Madison BRT Transit Corridor Study
Proposed BRT Operations Plans

This paper presents a description of the proposed BRT operations plan for use in the Madison BRT Transit Corridor Study. The objective is to develop reasonable assumptions on BRT and supporting bus service plans, for use in travel demand modeling/ridership forecasts, fleet sizing and estimating daily and annual revenue bus-hours of service, for use in O&M cost estimation. The operations plan presented in this paper does not any include any expansion or modifications of Metro service beyond what has been identified to accommodate and complement the proposed BRT system.

BRT Corridors

BRT alignments and station locations have been defined for the following four corridors:

- North Corridor – generally along Sherman Avenue, with a northern end-of-line BRT station at Warner Park
- East Corridor – generally along East Washington Avenue, with a mid-route deviation to Madison College, and with an eastern BRT end-of-line station at East Towne Mall
- South Corridor – generally along Park Street, Badger Road and Fish Hatchery Road, with a southern end-of-line BRT station at Caddis Bend
- West Corridor – generally along University Avenue, Whitney Way and Mineral Point Road, with a western BRT end-of-line station at High Point Road. An alternative West Corridor alignment utilizes Odana Road to the West Towne Mall area

All four corridors are connected to a Central Corridor alignment through the Isthmus. From east to west, the Central Corridor alignment begins at East Washington Avenue/Baldwin Street, follows East Washington Avenue to Capitol Square, and continues west on State Street and Gorham Street/University Avenue (Johnson Street for eastbound buses) to Park Street.

Maps of each corridor alignment are provided in this paper's Appendix.

BRT Operating Hours and Frequencies

Proposed BRT operating hours and service frequencies by time period are noted below in Table 1.

Table 1
Proposed BRT Operating Hours and Frequencies

Day of Week	Time Period	Hours	Service Freq.
Weekday	Early AM	5:00-6:00 a.m.	30 min.
	AM Peak	6:00-9:00 a.m.	10 min.
	Midday	9:00 a.m.-3:00 p.m.	15 min.
	PM Peak	3:00 p.m.-6:00 p.m.	10 min.
	Evening	6:00 p.m.-12 Midnight	30 min.
Saturday	Morning	7:00-9:00 a.m.	30 min.
	Midday	9:00-6:00 p.m.	15 min.
	Evening	6:00-11:00 p.m.	30 min.
Sunday	Morning	7:00-9:00 a.m.	30 min.
	Midday	9:00-7:00 p.m.	30 min.
	Evening	7:00-11:00 p.m.	30 min.

Annual service statistics (revenue bus-hours and revenue bus-miles of service) will be based on 255 weekdays, 52 Saturdays and 58 Sundays and holidays (holidays will be treated as Sundays). BRT vehicle requirements by time period will be based on a cycle time that reflects the estimated route travel time and layover time, which will be no less than 15 percent of the route travel time.

It is important to note that the service frequencies identified in Table 1 reflect an initial proposed service plan. This table corresponds with the existing service span for Metro Transit. Ridership forecasts will be reviewed to determine if these assumptions should be modified.

BRT Vehicles

The proposed BRT vehicle is an articulated bus. The specific type of bus and propulsion system (e.g., hybrid electric) is yet to be determined. For purposes of the service plan, it is assumed each articulated BRT bus has a seating capacity for 58 passengers, and a standing capacity for an additional 22 passengers, for a total capacity of 80 passengers. These articulated bus capacity figures are consistent with those recently used by Palm Tran in a recent acquisition of New Flyer articulated buses.

BRT Service Patterns

It is proposed that BRT service be interlined through downtown, to avoid the need to provide physical space for buses to layover at Capitol Square, and to eliminate transfer time at Capitol Square for through riders. Layovers will occur at each corridor's outer end-of-line station. For purposes of this study, it is assumed that the North and South Corridors are interlined, and the East and West Corridor are interlined. This routing pattern combines what is anticipated to be the two most heavily used corridors (east and west). However, with all four corridors, other interline combinations are possible.

BRT bus operations can be restricted to service just along the defined BRT corridors (e.g., Caddis Bend to Warner Park and East Towne Mall to High Point) or the BRT buses can continue beyond the end-of-line stations to adjacent neighborhoods and nearby destinations. The first option (service restricted to the defined BRT corridors) reduces the number of BRT buses that need to be purchased, avoids the possible use of

large articulated buses in residential neighborhoods, and strengthens the BRT brand. The second option reduces passenger transfer requirements at the end-of-line stations and creates more one-seat ride opportunities for passengers located beyond the BRT alignments.

The operating plan defined for this study assumes BRT buses continue beyond the end-of-line station on just the North Corridor because of possible service efficiencies to be gained in that area. Alternating BRT trips would continue to either the Dane County Regional Airport or to Troy Drive/Northport (Route 22). Further analysis of trade-offs will be needed in future studies to determine if this is the preferred operating plan, or if BRT should advance beyond the end-of-line station in any other corridors.

Figure 1 presents a schematic of the proposed route patterns. The East/West pattern is shown in Red, and the North/South pattern is shown in Blue, with two patterns shown for the North/South pattern (to/from the Airport is shown as Blue-A and to/from Troy Drive is shown as Blue-B).

Table 2 presents bus requirements by time period for the Mineral Point Road alignment on the East/West (Red) Line. This table presents estimated round trip travel times, layover times, cycle times and bus requirements by time period (am and pm peaks, midday and evening). A 15 percent layover has been assumed (i.e., layover/recovery time should be approximately 15 percent of the total cycle time). It is important to note that sometimes layover percentages can be in excess of 15% because the travel time does not fit will into a cycle (e.g., a 55-minute round trip travel time and a 15-minute service frequency cannot fit within a 60-minute cycle, for that would only achieve an 8% recovery percentage. Thus, a 75-minute cycle is required, resulting in a 27% recovery percentage). Note that this analysis is based on preliminary travel time estimates. Service frequencies, recovery times and cycle times should be reviewed and updated as this project advances and new BRT travel times are calculated. At such time, it may be possible to tighten recovery percentages.

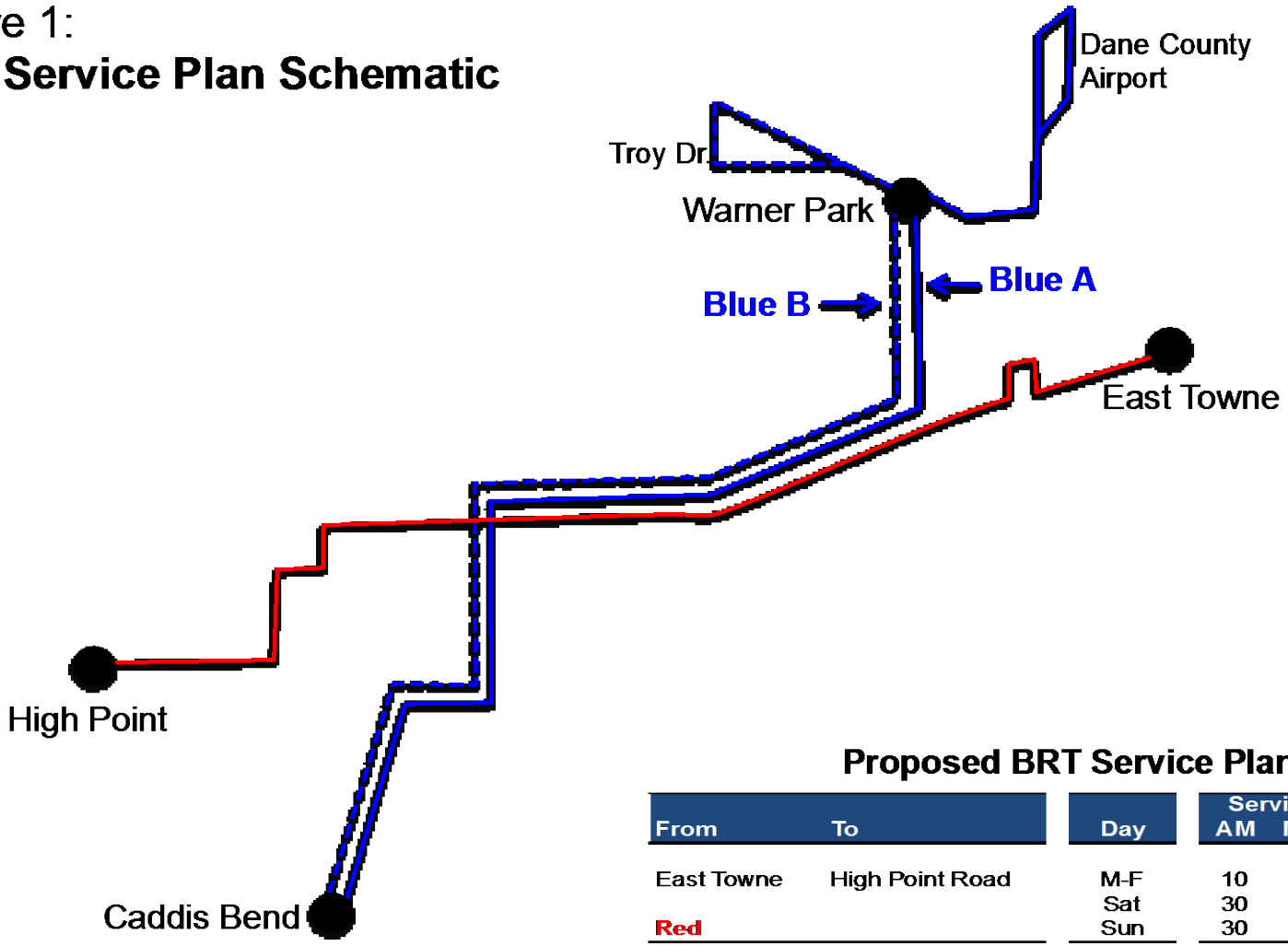
Peak bus requirements by corridor are as follows:

- East – 6 buses
- North – 6 buses
- South – 7 peak buses
- West: Both alignment options – 9 peak buses

Overall, 28 peak buses are required for the entire system, as shown in Table 2. Using a 20% spare bus ratio, required fleet buses for the full BRT system are 34 buses. The Odana Road alignment option has the same peak/fleet bus requirement as the Mineral Point Road alignment option that is presented in Table 2.

Table 3 presents daily and annual estimates of annual revenue bus-hours and bus-miles of service for the full BRT system, for both West Corridor alignment options. Both scenarios have the same estimate of annual revenue bus-hours. Bus-miles vary slightly because of the longer alignment associated with the Odana Road alignment option.

Figure 1:
BRT Service Plan Schematic



Proposed BRT Service Plan

From	To	Day	Service Frequency AM	Mid	PM	Eve
East Towne	High Point Road	M-F	10	15	10	30
		Sat	30	15	15	30
Red		Sun	30	30	30	30
Caddis Bend	Warner Park/ Airport	M-F	20	30	20	60
		Sat	60	30	30	60
Blue (A)		Sun	60	60	60	60
Caddis Bend	Warner Park/ Troy Drive	M-F	20	30	20	60
		Sat	60	30	30	60
Blue (B)		Sun	60	60	60	60

Table 2
Cycle Times and Bus Requirements by Time Period and Day of Week
Mineral Point Road Alignment Option

AM and PM Peak Time Periods

Route	From	To	Day	Serv. Freq.	Rnd Trip Time (min)	Total Layover	Cycle Time	Layover Percent	Bus Req't.
East/West Red	East Towne Mall	High Point Road	M-F	10	124.17	25.83	150.00	17%	15
			Sat	30	124.17	25.83	150.00	17%	5
			Sun	30	124.17	25.83	150.00	17%	5
North/South Blue (A)	Caddis Bend	Warner Park/ Airport	M-F	20	107.80	22.20	130.00	17%	6.5
			Sat	60	107.80	42.20	150.00	28%	2.5
			Sun	60	107.80	42.20	150.00	28%	2.5
North/South Blue (B)	Caddis Bend	Warner Park/ Troy Drive	M-F	20	112.60	17.40	130.00	13%	6.5
			Sat	60	112.60	37.40	150.00	25%	2.5
			Sun	60	112.60	37.40	150.00	25%	2.5

Total Bus Req't. for Period		
	M-F	28
	Sat	10
	Sun	10

Midday Time Period

Route	From	To	Day	Serv. Freq.	Rnd Trip Time (min)	Total Layover	Cycle Time	Layover Percent	Bus Req't.
East/West Red	East Towne Mall	High Point Road	M-F	15	124.17	25.83	150.00	17%	10
			Sat	15	124.17	25.83	150.00	17%	10
			Sun	30	124.17	25.83	150.00	17%	5
North/South Blue (A)	Caddis Bend	Warner Park/ Airport	M-F	30	107.80	27.20	135.00	20%	4.5
			Sat	30	107.80	27.20	135.00	20%	4.5
			Sun	60	107.80	42.20	150.00	28%	2.5
North/South Blue (B)	Caddis Bend	Warner Park/ Troy Drive	M-F	30	112.60	22.40	135.00	17%	4.5
			Sat	30	112.60	22.40	135.00	17%	4.5
			Sun	60	112.60	37.40	150.00	25%	2.5

Total Bus Req't. for Period		
	M-F	19
	Sat	19
	Sun	10

Evening Time Period

Route	From	To	Day	Serv. Freq.	Rnd Trip Time (min)	Total Layover	Cycle Time	Layover Percent	Bus Req't.
East/West Red	East Towne Mall	High Point Road	M-F	30	124.17	25.83	150.00	17%	5
			Sat	30	124.17	25.83	150.00	17%	5
			Sun	30	124.17	25.83	150.00	17%	5
North/South Blue (A)	Caddis Bend	Warner Park/ Airport	M-F	60	107.80	42.20	150.00	28%	2.5
			Sat	60	107.80	42.20	150.00	28%	2.5
			Sun	60	107.80	42.20	150.00	28%	2.5
North/South Blue (B)	Caddis Bend	Warner Park/ Troy Drive	M-F	60	112.60	37.40	150.00	25%	2.5
			Sat	60	112.60	37.40	150.00	25%	2.5
			Sun	60	112.60	37.40	150.00	25%	2.5

Total Bus Req't. for Period		
	M-F	10
	Sat	10
	Sun	10

Fleet Bus Requirement for Full BRT System = 34 (20% spare ratio factor)

NOTE: Odana Road alignment option has same peak/fleet bus requirements

Table 3
Estimates of Bus-Hours and Bus-Miles of Service

Mineral Point Road Alignment Option for East/West Line

From	To	One-Way Time (min)	One-Way Dist (mi)	Day	Service Frequency AM	Mid	PM	Eve	Daily Rev. Bus-Mi's	Bus-Hrs	Annual Rev. Bus-Miles	Bus-Hrs
East Towne	High Point Road	62.08	14.04	M-F	10	15	10	30	2,078	185	529,900	47,200
				Sat	30	15	15	30	1,460	130	75,900	6,800
Red				Sun	30	30	30	30	899	80	52,100	4,600
Caddis Bend	Warner Park/ Airport	53.90	11.41	M-F	20	30	20	60	844	84	215,300	21,300
				Sat	60	30	30	60	593	60	30,900	3,100
Blue (A)				Sun	60	60	60	60	365	40	21,200	2,300
Caddis Bend	Warner Park/ Troy Drive	56.30	12.01	M-F	20	30	20	60	889	84	226,600	21,300
				Sat	60	30	30	60	625	60	32,500	3,100
Blue (B)				Sun	60	60	60	60	384	40	22,300	2,300
TOTALS											1,206,700	112,000

OdanaRoad Alignment Option for East/West Line

From	To	One-Way Time (min)	One-Way Dist (mi)	Day	Service Frequency AM	Mid	PM	Eve	Daily Rev. Bus-Mi's	Bus-Hrs	Annual Rev. Bus-Miles	Bus-Hrs
East Towne	High Point Road	65.08	14.89	M-F	10	15	10	30	2,204	185	561,900	47,200
				Sat	30	15	15	30	1,549	130	80,500	6,800
Red				Sun	30	30	30	30	953	80	55,300	4,600
Caddis Bend	Warner Park/ Airport	53.90	11.41	M-F	20	30	20	60	844	84	215,300	21,300
				Sat	60	30	30	60	593	60	30,900	3,100
Blue (A)				Sun	60	60	60	60	365	40	21,200	2,300
Caddis Bend	Warner Park/ Troy Drive	56.30	12.01	M-F	20	30	20	60	889	84	226,600	21,300
				Sat	60	30	30	60	625	60	32,500	3,100
Blue (B)				Sun	60	60	60	60	384	40	22,300	2,300
TOTALS											1,246,500	112,000

Background Bus Service Modifications

The introduction of BRT service provides opportunities to restructure the background Metro bus service. Specific weekday route alignment and frequency changes that have been assumed for this study are described below. It is important to note that the service modifications described below reflect a *potential* restructuring of service for purposes of estimating ridership and cost impacts. Further planning with extensive public involvement will be required should this project advance towards implementation. As an example, route modifications will impact existing Metro interlines. Those impacts, and proposed adjustments to existing route interlines have not been addressed in detail at this stage of the project.

North Transfer Point Routes – It is proposed that Metro's North Transfer Point be relocated to Aberg Avenue and Sherman Avenue, to provide connectivity to proposed North Corridor BRT service. Thus, alignments for all routes that serve the North Transfer Point will need to be modified to operate to and from this new location (Routes 2, 4, 17, 20, 21, 28, 56, 57). Run times will eventually need to be reviewed to determine if required alignment modifications can be accommodated within existing cycle times, or if new interline options need to be considered to mitigate additional bus requirements.

West Transfer Point Routes – There are two BRT alignment options for the West Corridor. The Odana Road alignment option assumes the West Transfer Point remains at its current location. The Mineral Point alignment option, however, assumes the West Transfer Point is relocated to the vicinity of Mineral Point Road and Whitney Way (i.e., along the BRT alignment). Thus, alignments for all routes that serve the West Transfer Point will need to be modified to operate to and from this new location (Routes 2, 3, 6, 11, 12, 18, 28, 50, 51, 52, 55, 56, 57 and 73, in addition to weekend routes 7, 59, 63, 68 and 78). Run times will need to be reviewed to determine if required alignment changes can be accommodated within existing cycle times, or if new interline options need to be considered to mitigate additional bus requirements. As an example, it is known that Route 7 (a weekend route) currently has minimal recovery time at the West Transfer Point. Relocation of the West Transfer Point will require additional travel time for Route 7. An additional bus will probably be required on this route. Route 18 may also be adversely impacted, requiring an additional bus to maintain current frequencies.

Route 2 – This route operates between the West and North Transfer Points, with 30-minute all-day service, both weekdays and weekends. There is supplemental morning peak service between the West Transfer Point and downtown Madison. It is proposed that the supplemental a.m. peak trips be eliminated because they are duplicative of the new BRT service.

Route 5 – This route operates between the South and East Transfer Points. Weekday frequencies are 30-minutes during the day and 60-minutes in the evening. Weekend frequencies are 60-minutes all-day. It is proposed that the south portion of this route (between the South Transfer Point and downtown Madison) be eliminated and replaced with the BRT line. This change would eliminate service on the Fisher St deviation 1-2 blocks east of Park St, but high quality BRT service would be available on Park St. The elimination of service on the south side of downtown results in the need to consider interline options for Route 5. A possible interline option includes the revised Route 6 (described below).

Route 6 – This route operates from West Transfer Point through downtown Madison, to East Towne Mall, with alternating trips serving several different patterns. Existing weekday frequencies are 15 peak/30 midday and evening. Existing weekend frequencies are hourly. It is proposed the eastern portion of this route (east of downtown Madison) be eliminated, replaced with BRT service. As noted above, with elimination of Route 6 service east of downtown, new interline options may need to be considered, such as with Route 5. The resulting Route 6 west / Route 5 east line would operate from the West Transfer Point to East Transfer Point with 30-minute service throughout the day on weekdays, hourly service on weekends. The route would pulse at the East Transfer Point at 15 and 45 minutes after the hour, but would not coincide with the pulse at the West Transfer Point.

Route 13 – This route operates from the South Transfer Point to the UW Campus. Route 13's weekday frequencies are 30 peak/60 midday and 60 evening. Existing weekend frequencies are hourly. With the introduction of BRT service, it is proposed this route's northern alignment be modified to downtown Madison via West Washington Avenue (to replace lost Route 5 service on West Washington Avenue). It is also proposed Route 13 continue northeast on East Washington Avenue to Milwaukee Street, to provide supplemental local service under the proposed BRT service.

Route 14 – This route operates between Tree Lane and Gammon Road and downtown Madison, with peak trips continuing to the East Transfer Point and Cottontail Trail and Kings Mill Way. Weekday frequencies are 30-minutes in the peak and 60-minutes in the midday and evening periods. It is proposed this route's alignment be modified slightly, to remain on Regent Street instead of deviating to Sheboygan Avenue to reduce travel times and take advantage of the frequent service provided by BRT.

Route 20 – This route operates from the North Transfer Point, to the Dane County Regional Airport, to East Towne Mall. Existing frequencies are 30-minutes all-day – both weekdays and weekends. It is proposed that the airport portion of this alignment be eliminated. It is also proposed this route's alignment be modified to pick up service on Kinsman Blvd. and Bartillon Road, and on Portage Road and Hayes Road (to pick up service lost with the proposed elimination of Route 6 on the east side).

Route 22 – This route operates from the North Transfer Point to Troy Drive and Green Avenue. Existing weekday frequencies are 15 peak/30 midday and 30 evening. Existing weekend frequencies are 60 minutes. This route is proposed for elimination, to be replaced with extended BRT service (every other trip). The extended BRT trips could continue to be labeled as Route 22 service, or as labeled BRT service.

Route 25 – This route presently has two a.m. outbound and two p.m. inbound trips between downtown Madison and The American Center. This route is eliminated, replaced with all-day Route 26 service.

Route 26 – This route presently operates hourly in the midday between East Towne Mall and The American Center. This route is modified to operate during peaks as well as the midday with 30-minute peak headways, connecting to BRT service at the East Towne Mall.

Route 27 – This route provides peak period service between the North Transfer Point and downtown Madison and the UW campus. It is proposed this route be eliminated

because most of its service area is duplicative of BRT. It is important to note that this route serves East High School trips. Thus, supplemental service (trippers) may be needed at the start and end of school to accommodate high school passenger loads.

Route 29 – This route, known as the Sherman Flyer, provides 2 a.m. inbound and 2 p.m. outbound trips from the Lakeview area to downtown Madison and the UW campus. It is proposed this route be eliminated because it is duplicative of BRT service. Route 21 presently serves a large portion of this route's service area.

Route 34 – This route presently operates between the East Transfer Point and the Madison College. Existing frequencies are 30-minutes in the peak period and 60-minutes in the midday, with service on weekdays only. It is proposed that this route's alignment be modified to include service on East Washington Avenue. From Kinsman Blvd., the route would follow North Stoughton Road to East Washington, turning south on Fair Oaks Avenue.

Route 37 – This route operates from the east side of Madison (east of Lake Monona) to downtown Madison and the UW Campus. Select afternoon trips (3 trips) continue to Sheboygan Avenue and Eau Claire Avenue. It is proposed that those 3 trips do not continue to Sheboygan Avenue/Eau Claire Avenue.

Routes 44 and 48 – These routes provide weekday peak period service between Fitchburg and the UW Campus. These route alignments are modified to begin/end at the Caddis Bend BRT station. Thirty-minute service is proposed in the peak periods only.

Route 47 – This route operates from Fish Hatchery Road/Caddis to the UW Campus and downtown Madison. This route operates in the peak periods only, at 30-minute frequencies in both directions. It is proposed that this route's alignment be shifted from Park Street to Mills Street to replace frequency vacated by the 44/48 and reduce duplicative service.

Route 67 – This route operates from Mineral Point/Randolph Drive to the West Transfer Point. Existing weekday frequencies are 15 peak/30 midday/30 evening. Existing weekend frequencies are 60-minutes. It is proposed this route be eliminated because it is duplicative of the West Corridor Mineral Point Road BRT line and Route 14. If the Odana Road Routing is chosen for the West Corridor, Route 73 is planned to be rerouted to Mineral Point Road to provide local service, as described below.

Route 70 – This route operated from Middleton and the UW Health Center in Middleton to Capital Square via University Avenue. Route 70 generally operates in the midday and evening periods at approximately 60-minute frequencies. It is proposed Route 70 be modified to truncate at Hill Farms (University Avenue and Segoe Road), with minor improvements in frequencies to accommodate the route's new travel time while maintaining two buses in service. No changes are proposed to Routes 71, 72 and 74, which provide peak period service in this corridor.

Route 73 – This route operates from the Middleton Transfer Point to the West Transfer Point. Existing weekday frequencies are 30-minutes in the peak period and 60-minutes in the midday and evening periods. No changes are proposed to this route should the West BRT alignment utilize Mineral Point Road. It is proposed that this route's

alignment be modified from Odana Road to Mineral Point Road should the West BRT alignment utilize Odana Road (see Route 67 description). Note that Odana Road is served by Route 63 on the weekends. This alignment change is also proposed to weekend Route 63 service.

.

APPENDIX
CORRIDOR BRT ALIGNMENT MAPS
(Will be inserted in final draft)