Cal-B/C Training Module 6a
Understanding Project Benefits and Costs for Cal-B/C Sketch, Corridor, and PnR
About This Module
Module 6a: About This Module

This module will...

- Build on Modules 1 through 5 to provide a detailed understanding of project costs and benefits
- Describes benefit types and calculation methods
- Review detailed calculations for each benefit type

★ This module is covered in this presentation
Previous Modules…

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

- **Module 2** described the Cal-B/C suite of tools, discussed the types of projects that can be evaluated, and provided guidance on which tools to use for various project types.

- **Module 3** presented the Cal-B/C results page, detailed what each output measure means, and explained how they are calculated.

- **Modules 4a, b, and d** presented an overview of how Cal-B/C Sketch, Corridor, and PnR work including a review of all worksheets and inputs.
  
  - This current module complements Modules 4a, 4b, and 4d.

- **Module 5** highlighted the information in the Parameters worksheet and discussed key assumptions used by Cal-B/C.
## Overview of Benefit Categories

<table>
<thead>
<tr>
<th>Benefit Category</th>
<th>Cal-B/C Sketch</th>
<th>Cal-B/C Corridor</th>
<th>Cal-B/C PnR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel time savings</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>(aka user benefits and additional delay savings)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle operating cost savings</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Accident cost savings</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>(aka additional safety benefits)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emission cost savings</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Residual value</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Journey quality benefits</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Health benefits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shipper cost savings</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Cal-B/C Sketch**

<table>
<thead>
<tr>
<th>Summary Results</th>
<th>Passenger Benefits</th>
<th>Freight Benefits</th>
<th>Total Over 20 Years</th>
<th>Average Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life-Cycle Costs (incl. $)</td>
<td>$0.0</td>
<td>$0.0</td>
<td>$0.0</td>
<td>$0.0</td>
</tr>
<tr>
<td>Life-Cycle Benefits (incl. $)</td>
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<td>$0.0</td>
<td>$0.0</td>
<td>$0.0</td>
</tr>
<tr>
<td>Net Present Value (incl. $)</td>
<td>$0.0</td>
<td>$0.0</td>
<td>$0.0</td>
<td>$0.0</td>
</tr>
<tr>
<td>Benefit / Cost Ratio</td>
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<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Rate of Return on Investment</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Payback Period</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Person-Hours of Time Saved</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

**Cal-B/C Corridor**

<table>
<thead>
<tr>
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<td>NA</td>
</tr>
<tr>
<td>Rate of Return on Investment</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Payback Period</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Person-Hours of Time Saved</td>
<td>0</td>
<td>0</td>
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<td>0</td>
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</tbody>
</table>

**Cal-B/C PnR**

<table>
<thead>
<tr>
<th>Summary Results</th>
<th>Passenger Benefits</th>
<th>Freight Benefits</th>
<th>Total Over 20 Years</th>
<th>Average Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life-Cycle Costs (incl. $)</td>
<td>$0.0</td>
<td>$0.0</td>
<td>$0.0</td>
<td>$0.0</td>
</tr>
<tr>
<td>Life-Cycle Benefits (incl. $)</td>
<td>$0.0</td>
<td>$0.0</td>
<td>$0.0</td>
<td>$0.0</td>
</tr>
<tr>
<td>Net Present Value (incl. $)</td>
<td>$0.0</td>
<td>$0.0</td>
<td>$0.0</td>
<td>$0.0</td>
</tr>
<tr>
<td>Benefit / Cost Ratio</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Rate of Return on Investment</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Payback Period</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Person-Hours of Time Saved</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Overview of Project Cost Types in All Cal-B/C Tools

- All Cal-B/C tools can accommodate the following cost types:
  - Project support
  - Right-of-way
  - Construction
  - Maintenance and rehabilitation
  - Environmental mitigation
Overview of Calculations in Cal-B/C Tools
Overview of Benefit Calculations in All Cal-B/C Tools

- Benefit calculation worksheets produce detailed calculations for each benefit category.
- They are provided for model transparency, not a “Black Box”.
- Benefit estimates are functions of your inputs and assumptions contained in the parameters worksheet.

Module 6a: Overview of Calculations in Cal-B/C Tools
Overview of Benefit Calculations in All Cal-B/C Tools

The Final Calculations worksheet:
- Tabulates all the benefits and costs by year, in present value and constant dollars, from the benefit estimation worksheets
- Calculates BCA metrics (B/C ratio, IRR, NPV, and payback period)
Overview of Benefit Calculations in All Cal-B/C Tools

- Analysis worksheets estimate benefits from data in 1) Project Information and 2) Model Inputs
- Benefit estimates are linked to the Final Calculations worksheet
- Life-Cycle Benefits, Life-Cycle Costs, and all other BCA metrics are linked to the Results page.
03 Benefits in Cal-B/C Sketch
Benefit Calculations in Cal-B/C Sketch

- In Cal-B/C Sketch estimation worksheets, calculations are provided by:
  - Year
  - Mode (e.g., single occupant vehicles, carpools, trucks, transit)
  - Facility (e.g., mainline lane, HOV lane)
  - Period (e.g., peak and non-peak periods)
Intermediate calculations for several benefit categories based on the data in:

1) Project Information:
   - Avg. Annual Volume = Avg. Daily Traffic x Number of Days in Model Year
   - Vehicle-Miles Traveled (VMT) = Impacted Length x Avg. Annual Volume

Calculated for Base and Forecast years, in No Build and Build scenarios
Project Benefits in Cal-B/C Sketch

Travel Time (TT) Savings

- Function (volume, speed, value of time)
  - Ann. Person-Trips = AVO x Avg. Annual Volume
  - Ann. Travel Time (TT) = Person-Trips x Impacted Length / Speed
  - TT Reduction = No Build Travel Time – Build Travel Time
  - TT Savings (Existing Users) = TT Reduction x Value of Time (by veh. type)
  - TT Savings (Induced) = Change in Trips (No Build to Build) x TT Reduction * 0.5

- Travel Time Savings by year are linked to the Final Calculations worksheet
Project Benefits in Cal-B/C Sketch

Vehicle Operating Cost (VOC) Savings

- Function (volume, speed, fuel consumption, wear factors)
  - Fuel Cost = VMT x Fuel Consumption (by speed) x Fuel Price
  - Non-Fuel Cost = VMT x Cost Per Mile
  - VOC Savings = No Build Cost – Build Cost, for both Fuel and Non-Fuel costs
- VOC Savings by year are linked to the Final Calculations worksheet
Project Benefits in Cal-B/C Sketch

Accident Cost Savings

- Function (volume, facility type, accident rate, cost per accident) by accident type
  - Hwy Acc Cost = VMT x Rate (accidents/MVM) x Cost/Accident
  - Hwy-Rail Transit Acc. Cost = Rate (accidents/year) x Cost/Accident
  - Non-Hwy Transit Acc. Cost = VMT x Rate (accidents/MVM) x Cost/Accident
  - Cost/Accident from Parameters sheet
  - Acc. Cost Savings = No Build Cost – Build Cost

- Accident Cost Savings by year are linked to the Final Calculations worksheet
Project Benefits in Cal-B/C Sketch

Emission Cost Savings

- Function (volume, speed, emission rate) by emissions type
  - Hwy Emissions Cost = VMT x Em. Rate x Cost/Mile
  - Transit Em. Cost = VMT x Em. Rate x Cost/Mile
  - Emissions Cost Savings = No Build Cost – Build Cost

- Emissions Cost Savings by year are linked to the Final Calculations worksheet
Benefits in Cal-B/C Corridor
Benefit Calculations in Cal-B/C Corridor

- In Cal-B/C Corridor estimation worksheets, calculations are provided by:
  - Year
  - Mode (e.g., vehicles, buses, light-rail, passenger train)
  - “Model group” (e.g., geographic project segments, time periods, vehicle type, speed bin)
Module 6a: Benefits in Cal-B/C Corridor

Calculations

Intermediate calculations for several benefit categories based on the data in 2) Model Inputs:

- Speed = Vehicle-Miles Traveled (VMT) / Vehicle-Hours Traveled (VHT)
- VMT, VHT, and Person- or Vehicle-Trips are provided as model input

Calculated for Base and Forecast years, in No Build and Build scenarios
Project Benefits in Cal-B/C Corridor

Travel Time (TT) Savings

- Function (VHT, trips, value of time) by mode
  - Annual Vehicle-Hours Traveled (VHT) = Daily VHT x Ann. Factor
  - Avg. Travel Time (TT) (highway) = Ann. VHT x AVO / Person Trips
  - Avg. Travel Time (transit) = Ann. PHT / Person Trips
  - Adj. Person Trips in Build = Total Person Trips – Induced Demand
  - Ann. TT = Person Trips x Avg. TT (by mode and scenario)
  - TT Reduction = No Build Travel Time – Build Travel Time
  - TT Savings = TT Reduction x Avg. Value of Time (by mode)
Module 6a: Benefits in Cal-B/C Corridor

Project Benefits in Cal-B/C Corridor

Consumer Surplus (CS) Travel Time Savings for Induced and Diverted Trips

- Function (VHT, trips, value of time) by mode
  - Annual Vehicle-Hours Traveled (VHT) = Daily VHT x Ann. Factor
  - Avg. Travel Time (highway) = Ann. VHT x AVO / Person Trips
  - Avg. Travel Time (transit) = Ann. PHT / Person Trips

- Adj. Person Trips in Build = Total Person Trips – Induced Demand
- CS Travel Time Savings = Change in Travel Time (No Build to Build) x Value of Time x New Person Trips x 0.5 (by mode)

Total Travel Time Savings (for existing and new users) by year are linked to the Final Calculations worksheet
Project Benefits in Cal-B/C Corridor

Vehicle Operating Cost Savings

- Function (VMT, speed, trips, fuel consumption, wear factors)
  - Fuel Cost = VMT x Fuel Consumption (by speed) x Fuel Price
  - Non-Fuel Cost = VMT x Cost Per Mile
  - Out-of-Pocket Cost = Trips x Cost Per Trip (for existing trips)
  - VOC Savings = No Build Cost – Build Cost, for Fuel, Non-Fuel, and Out-of-Pocket costs

Vehicle Operating Cost Savings by year are linked to the Final Calculations worksheet
Project Benefits in Cal-B/C Corridor

**Accident Cost Savings**

- Function (VMT, accident rate, events per accident, cost per event)
  - Events = VMT x Accident Rate x Events per Accident
  - Events Avoided = No Build Events – Build Events (by event)
  - Accident Cost Savings = Events Avoided * Cost/Event (by event)
  - Total Accident Cost Savings = Fatal + Injury + PDO Cost Savings

Accident Cost Savings by year are linked to the Final Calculations worksheet.
Project Benefits in Cal-B/C Corridor

Emission Cost Savings

- Function (VMT, speed, emission rate, em. cost) by em. type
  - Hwy Emissions Cost = (VMT x Em. Rate x Cost/Ton) by type
  - Transit Emissions Cost = (VMT x Em. Rate x Cost/Ton) by type
  - Emissions Cost Savings = No Build Cost - Build Cost

Emissions Cost Savings by year are linked to the Final Calculations worksheet
Benefits in Cal-B/C Park & Ride
Benefit Calculations in Cal-B/C PnR

- In Cal-B/C PnR estimation worksheets, calculations are provided by:
  - Year
  - User Group (new and existing transit riders, new and existing carpoolers)
  - Destination

![Travel Time Savings](image1)

![Vehicle Operating Cost Savings](image2)

![Accident Cost Savings](image3)

![Emission Cost Savings](image4)
Module 6a: Benefits in Cal-B/C PnR

Calculations

Intermediate calculations for several benefit categories based on the data in

1) Project Information:

- **Users Benefited** = New Lot Users – Existing Lot Users

- **Vehicle-Miles Traveled (VMT)** = Distance x Users / Avg. Veh. Occupancy

Calculated for Base and Forecast years, in No Build and Build scenarios
Project Benefits in Cal-B/C Park & Ride

**Travel Time Savings**

- Function (users, travel time, wait time, value of time) by user group
  - Users Benefited = New Lot Users – Existing Lot Users
  - Travel Time is user provided
  - Wait Time = Transit Headway x 0.5 or Carpool Wait Time
  - Travel Time Savings = Travel Time Reduction x Avg. Value of Time

- Travel Time Savings by year are linked to the Final Calculations worksheet
Project Benefits in Cal-B/C Park & Ride

Vehicle Operating Cost Savings

- Function (users, distance, travel time, fuel consumption, wear factors)
  - Vehicle-Miles Traveled = Distance x Users / Avg Veh Occupancy
  - Fuel Cost = VMT x Fuel Consumption x Fuel Price
  - Non-Fuel Cost = VMT x Cost Per Mile
  - Out-Of-Pocket Costs = Parking Costs or Transit Fares
  - VOC Savings = No Build Cost – Build Cost

- Vehicle Operating Cost Savings by year are linked to the Final Calculations worksheet
Module 6a: Benefits in Cal-B/C PnR

Project Benefits in Cal-B/C Park & Ride

Accident Cost Savings

- Function (volume, distance, accident rate, cost per accident)
  - Users Benefited = New Lost Users - Existing Lot Users
  - Change in Vehicle-Miles Traveled (VMT) = Distance x Users Benefited / Avg Veh Occupancy
  - Accident Cost Savings = (Change in VMT x Accident Rate x Cost/Mile) by Accident Type

- Accident Cost Savings by year are linked to the Final Calculations worksheet
Module 6a: Benefits in Cal-B/C PnR

Project Benefits in Cal-B/C Park & Ride

Emission Cost Savings

- Function (volume, speed, emission rate)
  - Users Benefited = New Lost Users – Existing Lot Users
  - Change in Vehicle-Miles Traveled (VMT) = Distance x Users Benefited / Avg Veh Occupancy
  - Hwy Emissions Cost = (Change in VMT x Rate x Cost/Mile) by Emissions Type
  - Transit Emissions Cost = (Change in VMT x Rate x Cost/Mile) by Emissions Type
  - Emissions Cost Savings = No Build Cost – Build Cost

- Emissions Cost Savings by year are linked to the Final Calculations worksheet
Project Costs in All Cal-B/C tools
Project Cost Inputs

- All project costs are entered in Section 1E in the Project Information worksheet, in seven cost columns.
- Project costs should be entered as incremental costs.
  - Incremental costs are difference between No Build and Build scenarios.
- Project costs must be entered in constant dollars, in the same year as economic parameters used for benefit calculations (current year in Cal-B/C is 2016).
- Project costs must be entered in thousands of dollars ($1,000).
Project Cost Inputs

- Year 1 (current year) is represented by the “1” under the “Construction Period” header.
- Cal-B/C allows up to eight (8) years of initial project costs.
- Costs must be entered for each year to be consistent with “Length of Construction Period.”
  - Example: If the Length of Construction Period (entered in Project Information, Section 1A) is 5 years, then years 1 through 5 in Section 1E must have a direct project cost entered.
- Following construction, project opens and O&M & rehabilitation costs may be input for the duration of the project operating period.
- Year 1 (Base Year) is represented by the “1” under the “Project Open” header.
Project Costs – Direct Project Costs

Initial Costs

- Project support (e.g., preliminary engineering, design, management costs)
- Right-of-way acquisition costs
- Construction costs

No initial project costs should be incurred after the project opens

Cal-B/C assumes all construction funding is expended by opening day
Project Costs – Direct Project Costs

Subsequent Costs

- Maintenance and operating costs
- Rehabilitation costs (e.g., pavement overlay, vehicle, track, or station refurbishment)

These costs are incurred after the project is constructed and open for service
Module 6a: Project Costs in all Cal-B/C Tools

1E) Project Costs – Mitigation, Transit Agency, and Total Costs

Mitigation

- Costs to protect communities and the environment from negative impacts
- May include wetland and community preservation, sound walls to reduced highway or rail transit noise

Transit Agency Cost Savings

- In Cal-B/C Sketch, calculated automatically for TMS projects based on user data input (blue cells)
  - Represents savings to transit agency due to efficiency improvements
  - For example, signal prioritization projects speed up buses, which may reduce operating hours, resulting in lower labor and other costs
- Not included in Cal-B/C AT
- Blank for user data entry in all other Cal-B/C tools
Module 6a: Project Costs in all Cal-B/C Tools

1E) Project Costs – Mitigation, Transit Agency, and Total Costs

**Total Costs**

- Calculated automatically based on entry in previous seven columns of cost data
- Values are in total dollars (not in thousands of dollars)
1E) Project Costs – Mitigation, Transit Agency, and Total Costs

Total Costs

- Calculated automatically based on entry in previous seven columns of cost data
- Values are in total dollars (not in thousands)
- Project costs (in constant dollars and present value) for each year are linked to the Final Calculations worksheet
Project Costs in Final Calculations

- Project Costs are combined with Project Benefits estimates (in constant dollars and present value) in the Final Calculations worksheet to calculate all BCA metrics
- BCA metrics are linked to the Results page
Conclusion
In this module, you learned…

- What project costs are included in Cal-B/C tools
- What benefit categories are automatically estimated in the Cal-B/C Sketch, Corridor, and Park & Ride tools
- How each benefit category is estimated in these tools based on the data input
- How benefit estimates connect from the analysis sheets, through the Final Calculation sheet, to the Results sheet
What’s Next?

- Start an analysis!
  - Module 7: How to Start a Cal-B/C Analysis
- There are other versions of this module for the other Cal-B/C tools:
  - Module 6b: Understanding Project Benefits and Costs in Cal-B/C Active Transportation
  - Module 6c: Understanding Project Benefits and Costs in Cal-B/C Intermodal Freight