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 FY 2022 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 sponsors of capital projects should submit a benefit-cost analysis (BCA) as part of their RAISE grant application
- Use of the BCA in RAISE
  - Consider the extent to which the project is cost effective

Economic Analysis of Project Costs and Benefits

- USDOT will consider the relative magnitude of estimated project benefits and costs
- Assign projects one of two ratings
  - Positive: Benefits Exceed Costs
  - Negative: Costs Exceed Benefits
- Projects with a negative BCA rating will not be selected for an award, unless the project demonstrates clear outcomes for overburdened, underserved, or historically disadvantaged communities

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

USDOT BCA Guidance

- Covers all USDOT discretionary grant programs
- Updated March 2022
- Available at https://www.transportation.gov/office-policy/transportation-policy/benefit-cost-analysis-guidance-discretionary-grant-programs-0

What's New?

- New and updated monetization values
- Additional guidance and new examples on:
  - Valuing pedestrian, cycling, and transit infrastructure improvements
  - Valuing the benefits of improved health from active transportation and reduced crowding on transit
- Additional guidance on benefits from reduction in stormwater runoff and wildlife impacts

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)

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
  - Recommend 20 years maximum for capacity expansion or other operational improvements
- Avoid excessively long analysis periods (over 30 years of operations)
  - Use residual value to cover out-years of remaining service life for long-lived improvements

Inflation and Discounting

- Inflation Adjustments
  - Recommend using a 2020 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)
  - Recommend using a 2020 base year for discounting

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

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
  - KABCO injury scales
  - Fatal/Injury crashes vs. fatalities/injuries
  - BCA Guidance provides values covering all of these

Travel Time Savings

- Recommended values found in BCA Guidance
  - See footnotes for discussion of long-distance travel and 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

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**

Amenity Benefits

- Pedestrian, cycling, and transit facility/vehicle improvements can improve the quality or comfort of journeys
- Recommended values for different types of improvements found in BCA Guidance
  - Pay attention to whether value is on a “per-trip” or “per-person-mile” basis
- Carefully document baseline amenities, as well as specifically how the proposed project will add any amenity benefit category being claimed

Health Benefits

- Trips diverted to active transportation (walking and cycling) from other modes may yield health benefits to users
- Recommended monetization values, on a per trip basis, are found in BCA Guidance
- Absent local data on existing mode share and estimates age profiles of users, applicants may apply national averages included in the BCA Guidance.

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
  - Values for noise and congestion costs included in Guidance

Other Benefits and Issues

- Agglomeration Economies
- Noise, Stormwater Runoff, and Wildlife Impact Reduction
- Emergency Response
- State of Good Repair
- Resilience
  - Consider expected frequency of events and their consequences
- 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
  - Rehabilitation/reconstruction of a facility may result in net savings in maintenance costs between the build and no-build cases

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

RAISE Grants

Rebuilding American Infrastructure with Sustainability and Equity

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

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

RAISE Grants

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Questions?

Hypothetical BCA Example

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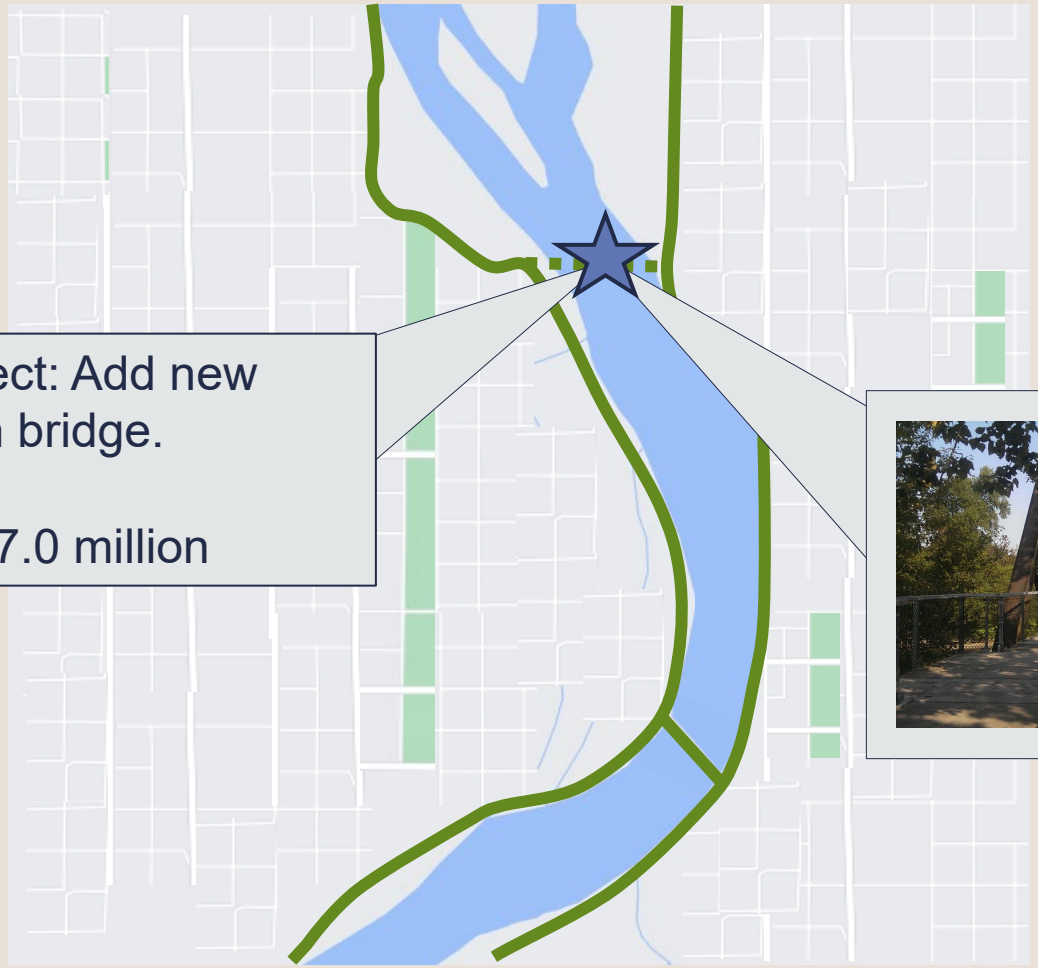
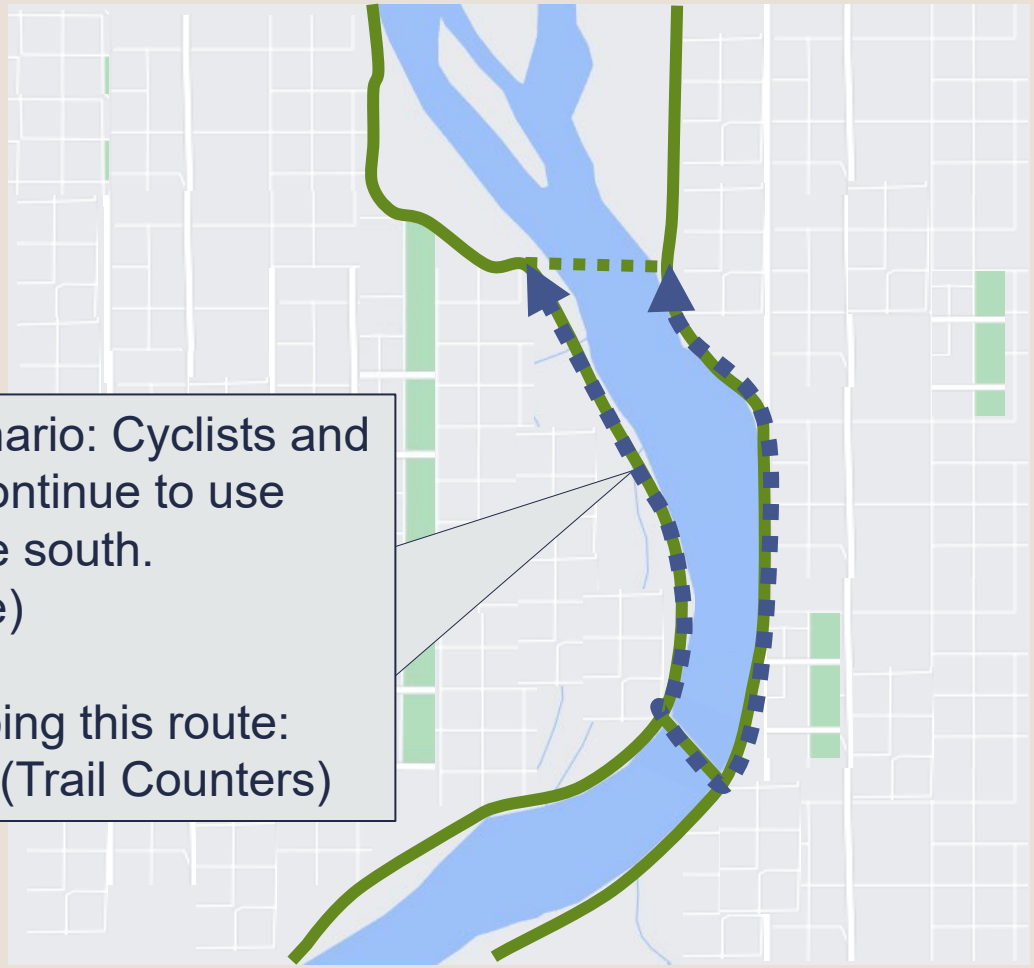


Proposed Project: Add new bike/pedestrian bridge.

Project Cost: $7.0 million

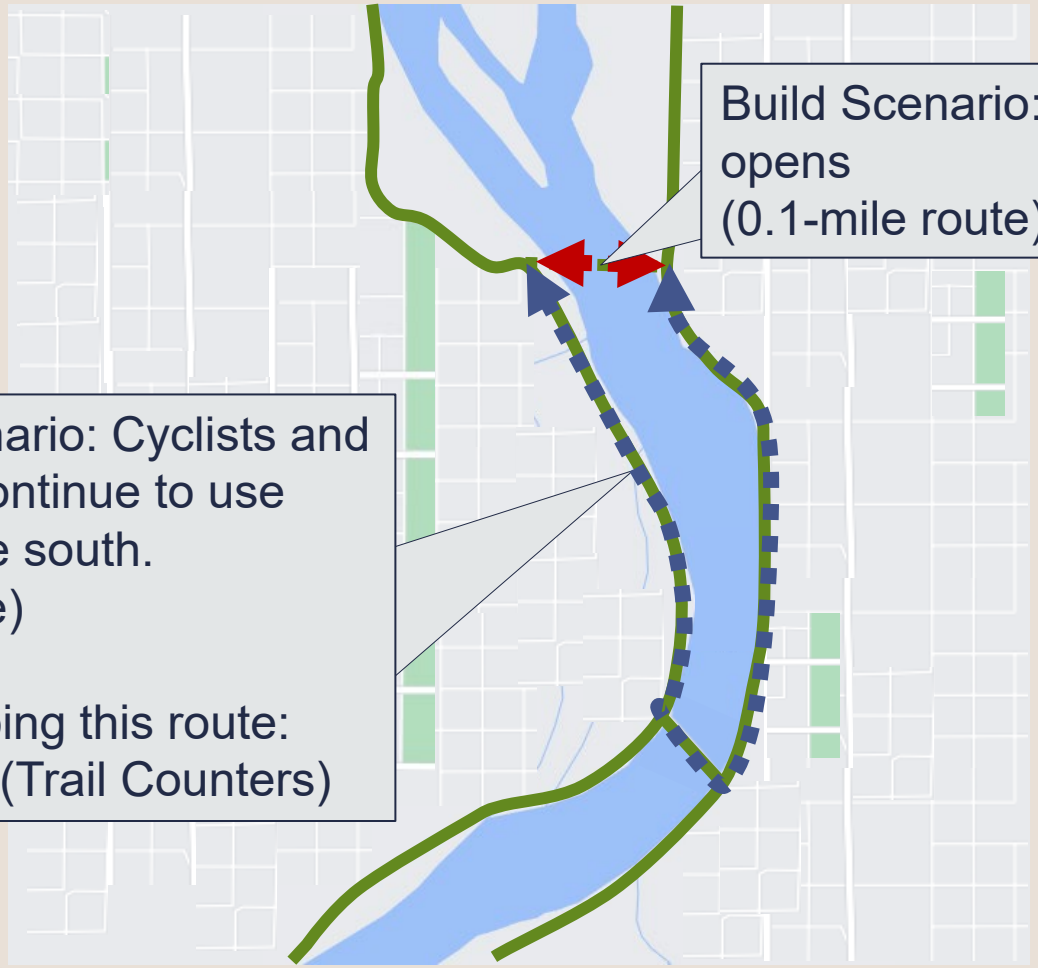
Hypothetical BCA Example



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

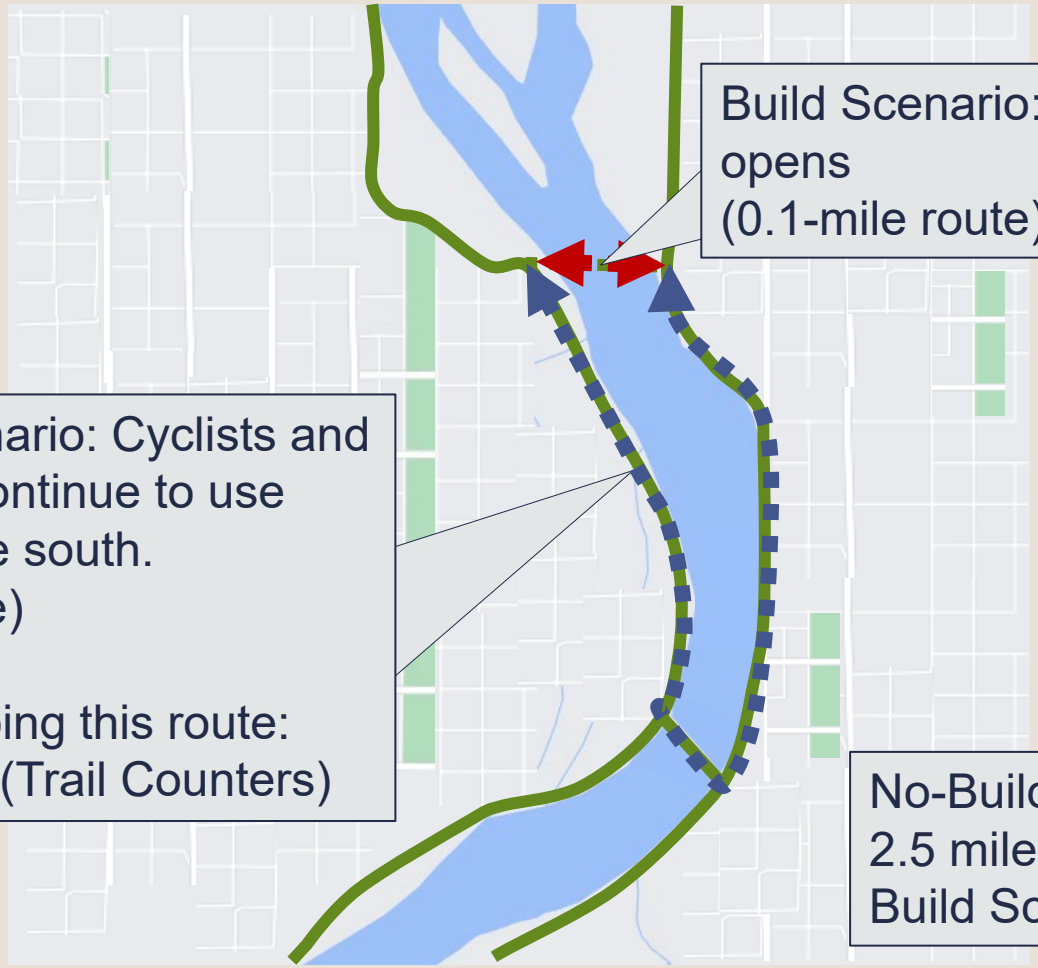


Build Scenario: Bridge opens
(0.1-mile route)

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 9.8 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 9.8 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* = $\frac{\text{2.5 Miles}}{\text{9.8 mph}}$

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 9.8 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* = $\frac{\text{2.5 Miles}}{\text{9.8 mph}}$ x 1,000 x

Recent trail count

*Undiscounted.

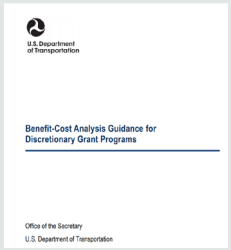
Travel Time Savings

- **For simplicity, let's assume no pedestrians, an average cycling speed of 9.8 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* = $\frac{\text{2.5 Miles}}{\text{9.8 mph}}$ x 1,000 x $32.40

USDOT BCA Guidance



(Appendix A)

*Undiscounted.

Travel Time Savings

- **For simplicity, let's assume no pedestrians, an average cycling speed of 9.8 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* = $\frac{\text{2.5 Miles}}{\text{9.8 mph}}$ x 1,000 x $32.40 x 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 9.8 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* = $\frac{\text{2.5 Miles}}{\text{9.8 mph}}$ x 1,000 x $32.40 x 365

= $3,016,837 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		$3,016,837	$10,000	
2024	$0		$3,016,837	$10,000	
2025	$0		$3,016,837	$10,000	
2026	$0		$3,016,837	$10,000	
2027	$0		$3,016,837	$10,000	
2028	$0		$3,016,837	$10,000	
2029	$0		$3,016,837	$10,000	
2030	$0		$3,016,837	$10,000	
2031	$0		$3,016,837	$10,000	
2032	$0		$3,016,837	$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	$6,114,071			
202		$0			
202		$0	$3,016,837	$10,000	$2,293,9 1
2025	$0	$0	$3,016,837	$10,000	$2,143,833
2026	$0	$0	$3,016,837	$10,000	$2,003,582
2027	$0	$0	$3,016,837	$10,000	$1,872,507
2028	$0	$0	$3,016,837	$10,000	$1,750,006
2029	$0	$0	$3,016,837	$10,000	$1,635,520
2030	$0	$0	$3,016,837	$10,000	$1,528,523
2031	$0	$0	$3,016,837	$10,000	$1,428,526
2032	$0	$0	$3,016,837	$10,000	$1,335,071

$7,000,000 / (1+0.07)^(2022-2020)

(3,016,837-10,000) / (1+0.07)^(2025-2020)

(3,016,837-10,000) / (1+0.07)^(2032-2020)

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	$6,114,071	$0	$0	$0
2023	$0	$0	$3,016,837	$10,000	$2,454,474
2024	$0	$0	$3,016,837	$10,000	$2,293,901
2025	$0	$0	$3,016,837	$10,000	$2,143,833
2026	$0	$0	$3,016,837	$10,000	$2,003,582
2027	$0	$0	$3,016,837	$10,000	$1,872,507
2028	$0	$0	$3,016,837	$10,000	$1,750,006
2029	$0	$0	$3,016,837	$10,000	$1,635,520
2030	$0	$0	$3,016,837	$10,000	$1,528,523
2031	$0	$0	$3,016,837	$10,000	$1,428,526
2032	$0	$0	$3,016,837	$10,000	$1,335,071
TOTAL		**$6,114,071**			**$18,445,945**

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

= $18,445,945 - $6,114,071

= **$12,331,874**

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

= $\frac{\$18,445,945}{\$6,114,071}$

= **3.0**

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