U.S. Department of Transportation
Office of the Under Secretary

RAISE Grants

Rebuilding American Infrastructure with Sustainability and Equity

U.S. Department of Transportation
Office of the Under Secretary

Preparing a Benefit-Cost Analysis for RAISE Grants

Office of the Assistant Secretary for Transportation Policy

Office of the Chief Economist

What is BCA?

Benefit-cost analysis (BCA) is a systematic process for *identifying*, *quantifying*, and *comparing* expected economic benefits and costs of a proposed infrastructure project.

Why do we do BCA?

- Provides a useful benchmark from which to evaluate and compare potential transportation investments
- Adds a degree of rigor to the project evaluation process

BCA and RAISE

- All project sponsors should submit a benefit-cost analysis (BCA) as part of their RAISE grant application
- Use of the BCA in RAISE
  - Evaluation of project costs and benefits
  - Advancement of projects for consideration for selection by the Secretary

USDOT BCA Review

- USDOT economists will review the applicant's BCA
  - Examine key assumptions
  - Correct for any technical errors
  - Perform sensitivity analysis on key inputs
  - Consider any unquantified benefits

Project Benefits and Costs

- USDOT considers the relative magnitude of estimated project benefits and costs
- Assign projects to one of four benefit-cost ratio ranges
  - BCR > 3.0
  - BCR 1.5 - 3.0
  - BCR 1.0 - 1.5
  - BCR < 1.0
- Also assign a confidence rating to the assessment (high, medium, low)

Use of BCA in RAISE

- Projects with a BCR<1 will not advance to the Secretary as Highly Rated and will not be selected for an award, unless the project demonstrates clear, unquantified outcomes, as identified by the Senior Review Team, consistent with the environmental sustainability and quality of life criteria

USDOT BCA Guidance

- Covers all USDOT discretionary grant programs
- Updated February 2021
- Available at https://www.transportation.gov/office-policy/transportation-policy/benefit-cost-analysis-guidance

What's New?

- Updated monetization values
- Additional guidance on valuing reductions in emissions (including CO_2)
- Additional guidance on benefits from agglomeration economies and state of good repair projects

Transparent & Reproducible Analysis

- BCAs should provide enough information for a reviewer to follow the logic and reproduce the results
  - Spreadsheet or database files showing the calculations
  - Technical memos describing the analysis and documenting sources of information used (assumptions and inputs)
  - Present annual benefit & cost streams by type (not just summary output)

Baselines

- Should measure costs and benefits of a proposed project against a baseline alternative (“base” or “no build”)
- “Do’s”
  - Factor in any projected changes (e.g., increased traffic volumes) that would occur even in the absence of the requested project
  - Factor in ongoing routine maintenance
  - Consider full long-term impacts of no build (e.g. bridge closure/posting)
  - Explain and provide support for the chosen baseline
- “Don’t’s”
  - Assume that the same (or similar) improvement will be implemented later
  - Use unrealistic assumptions about alternative traffic flows

Demand Forecasts

- Most benefit estimates depend on ridership or usage estimates
- Provide supporting info on forecasts
  - Geographic scope, assumptions, data sources, methodology
- Provide forecasts for intermediate years
  - Or at least interpolate—don't apply forecast year impacts to interim years
- Exercise caution about long-term growth assumptions
  - Consider underlying capacity limits of the facility

Analysis Period

- Should cover both initial development and construction and a subsequent operational period
- Generally tied to the expected service life of the improvement or asset
  - I.e., the number of years until you would anticipate having to take the same action again
  - Lesser improvements should have shorter service lives
- Avoid excessively long analysis periods (over 30 years of operations)
  - Use residual value to cover out-years of remaining service life for long-lived assets
  - Recommend 20 years maximum for capacity expansion

Inflation and Discounting

- Inflation Adjustments
  - Recommend using a 2019 base year for all cost and benefit data
  - Index values for the GDP Deflator included in the BCA guidance
- Discounting
  - Use a 7% discount rate for all benefits and costs (except CO_2)

Scope of the Analysis

- Project scope included in estimated costs and benefits must match
  - Don’t claim benefits from an entire project, but only count costs from the grant-funded portion
- Scope should cover a project that has independent utility
  - May need to incorporate costs for related investments necessary to achieve the projected benefits
- Project elements with independent utility should be individually evaluated in the BCA
  - BCA evaluation will cover both independent elements and the submitted project as a whole

Benefits

- Should be presented on an annual basis
  - Don’t assume constant annual benefits without a good reason to do so
- Negative outcomes should be counted as “disbenefits”
  - E.g., work zone impacts
- Avoid double-counting benefits

Travel Time Savings

- Recommended values found in BCA Guidance
  - See footnotes for discussion of non-vehicle time, long-distance travel, business travel
- Consider vehicle occupancy where appropriate
  - Local/facility-specific values preferred
  - National-level values provided in BCA Guidance
- If valuing travel time reliability:
  - Carefully document methodology and tools used
  - Show how valuation parameters are distinct from general travel time savings

Operating Cost Savings

- Avoid double counting operating savings and other impacts
  - E.g., truck travel time savings, fuel consumption reductions
- Localized, specific data preferred
  - Standard per-mile values for light duty vehicles and commercial trucks provided in DOT BCA Guidance

Safety Benefits

- Typically associated with reducing fatalities, injuries, and property damage
- Projected improvements in safety outcomes should be explained and documented
  - Justify assumptions about expected reductions in crashes, injuries, and/or fatalities (and document any CMF used)
  - Show clear linkage between project and improved outcomes
  - Use facility-specific data history for baseline where possible
- Crash-related injury and fatality data may be available in different forms
  - MAIS/KABCO injury scales
  - Fatal/Injury crashes vs. fatalities/injuries
  - BCA Guidance provides values covering all of these

Emissions Reduction Benefits

- For infrastructure improvements, emissions reductions will typically be a function of reduced fuel consumption
- Recommended year by year unit values for CO_2, SO_2, NO_x, and $PM_{2.5}$ found in BCA guidance
  - Be careful about the measurement units being applied
- Reductions in CO_2 emissions should be discounted at **3 percent**, while all others should be discounted at **7 percent**

Benefits to Existing and Additional Users

- Primary benefits typically experienced directly by users of the improved facility
- Includes both "existing" users (under baseline) and "additional" users attracted to the facility as a result of the improvement
  - Standard practice in BCA would value benefits to additional users less than those for existing users (see BCA guidance)

Modal Diversion

- Projected magnitude
  - Should be based on careful analysis of the market and potential for diversion from other modes that might be attributable to the project
- Benefits estimates should not be based on comparing user costs of “old” and “new” mode
  - Would be reflected in benefits to additional users
- Reductions in external costs would be relevant
  - E.g., emissions costs, pavement damage
- If using 1997 HCAS values…
  - Don’t apply urban values to rural truck travel
  - Should net out highway user fees paid by trucks from marginal pavement damage costs

Other Benefits

- Agglomeration Economies
- State of Good Repair
- Resilience
  - Consider expected frequency of events and their consequences
- Noise Reduction
- Emergency Response
  - FEMA methodology for fire and ambulance services
- Quality of Life
- Property Value Increases
  - Is a measure rather than a benefit—avoid double-counting

Unquantified Benefits

- Should quantify magnitudes/timing of the impacts wherever possible

- Should clearly link specific project outcomes to any claimed unquantified benefits

Capital Costs

- Include all costs of implementing the project
  - E.g., design, ROW acquisition, construction
  - Regardless of funding source
  - Include previously incurred costs
- Three forms of capital costs
  - Nominal dollars (project budget)
  - Real dollars (base year)
  - Discounted Real dollars (use in BCA)

Maintenance Costs

- Net maintenance costs may be positive or negative
  - New facilities would incur ongoing maintenance costs over the life of the project
  - Rehabilitated/reconstructed facilities may result in net savings in maintenance costs between the build/no-build

Residual Value

- For assets with remaining service life at the end of the analysis period, may calculate a "residual value" for the project
  - Recall that service life does not necessarily match the physical life of the asset
- Simple approach: assume linear depreciation
- Be sure to properly apply discounting

Comparing Benefits to Costs

- **Net Present Value (Benefits – Costs)**

- **Benefit-Cost Ratio (Benefits / Costs)**
  - **Denominator should only include capital costs (i.e., net maintenance costs and residual value should be in the numerator)**

Other Types of Economic Analysis

- Examples
  - Economic Impact Analysis
  - Financial Impacts
  - Distributional Effects
- Issues
  - Use different approaches and answer different questions than does BCA
  - Do not represent additional benefits to include in BCA

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- For additional RAISE information and how to apply: https://www.transportation.gov/RAISEgrants

- For technical questions, please email: RAISEgrants@dot.gov.

Questions?

Hypothetical BCA Example

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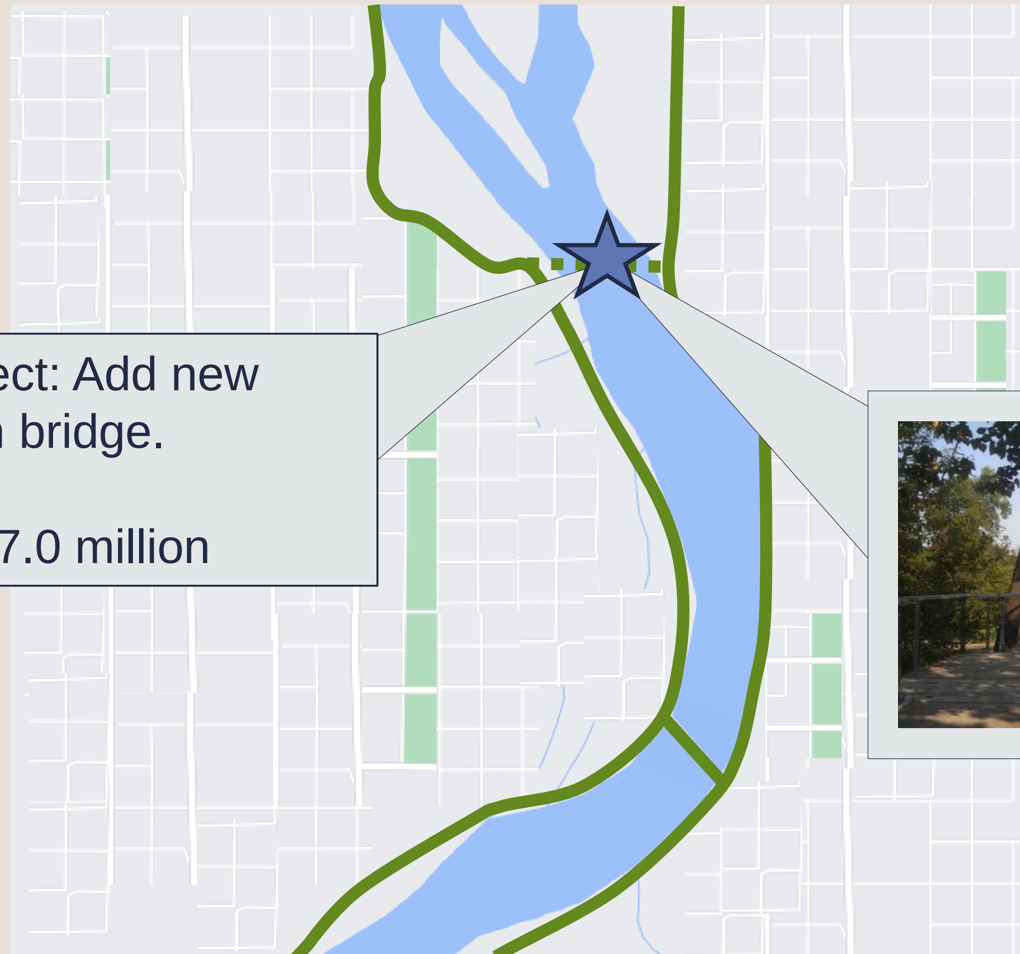
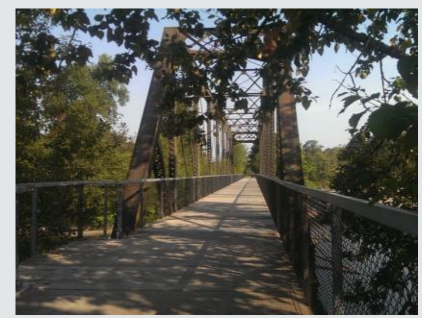
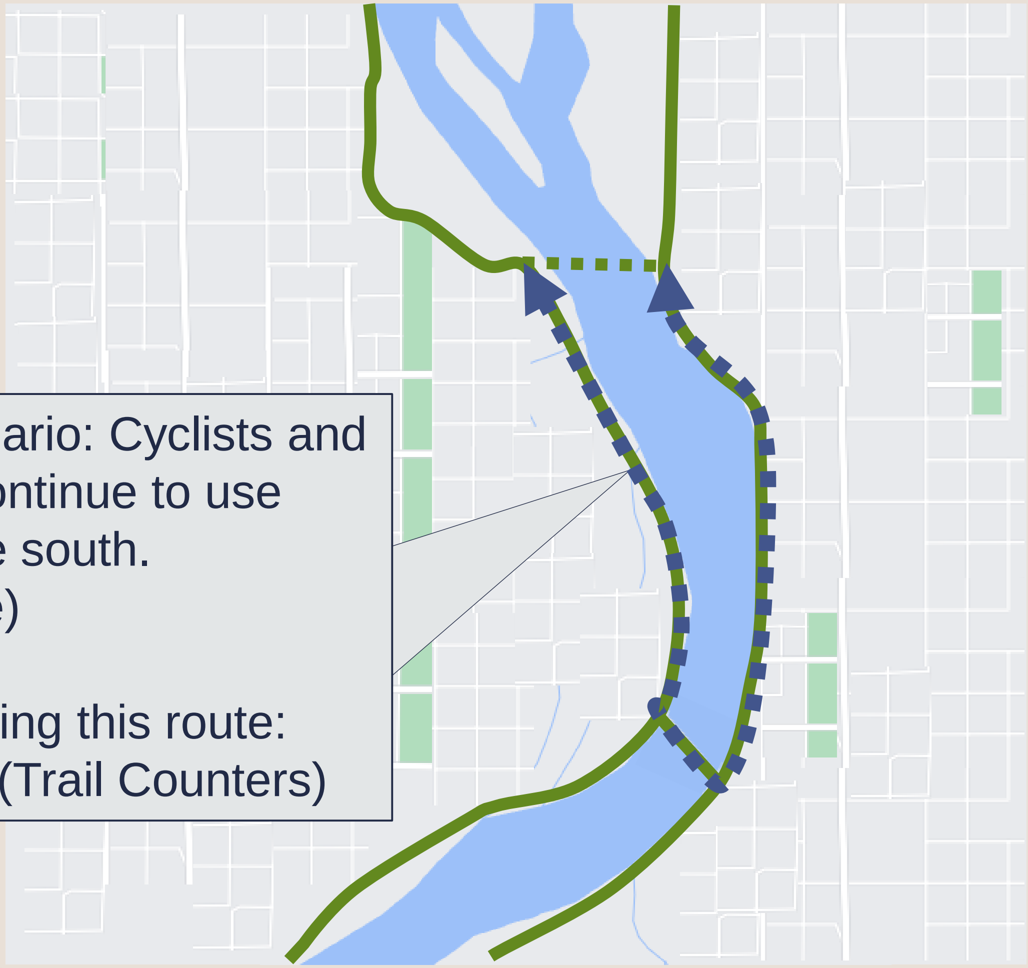


Proposed Project: Add new bike/pedestrian bridge.

Project Cost: $7.0 million



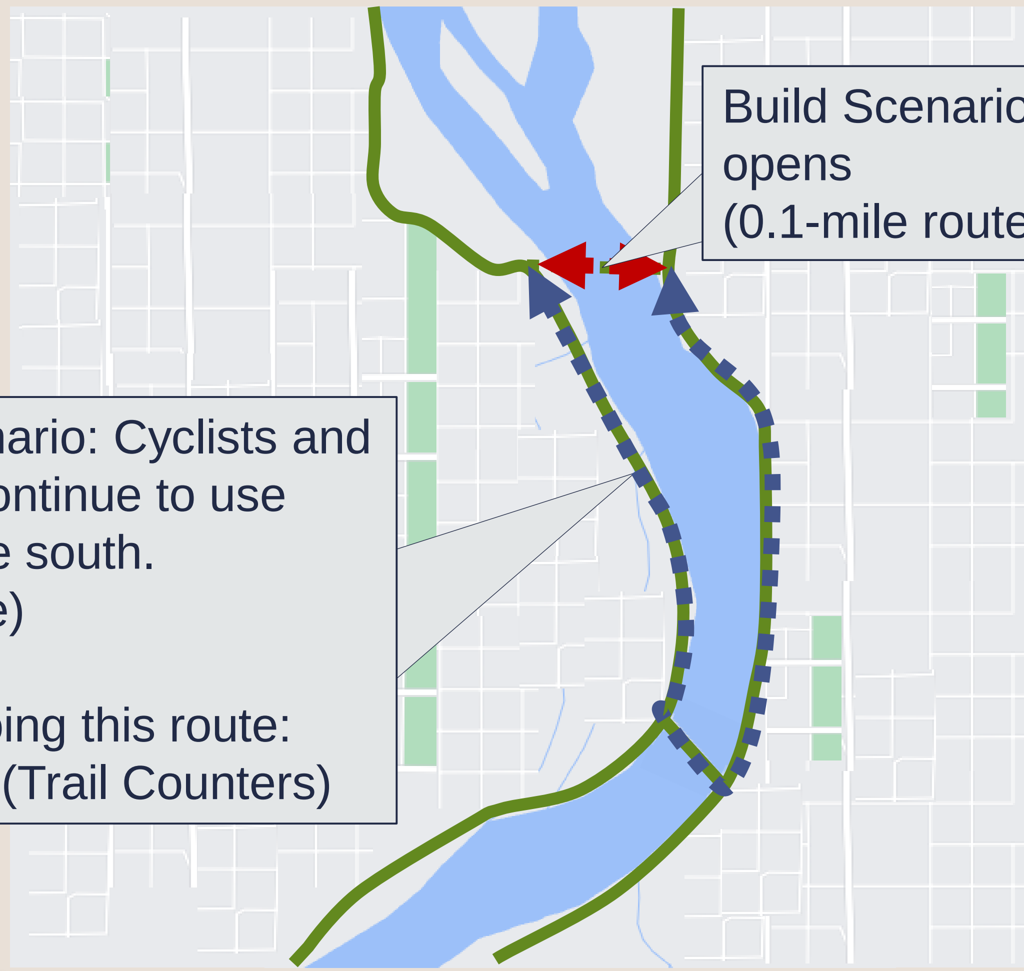
Hypothetical BCA Example



No-Build Scenario: Cyclists and pedestrians continue to use crossing to the south.
(2.6-mile route)

Daily users doing this route:
1,000 cyclists (Trail Counters)

Hypothetical BCA Example

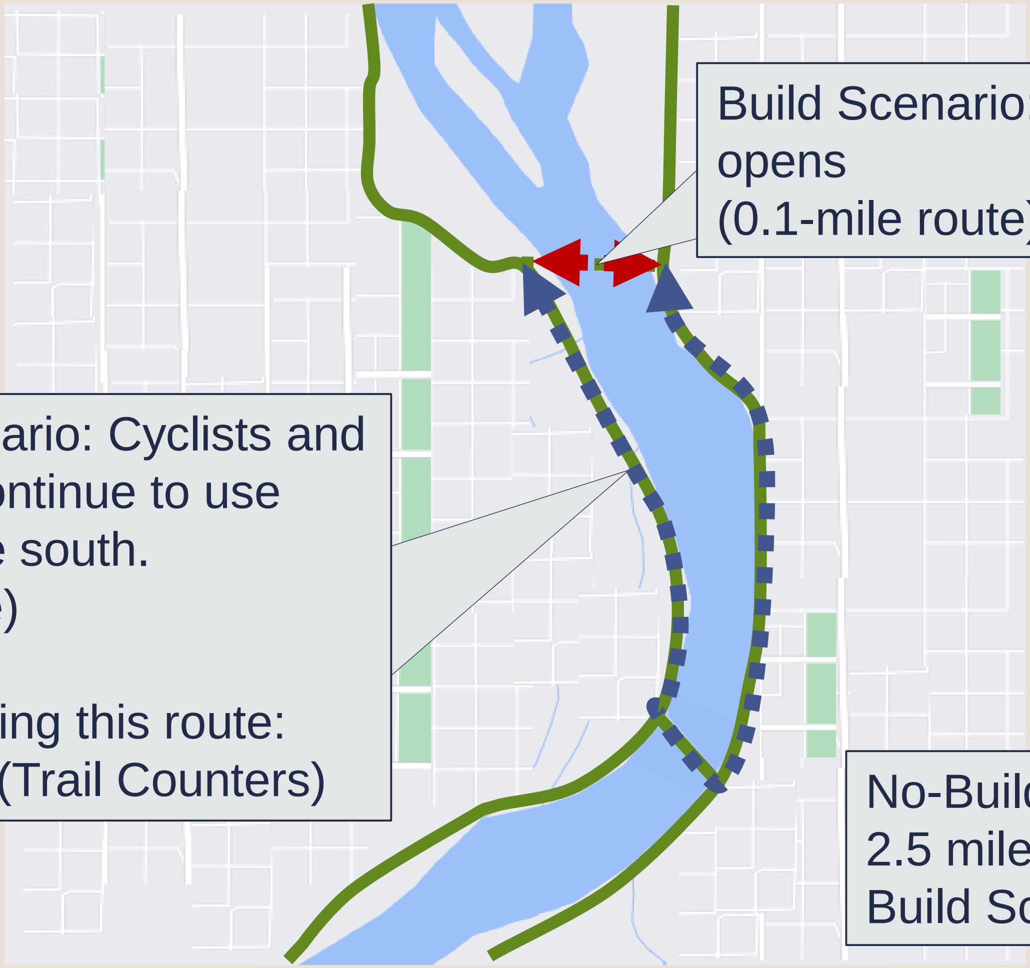


Build Scenario: Bridge opens
(0.1-mile route)

No-Build Scenario: Cyclists and pedestrians continue to use crossing to the south.
(2.6-mile route)

Daily users doing this route:
1,000 cyclists (Trail Counters)

Hypothetical BCA Example



Build Scenario: Bridge opens
(0.1-mile route)

No-Build Scenario: Cyclists and pedestrians continue to use crossing to the south.
(2.6-mile route)

Daily users doing this route:
1,000 cyclists (Trail Counters)

No-Build Scenario route is 2.5 miles longer than Build Scenario route.

Approach

- We want to compare the state of the world with and without the proposed project improvement.
  - No-Build Scenario: Cyclists use 2.6-mile route.
  - Build Scenario: Bridge opens, new route is 0.1 miles.
- The expected major benefit category in this case would be the travel time savings for mitigating 2.5-miles of additional travel, starting when the project opens.

Travel Time Savings

- **For simplicity, let's assume no pedestrians, an average cycling speed of 11.8 mph, and no cycling growth over time.**

Annual Travel Time Savings*	=	Marginal Detour Time	x	Daily Users	x	Hourly Value of Time	x	Annualization Factor

*Undiscounted.

Travel Time Savings

- **For simplicity, let's assume no pedestrians, an average cycling speed of 11.8 mph, and no cycling growth over time.**

Annual Travel Time Savings* = Marginal Detour Time x Daily Users x Hourly Value of Time x Annualization Factor

Annual Travel Time Savings* = $\frac{\text{2.5 Miles}}{\text{11.8 mph}}$

No-Build Scenario route: 2.6 miles
Build Scenario route: 0.1 miles

Speed: Observed average speed on both routes

*Undiscounted.

Travel Time Savings

- **For simplicity, let's assume no pedestrians, an average cycling speed of 11.8 mph, and no cycling growth over time.**

$$\text{Annual Travel Time Savings*} = \text{Marginal Detour Time} \times \text{Daily Users} \times \text{Hourly Value of Time} \times \text{Annualization Factor}$$

$$\text{Annual Travel Time Savings*} = \frac{2.5 \text{ Miles}}{11.8 \text{ mph}} \times 1{,}000 \times$$

Recent trail count

*Undiscounted.

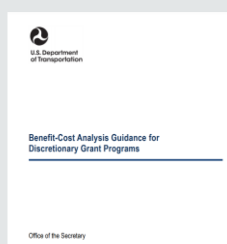
Travel Time Savings

- For simplicity, let's assume no pedestrians, an average cycling speed of 11.8 mph, and no cycling growth over time.

Annual Travel Time Savings* = Marginal Detour Time x Daily Users x Hourly Value of Time x Annualization Factor

$$\text{Annual Travel Time Savings*} = \frac{2.5 \text{ Miles}}{11.8 \text{ mph}} \times 1{,}000 \times \$33.00$$

USDOT BCA Guidance


U.S. Department of Transportation

Benefit-Cost Analysis Guidance for Discretionary Grant Programs

Office of the Secretary

U.S. Department of Transportation

(Appendix A)

*Undiscounted.

Travel Time Savings

- For simplicity, let’s assume no pedestrians, an average cycling speed of 11.8 mph, and no cycling growth over time.

$$\text{Annual Travel Time Savings*} = \text{Marginal Detour Time} \times \text{Daily Users} \times \text{Hourly Value of Time} \times \text{Annualization Factor}$$

$$\text{Annual Travel Time Savings*} = \frac{\text{2.5 Miles}}{\text{11.8 mph}} \times 1{,}000 \times \$33.00 \times 365$$

We expect this project to have an impact each day (not just weekdays, for example).

*Undiscounted.

Travel Time Savings

- **For simplicity, let's assume no pedestrians, an average cycling speed of 11.8 mph, and no cycling growth over time.**

$$\text{Annual Travel Time Savings*} = \text{Marginal Detour Time} \times \text{Daily Users} \times \text{Hourly Value of Time} \times \text{Annualization Factor}$$

$$\text{Annual Travel Time Savings*} = \frac{\text{2.5 Miles}}{\text{11.8 mph}} \times 1{,}000 \times \$33.00 \times 365$$

$$= \$2{,}551{,}907 \text{ Per Year}$$

*Undiscounted.

Hypothetical BCA Example

- **Assume construction in 2022, ten years of project operations, and $10,000 in maintenance costs between the scenarios.**

Year	Capital Cost		Travel Time Savings	O&M Costs	
2022	$7,000,000		$0	$0	
2023	$0		$2,551,907	$10,000	
2024	$0		$2,551,907	$10,000	
2025	$0		$2,551,907	$10,000	
2026	$0		$2,551,907	$10,000	
2027	$0		$2,551,907	$10,000	
2028	$0		$2,551,907	$10,000	
2029	$0		$2,551,907	$10,000	
2030	$0		$2,551,907	$10,000	
2031	$0		$2,551,907	$10,000	
2032	$0		$2,551,907	$10,000	

Hypothetical BCA Example

- **Next we discount costs and benefits using a 7% discount rate.**

Discounted Value = Future Year Value / (1+Discount Rate)^(Future Year - Base Discounting Year)

Year	Capital Cost	Discounted Costs	Travel Time Savings	O&M Costs	Discounted Benefits
2022	$7,000,000	$6,542,056	[illegible]	[illegible]	[illegible]
202[illegible]	[illegible]	$0	[illegible]	[illegible]	[illegible]
202[illegible]	[illegible]	$0	$2,551,907	$10,000	$2,074,9[illegible]3
2025	$0	$0	$2,551,907	$10,000	$1,939,209
2026	$0	$0	$2,551,907	$10,000	$1,812,344
2027	$0	$0	$2,551,907	$10,000	$1,693,780
2028	$0	$0	$2,551,907	$10,000	$1,582,972
2029	$0	$0	$2,551,907	$10,000	$1,479,413
2030	$0	$0	$2,551,907	$10,000	$1,382,629
2031	$0	$0	$2,551,907	$10,000	$1,292,177
2032	$0	$0	$2,551,907	$10,000	$1,207,642

$7,000,000 / (1+0.07)^(2022-2021)

(2,551,907-10,000) / (1+0.07)^(2025-2021)

(2,551,907-10,000) / (1+0.07)^(2032-2021)

Hypothetical BCA Example

- Next we sum the discounted benefits and costs to get total discounted benefits and total discounted costs.

Year	Capital Cost	Discounted Costs	Travel Time Savings	O&M Costs	Discounted Benefits
2022	$7,000,000	$6,542,056	$0	$0	$0
2023	$0	$0	$2,551,907	$10,000	$2,220,200
2024	$0	$0	$2,551,907	$10,000	$2,074,953
2025	$0	$0	$2,551,907	$10,000	$1,939,209
2026	$0	$0	$2,551,907	$10,000	$1,812,344
2027	$0	$0	$2,551,907	$10,000	$1,693,780
2028	$0	$0	$2,551,907	$10,000	$1,582,972
2029	$0	$0	$2,551,907	$10,000	$1,479,413
2030	$0	$0	$2,551,907	$10,000	$1,382,629
2031	$0	$0	$2,551,907	$10,000	$1,292,177
2032	$0	$0	$2,551,907	$10,000	$1,207,642
TOTAL		**$6,542,056**			**$16,685,317**

Results – The NPV and BCR

- **Lastly, we calculate the project's net present value (NPV) and benefit-cost ratio (BCR).**

Net Present Value (NPV) = Total Discounted Benefits - Total Discounted Costs

= $16,685,317 - $6,542,056

= **$10,143,261**

Benefit-Cost Ratio (BCR) = $\frac{\text{Total Discounted Benefits}}{\text{Total Discounted Costs}}$

= $\frac{\$16,685,317}{\$6,542,056}$

= **2.6**

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Questions?