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JULY 2019

**BUILD Grant
Application
FY 2019**



**Memphis
Innovation
Corridor**

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I. Project Description

Memphis Area Transit Authority (MATA) in partnership with the City of Memphis is seeking support of the federal BUILD grant to implement the Memphis Innovation Corridor Project. The Innovation Corridor Project seeks to redefine land use, shared mobility, and connectivity in the City of Memphis. Like many cities throughout the United States, Memphis faces many challenges brought on by suburbanization: low-density development, high poverty, inadequate sidewalks, and a lack of convenient transportation choices other than the private automobile. The transportation issues create a challenge for city residents and their ability to access job opportunities. The challenge is compounded by a spatial mismatch between jobs and housing.

The Memphis Innovation Corridor Project will provide a multimodal solution that utilizes the latest technology and best practices to deliver transportation solutions for residents, utilizing a balance of connections among various modes of transportation. The City of Memphis has adopted a host of policies to complement this goal, including a Complete Streets Policy, a form-based Unified Development Code, and the Memphis 3.0 Comprehensive Plan that guides future development, land use policies, and transportation priorities to reshape growth within the city.

The Innovation Corridor Project evolved from the Midtown Alternatives Analysis (AA) that was initiated in 2012. The AA assessed over 20 public transportation and multimodal alternatives. The study was funded by a Federal Transit Administration (FTA) grant which stressed the importance of the linkage between metropolitan and environmental planning processes. The grant also placed a strong emphasis on the local planning process influencing the ultimate selection of a mode of transit along a preferred corridor. Conducting an AA provided essential information to local decision-makers by addressing needs, benefits, issues, and costs of a local high capacity or fixed guideway transit project on each corridor studied. The study examined transit needs and the potential for providing a higher quality transit service within each corridor and surrounding neighborhoods. The AA process concluded with the selection of Alternative 11, a Bus Rapid Transit (BRT) project linking Downtown Memphis, Memphis Medical District, and the University of Memphis. Alternative 11 was subsequently adopted by the MATA's Board of Commissioners on April 26, 2016 and by the Memphis Urban Area Metropolitan Planning Organization (MPO) on May 25, 2017 as the Locally Preferred Alternative (LPA).

The AA builds on MATA's 2012 Short-Range Transit Plan to "create a framework for future development of Bus Rapid Transit (BRT) on highest ridership corridors." The Project will support this vision by enhancing economic competitiveness, introducing innovative technologies, and providing more mobility options in the urban core. Beyond economic growth, transportation investments in the corridor can help the downtown and the surrounding neighborhoods flourish by giving citizens an alternative to being automobile dependent. Neighborhoods with transit preserve mobility, encourage walking, support higher property values, and promote overall public health.

The need for this project arises from:

- **Interconnectivity of transit routes.** Other major transit corridors could become viable for high capacity transit services with better connections to employment and activity centers. This project will provide the interconnectivity to make the other corridors more desirable.



- **Continued population and employment growth.** According to MATA’s 2012 Short Range Transit Plan (SRTP), Midtown is one of the city’s neighborhoods with greatest growth in population and employment density and most appropriate for higher capacity transit service. Downtown, the Medical District, and other activity centers along the project corridor have the employment density to support high capacity transit and are home to industries with the greatest projected employment growth. This project will lead to more transit-oriented development in the corridor, which will spur more population and employment growth.
- **Redevelopment efforts within Downtown and Midtown.** Many corridors and markets within the study area have potential for new development but lack amenities, including reliable transit service, which would stimulate private investment while strengthening and diversifying the area’s economy. MATA’s mobility goals and this project’s goals are to maximize capital investment by aligning infrastructure development with economic opportunity and filling critical voids in transportation choices for the area’s residents. In support of this goal, the Innovation Corridor Project connects two of the City’s Opportunity Zones.

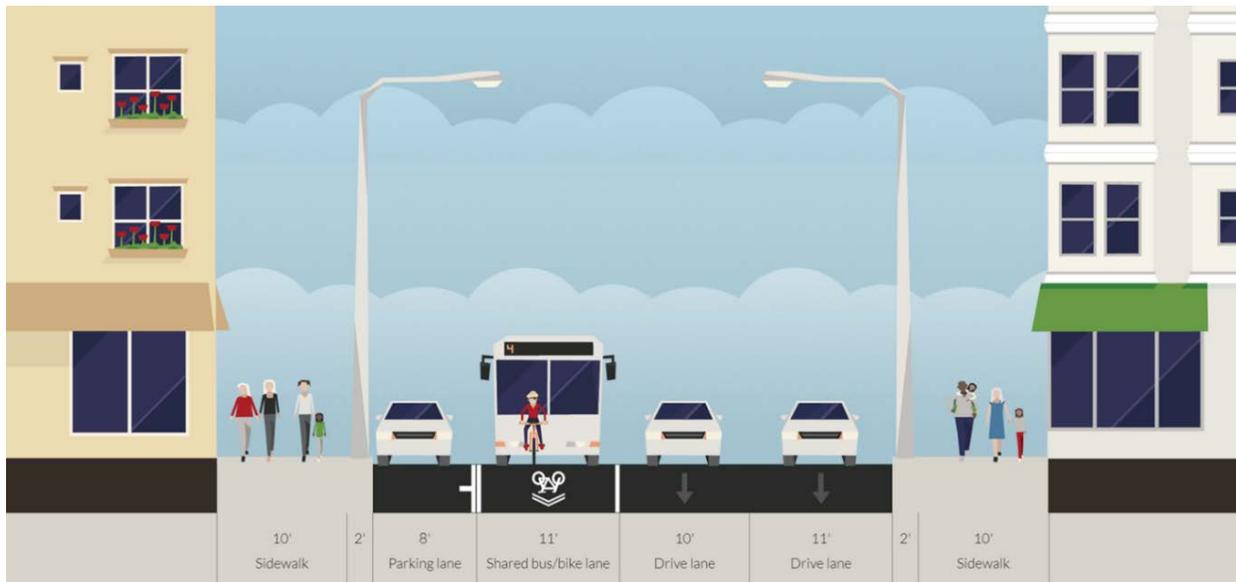
Goals of the Innovation Corridor Project

- Make** transit service in the corridor more compelling
- Connect** neighborhoods and improve local circulation
- Develop** support for local and regional economic growth
- Create** a thriving corridor of neighborhoods and business areas
- Create** an environment that will be sustainable

 <p>Enhance Make the Midtown Corridor transit service more compelling</p>	 <p>Connect neighborhoods and improve local circulation</p>	 <p>Develop Support local and regional economic development goals</p>	 <p>Thrive Strengthen Midtown Corridor neighborhoods and business areas</p>	 <p>Sustain Create an environment that will be sustainable over the long term</p>
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The key investments and project components include the implementation of a new branded high capacity 8-mile BRT line with 10-minute headways during peak periods with dedicated lanes on two miles of road through Downtown Memphis. It is anticipated that queue-jumps will be provided at select intersections where feasible. Fares for the system would be consistent with MATA’s current fare policy. The current adult fare is \$1.75 per ride and one-day passes are \$3.50 per day. New fare technology including the use of mobile apps for fare payment and off-board fare collection at transit stations along with level boarding stations will be utilized to speed up boarding and improve travel times. The project would entail the construction of 28 new transit stations, the purchase of nine new 40-foot long all-electric BRT vehicles with two-door boarding, and the purchase of electric charging equipment.

Figure 1 – Typical Section on North 2nd Street with Dedicated Bus Lanes



The new BRT vehicles will include Wi-Fi as well as other smart technology, including automated vehicle location (AVL), automated passenger counters (APC), automated voice annunciation (AVA), security cameras, Dedicated Short Range Communication (DSRC) devices, vehicle health monitoring, collision avoidance systems, and predictive maintenance technology. Traffic signals will be upgraded with new mast arms, video detection systems, DSRC vehicle to infrastructure communications equipment, and GPS based transit signal priority at all intersections throughout the corridor. The traffic signal system will provide real-time collection of operational data, automatic notifications of signal malfunctions, and adaptive signal control, where appropriate. Memphis has installed modern fiber optic cable connections on Poplar Avenue, Union Avenue, Second Street, and BB King Boulevard. Timing coordination and emergency vehicle signal preemption are in place along the entire route. Transit signal priority devices have been installed along Poplar Avenue. The DSRC devices will provide predictive traffic signal operations information to the BRT vehicle operators.

As a part of the project, the City of Memphis is investing in new Complete Streets projects and a re-design of Union Avenue to create a multimodal street. Improvements will include additional pedestrian amenities, such as pedestrian signage, pedestrian count-down signals, high-visibility crosswalks, LED streetlighting, and pedestrian alerts. A series of planned investments in resurfacing projects, road diets, traffic signal projects, and pedestrian and streetscape improvements will create broad connectivity for residents to access the BRT line and provide the City with connections ripe for transit-oriented development.

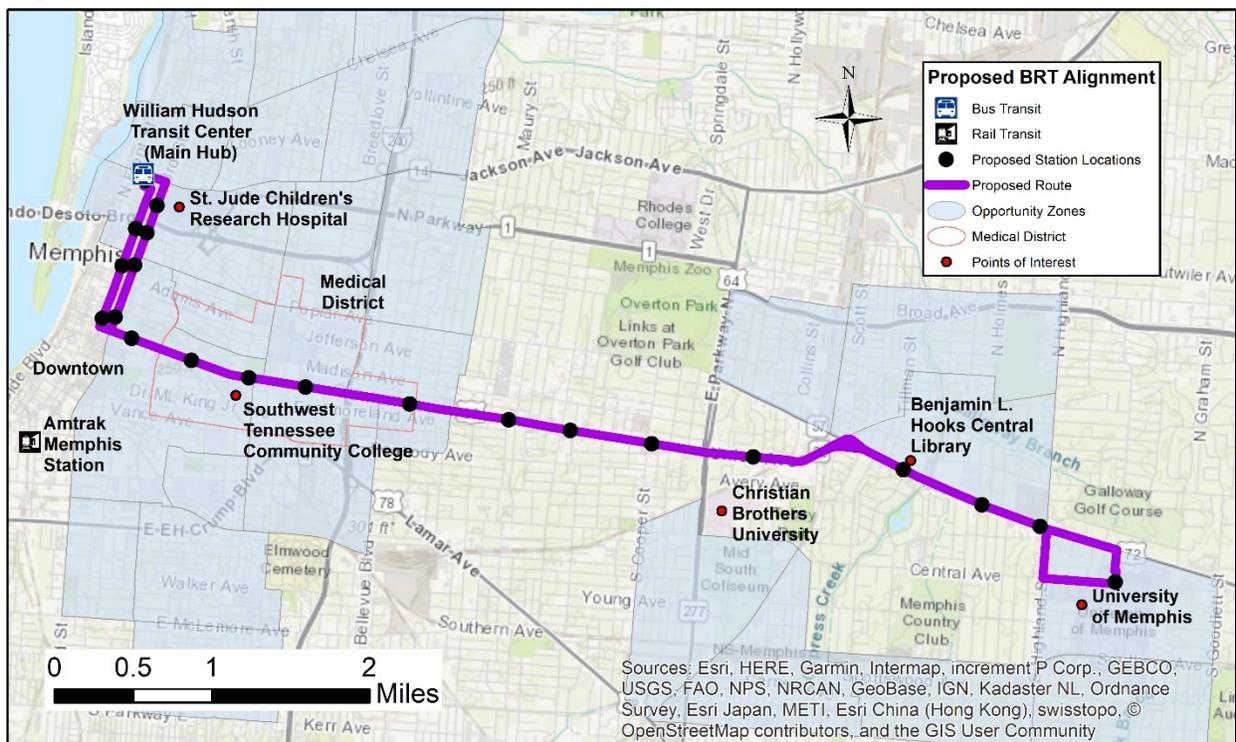
The City of Memphis plans to expand the Smart Cities concepts within the corridor. These improvements may include a GPS based bicycle detection system and new 5G wireless connected to local city infrastructure such as traffic signals, transit stops, and other city infrastructure. MATA and the City of Memphis plan to provide solar power and LED display message boards at transit stops for transit information and potential advertisement-revenue capture opportunities. New revenue streams from this technology can hopefully be used to

provide funding for ongoing maintenance and potentially pay for other capital costs associated with amenities for transit customers. MATA is seeking to partner with the University of Memphis to connect the BRT line to the University of Memphis campus. MATA and the University of Memphis are working on an alignment that will connect to future parking facilities and to the University of Memphis on-campus shuttle.

The Innovation Corridor is the backbone of the future vision for connectivity in Memphis. In 2017, a partnership of the City of Memphis, MATA, MPO, and Innovate Memphis commissioned a new short and long-range, system-wide *Transit Vision* for Memphis, adopted by the MATA Board of Commissioners on January 29, 2019. The current network functions primarily to provide lifeline coverage to many parts of the city, but service more frequent than every 60 minutes is uncommon. The future vision for transit in Memphis shifts this goal from coverage to increased frequency and ridership resulting in more buses arriving more often, 39 percent more jobs reachable in an hour by transit for the average Memphian, and 79,000 more people and 103,000 more jobs near frequent transit. The future vision for transit in Memphis connects frequently served places to areas primed for growth and density, as identified in the city’s Memphis 3.0 Comprehensive Plan, adopted February 14, 2019. The success of this vision starts with a successful implementation of the Innovation Corridor.

II. Project Location

Figure 2 – BRT Project Location



The Innovation Corridor project connects Downtown Memphis, the Memphis Medical District, and the University of Memphis along the alignment shown in **Figure 2** above. Specifically, the corridor begins at the William Hudson Transit Center located at the intersection of A.W. Willis

Avenue and North Second Street. The corridor follows Second Street south to Union Avenue, turning east along Union Avenue to Poplar Avenue and the University of Memphis. The return route follows Poplar Avenue and Union Avenue to B.B. King Boulevard and then turns north and follows B.B. King Boulevard northward to A.W. Willis Avenue and returns to the William Hudson Transit Center. The entire project is located within the Memphis, TN/MS/AR Urbanized Area as defined by the US Census Bureau.

The Innovation Corridor will connect many key Memphis institutions, growing residential districts, employment centers, and two Opportunity Zones. The addition of fast, modern, and convenient transportation will enhance the growth opportunities of each of these areas while creating a united economic engine for the entire region. It will also improve access to jobs, education, and medical care for all Memphians.

Districts

- **Downtown:** the CBID (Central Business Improvement District) counts 25,826 residents and 69,555 jobs, making it one of the largest employment centers in the region. Much of the Downtown is part of the recently designated Core City Opportunity Zone.
- **Three entertainment districts full of shopping, dining, and nightlife:** Downtown/Beale Street, Overton Square, and the Highland Strip adjacent to the University of Memphis. These growing districts provide entertainment, service-sector jobs, and substantial tax revenue.
- **Medical District:** Methodist, Le Bonheur, and St. Jude hospitals as well as the University of Tennessee Health Science Center are all undergoing large expansions. St. Jude, for example, is making a \$9 billion investment that includes new buildings, a major research center, and over 1000 new jobs. The district is a regional center for medical care, community services, and research. Much of the Medical District is part of the Core City Opportunity Zone.

Development and Business

There is currently more than \$4 billion in development planned, underway, or recently completed in Downtown Memphis, including adaptive reuse projects, new offices, retail space, and thousands of hotel and residential units. The City anticipates even greater development impact due to the Opportunity Zones. Important corporate headquarters in the corridor include ServiceMaster, AutoZone, First Horizon National Corporation, Indigo Ag, FedEx Logistics, and Baker Donelson Law Firm. FedEx Logistics was inspired to locate their facility Downtown specifically because of the opportunity that this project provides to connect their employees to the University of Memphis with an innovative, technologically advanced transportation system.

Transportation

The corridor connects the city's main transit center and its Amtrak station to a fast, frequent east-west route that will intersect with and allow easy transfer to several key corridor, mainline, and crosstown MATA routes. Initiatives are underway to facilitate improved connections to other modes, including bikeshare at the University of Memphis campus.

Education

Several institutions of higher learning, as well as the city's main public library, are located near the Innovation Corridor, including University of Memphis Law School, Visible Music College,

Southwest Tennessee Community College, University of Tennessee Health Science Center, Southern College of Optometry, Christian Brothers University, and the University of Memphis.

Recreation and Tourism

Tourism is an important industry for the Memphis economy. Attractions along or near to the corridor include the Mississippi riverfront, Beale Street, FedEx Forum, AutoZone Park, and Sun Studios.

III. Grant Funds, Sources and Uses of Project Funds

To satisfy the requirements of the BUILD application, project benefits and costs are estimated. The period of analysis used in the estimation of benefits and costs corresponds to 34 years, which includes four years of construction and 30 years of operation. The total capital costs are \$73.8 million dollars and are expected to be financed by federal, state, and local funds. MATA and the application partners request \$14.3 million in FY 2019 BUILD funds for the Memphis Innovation Corridor project. This will leverage other significant Federal, State, and City investment. **Table 1** shows the summary of the sources of funding and **Table 2** provides a breakdown of capital costs by major cost category. As noted in Table 1, the Memphis Innovation Corridor Project satisfies the statutory cost-sharing requirements. The total requested amount of FY 2019 BUILD funds constitutes 19% of the total project budget and is matched by City of Memphis CIP dollars; total anticipated federal funds including BUILD grant funds constitute 72% of the total project budget. Evidence of funding or cost-sharing commitments from State and City sources can be found in [Appendix E](#).

MATA is working with FTA to obtain formal entry into the Project Development stage to secure the 5309 funds. It is anticipated that this process will be complete in October 2019. The non-Federal funds do not have time limitations. The other Federal funds must be spent within three years of their obligation.

MATA is pursuing additional State and Local funding opportunities to replace planned federal investment and recoup committed city investments. The State of Tennessee offers competitive awards for transportation projects through its IMPROVE Act. MATA is seeking \$9 million over 3 years in the State's upcoming call for applications that will replace other non-Federal (non-BUILD) funding in the project budget.

The City is pursuing the creation of a development plan for a transit-oriented development tax increment financing (TOD TIF) zone along the corridor to supplement the BUILD award with additional investment in technology, capital infrastructure, green infrastructure, and mixed-use development over time. The TOD TIF program was created by the State of Tennessee in 2016 to augment transit-rich areas like the Memphis Innovation Corridor. The TOD TIF is supported by connecting two of the City's Opportunity Zones.

Table 1 – Project Budget

Project/Source	Cost (\$1,000,000s)	Total Percentage
Memphis Innovation Corridor	\$73.8	100%
<u>BUILD Grant</u>	<u>\$14.3</u>	<u>19%</u>
<u>Other Federal</u>	<u>\$38.9</u>	<u>53%</u>
Other Federal (TIP# 5309-2017-01)	\$38.9	53%
<u>Non-Federal</u>	<u>\$20.6</u>	<u>28%</u>
State (TIP# 5309-2017-01 Match)	\$4.4	6%
City (CIP)	\$10.5	14%
City (TIP# 5309-2017-01 Match)	\$5.6	8%

Table 2 – Project Capital Cost by Major Category

Major Construction Activity	Cost	BUILD		Other Federal	
		Federal	Non-Federal	Federal	Non-Federal
Vehicles	8,762,000			7,009,600	1,752,400
Stations	13,860,000			11,088,000	2,772,000
Repaving	4,089,000	1,136,768	2,952,232		
Striping Marking	1,354,000	1,083,200	270,800		
Sitework and Special Conditions	3,916,000	3,132,800	783,200		
Traffic Signal Improvements	13,225,000			8,281,272	4,943,728
BRT Vehicle Charging Stations	3,780,000			3,024,000	756,000
LED Street Lighting and Communications	3,740,000	2,992,000	748,000		
Right-of-way Acquisition	3,080,000	2,464,000	616,000		
Professional Services	14,509,000	2,810,280	1,089,696	7,644,747	2,964,278
Contingency (5%)	3,516,000	680,952	264,138	1,852,381	718,528
Total Project Cost	73,831,000	14,300,000	6,724,066	38,900,000	13,906,934
Percent of Total Project Cost		19%	9%	53%	19%
Federal Funds		14,300,000	68%	38,900,000	74%
Non-Federal Funds		6,724,066	32%	13,906,934	26%

IV. Selection Criteria

The primary components of the Memphis Innovation Corridor project will have a positive and long-term impact on the City of Memphis and the region. Collectively, they will provide for needed and efficient transportation connections between Downtown, employment centers, universities, medical facilities, residences, and tourist attractions, and will provide overall improvements to the regional transit service that MATA currently offers.

Safety

The Memphis Innovation Corridor provides numerous safety benefits within the project area that will result in an 8% reduction in the average annual crashes per year. Improvements to roadway geometry, laneage and intersections will result in an overall decrease in the expected number of crashes along the corridor for motorist, bicyclists, and pedestrians. In addition, by providing an alternative to cars, the project is designed to shift a portion of car trips to the BRT. This shift can be quantified in a reduction in vehicle traffic on roadways and less exposure, which translates into fewer motor vehicle crashes. Streetscape and traffic calming improvements to these transportation corridors in Downtown neighborhoods will enhance safety for residents by lowering speeds.

To quantify the expected level of improvement, a crash analysis was conducted to identify the existing crash issues, identify potential solutions, and estimate the change in the number, rate and consequences of transportation related crashes, serious injuries, and fatalities. Existing crashes were identified from the three most current years available (2016-2018) from the Enhanced Tennessee Roadway Information Management System (ETRIMS) database for the study corridor. There were a total of 3,198 crashes during that time along the proposed route. **Table 3** shows the average number of crashes per year by mode and severity over the three-year period. **Figure 3** shows the relative crash intensity over the project corridor.

Table 3 – Existing Number of Crashes by Mode and Severity (2016-2018)

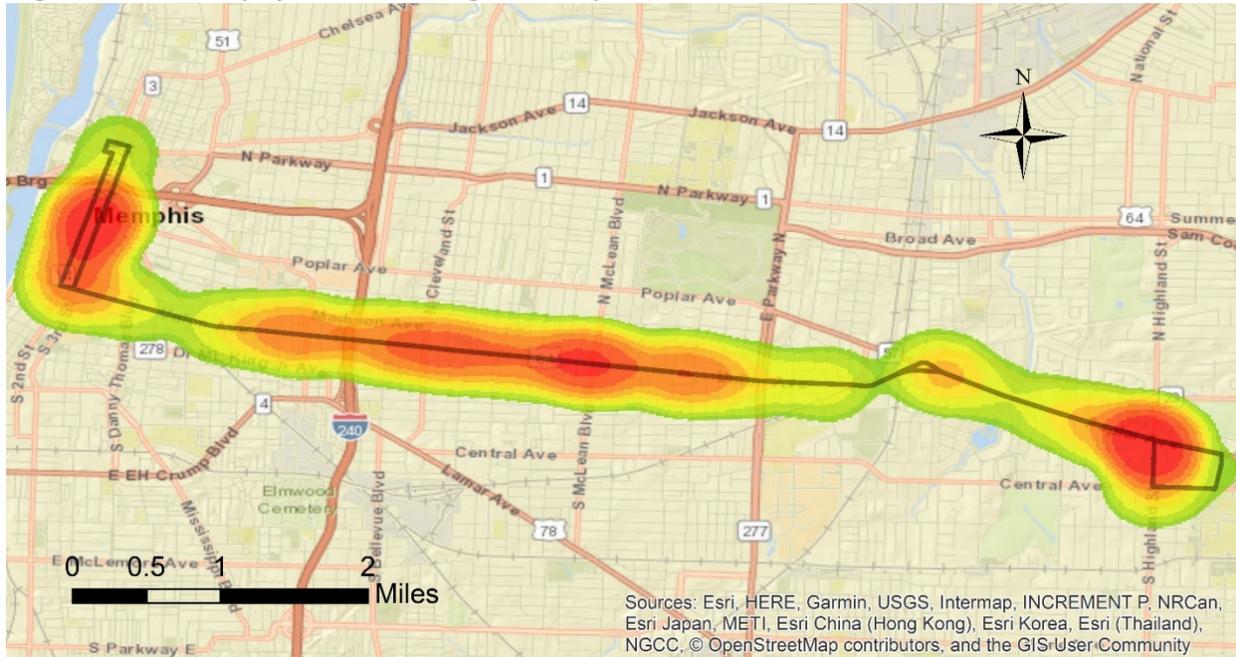
Type of Mode Involved	Fatal Crashes	Incapacitating Injury	Non-Injury	Total Crashes	Average per Year
Pedestrian	3	7	40	56	19
Bicycle	0	0	7	8	3
Motor Vehicle(s) only	2	24	534	3,134	1,045
Total	5	31	581	3,198	1,066

As shown in **Figure 3**, a significant number of crashes occur along the Union Avenue segment of the proposed alignment. Two of the five fatal crashes and 20 of the 31 incapacitating crashes occurred on this portion of the project corridor. Five of those 22 crashes involved a pedestrian, one of which resulted in a pedestrian fatality.

The majority of the route is on the National Highway System (NHS). There are no segments of the route that are designated as intermodal connector routes for freight. There are no at-grade

railroad highway grade crossings along the proposed route. There are grade separated railroad crossings on Union Avenue between Hollywood Street and Poplar Avenue.

Figure 3 – Intensity of Crashes along the Study Corridor (2016-2018)



Union Avenue currently operates as a six-lane undivided urban principal arterial route with left turn restrictions at several key intersections. An element of the Memphis Innovation Corridor is to change the six-lane portion of Union Avenue to a five-lane roadway with two-way left turn lanes and dedicated left turn lanes at signalized intersections. Exclusive turn lanes will be added at the signalized intersections of Union Avenue at East Street, Pauline Street, McNeil Street, Belvedere Street, McLean Street, and Cooper Street. Access management improvements will also be implemented on Union Avenue between McLean Street and East Parkway by reducing and consolidating commercial driveways where practical.

The potential reduction in the number of crashes was estimated using the Tennessee Department of Transportation’s study on Statewide Average Crash Rates for Sections and Spots, which was completed between 2014-2016, and Crash Modification Factors (CMFs) from the American Association of State Highway and Transportation Officials’ (AASHTO) *Highway Safety Manual* (HSM), 2010. To avoid double counting the benefits associated with crash reduction at intersections or on segments that could be improved using both methods, only the TDOT Statewide Average Crash Rates methodology was included in the benefit cost analysis.

The TDOT average crash rate for a multi-lane undivided urban state route is 3.954 crashes per million vehicle miles traveled (MVMT), while the average crash rate for a multi-lane roadway with a two-way left-turn lane is 3.294 crashes per MVMT. The 2.96-mile segment of Union Avenue between Manassas Street and East Parkway is proposed to be converted from a six-lane undivided road to a five-lane road with a center two way left turn lane. This segment of roadway had 1,475 crashes during the three years from 2016 to 2018 with an average AADT of 32,489 vehicles per day. This difference between the statewide average crash rates for roads with and without a two way left turn lane indicates that there would be a **17% reduction in the number**

of crashes along this segment of the corridor. This equates to an average reduction of 82 crashes per year along this segment of Union Avenue. This represents an 8% reduction in the average number of crashes per year along the entire corridor. More details regarding the crash analyses can be found in [Appendix B](#).

State of Good Repair

There are project improvements that will result in user benefits stemming from the ability to maintain the system in a state of good repair. These benefits include reducing non-recurring congestion, reducing long-term maintenance and repair costs, and improved accessibility and safety for persons with disabilities.

Recurring congestion is congestion experienced by motorist as a result of daily traffic volumes approaching or exceeding the capacity of the roadway. Travelers generally understand the impact of recurring congestion to their travel time and plan their trips accordingly. Non-recurring congestion is congestion experienced by motorists due to a disruption in traffic flow not related to high daily traffic flows, such as a crash, disabled vehicle, special event traffic, work zone, or other unforeseen event. Non-recurring congestion is generally considered to be more impactful than recurring congestion due to its ability to dramatically reduce the available capacity and travel time reliability of the system. From FHWA's Office of Operations, the three main causes of non-recurring congestion are incidents, work zones, and weather.

With the proposed improvements, the number of incidents associated with crashes along the corridor are expected to decline. With this reduction in the number of crashes, there will be a corresponding reduction in the non-recurring congestion. The time required to clear lane blockages from the roadway resulting from crashes according to the Tennessee Department of Transportation (TDOT) Region 4 SmartWay Quarterly Report for the first quarter of 2018 were as follows:

- 85% of crashes cleared within 30 minutes
- 9% of crashes cleared between 30 minutes and 60 minutes
- 3% of crashes cleared between 60 minutes and 90 minutes
- 3% of crashes cleared in greater than 90 minutes

Based on these ranges, the average time to clear a crash is approximately 22 minutes per incident. With a reduction of 82 crashes per year along the study corridor in the horizon year of 2040, this could result in roughly **30 fewer hours per year that motorists would encounter non-recurring congestion due to an incident** along the study corridor.

Another user benefit resulting from a state of good repair along the corridor is from proposed accessibility improvements associated with compliance with the American's with Disabilities Act (ADA). It is a TDOT requirement that projects be compliant with PROWAG standards and the City of Memphis currently has a program to replace curb ramps throughout the City to make them compliant with ADA standards.

The Memphis Innovation Corridor project will improve the pedestrian access along the corridor by improving the sidewalks and ramps to make them PROWAG compliant in locations where there are newly constructed or altered pedestrian pathways. This will also reduce the long-term

maintenance and repair costs of this aging infrastructure. The project will provide installation of more than **340 additional pedestrian countdown signal displays** at the traffic signals along the proposed route. Improving the route for ADA compliance will enhance safety and usability of the transportation system for all users.

An important part of investing in premium transit is to improve transit service for existing riders and to make transit more compelling to attract new riders. The expanded Memphis Innovation Corridor BRT services are projected to carry 5,400 total daily trips, 900 of which will be transit trips shifted from autos. The 900 trips shifted from auto to transit will reduce the wear on the road by reducing the vehicle miles traveled by 5,600 miles per day.

The BRT system will use electric buses. There are anticipated benefits to the state of good repair related to the use of electric buses compared to diesel buses. With fewer moving parts, electric vehicles generally require less maintenance than a similar diesel vehicle. The annual maintenance cost is \$36,000 for a 40' diesel bus and \$20,000 for a comparable electric bus. The lifetime maintenance cost per vehicle for diesel is \$432,000 and \$240,000 for electric.

The project will retrofit approximately 600 existing conventional street light with LED street lights. LED lights have a longer service life and require less energy to provide the same illumination. This project will nearly double the number of LED lights in operation across the City resulting in cost savings to MLGW and their rate payers.

The project is consistent with relevant plans to maintain transportation facilities or systems in a state of good repair and address current and projected vulnerabilities. If left unimproved, the poor condition of the asset will threaten future transportation network efficiency, mobility of goods, accessibility and mobility of people, and economic growth.

The project is appropriately capitalized up front and uses asset management approaches that optimize its long-term cost structure. The BRT component of the project has a sustainable source of revenue that is available for operations and maintenance of the project. **The project will contribute to maintaining the transportation infrastructure in a state of good repair.**

Economic Competitiveness

Major benefits related to economic competitiveness of the Memphis Innovation Corridor are the project's ability to guide and promote urban and economic growth, the benefits associated with improved efficiency of movement of goods and people, and the reduced burdens of commuting along the corridor. High frequency transit can help make neighborhoods attractive places to live, work, and shop; however, the success of such revitalization is dependent on many factors including zoning and local support. The BRT alignment was evaluated to determine its potential to support employment centers and retail districts, the potential to create compact, mixed-use neighborhoods, and the potential to attract and accommodate future residences and businesses.

The Memphis Innovation Corridor will increase opportunities for regional and local employment. The vision statement of the Memphis 3.0 Comprehensive Plan is to influence long-term growth in the City to occur "up and not out" by increasing density and encouraging mixed use development. Investing in premium transit can attract residential and commercial growth by spurring development of underutilized areas. The Innovation Corridor passes through two of the

City's Opportunity Zones. The Opportunity Zone in the Downtown area includes several underutilized properties which are proposed for redevelopment into mixed use developments consisting of office, hotels, residential, retail, and restaurants, highlighted by the announced \$1 billion Union Row project. One of the keys to the success of these proposed developments is their proximity to the Innovation Corridor. The corridor includes approximately 1,398 total acres of developable land, or approximately 183 acres of land per mile, providing strong potential for transit-oriented development within ½ mile of the corridor.

A STOPS model was developed to estimate the ridership on the proposed BRT route as part of the alternatives analysis in May 2016, from which the Memphis Innovation Corridor was selected as the locally preferred alternative. The STOPS model was updated as part of this grant application to reflect improvements proposed as part of the Memphis Innovation Corridor.

From the updated STOPS model, the base year ridership is estimated to be 5,400 trips per day, with approximately 900-person trips per day shifting from auto to BRT. This results in a reduction of vehicle traffic along the corridor. Based on an auto occupancy rate of 1.3 persons per vehicle, a reduction of 700 cars per day could be realized based on the STOPS model analysis. For captive transit riders, the BRT route will improve their access by providing travel time reliability and timely access to employment centers and job opportunities.

Analysis was also conducted to understand the potential impact of the project on the movement of goods and people along the corridor and the surrounding area. The following existing information was used to develop a microsimulation model to evaluate the impact of the proposed improvements:

- 24-hour historic counts
- Intersection turning movement counts
- Roadway laneage and geometry
- Traffic signal timing and coordination data
- Corridor travel times from Regional Integrated Transportation Information System (RITIS)

The traffic simulation model was calibrated to match the current year travel times along the corridor for the peak periods of travel. Forecasts from the regional travel demand model were used to estimate the no-build growth along the corridor as a baseline for the analysis years of 2025 and 2040. The no-build traffic simulation model with the future no-build condition was then optimized and the baseline no-build travel time and delay were reported. No reduction in traffic volume was assumed due to the potential diversion from auto to BRT.

The regional travel demand model was then modified to replicate the proposed improvements along the project corridor. The change in future year volume was applied in the microsimulation model to estimate the travel time and delay in 2025 and 2040 with the proposed project. The no-build and build travel time and delay along the project corridor are shown in **Table 4**.

Table 4 – Travel Time and Delay Performance Measures

Performance Measure	Analysis Scenario							
	No Build				Proposed			
	2025		2040		2025		2040	
	AM	PM	AM	PM	AM	PM	AM	PM
Total Delay (hr)	63.1	94.3	77.8	125.1	66.1	95.3	66.1	95.3
Total Delay/Veh (sec)	123.4	175.7	134.3	199.9	132.3	193.7	132.3	193.7
Travel Time (hr)	158.5	206.9	184.9	250.6	157.6	202.9	157.6	202.9

The peak period travel time and delays are improved with the proposed improvements of the Memphis Innovation Corridor project. The reduction in travel time and delay represents improvement in the efficiency in movement of people and goods along the study corridor. The majority of trips during the peak periods are associated with commuting. It is expected **there will be a 15 percent or greater reduction in travel time and delay in the AM and PM peak periods** along the corridor in 2040, which is a dramatic reduction in the burden of commuting.

With the Memphis Innovation Corridor project, one lane of travel on Second Street and on BB King Boulevard will be converted from a general-purpose lane to a bus only lane while on-street parking will be retained. The number of lanes on Union Avenue will be reduced from six lanes to five lanes from Manassas Street to Poplar Avenue. The regional travel demand model was used to evaluate the impacts of this lane reduction. Due to corridor capacity constraints, the traffic volumes along Union Avenue are expected to grow by 1.02% by the year 2040. Overall, the grid network has multiple parallel facilities with excess capacity to absorb any traffic diversion. The travel demand model indicates there will be a slight reduction in the vehicle miles traveled and vehicle hours traveled in the area influenced by the proposed improvements. No excessive delays are expected in the area in 2040.

Union Avenue is currently a six-lane undivided roadway. As described in the section that addresses crashes, this six-lane undivided roadway makes it difficult for motorists to access commercial and residential properties that front the roadway. A five-lane roadway with a two-way left-turn lane will make these turning movements easier, and will reduce the potential for rear-end collisions for motorist waiting for a gap in opposing traffic to make a turn from Union Avenue. This will increase the efficiency of traffic flow along Union Avenue and will increase the patronage of those businesses.

For people and freight, the improvement in travel time and reduction in delay can also be quantified in terms of dollars. The USDOT *Figure 1 - Typical Section on Downtown Memphis North 2nd Street with Dedicated, June 2018*, provides recommended monetized values for travel time savings. Applying the value for in-vehicle travel for all purposes and for truck drivers, the **combined annualized peak period travel time savings and safety benefits due to the reduced number of crashes is over \$5.4 million annually.**

Environmental Sustainability

Although the project is an urban setting, it will enhance the natural environment through improved stormwater management, reduced energy consumption, reduced motor vehicle emissions, and reduced noise pollution. Based on an environmental screening, the project does



not impact wetlands, floodways or threatened or endangered species. The project will also enhance the redevelopment of brownfield sites. A brief description of the positive environmental impact of the project is as follows.

Energy Efficiency

One key element of the Memphis Innovation Corridor project is the use of electric buses as the BRT vehicles. Electric vehicles will improve the efficiency of energy use and reduce the dependency on petroleum products. A paper produced by the Environmental and Energy Study Institute in October 2018 states “The lower operating costs of BEBs (battery powered electric buses), however, make them more economical in the long run than internal combustion engine buses. It is about 2.5 times cheaper to power vehicles with electricity rather than diesel, and electricity prices are generally much more stable than gasoline or diesel prices. The U.S. National Renewable Energy Laboratory has found that the fuel economy of BEBs is five times higher than that of diesel buses operated on equivalent routes.”

Stormwater

The project will improve water quality and reduce storm water runoff along the project corridor through the installation of bioretention and other landscaping features, acknowledged as best management practices.

Bioretention areas will be installed in locations such as curb bump outs along North Second Street and BB King Boulevard between Union and MATA’s Hudson Transfer Center and at BRT station locations throughout the corridor. The bioretention features will capture and filter the storm water runoff before it gets to the storm water outfalls allowing for ground water recharge. These design elements are expected to lead to a more favorable review of the project by the Tennessee Department of Environment and Conservation (TDEC). **Figure 4** and **Figure 5** show a typical on-street bioswale application and a typical section, respectively.



*Figure 4 – Typical On-Street Bioswale Application
Source: National Association of City Transportation Officials (NACTO)*

The benefits of bioretention and infiltration as part of this project are the following:

- Reduces stormwater runoff, mitigating flood impacts and reducing pollution in local waterways
- Reduces urban heat island effects through evaporative cooling,
- Improves community livability through aesthetics, and
- Cultivates opportunities for public education and community awareness of water resource management.



The project lies within three watersheds with only one open drainageway that crosses the project. Cypress Creek crosses Poplar Avenue approximately 2,400 feet east of Union Avenue. Cypress Creek is identified by EPA’s EnviroMapper as an impaired stream, or a stream that has excess pollutants and is not clean enough to support recreational uses. There are no construction improvements proposed along this segment of Poplar Avenue.

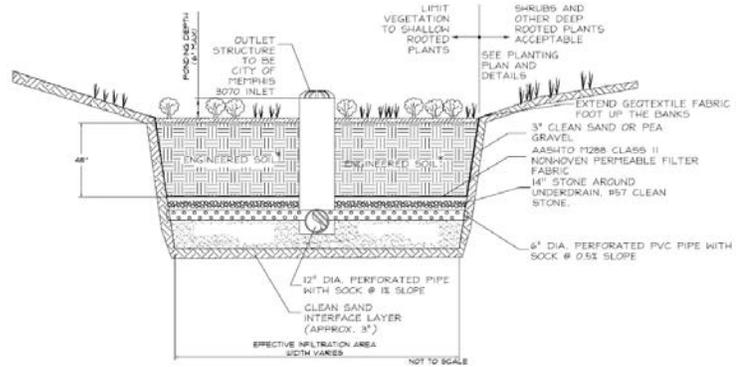


Figure 5 – Bioswale Typical Cross Section Detail
Source: Kimley-Horn and Associates, Inc.

Energy and Air Quality

The Environmental Protection Agency’s (EPA) Motor Vehicle Emissions Simulator (MOVES2014b) was used to estimate rates for fuel consumption and emissions of volatile organic compounds (VOC), nitrogen oxides (NO_x), particulate matter (PM_{2.5}), and sulfur dioxide (SO₂) for the study corridor. Planning assumptions used in the MOVES2014b rates estimates were from the most current conformity analysis and demonstration conducted for an Amendment to the Memphis MPO Fiscal Year (FY) 2017-2020 Transportation Improvement Program (TIP) and Livability 2040 Regional Transportation Plan (RTP) on October 27, 2017.

These rates were applied to the average annual daily traffic (AADT) based on the projected travel speeds to estimate the total fuel consumption and emissions for the build and no-build condition for the analysis years of 2025 and 2040. **Table 5** shows the results of the estimates of annual fuel consumption and emissions of pollutants for the year 2040 along the project corridor.

Table 5 – Corridor Level Motor Vehicle Emissions and Fuel Consumption

Pollutant	No-Build (tons/year)	Build (tons/year)	Percent Reduction
Volatile Organic Compounds (VOC)	1,268.9	1,180.2	7.5%
Nitrogen Oxides (NO _x)	3.5	3.1	14.5%
Particulate Matter (PM _{2.5})	154.9	135.3	14.5%
Sulfur Dioxide (SO ₂)	22.9	20.0	14.5%

The percent reduction in VOC emissions is 7.5%, and 14.5% for NO_x, PM_{2.5}, and SO₂ over the baseline for these emissions, resulting in cleaner air along the project corridor. The total fuel consumption along the project corridor was reduced by approximately 18,900 gallons per year or 14.5%. This reduction in fuel consumption is small, but will contribute to a reduced dependence on oil. The benefit in reduction in pollutants can also be quantified in terms of dollars. The USDOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs provides recommended monetized values for reduction in emissions. Applying the value for reduction in motor vehicle emissions, the benefit is over \$6 million per year in 2040.

There will also be a reduction in emissions resulting from the use of electric buses instead of the conventional diesel buses currently in use along the route. Diesel buses have an average of 274,400 lbs. of tailpipe greenhouse gas emissions per vehicle, while electric has zero. Use of electric buses decreases dependence on oil to power the vehicle. This reduction in pollution is not included in the results provided in **Table 5**.

Other Environmental Impacts

Electric buses operate more quietly than a diesel bus. A conventional diesel bus operates at 72 dB, while a comparable electric bus operates at 57 dB when in motion. The project corridor was screened to identify potential environmental impacts. The United States Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) map was reviewed to identify potential wetlands along the project corridor. Cypress Creek is the only drainage feature identified as a wetland in the project area. The Federal Emergency Management Agency (FEMA) flood maps were reviewed to identify any potential areas of risk for flooding. The majority of the alignment lies in an area designated by FEMA as an Area of Minimal Flood Hazard. There is a short section of Union Avenue, Second Street, and BB King Boulevard designated as Area with Reduced Flood Risk due to Levee as shown in **Figure 6**.

The U.S. Fish & Wildlife Service maintains records of rare, threatened and endangered species accessible through their Information for Planning and Consultation (IPaC) resource website. Using this resource, a project report was generated to identify threatened and endangered species that could be in the general vicinity of the project. The proposed project may contain multiple species that are either endangered or threatened which are shown in **Table 6**. Based on a review of the report, there are no critical habitats for the species identified below along the project corridor.

Table 6 - Threatened or Endangered Species

Species	Name	Category of Protection
Mammals	Indiana Bat	Endangered
	Northern Long-eared Bat	Threatened
Birds	Least Tern	Endangered

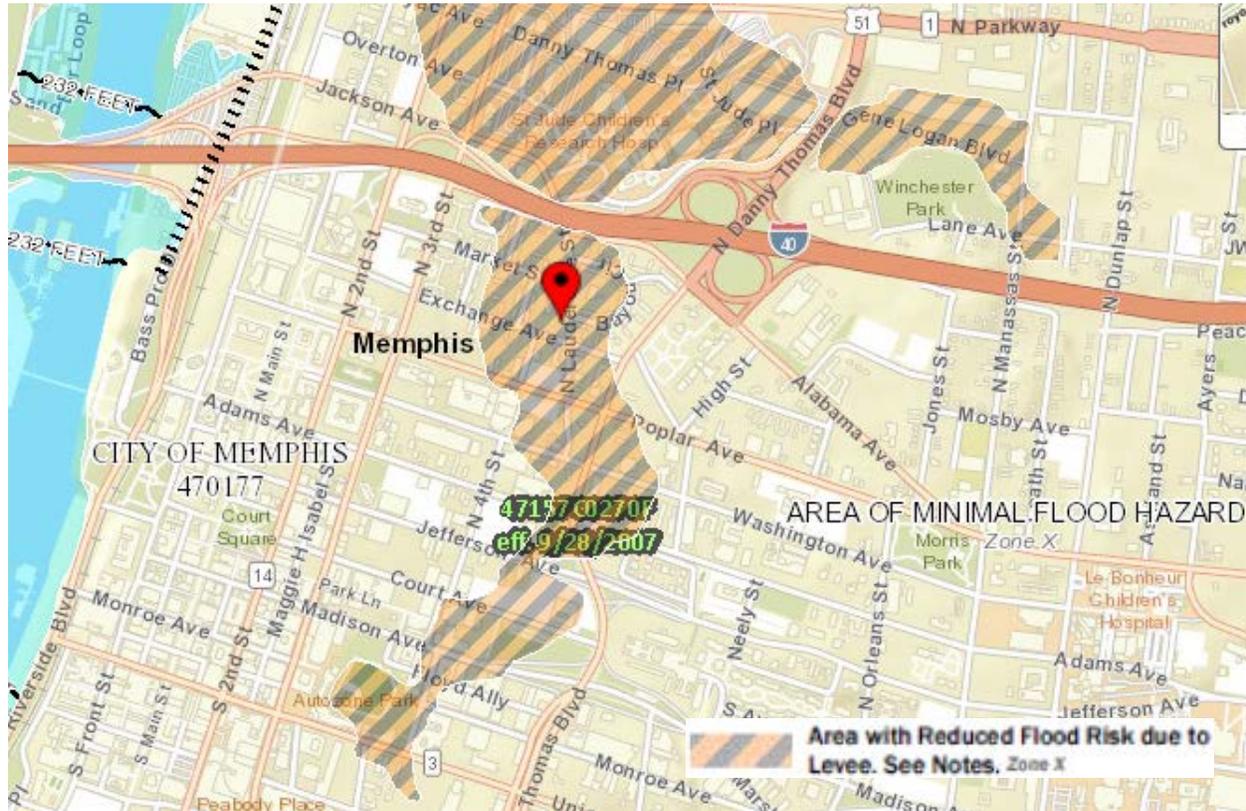
Based on a planning level environmental screening of the proposed corridor, **there are no impacts to wetlands, floodways or threatened or endangered species.**

Brownfield Redevelopment

Along the project corridor there currently are no EPA identified brownfield sites. If sites are identified, the project may have the opportunity for cleanup and re-use of these sites. Sites along Poplar Avenue and Union Avenue could potentially be used for BRT stations, depending on the final determination of the location of the stations. If brownfield sites are identified close to the potential BRT station sites, the brownfield sites would be evaluated based on several factors including the size of the property, the cost of the site remediation, and the ability of the property to be obtained in a timely manner, since the project right-of-way acquisition schedule will be short. If it is found that a brownfield site can be used for a BRT station, MATA will proceed with the acquisition and cleanup of the property, and the design and construction of the BRT station on that property.



Figure 6 – Minimal and Reduced Flood Risk Areas
 Source: Federal Emergency Management Administration (FEMA)



Quality of Life

The Memphis Innovation Corridor project will improve the quality of life for many Memphians. The Memphis 3.0 Comprehensive Plan and the Transit Vision project involved over 15,000 Memphians, some who are regular transit riders and others that do not ride transit at all. The common identified theme regarding how to improve transit service and increase ridership was to provide more frequent and reliable routes along the primary corridors. This project addresses that need. It will provide access to the Medical District, to entertainment and jobs in Downtown and Midtown Memphis, and to the University of Memphis. With ten-minute headways, the services will be frequent and reliable, making it a viable transportation option for everyone to gain access to essential services.

For people that are not transit dependent, a frequent, reliable BRT option will provide them alternative choices for transportation. Whether they are going to work, to dinner, or to a Memphis Grizzlies NBA game, people that live along the corridor will have a viable alternative to driving their own car, Uber, or a taxi.

For those that are transit dependent, the frequent, reliable service will give them more options for connecting to services and jobs in the corridor, but also to connect to bus routes that serve other areas. This will improve the opportunity for access to jobs or essential services that may have not been reasonably available before due to less frequent bus service.

One reason that this route was selected for this project was because of the jobs and services available within the corridor. The project passes within ½ mile of three universities and seven hospitals, including St. Jude Children’s Research Hospital; within ½ mile of AutoZone’s global corporate headquarters; within ½ mile of Memphis City Hall, and the Shelby County and Federal office buildings; within ½ mile of Beale Street and the FedEx Forum; and adjacent to AutoZone Park, Overton Square, the Benjamin L. Hooks Central Library, and the Peabody Hotel. Along this one BRT route, the community has access to every essential need from entertainment to hotels, to government services to health care to jobs to education to grocery stores to retail. Access to these many services and needs currently requires riders to transfer between buses at least once, if not more, and to rely upon buses with 30-minute to one-hour frequencies. This project will provide people access to all of these options on a BRT with 10-minute headways.

Since the transportation system along this corridor is already served by fiber optic cable communications, no new communications capabilities will be deployed as part of this project that could provide broadband service to the area.

Secondary Selection Criteria

Innovative Technologies

Innovative technologies will be implemented with this project to enhance the transportation system, to provide better service for the BRT patrons, to provide improved resilience, and to provide increased sustainability. These innovations include provision for connected autonomous vehicle technologies, bicycle detection, performance monitoring, adaptive traffic signal control, bio-swales, and LED street lights. The City of Memphis and MATA have the capacity to implement all of the innovative technologies listed below. No extraordinary permitting, approvals, or other procedural actions are required that will impact the project delivery timeline.

To enhance the safe operation of the BRT vehicles, Dedicated Short Range Communications (DSRC) devices will be installed in the traffic signal cabinets and the BRT vehicles. These devices will broadcast traffic signal phase and timing (SPaT) data to the BRT vehicles, providing advanced notice to the operators. The BRT operators will receive SPaT notifications before the traffic signals turn red and green so that the operators can make safe decisions regarding stopping the vehicles or proceeding through signalized intersections. These notifications will provide opportunities for safer operation of the vehicles. As the technology advances, it is anticipated that the DSRC devices will also be able to communicate road congestion information to the operators, allowing the operators and passengers to make decisions when unexpected conditions arise that may impact the BRT schedule. Since TDOT has adopted DSRC as the preferred communications method for the infrastructure to communicate with autonomous vehicles, this corridor will serve as the backbone for a future autonomous vehicle communications network.

The Advanced Traffic Management System (ATMS) will improve traffic flow and safety. Real time data will be collected from video detection devices, CCTV cameras, speed detection devices, and the traffic signal controllers and processed to provide information on changes in traffic flows or potential incidents. This data will be used to implement actions that will result in the improvement of traffic flow. Traffic signal maintenance personnel can be notified instantly of

equipment malfunctions. City traffic engineers can be notified of sudden changes in traffic flow, can use the video cameras to help identify the issues, and can notify emergency responders of incidents.

Through a separate grant, MATA is developing a process to measure the performance of the transit system. Information such as on time performance, ridership, and incidents will be collected in a cloud-based data exchange and will be aggregated into a useable operational asset. With the implementation of the Innovation Corridor, the same data will be collected for this corridor, which will allow MATA to easily monitor the performance of the BRT. The intention is that the successful implementation of this data exchange will lead to participation by more agencies and provide performance data for all modes of the transportation system.

One of the elements of the ATMS will be the adaptive control of traffic signals. This system is capable of changing the signal timing and phasing within the corridor to respond to changing traffic conditions. For instance, if an incident were to occur on I-240 that caused traffic to be diverted to Union and Poplar, the adaptive control system would recognize the unusual increase in traffic volume and adjust the signal timing, phasing, and coordination to accommodate the traffic flows. This system would also provide better traffic control for special events, such as events at FedEx Forum or the Liberty Bowl Memorial Stadium, by modifying traffic signal operations based on the traffic volumes. Historical data indicates that when properly designed and installed, adaptive signal control will result in improved traffic flow and reductions in congestion.

The ATMS will also provide real-time performance data to the City. This data will tell the traffic engineers how well the road system is operating, will allow the traffic engineers to compare existing operations to prior years, and will help to identify operational and maintenance issues before they become major problems. With this data, recurring and non-recurring congestion can be easily identified, allowing the City to take the appropriate actions to reduce congestion in the areas where the most benefits will be realized.

The ATMS will also provide reliable technology to detect bicyclists as they approach the signalized intersections within the corridor, alert the bicyclist of the approaching traffic signal, and provide the appropriate signal response to extend green times or provide green time for the bicyclists. Bicyclists that are traveling in all directions will benefit from this system.

The BRT vehicles and traffic signals will be equipped to provide Transit Signal Priority (TSP) systems. Memphis and MATA have installed a pilot project of GPS TSP on two corridors and have found it to be beneficial. The TSP will allow the traffic signals to provide early green times or extend green times when BRT vehicles approach, which will help the system to keep the vehicles on schedule without taking the traffic signal system out of coordinated operation. The TSP devices will also serve the dual role of Automated Vehicle Location (AVL) devices.

Other Intelligent transportation systems (ITS) equipment will be installed in the corridor. The City will extend the installation of Bluetooth travel sensors into this corridor to provide corridor travel times by segment and travel speeds. The video detection devices for traffic signal detection will also serve as traffic counters for bicycles and vehicles, providing better traffic

signal operations and providing data on the use of the facilities by both modes of travel. CCTV cameras will be installed for traffic observation purposes. As incidents are detected by the field devices, the traffic engineers will be able to observe the locations through both the CCTV cameras to help provide context and understanding of the incidents.

In addition to providing technological innovations, the Memphis Innovation Corridor will also implement systems that are more sustainable than current practices. Among those systems will be electric BRT vehicles and LED street lights. MATA has begun purchasing hybrid and electric buses and has seen the benefits in both reduced energy costs and improved air quality. MATA was recently awarded a \$20 million grant by TDOT to purchase electric buses and charging infrastructure. Therefore, the BRT vehicles purchased for this project will be electric.

The street lights throughout the corridor are a mixture of high pressure sodium and metal halide fixtures. These have proven to be reliable lighting fixtures for years, but they do not last as long and are not as energy efficient as LED lights. This project will replace over 600 existing street lights with the more sustainable option of LED fixtures.

Innovative Project Delivery

Innovative approaches to project delivery are being considered for this project. MATA is considering purchasing certain elements of the project equipment as separate procurements in order to expedite project delivery. One element is the purchase of the battery powered electric buses (BEB). The lead time on the purchase and delivery of BEB's is typically longer than the expected construction time of the other elements of the project. Further, since the project will include level boarding platforms for the BRT stations, pre-purchase of the BEB's will allow the design team to determine the BEB floor height before the construction project is bid, and therefore design the BRT stations to the correct heights for level boarding.

Other equipment that could be purchased separately to expedite the delivery of the project includes LED street light poles and fixtures, traffic signal priority equipment, and architectural elements of the BRT stations. In addition to assisting with expedited project delivery, pre-purchase of some of these items will help to control cost escalation and maintain the project budget.

Partnership

A key strength to this project is the dedicated coordination among several agencies, including MATA, the City of Memphis, Memphis MPO, Shelby County, the Memphis Medical District Collaborative, and Downtown Memphis Commission. These parties have worked collaboratively to support greater investments in transit in Memphis from planning (such as the AA and Transit Vision) to key projects (such as the Memphis Innovation Corridor Project). This application and project also has significant support from key stakeholders as evidenced by the letters of support in [Appendix A](#). A description of the primary project parties along with their roles is provided below.

The Memphis Area Transit Authority (MATA) is the public transportation provider for the Memphis area, and is the lead applicant for this FY 2018 BUILD Grant application. As one of the largest transit operators in the state of Tennessee, MATA proudly transports nearly 8 million

trips a year in the City of Memphis and other parts of Shelby County on fixed-route and paratransit buses, and vintage rail trolleys.

The City of Memphis had a population of 655,770 in 2017, making it the largest city in the state of Tennessee (2019 World Population Review). It is the largest city on the Mississippi River, the third largest in the greater Southeastern United States, and the 28th largest in the United States. The City is the responsible jurisdiction for the entire 8.5 miles of the project corridor. Approximately 2 miles of the corridor passes through downtown Memphis and links to the business, governmental, and tourism destinations located there. The City has committed 22% of the project budget and looks to continue investment in the corridor by taking advantage of the transit-oriented development tax increment financing (TOD TIF) tool to further invest in the corridor.

Shelby County is the State of Tennessee's largest county both in terms of population and geographic area, with a population of 927,644 at the 2010 census. Its county seat is Memphis. Shelby County is part of the Memphis Metropolitan Statistical Area, which comprises eight counties in the three states of Tennessee, Mississippi, and Arkansas.

The Downtown Memphis Commission (DMC), formerly known as the Center City Commission, is the organization charged with advancing Memphis and Shelby County by making Downtown Memphis a better place to work, live, learn, invest and visit. DMC's charge is to advance Downtown for the betterment of all of Memphis and Shelby County. A strong, vibrant Downtown serves as a vital economic engine that ultimately helps all communities throughout the county prosper and grow. As such, the City of Memphis and Shelby County governments established the Downtown Memphis Commission to capitalize on Downtown's role as the economic, cultural, and governmental heart of the city and county. The DMC is the official partnership between local government and the private business community in Downtown's development.

The University of Memphis (UofM) is an American public research university located in the Normal Station neighborhood of Memphis, Tennessee. Founded in 1912, the university has an enrollment of more than 23,000 students. With 25 Chairs of Excellence and five state-approved Centers of Excellence, the school is a flagship institution of Tennessee.

The Chief Executive Officers and leaders of some of Memphis' most significant public and private healthcare and higher education institutions have created a new nonprofit community development entity to direct the future of the Memphis medical district. This entity is called the Medical District Collaborative (MDC). The MDC is responsible for making the district, roughly defined as the area generally bordered by Poplar Avenue, Front Street, A. W. Willis Avenue, I-240, Vance Avenue, and Danny Thomas Boulevard between Downtown and Midtown, more livable, economically prosperous, clean, and safe. The member institutions include University of Tennessee Health Sciences Center, Region One Health, Methodist Le Bonheur Healthcare, Baptist College of Health Sciences, Memphis Bioworks Foundation, Southern College of Optometry, St. Jude Children's Research Hospital, and Southwest Tennessee Community College

The Tennessee Department of Transportation (TDOT) is a multimodal agency with responsibilities in highways, aviation, public transit, waterways and railroads. Their involvement includes funding, environmental permitting assistance and project design approval, since the majority of the project is within State of Tennessee right-of-way.

V. Project Readiness

Technical Feasibility

Basis of Design

The technical feasibility of the Memphis Innovation Corridor project is grounded in the Alternatives Analysis MATA conducted for this corridor that identified this alignment with BRT vehicles as the best alternative and the Locally Preferred Alternative. The Alternatives Analysis considered construction and operating costs, ridership, convenience to users, travel times, and development opportunities, among other factors. The information in the Alternatives Analysis has been supplemented with additional engineering and design studies to determine the project technical feasibility. As referenced in Section 4, the STOPS model and the Memphis MPO travel demand model have been used to estimate ridership for the BRT and to determine the impact on traffic of the addition of the BRT and the changes in road typical sections. The road and right-of-way widths have been checked at critical locations to make sure the existing road width and right-of-way width is sufficient for the proposed construction. Intersection and corridor capacity analyses have been conducted in accordance with the most recent version of the Highway Capacity Manual to determine the impact on the capacity and operational characteristics of the project corridor and the adjacent streets.

The results of these studies have shown that the proposed project can be built within the existing roadways. Some minor right-of-way acquisition may be required at some BRT station locations.

The change in roadway typical section along Union Avenue to provide the center left turn lane from Second Street to Poplar Avenue and dedicated bus lanes on Second Street and B. B. King Boulevard from Union to A. W. Willis Street will result in some vehicular traffic diverting to other roadways in the area. All of the roadways and intersections within the project corridor are projected to operate at level of service D or better on opening day and 20 years beyond opening day. With the implementation of the project, the intersections and roadway segments are expected to operate equivalent to or better than they are projected to operate without the project. In general, the travel speeds for the length of the corridor are expected to be slightly higher after project completion, which will also result in better transit travel times.

Based on these analyses and studies, the project is technically feasible. The road width and right-of-way are sufficient to accommodate the project. The roadway and intersection capacities are sufficient to maintain acceptable operational characteristics. And travel times in the corridor are expected to improve.

Design Criteria

The design criteria established for this project are based on improving traffic flow and safety while accommodating the BRT operation. Transit signal priority will be implemented throughout the corridor. Where appropriate, bus queue jump lanes or phase insertions will be provided. Traffic signal equipment will be upgraded as needed to accommodate the transit signal priority

and to meet PROWAG requirements. Pedestrian safety will be addressed through the inclusion of new pedestrian mid-block cross walks at locations with high pedestrian activity and pedestrian countdown signals. Transit only lanes will be provided on Second Street and B. B. King Boulevard to aid with the efficient movement of transit vehicles. Union Avenue will be converted from six lanes to five lanes to provide turn lanes at intersections, two-way left turn lanes between intersections, and improved lane widths to enhance traffic flow.

Basis for cost estimate

The Project cost estimate is based on the scope of the project as described in this application. For items that are known, such as the limits of paving and striping and the extent of the traffic signal modifications, costs from recently bid projects in the Memphis area and TDOT average unit cost data were applied to the quantities of each of those items to determine the projected costs. Ten percent contingencies were added to those items.

For items that are not yet well defined, such as the BRT stops, costs from similar projects were used, inflated to the current year, and a 20% minimum contingency was added. A 50% contingency was added to the projected cost of the right-of-way.

Scope, Schedule, and Budget Risk Mitigation

The scope of the project is well defined. Changes to the scope will most likely be driven by budget issues, public input, NEPA findings, or changes in federal regulations. For instance, the scope and schedule currently takes into account upgrading the roads to meet current ADA requirements. In Tennessee, the DOT has adopted the current version of PROWAG, and the scope reflects that. However, since PROWAG has not yet been adopted, there is the possibility that its requirements may change or that the interpretation of the requirements may change. If that happens, those changes could impact the scope, schedule, and budget of the proposed improvements. Flexibility has been built into the scope of the project as described in the NEPA documents in anticipation of some changes in regulations. So, the extent of the changes will determine if the risk has been adequately mitigated. If the scope of the project changes significantly after the NEPA document has been approved, a re-evaluation of the NEPA document may be required, which would likely cause delays to the project design completion.

Budget risks have attempted to be mitigated by using reasonable contingencies based on the status of the design at this time, as described in the “Basis for Cost Estimate” section. Schedule risk mitigation is discussed in the Project Schedule section.

Detailed Statement of Work

The project will consist of providing an on-street bus rapid transit system with some portions in transit only lanes and other portions mixed with traffic. The project connects the MATA Hudson Transit Center to the University of Memphis. The route, as shown in Figure 1-1, includes routing BRT vehicles on the one-way pair of Second Street and BB King Boulevard between A. W. Willis Avenue and Union Avenue, Union Avenue from Second Street to Poplar Avenue, Poplar Avenue from Union to the University of Memphis campus, Central Avenue from the University of Memphis campus to Highland, and Highland Street from Central Avenue to Poplar Avenue. The project will have a typical section on Second Street and B. B. King Boulevard of two through lanes, one transit only lane, and on-street parking. Union Avenue from Second Street to Manassas will remain a five-lane section with the BRT vehicles mixed with other traffic.

From Manassas Street to East Parkway, Union will be converted from a six-lane section to a five-lane section with a center turn lane. The right-hand lane will be jointly used by cars and BRT vehicles. Union Avenue from East Parkway to Poplar will maintain the existing typical section. Poplar Avenue from Union Avenue to Deloach Street will remain seven-lanes wide. The corridor will enter the University of Memphis campus on Conlee Street and then exit the campus on Central Avenue. The project will follow Central Avenue from Conlee Street to Highland Street and then follow Highland Street to connect to Poplar Avenue. On both Central Avenue and Highland Street, the BRT vehicles will be mixed with the other traffic and no changes are planned to the street typical sections. A mid-block cross walk is planned on Poplar near Tillman to service the City’s main library. MATA and the University of Memphis are working to develop a plan that will provide a BRT vehicle charging station on the University of Memphis campus.

The project will include paving, striping, signing, replacement or modification of 54 traffic signals to provide transit signal priority, construction of new transit stops, deployment of intelligent transit system devices at each stop, purchase of nine new low-floor electric buses, and charging stations. The traffic signal modifications will include making all traffic signals accessible and ADA compliant. A total of 28 BRT stops are planned for the project. Those stop locations will include the Hudson Transit Center and the University of Memphis. It is anticipated that BRT vehicle maintenance will be provided at the existing bus maintenance facility. Modifications to the existing facility may be required to accommodate the BRT vehicle needs. Those modifications have been included in the project budget.

Work on the BRT project that is the subject of this application has already begun with the Locally Preferred Alternative being selected in the AA Study. The environmental clearance documentation is underway. Preliminary engineering in support of the NEPA document is underway. After FTA review and approval of the NEPA document in May 2020, approximately 2 months is needed for additional design and engineering work to prepare the right-of-way acquisition plans. The right-of-way acquisition will be completed by April 2021. Final design will occur concurrent with the right-of-way acquisition. Based on a second FTA review and approval date of March 2021, the final construction obligation of funds will occur prior to September 30, 2021. Construction activities will take place over the next 45 months, concluding in March 2025. Systems testing will take 9 months and revenue service is anticipated to begin in January 2026. The Memphis Innovation Corridor (BRT) project schedule is summarized in **Figure 7**.

Figure 7 – Project Schedule



Required Approvals

National Environmental Policy Act (NEPA)

The Alternatives Analysis completed for the Memphis Innovation Corridor project included an overview of potential environmental constraints. Based on the preliminary evaluation, permitting assessment, coordination with some resource agencies, and public involvement conducted during both the Alternatives Analysis and the Memphis Transit Vision project, **the project will not significantly impact the natural, social or economic environment**. Since the project will not likely involve major demolition, infringement on environmentally sensitive areas, or disturbance of historical or cultural sites, and right-of-way acquisition will be minimal, it is anticipated that the project will likely require a Categorical Exclusion. FTA has concurred with this opinion and stated that the project should proceed as a Documented Categorical Exclusion. The project is expected to have no violations of Federal, State and local environmental regulations. Agency coordination will be conducted with the applicable resource agencies including the City of Memphis, Shelby County, Tennessee Department of Environment and Conservation, Tennessee Historical Commission, Native American tribes, US Environmental Protection Agency, and US Fish and Wildlife Service at a minimum. A Categorical Exclusion environmental document is currently being developed and is estimated to be completed and approved by May 2020. The detailed schedule is as follows:

- **July 2019** – The Area of Potential Effect (APE) will be submitted for FTA review
- **August 2019** – Tennessee SHPO review of APE.
- **October 2019** – The field survey and National Register Evaluation Report will be submitted to FTA for review
- **November 2019** – Tennessee SHPO to review field survey and National Resources Evaluation Report.
- **January 2020** – The draft DCE and the assessment of effects report will be submitted to FTA for review.
- **March 2020** – The Assessment of Effects report will be submitted to Tennessee SHPO for review. Prepare Section 4(f) evaluation
- **May 2020** – Final DCE submitted to FTA for review and approval.

The lead federal agency for the NEPA documentation will be the Federal Transit Administration (FTA).

Reviews and Permits by other Agencies

The Tennessee DOT will provide design review of the portion of the alignment that is on state routes. In addition, TDOT is required by State law to provide approval for the transit only lanes on Second Street and B. B. King Boulevard. A resolution supporting the transit only lanes was passed by the Memphis City Council on October 9, 2018. The TDOT Commissioner was sent a letter from the City of Memphis on November 18, 2018, requesting approval of the transit only lanes. TDOT has verbally agreed to the transit only lanes on Second Street and B. B King Boulevard, and a letter confirming that approval is forthcoming. TDOT also must approve the conversion of Union Avenue from Manassas Street to East Parkway from six lanes to five lanes. TDOT is developing the criteria for how this request will be evaluated. Based on the final criteria, it is expected that the required study will be submitted to TDOT for review and approval in September, 2019.

Tennessee state law requires two distinct utility coordination periods. The Early Utility Coordination period of 70 days is used to identify any utility companies or Native American tribes that may have facilities or an interest within the project boundaries. Once those groups have been identified, Utility Plans will be provided to them for review. The groups will have 120 days to review the plans and to notify the City of any conflicts or concerns. The end of these utility notification periods will occur at the end of July 2020, when the Right-of-Way acquisition process begins. That will allow up to eleven months to resolve any utility conflicts.

Any environmental permits required before construction begins will be submitted to the appropriate agencies once the design has progressed to the point at which those permits can be appropriately determined.

The environmental studies that describe the project impacts will be posted to the project website once the studies have been completed.

A meeting will be held with FTA in July 2019 to discuss the project's compliance with NEPA and other Federal environmental reviews.

Throughout the AA process, the development of the Transit Vision, and the development of Memphis 3.0 Comprehensive plan, hundreds of public engagement meetings were held in which this project was discussed. Documentation of those studies and their related meetings can be found in at www.memphis3point0.com. Further, additional public engagement will be conducted for this project throughout the NEPA, design, and construction phases of the project.

State and Local Planning Approvals (TIP and STIP)

The BRT element of this has been reviewed by the appropriate legislative authorities under MATA, the City of Memphis, and Shelby County, and has been approved to proceed. The locally preferred alternative was approved by the Memphis MPO Transportation Policy Board in May 2017.

The project is in the current Memphis MPO Regional Transportation Plan (RTP) and the current local and State Transportation Improvement Programs (TIP/ STIP). The TIP and STIP will need to be modified once the grant is awarded to include the grant funding. Because the Memphis MPO area is designated as a maintenance area for precursors to ozone, TIP amendments normally require an air quality conformity analysis. However, since this amendment is just to add a funding source, the amendment will be considered as exempt from the air quality conformity analysis process, which should allow the TIP to be amended administratively. The Memphis MPO RTP and TIP can be found at www.memphismpo.org. These documents and the STIP can be found in [Appendix E](#).

MATA undertook an extensive public involvement process as part of the Alternative Alignment study. Further, as part of the Memphis Transit Visioning Study, the public reaffirmed the desire for more frequent transit service along Union Avenue and Poplar Avenue. During the final stakeholders and public review of the Alternatives Analysis, several changes were made to the Locally Preferred Alternative. Those changes have been incorporated into the project and will be carried forward into the NEPA process.

Assessment of Project Risks and Mitigation Strategies

For any project that involves construction there is a risk of delays. Since we have locally managed federally funded projects for both FTA and FHWA, we understand those risks and have built time into our schedule to minimize those risks. We have also planned to conduct concurrent activities to reduce the total project time. For the Memphis Innovation Corridor, the primary risks are environmental approvals, increases in real estate acquisition costs, funding, and approval time for state and federal agencies.

The City of Memphis and MATA are committed to this project and have budgeted funds in the Capital Improvements Program, the RTP, and the TIP for the project. The procurement process for projects using federal funds is a process we are familiar with and know how to manage. The risks associated with those items are that the local CIP funds will not get appropriated for the required local match funding and that the Federal funds identified are not made available to Memphis and MATA. This risk is being mitigated through regular discussions with the Mayor and other elected officials to remind them of the importance of this project to the balance of the transit system and of their commitment to fund the project. The project is included in the current RTP and TIP and in the new RTP and TIP that will be officially approved in August 2019. Applications are being prepared for additional federal and state grants to fund design and construction as they become available.

From the project assessment conducted as part of the Alternatives Analysis, there should not be any environmental issues that cannot be addressed as part of a Categorical Exclusion. The project will generally be constructed within the existing right-of-way, which minimizes the potential risks involved with property acquisitions, hazardous materials impacts, native American properties, and water resources impacts. The project borders several historic districts, so additional time has been allotted for coordination with the State Historic Preservation Officer (SHPO). From recent previous projects, we understand the SHPO requirements and the information needed to satisfy their concerns. Coordination with SHPO will be one of the first tasks undertaken as part of the NEPA process. The additional time built into the schedule for SHPO coordination should mitigate the potential risks associated with the environmental reviews.

In a healthy economy, there is always a risk of the right-of-way acquisition costs exceeding budget. Recognizing that potential, the project budget for property acquisition was developed based on inflated property values, potential damages to business activities, and using a generous approach to identify the number and size of acquisitions required. We also recognize that the property owners' inflated perceived values of their property will likely impede the acquisition process. Therefore, we built in time to the schedule for appraisals, appraisal reviews, and negotiations, allowing the acquisition process to begin as soon as the NEPA document has been approved.

The remaining known risk is one that we have no control of - that is the review and approval times by the state and federal agencies. For instance, approval of a categorical exclusion can take anywhere from a week to six months. Right-of-way certification by TDOT can be impacted by decisions to change forms or approval processes. If those changes are not communicated with the City, significant delays, including time to get the right-of-way documents re-signed by the

property owners can occur. Similar delays can occur at any of the state and federal agency review points. To attempt to mitigate this risk, we will proactively communicate with the lead agency (FTA) throughout the project to make sure they are aware of upcoming submittals, that they know about any unusual conditions before the submittals, and to try and address concerns before the formal submittals are made. We have also allowed extra time in our schedule for the state and federal reviews.

Based on our previous experience locally managing projects that have state and federal funding, we have developed a realistic schedule that addresses all elements of the project. The schedule includes conducting concurrent activities as permitted and provides extra time for the items that have the most risk. We are familiar with the approval processes required by the federal funding and have successfully completed several other projects following those steps. We are confident that we can successfully implement this project in a timely manner.

Project Partnership

The Memphis Innovation Corridor Project includes commitments from State and Local sources constituting 29% of the project budget. Evidence of funding or cost-sharing commitments from State and City sources can be found in [Appendix E](#). MATA is pursuing additional State and Local funding opportunities to replace planned federal investment and recoup committed city investments. The State of Tennessee offers competitive awards for transportation projects through its IMPROVE Act. MATA will seek \$9 million over 3 years in the State's upcoming call for applications that will replace Federal (non-BUILD) funding in the project budget.

The City is also pursuing creation of a development plan for a transit-oriented development tax increment financing (TOD TIF) zone along the corridor to supplement the BUILD award with additional investment in technology, capital infrastructure, green infrastructure, and mixed-use development over time. The TOD TIF was created by the State of Tennessee in 2016 to augment transit-rich areas like the Memphis Innovation Corridor. The TOD TIF is supported by connecting two of the City's Opportunity Zones.

Construction

Construction is anticipated to take approximately 36 months. With the contract beginning in Spring 2022, the contractor will be starting in the middle of the construction season in Memphis. Efforts will be made to speed up the construction process, such as requesting approval from TDOT to place asphalt and concrete anytime the weather is warm and dry enough, which could allow the contractor to work year-round. With good weather, the contractor could complete the project as much as 9 months early.

However, if the construction takes 36 months and 9 months is allowed at the end of the construction for system testing and training, the construction and system testing is projected to be complete by Spring 2026. This schedule leaves six months of cushion to accommodate any unforeseen circumstances. However, since the construction activities are primarily above ground, few unforeseen circumstances are expected to arise.

VI. Benefit Cost Analysis

A Benefit-Cost Analysis (BCA) was conducted to identify, estimate, and quantify the expected benefits of the project compared to the baseline condition. The analysis was conducted using U.S. DOT’s *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, June 2018. The monetary estimates of benefits developed accounted for inflation. A second adjustment was made to account for the time value of money. A 7 percent per year rate was used to discount streams of benefits and costs to their present value. Sources of data used in the BCA are documented in [Appendix B](#).

The results of the BCA show that project will significantly enhance the welfare of communities along the project corridor. The Memphis Innovation Corridor project will increase and promote safe, efficient, affordable, healthy, and sustainable transportation options, and improve access to job centers, education and medical services, especially for low-income families. The project also has the potential to attract new businesses and spur economic development in historically disadvantaged communities. **Table 7** provides a description of the baseline criteria and summarizes the changes and associated benefits expected from the project.

Table 7 – Baseline Categories and Type of Benefits

Baseline Category	Description / Type of Benefit
Change to Baseline Condition	Implementation of BRT with Transit Signal Priority Reduced general purpose travel lanes on Union Avenue
Type of Impacts	Improved Safety Reduced Travel Time and Delay
Population Affected by Impacts	Bus service users, transit agency, roadway users, roadway agency, and utility service provider
Economic Benefits	Improved safety Travel time savings Emissions reductions from bus and cars Reduced operations and maintenance costs
Summary of Results	Safety benefits Estimated dollar value of time savings Reduced pollution Lower transit and roadway operation and maintenance cost

Overall, the project is expected to generate **over \$105.5 million in benefits** over a lifecycle of 34 years. Benefits will accrue primarily to non-auto users (bus riders, cyclists and pedestrians) and low- income households. A summary of the BCA results for the merit criteria are shown in **Table 8**.

Table 8 – Estimate of Benefits by Selection Criteria and Long-Term Outcome

Selection Criteria – Long Term Outcome	Baseline Category	7% Discount Rate
Safety	Reduction in Crashes	\$32,601,829
State of Good Repair	Pavement Maintenance Cost Savings	\$83,068
	Residual Value	\$ -
	Reduced Non-Recurring Congestion	\$ -
	Transit Operations and Maintenance Costs	\$ -
	Improved Pedestrian and ADA Compliance	\$ -
Economic Competitiveness	Travel Time Savings	\$25,152,130
	Vehicle Operating Cost Savings	
Environmental Protection	Reduction in Motor Vehicle Emissions	\$47,669,263
	Reduction in Vehicle Noise Pollution	\$ -
Quality of Life	Improved Transportation Choice	\$ -
	Improved Access to Jobs	\$ -
Innovative Technologies		\$ -
Agency Benefits	Sum of Benefits	\$105,506,290
	Fare Revenue	\$3,403,391

The blank values in the table represent real positive benefits associated with the project that were not quantified in the BCA. Considering all monetized benefits (user as well as non-user) and costs (capital as well as operating and maintenance costs), the internal rate of return of the project is estimated at 9.1 percent. With a 7 percent real discount rate, the \$73.8 million investment would result in a net present value of \$18.8 million and a benefit/cost ratio of 1.32. **Table 9** summarizes the results of the benefit-cost analysis. The full benefit-cost analysis is available as [Appendix B](#).

Table 9 – Summary Results of the Benefit/Cost Analysis (Year 2019 Dollars)

Project Evaluation Metric	7% Discount Rate
Total Discounted Benefits	\$ 105.5
Total Discounted Operation & Maintenance Costs	\$ 28.3
Total Discounted Capital Costs	\$ 58.4
Net Present Value	\$ 18.8
Benefit / Cost Ratio	1.32
Internal Rate of Return (%)	9.1%
Payback Period (years after start of construction)	16