

APPENDIX D

MADISON EAST-WEST BRT

Documented Categorical Exclusion

Service Plan and Operations and Maintenance

Costs

May 10, 2022

Prepared for:

City of Madison



Prepared by:

SRF Consulting Group

Commonwealth Heritage Group

Cross-Spectrum Acoustics

MADISON EAST-WEST BRT

Service Plan and Operations and Maintenance (O&M) Cost Memo

Original Submittal **August 2020**

Updated March 2022

Prepared for:

City of Madison



Revision History

Revision	Revision date	Details	Prepared By

Service Plan and Operations and Maintenance (O&M) Cost Memo

This document provides an update to an August 2020 memo that presented the proposed service plan, operating statistics, and O&M cost for the Madison BRT project and background bus service changes.

There are two sections to this document. The service plan includes operational details for proposed BRT service, including alignments, frequency, service span, and operating statistics. The service plan section also describes all background bus service changes that are proposed to occur with the implementation of the BRT. These background bus changes primarily focus on routes that operate on the locally preferred alternative (LPA) corridor along University Avenue and E. Washington Avenue and consists of eliminated routes and adjustments to existing service alignments and frequencies.

The second section, O&M Cost Estimate, takes the operating statistics generated from the service plan and applies them to the O&M cost model to determine the annual O&M cost impact of the project.

This project is being submitted to the Federal Transit Administration as a Small Starts Warrant Project under 5309 Fixed Guideway Capital Investment Grants Program.

Since completion of the 2020 memo, Metro Transit has been engaged in a bus network redesign project. Draft recommendations are currently in place for public review and comment. Adoption of the redesign network is expected in early Summer 2022. Since that network significantly changes service coverage characteristics for the entire Metro Transit service area, and since this plan is not yet adopted, it was determined that the evaluation of BRT-related impacts should still be measured against the Metro Transit network that was in place pre-COVID (i.e., the network that was the basis for the August 2020 Service Plan memo).

Service Plan

This section provides details on proposed BRT facilities, the BRT service plan, and background bus changes that are proposed to support the BRT. Details in this section include proposed frequencies, service span, and alignments for the BRT and background bus service.

BRT Runningway

The proposed East-West BRT will operate between the east and west sides of Madison between the East Towne Mall and High Point Road primarily along E Washington Avenue, through the Isthmus, and University Avenue, near the University of Wisconsin-Madison (UW). **Figure 1** presents the proposed BRT runningway and station locations. This figure identifies proposed locations for center and side bus lanes, and locations with mixed traffic operations.

BRT Service Plan

To provide sufficient capacity, the BRT service needs to have more frequent service in the core parts of the route than it does in the outer areas. To accomplish this, the BRT operating plan will consist of three service patterns that overlap through the core of the system. To minimize unnecessary transfers, all

three patterns will have short stretches that operate as a local service. The following describes each proposed BRT service pattern:

- **Red Line Pattern:** This pattern operates between the East Towne Mall and High Point Road mainly along E Washington Avenue, University Avenue, and Mineral Point Road. For purposes of this service plan tech memo, a connection to the West Transfer Point is assumed. On the east end of the alignment, this pattern splits into two alignments, each operating in mixed traffic with local stop service. One pattern (route pattern A) goes to the Sun Prairie park-and-ride lot. The other (route pattern B) goes to Metro Transit's proposed satellite maintenance facility located along Hanson Road. Electric-powered buses are planned for this service pattern.
- **Green Line Pattern:** This pattern provides service connecting the North and South Transfer Points, using BRT infrastructure between Park Street and First Street. This pattern operates in mixed traffic when not within planned BRT infrastructure. The alignment for the Green Line pattern currently assumes Packers Avenue to the North Transfer Point and Park Street to the South Transfer Point. Service on this pattern is assumed beyond these locations but has been left undefined in this memo. The network redesign project does include service extensions that are not covered in this memo, but those service extensions are related to the network redesign project and are not specific to the BRT project. Electric-powered buses are planned for this service pattern.
- **Blue Line Pattern:** This service runs from Middleton to the Capitol Square, using BRT infrastructure between Eau Claire Station and the Capitol Square. Three distinct services will be used to operate the Blue Line pattern. Existing Routes 71 and 72 trips that start in Middleton will be branded as peak period Blue Line service. In the midday, Blue Line service will just operate between Eau Clair Station and Capitol Square. Note that draft network redesign recommendations include modifications to this service pattern that are not covered in this memo, for those changes are related to the network redesign project and not specific to the BRT project. Diesel-powered buses are planned for this service pattern.

Figure 2 displays the East-West BRT service patterns. Dashed lines for all three patterns reflect locations where BRT service patterns would operate without BRT infrastructure.

Figure 1: East-West BRT Alignment and Station Locations

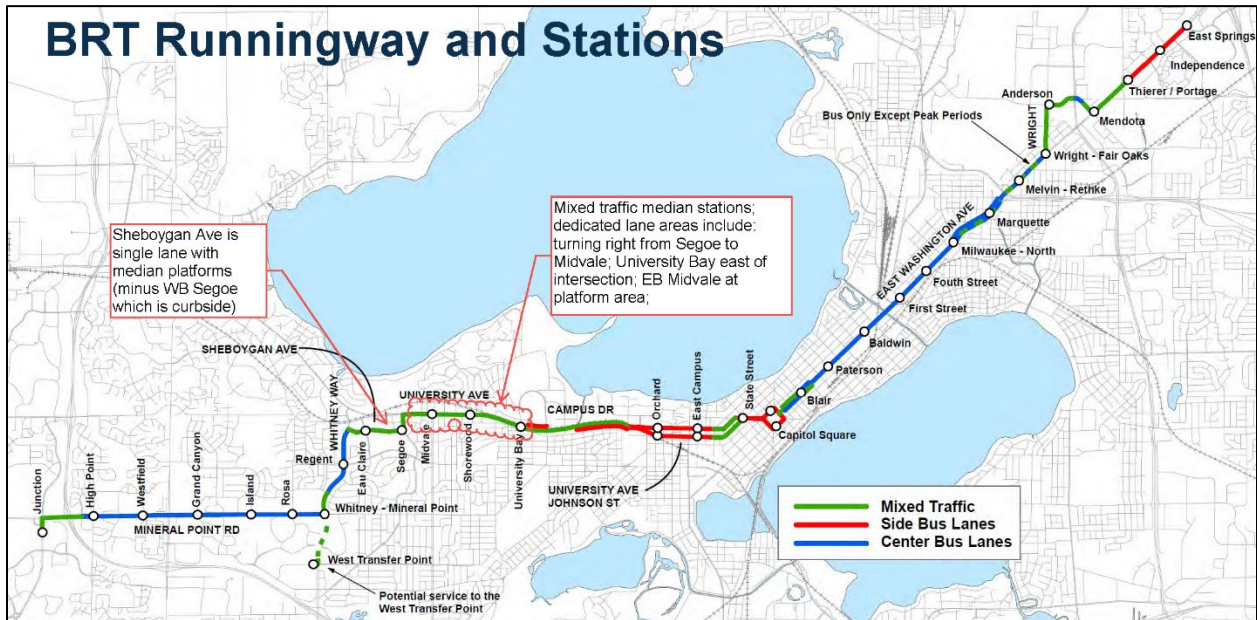


Figure 2: Proposed BRT Service Patterns



All three service patterns are proposed to operate at 15-minute peak and midday frequencies on weekdays, resulting in a combined 5-minute frequency in the trunk portion of the alignment (between East Campus and First Street). Reduced frequencies are assumed in the evenings and weekends. The proposed BRT span of service is similar to most of the city’s other fixed route service with weekday service. **Table 1** details proposed headways and span for the East-West BRT service. **Table 2** displays projected BRT service requirements.

Table 1: BRT Proposed Headway and Span

		Red Line (A+B)	Green Line	Blue Line (71+72)	Blue Line (Short)
Weekday	<i>Early</i>	30 min	30 min.	-	-
	<i>AM Peak</i>	15 min	15 min.	15 min	-
	<i>Midday</i>	15 min	15 min.	-	15 min
	<i>PM Peak</i>	15 min	15 min.	15 min	-
	<i>Evening</i>	30 min	30 min.	-	-
Saturday	<i>AM Peak</i>	30 min	30 min.	-	-
	<i>Midday</i>	15 min	30 min.	-	-
	<i>PM Peak</i>	15 min	30 min.	-	-
	<i>Evening</i>	30 min	30 min.	-	-
Sunday	<i>AM Peak</i>	30 min	30 min.	-	-
	<i>Midday</i>	30 min	30 min.	-	-
	<i>PM Peak</i>	30 min	30 min.	-	-
	<i>Evening</i>	30 min	30 min.	-	-

		Red Line (A+B)	Green Line	Blue Line (71+72)	Blue Line (Short)
Weekday	<i>AM Peak</i>	5:00a-6:00a	5:00a-6:00a	-	-
	<i>AM Peak</i>	6:00a-9:00a	6:00a-9:00a	6:00a-9:00a	
	<i>Midday</i>	9:00a-4:00p	9:00a-4:00p	-	9:00a-4:00p
	<i>PM Peak</i>	4:00p-7:00p	4:00p-7:00p	4:00p-7:00p	
	<i>Evening</i>	7:00p-12:00a	7:00p-12:00a	-	-
Saturday	<i>AM Peak</i>	6:00a-8:00a	6:00a-8:00a	-	-
	<i>Midday</i>	8:00a-4:00p	8:00a-4:00p	-	-
	<i>PM Peak</i>	4:00p-7:00p	4:00p-7:00p	-	-
	<i>Evening</i>	7:00p-11:00p	7:00p-11:00p	-	-
Sunday	<i>AM Peak</i>	6:00a-8:00a	6:00a-8:00a	-	-
	<i>Midday</i>	8:00a-4:00p	8:00a-4:00p	-	-
	<i>PM Peak</i>	4:00p-7:00p	4:00p-7:00p	-	-
	<i>Evening</i>	7:00p-11:00p	7:00p-11:00p	-	-

Table 2: BRT Service Requirements

BRT Pattern	1-Way Distance	Avg. Speed	1-Way Time	Day	Headway					Total Trips	Daily			Annual	
					Early	AM	Mid	PM	Eve		Pk Bus	Rev.-Hr.	Rev.-Mi.	Rev.-Hr.	Rev.-Mi.
Red Line - Pattern A Junction to East Springs & Sun Prairie P&R (w/ deviation to W. Transfer Pt.)	19.10	17.0	67.0	M-F	60	30	30	30	60	64	5.5	90	1,222	22,800	311,700
				Sat	n/a	60	30	30	60	54	5.5	76	1,031	3,900	52,600
				Sun	n/a	60	60	60	60	34	3.0	51	649	3,100	39,000
Red Line - Pattern B Junction to East Springs & Metro Garage (w/ deviation to W. Transfer Pt.)	19.60	17.0	69.0	M-F	60	30	30	30	60	64	5.5	90	1,254	22,800	319,900
				Sat	n/a	60	30	30	60	54	5.5	76	1,058	3,900	54,000
				Sun	n/a	60	60	60	60	34	3.0	51	666	3,100	40,000
Green Line South Transfer Point to North Transfer Pt.	7.50	14.0	32.0	M-F	30	15	15	15	30	128	6.0	96	960	24,500	244,800
				Sat	n/a	30	30	30	30	68	3.0	51	510	2,600	26,000
				Sun	n/a	30	30	30	30	68	3.0	51	510	3,100	30,600
Blue Line - Route 71 Middleton to Capital Square	15.42	23.1	40.0	M-F	n/a	30	n/a	30	n/a	24	4.0	24	370	6,100	94,300
				Sat	n/a	n/a	n/a	n/a	n/a	0	0.0	0	0	0	0
				Sun	n/a	n/a	n/a	n/a	n/a	0	0.0	0	0	0	0
Blue Line - Route 72 Middleton to Capital Square	15.42	17.8	52.0	M-F	n/a	30	n/a	30	n/a	24	4.0	24	370	6,100	94,300
				Sat	n/a	n/a	n/a	n/a	n/a	0	0.0	0	0	0	0
				Sun	n/a	n/a	n/a	n/a	n/a	0	0.0	0	0	0	0
Blue Line - Middy Eau Claire to Capitol Square	4.50	14.0	19.0	M-F	n/a	n/a	15	n/a	n/a	56	0.0	21	252	5,400	64,300
				Sat	n/a	n/a	n/a	n/a	n/a	0	0.0	0	0	0	0
				Sun	n/a	n/a	n/a	n/a	n/a	0	0.0	0	0	0	0
BRT System Totals											25		107,400	1,371,500	

Note:
1. One half buses are shown on the Red Line patterns to reflect interlining of the two service patterns.

BRT Fleet Requirements

As previously noted, the Green Line pattern is assumed to operate from the South Transfer Point to the North Transfer Point in this analysis. As part of the redesign effort, this route pattern is likely to be extended. An additional two peak buses are assumed in the fleet estimates for that extension, resulting in a need for 27 peak buses. A 20 percent spare ratio is proposed, resulting in the need for 33 peak buses. A charging facility for the north-south Green Line pattern is presently not planned to be on the route, thus necessitating the need for a midday swap of buses. An additional 8 fleet buses is assumed for that swap (i.e., doubling the peak bus requirement for that service pattern). This results in a need for a total of 41 fleet buses. Table 3 provides a breakdown of buses by service pattern and by propulsion type (diesel vs. electric).

Table 3: BRT Fleet Bus Calculations

BRT Pattern	Electric Buses	Diesel Buses	Total Buses
Red Line	11	-	11
Green Line ¹	8	-	8
Blue Line	-	8	8
Total Peak Req't.	19	8	27
Spares (20%)	4	2	6
Fleet Estimate	23	10	33
Add'l. Green Line Buses ²	8	-	8
Total Fleet Req't.	31	10	41

Notes:
1. An additional 2 peak buses assumed on Green Line for service extension beyond North/South Transfer Pts
2. Green Line peak bus req't. doubled to allow for midday swap of fully-charged buses.

Background Bus Service Changes

The introduction of BRT service provides an opportunity to modify service on other Metro Transit routes in the network, particularly with routes that operate on the LPA corridor along University Avenue and E Washington Avenue.

Background bus service changes consist of several eliminated routes and adjustments to existing service alignments and frequencies. Service spans were generally not modified as part of this analysis. Note that service changes proposed here are assumed for the purposes of estimating BRT project-related service changes and O&M costs for the background bus network. As previously noted, Metro Transit is in the midst of completing a network redesign project that will dramatically alter transit service in Madison beyond this BRT project. Thus, service modifications described in this section are solely for the purpose of estimating potential impacts related to the proposed BRT project.

Table 4 outlines the modifications made to each background bus service followed by detailed descriptions and maps of each change.

Table 4: Background Bus Service Change Summary

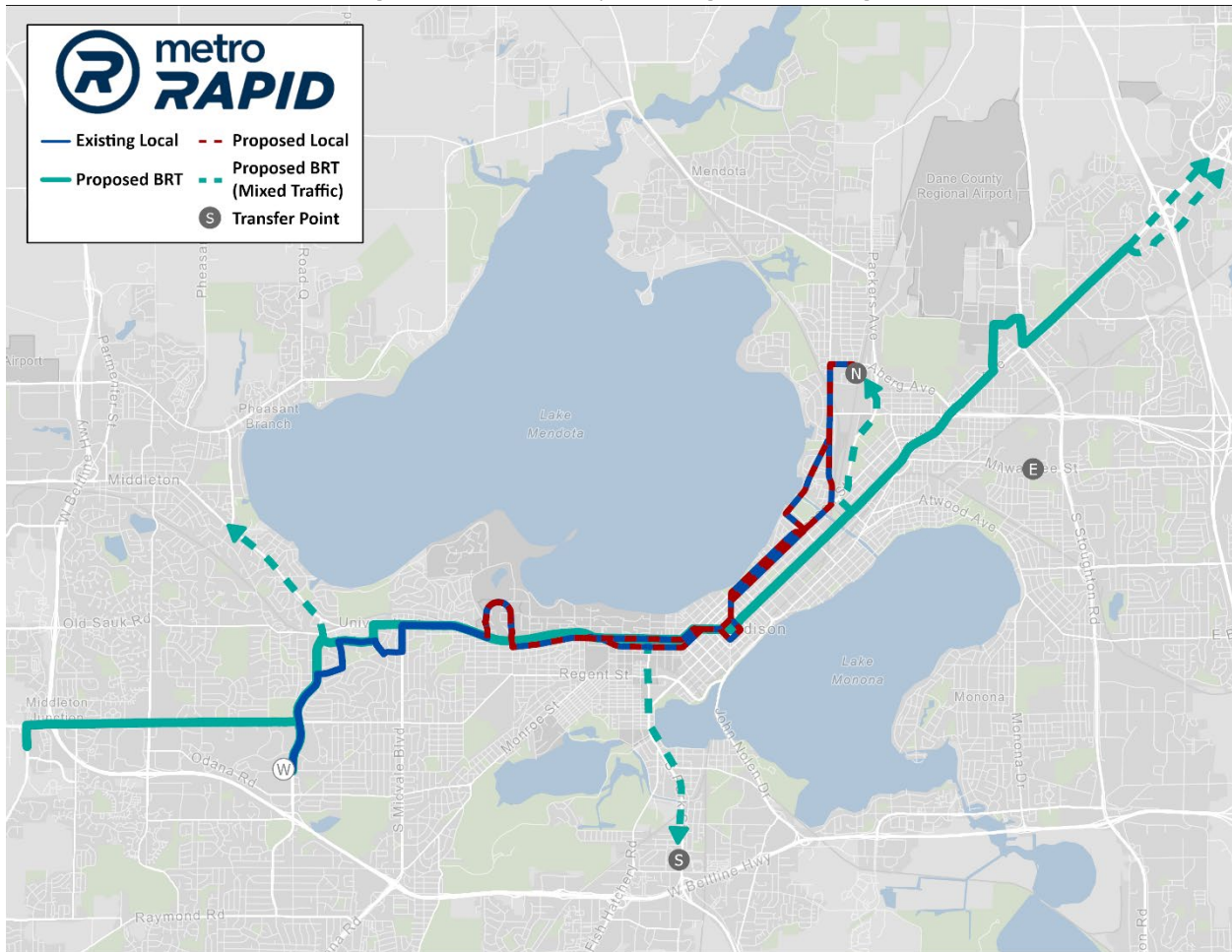
Metro Transit Route	Change Summary
Route 2	Shortened and frequency reduced
Route 3	Alignment modified
Routes 5 + 6	Combined into singular service
Route 10	Shortened and frequency reduced
Routes 11 + 12	Shortened and west end modified to circulator
Routes 14 + 15	Combined and frequency reduced
Route 23	Alignment shortened
Route 25	Eliminated
Routes 26	Eliminated
Route 27	Eliminated
Route 29	Alignment shortened
Routes 28 + 56 + 57	Combined and frequency reduced
Route 29	Alignment shortened
Route 30	Alignment extended
Route 36	Eliminated
Route 67	Eliminated
Route 70	Alignment shortened

Eliminated Service. Several routes are proposed to be eliminated in this service plan, with their resources applied to the BRT service. These services are duplicative with the BRT, mainly operating along the LPA corridor. The following lists each eliminated route with a brief description of its existing service and alignment.

- Route 25 operates between Capitol Square and The American Center, via East Washington Avenue and East Towne Mall. The route offers weekday service only, operating one AM eastbound and one PM westbound trip.
- Routes 26 is a circulating route that is anchored at East Towne Mall and operates north/east of the mall. This route operates at 30-minute frequencies on weekdays and weekends.
- Route 27 operates between Metro Transit's North Transfer Point and UW Campus serving Downtown Madison via primarily East and West Washington Avenues. The route operates westbound in the AM and eastbound in the PM. The route operates on weekdays only during peak periods.
- Routes 36 is a circulating route immediately north/east of East Towne Mall. This route operates at 30-minute frequencies on weekdays and 60-minute frequencies on weekends.
- Route 67 operates as a loop with service between Metro Transit's West Transfer Point and West Towne Mall, along Mineral Point Road. Route 67 provides all day service, seven days a week.

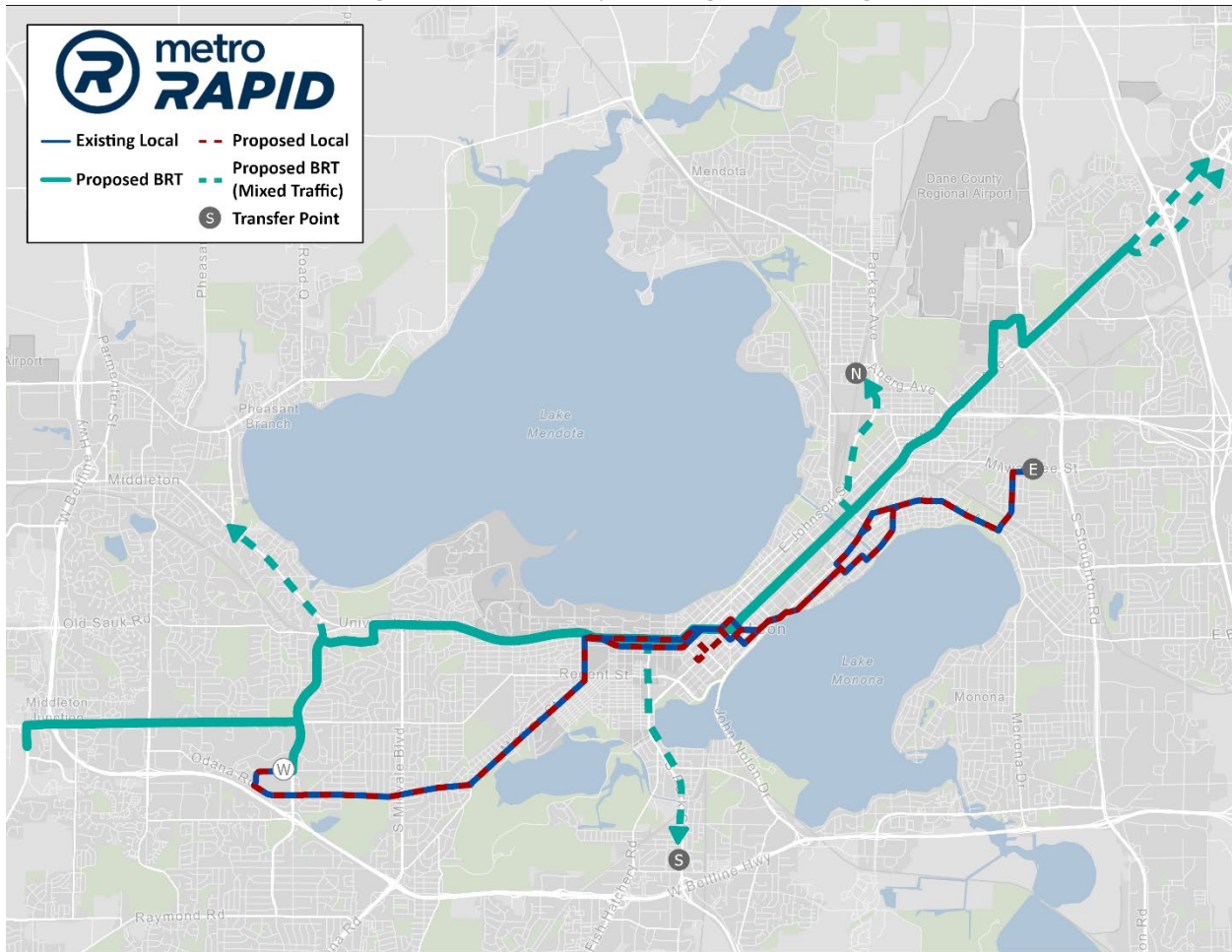
Route 2. The existing Route 2 operates between the West and North Transfer Points primarily via University Avenue and the Johnson/Gorham Street couplet. It provides all day service at generally 30-minute frequencies seven days a week, with 15-minutes peak period frequencies west of the Capitol Square. To avoid duplication with the BRT, it is proposed that Route 2 is shortened to operate between the UW Hospital and the North Transfer Point. A small frequency reduction to 30-minutes all day is also proposed. **Figure 3** displays the proposed alignment change for this route.

Figure 3: Route 2 Proposed Alignment Change



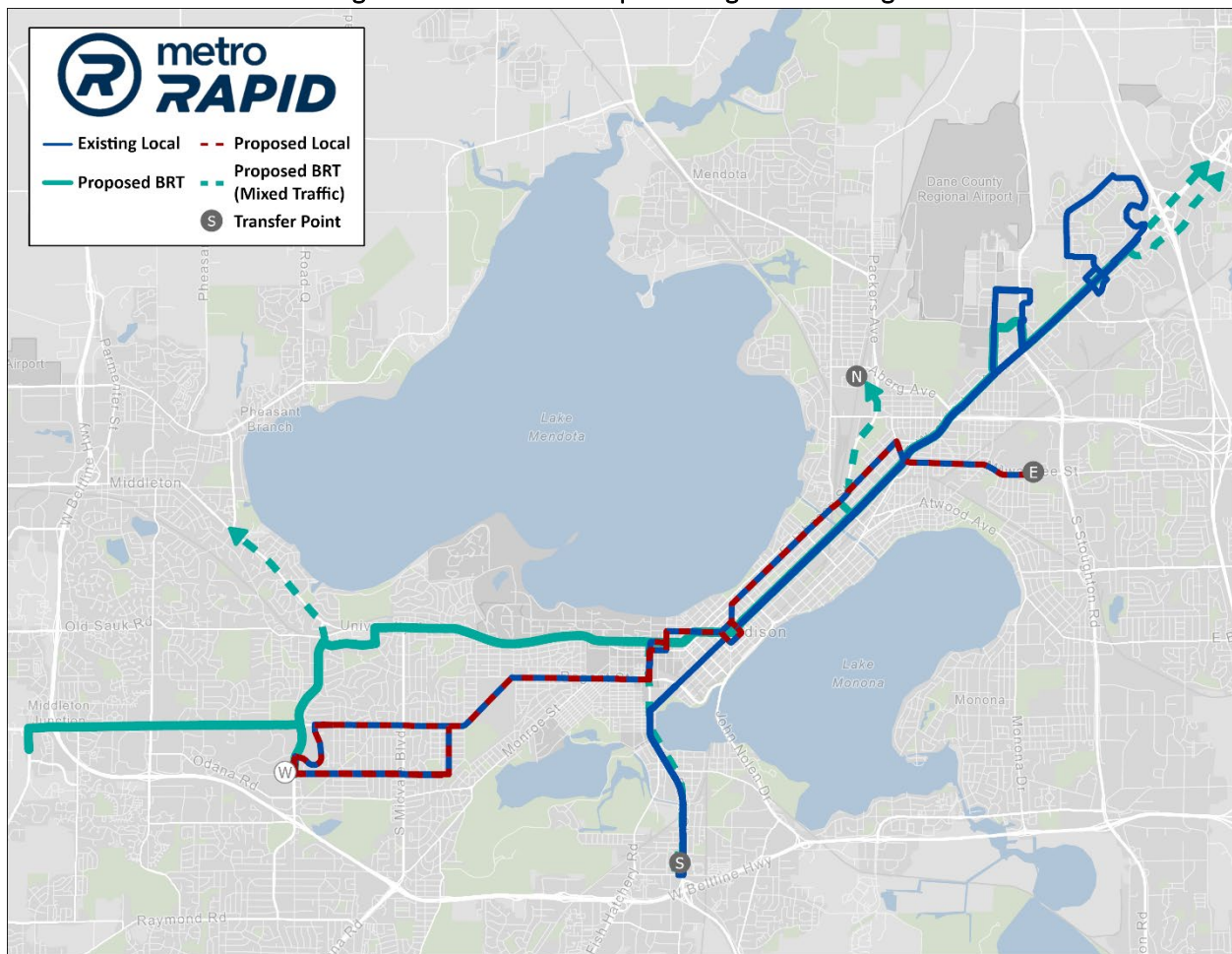
Route 3. The existing Route 3 operates between the West and East Transfer Points Point. Within the central area of Madison the alignment primarily follows University Avenue and the Johnson/Gorham Street couplet and Williamson Street. To maintain service coverage, this route is modified to follow Bassett/Broom and West Washington to Capital Square. Route 3’s alignment remains unchanged on the east side. No changes are proposed to route service frequencies. **Figure 4** displays the proposed alignment change for this route.

Figure 4: Route 3 Proposed Alignment Change



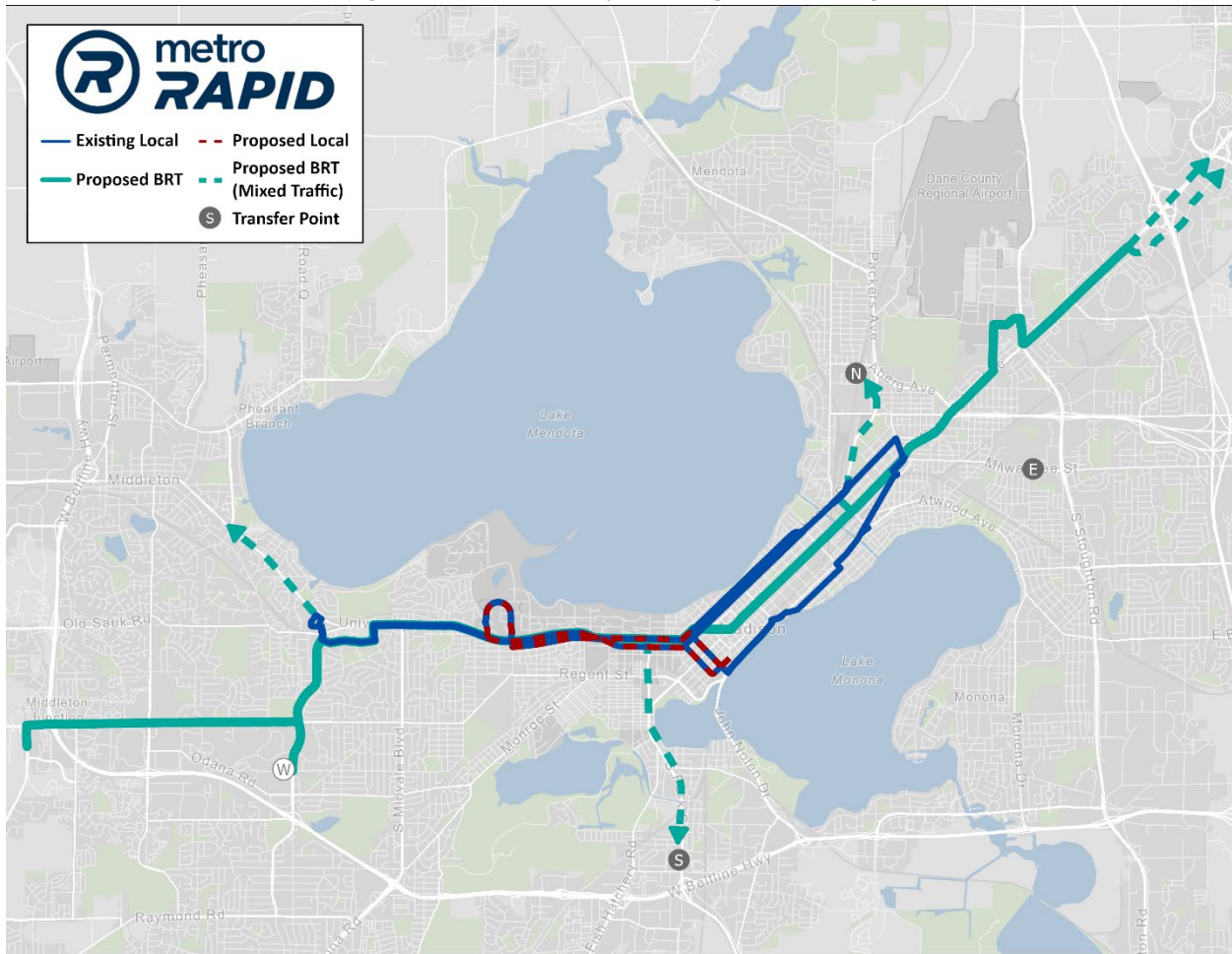
Routes 5 + 6. The existing Route 5 operates between the South and East Transfer Points mainly via Park Street and the Johnson/Gorham Street couplet. It provides 30-minute service throughout the day and 60-minute in the evenings on weekdays and 60-minute service on Saturday and Sundays. The existing Route 6 operates between the West Transfer Point and East Towne Mall and primarily utilizes Mineral Point Road, Regent Street, and E Washington Avenue. It also provides circulation amongst residential neighborhoods adjacent to the East Towne Mall and provides 15 to 30-minute service on weekdays and 60-minute service on Saturday and Sundays. The proposed route combines the eastern portion of Route 5 (East Transfer Point to the Capitol Square) and the western portion of Route 6 (West Transfer Point to the Capitol Square) into one route operating 15 to 30-minute service on weekdays and 60-minute service on Saturday and Sundays. The eastern portion of Route 6 is proposed to be covered by the BRT and a proposed extension of Route 30. **Figure 5** displays the proposed alignment change for these routes.

Figure 5: Route 5 + 6 Proposed Alignment Change



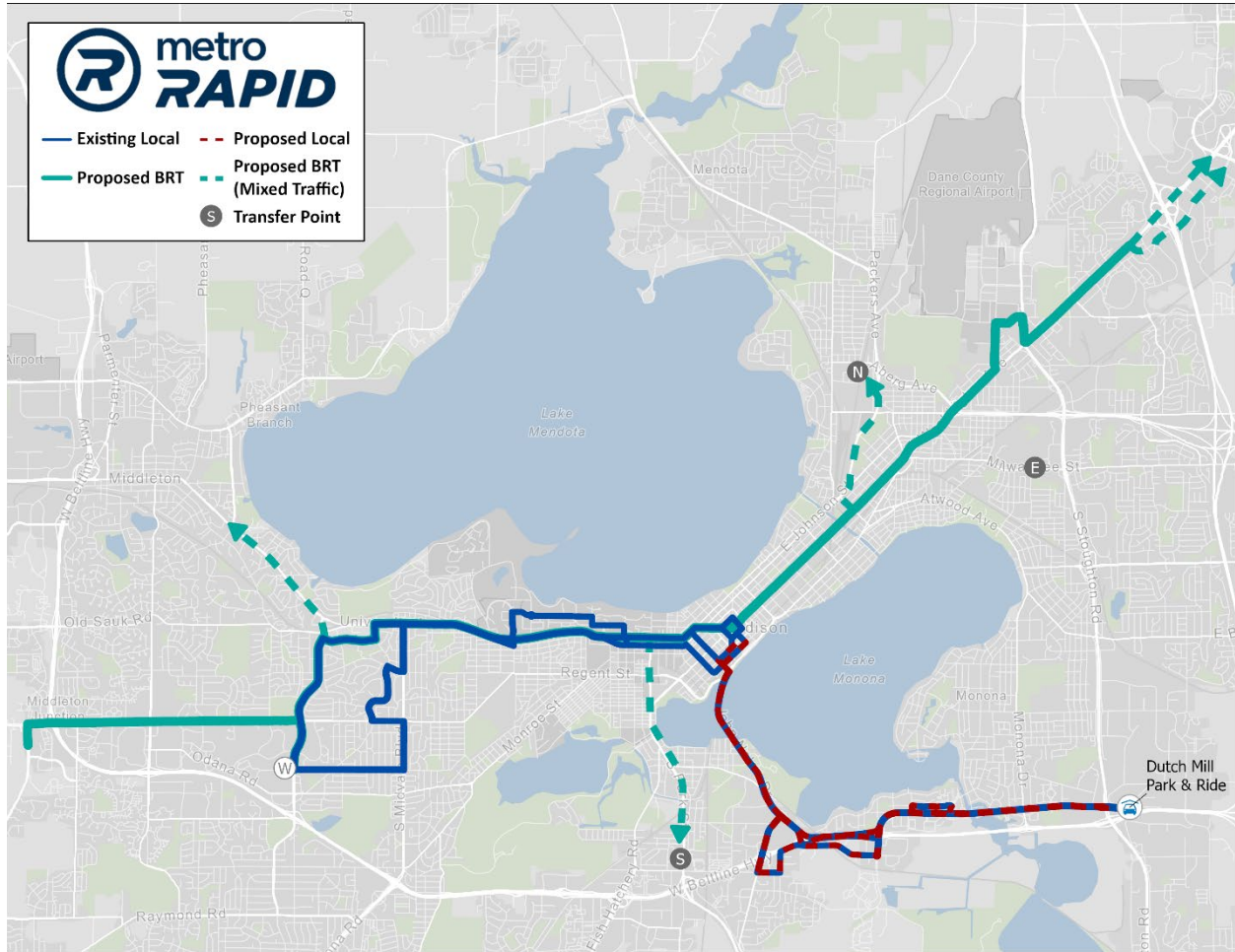
Route 10. The existing Route 10 operates between Whitney Way and Milwaukee Street via University Avenue, Johnson/Gorham Street couplet, and Jenifer Street. It offers a variety of patterns and provides a range of 5 to 30-minute service between Sheboygan Avenue and multiple areas along the Isthmus on weekdays only. The proposed Route 10 would eliminate many of the existing patterns and retain service between the UW Hospital and Broom/Bassett Streets in Downtown Madison every 15 to 30-minutes. **Figure 6** displays the proposed alignment change for this route.

Figure 6: Route 10 Proposed Alignment Change



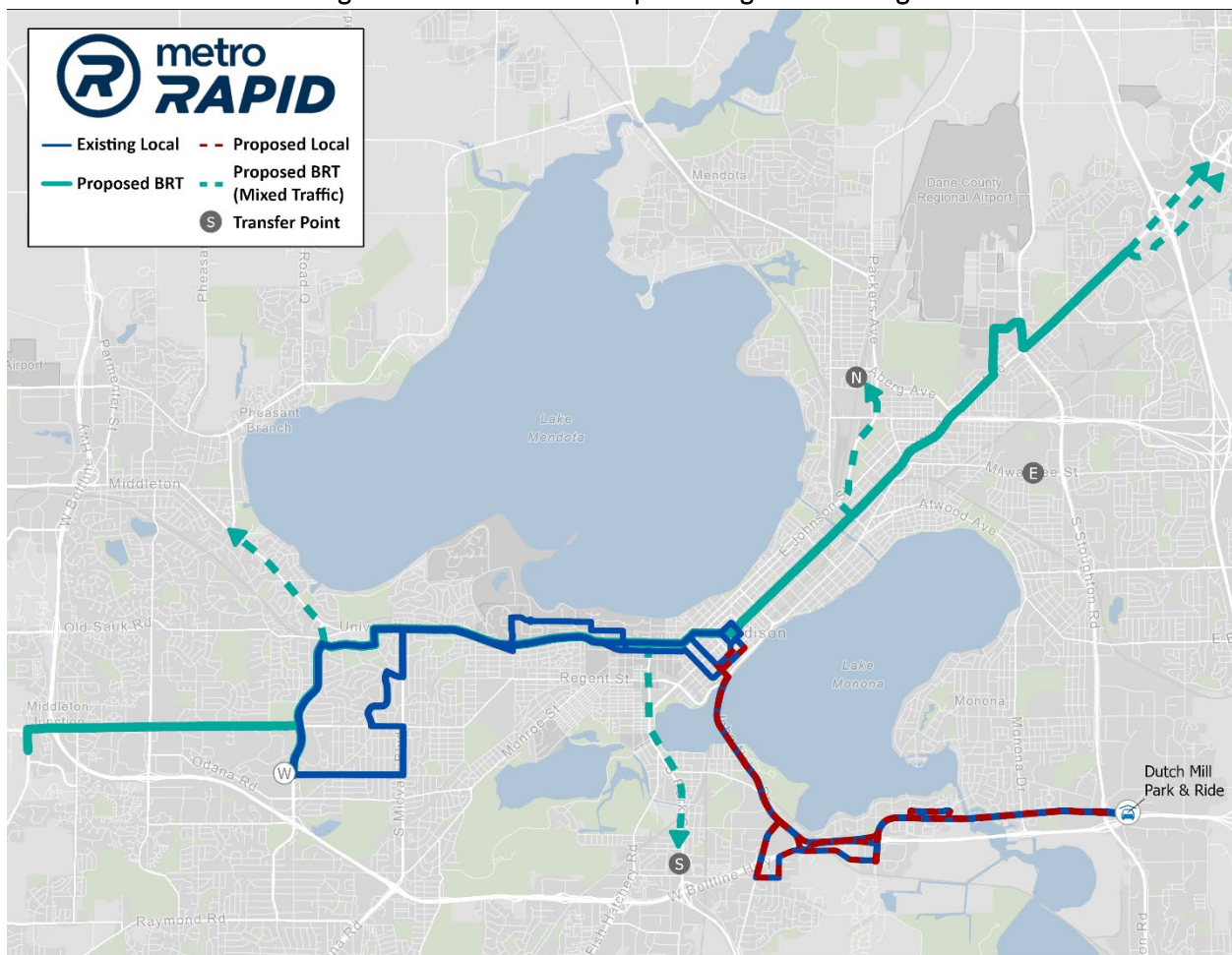
Routes 11 + 12. Existing routes 11 and 12 are similar services that operate between the West Transfer Point and the Dutch Mill Park and Ride Lot. The routes provide approximately 30-minute service to the UW Campus and Downtown Madison during peak periods on weekdays only via primarily University Avenue, John Nolan Drive, and W Broadway. The introduction of BRT and subsequent bus service changes lead to duplicative service west of downtown, allowing the proposed routes 11 and 12 to be shortened. The new service will provide commuter service between Dutch Mill and Downtown Madison via W Broadway and John Nolan Drive. The routes will maintain their existing frequencies and alignments east of downtown. **Figure 7** displays the proposed alignment change for these routes.

Figure 7: Route 11 + 12 Proposed Alignment Change



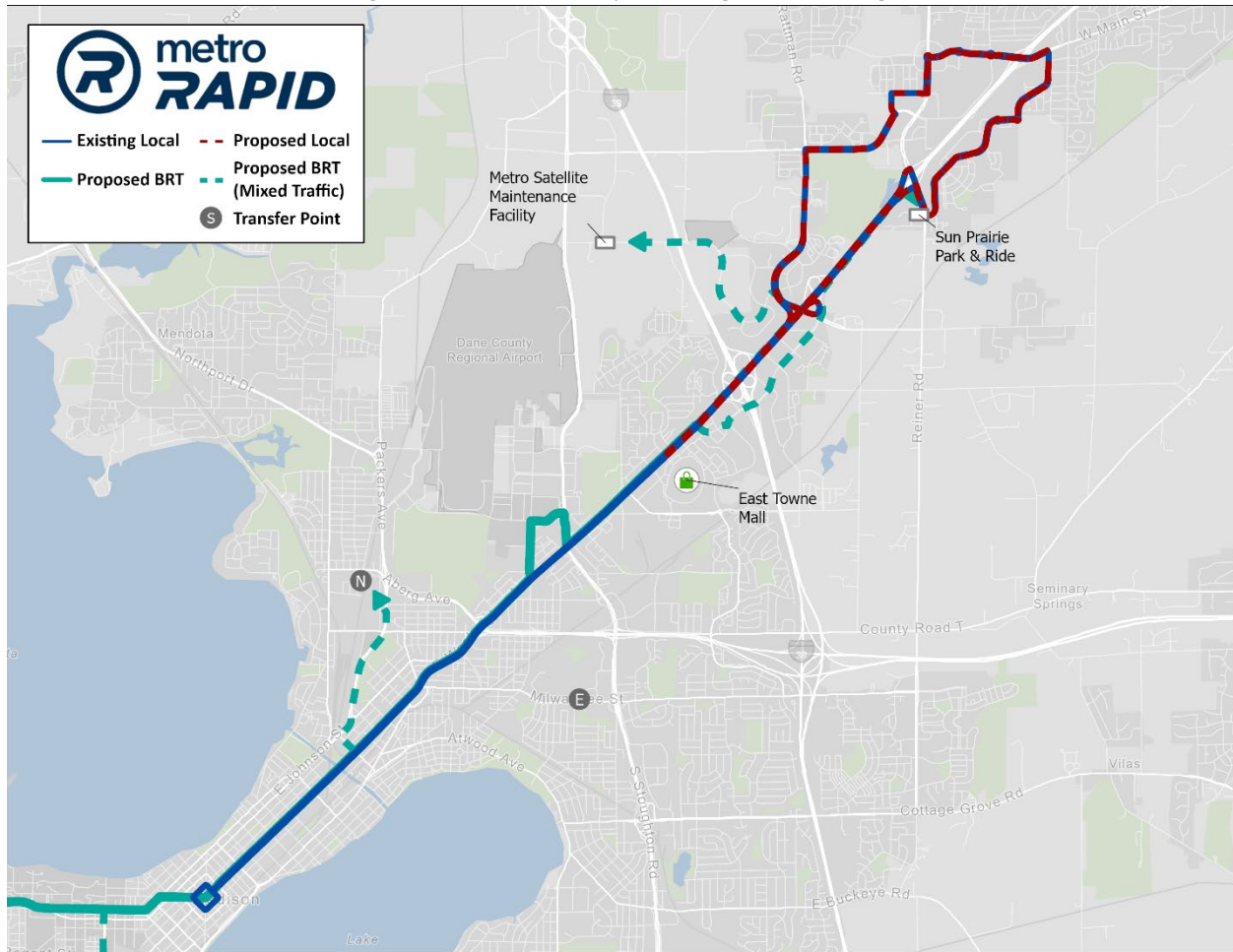
Routes 14 + 15. Existing routes 14 and 15 are similar services that operate from the western side of Madison to the East Transfer Point predominantly via Mineral Point Road, Old Sauk Road, University Avenue, and E Washington Avenue. Both routes provide all day service weekdays between the west side and the Capitol Square every 15 to 30-minutes during peaks and 60-minutes during the midday and evening. Service from the west side to the East Transfer Point is also offered every 15-minutes during peaks only on the two combined routes. These routes will have significant overlap with the proposed BRT, so routes 14 and 15 were combined into a singular route with a new alignment that will serve many of the existing constituents and provide additional frequency to adjacent corridors (e.g., Johnson/Gorham Street couplet). The new route will operate two patterns: a short pattern between the West Towne Mall and Capitol Square and a full pattern between the West Towne Mall and East Transfer Point. It will use primarily Old Sauk Road, Regent Street, University Avenue, Johnson/Gorham streets, and Milwaukee Street. Service to Junction Road will be eliminated and riders will use Route 73. Downtown, the route will use West Washington Avenue to serve the area currently served by Route 5. Both patterns will operate approximately every 30-minutes during peaks, with the full pattern only operating during the peaks, and the short pattern will operate every 30-minutes during the midday and evenings. **Figure 8** displays the proposed alignment change for these routes.

Figure 8: Route 14 + 15 Proposed Alignment Change



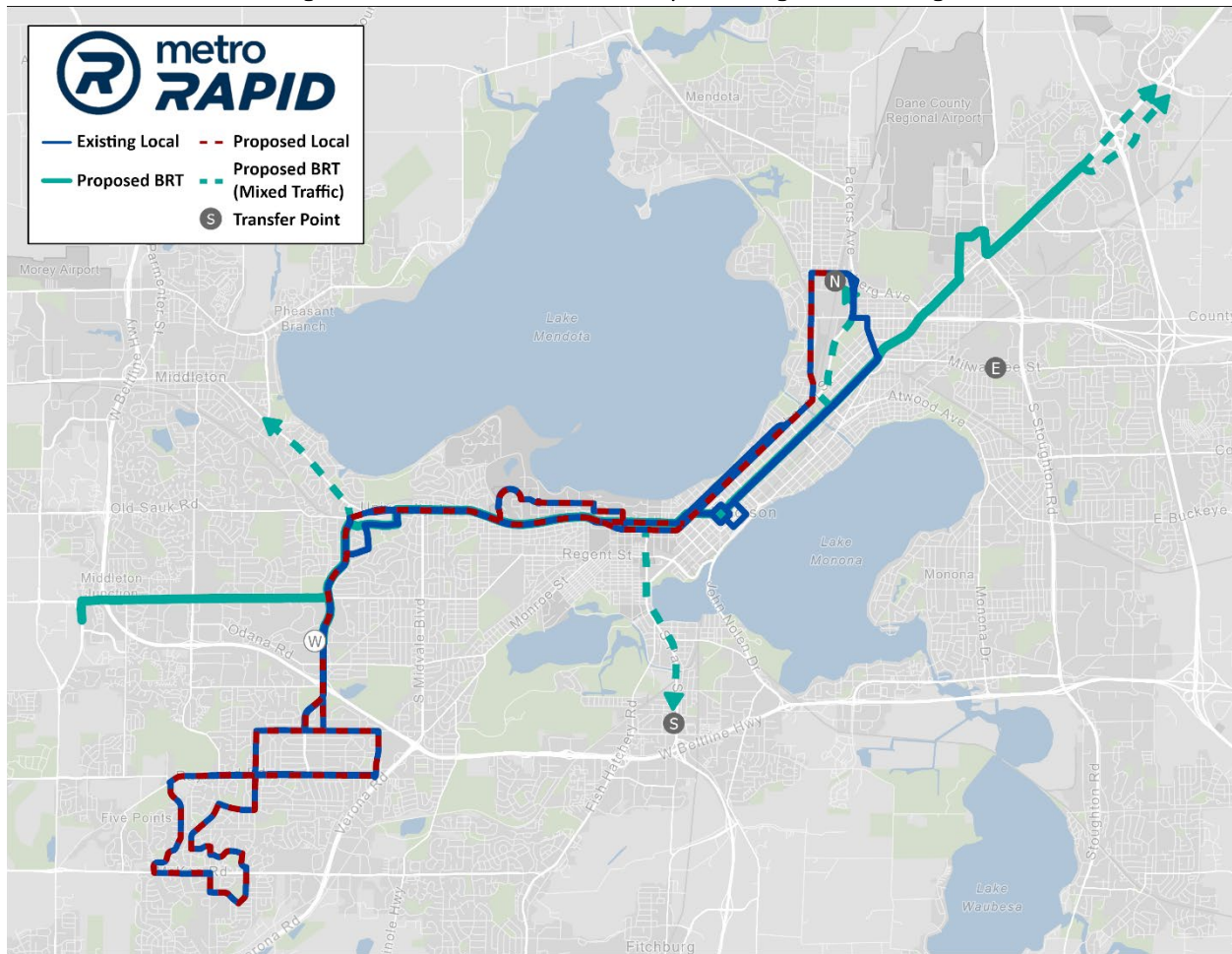
Route 23. Existing route 23 provides peak period service from the Sun Prairie park-and-ride lot along the East Washington Avenue corridor to downtown Madison. This route also provides local service along O’Keeffe, Main, Gran, Blue Astor, Hoepker and American Parkway. It is proposed that this route operate as a circulator that is anchored at East Towne Mall where it would connect to BRT service, providing the same coverage as today east of East Towne Mall. No changes are proposed to service frequencies. **Figure 9** displays the proposed alignment change for this route.

Figure 9: Route 23 Proposed Alignment Change



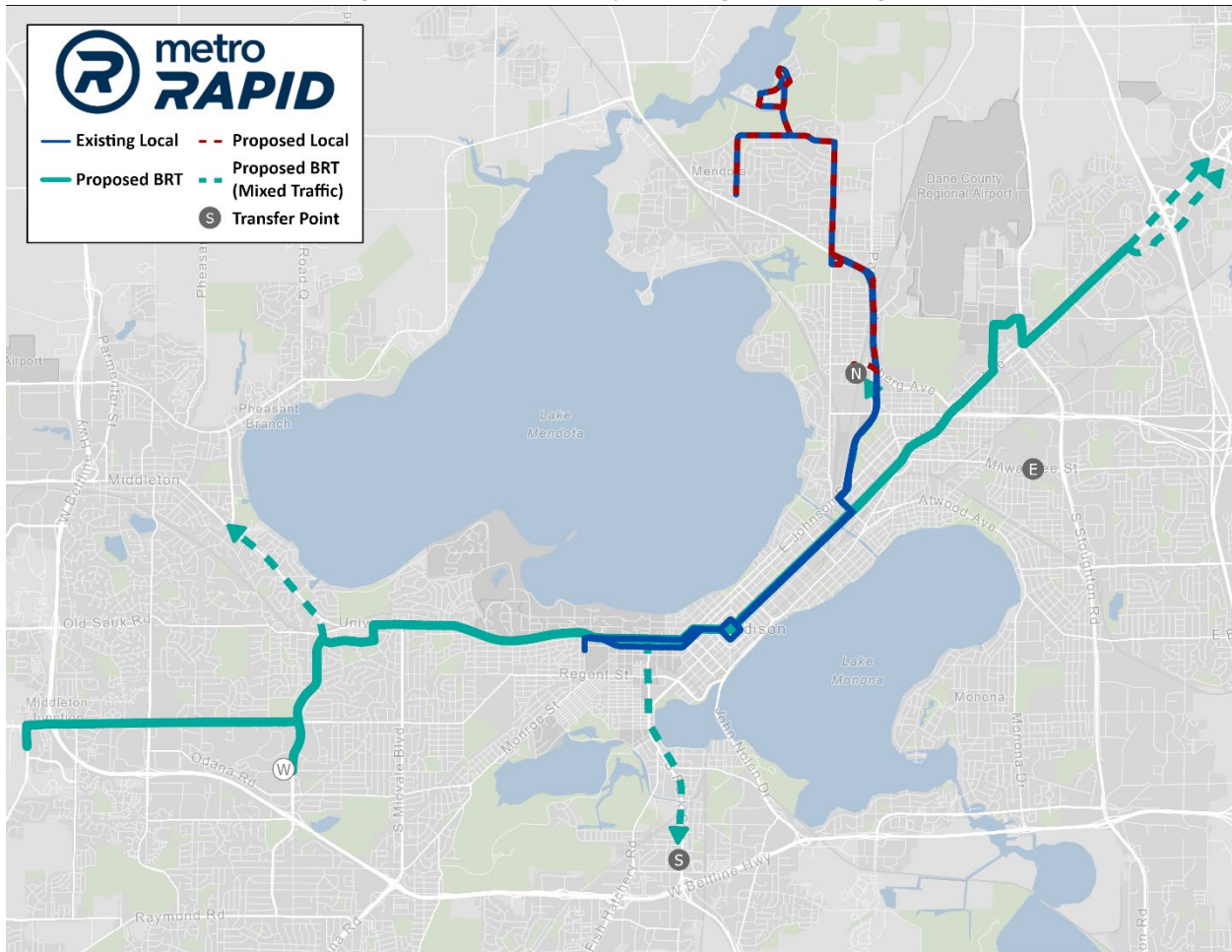
Routes 28 + 56 + 57. Existing routes 28, 56, and 57 are similar services that operate from southwest Madison to the North Transfer Point during peak periods on weekdays only. Route 28 provides 10 to 15-minute service from the West Transfer Point to the UW Campus via Whitney Way, University Avenue, and Observatory Drive, and then continues to serve the North Transfer Point via Johnson/Gorham Street. Routes 56 and 57 operate approximately every 30-minutes each, with 15-minute combined frequency on most of the route, and provide circulation in residential communities south of the West Transfer Point before continuing north and east along Whitney Way, University Avenue, and E Washington Avenue and ending at the North Transfer Point. The system operates as a married pair with Route 28 operating westbound and Routes 56/57 operating eastbound in the morning, and the reverse in the afternoon. The proposed service will consolidate these routes into a single service providing approximately 20-minute service on weekdays only. The route will still offer circulation to the residential communities south of the West Transfer Point then proceed to UW Campus via Whitney Way, University Avenue, and Observatory Drive. It then will continue through the Isthmus to the North Transfer Point primarily via the Johnson/Gorham Street couplet and Sherman Avenue. **Figure 10** displays the proposed alignment change for these routes.

Figure 10: Route 28 + 56 + 57 Proposed Alignment Change



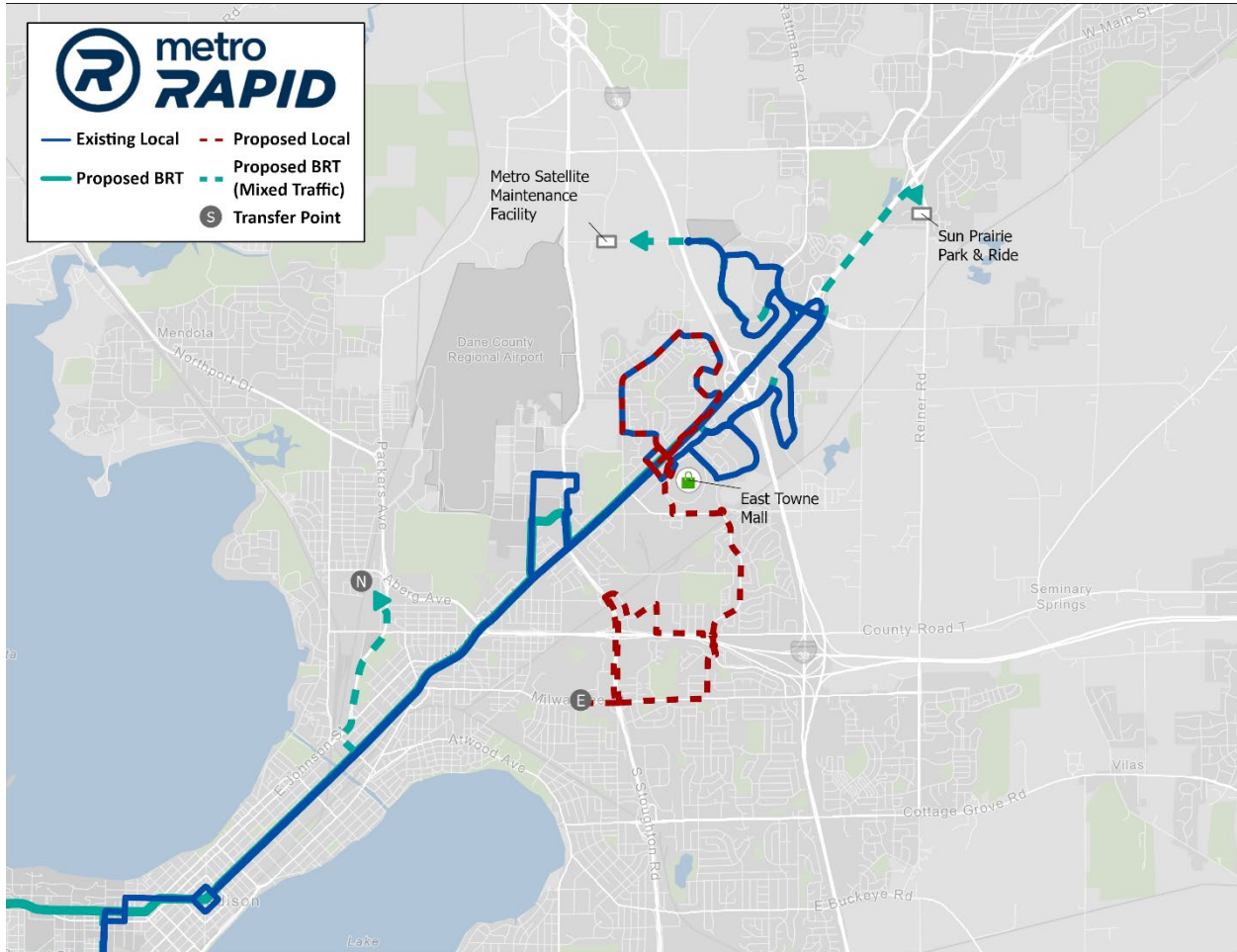
Route 29. Route 29 provides peak period only service from the North Side to downtown Madison, with continuing service to the University of Wisconsin campus. This route operates on weekdays in the peak periods, peak direction only at approximately 20-minute frequencies. Much of this route is duplicative of the BRT alignment. The proposed service maintains service north of the North Transfer Point, where service will terminate, providing connections to the proposed BRT Green Line pattern. No changes are proposed to service frequencies. **Figure 11** displays the proposed alignment change for this route.

Figure 11: Route 29 Proposed Alignment Change



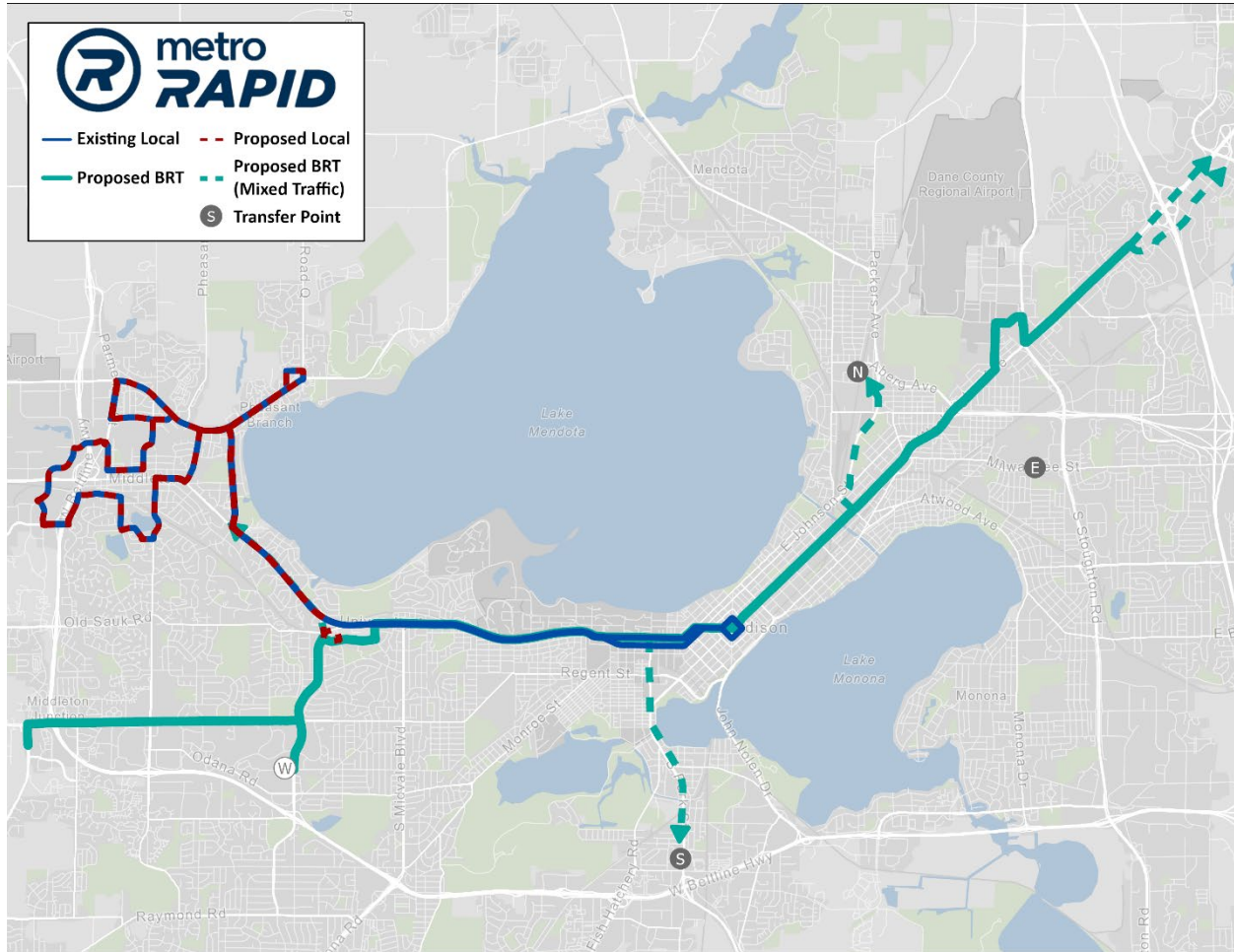
Routes 30. Existing route 30 provides service between the East Transfer Point and East Towne Mall. Service alternatives between use of Stoughton/Hwy 51/Commercial and Milwaukee/Thompson. Frequencies are 30-minutes. To replace loss service on Route 6, this route is extended to provide coverage to the area immediately north of East Towne Mall. No changes are proposed to service frequencies. **Figure 12** displays the proposed alignment change for this route.

Figure 12: Route 30 Proposed Alignment Change



Route 70. The existing Route 70 operates between Middleton and the Capitol Square via mainly Century Avenue, Allen Boulevard, and University Avenue. It primarily provides midday and evening services every 60-minutes to the Middleton area and is complimentary to routes 71 and 72, which provide a similar service in the peak periods. The existing service is duplicative of the proposed BRT along University Avenue and was modified to reduce overlapping services. The proposed service will maintain existing circulation and service characteristics in Middleton and terminate at the proposed Eau Claire Station where riders can transfer to the BRT and other routes. **Figure 13** displays the proposed alignment change for this route.

Figure 13: Route 70 Proposed Alignment Change



Operating Statistics

Operating statistics were calculated for both BRT service and background bus changes to understand the resources required to implement the entire service plan. Statistics primarily consist of revenue bus-hours, revenue bus-miles, and peak vehicles. Each of these statistics were then applied to the O&M cost model to calculate O&M costs for each proposed change. The methodology for calculating operating statistics begins by determining the total one-way trips. Trips are calculated using inputs for frequency and service span (from the service plan for BRT, or available schedule and GTFS data for existing routes).¹ Second, revenue hours and revenue miles are calculated using the total number of one-way trips multiplied by the hours and miles required for a single trip.

Table 2 previously presented operating statistics for BRT by pattern. All BRT patterns are expected to operate 60-foot articulated vehicles with the red and green service patterns using electric vehicles and the blue pattern using diesel vehicles. These vehicle types garner slightly different revenue mile unit costs and are shown in detail in the following Operations and Maintenance (O&M) Cost Estimate section. **Table 5** provides operating statistics for the background bus service changes.

Table 5: Background Bus Service Change Operating Statistics

Route	Existing			Proposed			Difference		
	Annual Revenue Hours	Annual Revenue Miles	Peak Buses	Annual Revenue Hours	Annual Revenue Miles	Peak Buses	Annual Revenue Hours	Annual Revenue Miles	Peak Buses
2	31,540	326,320	6	19,700	188,600	3	-11,840	-137,720	-3
3	24,250	273,770	4	25,700	286,500	4	1,450	12,730	0
5	16,260	150,740	3	0	0	0	-16,260	-150,740	-3
6	35,350	396,590	9	26,600	285,100	7	-8,750	-111,490	-2
10	22,220	209,320	8	7,200	65,500	3	-15,020	-143,820	-5
11	3,090	39,010	4	2,300	26,500	3	-790	-12,510	-1
12	2,650	33,930	4	1,600	22,200	2	-1,050	-11,730	-2
14	15,690	154,830	7	1,700	21,500	0	-13,990	-133,330	-7
15	17,690	202,280	10	19,000	236,300	10	1,310	34,020	0
23	2,810	41,700	3	1,500	19,700	2	-1,310	-22,000	-1
25	260	4,750	1	0	0	0	-260	-4,750	-1
26	5,630	97,860	1	0	0	0	-5,630	-97,860	-1
27	2,100	21,760	3	0	0	0	-2,100	-21,760	-3
28	6,760	72,940	5	13,100	177,700	9	6,340	104,760	4
29	2,100	11,670	2	700	7,100	1	-1,400	-4,570	-1
30	11,700	105,410	2	11,700	144,100	2	0	38,690	0
36	2,790	21,820	1	0	0	0	-2,790	-21,820	-1
56	5,130	69,850	4	0	0	0	-5,130	-69,850	-4
57	4,340	53,010	4	0	0	0	-4,340	-53,010	-4
67	6,610	89,440	2	0	0	0	-6,610	-89,440	-2
70	8,100	102,330	1	5,600	52,700	0	-2,500	-49,630	-1
71	3,670	49,610	3	0	0	0	-3,670	-49,610	-3
72	5,640	72,390	5	0	0	0	-5,640	-72,390	-5
Totals	236,380	2,601,330	92	136,400	1,533,500	46	-99,980	-1,067,830	-46

¹ Operating and/or schedule data pre-COVID-19 (Fall 2019) was utilized for this analysis.

Operations and Maintenance (O&M) Cost Estimate

This section details the operations and maintenance (O&M) cost estimate for the proposed BRT project and background bus changes.

Methodology

An O&M cost spreadsheet model has been developed for this project to estimate the annual cost to operate, maintain, and administer the project. O&M costs are expressed as the annual total of employee earnings and fringe benefits, contract services, materials and supplies, utilities, and other day-to-day expenses incurred in the operation and maintenance of a transit system.

The Federal Transit Administration (FTA) believes a fully-allocated cost model is the best approach to O&M costing because it is a) able to reflect cost differences by mode and service type; b) structured based on actual operating experience; and c) sensitive to future changes in cost factors. The FTA has issued guidelines that specify the following methodology for calculating O&M costs:

- Estimate labor and materials needed to provide a specific level of service and then apply current unit costs to the estimated future labor and non-labor items.
- Calculate costs based on operating characteristics by mode (e.g., BRT revenue-hours) rather than for all modes combined (e.g., system-wide passengers).
- Model each reported labor and non-labor expense separately to ensure that equations are mutually exclusive and cover all operating costs.
- Model expense items as variable, so that cost estimates will change with projected changes in service.

A cost allocation model assumes that each operating expense incurred by a transit system is driven by a key supply variable such as revenue-hours, revenue-miles, or the number of vehicles operated during peak periods. Combining recent actual O&M costs with the quantity of relevant supply variables establishes unit costs and productivity ratios that can be applied to a different set of service indicators (such as projected future expansions or cut-backs). The result is an estimated annual O&M cost that is specific for a test scenario.

Two spreadsheet models were developed to estimate annual O&M costs for the East-West BRT service plan. A Metro Transit local bus O&M cost model was developed with recent actual expenses, system characteristics and service statistics as reported to the National Transit Database (NTD) for the 2019 report year. The second O&M cost model for BRT was also developed, pivoting from the Metro Transit local bus cost model. The BRT model captures the bus mode's service-related expenses and costs unique to that mode (e.g., BRT facilities). The BRT cost model is based on the Metro Transit local bus model, supplemented with BRT-specific expense data from other locations in the US planning or operating BRT service. Both models were inflated to 2021 dollars based with a 5.2% factor, based on the Bureau of Labor Statistics' consumer price index for urban consumers in the Midwest region, from May 2019 to May 2021.

Metro Transit Local Bus O&M Cost Model

As noted above, the cost model developed to estimate Metro Transit O&M cost impacts is based on Metro Transit's 2019 NTD submittal. In FY 2019, Metro Transit reported \$49.45 million in annual O&M expenditures for motor bus operations. They also reported 403,570 annual revenue bus-hours of service and 5,072,756 annual revenue bus-miles of service, with a maximum 183 buses in peak period service.

Key supply variables selected as the model's cost-driving inputs are:

- Annual Revenue Bus-Hours – The hours that vehicles travel while in revenue service over the entire fiscal year. Revenue bus-hours include layover and schedule recovery but exclude time for deadhead, operator training, and maintenance testing. This variable is utilized to assess transit operation costs.
- Annual Revenue Bus-Miles – The miles that vehicles travel while in revenue service over the entire fiscal year. Revenue bus-miles include layover and schedule recovery but exclude miles for deadhead, operator training, and maintenance testing. This variable is utilized to vehicle maintenance costs.
- Peak Buses – The maximum number of passenger service vehicles operated simultaneously on an average weekday. Peak buses were used as an input for variable administration costs to account for administration costs that vary depending on the amount of service being operated.
- Fixed Administration Costs – These are costs that will not change regardless of the amount of service being operated. Fixed administration costs were not included in the incremental O&M cost calculation.

After identification of key supply variables, the next step in model development is to record Metro Transit's bus expenses as a series of line items. The NTD report format categorizes operating expenses within the four functional areas of Vehicle Operations, Vehicle Maintenance, Non-Vehicle Maintenance, and General Administration. For each functional area, line item expenses are further classified as salaries/wages, fringe benefits, services, materials/supplies, utilities, casualty and liability, taxes/fees, and miscellaneous.

After the list of line items was established, each was assigned a key supply variable as its most relevant cost driver. One General Administration line item expense, Casualty and Liability, was deemed to be strongly influenced by both annual revenue bus-miles and peak buses, so this expense was evenly divided between those two supply variables.

In addition to the supply variables listed above, from which line item unit costs are derived, the model also incorporates resource variables specifically to provide labor productivity ratios. NTD-reported employee work hours are included as a resource variable for estimating salaries and wages by functional area for the project. For vehicle operations, NTD does not subdivide total work hours by operator and non-operator so the model applies their respective ratios of reported earnings to total work hours as an estimated allocation. For all non-labor line items, the model calculates productivity using key supply variables.

Table 6 presents aggregated O&M unit costs for Metro Transit's local bus service in 2021 dollars. The unit costs in this table reflect the dollar amount the model will adjust for each added or deleted unit of a

supply variable – in other words, the incremental change from the calibration. For example, for each Metro-operated revenue bus-mile added, the model will increase its total estimate by \$2.68; for each revenue bus-hour deleted, the model will subtract \$71.65 from its estimate, and so forth. The full spreadsheet model is presented in the **Appendix**.

Table 6: Metro Local Bus O&M Unit Costs (In 2021 dollars)

Mode	Key Supply Variable	Unit Cost (in \$2021)
Metro Local Bus		
	Cost per Revenue Bus Hour	\$69.56
	Cost per Revenue Bus Mile	\$2.60
	Cost per Peak Bus	\$16,517

BRT O&M Cost Model

Also necessary is an estimate of the cost to operate the proposed BRT service. The BRT cost model uses the Metro Transit local bus model as its base but augments it by including line items that reflect BRT-specific unit operation and infrastructure expenses not currently incurred by Metro Transit within the bus operation.

BRT unit operation costs are derived from the local bus supply variables and are as follows:

- BRT Annual Revenue Bus-Hours – The hours that BRT vehicles travel while in revenue service over the entire fiscal year. Revenue bus-hours include layover and schedule recovery but exclude time for deadhead, operator training, and maintenance testing.
- BRT Annual Revenue Bus-Miles – The miles that BRT vehicles travel while in revenue service over the entire fiscal year. Revenue bus-miles include layover and schedule recovery but exclude miles for deadhead, operator training, and maintenance testing. All BRT vehicles are anticipated to be comprised of 60-foot articulated diesel or electric buses and separate unit costs were developed for each.
- BRT Peak Buses – The maximum number of BRT service vehicles operated simultaneously on an average weekday. Peak buses were used as an input for variable administration costs to account for expenses related to overall bus system size.

In addition to unit operation costs, the East-West BRT service is anticipated to include unique features that will result in additional maintenance costs that are not reflected in Metro Transit’s current bus expenses. These BRT-specific maintenance and infrastructure expenses are modeled as follows:

- Fare Validation – Additional personnel will be required in order to validate fares at platforms and on-board vehicles. The assumption for this is \$50,000 in annual wages per full time equivalent (FTE) and a 0.66 fringe benefit factor (based on current Metro Transit fringe benefit factors). One work hour per ten BRT revenue hours was used to estimate FTEs for fare validation. The resulting unit cost is \$4.62 per BRT revenue hour.
- BRT Station Maintenance – City of Madison maintenance staff will be required for periodic cleaning and maintenance of each BRT station platform. The assumption for this is \$50,000 in

annual wages per full time equivalent (FTE), a 0.66 fringe benefit factor, and three FTEs for all stations. The resulting unit cost is \$5,806 annually per station platform.

- ITS Signage Maintenance – City of Madison maintenance staff will be used to maintain ITS signage at each BRT station platform. The assumption for this is \$65,000 in annual wages per full time equivalent (FTE), a 0.66 fringe benefit factor, and one FTE for the entire project. The resulting unit cost is \$2,516 annually per station platform.
- Ticket Vending Machine (TVM) Maintenance – Fare collection O&M includes the labor associated with maintaining the machines, the labor for weekly cash collection at the machine, and supplies. Two ticket vending machines have been assumed for each station platform.
 - For machine maintenance, an annual wage of \$50,000, a fringe benefit factor of 0.66, and 0.125 per FTE (15 minutes per machine x 2 technicians x 1 visit per week) was assumed.
 - For cash collection the cost was assumed to be \$50 per week per station platform.
 - For ticket vending machine supplies the cost is assumed to be \$1,000 per TVM, annually.

The resulting cost for ticket vending machine maintenance and supplies is \$6,680 per station platform.

Table 7 presents the project’s BRT O&M cost model in FY 2021 dollars. The full spreadsheet model is presented in the **Appendix**.

Table 7: Metro BRT O&M Unit Costs (In 2021 dollars)

Mode	Key Supply Variable	Unit Cost (in \$2021)
BRT		
	BRT Annual Revenue Bus Hours	\$69.56
	BRT Annual Revenue Bus Miles (Articulated-Diesel)	\$3.18
	BRT Annual Revenue Bus Miles (Articulated-Electric)	\$2.90
	BRT Annual Peak Bus	\$16,517
	On-Board Fare Validation	\$4.62
	BRT Station Maintenance	\$5,806
	ITS Signage Maintenance	\$2,516
	Ticket Vending Machine Maintenance	\$6,680

Summary of Results

The operating statistics generated by the service plan were applied to the O&M unit costs. BRT service is estimated to have an annual O&M cost of \$13.07 million. Proposed changes to the background bus service are estimated to have a cost savings of \$10.49 million. The net result is an increase of \$2.58 million in annual O&M costs, as shown in **Table 8**.

A project submitted for FTA's Small Starts program can qualify for a highly simplified financial plan if the additional O&M cost to the agency for the project is less than five percent of the project sponsor's existing operating budget. Metro Transit's operating budget for FY 2021 was \$62.234 million. The estimated increase in annual operating expenses for this project is approximately \$2.58 million, which is 4.15 percent of Metro Transit's operating budget, thus within the 5 percent threshold.

Table 8: Net Change in O&M Cost Estimates (In 2021 dollars)

2021 Unit Cost =>	Local Bus (Incr. Diff.)			Bus Rapid Transit						Total O&M Cost (FY21\$)
	\$69.56	\$2.60	\$16,517	\$69.56	\$3.18	\$2.90	\$16,517	\$4.62	\$15,002	
	Revenue Hours	Rev Miles diesel 40-ft	Peak Bus	Revenue Hours	Rev Miles diesel 60-ft	Rev Miles electric 60-ft	Peak Bus	On-board Fare Validation	BRT Stations	
Local Bus Route										
2	-11,840	-137,720	-3							-\$1,231,200
3	1,450	12,730	0							\$134,000
5	-16,260	-150,740	-3							-\$1,572,500
6	-8,750	-111,490	-2							-\$931,600
10	-15,020	-143,820	-5							-\$1,501,300
11	-790	-12,510	-1							-\$104,000
12	-1,050	-11,730	-2							-\$136,600
14	-13,990	-133,330	-7							-\$1,435,400
15	1,310	34,020	0							\$179,600
23	-1,310	-22,000	-1							-\$164,800
25	-260	-4,750	-1							-\$47,000
26	-5,630	-97,860	-1							-\$662,600
27	-2,100	-21,760	-3							-\$252,200
28	6,340	104,760	4							\$779,500
29	-1,400	-4,570	-1							-\$125,800
30	0	38,690	0							\$100,600
36	-2,790	-21,820	-1							-\$267,300
56	-5,130	-69,850	-4							-\$604,500
57	-4,340	-53,010	-4							-\$505,800
67	-6,610	-89,440	-2							-\$725,400
70	-2,500	-49,630	-1							-\$319,500
71	-3,670	-49,610	-3							-\$433,800
72	-5,640	-72,390	-5							-\$663,100
Total Local Bus	-99,980	-1,067,830	-46							-\$10,490,700
Bus Rapid Transit										
Service - All Patterns				107,400	252,900	1,118,600	25	107,400		\$12,428,000
Infrastructure									43	\$645,100
Total BRT										\$13,073,100

Net O&M Cost \$2,582,400

Appendix – O&M Cost Models

Madison Metro Transit Bus O&M Cost Model		Inflation 1.0520							
Expense Line Item	2019 Bus Expenses	Supply Variable Unit Cost (\$2019)				Supply Variable Unit Costs in \$2021			
		Revenue Bus-Hours	Revenue Bus-Miles	Operating Divisions	Peak Buses	Bus Revenue Hrs	Bus Revenue Miles	Operating Divisions	Peak Buses
Vehicle Operations									
Operators' Salaries and Wages (501.01)	\$16,265,203	\$40.30				\$42.40			
Other Salaries and Wages (501.02)	\$1,583,400			\$1,583,400				\$1,665,737	
Fringe Benefits (Bus-hr driven)	\$10,417,448	\$25.81				\$27.16			
Fringe Benefits (Garage driven) Services (503)	\$1,014,127			\$1,014,127				\$1,066,862	
	\$2,028	\$0.01				\$0.01			
Fuels and Lubricants (504.01)	\$2,787,633		\$0.55				\$0.58		
Tires and Tubes (504.02)	\$246,095		\$0.05				\$0.05		
Other Materials and Supplies (504.99)	\$104,702		\$0.02				\$0.02		
Taxes	\$3,947			\$3,947				\$4,152	
Miscellaneous Expenses (509)	\$50,010			\$50,010				\$52,611	
Vehicle Maintenance									
Salaries and Wages (501.02)	\$4,107,657		\$0.81				\$0.85		
Fringe Benefits (502)	\$2,713,839		\$0.53				\$0.56		
Services (503)	\$104,619		\$0.02				\$0.02		
Fuels and Lubricants (504.01)	\$158,772		\$0.03				\$0.03		
Tires and Tubes (504.02)	\$12,952		\$0.003				\$0.003		
Other Materials and Supplies (504.99)	\$1,417,572		\$0.28				\$0.29		
Taxes	\$3,055			\$3,055				\$3,214	
Miscellaneous Expenses (509)	\$17,714			\$17,714				\$18,635	
Non-vehicle Maintenance									
Salaries and Wages (501.02)	\$557,334			\$557,334				\$586,315	
Fringe Benefits (502)	\$368,887			\$368,887				\$388,069	
Services (503)	\$288,388			\$288,388				\$303,384	
Other Materials and Supplies (504.99)	\$208,174			\$208,174				\$218,999	
Miscellaneous Expenses (509)	\$2,372				\$12.96				\$13.64
General Administration									
Salaries and Wages (501.02)	\$2,309,596			\$1,154,798	\$6,310.37			\$1,214,847	\$6,639
Fringe Benefits (502)	\$1,976,479			\$988,240	\$5,400.22			\$1,039,628	\$5,681
Services (503)	\$1,191,249			\$595,625	\$3,254.78			\$626,597	\$3,424
Other Materials and Supplies (504.99)	\$162,262			\$81,131	\$443.34			\$85,350	\$466.39
Utilities (505)	\$388,051			\$388,051				\$408,230	
Casualty and Liability Costs (506)	\$882,200		\$0.17				\$0.18		
Miscellaneous Expenses (509)	\$102,097			\$51,049	\$278.95			\$53,703	\$293.46
TOTALS	\$49,447,862	\$66.12	\$2.47	\$7,353,929	1	\$15,701	\$69.56	\$7,736,333	\$16,517
Resource Variable Values		403,570	5,072,756			183			

Madison Metro Transit BRT O&M Cost Model						
						Inflation 1.0520
Expense Line Item	Supply Variable Unit Costs (\$2021)					
	Bus Rev. Hrs.	Diesel Rev. Bus-Miles	Elect. Rev. Bus-Miles	Peak Buses	On-Board Fare Valid.	BRT Stations
Vehicle Operations						
Operators' Salaries and Wages (501.01)	\$42.40					
Other Salaries and Wages (501.02)						
Fringe Benefits (Bus-hr driven)	\$27.16					
Fringe Benefits (Garage driven)						
Services (503)	\$0.01					
Fuels and Lubricants (504.01)		\$0.72				
Tires and Tubes (504.02)		\$0.06	\$0.06			
Electricity (Vehicle Propulsion)			\$0.65			
Other Materials and Supplies (504.99)		\$0.02	\$0.02			
Taxes						
Miscellaneous Expenses (509)						
Vehicle Maintenance						
Salaries and Wages - Diesel (501.02)		\$1.06				
Salaries and Wages - Electric (501.02)			\$0.96			
Fringe Benefits - Diesel (502)		\$0.70				
Fringe Benefits - Electric (502)			\$0.63			
Services (503)		\$0.02	\$0.02			
Fuels and Lubricants (504.01)		\$0.03	\$0.03			
Tires and Tubes (504.02)		\$0.003	\$0.003			
Other Materials and Supplies - Diesel (504.99)		\$0.37				
Other Materials and Supplies - Electric (504.99)			\$0.33			
Taxes						
Miscellaneous Expenses (509)						
Non-vehicle Maintenance						
Salaries and Wages (501.02)						
Fringe Benefits (502)						
Services (503)						
Other Materials and Supplies (504.99)						
Miscellaneous Expenses (509)				\$13.64		
General Administration						
Salaries and Wages (501.02)				\$6,639		
Fringe Benefits (502)				\$5,681		
Services (503)				\$3,424		
Other Materials and Supplies (504.99)				\$466.39		
Utilities (505)						
Casualty and Liability Costs (506)		\$0.18	\$0.18			
Miscellaneous Expenses (509)				\$293.46		
General Administration						
BRT Fare Inspection					\$4.62	
BRT Station Platform Maintenance						\$5,806
TVM Maintenance						\$6,680
ITS Signage Maintenance						\$2,516
Surface Park and Ride Maintenance						
TSP Maintenance						
Exclusive Lane Mile Maintenance						
TOTALS	\$69.56	\$3.18	\$2.90	\$16,517	\$4.62	\$15,002
Resource Variable Values						