Appendix: Benefit-Cost Analysis

Executive Overview

This Benefit-Cost Analysis was completed for the Glass City (Toledo) Riverwalk project and follows methods established by U.S. Department of Transportation's (USDOT's) Benefit-Cost Analysis Guidance for Discretionary Grant Programs (December 2023) and the National Cooperative Highway Research Program (NCHRP) in their Report 552: Guidelines for Analysis of Investments in Bicycle Facilities (2006). Benefits for this project are considered as improvements to six categories: safety, health, recreation, mobility, vehicle operating cost savings, and emissions reductions. Results listed in this summary are based on the prescribed discount rate of 3.1% (2% for carbon dioxide emissions reductions), and a proposed lifetime of 20 years for the project, with the project fully opening in 2029.

Table 1 below is a brief summary of the results of this analysis[1]. The proposed project will provide an estimated Net Present Value Benefits of $934 million. This is a benefit to cost ratio of 37.1:1. In the sensitivity analysis section we will discuss using different assumptions when estimating the project benefits and we will show the results are robust.

Table 1: Net Present Value Benefits with 3.1% Discount Rate

Present Value of Benefits	Present Value of Capital Costs	Net Present Value	Benefit to Cost Ratio
$959,909,112	$25,869,372	$934,039,741	37.11

Project Costs

Cost Estimates for the life of the project are provided by Metroparks Toledo. Below in Table 2 is a summary of project costs; a complete list and the Present Value (PV) calculations are available in the accompanying Excel files.[2] All costs are associated with the year in which they will occur and discounted at a rate of 3.1% to obtain the Present Value (PV) of costs.

Table 2: Present Value of Costs with 3.1% Discount Rate

Category	Timeframe	Annual Average	Total Present Value
Capital/Construction	2026-2028	$9,981,440	$25,869,372
Maintenance/Operations	2029-2048	$636,443	$7,811,424
		Total	$33,680,796

[1] See Table 1. BCA Results in the "Final Results" excel file worksheet tab. The USDOT BCA spreadsheet template was used and is titled, "Toledo_Riverwalk_240226.xlsx".
[2] See Table 1. Summary of Benefits and Table 2. Summary of Costs in the "Summary" excel file worksheet tab.

Project Benefits

To begin measuring benefits we first forecasted the demand for this new riverwalk path using the Benefit-Cost Analysis of Bicycle Facilities guidance developed by the NCHRP and the University of Minnesota. Using data from the National Household Transportation Survey (NHTS) and U.S. Census, NCHRP estimates demand for bicycle facilities in three possible scenarios. The "low" scenario represents the minimum expectation for demand, which we do not believe is appropriate for this analysis. Given the unique characteristics of this riverwalk project, and its scenic and central location we believe that the "medium" estimates are the best representation of anticipated demand. We did not use the "high" estimates because we wish to establish a relatively conservative estimation of the expected benefits.

Using current GIS and U.S. Census data we obtained population estimates for 800 meter, 1600 meter, and 2,400 meter buffers around the new Vistula and International Park riverwalk sections. Using the Report 552 demand estimate functions[3] and assuming a 0.2% commute share for Toledo, OH[4], we estimate 24,738 existing cyclists with 58 of those being commuters. With the installation of the riverwalk shared use path we expect 6,908 new cyclists, with 15 of them being new commuters. With an estimated number of users for the new path we followed the continued guidance of Report 552 in measuring benefits.

Below we discuss the methods used to quantify each category of benefits. A summary of the findings can be found in Table 4 at the end of this section. Note that amounts listed in this section are annual benefits for the life of the project. The discounted total PV of benefits can be found in the executive summary, and intermediate calculations can be found in the accompanying data file.

- Recreation

  To obtain a figure for recreation benefits, the estimated number of total new cyclists, minus new commuters, was multiplied by the estimated value of outdoor recreation. NCHRP compiled a wide variety of studies on valuing outdoor recreational activities and generated a typical value of $10/hour in 2004 dollars and that a "typical" day involved about one hour of bike riding. After adjusting to 2022 dollars, that is $14.2 per cyclist per day in benefits. The results of these calculations are presented in Table 3 below.

  The above calculations are based solely on recreational benefits to cyclists, and do not capture the benefits this shared use path will have for pedestrians. Report 552 urges caution in using their guidance to estimate pedestrian benefits. However, there is literature describing the large benefits that have resulted from past pedestrian riverwalk projects. For example, an economic impact analysis in Pittsburg, PA found for every public dollar spent

[3] See "Vehicle Operating Cost Savings" Excel worksheet tab for all demand calculations.
[4] From the, "Report on 2016 American Community Survey Data by the League of American Bicyclists": https://bikeleague.org/where-we-ride-2016-analysis-of-bike-commuting/.

on riverfront improvements, $20 in private investments followed[5]. In San Antonio, TX their renowned riverwalk has overtaken the Alamo as their number one tourist attraction. This new riverwalk in Toledo, OH similarly encircles a previously underdeveloped downtown urban riverfront that now includes a new popular metropark, Glass City Metropark, with this connected riverwalk offering a round trip path on both sides of the Maumee River.

According to Report 552 recreational walking is ten times as common as biking. Additionally, the unique characteristics of this riverwalk project will attract more pedestrian use than cyclists. For these reasons, we assume a conservative estimate for pedestrian recreation benefits is to be equal to the estimated cycling recreation benefits. See results below in Table 3.

Table 3: Annual Recreation Benefits for Cyclists and Pedestrians

Cyclists	Pedestrians	Total
$35,726,419	$35,726,419	$71,452,838

- Decreased Auto Use

Decreased Auto Use benefits encompasses benefits from emissions reductions and vehicle operating cost savings. Following the guidance of NCHRP Report 552, we assume that the 15 new bicycle commuters were previously driving to work, and that they work 5 days a week, 50 weeks a year. An average commute of 6 miles was used per a report compiled by the Brookings Institute[6]. Finally, NCHRP estimates a savings of $0.13 per mile ($2006) in urban areas. In the figure below you can see that this, adjusted to $2022, produced an estimated vehicle operating cost savings of $8,307 annually.[7]

$$\mathbf{15}\ \boldsymbol{commuters} \cdot \$\mathbf{0.13}/\boldsymbol{mile} \cdot \mathbf{6}\ \boldsymbol{miles} \cdot\ \mathbf{250}\ \boldsymbol{days} \cdot \mathbf{2} \cdot \mathbf{1.42} = \$\mathbf{8,307}$$

Because there are few estimated new bicycle commuters, given the current bicycle commuter share for Toledo is only 0.2%, there is also a small amount of estimated vehicle emission reduction savings similar to the small amount of vehicle operating cost savings shown above. Following the U.S. DOT benefit-cost analysis guidance, we estimate the emission reductions annual savings to be $135 non-$CO_2$ and $1,204 for CO_2 emission reductions.[8]

[5] *Three U.S. Cities Reinventing the Modern Waterfront*, Urban Land Magazine January 2019.

[6] Kneebone, Elizabeth and Natalie Holmes. The growing distance between people and jobs in Metropolitan America. Brookings Metropolitan Policy Program. March 2015. Available at: https://www.brookings.edu/wp-content/uploads/2016/07/Srvy_JobsProximity.pdf.

[7] See "Vehicle Operating Cost Savings" Excel worksheet tab for these calculations.

[8] See "Emissions Reduction" Excel worksheet tab for all calculations.

- Health

  Health benefits occur due to reduced healthcare costs caused by the increase in physical activity associated with the new cyclists. Using the U.S. DOT benefit-cost analysis guidance, we multiply our estimate of new recreation cyclists (6,908) by the recommended health benefit value per induced trip of $6.80. Also, as recommended, we assume 89% of the new cyclists are within the applicable age range of 20 to 64 and we assume a modest 5 new trips per year. The resulting cycling health benefits is $209,036 annually.[9] For comparison, an alternative calculation is to use the Report 552's suggested estimate of $128 annually per new cyclist (2006 dollars). Multiplying the expected number of new cyclists by the value of $128 and adjusting to $2022 results in annual benefits of $1,255,600; an estimate six times higher. To be conservative in our health benefit estimates we use the lower health benefits using the U.S. DOT benefit-cost analysis guidance, and moreover, we do not include any health benefits from the new pedestrians using the riverwalk.

- Mobility

  Mobility describes the benefits associated with bicycle mobility improvement. NCHRP Report 552 finds that bicycle commuters are willing to spend 20.38 extra minutes per trip to travel on an off-street bicycle path such as the one proposed by this project. Using an average value of $12/hour to value time, this means a benefit of $4.08 per trip. Multiplying this benefit by the assumed number of trips for all bicycle commuters and adjusting to $2022 the annual benefit is $211,466.[10]

$$\mathbf{73}\ \boldsymbol{commuters} \cdot \frac{\mathbf{\$4.08}}{\boldsymbol{trip}} \cdot \mathbf{250}\ \boldsymbol{days} \cdot \mathbf{2} \cdot \mathbf{1.42} = \mathbf{\$211,466}$$

- Safety

  This category measures the benefits gained from a reduction in cyclist and pedestrian injuries and fatalities. The provision of a shared use path off-road facility would allow cyclist and pedestrians to travel a safe distance away from vehicles, thus reducing the number of vehicle accidents involving pedestrians and cyclists.

  To measure these benefits, we utilized data from the Ohio Department of Transportation's (ODOT's) GCAT Crash Analysis Tool for the city of Toledo. USDOT's guidance is to use a timeframe of 3 to 7 years for this data. We used the most recent 5 years (2019 to 2023) of crash data near the area to capture the trend of increasing injuries and fatalities in Ohio[11]. For pedestrians we analyzed crashes within a 0.5-mile radius of the project (approx. 10 minutes walking), and for cyclists we used a baseline assumption of a 2-mile radius. Literature on this subject suggests a radius between 1.5 miles and 5 miles is appropriate for

[9] See "Health Benefits" Excel worksheet tab for these calculations.
[10] See "Other 3-MOBILITY" Excel worksheet tab for these calculations.
[11] Walking & Biking Safety in Ohio GroundWork, Issue 46. Available at: https://www.middletontownship.com/wp-content/uploads/2020/04/GroundWork-Issue-46-Walking-Biking-Safety-in-Ohio.pdf

cyclists. Our 2-mile radius is at the low end of this range to keep our estimates conservative. Using this data, we calculate the expected annual number of injuries and fatalities as an average of the past five years.

To measure the value of avoided injuries and fatalities we followed the USDOT's Benefit-Cost Analysis Guidance[12]. Per their guidelines, injuries were associated with severities on the KABCO scale and monetized with values from Table A-1 in Appendix A. To assume a 100% reduction in accidents does not seem reasonable, so we used a Crash Modification Factor (CMF) of 0.37[13], equating to a 63% reduction in crashes. The reference for this CMF is Minikel (2011), who studied separate bicycle lanes reducing collisions in Berkely, CA (see footnote 13 for full reference).

This process yielded an estimate of $6,962,739 in annual benefits from prevented crashes.

Table 4: Summary of Annual Benefits

Recreation	$71,452,838
Decreased Auto Use	$9,646
Health	$209,036
Mobility	$211,466
Safety	$6,962,739
Total	**$78,845,725**

Sensitivity Analysis

To begin, note that we conservatively assumed zero population growth over the twenty-year life of the project. We also assumed zero residual value at the end of the twenty years. Finally, we did not add any additional "amenity benefits" from the many amenities that will be added along the new sections of the Toledo Riverwalk, such as almost 100 new trees planted, several benches, restrooms, fishing access, river overlooks, picnic areas, bike fix-it stations, and an adventure playground. We note that all these amenities indicate the unique and expansive opportunity this project is to the currently underdeveloped Toledo downtown riverfront and that the recreation benefits to cyclists and pedestrians are likely conservative and may be

[12] Benefit Cost Analysis Guidance for Discretionary Grant Programs December 2023, U.S. Department of Transportation. Appendix A: Recommended Parameter Values.

[13] http://www.cmfclearinghouse.org using the Countermeasure: install bicycle boulevard (CMF ID: 3092), from Minikel, E. "Cyclist Safety on Bicycle Boulevards and Parallel Arterial Routes in Berkely, California." Presented at the 90th Meeting of the Transportation Research Board, Washington, D.C. (2011). Also, see "Safety" Excel worksheet tab for all calculations for Safety Benefits.

higher that we have estimated. For example, similar cities to Toledo, OH, such as Cincinnati, OH, has double the cycling commute share (0.4%), and Columbus, OH, has triple (0.6%)[14]. With continued expansion of dedicated cycling/pedestrian paths in Toledo, OH, we expect Toledo to increase its commute share like these other cities and commensurately the number of citizens cycling and walking for enjoyment and exercise.

With that said, we next show how the present value net benefits would change if we made different assumptions for the major benefit categories we did include, focusing on the two largest benefit categories, Recreation and Safety. We summarize the effects of these proposed changes in Table 5.

For recreation benefits, the major assumption is the use of the medium scenario of projected demand, versus the low or high scenarios provided by NCHRP Report 552. We hold that the low scenario is not a reasonable parameter for this analysis, for the reasons listed previously. However, for sensitivity analysis we show that even assuming the low scenario for demand the project leads to over $4 in benefits for every $1 of real resource cost, with a benefit to cost ratio of 4.21.[15] The "low" scenario only assumes 238 total new cyclists, thus reducing substantially the cycling recreation benefits and health benefits. For this scenario we also maintained the assumption of equal benefits for cyclists and pedestrians, hence substantially reducing pedestrian recreation benefits as well.

The high scenario of demand estimates 10,300 new cyclists adding to 24,738 existing. This increases the cycling recreation benefits and cycling health benefits and pedestrian recreation benefits as we again assume equal recreation benefits for both groups. The resulting benefit cost ratio increases to 53.84.[16] Table 5 lists the impacts these changes would have on the Net Benefits of the project.

Next is Safety. First, we tested a change in the CMF (crash modification factor). The proposed path would offer a completely off-road alternative to a heavily trafficked route. Therefore, we believe that the reduction in accidents will be similar to the 63% baseline reduction. However, if instead we assume the CMF is 0.75 equaling a much smaller 25% reduction in accidents, then the benefit to cost ratio reduces to 35.11.[17]

The second safety assumption we assess is the chosen radius for cycling crash data. A new popular metropark, Glass City Metropark, is connected to the new Toledo Riverwalk project and draws new cyclists and pedestrians from surrounding neighborhoods. The new Toledo Riverwalk provides much safer routes to the new metropark as it encircles both sides of the Maumee River and connects the Vistula neighborhood on the west side of the river to the new

[14] "Where we Ride, Analysis of bicycle commuting in American cities," 2016 Report by the League of American Bicyclists.
[15] The adjusted calculations are in the new Excel file, "Toledo_Riverwalk_SensitivityA_Recreation_LOW_240226.xlsx".
[16] See the new "Toledo_Riverwalk_SensitivityA_Recreation_HIGH_240226.xlsx" excel file for these calculations.
[17] See the new "Toledo_Riverwalk_SensitivityA_Safety_LowerCMF_240226.xlsx" excel file for these calculations.

metropark on the east side of the river. Thus, we also now consider a 5 mile radius for cycling crash data. This increased radius increases the benefit to cost ratio to 41.2.[18]

The final point of consideration in this section is the real discount rate. Given that costs for this project are incurred in the beginning and benefits throughout the lifetime, the affect of the real discount rate is disproportionate on the two. To illustrate how a change in the real discount rate affects this analysis we consider a 1% change in either direction from the prescribed 3.1% in the analysis. A 1% higher real discount rate reduces the benefit cost ratio to 33.5, and a 1% lower real discount rate increases the benefit cost ratio to 41.3.[19]

Table 5: Sensitivity Analysis

Proposed Change	New NPV of Benefits	Change	Benefit cost Ratio
Baseline, no change	$934,039,741	$0	37.1
Lower Recreation/Health Benefits	$82,953,522	-$851,086,219	4.2
Higher Recreation/Health Benefits	$1,366,856,001	$432,816,260	53.8
Lower Safety Benefits (Lower CMF)	$882,493,885	- $51,545,856	35.1
Higher Safety Benefits (Higher Radius)	$1,040,467,872	$106,428,131	41.2
Increase Real Discount Rate 1%	$803,142,041	-$130,897,700	33.5
Decrease Real Discount Rate 1%	$1,090,987,658	$156,947,917	41.3

The results of this sensitivity analysis show that our conclusions are robust to different assumptions for the most crucial assumptions that can change the benefit estimates the most, particularly the assumed new cyclists changing the recreation benefits. All scenarios show positive present value net benefits indicating the Toledo Riverwalk project is an efficient public good investment.

[18] See the new "Toledo_Riverwalk_SensitivityA_Safety_HigherRadius_240226.xlsx" excel file for these calculations.
[19] See the new "Toledo_Riverwalk_SensitivityA_DiscountRate_Higher_240226.xlsx" excel file for these calculations and "Toledo_Riverwalk_SensitivityA_DiscountRate_Lower_240226.xlsx".