff, outreach effort, duration of program, etc.) as well as having direct linkages with AT facilities.

While anecdotal evidence exists on the effectiveness of programs in inducing additional diversion from motorized vehicles, it is not reasonable to attribute these findings to only the program (exclusive of a capital project) nor is it reasonable to assume that another program would have a similar level of effectiveness. Moreover, since ATP fund applicants supply evidence on existing and new trips, they may already be accounting for programming activity in estimating the increase in facility use. Therefore, it is reasonable to characterize projects with accompanying AT non-infrastructure programs as having a *qualitatively* higher level of value than a similar project without such programs.

A datasheet though has been formed to collect information about the proposed initiative and applies a scoring framework to determine the overall program impact score. The score is influenced by the numbers of people reached who are not currently engaging in active transportation. In addition, four program performance criteria are established to assess the effectiveness of the initiative, each with different measures of relative value. The criteria themselves have an equal relative weight of 25 percent each. The scoring system is designed to provide a maximum potential score of 1.0. The percentage is applied to the number of currently non-active transportation mode users, who would switch to an active transportation mode, to determine a program impact score. The cost of the program is then divided by the score to determine the cost per program impact score – which can be a common basis for comparing programs across applicants.