



Cal-B/C Training Module 2

Overview of Cal-B/C Suite of Tools

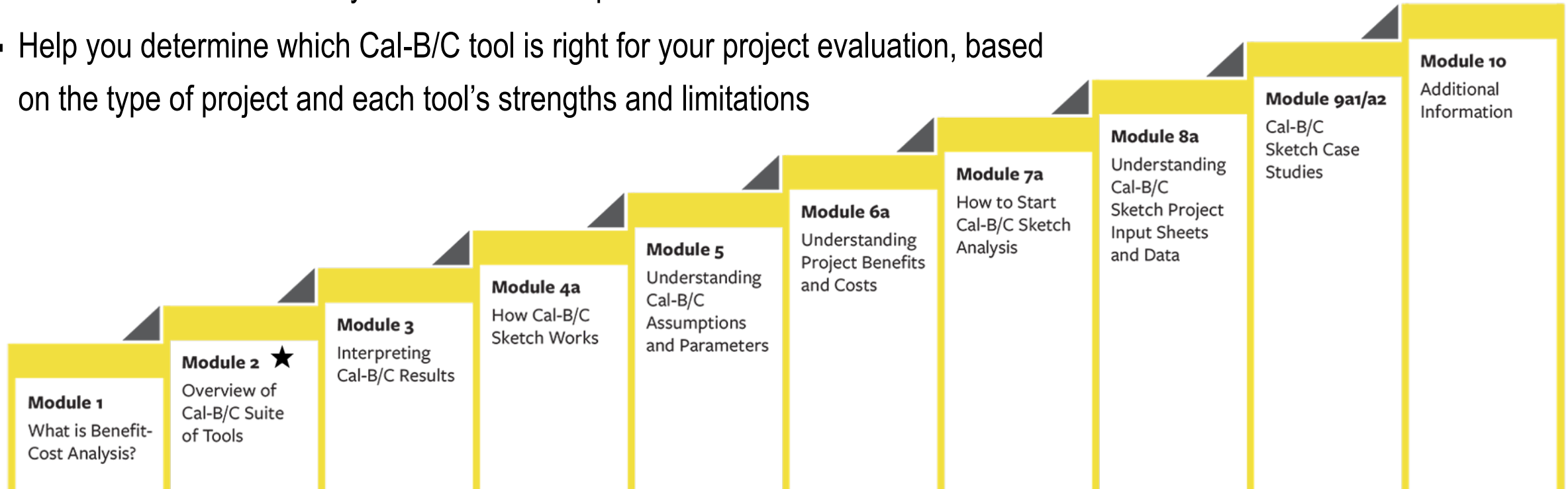


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About This Module

This module will...

- Introduce each tool in the Cal-B/C suite
- Include a brief history of the Cal-B/C tools
- Provide an overview of key features and components common in all Cal-B/C tools
- Help you determine which Cal-B/C tool is right for your project evaluation, based on the type of project and each tool's strengths and limitations



★ *This module is covered in this presentation*

The Previous Module...

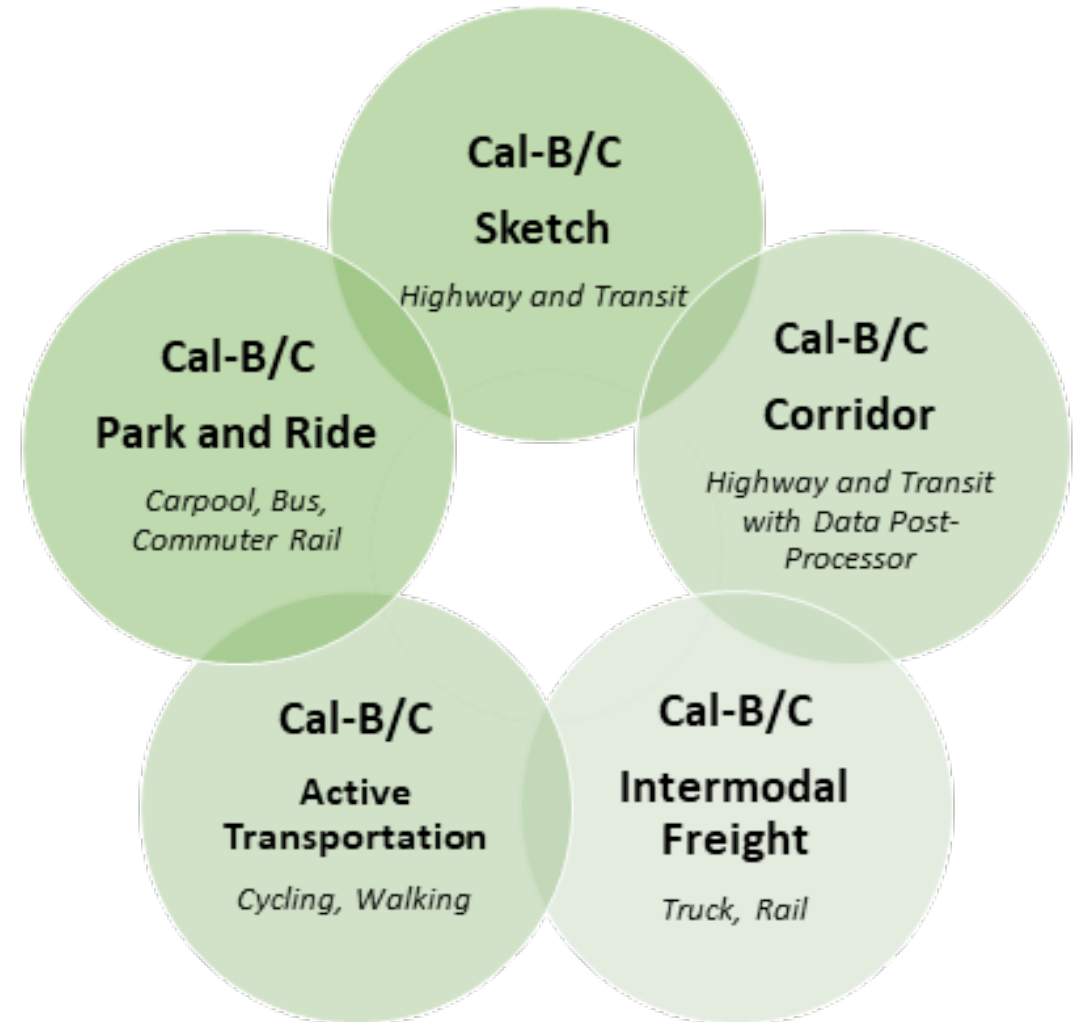
- **Module 1** provided a basic introduction on benefit-cost analysis (BCA) and a general overview of how to conduct a BCA

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Introduction to Cal-B/C

Cal-B/C Tools

- Cal-B/C is a suite of Excel workbooks developed by Caltrans to provide decision-makers with the ability to assess the benefits and costs of transportation projects
- Cal-B/C is continuously updated to ensure that it aligns with current transportation benefit-cost findings and practices
- Cal-B/C consists of five modules:
 - 1) Cal-B/C Sketch
 - 2) Cal-B/C Corridor
 - 3) Cal-B/C Active Transportation (AT)
 - 4) Cal-B/C Park and Ride (PnR),
 - 5) Cal-B/C Intermodal Freight (IF)
- The Cal-B/C Sketch model is also periodically modified to comply with benefit-cost guidance from the U.S. Department of Transportation, so it can be used for federal grant applications



History of Cal-B/C Sketch

- Initial tool was developed in mid-1990s to conduct investment analysis of the State Transportation Improvement Program (STIP)
- Cal-B/C provided sketch planning capabilities (in lieu of detailed planning analysis)
- Initial tool was updated several times and ultimately renamed the **Cal-B/C Sketch** model
- Framework has expanded over the years
 - Added a tool to post-process planning model data
 - Included new tools to cover projects that impact additional modes

History of Other Cal-B/C Tools

Cal-B/C Corridor

- Originally developed in 2009 to calculate benefits from micro-simulation or travel demand model data for corridor studies
- Recently updated to estimate accident cost savings and to allow data inputs for four modes for projects with multi-modal impacts

Cal-B/C Intermodal Freight (IF)

- Designed in 2017 to provide economic benefit-cost analysis for a range of intermodal freight projects

Cal-B/C Active Transportation (AT)

- Developed in 2017 from a first-generation AT model by Caltrans
- Refinements to the original model have been developed through a comprehensive literature review and in coordination with several organizations

Cal-B/C Park and Ride (PnR)

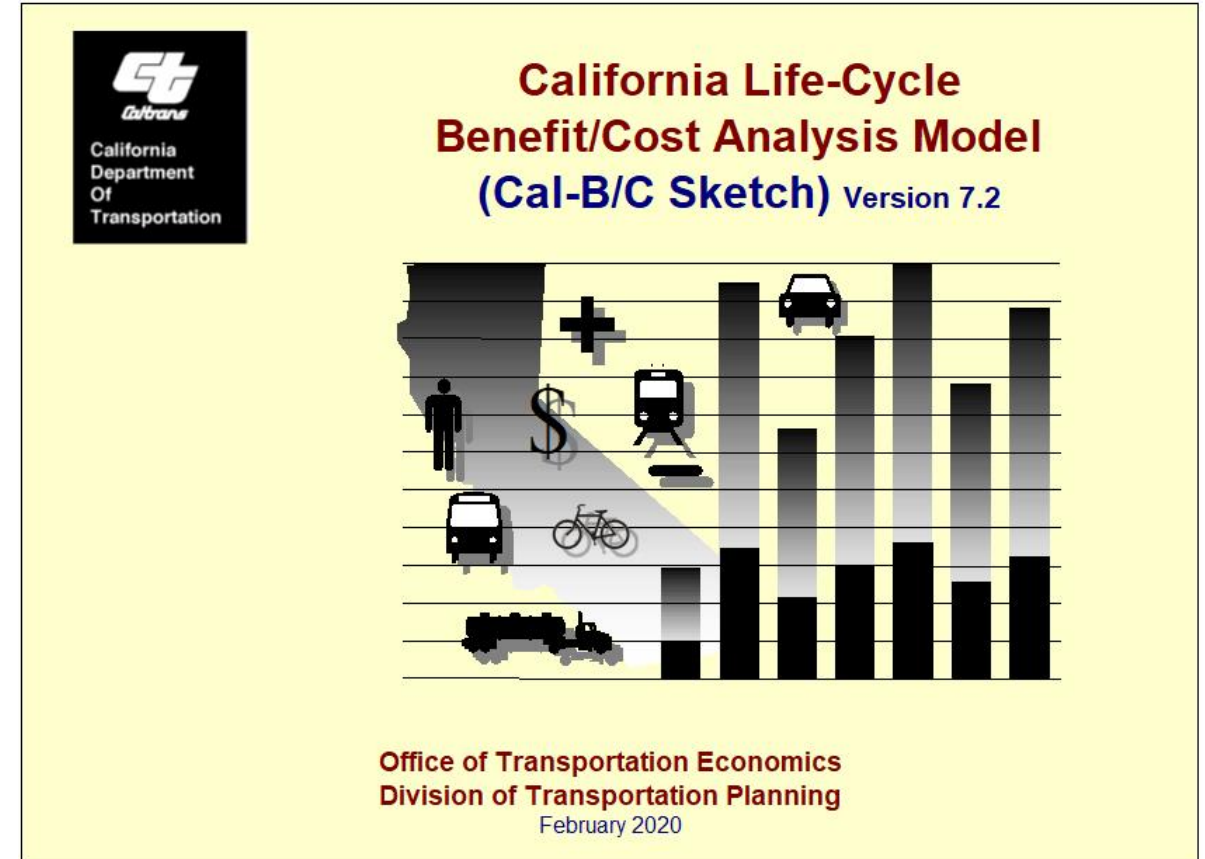
- Originally developed for Caltrans District 12 in 2013 to assess park and ride projects
- Incorporated into the Cal-B/C suite in 2019

Characteristics of All Cal-B/C Tools

- Each tool is set up as an **interconnected**, multi-sheet **spreadsheet** with formulas
- User will primarily use the **1) Project Information** and the **2) Model Inputs** worksheets for data entry
- Results are presented in the **3) Results** worksheet and BCA metrics are **comparable** across Cal-B/C tools
- Analysis worksheets perform calculations automatically from project input data
- Simple, intuitive design (not a black box, complete documentation, color-coded inputs)
- Maintains **consistency** through a number of default values, assumptions, and lookup tables to standardize analysis
 - Common parameters (value of life, value of time, etc.)
 - Similar model assumptions (discount rates, 20-year planning horizon, etc.)

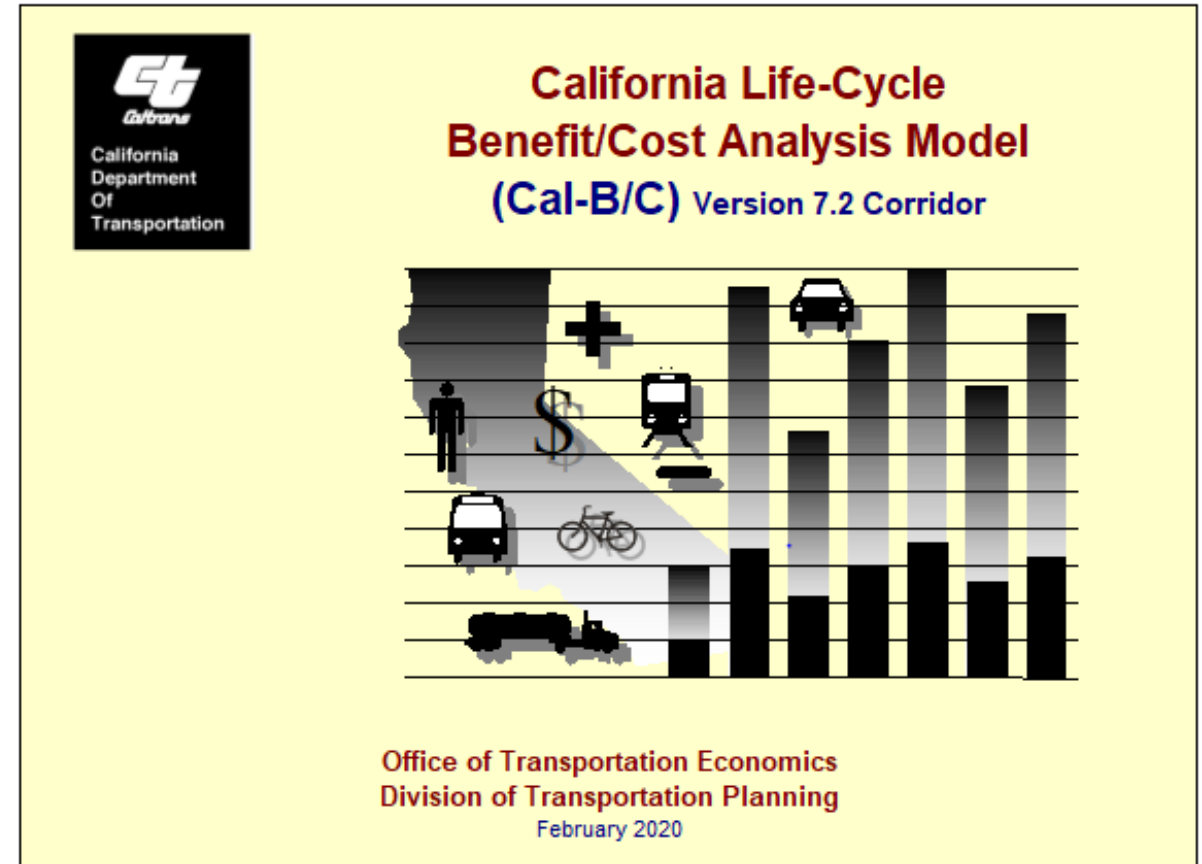
Overview of Cal-B/C Sketch

- Simple, **sketch** planning model
 - Allows for the evaluation of Highway Capacity Expansion, Highway Operational Improvements, Rail or Transit Capacity Expansion, and Transportation Management System (TMS) projects
 - In total, any one of 29 project types can be evaluated
 - Structure: 11 worksheets in total (including title page shown at right)
- Contains a number of **default values** and lookup tables to standardize analysis
- Estimates **four** categories of **user benefits**:
 - Travel time savings
 - Vehicle operating cost savings
 - Accident cost savings
 - Emission cost savings
- Estimates **speeds from volumes** (v/c ratios) when speed data is not available



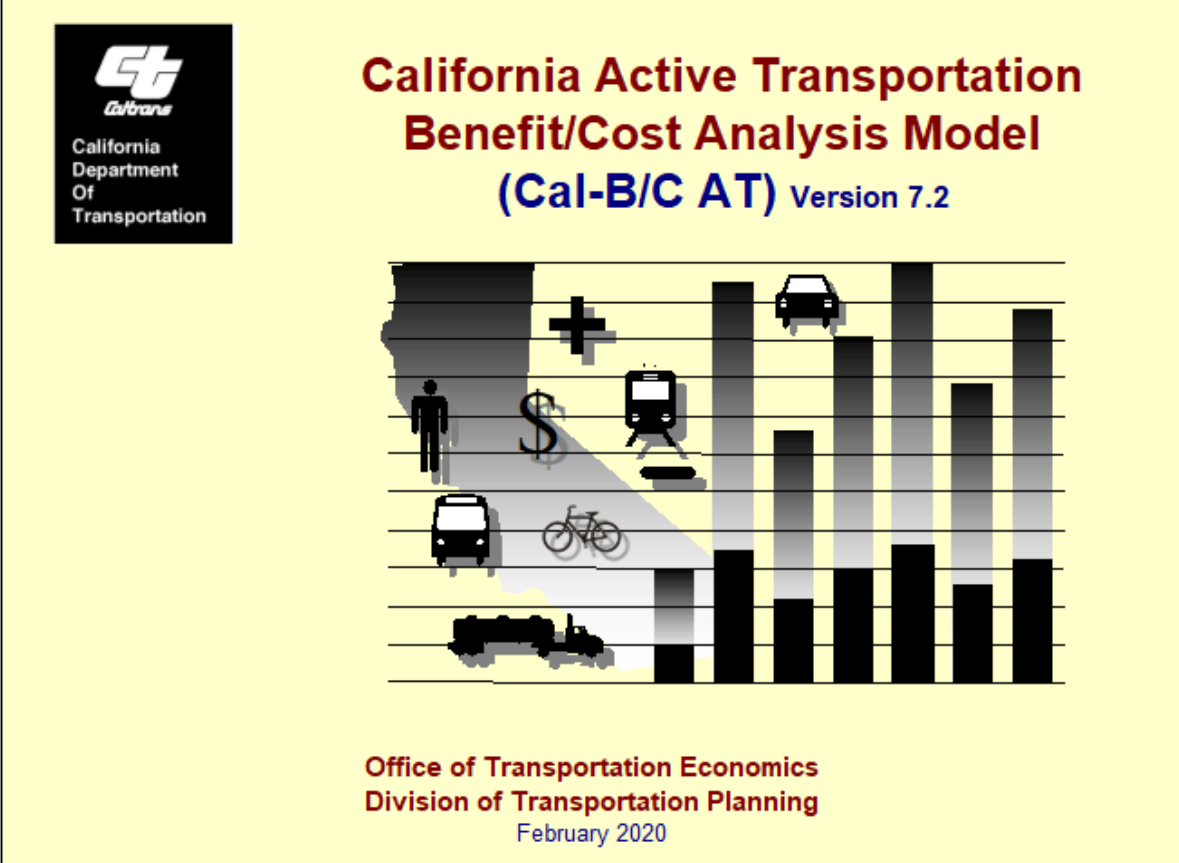
Overview of Cal-B/C Corridor

- **Post-processor**, BCA tool for preparing economic analyses of highway and transit projects
 - Structure: 12 worksheets in total
- Estimates **four** categories of **user benefits**:
 - Travel time savings
 - Vehicle operating cost savings
 - Accident cost savings
 - Emission cost savings
- Flexible design that supports a **variety of input data**
- Estimates benefits using changes in vehicle-miles traveled (VMT) and vehicle-hours traveled (VHT) by mode from travel demand or micro-simulation models



Overview of Cal-B/C AT

- Part of larger effort to include **bicycle and pedestrian modes** in Cal-B/C suite
 - Structure: 16 worksheets in total
- Designed to meet Active Transportation Program (ATP) Guidelines
- Capable of evaluating infrastructure projects and non-infrastructure programs
- Flexible design that supports a **variety of input data**
- Estimates **five** categories of **user benefits**:
 - Journey Quality
 - Additional delay savings
 - Additional safety benefits
 - Health benefits
 - Emission cost savings



California Active Transportation Benefit/Cost Analysis Model (Cal-B/C AT) Version 7.2

Office of Transportation Economics
Division of Transportation Planning
February 2020

Overview of Cal-B/C PnR

- Originally developed for District 12 and updated for Cal-B/C suite to estimate benefits of **park and ride lots**
 - Structure: 10 worksheets in total
- Estimates **five** categories of **user benefits**:
 - Travel time savings
 - Vehicle operating cost savings
 - Accident cost savings
 - Emission cost savings
 - Residual value
- Calculates benefits for existing and new users

Caltrans
California
Department
Of
Transportation

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

Office of Transportation Economics
Division of Transportation Planning
February 2020

Overview of Cal-B/C IF

- Provides ability to conduct BCA for **intermodal freight projects**
 - Structure: 10 worksheets in total
- Estimates **three benefits** for bulk/break bulk and containerized shipments:
 - Shipper cost savings
 - Accident cost savings
 - Emission cost savings
- A unified approach to estimate project benefits, considering:
 - Full freight trip movements
 - Drayage
 - Transload operations

California Intermodal Freight Benefit/Cost Analysis Model (Cal-B/C IF) Version 7.2

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February 2020

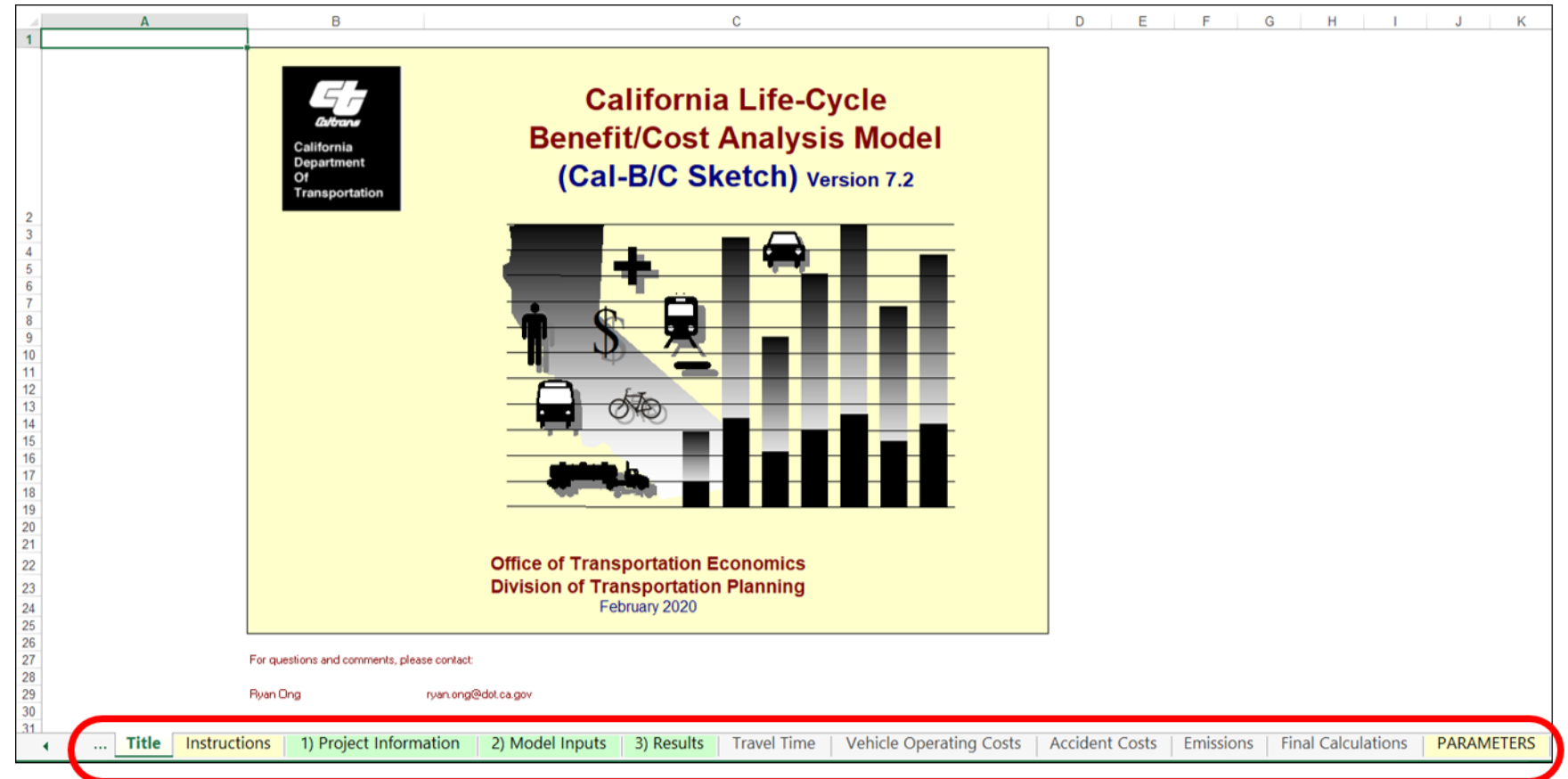
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Key Features of Cal-B/C Tools

Worksheet Layout in Cal-B/C Tools

- Generally, all Cal-B/C tools have the following (or similar) worksheets:
 - Title page
 - Instructions
 - **1) Project Information**
 - **2) Model Inputs**
 - **3) Results**
 - Benefit category estimations
 - Final Calculations
 - Parameters

Refer to Module 4a to 4e for more detail on spreadsheet layout and contents for each tool



Cal-B/C Tools Are User Friendly

- Simple and easy to use in a spreadsheet format
- Each Cal-B/C tool is generally set up to follow a three-step process:
 - 1) Project Information
 - 2) Model Inputs
 - 3) Results
- Refer to Module 7 for a quick-start analysis guide using this three-step process

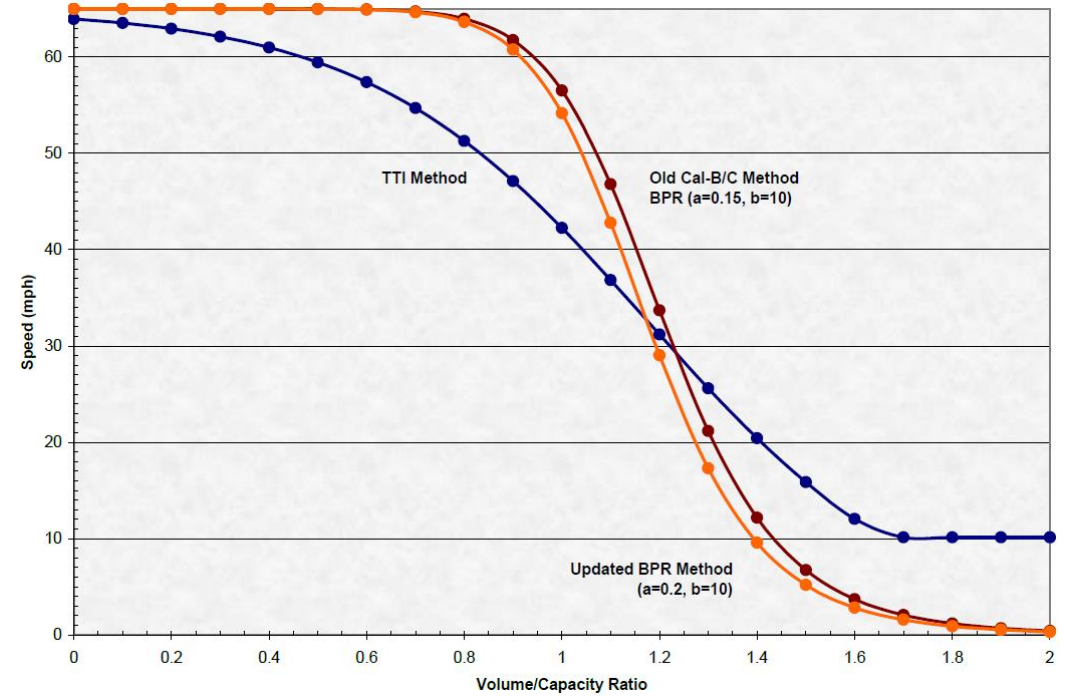
Example: Cal-B/C Corridor Project Information Sheet

The screenshot shows a spreadsheet interface for a Cal-B/C Corridor Project Information Sheet. The interface is divided into two main sections: "PROJECT DATA" (1A) and "MODEL STRUCTURE" (1B). "PROJECT DATA" includes fields for Type of Project, Project Location (set to 1), and Project Timing (Current Year: 2019, Year Construction Begins: 2019, Year Project Opens: 2020). "MODEL STRUCTURE" includes input fields for Number of Model Groups (10), Number of Safety Groups (10), and Years (20), and a table for "Values in This Model" with rows for 1-500, 500-1000, and 1000-1500, and columns for 1, 1, and 50. A "Create Model" button is located below the model structure section. A diagram at the bottom of the spreadsheet shows three steps: 1) Project Information, 2) Model Inputs, and 3) Results, with arrows pointing to the corresponding sections in the spreadsheet.

Cal-B/C Tools Have Transparent Benefit Calculations

- Tools use formulas to automate calculations of costs, benefits, and BCA metrics
- Benefit estimation uses commonly accepted estimation methodologies
- Refer to Module 6 for more detail on cost and benefit estimation methods

Bureau of Public Roads (BPR) Curve



Travel Time Savings

Travel Time Benefits
This sheet calculates total travel time benefits for highway and transit.

Formulas:
 Avg. Annual Volume = Avg. Daily Traffic * Number of Days in Study Year
 TTI Savings = Travel Time Reduction * Avg. Value of Time
 Value of Time = Avg. Value of Time to Vehicle User
 Value of Time = AVT * Avg. Annual Volume * Affected Length / Speed
 Change in Time = Change in Travel Time * BE

HIGHWAY BENEFITS

Year	AVERAGE VOLUME (vehicles/hour)		AVERAGE SPEED (mph)		ANNUAL PERSON TRIPS		AVERAGE TRAVEL TIME (hours)		TIME BENEFIT (\$/hour)		Constant Dollars	Present Value
	No Build	Build	No Build	Build	No Build	Build	No Build	Build	Old	New		
1	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
2	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
3	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
4	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
5	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
6	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
7	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
8	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
9	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
10	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
11	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
12	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
13	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
14	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
15	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
16	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
17	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
18	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
19	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
20	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
Total	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00

Vehicle Operating Cost Savings

Emission Reduction Benefits
This sheet calculates emissions benefits for highway and transit.

Formulas:
 Vehicle Miles Traveled = Affected Length * Avg. Annual Volume
 Change in Cost = 2004 Miles * Rate * Cost/Mile by Emission Type
 New Emissions Cost = 2004 * Rate * Cost/Mile by Emission Type

HIGHWAY BENEFITS

Year	AVERAGE VOLUME (vehicles/hour)		AVERAGE SPEED (mph)		TOTAL VMT (miles)		PLANNING EMISSIONS (lb/day)		STARTING EMISSIONS (lb/day)		Constant Dollars	Present Value
	No Build	Build	No Build	Build	No Build	Build	No Build	Build	No Build	Build		
1	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
2	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
3	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
4	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
5	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
6	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
7	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
8	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
9	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
10	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
11	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
12	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
13	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
14	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
15	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
16	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
17	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
18	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
19	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
20	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00
Total	0	0	50	50	0	0	0.00	0.00	0.00	0.00	0.00	0.00

Accident Cost Savings

Vehicle Operating Cost Benefits
This sheet calculates changes in highway vehicle operating costs as benefits for highway and transit projects. Net changes in transit operating costs should be included as project costs.

Formulas:
 Vehicle Miles Traveled = Affected Length * Avg. Annual Volume
 New Fuel Cost = VMT * Fuel Price
 Benefit = Existing Cost - New Cost

HIGHWAY BENEFITS

Year	AVERAGE VOLUME (vehicles/hour)		AVERAGE SPEED (mph)		TOTAL VMT (miles)		BENEFITS (\$/year)		Constant Dollars	Present Value
	No Build	Build	No Build	Build	No Build	Build	Fuel Costs	Non-Fuel Costs		
1	0	0	50	50	0	0	0.00	0.00	0.00	0.00
2	0	0	50	50	0	0	0.00	0.00	0.00	0.00
3	0	0	50	50	0	0	0.00	0.00	0.00	0.00
4	0	0	50	50	0	0	0.00	0.00	0.00	0.00
5	0	0	50	50	0	0	0.00	0.00	0.00	0.00
6	0	0	50	50	0	0	0.00	0.00	0.00	0.00
7	0	0	50	50	0	0	0.00	0.00	0.00	0.00
8	0	0	50	50	0	0	0.00	0.00	0.00	0.00
9	0	0	50	50	0	0	0.00	0.00	0.00	0.00
10	0	0	50	50	0	0	0.00	0.00	0.00	0.00
11	0	0	50	50	0	0	0.00	0.00	0.00	0.00
12	0	0	50	50	0	0	0.00	0.00	0.00	0.00
13	0	0	50	50	0	0	0.00	0.00	0.00	0.00
14	0	0	50	50	0	0	0.00	0.00	0.00	0.00
15	0	0	50	50	0	0	0.00	0.00	0.00	0.00
16	0	0	50	50	0	0	0.00	0.00	0.00	0.00
17	0	0	50	50	0	0	0.00	0.00	0.00	0.00
18	0	0	50	50	0	0	0.00	0.00	0.00	0.00
19	0	0	50	50	0	0	0.00	0.00	0.00	0.00
20	0	0	50	50	0	0	0.00	0.00	0.00	0.00
Total	0	0	50	50	0	0	0.00	0.00	0.00	0.00

Emission Cost Savings

Accident Reduction Benefits
This sheet calculates accident benefits for highway and transit.

Formulas:
 Accident Reduction = (Existing Accident Rate - New Accident Rate) * VMT * Accident Cost
 New Accident Rate = Existing Accident Rate * (1 - Reduction Rate)
 New Accident Cost = New Accident Rate * VMT * Accident Cost

HIGHWAY BENEFITS

Year	AVERAGE VOLUME (vehicles/hour)		TOTAL VMT (miles)		ACCIDENT COSTS (\$/year)		Constant Dollars	Present Value
	No Build	Build	No Build	Build	Existing	New		
1	0	0	0	0	0.00	0.00	0.00	0.00
2	0	0	0	0	0.00	0.00	0.00	0.00
3	0	0	0	0	0.00	0.00	0.00	0.00
4	0	0	0	0	0.00	0.00	0.00	0.00
5	0	0	0	0	0.00	0.00	0.00	0.00
6	0	0	0	0	0.00	0.00	0.00	0.00
7	0	0	0	0	0.00	0.00	0.00	0.00
8	0	0	0	0	0.00	0.00	0.00	0.00
9	0	0	0	0	0.00	0.00	0.00	0.00
10	0	0	0	0	0.00	0.00	0.00	0.00
11	0	0	0	0	0.00	0.00	0.00	0.00
12	0	0	0	0	0.00	0.00	0.00	0.00
13	0	0	0	0	0.00	0.00	0.00	0.00
14	0	0	0	0	0.00	0.00	0.00	0.00
15	0	0	0	0	0.00	0.00	0.00	0.00
16	0	0	0	0	0.00	0.00	0.00	0.00
17	0	0	0	0	0.00	0.00	0.00	0.00
18	0	0	0	0	0.00	0.00	0.00	0.00
19	0	0	0	0	0.00	0.00	0.00	0.00
20	0	0	0	0	0.00	0.00	0.00	0.00
Total	0	0	0	0	0.00	0.00	0.00	0.00

Example: Cal-B/C PnR Analysis sheets

All Tools Use the Same Parameters

- Each tool includes a Parameters sheet with relevant default inputs
- Parameters and estimation methodology are consistent across the framework
- Every tool uses the same established data sources for the Parameters sheet

Parameter Examples	Source
Average Vehicle Occupancy (AVO)	2010-2012 California Household Travel Survey (CHTS, 2012)
Average Hourly Wages	Bureau of Labor Statistics (BLS) OES
Value of Time Estimation	USDOT Department BCA Guidance & California Department of Transportation TSI and Traffic Operations
Highway Operation Parameters	Highway Capacity Manual, NCHRP 387, PeMS data
Highway Emissions Factors	California Air Resources Board, EMFAC 2017

Refer to Module 5 for more detail on source information for assumptions and parameters

Commonly Accepted Methodologies

- Tools generally use a 20-year life cycle
 - Cal-B/C Corridor allows the user to specify the lifecycle
- Costs and benefits are discounted for the future value of the dollar (discount rate set in Parameters worksheet)

Vehicle Operating Cost Benefits

This sheet calculates changes in highway vehicle operating costs and out-of-pocket costs. Net changes in transit operating costs should be included as project costs.

Formulas:

$\text{Vehicle-Miles Traveled} = \text{Distance} \times \text{Users} / \text{Avg Veh Occupancy}$ veh-miles/yr miles vehicles/yr	$\text{Non-Fuel Cost} = \text{VMT} \times \text{Cost Per Mile}$ dollars \$/mile
$\text{Fuel Cost} = \text{VMT} \times \text{Fuel Consumption} \times \text{Fuel Price}$ dollars gallons/mile \$/gallon	$\text{Out-Of-Pocket Costs} = \text{Parking Costs or Transit Fares}$
	$\text{Benefit} = \text{No Build Cost} - \text{Build Cost}$

A DESTINATION 1 - OC

New Transit Riders (switch from automobile to express bus)

Year	ANNUAL NUMBER OF USERS (people/yr)			TOTAL AUTO VMT (veh-miles/yr)		HWY VEH OP COSTS (\$/yr)		OUT-POCKET COSTS (\$/yr)		BENEFITS (\$/yr)		Constant Dollars	Present Value
	Existing Lot	New Lot	Users Benefited	No Build	Build	No Build	Build	No Build	Build	Hwy Veh Op Costs	Out-of-Pocket		
1	0	3,513	3,513	105,394	0	\$37,035	\$0	\$7,026	\$42,158	\$37,035	(\$35,131)	\$1,904	\$1,924
2	0	4,684	4,684	140,525	0	\$49,380	\$0	\$9,368	\$56,210	\$49,380	(\$46,842)	\$2,533	\$2,347
3	0	5,855	5,855	175,656	0	\$61,726	\$0	\$11,710	\$70,263	\$61,726	(\$58,552)	\$3,174	\$2,821
4	0	7,026	7,026	210,788	0	\$74,071	\$0	\$14,053	\$84,315	\$74,071	(\$70,263)	\$3,808	\$3,255
5	0	7,026	7,026	210,788	0	\$74,071	\$0	\$14,053	\$84,315	\$74,071	(\$70,263)	\$3,808	\$3,130
6	0	7,026	7,026	210,788	0	\$74,071	\$0	\$14,053	\$84,315	\$74,071	(\$70,263)	\$3,808	\$3,010
7	0	7,026	7,026	210,788	0	\$74,071	\$0	\$14,053	\$84,315	\$74,071	(\$70,263)	\$3,808	\$2,884
8	0	7,026	7,026	210,788	0	\$74,071	\$0	\$14,053	\$84,315	\$74,071	(\$70,263)	\$3,808	\$2,763
9	0	7,026	7,026	210,788	0	\$74,071	\$0	\$14,053	\$84,315	\$74,071	(\$70,263)	\$3,808	\$2,676
10	0	7,026	7,026	210,788	0	\$74,071	\$0	\$14,053	\$84,315	\$74,071	(\$70,263)	\$3,808	\$2,573
11	0	7,026	7,026	210,788	0	\$74,071	\$0	\$14,053	\$84,315	\$74,071	(\$70,263)	\$3,808	\$2,474
12	0	7,026	7,026	210,788	0	\$74,071	\$0	\$14,053	\$84,315	\$74,071	(\$70,263)	\$3,808	\$2,379
13	0	7,026	7,026	210,788	0	\$74,071	\$0	\$14,053	\$84,315	\$74,071	(\$70,263)	\$3,808	\$2,287
14	0	7,026	7,026	210,788	0	\$74,071	\$0	\$14,053	\$84,315	\$74,071	(\$70,263)	\$3,808	\$2,199
15	0	7,026	7,026	210,788	0	\$74,071	\$0	\$14,053	\$84,315	\$74,071	(\$70,263)	\$3,808	\$2,115
16	0	7,026	7,026	210,788	0	\$74,071	\$0	\$14,053	\$84,315	\$74,071	(\$70,263)	\$3,808	\$2,033
17	0	7,026	7,026	210,788	0	\$74,071	\$0	\$14,053	\$84,315	\$74,071	(\$70,263)	\$3,808	\$1,955
18	0	7,026	7,026	210,788	0	\$74,071	\$0	\$14,053	\$84,315	\$74,071	(\$70,263)	\$3,808	\$1,880
19	0	7,026	7,026	210,788	0	\$74,071	\$0	\$14,053	\$84,315	\$74,071	(\$70,263)	\$3,808	\$1,808
20	0	7,026	7,026	210,788	0	\$74,071	\$0	\$14,053	\$84,315	\$74,071	(\$70,263)	\$3,808	\$1,738
Total												\$48,186	

1D PROJECT COSTS (enter costs in thousands of dollars)

Year	DIRECT PROJECT COSTS						Transit Agency Cost Savings	TOTAL COSTS (in dollars)	
	Project Support	R / W	Construction	Maint./ Op.	Rehab.	Mitigation		Constant Dollars	Present Value
Construction Period									
1			\$550					\$550,000	\$550,000
2								0	0
3								0	0
4								0	0
5								0	0
6								0	0
7								0	0
8								0	0
Project Open									
1				\$40				\$40,000	\$38,462
2				\$40				40,000	36,982
3				\$40				40,000	35,560
4				\$40				40,000	34,192
5				\$40				40,000	32,877
6				\$40				40,000	31,613
7				\$40				40,000	30,397
8				\$40				40,000	29,228
9				\$40				40,000	28,103
10				\$40				40,000	27,023
11				\$40				40,000	25,983
12				\$40				40,000	24,984
13				\$40				40,000	24,025
14				\$40				40,000	23,099
15				\$40				40,000	22,211
16				\$40				40,000	21,356
17				\$40				40,000	20,535
18				\$40				40,000	19,745
19				\$40				40,000	18,986
20				\$40				40,000	18,255
Total	\$0	\$0	\$550	\$800	\$0	\$0	\$0	\$1,950,000	\$1,093,613

Constant Dollars (i.e., 2016 current dollars)
Present Value (i.e., discounted to current year)

Example: Cal-B/C PnR Project Cost and Vehicle Operating Cost Benefits tables

Commonly Accepted Methodologies (cont'd)

- Benefit estimation for existing and new (induced) users are handled separately
 - Consumer surplus is estimated using the rule of half
- Estimation of every benefit category is consistent with the USDOT BCA Guidance for Discretionary Grant Programs
 - Each analysis sheet includes a summary of the methodology in formulas at the top of the sheet

Cal-B/C Sketch, Travel Time worksheet

Travel Time Benefits

This sheet calculates total travel time benefits on highway and transit.

Formulas:

$\text{Avg. Annual Volume} = \frac{\text{Avg. Daily Traffic} \times \text{Number of Days in Model Year}}{\text{vehicles / yr}}$	$\text{TT Savings} = \frac{\text{Travel Time Reduction} \times \text{Avg. Value of Time}}{\$ / \text{year} \quad \$ / \text{hour}}$
$\text{Travel Time} = \frac{\text{AVO} \times \text{Avg. Annual Volume} \times \text{Affected Length}}{\text{vehicle-hrs / yr} \quad \text{vehicles / yr} \times \text{miles} \quad \text{miles/hour}}$	$\text{Induced} = \text{Change in Trips} \times \text{Change in Travel Time} \times 0.5$

HIGHWAY BENEFITS

Peak Period HDV

Year	AVERAGE VOLUME (vehicles/yr)		AVERAGE SPEED (mph)		ANNUAL PERSON-TRIPS (trips/yr)		AVERAGE TRAVEL TIME (hours)		TIME BENEFIT (person-hours/yr)	
	No Build	Build	No Build	Build	No Build	Build	No Build	Build	Existing Users	New (Induced)
1	0	0	55.0	55.0	#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!
20	0	0	55.0	55.0	#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!
2	0	0	55.0	55.0	#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!
3	0	0	55.0	55.0	#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!
4	0	0	55.0	55.0	#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!
5	0	0	55.0	55.0	#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!
					#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!
					#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!
					#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!
					#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!
					#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!
					#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!
					#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!
					#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!
					#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!
					#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!
					#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!
					#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!
					#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!
					#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!
					#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!
					#VALUE!	#VALUE!	0.00	0.00	#VALUE!	#VALUE!

Formulas:

$\text{Avg. Travel Time} = \frac{\text{Total VHT} \times \text{AVO}}{\text{Total Person Trips}}$ hrs / person vehicle-hrs / yr people / veh trips / yr	$\text{Adj. Person Trips} = \text{Total Person Trips} - \text{Induced Demand}$ trips / yr trips / yr trips / yr
$\text{Avg. Travel Time} = \frac{\text{Total PHT}}{\text{Total Person Trips}}$ hrs / person passenger-hrs / yr trips / yr	$\text{CS Benefit} = \text{Diff. in Travel Time} \times \text{Avg. Value of Time} \times \text{Diff. in Adj. Person Trips} \times 0.5$ dollars / year hrs / trip dollars / hr trips / yr

Cal-B/C Corridor, excerpt from Consumer Surplus worksheet

Consumer Surplus Benefits

This sheet calculates consumer benefits associated with induced demand.

Similar Results and Metrics in Cal-B/C Tools

- All Cal-B/C tools calculate the same metrics for project benefit evaluation
- These metrics are fully comparable between tools and projects
- Refer to Module 3 for more detail on results and metrics calculated in the Cal-B/C tools

District: **HQ**

PROJECT: **Hypothetical Project**

EA:
PPND:

3

INVESTMENT ANALYSIS

SUMMARY RESULTS

<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 2px;">Life-Cycle Costs (mil. \$)</td> <td style="text-align: right; padding: 2px;">\$0.0</td> </tr> <tr> <td style="padding: 2px;">Life-Cycle Benefits (mil. \$)</td> <td style="text-align: right; padding: 2px;">#N/A</td> </tr> <tr> <td style="padding: 2px;">Net Present Value (mil. \$)</td> <td style="text-align: right; padding: 2px;">#N/A</td> </tr> <tr> <td style="padding: 2px;">Benefit / Cost Ratio:</td> <td style="text-align: right; padding: 2px;">N/A</td> </tr> <tr> <td style="padding: 2px;">Rate of Return on Investment:</td> <td style="text-align: right; padding: 2px;">N/A</td> </tr> <tr> <td style="padding: 2px;">Payback Period:</td> <td style="text-align: right; padding: 2px;">N/A</td> </tr> </table>	Life-Cycle Costs (mil. \$)	\$0.0	Life-Cycle Benefits (mil. \$)	#N/A	Net Present Value (mil. \$)	#N/A	Benefit / Cost Ratio:	N/A	Rate of Return on Investment:	N/A	Payback Period:	N/A	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left; padding: 2px;">ITEMIZED BENEFITS (mil. \$)</th> <th style="text-align: center; padding: 2px;">Passenger Benefits</th> <th style="text-align: center; padding: 2px;">Freight Benefits</th> <th style="text-align: center; padding: 2px;">Total Over 20 Years</th> <th style="text-align: center; padding: 2px;">Average Annual</th> </tr> </thead> <tbody> <tr> <td style="padding: 2px;">Travel Time Savings</td> <td style="text-align: right; padding: 2px;">\$0.0</td> <td style="text-align: right; padding: 2px;">\$0.0</td> <td style="text-align: right; padding: 2px;">\$0.0</td> <td style="text-align: right; padding: 2px;">\$0.0</td> </tr> <tr> <td style="padding: 2px;">Veh. Op. Cost Savings</td> <td style="text-align: right; padding: 2px;">\$0.0</td> <td style="text-align: right; padding: 2px;">\$0.0</td> <td style="text-align: right; padding: 2px;">\$0.0</td> <td style="text-align: right; padding: 2px;">\$0.0</td> </tr> <tr> <td style="padding: 2px;">Accident Cost Savings</td> <td style="text-align: right; padding: 2px;">\$0.0</td> <td style="text-align: right; padding: 2px;">\$0.0</td> <td style="text-align: right; padding: 2px;">\$0.0</td> <td style="text-align: right; padding: 2px;">\$0.0</td> </tr> <tr> <td style="padding: 2px;">Emission Cost Savings</td> <td style="text-align: right; padding: 2px;">#N/A</td> <td style="text-align: right; padding: 2px;">#N/A</td> <td style="text-align: right; padding: 2px;">#N/A</td> <td style="text-align: right; padding: 2px;">#N/A</td> </tr> <tr> <td style="padding: 2px;">TOTAL BENEFITS</td> <td style="text-align: right; padding: 2px;">#N/A</td> <td style="text-align: right; padding: 2px;">#N/A</td> <td style="text-align: right; padding: 2px;">#N/A</td> <td style="text-align: right; padding: 2px;">#N/A</td> </tr> <tr> <td style="padding: 2px;">Person-Hours of Time Saved</td> <td colspan="2"></td> <td style="text-align: right; padding: 2px;">0</td> <td style="text-align: right; padding: 2px;">0</td> </tr> </tbody> </table>	ITEMIZED BENEFITS (mil. \$)	Passenger Benefits	Freight Benefits	Total Over 20 Years	Average Annual	Travel Time Savings	\$0.0	\$0.0	\$0.0	\$0.0	Veh. Op. Cost Savings	\$0.0	\$0.0	\$0.0	\$0.0	Accident Cost Savings	\$0.0	\$0.0	\$0.0	\$0.0	Emission Cost Savings	#N/A	#N/A	#N/A	#N/A	TOTAL BENEFITS	#N/A	#N/A	#N/A	#N/A	Person-Hours of Time Saved			0	0
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TOTAL BENEFITS	#N/A	#N/A	#N/A	#N/A																																												
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CO Emissions Saved	0	0	#N/A	#N/A																																																		
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VOC Emissions Saved	0	0	#N/A	#N/A																																																		

Example: Cal-B/C Sketch Results sheet

04

Types of Projects Evaluated Using Cal-B/C Tools

Cal-B/C Sketch Can Evaluate...

Highway Capacity Expansion Projects

- General Highway
- HOV Lane Addition
- HOT Lane Addition
- Passing Lane
- Intersection
- Truck Only Lane
- Bypass
- Queuing
- Pavement

Rail/Transit Capacity Expansion Projects

- Passenger Rail
- Light-Rail (LRT)
- Bus
- Hwy-Rail Grade Crossing

Highway Operational Improvement Projects

- Auxiliary Lane
- Freeway Connector
- HOV Connector
- HOV Drop Ramp
- Off-Ramp Widening
- On-Ramp Widening
- HOV-2 to HOV-3 Conversion
- HOT Lane Conversion

Transportation Management Systems (TMS)

- Ramp Metering
- Ramp Metering Signal Coordination
- Incident Management
- Traveler Information
- Arterial Signal Management
- Transit Vehicle Location (AVL)
- Transit Vehicle Signal Priority
- Bus Rapid Transit (BRT)

Methods

BPR Curve (v/c ratio)	Transit
HCM/Weaving	IDAS
Multiple Roads/Macro	Queuing
TMS Master Plan	Other

Cal-B/C Corridor Can Evaluate...

- Any project with highway and/or transit components and detailed data:
 - Modeled in a travel demand model
 - Modeled in a micro-simulation model
 - Traffic by segment estimated using the Highway Capacity Manual (HCM) methods
- For example:
 - Highway Expansion projects (interchange improvements, capacity expansion, bypass construction, bridge reconstruction, etc.)
 - Transit projects (new or improved passenger rail, light rail, or bus systems)



Cal-B/C AT Can Evaluate...

- Infrastructure & non-infrastructure projects for active transportation
 - Capital investments on facilities (upgraded or new, on- or off-road facilities), intersection or signal improvement, and other physical amenities
 - Educational, promotional and other initiatives to encourage ridership and safety
- Projects with bicycle and pedestrian traffic
- Projects with Safe Routes To School (SR2S) components: Encourage children walking or bicycling to school by improving safety



Source: <http://tinyurl.com/q8bhjss>

Cal-B/C PnR Can Evaluate...

- Park and ride lot investments
 - New locations
 - Improved highway, transit, and/or bicycle access to park and ride lots
- Up to four user types
 - Existing and new transit riders
 - Existing and new carpoolers
- Up to three destinations for park and ride lot users
 - Macro-enabled to enter additional destinations



Cal-B/C IF Can Evaluate...

- Modal Diversion and Freight Network Improvements
 - Rail Corridor Capacity Improvements
 - Truck Corridor Capacity Improvements
 - Projects Enabling Dedicated Freight Movements in Unit Trains
 - Loop Track Construction
 - Wye Construction/Extension
 - Rail Infrastructure Upgrades and Enhancements
 - Other Projects that Divert Freight Movements Between Truck and Rail
- Transload Operations and Terminal Efficiency Improvements
 - New Terminal Construction
 - Port/Terminal Capacity Improvements
 - New Port/Terminal Technology Implementation



05

Choosing the Best Tool for Your Project Evaluation

Which Cal-B/C Tool is right for your project?

	Sketch	Corridor	AT	PnR	IF
Is your project at a preliminary planning phase?	X		X	X	X
Are there few data points from which to estimate demand, costs, and benefits?	X		X	X	X
Is there a completed travel demand study or traffic report?		X			
Are there data from a travel demand model or micro-simulation model available?		X			
Does the project impact multiple modes?	X	X			
Are there shifts in traffic from one mode to another?	X	X			
Is your project a highway, rail, or transit capacity expansion, or a highway operational improvement?	X	X			
Is your project a transportation management system?	X				
Does the project impact bicycle and/or pedestrian traffic with infrastructure or non-infrastructure improvements?			X		
Does the project have Safe Routes To School (SRTS) components?			X		

Which Cal-B/C Tool is right for your project?

	Sketch	Corridor	AT	PnR	IF
Does the project impact bicycle and/or pedestrian traffic with infrastructure or non-infrastructure improvements?			X		
Is there bicycle or pedestrian traffic data available?			X		
Does the project have Safe Routes To School (SRTS) components?			X		
Does the project involve a park and ride lot?				X	
Is the project expected to promote increased usage of transit, carpool, and bus modes from a park and ride lot?				X	
Does the project include modal diversion or freight network improvements?					X
Does the project include transload operations or terminal efficiency improvements?					X

06

Limitations of Cal-B/C

Limitations of Cal-B/C tools

- Cal-B/C tools are for benefit-cost analysis
 - They cannot estimate changes in demand, economic impacts, or other performance measures
- None of the Cal-B/C tools are equipped to assess:
 - Noise reduction
 - Projects on local streets and roads
 - Culverts
- Limitations of Cal-B/C Sketch
 - Analysis is limited to a set of applicable project types
 - e.g., cannot evaluate interchanges, complex projects, or combinations of projects
 - Sketch relies more heavily on rules-of-thumb and assumptions
 - e.g., Bureau of Public Roads formulas are used to estimate speeds from flows and capacities
 - Calculated speeds may not reflect actual roadway conditions

Limitations of Cal-B/C tools

- Limitations of Cal-B/C Corridor
 - Potentially requires post-processing of micro-simulation or travel demand model results to calculate VMT and VHT inputs
 - Requires data entry for number of trips
 - Requires more detailed safety data that may or may not be available
- Limitations of Cal-B/C AT
 - BCA for active transportation projects is evolving and Cal-B/C AT is a first-generation model
 - Data for AT projects, particularly forecast data, is difficult to obtain
 - The Non-Infrastructure Program component is evaluated through a multi-criteria analysis approach rather than BCA methods
- Limitations of Cal-B/C PnR
 - Requires information on typical destinations reached from the park-and-ride lot
- Limitations of Cal-B/C IF
 - Requires user to provide information on shipping costs and use of intermodal freight facilities

07

Evaluating Projects with Multiple Improvements

Projects with Multiple Improvements

- You can use more than one tool in the Cal-B/C suite to get a comprehensive estimate of a project's benefits
- Benefits estimated from independent components of a project can be combined because results are fully comparable across tools
 - Lifecycle benefits can be added together (ensure this does not double-count benefits)
- Refer to Module 3 for more detail and instruction

California Active Transportation Benefit/Cost Analysis Model (Cal-B/C AT) Version 7.2

California Department Of Transportation

Office of Transportation Economics
Division of Transportation Planning
February 2020



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

California Department Of Transportation

Office of Transportation Economics
Division of Transportation Planning
February 2020

08

Conclusion

In this module, you learned...

- A brief history of the Cal-B/C tools
- Key features common across all Cal-B/C tools
- The types of projects evaluated by each Cal-B/C tool
- How to determine which Cal-B/C tool is right for your project evaluation

What's Next?

- Description of the results in the Cal-B/C tools
 - **Module 3: Interpreting Cal-B/C Results**
- Get more information on one Cal-B/C tool and how it works
 - **Module 4a** (Cal-B/C Sketch)
 - **Module 4b** (Cal-B/C Corridor)
 - **Module 4c** (Cal-B/C Active Transportation)
 - **Module 4d** (Cal-B/C Park & Ride)
 - **Module 4e** (Cal-B/C Intermodal Freight)
- Start an analysis!
 - **Module 7: How to Start a Cal-B/C Analysis**