Memorandum

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Government & International Affairs

From: Nick Semeja, PE, Associate

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Subject: MidTown-Hough Connector Project – 2021 RAISE Program Application Benefit-Cost Analysis Memorandum

Introduction

This memorandum summarizes the assumptions, methodology and results developed for the benefit-cost analysis of the No Build and Build Alternatives evaluated as part of the MidTown-Hough Connector Project – 2021 RAISE Grant Program Application. The objective of a benefit-cost analysis (BCA) is to bring all the direct effects of a transportation investment into a common measure (dollars), and to account for the fact that benefits accrue over an extended period while costs are incurred primarily in the initial years. The primary elements monetized in this analysis are crashes, fiber connectivity, quality of life, remaining capital value, and maintenance costs. The benefit-cost analysis can provide an indication of the economic desirability of an alternative, but decision-makers must weigh the results against other considerations, effects, and impacts of the project.

The primary issues to be addressed by the project are safety, options for alternative transportation modes, community connectivity and accessibility, and quality of life in the project area and surrounding neighborhoods. Currently, the portion of E 66th Street between Euclid Avenue on the south and Superior Avenue on the north is a two-lane urban roadway with minimal-to-no safety features and deteriorating pavement and sidewalks. The corridor is a critical north-south link to major arterials, and its current state is impeding the surrounding resident's ability to efficiency and safely travel to other areas of the City of Cleveland.

Description of Alternatives

For the purpose of this analysis, a No Build and Build Alternative were under consideration.

No Build Alternative

The No Build Alternative includes leaving the E 66th Street corridor in its current geometric and operational state, as described in the above section of this document. Intensified maintenance activities that were recently incurred to keep the corridor operational are expected to persist over the upcoming years.

Build Alternative

The Build Alternative assumes a full-depth reconstruction and redesign of the E 66th Street corridor from Euclid Avenue on the south to Superior Avenue on the north. In addition to reconstructing the deteriorating pavement and subsurface infrastructure, the project provides high-speed broadband internet to nearby residents, an off-street mixed-use path for bicyclists, upgraded sidewalks for pedestrians, and numerous spot mobility and traffic calming improvements to increase safety.

BCA Methodology

The following methodology and assumptions were used for the benefit-cost analysis:

1. **Main Components**: The main components analyzed included:
   - Safety: crashes by severity
   - Fiber: high-speed broadband internet
   - Quality of life benefits:
     - Bicyclists' mobility
     - Bicyclists' health
     - Bicyclists' recreation
     - Reduced auto-use: congestion, emissions, and vehicle operating costs
   - Initial capital costs
   - Remaining capital value: value of improvement beyond the analysis period
   - Maintenance and rehabilitation costs: These costs include scheduled rehabilitation activities and annual routine maintenance.
2. **Analysis Years**: The analysis assumed that construction would take place from year 2024 to 2026. Therefore, year 2027 was assumed to be the first full year that benefits will be accrued from the project. The analysis focused on the estimated benefits for the twenty-year period from 2027 to 2046. The present value of all benefits and costs was calculated using 2019 as the year of current dollars.
3. **Economic Assumptions**: All economic values and analysis methodology were obtained from the *Benefit Cost Analysis Guidance for Discretionary Grant Programs*, dated February 2021[1], unless otherwise stated in the ensuing sections of this document. The analysis was completed using an assumed discount rate of seven percent.
4. **Safety Analysis:** The Build Alternative improves safety for travelers in the E 66th Street project area by providing safety enhancements to the existing facility and providing a safer route for travelers of alternative modes (e.g. pedestrians and bicyclists). There are several

[1] https://www.transportation.gov/sites/dot.gov/files/2021-02/Benefit%20Cost%20Analysis%20Guidance%202021.pdf

traffic calming devices proposed as part of the project, including: intersection bump outs, special paving material in crosswalks to prioritize pedestrian and bicyclist movement, pedestrian-activated crossing controls, pedestrian refuge islands, and increased crosswalk widths, that are expected to slow vehicle speeds and make drivers more attentive to their surroundings. A crash modification factor (CMF) [2] for adding traffic calming devices to an urban 2-lane corridor was obtained from Crash Modification Factors Clearinghouse and applied to existing crash costs along E 66th Street to estimate crash cost savings. Three years (2017-2019) of existing crash data by severity were collected from the ODOT's Transportation Information Mapping System[3] to establish existing annual average crash costs within the project extents of E 66th Street.

The project is also adding a multi-use path and widened sidewalks to replace the current deteriorated sidewalks that span the corridor. It was assumed that the enhanced pedestrian and bicycle facilities would induce travel from these modes on adjacent north-south corridors to divert to E 66th Street. Thus, pedestrian and bicycle crashes on north-south roads were collected from E 55th Street to the west to E 79th Street to the east. This area spans roughly 0.4 to 0.5 miles on either side of E 66th Street and is terminated at the closest adjacent main collector/arterial roadways. Note that there are no bicycle facilities or bike lanes within these extents, and most sidewalks are deteriorated beyond use.

Five years (2015-2019) of existing crash data involving pedestrians and bicyclists were provided by City of Cleveland engineering staff and used to establish existing annual average crash costs in the E 66th Street project area. Crash reduction factors for providing sidewalks and barrier-separated bike facilities were obtained from the *Oregon Department of Transportation HSIP Countermeasures and Crash Reduction Factors*[4]. Information on the crash reductions for adding barrier-separated bike facilities and sidewalks can be found on pages 146 (BP23) and 152 (BP29), respectively. The crash reduction factors were applied to existing annual average crash costs in the project area to estimate crash savings associated with the enhanced pedestrian and bicycle facilities.

Safety benefits were assumed to remain constant throughout the benefit-cost analysis period, which can be considered a conservative estimate assuming vehicle traffic and alternative modes of transportation grow over time. Crash cost assumptions for the KABCO scale are consistent with values and methodologies published in the *Benefit Cost Analysis Guidance for Discretionary Grant Programs*, dated February 2021.

5. **Fiber Benefits:** The project will increase economic competitiveness for adjacent residents by providing high-speed broadband internet. Advantages from having high-speed broadband include an increased access to education, civic engagement, political participation, increase the ability to work remotely, and numerous others. The city currently has fiber running through the project area, but it is simply being used as a 'pass-by' route to get to other locations and is not available for use by the residents on and around E 66th Street.

   The project will add infrastructure at key locations along the corridor to wirelessly broadcast broadband internet to nearby residents. The wireless speed is not expected to be as fast as a wired fiber connection (up to 1 Gbps), however it was assumed that nearby residents would

[2] http://www.cmfclearinghouse.org/detail.cfm?facid=128
[3] https://gis.dot.state.oh.us/tims/map
[4] https://www.oregon.gov/ODOT/Engineering/Docs_TrafficEng/CRF-Appendix.pdf

be able to obtain, on average, download speeds of 150 Mbps, which is typical for the current state of this technology but could increase over time. Existing broadband speeds adjacent to the project area can be found on the Federal Communications Commission Fixed Broadband Deployment map. Note that many of the adjacent census blocks show near Gbps speeds from Charter Communications, however this service refers to the 'pass-by' infrastructure mentioned earlier and is not available for use by the nearby residents. The next highest download speed available along the corridor is listed at 35 Mbps and was assumed for the baseline condition in the analysis. It has been reported that actual internet speeds in the area can be around 15 Mbps to 20 Mbps, so the baseline internet speed estimate can be considered conservative for the analysis.

The number of residents that could benefit from the broadcasted broadband technology was obtained by collecting the population in TAZs adjacent to the E 66th Street corridor[5]. The population was multiplied by 90 percent assuming a certain percentage of the population doesn't utilize internet (e.g. persons of very young age). This population estimate is likely conservative considering 77.9 percent of the Cleveland population is 18 years or older, and much of the age population below 18 uses internet for education and other purposes.

The value of increased internet speed was obtained from *Eliciting Consumer Willingness to Pay for Home Internet Service: Closing the Digital Divide in the State of Indiana*[6] and was determined to range from $0.06 per Mbps and $0.10 per Mbps. The analysis used an average of the two for a value of $0.08 per Mbps, which resulted in a willingness to pay of $9.20 per resident to increase speeds from 35 Mbps to 150 Mbps. Total annual benefits were determined by multiplying the willingness to pay for each resident by the total number of residents effected. Benefits were kept constant throughout the benefit-cost analysis period, which can be considered conservative.

6. **Quality of Life Benefits:** Since the project includes multi-use paths and bicycle and pedestrian infrastructure, it is important to quantify the quality of life benefits the improvements will bring to the community.

Demand Model

Biking and walking demand were calculated using the methodology developed by National Cooperative Highway Research Program's (NCHRP) Report 552: Guidelines for Analysis of Investments in Bicycle Facilities (2006)[7] for Build Alternative in comparison with No Build Alternative. Page numbers for methodologies and parameters used in the analysis are provided in the attached BCA Workbook.

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[5] Data for adjacent TAZs is provided in the BCA Workbook.

[6] https://www.researchgate.net/publication/338519155_Eliciting_Consumer_Willingness_to_Pay_for_Home_Internet_Service_Closing_the_Digital_Divide_in_the_State_of_Indiana

[7] National Cooperative Highway Research Program (NCHRP), Report 552: Guidelines for Analysis of Investments in Bicycle Facilities, 2006.

Population Near Project Area and Other Relevant Population Characteristics

GIS buffer analysis using TAZ-level data[8] provided by the City of Cleveland Planning Commission was used for estimating the population within 0.25-mile, 0.25-0.5 mile and 0.5-1 mile distance from the bicycle infrastructure. The percent of commuters within a mile of the project area that cycle to work was also provide by the City of Cleveland Planning Commission. Other data relevant to the analysis included the percent of population over 18 years old and the percent of adults who commute to work, which were obtained from the United States Census Bureau[9] and the NCHRP Report 552, respectively.

Cycling Demand - New and Existing Bicyclists

The first step to determine bicycle demand is to estimate the population residing near the assumed facilities. Bicycle demand and benefit calculations were based on a methodology described in the NCHRP Report 552. A buffer analysis was performed around the project area using TAZ level population data provided by the City of Cleveland Planning Commission. Buffers were created at the quarter-mile, half-mile, and one-mile distances from the project. The population residing within these distances of the project was the population assumed to use the new facilities at propensities that vary with distance. Of the population residing in the buffers, the number of commuters for all modes was estimated and the local share of bicycle commuters (1.26 percent) was used. The NCHRP report supplied multipliers to estimate new commuters and existing and new total riders based on the number of existing commuters. For the existing total riders, the report suggests three different models to calculate low, moderate, and high estimates of riders due to large variability in bicycle usage in different cities and even larger differences between different neighborhoods within a city. The study allows applying local knowledge and judgement to choose a most likely point estimate within the range of demand levels estimated by those three models. The judgement criteria included design detail of the facility, land use, how suggested facility fits into a larger system, existing counts, etc. For this project, a moderate estimate of total daily cyclists and a 50 percent existing rate was assumed for benefit estimation. The existing rate is the share of daily cyclists in the project area that can be assumed to be existing bicyclists and not induced by new infrastructure.

Walking Demand

NCHRP Report 552 states that building new walk facilities is not likely to tangibly increase walking demand as opposed to bicycling for a couple of reasons including: walking is much more common than bicycling and walking facilities are much more widespread than bike facilities. No new daily walkers were assumed for the Build Alternative.

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[8] Geodatabase containing TAZ-level population data
[9] https://www.census.gov/quickfacts/clevelandcityohio

Mobility Benefits

To estimate the value bicyclists place on mobility, the NCHRP recommends applying the value of time to the additional travel time bicycle commuters are willing to travel out of their way to get to the facilities. Researchers defined five facility types as:

A) Off-road facilities,
B) In-traffic facilities with bike lane and no on-street parking,
C) In-traffic facilities with a bike lane and on-street parking,
D) In-traffic facilities with no bike lane and no on-street parking, and
E) In-traffic facilities with no bike lane but with on-street parking

These facility types were used to conduct a stated preference survey. The resultant logit model suggests that bicyclists were willing to travel an additional 21.6 minutes to use an off-street facility instead of a street with no facility and no on-street parking. Table 1 summarizes some of NCHRP's suggested mobility benefits that are relevant to the project.

Table 1. Mobility benefits of different bicycle facility improvements

Base facility	Improved facility	Minutes
B	A	5.2
D	A	21.6
E	A	30.5
E	C	16.4

The E 66th Street project area's existing conditions are assumed to be a 'D' facility type and the Build Alternative is assumed as category A.

After multiplying by the value of time ($17.90/hour)[10], the values were applied to new and existing commuters to calculate the mobility benefit. An adjustment factor was added to the NCHRP method to account for the existing facilities in the proximity of the segment of interest. The mobility yielded a total benefit of $11.7M (undiscounted) over the 20-year evaluation period. Mobility benefits of weekend travel were not included in this estimate.

Health Cost Savings

Exercise helps to keep people healthy, thereby reducing their annual health costs. Based on an examination of ten studies, the NCHRP estimates that the daily physical activity of new bicyclist, either commuter or recreational, saves each of them $128 per year (dollars were inflated from year 2006 dollars to year 2019 dollars). Over the first twenty years after project implementation, it was estimated that these savings totaled nearly $763k (undiscounted).

[10] Benefit Cost Analysis Guidance for Discretionary Grant Programs, dated February 2021

Recreation Benefits

Examining the value people place on different recreational activities, the NCHRP estimates that one hour of bicycle recreation is worth $10 (dollars were inflated from year 2006 dollars to year 2019 dollars). The BCA assumed that a "typical" day of bicycling included one hour of activity. Applying this value to the new daily recreational riders yielded a total benefit of $8.2M (undiscounted) over the evaluation period. Nine months of the year was assumed to be appropriate for recreational bicycling.

Reduced Auto Congestion Benefits

As the new bicycle facilities encourage a mode shift to bicycle commuting from automobile commuting, it was assumed that the region would see benefits related to reduced congestion. These benefits include lower travel times through improved traffic flow, reduced emissions, and operational savings for bicyclists. The NCHRP estimated that the benefit derived per commuter is $0.13 per mile for city centers and $0.08 for suburban areas. Given the project location, land use, congestion and air pollution level, an average of these two values, 10.5 cents (in year 2006 dollars), was used. Also, NCHRP suggests using the average trip length, which was estimated to be one mile given the E 66th Street corridor connects main arterial roadways on the north and south ends. The project generated roughly $103k (undiscounted) in reduced auto congestion benefits over the study period.

Pedestrian Benefits

According to the *NCHRP Report 552* guidelines, pedestrians' benefits from new walking facilities can be categorized under health and recreation and can be quantified and monetized in a way like bicycle facilities. To be conservative in the benefit quantification, no new walkers (and consequently no pedestrian benefits) were assumed in the BCA.

7. **Maintenance and Rehabilitation Costs**: It is expected that reconstructing the E 66th Street corridor will reduce the required future rehabilitation and maintenance activities to keep the roadway serviceable. Intensified rehab and maintenance activities that have been recently required or planned to keep the E 66th Street corridor to minimum standards are expected persist over the analysis period. Activities and their costs on the project portions of E 66th Street are provided in the *Roadway Pavement Maintenance Report* from the Northeast Ohio Areawide Coordinating Agency (NOACA)[11]. The five-year record of rehab and maintenance activities were used to determine an average annual cost for the No Build Alternative.

   Annual routine maintenance was obtained from the City of Cleveland engineering staff and were assumed for both the No Build and Build Alternatives. Other maintenance costs

[11] https://www.noaca.org/home/showdocument?id=22446

between the alternatives were assumed to be similar. Detailed costs for rehab and annual maintenance activities are provided in the BCA Workbook.

8. **Calculation of Remaining Capital Value**: The project is expected to have a service life of 40 years before another full reconstruction is expected to be required. Since the benefit-cost analysis period was 20 years, the remaining value of the infrastructure was calculated for the Build Alternative. The project was assumed to have a linear depreciation; thus, half of the project cost was assumed to be remaining at the end of the benefit-cost analysis period. This value was expressed in terms of 2019 dollars and was added to other user benefits in accordance with USDOT guidance.
9. **Factors Not Quantified**: Several factors were not quantified as part of the analysis because of limited data availability or methodologies to determine accurate benefits. These factors included the following:
    - Trips lying outside the specified subarea may accrue benefits that were not accounted for.
    - Reduction in future crashes at locations undergoing safety improvements that have not experienced crashes in the last three years
    - Quality of life improvements associated with increased community gathering space and enhanced overall aesthetics
    - Safety benefits from enhanced pedestrian lighting along the multi-use path
    - Child cyclists: the official documentation in NCHRP Report 552 (2006) does not cover this category of facility beneficiaries

BCA RESULTS

The benefit-cost analysis provides an indication of the economic desirability of a scenario, but results must be weighed by decision-makers along with the assessment of other effects and impacts. Projects are considered cost-effective if the benefit-cost ratio is greater than 1.0. The larger the ratio number, the greater the benefits per unit cost. Results of the benefit-cost analysis are shown for the project in Table 1 below. See Attachment A for the complete benefit-cost analysis workbook.

Table 1 – Total Project Results

	Initial Capital Cost (2019 Dollars)	Project Benefits (2019 Dollars)	Benefit-Cost Ratio (7% Discount Rate)	Net Present Value (2019 Dollars)
No Build vs. Build	$12.1 million	$15.4 million	1.3	$3.3 million

Attachment A

Benefit-Cost Analysis Worksheet