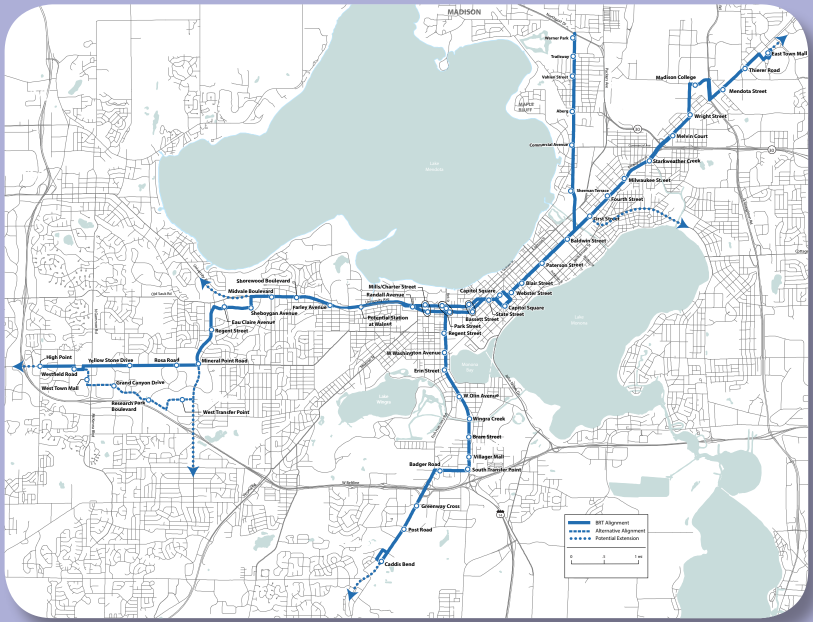
Madison Transit Corridor Study

Investigating Bus Rapid Transit in the Madison Area



A Study By

The Capital Region Sustainable Communities Initiative

Capital Region Sustainable Communities

The Madison Area Transportation Planning Board

Madison Area T•P•B Transportation Planning Board A Metropolitan Planning Organization (MPO)

MAY 2013

CAPITAL REGION SUSTAINABLE COMMUNITIES INITIATIVE

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May 2013

Prepared by the
SRF Consulting Group Team

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Study Process

The Madison metropolitan area has grown substantially in recent years, placing pressure on the transportation system and prompting conversations about high-capacity transit. Over the last 30 years, the greater Madison community has invested time, effort, and resources discussing the potential for possible solutions, including light rail, commuter rail, and a streetcar system. Through the course of these studies, bus rapid transit (BRT) solutions have been considered, but never analyzed in great depth.

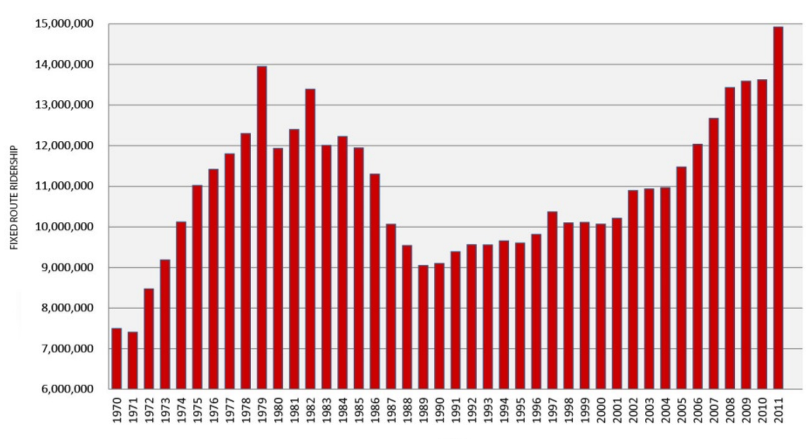
The Madison area's primary transit system, Metro Transit, has seen significant increases in ridership starting in 2003, as shown in Figure 1. With these increases in ridership, Metro has experienced overcrowding, particularly on the lines that serve UW Madison and Madison College, often resulting in the need to add additional buses. For example, Metro buses' seating capacity is 34 to 38. A crowded bus is generally defined as having 15 to 20 riders standing. Some bus trips have chronic overcrowding problems with passenger counts as high as 65 or more.

With continued urban growth comes longer transit trips. In many cases, people are making trips across Madison to access jobs, schools, and other destinations. These trips may take well over an hour and involve one or more transfers. Long, regional trips using core bus routes often make many stops, use low-speed neighborhood streets, and take riders on circuitous deviations.

While a positive sign that the community is availing itself of the transit system, the overcrowding and associated operational issues negatively impact customer satisfaction. The overcrowding, in particular, is a strong indication that Madison is in need of improved service as well as the development of a substantial transit expansion, such as BRT.

Despite these difficulties, in 2012 Madison Metro Transit was awarded the National Outstanding Public Transportation System Award, which is sponsored by the America Public Transportation Association (APTA). Called the "best of the best" in the industry, APTA recognizes its winners as outstanding role models of excellence, leadership, and innovation whose accomplishments have *greatly* advanced public transportation.

Figure 1: Metro Transit Annual Fixed Route Ridership 1970 – 2011



Bus rapid transit (BRT) is a high frequency, limited-stop bus system that is intended to provide faster service and improved reliability in urban environments. BRT service design typically incorporates unique lane treatments to give an advantage to bus service along with transit signal priority, unique station and vehicle designs, and enhanced customer service features to improve service quality. BRT service is most appropriate to consider along high transit utilization corridors serving a number of key travel generators within a community. Implementing BRT is often less expensive and has a shorter timeframe than many other improvements such as rail services.

Over the past 30 years, Madison has conducted a number of studies intended to identify the most promising prospects to provide improved transit service opportunities. The Transport 2020 Alternatives Analysis Study analyzed area hybrid light-commuter rail system from Middleton to east of Madison and a recent effort looked at streetcar system feasibility in the downtown and University of Wisconsin area. None of those earlier efforts looked seriously at the opportunities of providing BRT service although it can offer many similar advantages to rail service such s reduced travel times, greater carrying capacity, enhanced image and opportunity for transit oriented development (TOD).

BRT in its highest form can resemble rail service in that it can operate in its own right of way. But BRT has proven flexible enough in recent applications to operate satisfactorily within existing street configurations. In some locations BRT is considered a long-term, permanent transit solution and in others is expected to serve as a precursor to future rail development.

The Madison Transit Corridor Study was intended to evaluate the feasibility of implementing BRT service along arterial street corridors. Four corridors were evaluated in the study: north, south, east and west out of the downtown area that include a common central segment in the UW Campus area and central isthmus. Those corridors are the most heavily traveled transit corridors in the city with over 20,000 of about 60,000 total daily boardings. The purpose of the study was to provide a detailed assessment of arterial BRT service along these corridors by identifying the potential costs to construct and operate the service and estimating how many riders the service might attract. As part of that assessment, considerations for altering the existing transit services had to be incorporated and the location, sizing and operation of timed-transfer points within the system also had to be considered. The most promising segments were identified for initial consideration with longer-term connections and expansions set aside for future consideration.

Both “corridor BRT” - utilization of existing travel lanes or side running non-exclusive bus lanes and “fixed guideway BRT” - creating new guideways - were evaluated where possible. A corridor BRT system would function similar to lower capital cost systems in Seattle, WA; Albuquerque, NM; Nashville, TN; and New York, NY; while a fixed-guideway BRT system would model more intensive infrastructure in Eugene, OR; Cleveland, OH; Miami, FL; and Pittsburgh, PA.

Information from the study is intended to help guide future transit service facilities and land use planning efforts across the community. The study was coordinated with a separate transit-oriented development (TOD) market study that will provide information on meeting regional housing, employment and service needs in pedestrian-friendly transit-supportive developments. The potential ridership increment resulting from TOD along the BRT corridors was incorporated into this study.

Engaging the Greater Madison community in the Madison Transit Corridor Study public involvement process creates linkages between the community and additional planning efforts like the City of

Madison Comprehensive Transportation Master Plan. The City has identified a need for a comprehensive transportation master plan that integrates all modes of passenger and freight transportation (i.e., air, auto, bicycle, freight rail and truck, high-capacity transit, pedestrian, public transportation, etc.), identifies how those modes interconnect, and highlights how the City's numerous plans and policies enhance and support the master plan. Essentially, the Madison Transit Corridor Study will inform the Comprehensive Transportation Master Plan. It will also inform the future update of the long-range Regional Transportation Plan by the Madison Area Transportation Planning Board – A Metropolitan Planning Organization (MPO).

Study Sponsor

The Madison Transit Corridor Study was undertaken by a partnership of agencies, including:

- Capital Area Regional Planning Commission (CARPC)
- Madison Area Transportation Planning Board (TPB) – An MPO
- City of Madison
- Dane County
- Madison Area Transportation Planning Board/Metropolitan Planning Organization (MPO)
- Metro Transit

Funding for the project was provided through a Sustainable Community Regional Planning Grant (SCRPG). As the regional transportation planning body, the MPO was the lead agency for the study.

The Capital Region Sustainable Communities Consortium (CRSCC) of government, business and nonprofit organizations, which is led by the Capital Area Regional Planning Commission (CARPC), received a Sustainable Community Regional Planning Grant (SCRPG) from the US Department of Housing and Urban Development (HUD). A major goal of the three-year grant project is to create a broad partnership to advance regional sustainable development and promote shared goals and performance targets in local and regional plans. Among the activities of the Sustainable Communities project is to develop plans for improved regional transit and transit-supportive development that increases connections between residents, including low-income and those more reliant on transit services, and employment centers.

One of the goals of the CRSCC partnership is to increase equity in planning and decision-making. The workgroup responsible for advancing this goal seeks to integrate social equity into all aspects of the partnership's work, including this transit study. They propose that "equity" means just and fair inclusion that enable all residents to access and take advantage of the region's economic, social and environmental assets. While this study is meant to focus on technical recommendations, issues of equity and inclusion were identified and considered wherever possible.

Oversight Committee

The study was guided by a 20-person advisory committee that provided technical direction. The committee was comprised of representatives from the MPO Policy Board and staff, Capital Area Regional Planning Commission, the Cities of Madison and Fitchburg, UW-Madison, Wisconsin Department of Transportation, Dane County, MPO board members and MPO staff, and other agencies and organizations. Members of the committee are presented in Table 1.

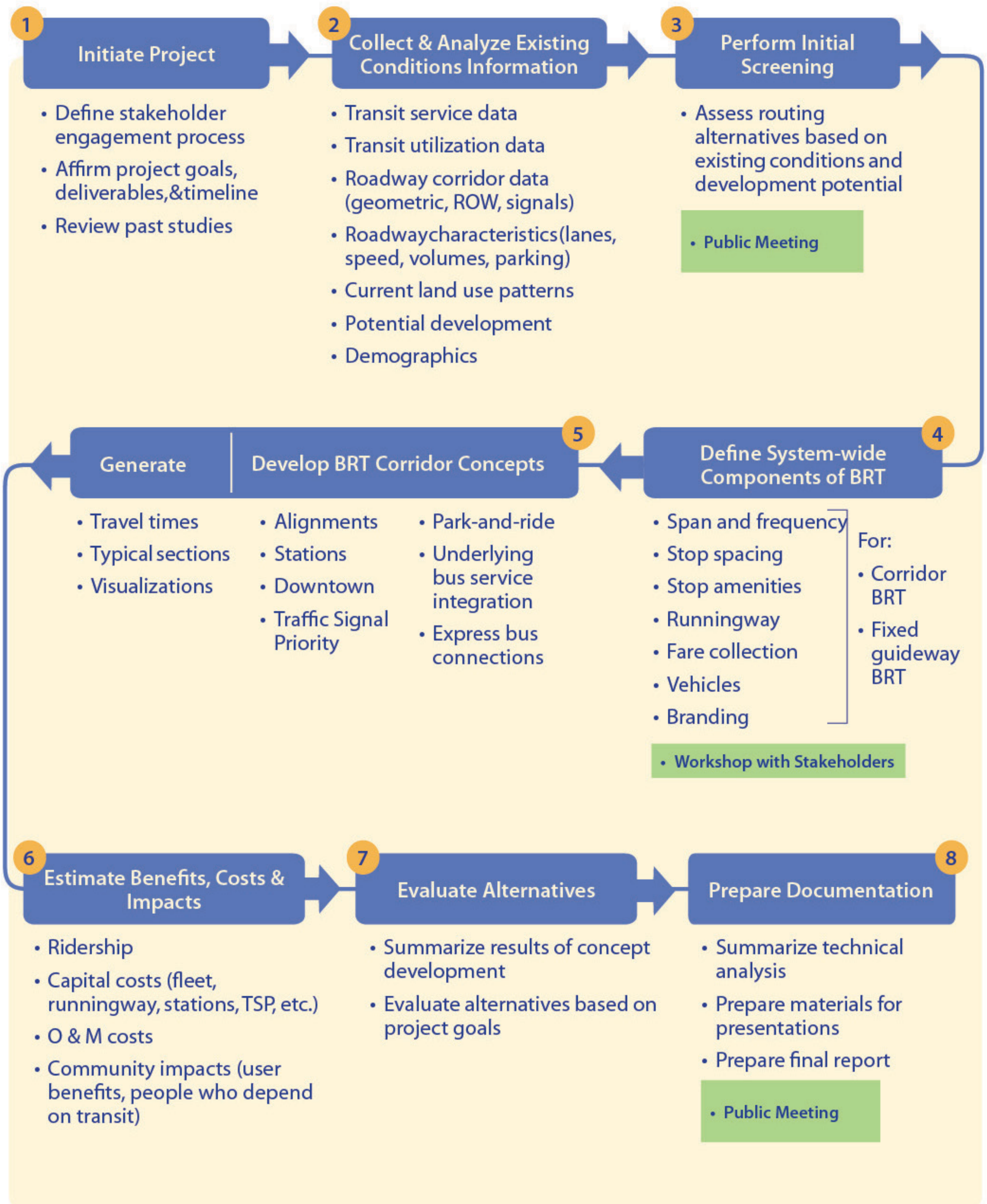
Table 1: Oversight Committee

Name	Organization/Affiliation
Bill Schaefer	Madison Area TPB (MPO) Staff
Mike Cechvala	Madison Area TPB (MPO) Staff
Mark Opitz	MPO Policy Board
Steve Steinhoff	Capital Area Regional Planning Commission
Chuck Kamp	City of Madison Metro Transit
Drew Beck	City of Madison Metro Transit
David Trowbridge	City of Madison Planning
Ken Golden	City of Madison Transit & Parking Commission
Chris Petykowski	City of Madison Engineering
Dave Dryer	City of Madison Traffic Engineering
Brian Smith	City of Madison Traffic Engineering
Delora Newton	Greater Madison Chamber of Commerce
Bruce Wilson	Madison Area Bus Advocates
Dar Ward	UW-Madison Transportation Services
Pam Dunphy	Dane County Public Works & Transportation
Diane Paoni	Wisconsin Department of Transportation
Michelle Brokaw	Wisconsin Department of Transportation
Ahnaray Bizjak	City of Fitchburg
Susan Schmitz	Downtown Madison, Inc.
Joe Kapper/Ian Ritz	Wisconsin Department of Transportation

Project Approach

The major activities completed for the project are shown in Figure 2.

Figure 2: Project Approach



Public Involvement

The Transit Corridor Study developed a public participation plan in order to engage stakeholders at key points during the study process. The purpose of the public participation process was to educate the community about BRT and the positive impact it can have on city-wide and regional goals for mobility, sustainability, economic development, and environmental justice. The process also provided the community the opportunity to give input on the recommendations of the technical study. The goals of the public involvement plan were:

1. Educate the community about Metro Transit's challenges, including overcrowding, operations, and rising costs, as well as its success in the face of these challenges.
2. Educate the community about BRT – what it is, how it works, and the benefits for residents, employers, current transit users, and the community as a whole in terms of sustainable development, economic development, and quality of life.
3. Seek input from the community in response to the study recommendations for the BRT system in terms of functionality, design, routes, and operations.
4. Lay the groundwork for the strong community support that will be necessary for the implementation of the BRT system.
5. Educate the community about the connection between land use and transit.
6. Ensure the community has confidence in the technical analysis by adequately explaining the process and the outcomes of the analysis.
7. Help the community understand that improved transit service will also improve other modes of travel.

The desired outcome for the public involvement process was to receive useful input and give the public and the Dane County and City of Madison policy-makers confidence in the report. The full public involvement plan can be found in

Appendix A.

The project study area ran through or touched nearly forty neighborhood associations and many of the area business associations. The project management team used the existing communication structures, such as association listservs and websites, to disseminate information about the Transit Corridor Study to all of these groups. Information about the study was also posted on the MPO's website. Additionally, the news media was kept abreast of project news and announcements over the course of the study in order to publicize the study's public meeting dates and locations.

Two public meetings were held for the Transit Corridor Study. The first public meeting for the project drew over 75 community members. Participants at this meeting gave feedback on the initial alignments as well as which BRT amenities they felt were most important to the proposed system. A second public meeting was held, attracting about 65 community members, to present the proposed BRT system and analysis results.

Transit Corridor Study Goals

The Oversight Committee established the following set of goals for BRT implementation in Madison:

1. Reduce transit travel times
2. Attract new transit riders
3. Improve connections between low income and/or transit dependent neighborhoods and centers of employment and activity
4. Provide expanded transit carrying capacity
5. Improve operational efficiencies
6. Provide an enhanced image for transit service
7. Improve the comfort and convenience of the transit experience
8. Integrate well with the existing and planned transit system
9. Enhance opportunities for transit-oriented development (TOD)

The Transit Corridor Study used the goals to evaluate the potential benefits of the proposed BRT corridors.

Universe of Corridors

One of the early steps in the technical analysis of BRT options was to identify the candidate corridors and segments to carry forward into detailed analysis. The set of corridors initially considered is shown in Figure 3. These alignment alternatives cover four corridors, each arranged radially around Capitol Square and oriented towards the North, East, South, and West transfer points. Common to all radial corridors is the Central Segment which spans from the Isthmus and the Capitol Square to the University of Wisconsin campus. Several alternative routings along the main corridors, as well as potential future extensions to Sun Prairie, Monona, Middleton, and Verona were considered in this initial review. The universe of corridors process was meant to encompass all realistic BRT routings. Alternatives were initially developed by MPO staff with additional corridors added by the consultant team and the Oversight Committee.

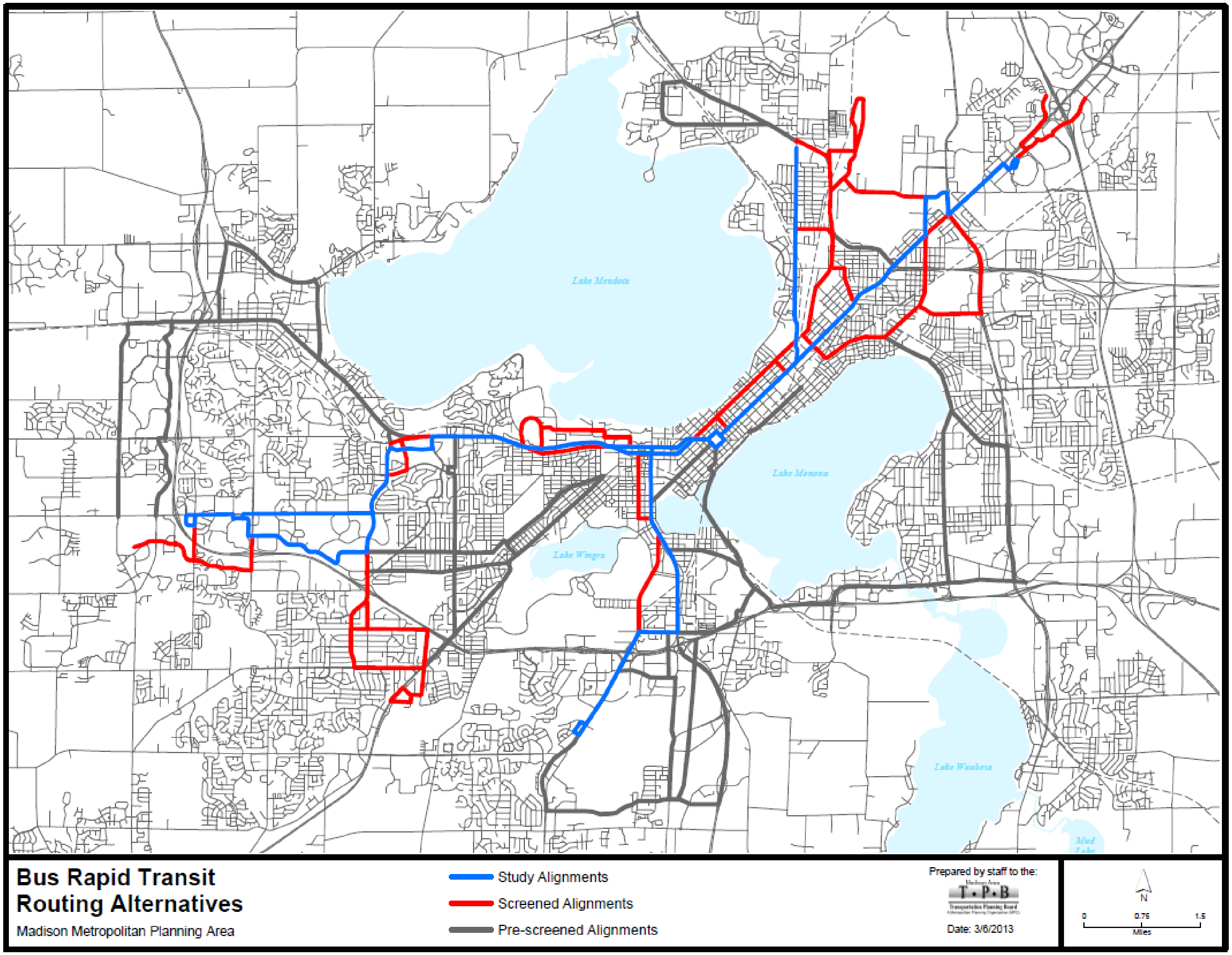
This process selected the most promising corridors from a transit service planning and feasibility standpoint. Corridors such as Middleton, Midvale Boulevard, Monroe Street, the East Rail Corridor, and Monona Drive were not among the most promising at this time. These corridors have insufficient all-day transit ridership or would be impractical to construct and operate.

Refinement of Initial Alternatives

Following the initial screening process, the criteria were used to identify the most promising alignment segments to move forward into detailed study. These metrics were analyzed using GIS and other methods, as described in Appendix C.

- Population within 1/4 mile of the alignments
  - Greater concentrations of population allow routes to operate more productively by serving a larger population with fewer resources.
- Employment within 1/4 mile of the alignments
  - As with population density, a higher concentration of jobs allows transit routes to provide service more effectively.

Figure 3: Initial Universe of Corridors



- Existing transit ridership along the alignments
    - Existing Metro customers represent the current demand for transit service in an area.
- Transit Oriented Development (TOD) potential along route
    - TODs, developments designed and built to encourage transit use, increase demand for—and are benefitted by—high quality transit along a corridor.
- Roadway Suitability
    - The functional class of a roadway as well as speed, right of way/street width, and traffic volumes all effect the implementation of BRT system.

The corridors and segments advanced for detailed review are shown in blue and labeled “Study Alignments” on Figure 3. Some alternatives and segments, such as in the downtown area, were not fully studied at this time due to their complexity and relatively small impact on the system as a whole. Some of these may merit further review in the future.

West Corridor

In the University Avenue corridor, four sub-alternatives were developed between Farley Avenue and Randall Avenue: direct service via Campus Drive, via University Bay Drive and Campus Drive, via “Old” University Avenue, and via University Bay Drive and “Old” University Avenue. Including University Bay Drive and/or “Old” University Avenue in the alignment increases travel times by an estimated two to five minutes, subjects riders to circuitous routing, and introduces substantial reliability concerns, particularly on “Old” University Avenue. The direct route via Campus Drive was advanced because it was the only one that satisfied the project goals to reduce travel times, improve the comfort and convenience of the transit experience, and integrate well with the existing and planned transit system.

In the Hill Farms area, transit service currently operates from University Avenue to Whitney Way via a circuitous path involving Segoe Road, Sheboygan Avenue, Eau Claire Avenue, and Regent Street. Two sub-alternatives to this routing were evaluated, via Sheboygan Avenue (eliminating Eau Claire Avenue and Regent Street) and via Old Middleton Road. The current alignment via Eau Claire Avenue and Regent Street was dismissed because of circuitous routing and reliability concerns from Metro Transit. The Old Middleton Road alignment would be the fastest, most direct path, but the travel time savings would likely be less than a minute on average. This alignment substantially degrades service to the Hill Farms neighborhood centered on Sheboygan Avenue which has over 1,000 daily boardings, likely failing the project goals of providing expanded carrying capacity and improving operational efficiencies.

West of Whitney Way, two alternatives were evaluated for the west corridor, via Mineral Point Road and via Odana Road. The Mineral Point Road alternative requires the relocation of the West Transfer Point to the north near Mineral Point Road. However, this change moves the West Transfer Point away from an activity center with a grocery store (Westgate mall) to an area that is primarily open space (if a suitable site can be found) and relocates the West Towne Mall stop to the north of the ring road, away from the main mall entrance. In contrast, the Odana Road alternative serves the West Transfer Point at or near its existing location and serves West Towne Mall at the existing bus stop near its front entrance. However, it is about two minutes slower, more circuitous, and does not serve residential areas near Mineral Point Road and Yellowstone Drive. These two alternatives demonstrate the trade-off between different project goals, such as reducing travel times, providing an enhanced image for transit service (Mineral Point Road), improving connections between low income and/or transit dependent neighborhoods and centers of employment and activity, integrating well with the existing and planned transit system, and enhancing opportunities for transit oriented development (Odana Road). As a result, both alignments were analyzed in the study, and future planning efforts will need to determine which moves forward.

South Corridor

The number of viable alignment alternatives in the south corridor is limited by the geography of the area which is bounded by the Arboretum to the west, Lake Monona to the east, and the Nine Springs Greenway to the southeast. The study alignment on Park Street matches that of the streetcar planning work completed in 2007. Alternative alignments on Fish Hatchery Road, John Nolen Drive, and West Washington Avenue were found to have insufficient ridership, circuitous routing, or both.

East Corridor

The number of viable alignment alternatives in the east corridor is limited by the relative lack of radial arterial streets serving transit supportive land uses like East Washington Avenue. BRT in the east corridor is anticipated to save about three to four minutes from Metro Transit's current Route 6 via Madison College by cutting off the Kinsman Boulevard deviation and being routed via Anderson Street. A further potential improvement in route directness was identified by travelling between Stoughton Road and East Washington Avenue via Mendota Street or a new street connection between Anderson Road and Lien Road. Specific routing options in this area are dependent on the Stoughton Road corridor study. Eliminating the Madison College deviation altogether would result in the fastest possible service (saving three additional minutes over Anderson Street); however, this alignment would likely not generate sufficient ridership, nor ease overcrowding on Route 6.

The east corridor is the only corridor that does not directly serve a transfer point. Additional corridors between the Capitol Square and East Towne were considered in the universe of corridors review that would serve the East Transfer Point in its existing location or a new location. However, these corridors (Fair Oaks Avenue, Milwaukee Street, and Stoughton Road), are circuitous, congested, and/or serve land uses that are not supportive of premium transit service.

North Corridor

Similar to the south corridor, the north corridor has two potential arterial street alignments for BRT, Sherman Avenue and Packers Avenue. Although Packers Avenue is fastest path, it serves land uses that are not supportive of premium transit service, including industrial, suburban office, low-density residential and open space (Demetral Field and Bridges Golf Course). As a result, it would likely not generate sufficient all-day ridership to support BRT. Additionally, a Packers Avenue alignment would likely require BRT buses to exit at Aberg Avenue, serve the North Transfer Point, and reenter Packers Avenue, eliminating most or all of its travel time advantages. Sherman Avenue was identified as the best alignment to study as it serves transit supportive land uses (Sherman Terrace, Maple Woods, and multi-family buildings on Trailsway) as well as areas that may be candidates for transit-oriented urban development. The Sherman Avenue alignment requires the relocation of the North Transfer Point from Huxley Street to near Sherman Avenue, bringing it closer to a more pedestrian-oriented activity center with retail and potential redevelopment opportunities.

Between the Capitol Square and the Fordem Avenue / Johnson Street intersection, BRT could follow East Washington Avenue or the Johnson Street and Gorham Street couplet. East Washington Avenue was chosen because it would unify the regional BRT service onto one corridor, support planned high densities along East Washington Avenue, and not be subject to traffic delays on Johnson and Gorham Streets, which are not good candidates for BRT treatments such as dedicated lanes and in-lane stops. To maximize BRT speeds, the East Washington Avenue alignment would benefit from a connection to Fordem Avenue. One option for this connection is a new 0.3-mile busway along the railroad corridor crossing the Yahara River, informally referred to as the Yahara Busway. Alternatives with the East Washington Avenue routing (Baldwin Street, First Street, Commercial Street, Aberg Avenue, and Anderson Street) are circuitous (likely taking more time than Route 2), duplicative of the east corridor, and/or use local residential streets. The Yahara Busway would substantially improve reliability by avoiding congested intersection approaches on First Street and at Johnson Street and Fordem Avenue.

The north corridor was initially considered to serve the Dane County Airport via Darwin Road. However, this part of the BRT alignment was not advanced for detailed study due to low existing ridership at the airport, currently only about 15 boardings per weekday. Conversely, extending the BRT line to the northwest would serve substantially more people; however, the only viable service pattern – a loop via Troy Drive and Northport Drive similar to Route 22 – is not conducive to BRT service patterns with limited or substantially consolidated stops, and the land uses do not support the frequent all-day service. As a result, the formal north corridor was ended near Northside Town Center just south of Northport Drive. From that point BRT service splits to provide lower frequency service to both the Troy Drive and Northport Drive area and to Dane County Airport. Besides providing one-seat rides to and from these areas at appropriate frequencies, this service design eliminates the duplication between Route 22 and BRT on North Sherman Avenue. A new terminal would need to be constructed near Northside Town Center to accommodate a layover. Ideally this terminal would also serve the Northside Towne Center park-and-ride.

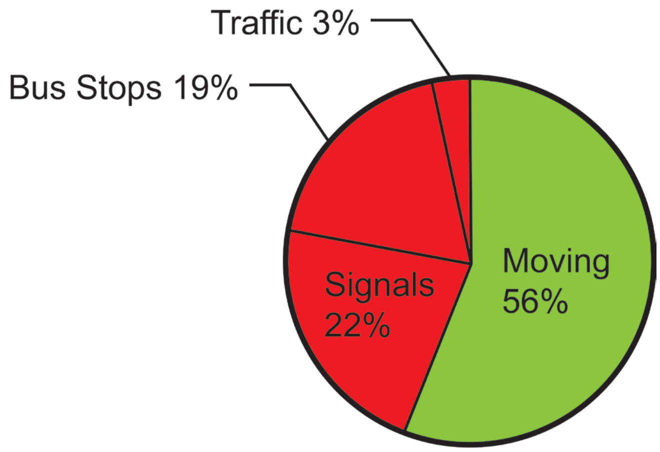
BRT Components

BRT is a corridor-based transit improvement designed to provide fast, frequent, reliable and comfortable service. The key design components, shown in Figure 5, which can affect the overall performance of BRT are:

- Service frequency
- Alignment runningway
- Station location and design
- Vehicles
- Connecting and parallel local bus service
- Fare collection
- Advanced technology
- Identity and branding

Transit travel times, in general, are long because buses are stopped for a great deal of the time they are in service. Often most the delay is not caused by traffic congestion, but rather by waiting at traffic lights and waiting for passengers to board and pay their fares. To illustrate this, a travel time analysis was done during a typical trip on Metro's Route 57, a commuter route with some express service that closely resembles the west corridor BRT line. Almost half of the travel time from the Capitol Square to the West Transfer Point was spent serving bus stops or waiting at traffic signals, as shown in Figure 4. Routes without express service likely spend more time at bus stops. BRT looks to reduce these delays by offering off-board fare collection, limiting the number of stations, and by implementing transit signal priority.

Figure 4: Route 57 Travel Time Analysis



Note: Route 57, Capitol Square to West Transfer Point, October 15, 2012, 4:22 to 4:48 p.m. Normal weather, loading, and traffic conditions were observed. Average penalties for acceleration and deceleration were estimated at 8 seconds per stop.

Figure 5: BRT Component Summary

BRT Components

Service

BRT service typically runs every 15 minutes or better, throughout most of the weekday and on weekends.

Runningways

BRT can use dedicated or preferential lanes to allow buses to move more quickly through traffic. Runningways significantly impact travel speeds, reliability and identity in a system. Minor intersection treatments can make a big difference in a mixed traffic environment

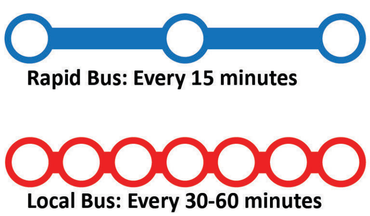
Stations

Bus stops are often upgraded to premium transitway stations with enhanced amenities and information kiosks. BRT Stations can be simple or complex, but they offer passengers increased comfort, safety, and security.

Vehicles

BRT vehicles should have a unique look distinct from regular local and express service and could be hybrid or alternative fuels.

Route Structure

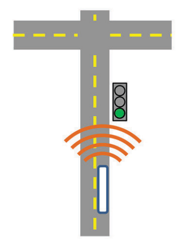


Stations are spaced at similar distances to LRT stops, generally one stop every half mile, to provide express service. Local bus service, with stops spaced generally every quarter-mile, can be maintained along a BRT route.

Fare Collection

Innovative fare collection methods such as electronic pre-pay smartcards and pre-payment kiosks allow for off-board fare collection to speed boarding and increase convenience.

Transit Signal Priority



ITS components such as transit signal priority and real-time arrival signs make the system faster, more reliable, and more user-friendly.

Branding

A system brand is developed to differentiate BRT transitways from other transit service.

Service

BRT service relies on high frequency operation as a key attractor. Frequent service is typically defined as 15 minutes or less of wait time between BRT vehicles. Frequent service means customers can rely on the system to take them where they need to go without consulting complicated schedules and without fear of missing a bus. A service can be fast, but it must also be frequent in order for customers to feel like it is a dependable transportation option for their everyday activities.

The BRT operating plan defines how many buses will serve each stop per hour and the system's operating hours; in transit planning terms this is the system's frequency and span of service. These operating components determine the number of buses needed to support the system in each corridor. Table 2 shows the assumed frequency and span of service for the Madison BRT system analyzed in this study.

Table 2: Proposed System Frequency and Span of Service

Day of Week	Time Period	Hours	Service Frequency
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	9:00-6:00 p.m.	30 min.
	Evening	6:00-11:00 p.m.	30 min.

Runningways

BRT can operate in a dedicated bus-only fixed guideway or share the roadway with other vehicles as necessary. The options considered for the Madison corridors are as follows:

Median Busway:

Buses run in a median running lane constructed for transit use only. Platforms at station locations are typically provided as part of this runningway configuration. Depending on the intersection layout and available space, the platforms may be a single center platform or two right-side platforms. A typical median busway cross section is shown in Figure 6.

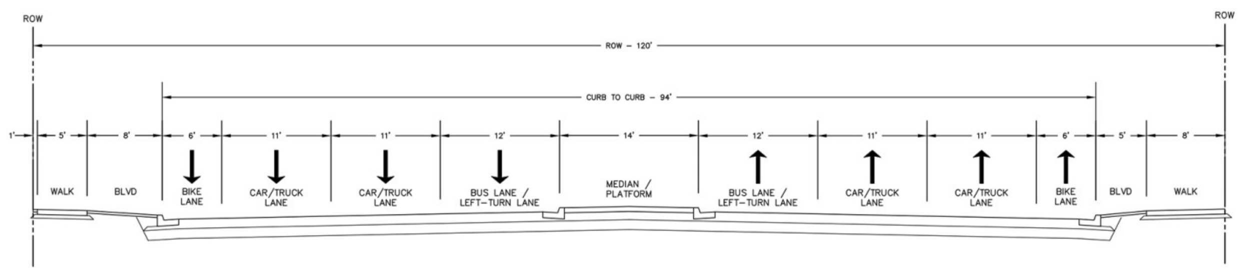
Advantages:

- Buses are not delayed by traffic congestion, including from bikes and turning traffic, which are allowed to use side running lanes
- Fixed guideways create a sense of physical permanency similar to a rail line, which is more visible to potential transit riders and more conducive to transit oriented development.

Disadvantages:

- Fixed guideways are expensive to construct, potentially requiring the purchase of new right-of-way and the rebuilding of entire street cross sections.
- Occasionally requires the purchase of additional right-of-way along an alignment
- Potentially displaces street parking
- Intersections become more complex with left turn movements conflicting with bus movements, with potentially significant reductions to corridor capacity.
- Standard buses that make more frequent stops and/or don’t have left-side doors are not able to use the busway.

Figure 6: Median Busway Cross Section



Examples include: Franklin Boulevard, Eugene, OR; Casino Center Boulevard, Las Vegas, NV; and Euclid Avenue, Cleveland, OH.

Side Running Lanes:

BRT vehicles run in a lane reserved for buses and bicyclists. The lane runs on the outermost side of the street closest to the curb. Other traffic is allowed to use the lane to make right turns. This study assumed Side Running Lanes would be painted red and stamped with “Bus and Bike Only” legends. A typical side running lane cross section is shown in Figure 7.

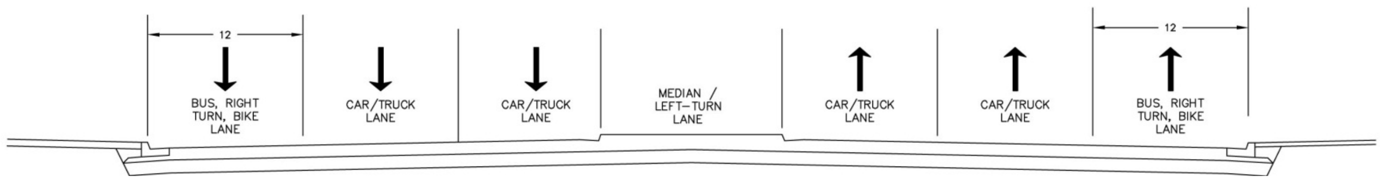
Advantages:

- Decreases delays caused by traffic congestion.
- Cost effective, side running lanes utilize existing roadways and require changes to pavement markings.

Disadvantages:

- Potential reduction in roadway capacity.
- Buses can be delayed by right turning vehicles, bicycles, loading activities, or illegally parked cars
- Can be difficult to enforce

Figure 7: Side Running Lane Cross Section



Examples include: University Avenue (through the UW campus), Mineral Point Road, and the Capitol Square.

Mixed Traffic:

BRT vehicles share lanes with other traffic. Spot improvements, such as queue jumps, through movements from right-turn lanes, parking restrictions, and minor traffic signal changes, may be used reduce delay at pinch points.

Advantages:

- No runningway construction costs

Disadvantages:

- BRT vehicles slowed by traffic congestion and parked vehicles
- Does not project a sense of permanence

Example BRT systems that operate primarily in mixed traffic include RapidRide (Seattle, WA), MetroRapid (Los Angeles, CA), and BusPlus (Albany, NY).

For this study, each corridor was evaluated for the potential to incorporate a median busway or side running lanes. Where those conditions were not possible, it was assumed BRT would operate in mixed traffic. Potential concepts for spot improvements were not evaluated.

The runningway option identifies the investment level for this study. The Corridor BRT alternatives use a combination of mixed traffic and side running lanes. The Fixed Guideway BRT alternatives use a combination of all three.

Stations

BRT stations can range from simple to expansive depending on local needs. Providing appropriately-sized waiting areas with some levels of customer information and amenities are highly desirable to attract and retain new riders who are unfamiliar with the bus system. Locating the station along the runningway is highly dependent on existing space availability.

The Transit Corridor Study assigns one of three station sizes, small, medium, or large, to each station in the system. Station sizes were assigned based on anticipated passenger demand and near term development potential in areas adjacent to the station. Conceptual layouts and station amenities differ depending on station size.

Examples of station constrained and unconstrained configurations are shown in Figure 8 and Figure 9. Figure 10 and Figure 11 show the constrained and unconstrained station views.

The Transit Corridor Study also reviewed all station locations to determine two main configuration characteristics. First, it reviewed the optimum station location in relation to the nearest street intersection (i.e., near side, far side, or mid-block), Figure 12 describes the advantages and disadvantages of near side, far side and mid configurations. In general, Far-side stops are generally preferred for BRT operations because they facilitate transit signal priority and generally work well on higher-speed arterial roadways. Second, it reviewed if the existing conditions allow for a constrained or unconstrained station layout. A constrained station site assumes all station amenities are sited within the existing right-of-way. Unconstrained stations assume the station shelter can be set back behind the existing right-of-way boundary. From a cost estimate perspective, unconstrained stations are more expensive, because they require the acquisition of additional right-of-way. The amenities proposed at each station size are shown in Figure 13.

Figure 8: Constrained Small Station - Plan View

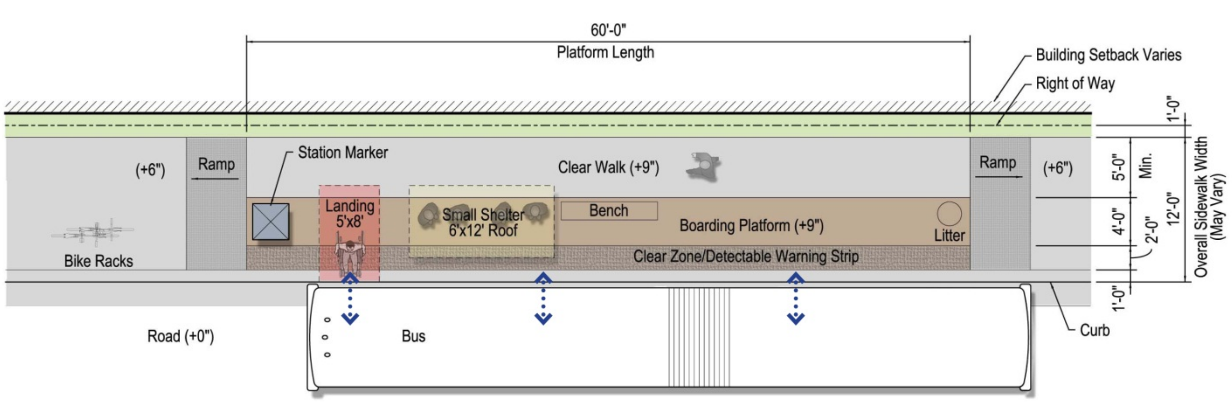


Figure 9: Unconstrained Medium Station - Plan View

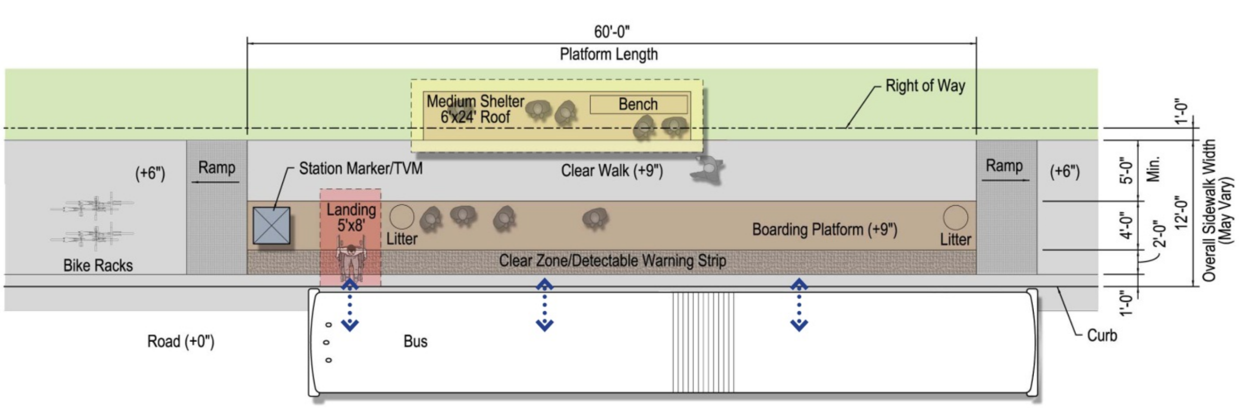


Figure 10: Constrained Station - Section View

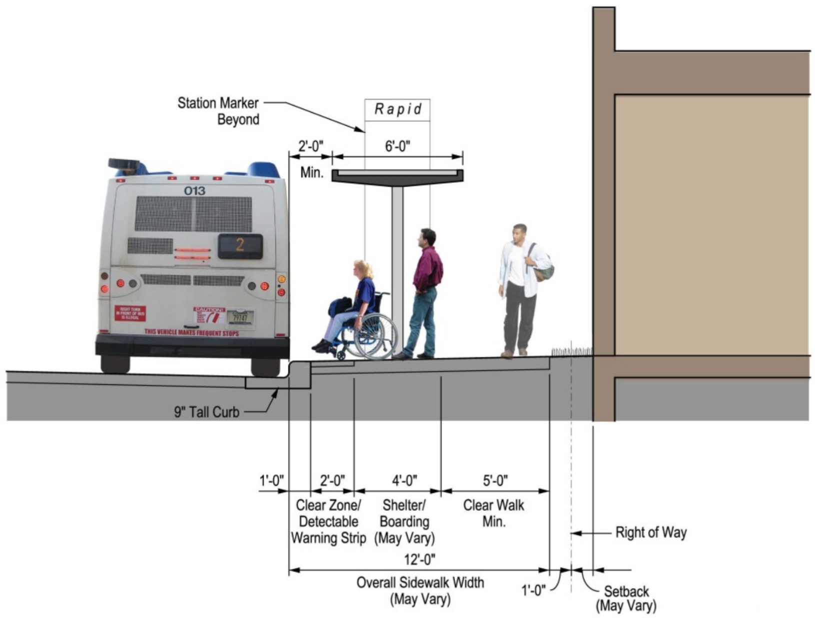


Figure 11: Unconstrained Station - Section View

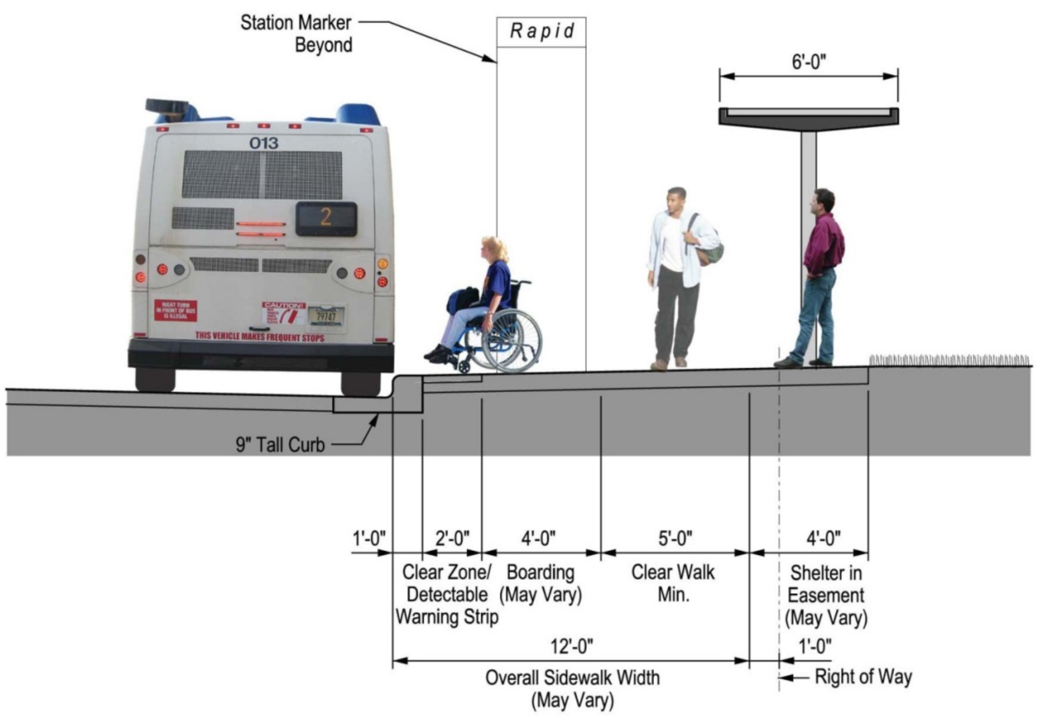


Figure 12: Station Configuration Advantages and Disadvantages

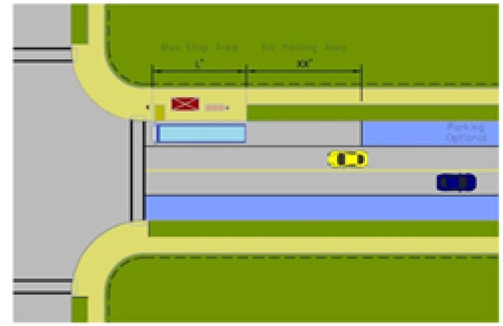
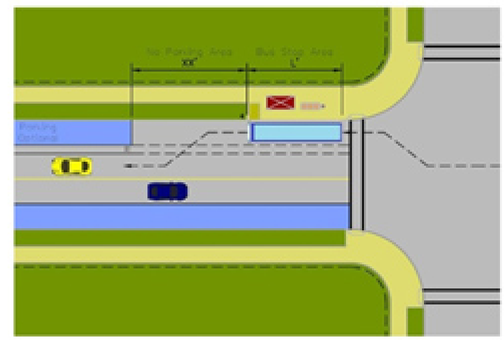
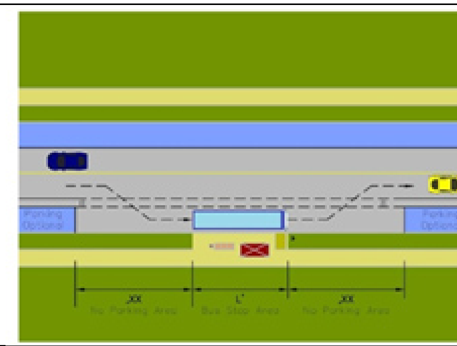
Location	Advantages	Disadvantages	Figure
Nearside	• Allows passengers to access buses close to crosswalk • Intersection width available for bus to pull away from the curb • Eliminates the potential for double-stopping • Allows passengers to board and alight while stopped for a red light • Many existing bus stops are near side, and Metro Transit would not have to establish new ones.	• Increases conflicts with right-turning vehicles • May result in stopped buses obscuring curbside traffic control devices and crossing pedestrians • May cause sight distance to be obscured for side street vehicles stopped to the right of the bus • Increases sight distance problems for crossing pedestrians • Complicated bus signal priority operation, may reduce effectiveness or require a special queue-jump signal if the stop is located in the parking lane or right turn lane • Increases the chances a bus will be stopped during a green light	
Farside	• Minimizes conflicts between right turning vehicles and buses • Minimizes sight distance problems on intersection approaches • May encourage pedestrians to cross behind the bus, depending on distance from intersection • Creates shorter deceleration distances for buses, since the intersection can be used to decelerate • Buses can take advantage of gaps in traffic flow created at signalized intersections • Facilitates bus signal priority operation, as buses can pass through intersection before stopping	• May result in intersections being blocked during peak periods by stopped buses • May obscure sight distance for crossing vehicles • May increase sight distance problems for crossing pedestrians • Can cause a bus to stop farside after stopping for a red light, interfering with both bus operations and all other traffic	
Midblock	• Minimizes sight distance problems for vehicles and pedestrians • May more effectively serve high-ridership destinations	• Requires additional distance for no parking restrictions • Encourages passengers to cross outside an intersection • Increases walking distance for passengers crossing at intersections	

Figure 13: Proposed Station Amenities

		Item	Small	Medium	Large	Notes
1		Shelter	X	X	X	Primary identity element. Open layout with as few impediments to pedestrian circulation as possible. Modularity desirable. Clear visibility critical.
2		Security Camera			X	Consistent with system plans.
3		Static Information Signage	X	X	X	Arterial BRT branding and other passenger information (route identification, system maps, route schedules, etc.)
4		Dynamic Information Signage		X	X	Consistent with system plans.
5		Station Marker	X	X	X	Primary identity element in conjunction with shelter. Guide for drivers for stopping location.
6		Ticket Vending Machine		X	X	Consistent with system plans.
7		Smart Card Reader	X	X	X	Consistent with system plans.
8		Bicycle Shelter			X	Overhead shelter to provide weather protection of bike rack area.
9		Bicycle Racks	X(2)	X(4)	X(6)	Increasing quantities as station size increases.
10		Bicycle Lockers				Too space consumptive for most on-line station sites but could be considered.
11		Landscaping	P	P	P	Potential where space permits on a site-specific basis. Low maintenance perennials or shrubs.
12		Street Trees				Desirable but more appropriately part of a larger streetscape plan.
13		Bench	P	P	P	More space-efficient seating elements should be considered instead to reduce circulation impediments. Potential where space permits.
14		Seat Wall/Retaining Wall	P	P	P	Only as required by surrounding grade.
15		Leaning Rail	X	X	X	Integral with shelter. Less space consumptive than traditional benches.
16		Litter Receptacles	X(1)	X(2)	X(3)	Increasing quantities as station size increases.
17		Newspaper Box Corral			X	Desirable where higher passenger volumes may attract more periodicals but kept out of the way as much as possible.
18		Lighting	X	X	X	Lighting integral with station marker and shelter. Street lightpoles more appropriately part of a larger streetscape plan.
19		Advertising	P	P	P	Integral with shelter in modular panels on a site-specific basis. Some transparency is desired so visibility is not completely cut off in certain directions.
20		Heating	P	P	P	Push-button radiant heat is desirable for passenger comfort in cold weather climate. Need to account for electrical load requirements.

X = Item included at station

P = Item potentially provided at station

(1) = Number provided at each station

Transfer Points

During development of the BRT options, it was determined that it would be necessary to relocate several of the existing Metro Transit transfer points to better align with proposed BRT routings. The West – Mineral Point Road Alignment and the North Corridor Alignment options assume the relocation of the West and North Transfer Points respectively. For these alignments it is assumed that all local bus routes serving the West and North Transfer Points will need to be modified to operate to and from the new locations. The Transit Corridor Study also assumes that in order to accommodate the larger BRT vehicles the South Transfer Point will need to be expanded from its current capacity of six 40-foot buses. The East Transfer Point is not served by the BRT system; however, relocating it so that it would be part of the system would place it too close to the North Transfer Point and require substantial restructuring of east Madison service. Several alternatives in the Universe of Corridors present options to include the East Transfer Point in the BRT system, but they were dismissed because of circuitous routing or low ridership potential.

The study does not analyze specific locations for the transfer point relocations/expansions; however the capital cost estimates for each configuration include a cost for the new facilities and required right-of-way. The Transit Corridor Study assumes each new transfer point would require roughly 1.5 acres of land to construct.

During the concept development for the BRT system, several possible transfer point configurations were mentioned. These included locating BRT stations adjacent to the transfer point rather than inside of it in order to reduce delay at the expense of longer distances for people transferring buses. Figure 14 shows a prototypical transfer point design that will accommodate the BRT vehicles and provide space for other local bus service connections as well.

Commuter Express Routes and Park and Ride Lots

The Transit Corridor Study did not analyze in detail how future commuter express routes could interact with the BRT system due to the separate functions of the two systems. Designing regional routes to connect with the proposed BRT system will allow regional commuters – particularly those not traveling to central Madison – to take advantage of the benefits of BRT. Figure 15 shows options for potential express routes throughout Dane County as proposed by the MPO in the Draft 2013-2017 Transit Development Plan. These routes are envisioned to travel through the BRT corridors, stopping at only a few BRT stations to facilitate transfers. They would potentially take advantage of some BRT aspects such as runningway improvements.

The Transit Corridor Study assumes that the existing available parking located at the North Transfer Point will be replaced with the reconstruction of the North Transfer Point near Sherman Avenue. The North Transfer Point is the only transfer point along the proposed corridors that currently offers parking. New park-and-ride facilities are recommended at the outer edges of the West, South, and East corridors in order to increase access to the system. Specific locations are recommended to be identified in future planning efforts. Costs for park-and-ride lots are not included in the cost estimates for the system because of the wide range of arrangements – from low-cost shared retail lots to structured ramps.

Figure 14: Potential Transfer Point Configuration

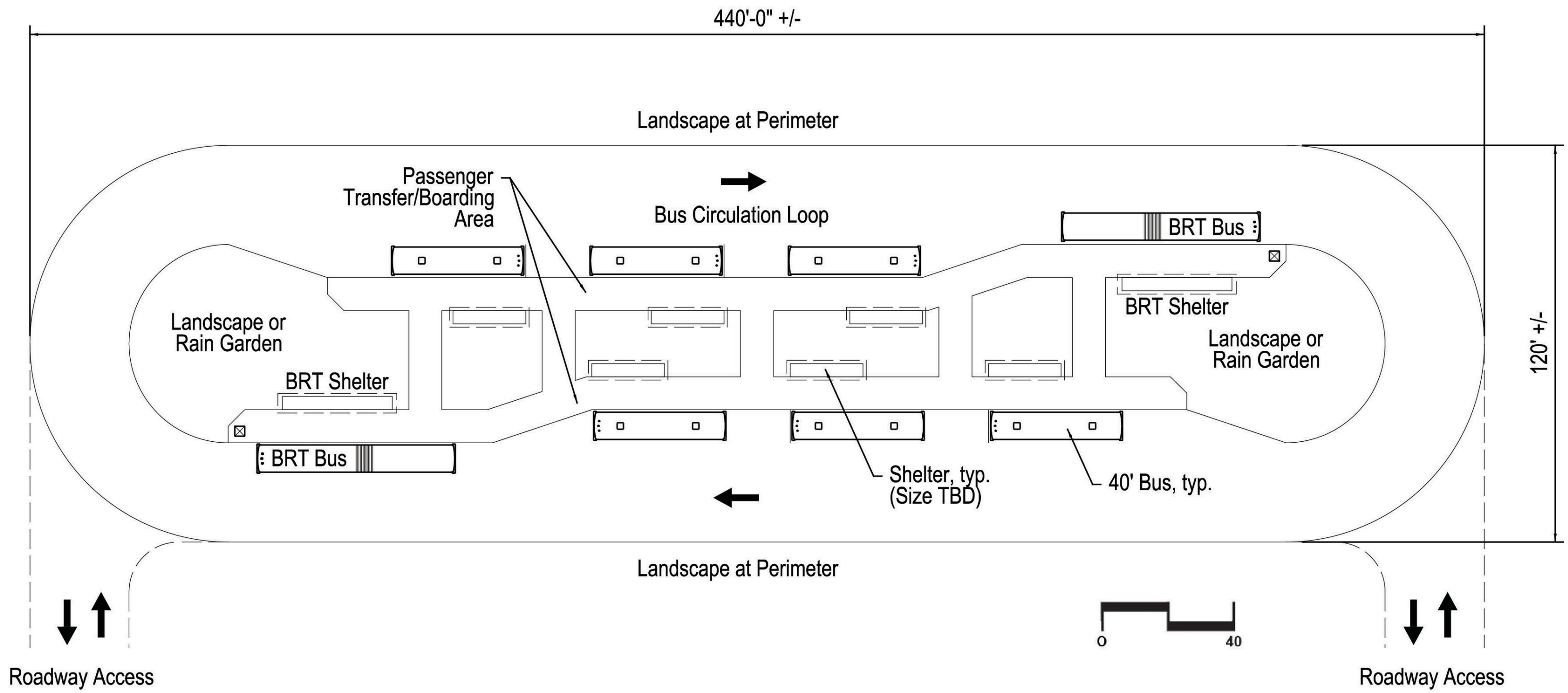
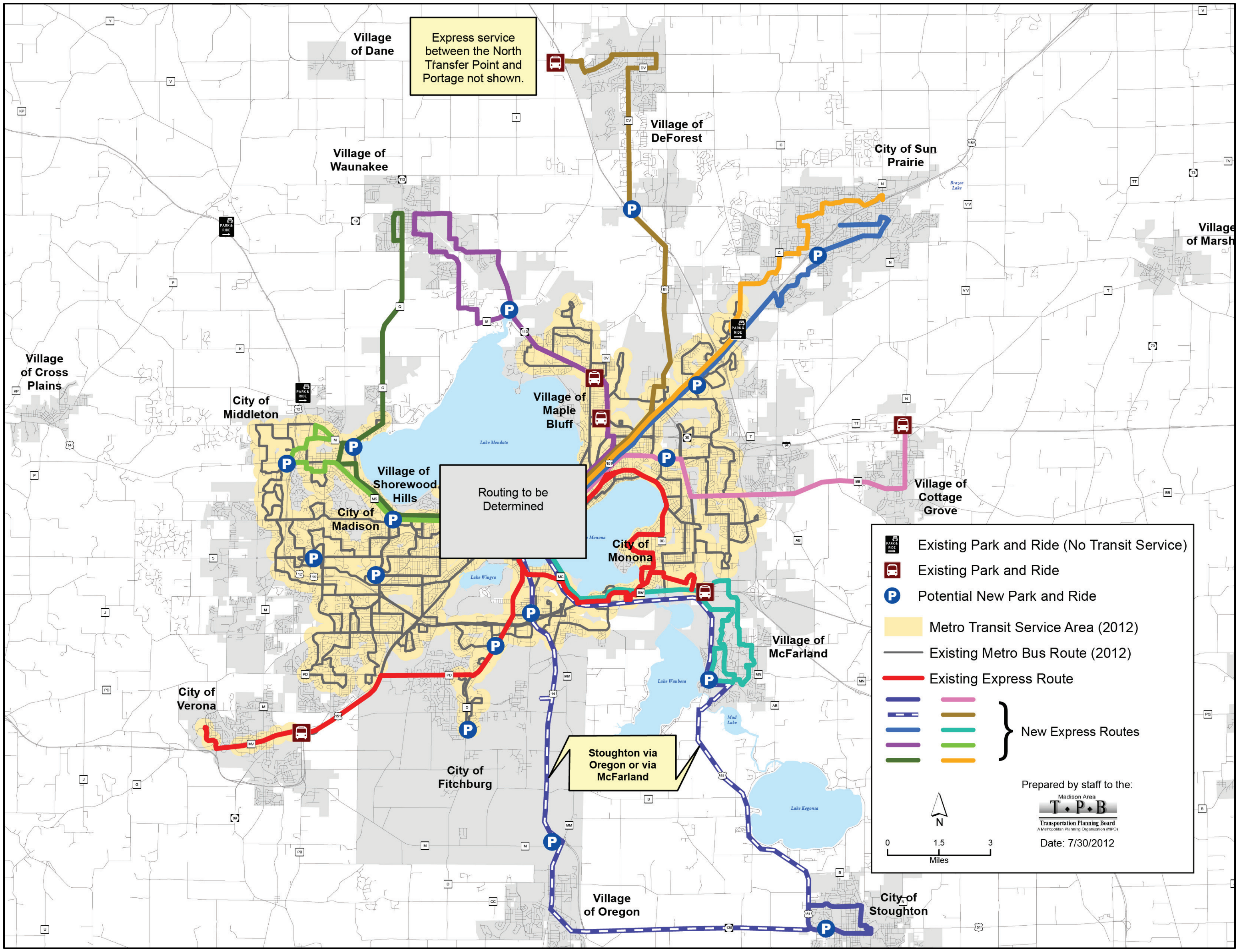


Figure 15: Potential Express Commuter Routes and Park and Ride Locations



Vehicles

BRT vehicles often have a unique look distinct from regular local and express service, and are typically designed to allow for faster boarding and alighting. Examples of BRT vehicles currently in service in the United States are shown in Figure 16 and Figure 17. When designing a BRT system, it is important for the vehicles to be unique for the two reasons. First, it helps create a strong brand recognition for the service and second, it allows customers to quickly and easily differentiate the between BRT and local bus service. The Transit Corridor Study assumed all BRT vehicles would have the amenities listed in Table 3.

Figure 16: BRT Vehicle, Seattle, Washington

Figure 17: BRT Vehicle, Snohomish County, Washington

Table 3: BRT Vehicle Characteristics

Characteristic	Amenities Included
Bus length	• Articulated bus (60’)
Accessibility Characteristics	• Low floor • Ramp • Passive wheelchair restraint
Doors	• 3 doors • Left side doors for fixed-guideway alternatives • Sliding doors
Propulsion	• Hybrid – diesel
Bike Storage	• On board bike storage
Precision Docking	• Curb runners
Advanced Technology	• Transit signal priority capability • Wifi • Automatic stop announcements • Automated Passenger Counting (APC) system
Passenger accommodations	• Alternative seating configurations • Pull chords • Onboard card readers • Fare boxes

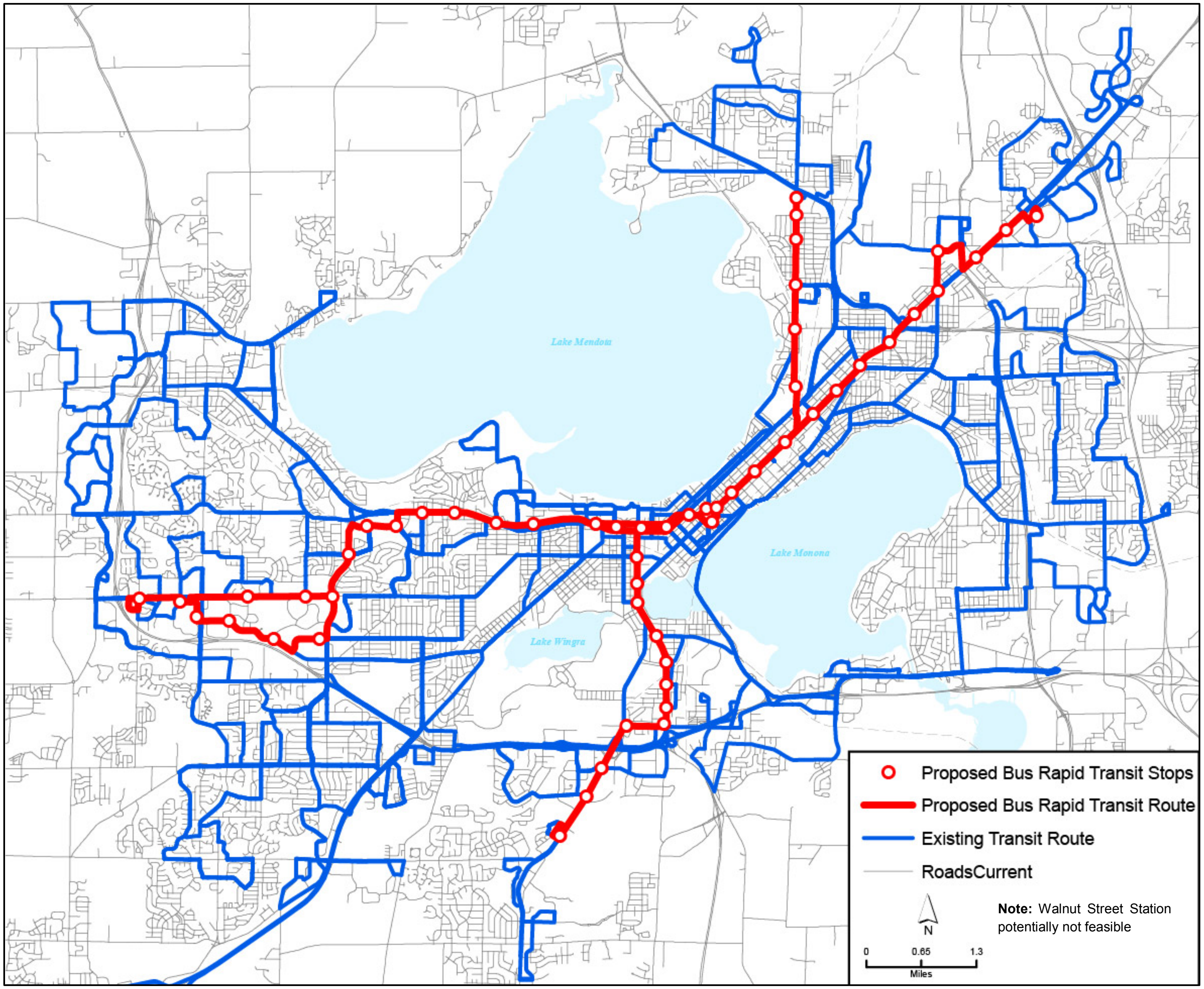
Route Structure

A key to maximizing the benefits while eliminating unnecessary costs associated with BRT service is to replace some local service along BRT corridors, to the extent possible, while improving connections to major destinations. This allows for cost savings from the existing service to be reinvested in BRT service.

Since the BRT system will become the principal transit service in each corridor, the Transit Corridor Study assumed that some of the local bus routes currently running along the corridors would be eliminated or operated at reduced frequencies. Generally, when an existing route was eliminated or service reduced, the planned BRT system was intended to provide adjacent areas with more frequent service over a longer period throughout the day. Figure 18 shows how the BRT system is positioned in coordination with the existing local routes[1].

[1] For a fully labeled map of Metro Transit’s existing service please see the maps available http://www.cityofmadison.com/metro/schedules/systemMaps.cfm

Figure 18: Proposed BRT Service and Existing Local Bus Service



BRT Service Patterns

BRT service is proposed to be provided using essentially two routes that connect the four corridors. An east-west route would travel between High Point Road and East Towne Mall, and a north-south route would travel between Fitchburg and Warner Park. With the exception noted below, BRT buses are generally not mixed and interlined with local service.

At Warner Park, the north-south route splits – alternating buses travel west along Troy Drive and Northport Drive (Route 22), and east to Dane County Airport. This solution balances requests received from the public to provide fast, direct service to the airport with the need to achieve reasonable productivity performance with the high levels of service. It also prevents the north-south line from ending just before serving the medium density, transit dependent land uses along Northport Drive.

Many alternative service delivery concepts are practical and possible, including a west-north and south-east configuration and more thorough integration of commuter express and BRT integration for improved efficiency. However, these alternatives were not explored for the Transit Corridor Study and may be explored in future planning activities.

Modifications made to the local bus service within each corridor are presented in the corridor analysis later in this report and are detailed in Appendix I. A list of affected routes by corridor is shown in Table 4. Significant changes assumed include the deletion of Route 5 south of the Capitol Square, Route 6 east of the Capitol Square, and Route 67; and the rerouting of Route 70 from the Capitol Square to the West Transfer Point. Route 5 along Park Street is almost entirely duplicative of the south BRT corridor with the exception of the deviation along Fisher Street. This deviation serves an important neighborhood center; however, two BRT stations would be located two blocks to the west on Park Street. Route 6 along East Washington Avenue would be replaced with a low-frequency route serving local stops west of about Milwaukee Street. East of Milwaukee Street, some service coverage would be provided by Routes 4, 34, and 20. Route 20 would be rerouted to provide service coverage on Portage Road and Hayes Road. Route 67 primarily serves trips from the West Transfer Point to West Towne, which would be served by the east-west BRT line. Local coverage along Mineral Point Road would be provided by Route 14 and potentially a lower frequency peripheral route.

Table 4: Local Bus Service Modifications – Potentially Affected Routes

Corridor	Affected Routes
West	2, 14, 15, 37, 67, 70, 73
South	5, 13, 47, 44, 48
East	6, 25, 26, 34
North	20, 22, 27, 29

Fare Collection

Paying the fare on-board transit vehicles can be a time consuming activity slowing down the boarding process and extending dwell time at stations. Use of innovative fare collection methods coupled with off-board fare payment can significantly speed up the boarding process.

The Transit Corridor Study proposes that the BRT system would feature off-board fare collection and all door boarding. Passengers can pre-purchase a ticket using ticket vending machines (TVMs) at large and medium sized stations. Passengers with Smart Cards can pay using the smart card reader located at all stations or use an on-board Smart Card reader affixed inside each vehicle door. To accommodate passengers without Smart Cards that board at small stations, each BRT vehicle would also be equipped with a standard farebox, which may be located on the interior of the bus, rather than at the front, so that fare-paying passengers do not block the door. Fare checkers would be assigned to randomly check for proof of payment in order to enforce the fare system. Proof of payment fare systems are in wide use around the U.S. on BRT, light rail, and metro transit systems, and are generally considered to be highly beneficial. However, the needed fare checkers add significant operating cost to the system.

Transit Signal Priority (TSP)

TSP has the potential to reduce delay for buses at traffic signals while minimizing negative impacts on overall traffic operations. Reduced delay benefits transit customers by providing faster, more reliable travel times, and benefits transit operations by reducing operating costs. TSP can be designed flexibly to respond to traffic and transit needs. TSP is not signal preemption, the type of priority given to emergency vehicles. Signal preemption interrupts signal cycles and can cause greater disruption to traffic by causing traffic signal to break coordination, causing the loss of consecutive green lights on corridors. Instead, with TSP, priority is granted by making small changes to traffic signal timing in real time. This is expressed through an “early green” for a bus approaching an intersection, or an “extended green” for a bus about to be stopped at a signal. TSP for buses is in use in a number of urban areas around the U.S., including Portland, OR; Los Angeles, CA; New York, NY; and Minneapolis, MN.

How TSP Works

- A bus approaches an intersection with TSP technology
    - The bus will request priority if it is not ahead of schedule and other conditions are met.
    - Priority will not be granted if a call was recently granted, the signal controller is transitioning between timing plans, or if other conditions are met.
- TSP adjusts the signal timing to accommodate the bus:
    - If the signal is green, TSP technology extends the green light and shortens future phases to maintain coordination. This is called “Extended Green.”
    - If the signal is red, TSP technology shortens conflicting phases, if possible, so that a green light comes up sooner. This is called “Early Green.”
- The bus passes through the intersection.
- Signal timing returns to normal operation.

- Other methods of reducing traffic signal delay include phase skipping, phase insertion, and queue jumps. These strategies may be employed on a case-by-case basis, but were not examined for this study.

All signalized intersections along the corridors were evaluated for their potential to utilize TSP based on the “slack time” in their cycles (the amount of time beyond the minimum length of time needed to serve all the phases) in addition to other factors, such as the locations of bus stops, turning maneuvers, and congested intersections. 58 of the 99 signalized intersections along the BRT alignment were identified as potentially having the capability to incorporate TSP.

Traffic signals along the BRT corridors are almost entirely operated by the City of Madison, which exclusively uses Econolite controllers. The newest version of the Econolite traffic signal controller, the ASC/3, comes ready to integrate TSP with the purchase of a key that unlocks the software. Older controllers (ASC/2’s and ASC/8000’s) will likely need to be upgraded. Various communication strategies between the bus and traffic signal controller are available, including optical pulse, secure Wifi network, and wired wayside radio frequency readers and transponders.

If the City of Madison chooses to use TSP as an element of a future BRT system, city traffic engineers, the MPO and Metro Transit will all need to work together to design a TSP system that complements the city’s current signal system. Next steps include a more detailed analysis of the impacts to general purpose traffic and the estimate of benefits for transit in order to justify the installation and maintenance of TSP.

Branding

The Madison BRT system will have unique branding that will allow passengers to quickly differentiate BRT service from local bus service. The branding will be consistent across all system components include vehicles, stations, signage, etc.

Table 5: Summary of Madison BRT Component Assumptions

BRT Component	Assumption for Madison BRT Study
1. Service	• 10 minute peak period • 15 minute middle of the day, weekdays and Saturdays • 7 day per week service • 19 hours per weekday
2. Runningways	• Median busway where reasonable conditions exist • Side running in reserved lane for transit, right turns, and bicycles • Mixed traffic
3. Stations	• Far-side of intersections where possible • Unique shelter design with accompanying amenities • 9-inch platform height
4. Vehicles	• Articulated 60-foot bus; low floor, 3 doors • Hybrid diesel
5. Route Structure	• Two BRT routes: north-south and east-west • Replace duplicating service with BRT • Make new connections • Move transfer points as needed
6. Fare Collection	• Off-board ticket vending machines at major stations • Compatibility with existing fare card system
7. **Transit Signal Priority**	• Transit signal priority where possible • Customer information at stations
8. Branding	• Unique appearance at stations and on vehicles

Analysis Methods

Capital Costs

Capital costs include the one-time expenditures to build a system. Typically, capital costs include corridor improvements, stations, structures, signalization and communications systems, operations and maintenance facilities, vehicles, and right-of-way acquisition. Also included are "soft costs" for items such as engineering, construction services, insurance, and owner's costs, as well as contingencies for uncertainty in both the estimating process and the scope of the project. The Transit Corridor Study estimates capital costs in 2016 dollars to account for cost inflation over time as it will take some time to complete design activities leading up to construction if BRT is selected to move forward.

At this early study stage, there was not sufficient definition or detail to prepare detailed construction cost estimates for the various configurations under consideration. Rather, the capital cost estimates were developed using representative typical unit costs or allowances on a per-unit basis that are consistent with this level of review. Capital cost estimates developed for this study will need to undergo refinement based on additional design development work in future project phases.

Separate capital cost estimates were developed for each corridor and contain estimates for:

- Runningway improvements
- Stations
- Vehicles
- Right-of-way
- Professional services

Capital costs are broken out by corridor. Since several corridors overlap each other along University Avenue, Johnson Street, the Capitol Square, and East Washington Avenue, these costs are counted multiple times. In addition, there are system-wide costs that cannot be allocated directly to a single corridor. As a result, the total system-wide capital costs are different from the sum of the costs for each corridor. The assumptions for the study follow.

Runningway Treatment

Three different types of running-way treatments were evaluated for the Madison Transit Corridor Study. These treatments included constructing a median busway, side running dedicated lane and mixed-use lanes. The "Station and Running-way Types" graphics presented in the analysis section for each of the corridors (north, south, west, east and central) identify where these running-way treatments were used as the basis for preparing running-way treatment cost estimates. In some areas, costs to construct both a fixed guideway and corridor alternative were estimated to evaluate the difference in cost between the two alternatives.

Median busway treatments were considered on Mineral Point Road, University Avenue (Farley Avenue to Midvale Boulevard), South Park Street, and Fish Hatchery Road. The construction limits were identified roughly through aerial photographs and other sources. In general, a cross section was chosen to fit within the existing street right-of-way, with the exception of University Avenue, where a busway design would require substantial right-of-way acquisition and roadway reconstruction. See Appendix O for selected cross sections.

Runningway costs to construct the median busway included demolition, sub-grade preparation, pavement, curb and gutter, utility relocations, and reconstruction of the roadway/adjacent infrastructure to accommodate the median busway. In areas where a barrier is not provided between the adjacent roadway and busway, costs included painting the bus lane red.

Runningway costs to construct the side running dedicated lane included restriping of the existing roadway, costs to paint the bus lane red, and pavement costs for any roadway reconstruction that is required.

BRT Station Cost Estimates

BRT Stations were quantified as small, medium or large, based on the anticipated ridership for that particular station. Typical costs for each type of BRT station (small, medium, large) were developed for both unconstrained and constrained sites and include varying degrees of the following elements:

- BRT shelter structure
- Station lighting
- Platform area surface treatments
- Off-board fare collection
- Bike racks
- Seating
- Trash receptacles
- Real time signage
- Signage/branding
- Wayfinding/system maps/community maps
- Electric/communication equipment

The items listed below were included as variable costs that are dependent on the size and type of each BRT station:

- Demolition
- Utilities and drainage modifications
- Street improvements
- Urban design / landscape improvements
- Sidewalk / pedestrian improvements
- Traffic control
- Communication and electrical service

A range of lump sum unit prices were developed for these elements based on the small, medium and large station designs and the unit prices adjusted accordingly to take into account existing conditions that are unique to a particular station area. Included in all station cost estimates is the cost of building a raised platform at each BRT station. A typical Madison curb is 6" high, resulting in an 8-9" step to board a bus. For new BRT platforms, the study is recommending a 9" high platform, reducing the step to 5-6". This results in faster boarding and a more rail-like feel without the full expense of a 14" high curb needed for full level boarding.

Vehicles

Quantities for BRT buses were based on the operating service levels that are developed as part of the operating plan for the BRT corridors. The quantities for all buses were adjusted to reflect a spare ratio of 20 percent.

Right-of-way

Anticipated costs associated with the acquisition of right-of-way needed for construction and operation of the project was limited to the median busway alternatives and pinch point locations where station platforms did not fit within the existing right-of-way limits. Right-of-way quantities were classified by assumed land use characteristics or ownership.

Professional Services

Cost estimates for Professional Services include preliminary engineering; final design; project management for design and construction; construction administration and management; insurance; legal, permits review fees; surveys, testing, investigation, inspection; agency force account work. These costs were generated by applying assumed rates to different categories of the estimate. Table 6 identifies the professional services assumptions that were incorporated into the capital cost estimates.

Table 6: Professional Service Assumptions

Professional Service	Construction	Right of Way	Vehicles
Preliminary Engineering	2%	–	–
Final Design	2%	2%	1%
Project Management for Design and Construction	2%	2%	2%
Construction Administration and Management	5%	1%	–
Insurance	2%	–	–
Legal; Permits; Review Fees	1%	3%	–
Surveys, Testing, Investigation, Inspection	2%	6%	2%
Agency Force Account Work	4%	6%	1%
Total	**20%**	**20%**	**6%**

Allocated Contingencies

These contingencies are intended to compensate for unforeseen items of work, quantity fluctuations, and variances in unit costs that develop as the project progresses through the various stages of design development. The allocated contingency assumptions included in the capital cost estimates are as follows:

- Corridor Improvements 20%
- BRT Stations 20%
- Vehicles 5%
- Right of way 100%

Unallocated Contingencies

An unallocated contingency of 15% was also included in the capital cost estimates applied to the runningway and station construction, but not to vehicles or soft costs. This contingency generally is scaled back as projects proceed through more levels of design.

BRT Vehicle Storage and Maintenance

Implementing a BRT system would require Metro Transit to acquire additional storage space for the new larger BRT vehicles. Correctly estimating the cost of a new storage and maintenance facility at the feasibility study level is difficult, because the necessary inputs for such a facility vary greatly. The Transit Corridor Study includes a cost estimate for a maintenance facility in the overall system cost estimate; however the cost of the facility is not included in each of the individual corridor estimates as it is inappropriate to allocate such a full cost to any one corridor cost estimate. The study assumed an 85,000 square foot maintenance facility in order to accommodate administrative offices, bus operations, maintenance area, bus wash area, and come circulation within the facility.

Operating and Maintenance (O&M) Costs

O&M cost estimates incorporate costs that are anticipated for general bus operations and maintenance as well as additional costs related to BRT-specific service and facility features.

A cost model reflecting actual 2011 Metro Transit expenditures was developed to estimate operating costs for bus operations. Service variables driving the cost model include revenue bus-hours and revenue bus-miles. An additional fixed percentage amount was incorporated to reflect system administrative charges. Operating statistics (revenue bus-hours, revenue bus-miles, and peak buses) were determined for each proposed BRT route, and for proposed background bus service changes within each BRT corridor. The unit costs were applied to these statistics to determine O&M costs for each corridor configuration. Other variables in the O&M cost model specific to BRT operations include:

- BRT vehicle maintenance
- TVM maintenance
- BRT Station maintenance
- Police/fare enforcement

Vehicle Type. The proposed BRT corridors are assumed to operate articulated buses. Information from other studies indicates maintenance costs for articulated buses could be 25 percent higher than regular buses (e.g., more tires, larger interior to clean, etc. For articulated buses, an additional $0.35 per revenue bus-mile (25%) was used for articulated bus service.

Fare Collection O&M includes the maintenance of Ticket Vending Machines (TVMs) at BRT stations and the maintenance of fare media (smart card) validators on buses. For this project, $6,500 was used per TVM. TVMs were proposed only at higher ridership stops. On-board fare collection equipment (a farebox and smart card readers) were also assumed on the buses to provide a means for passengers to pay fares when boarding a stop without a TVM.

BRT Station Maintenance will require additional Metro Transit staff for periodic cleaning and maintenance of each station stop. A majority of the BRT stops in the corridors will be curb stops without extensive furnishings and with moderate passenger activity. Thus, a unit cost of $2,000 per directional stop was used as an annual O&M cost.

Additional **Police/Fare Enforcement** was also assumed to monitor the compliance of the off-board fare collection system. An average of $6.50 per revenue-hour was included.

Ridership Forecasts

The Transit Corridor Study uses the incremental pivoting method of forecasting to estimate ridership levels for 2016, the system's assumed opening year, and future ridership levels in the year 2035. The incremental pivoting method uses existing transit ridership as a baseline and then applies growth factors to the baseline numbers to account for transit service improvements and socio-demographic growth. Ridership estimates are provided for each BRT corridor and for the system as a whole. The Transit Corridor Study used the following sources of data to build the study forecasts:

Forecasting Model Inputs

- Metro Transit stop level ridership data from August 2011 calculated by the MPO: This dataset shows the ridership levels at each existing bus stop in the Metro Transit System.
- 2008 On-board Metro Transit Survey: This dataset reveals the trip origins and destinations for a sub-set of riders.
- MPO Regional Population and Employment Projection Model: The model maintained by the MPO that projects population, employment and travel patterns.

How the forecasts were estimated:

- The existing ridership at each station was identified using 2011 Metro Transit ridership data.
- To establish an existing baseline ridership level, all trips taken within 1/8 mile of a planned station location were aggregated and assigned to that station. The 1/8-mile distance was used, because many parallel lines of transit service will continue to draw riders when BRT is implemented. For example, it is assumed Route 28, a frequent service peak hour route that runs parallel to the planned BRT North Corridor, will continue to draw passengers along the East Johnson Street corridor.
- Areas along the planned BRT alignments were split along Traffic Analysis Zone lines into districts based current rider travel patterns found in the 2008 On-Board Metro Transit Survey. For example, a cluster of riders identified the Capitol Square area as the origin or destination of their trips; therefore a district was created in this area. Each of the proposed BRT stations was assigned to a district.

- Existing travel patterns between districts were applied to the 2011 Metro Ridership data to approximate the number of riders traveling between districts. For example, if 50 percent of the on-board survey participants reported they traveled from District 1 to District 2, it was assumed that 50 percent of 2011 ridership in those districts would also travel between Districts 1 and 2.
- The proportion of existing bus riders who would opt to use the BRT system instead of local bus service was estimated. Speed and frequency improvements attract a percentage of existing riders to the new system.
- The number of new riders the improved service is expected to generate is estimated. This estimate is calculated by applying several "attractiveness" factors to existing ridership levels. Attractiveness factors are based on the following characteristics of the service:
  - Span of service
  - Service frequency
  - Speed of service
  - Number of required transfers
  - Service reliability and comfort

  Attractiveness factors were taken from Transit Cooperative Research Project (TCRP) Report 95, Traveler Response to Transportation System Changes (http://www.trb.org/Publications/Blurbs/162432.aspx).
- The expected population and employment growth rates, taken from the MPO model, are applied to the estimates to forecast ridership levels in 2016 and 2035.

The ridership estimates are presented for each corridor in order to compare the corridors to each other, although the proposed service patterns contain interlined pairs of corridors. As a result, the west and south corridors are given credit for all boardings in the UW campus area west of the Capital Square.

Redevelopment Potential and Transit Oriented Development (TOD) Factor

Redevelopment Potential: The Transit Corridor study relied on the information reported in *Infill and Redevelopment Assessment*, a CARPC report, to assess the potential for redevelopment along each of the alignments. The *Infill and Redevelopment Assessment* identified sites along the corridors ready for redevelopment using several metrics addressing value, building size and others, combined with a visual inspection of the corridors. Based on conditions on the sites, they were classified by the estimated timeframe of their potential redevelopment, recognizing that certain sites will likely develop sooner than others. Next, each site was assigned a detailed building program (based on existing plans when available) or a building type suitable to the site's context. This process allowed the study to estimate the number of residential units and square feet of commercial development available to for infill and redevelopment along each alignment. The full *Infill and Redevelopment Assessment* is located in Appendix M.

TOD Factor: CARPC commissioned the Center for Neighborhood Technology (CNT) to analyze how TOD near BRT station locations would affect future year ridership projections. The result of this analysis is future year TOD ridership projections by corridor and for the entire BRT system.

Madison BRT Corridors

The Transit Corridor Study evaluated four corridors that radiate out from the Capitol Square, as shown in Figure 20. This portion of the report analyzes each of the corridors – West, South, North, and East – as separate corridors and presents a combined or system overview of key performance metrics. Common to all individual corridors is some portion of the Central Segment.

The Central Segment

The Central Segment is the portion of the system that runs through the Isthmus and the Capitol Square area between Park Street and Baldwin Street. This segment is unique, because the Transit Corridor Study assumes each corridor incorporates a portion of the Central Segment into its alignment. The Central Segment is a mix of side running and mixed traffic lanes, as shown in Figure 19. The West and South alignments share the portion of the Central Segment from the Capitol Square to N. Park Street. The North and East alignments share the portion from the Capitol Square to N. Baldwin Street.

Figure 19: Central Segment

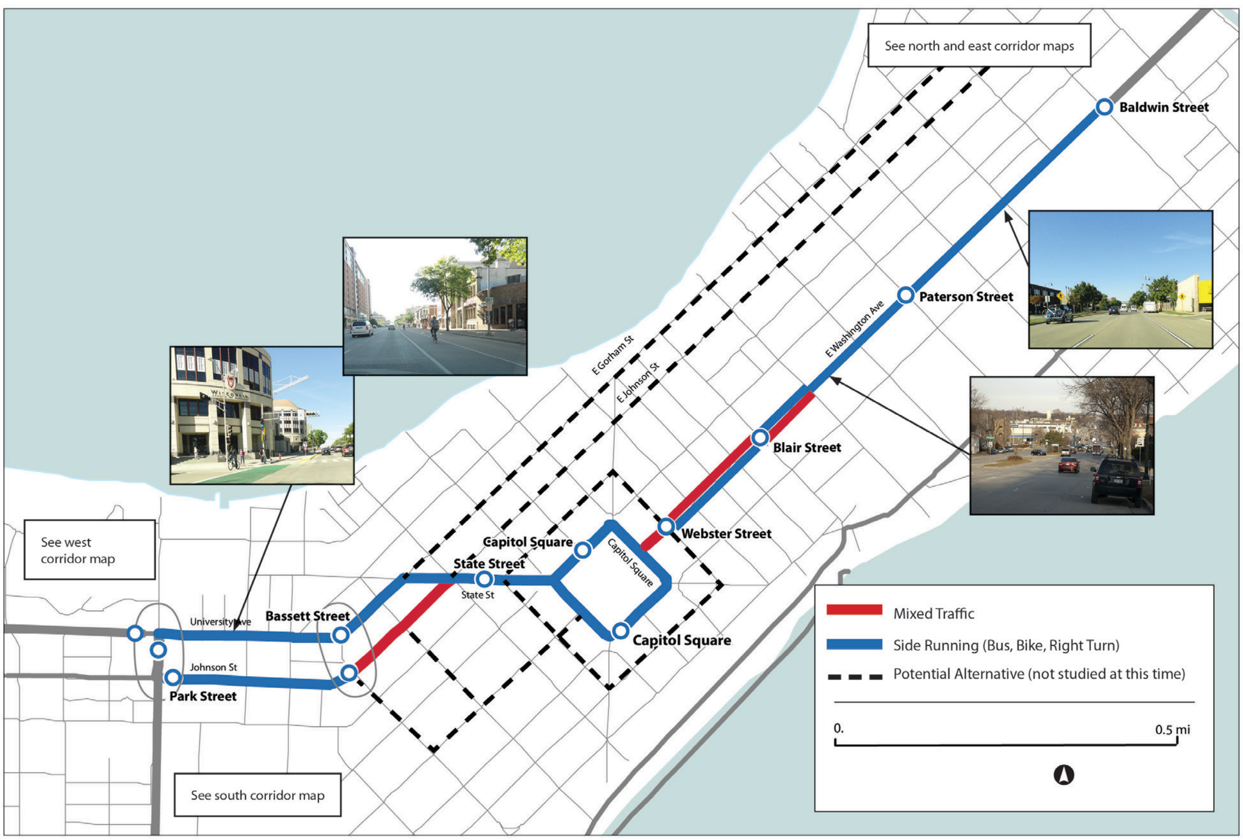
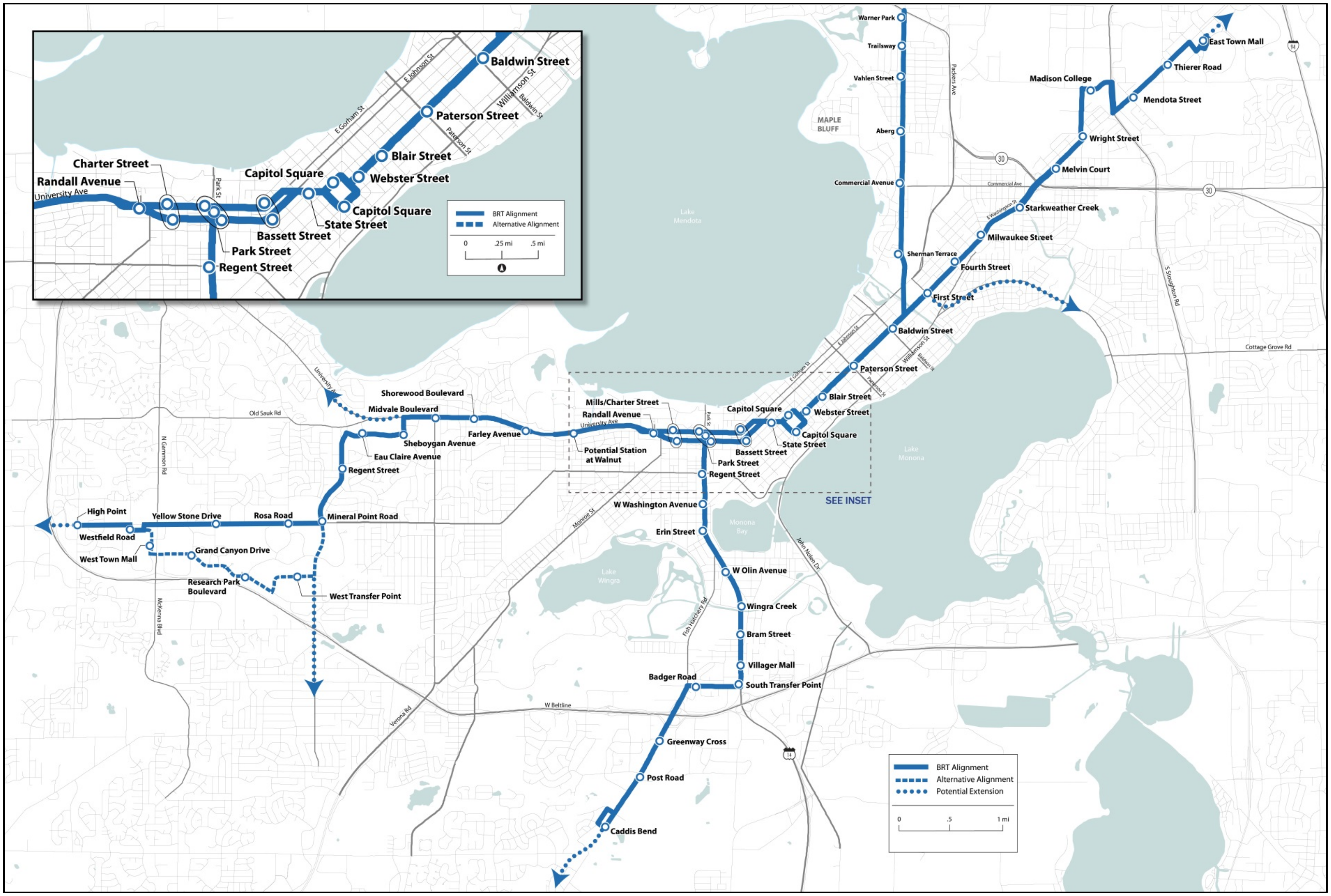


Figure 20: Madison BRT System – Proposed System



West Corridor – Mineral Point Road

Runningway

The West Corridor – Mineral Point Road alignment is 7.76 miles long. It begins at the Capitol Square, runs west along State Street to W. Gorham Street, and then through the University of Wisconsin-Madison's campus. It continues west along Campus Drive and University Avenue, turning south at N. Segoe Road to Sheboygan Avenue, and then continuing south along Whitney Way. Then the alignment turns west and runs along Mineral Point Road until S. High Point Road. For this alignment, the Transit Corridor Study assumes the West Transfer Point is relocated from its current site near Whitney Way and Tokay Boulevard to a new site near along Mineral Point Road in the vicinity of Whitney Way or Rosa Road.

The study analyzed a Corridor BRT and a Fixed Guideway BRT configuration in this corridor. The majority of the Corridor BRT Configuration is made up of side running lanes. Over half of the Fixed Guideway BRT configuration is a median running fixed guideway lane. The total length of each type of runningway for both configurations is shown in Table 7. The location of each runningway configuration is shown in Figure 21.

Major destinations along this route include:

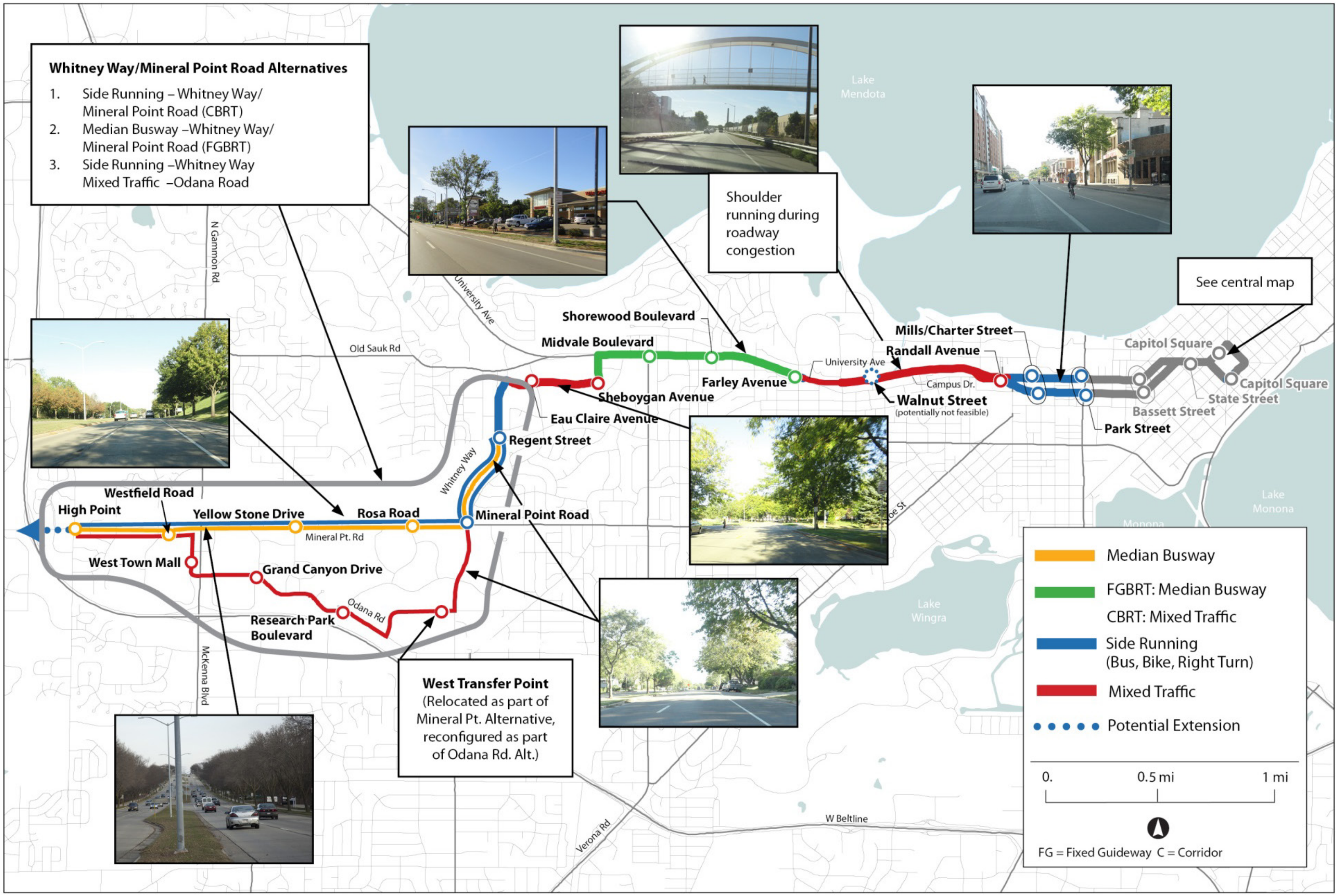
- Capitol Square
- University of Wisconsin – Madison
- UW Hospital and Clinics
- Hilldale Shopping Center
- Hill Farms State Office Building and residential area
- West Towne Mall

Table 7: West Corridor - Mineral Point Runningway Lengths

	Corridor BRT	Fixed Guideway BRT
One-Way Corridor Length (miles)	**7.76**	**7.76**
Fixed Guideway Length	-	4.30
Side Running Length (miles)	5.10	2.10
Mixed Traffic Length (miles)	2.66	1.36

Cross sections for the Mineral Point Road runningway configurations showing how side running and median fixed guideway lanes could fit into the current right-of-way in typical locations along the West Corridor are presented in Appendix O.

Figure 21: West Corridor Runningway Types and Station Locations



Stations

Both the Fixed Guideway and Corridor BRT configurations along the West Corridor – Mineral Point Road alignment have 17 stations per direction, resulting in stations spaced on average about 0.5 miles apart. The majority of the stations are almost evenly split between small and large stations. The large stations are generally found in the downtown and UW campus area, with the exception of the inbound Midvale Boulevard, Sheboygan Avenue and Eau Claire Avenue stations. All of the stations use a curbside platform and the majority are farside stations.

Table 8: West Corridor - Mineral Point Stations

Direction	Station Name	Shelter Size	Platform Type	Platform Location	Constrained/ Unconstrained Site
INBOUND	Capitol Square South	Existing*	Existing	Existing	Existing
	State Street	Existing	Existing	Existing	Existing
	Bassett Street	Medium	Curbside	Farside	Constrained
	Park Street (@ Johnson)	Large	Curbside	Farside	Unconstrained
	Mills Street	Large	Curbside	Nearside	Unconstrained
	Randall Avenue	Large	Curbside	Nearside	Unconstrained
	Farley Avenue	Large	Curbside	Nearside	Unconstrained
	Shorewood Boulevard	Medium	Curbside	Nearside	Constrained
	Midvale Boulevard	Large	Curbside	Farside	Constrained
	Sheboygan Avenue	Large	Curbside	Nearside	Unconstrained
	Eau Claire Avenue	Large	Curbside	Farside	Unconstrained
	Regent Street	Small	Curbside	Farside	Constrained
	Mineral Point Road	**TP – Large	TP	N/A	Unconstrained
	Rosa Road	Small	Curbside	Farside	Unconstrained
	Yellow Stone Drive	Small	Curbside	Farside	Unconstrained
	Westfield Road	Small	Curbside	Farside	Unconstrained
	High Point	Small	Curbside	Farside	Constrained
OUTBOUND	Capitol Square North	Existing	Existing	Existing	Existing
	State Street	Existing	Existing	Existing	Existing
	Bassett Street	Large	Curbside	Farside	Constrained
	Park Street (@ University)	Large	Curbside	Farside	Unconstrained
	Charter Street	Large	Curbside	Farside	UnConstrained
	Randall Avenue	Large	Curbside	Farside	Unconstrained
	Farley Avenue	Large	Curbside	Farside	Unconstrained
	Shorewood Boulevard	Small	Curbside	Farside	Unconstrained
	Midvale Boulevard	Medium	Curbside	Farside	Unconstrained
	Sheboygan Avenue	Small	Curbside	Farside	Unconstrained
	Eau Claire Avenue	Small	Curbside	Farside	Unconstrained
	Regent Street	Small	Curbside	Farside	Constrained
	Mineral Point Road	**TP – Large	TP	N/A	Unconstrained
	Rosa Road	Small	Curbside	Farside	Unconstrained
	Yellow Stone Drive	Small	Curbside	Farside	Constrained
	Westfield Road	Small	Curbside	Midblock	Unconstrained
	High Point	Small	Curbside	Farside	Unconstrained

Note: *Existing = Existing Shelters will be retained in this location and do not add to the cost estimate, **TP = Transfer Point

Walnut Street Station

The feasibility of placing a station where Walnut Street would intersect Campus Drive was reviewed as part of this study in order to provide access to the BRT system to and from the high density neighborhood near "Old" University Avenue to the south and parts of the west end of the UW campus to the north. The approximate location of the proposed station can be seen in Figure 21. Campus Drive is currently grade separated from Walnut St. and runs parallel to a railroad and bike path as shown in Figure 22. The study includes a station in this location but recognizes that it may be infeasible because of the following constraints:

- A substantial amount of civil engineering work would be necessary to allow pedestrian access to the station platform, including new or modified bridges and retaining walls.
- Considering the structural constraints of the location, the footprint necessary for a station would likely encroach into the railroad right-of-way and require the removal of the storage track south of the mainline track.
- Without elevators and/or escalators, the project would need several hundred feet of sidewalk ramp to connect the two different grades, making competing transit service on University Avenue or Route 80 more attractive than the BRT service.

For a more detailed description of the constraints associated with this site please see Appendix N.

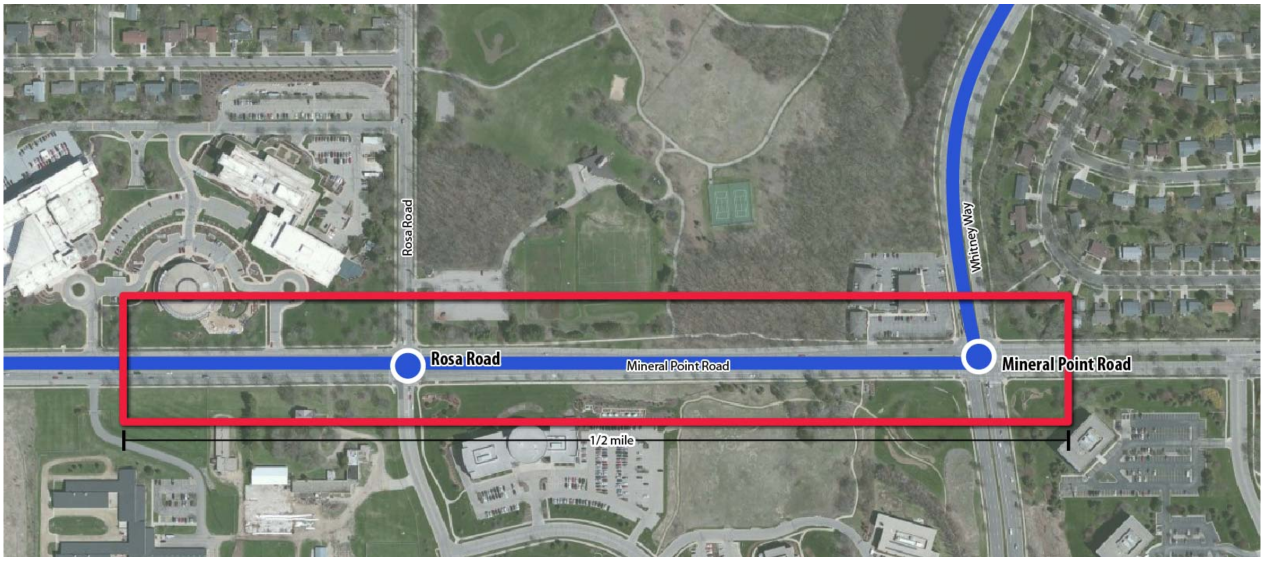
Figure 22: Campus Drive and Walnut Street

Source: Google Maps

Transfer Point

On the West Corridor Mineral Point Road alignment, the Transit Corridor Study assumes the West Transfer Point would be relocated along Mineral Point Road, as shown by the highlighted area in Figure 23. The Transit Corridor Study assumes the new transfer point needs a site with approximately 1.5 acres of land. It also assumes that all routes currently serving the West Transfer Point would be rerouted to the new location. As demonstrated by the aerial photography in Figure 23, the surrounding land uses in this area are predominantly low-density office and open space and do not currently support pedestrian-oriented retail activities.

Figure 23: West Transfer Point Potential Relocation Area



Travel Time Estimates

The Transit Corridor Study's travel time estimates for the West Corridor are shown in Table 9. To find the time passengers would save by using the proposed BRT system, the study compared the estimated BRT travel time in the corridor to the travel time of an existing Metro Transit route. The comparable existing peak-period transit route for the Mineral Point Road alignment is a combination of the Route 57 from the Capitol Square to the West Transfer Point, and the Route 67 to High Point Road. This trip currently has a scheduled travel time of 48 minutes. The proposed West Corridor – Mineral Point Road alignment offers a 23% percent travel time savings over the Route 57 to Route 67 option, in large part due to more direct routing and the elimination of the transfer.

Table 9: West Corridor – Mineral Point Road Travel Time Estimates

BRT One-way Travel Time (minutes)	**37**
Current One-way Peak Transit Travel Time (minutes)	48
Projected Travel Time Savings (minutes)	11
Percent of Travel Time saved using BRT	23%
Current Peak Drive Time (minutes)	23

Transit Signal Priority

The Transit Corridor Study travel time estimates assumed transit signal priority technology can be implemented at the 20 intersections shown in Table 10, but additional study is required before a final determination about transit signal priority is made.

Table 10: West Corridor – Mineral Point Road Intersections Recommended for Further Consideration of TSP

Street 1	Street 2
Mifflin Street	Wisconsin Avenue
Carroll	Main Street
Mifflin Street	Carroll Street/State Street
Carroll	W. Washington Avenue
Main Street	Pinckney Street/King Street
Main Street	Martin Luther King Blvd., Jr.
State Street	W. Dayton Street
State Street	Johnson Street
State Street	Gorham Street
University Avenue	Ridge Street
University Avenue	Segoe Road
Segoe Road	Frey Road
Whitney Way	Regent Street
Whitney Way	Mineral Point Road
Mineral Point Road	Yellowstone Dr.*
Mineral Point Road	Grand Canyon Dr.
Mineral Point Road	Gammon Road
Mineral Point Road	Westfield Rd.
Mineral Point Road	High Point Road
Mineral Point Road	Randolph Drive

Note: *Yellowstone Drive is anticipated to be a future signalized intersection

Major Changes to Local Bus Service

The Transit Corridor Study assumed major route changes to three existing Metro Transit routes as part of BRT implementation in the West Corridor. The affected routes and the proposed operational changes are shown in Table 11 and Table 12. In all cases changing or replacing these local routes with BRT service provides increased or similar frequencies in the corridor during peak hours, the midday and the evening.

Table 11: West Corridor Mineral Point – Affected Local Routes

Route	Existing Service	Peak Hours	Midday	Evening
2	Runs between West and North Transfer Points via the Capitol Square	15*	30	30
37	In the PM Peak hour three trips per day run on University Avenue from Highland Avenue to Eau Claire and Sheboygan Avenue	30	n/a	n/a
67	Runs from West Transfer Point to West Towne Mall	15	30	30

Note: *15 min frequencies in AM peak hour between West Transfer Point and Capitol Square. Other portions of this route have 30 min peak hour service during this time

Table 12: West Corridor Mineral Point – Proposed Operational Changes to Affected Local Routes

Route	Operational Change	Peak Hours	Midday	Evening
BRT	**All day service between High Point Road and Capitol Square**	**10**	**15**	**30**
2	Supplemental AM peak service between West Transfer Point and downtown replaced with BRT	30	30	30
37	Three PM peak hour trips to Eau Claire and Sheyboygan eliminated.		Replaced	
67	Service replaced with BRT		Replaced	

Redevelopment Potential

There are number of major sites within the West Corridor that have the capacity to add significant density, both residential and commercial. Implementation of BRT within this corridor could be the impetus for the development of some of these important sites.

Based on the analysis in the *Infill and Redevelopment Assessment*, completed by CARPC, the West Corridor - Mineral Point Road alignment has the potential to add approximately 1,500 residential units and 2.3 million square feet in commercial development. The location of the BRT stations will improve the potential for redevelopment for the following sites identified in the *Infill and Redevelopment Assessment*:

Station Location	Redevelopment Site
Farley Avenue	• Commercial area located at University and University Bay Drive • South side of University opposite Marshall Court
Midvale Boulevard	• Shopping area north of Hilldale
Sheboygan Avenue	• Hill Farms State Office Building
Eau Claire Avenue	• Red Cross Site
Rosa Road	• Northern end of CUNA Mutual parcel
West Towne Mall	• Various Parcels

West Corridor – Mineral Point Road Results

The total estimated capital costs for the Fixed Guideway Configuration is $61.17 million. Total estimated capital costs for the Corridor BRT configuration is $39.69 million. Total annual costs to operate the BRT service is $4.4 million, with the proposed local service changes saving $1.1 million, resulting in a total net annual operating and maintenance cost of $3.3 million for both configurations. Opening year daily ridership for the alignment is projected to be 8,780 riders and that estimate is expected to grow 10.1 percent by 2035. Assuming TOD influences, daily ridership is expected to grow by 10 percent by 2035. No differences in ridership are anticipated between the Fixed Guideway BRT and Corridor BRT configurations as the service plan assumptions and station locations are the same for both options.

Table 13: West Corridor - Mineral Point Road - Capital Costs

Alignment Configuration	Mineral Point Road - Fixed Guideway	Mineral Point Road – Corridor BRT
Side Running Lane Improvements	$0.9 M	$2.18 M
Median Running Lane Improvements	$21.37 M	$0
TSP	$0.76 M	$0.76 M
ROW Acquisition	$2.23 M	$1.11 M
Station Costs	$8.23 M	$9.56 M
Fleet Costs (includes 20% spare factor)	$15.6 M	$13.0 M
Transfer Point Reconstruction Costs	$2.16 M	$2.16 M
Soft Costs	$10.75 M	$5.09 M
Unallocated Contingency Costs	$6.96 M	$3.13 M
Total Construction Costs (2016 $)	**$68.96 M**	**$36.99 M**

Table 14: West Corridor Mineral Point - Annual Operating and Maintenance Costs (2012$)

BRT Operating Costs	$2.7 M
BRT Maintenance Costs	$1.7 M
Reductions to Local Service	-$1.1 M
Total O&M Costs	**$3.3 M**

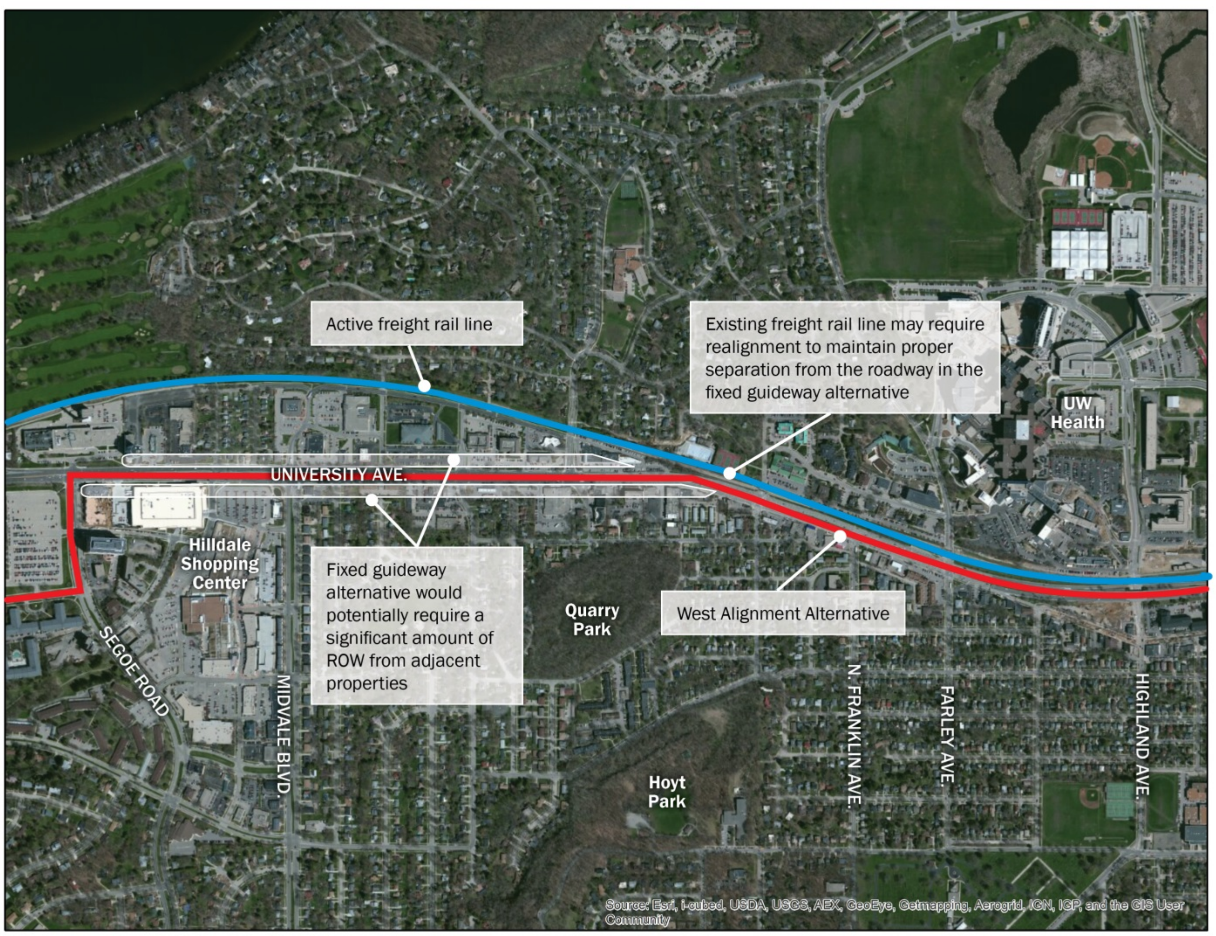
Table 15: West Corridor Mineral Point - Daily Ridership

Opening Year (2016)	8,780
Future Ridership (2035)	9,670
TOD Enhanced Ridership (2035)	10,650

University Avenue Fixed Guideway Impacts

Construction of a fixed guideway on University Avenue, which would include expansions of the existing roadway to accommodate additional travel lanes for BRT buses and bike lanes, would have a significant impact to the adjacent businesses and existing freight rail line. The fixed guideway alternative, with a median busway in this area, would require additional ROW to be purchased from adjacent businesses north and south of University Avenue to accommodate the proposed typical section. East of Shorewood Boulevard, the problem is particularly severe because an active rail line is immediately north of University Avenue and buildings with little setback are south of University Avenue. Additionally, University Avenue was reconstructed within the last few years. Figure 24 illustrates these constraints. Due to the significance of these impacts, it is recommended that a fixed guideway alternative on University Avenue not move forward for further evaluation at this time.

Figure 24: University Avenue Fixed Guideway Impacts



West Corridor – Odana Road

Runningway

The West Corridor – Odana Road alignment begins at the Capitol Square, runs west along the same alignment as the West Corridor – Mineral Point Road alignment. Approaching Mineral Point Road, the alignment continues to the existing West Transfer Point and travels west along Odana Rd, then entering the West Towne ring road serving West Towne Mall. Finally the alignment turns west onto Mineral Point Road at Westfield Road and continues to High Point Road. Only a Corridor BRT configuration was analyzed for this alignment. The Transit Corridor study assumes this configuration connects with the West Transfer Point in its current location. The majority of the Odana Road alignment runs in mixed traffic. The total length of each runningway type is shown in Table 16 and the location of each type of runningway configuration is shown in Figure 21.

Major destinations along this route include:

- Capitol Square
- University of Wisconsin – Madison
- UW Hospital and Clinics
- Hilldale Shopping Center
- Hill Farms State Office Building and residential areas
- University Research Park
- West Towne Mall

Table 16: West Corridor Odana Road - Runningway Lengths

One-Way Corridor Length (miles)	**8.61**
Side Running Length (miles)	2.70
Mixed Traffic Length (miles)	5.91

Cross sections in Appendix O show how side running lanes could fit into the current right-of-way in a typical location along the West Corridor – Odana Road alignment.

Stations

The West Corridor – Odana Road alignment contains 19 stations per direction spaced, on average, 0.5 miles apart. The characteristics of each station are shown in Table 17. Approximately half of the stations are evenly split between small and large stations. The large stations are generally found in the downtown and UW campus area, with the exception of the inbound Midvale Boulevard, Sheboygan Avenue and Eau Claire Avenue stations. All of the stations use a curbside platform and the majority are farside stations. There are 24 unconstrained stations in this alignment, adding to the estimated amount of purchased right-of-way necessary for this alignment.

Table 17: West Corridor - Odana Road Station Characteristics

	Station Name	Shelter Size	Platform Type	Platform Location	Constrained/ Unconstrained Site
INBOUND	Capitol Square South	Existing	Existing	Existing	Existing
	State Street	Existing	Existing	Existing	Existing
	Bassett Street	Medium	Curbside	Farside	Constrained
	Park Street (@ Johnson)	Large	Curbside	Farside	Unconstrained
	Mills/Charter Street	Large	Curbside	Nearside	Constrained
	Randall Avenue	Large	Curbside	Nearside	Unconstrained
	Farley Avenue	Large	Curbside	Nearside	Unconstrained
	Shorewood Boulevard	Medium	Curbside	Nearside	Constrained
	Midvale Boulevard	Large	Curbside	Farside	Constrained
	Sheboygan Avenue	Large	Curbside	Nearside	Constrained
	Eau Claire Avenue	Large	Curbside	Farside	Unconstrained
	Regent Street	Small	Curbside	Farside	Unconstrained
	Mineral Point Road	Small	Curbside	Farside	Unconstrained
	West Transfer Point	TP** - Large	TP	N/A	Unconstrained
	Research Park Boulevard	Small	Curbside	Nearside	Unconstrained
	Grand Canyon Drive	Small	Curbside	Farside	Unconstrained
	West Towne Mall	Large	Curbside	Midblock	Unconstrained
	Westfield Road	Small	Curbside	Farside	Unconstrained
	High Point	Small	Curbside	Farside	Constrained
OUTBOUND	Capitol Square South	Existing	Existing	Existing	Existing
	State Street	Existing	Existing	Existing	Existing
	Bassett Street	Large	Curbside	Farside	Constrained
	Park Street (@ University)	Large	Curbside	Farside	Unconstrained
	Mills/Charter Street	Large	Curbside	Farside	Constrained
	Randall Avenue	Large	Curbside	Farside	Unconstrained
	Farley Avenue	Large	Curbside	Farside	Unconstrained
	Shorewood Boulevard	Small	Curbside	Farside	Unconstrained
	Midvale Boulevard	Medium	Curbside	Farside	Unconstrained
	Sheboygan Avenue	Small	Curbside	Farside	Unconstrained
	Eau Claire Avenue	Small	Curbside	Farside	Unconstrained
	Regent Street	Small	Curbside	Farside	Unconstrained
	Mineral Point Road	Small	Curbside	Farside	Unconstrained
	West Transfer Point	TP** - Large	TP	N/A	Unconstrained
	Research Park Boulevard	Small	Curbside	Far	Unconstrained
	Grand Canyon Drive	Small	Curbside	Farside	Unconstrained
	West Towne Mall	Small	Curb	Midblock	-
	Westfield Road	Small	Curbside	Farside	Unconstrained
	High Point	Small	Curbside	Farside	Unconstrained

Note: *Existing = Existing Shelters will be retained in this location and do not add to the cost estimate, **TP = Transfer Point

Transfer Point

The Transit Corridor Study assumed that for the West Corridor – Odana Road alignment the West Transfer Point would be expanded in its existing location.

Travel Time Estimates

The Transit Corridor Study's travel time estimates for the West Corridor – Odana Road alignment are shown in Table 18. The comparable existing transit route to the West Corridor – Odana Road alignment is a combination of the Route 57 from the Capitol Square to the West Transfer Point, and the Route 67 to High Point Road. This trip currently has a scheduled travel time of 48 minutes. The proposed West Corridor – Mineral Point Road alignment offers a 17% percent travel time savings over the Route 2 to Route 67 option.

Table 18: West Corridor – Odana Road Travel Time Estimates

BRT One-way Travel Time (minutes)	**40**
Current One-way Peak Transit Travel Time (minutes)	48
Projected Travel Time Savings (minutes)	8
Percent of Travel Time saved using BRT	17%
Current Peak Drive Time (minutes)	29

Transit Signal Priority (TSP)

The Transit Corridor Study assumed TSP technology can be implemented at the 21 intersections shown in Table 19.

Table 19: West Corridor - Odana Road Intersections Recommended for Further Consideration of TSP

Street 1	Street 2
Mifflin Street	Wisconsin Avenue
Carroll Street	Main Street
Mifflin Street	Carroll Street/State Street
Carroll Street	W. Washington Avenue
Main Street	Pinckney Street/King Street
Main Street	Martin Luther King Blvd., Jr.
State Street	W. Dayton Street
State Street	Johnson Street
State Street	Gorham Street
University Avenue	Ridge Street
University Avenue	Segoe Road
Segoe Road	Frey Road
Whitney Way	Science Drive
Whitney Way	Tokay Blvd.
Odana Road	Research Park Blvd.
Odana Road	Potomac Lane
Tokay Blvd.	Odana Road
Odana Road	Grand Canyon Drive
Odana Road	Gammon Road
Westfield Road	Mineral Point Road
Mineral Point Road	High Point Road

Major Changes to Local Bus Service

Local bus service changes in the West Corridor are the same for both the Mineral Point Road and Odana Road alignments. Please see Table 11 and Table 12 in the Mineral Point Road section for a description of the affected routes and proposed operational changes.

Redevelopment Potential

Based on the analysis in the *Infill and Redevelopment Assessment*, the West Corridor – Odana Road alignment has the potential to add approximately 2,600 residential units and 2.9 million square feet in commercial development. The location of the BRT stations will improve the potential for redevelopment for the following sites identified in the *Infill and Redevelopment Assessment*:

Station Location	Redevelopment Site
Farley Avenue	• Commercial area located at University and University Bay Drive • South side of University opposite Marshall Court
Midvale Boulevard	• Shopping area north of Hilldale
Sheboygan Avenue	• DOT Hill Farms
Eau Claire Avenue	• Red Cross Site
West Transfer Point	• Westgate Mall • Low density commercial development on the southwest corner of Odana Road and Whitney Way
Grand Canyon Drive	• Market Square and properties adjacent to the west • Burlington Coat Factory/Joanne Fabrics retail center
West Towne Mall	• West Towne Mall

West Corridor – Odana Road Results

The total estimated capital cost for building Corridor BRT in the Odana Road alignment is $37.43 million, as shown in Table 20. Total annual costs to operate the BRT service is $4.5 million, with the proposed local service changes saving $1.1 million, resulting in a total net annual operating and maintenance cost of $3.4 million. Opening year daily ridership for the alignment is projected to be 8,930 riders and that estimate is expected to grow 9.6 percent by 2035. Assuming TOD influences, daily ridership is expected to grow by 10 percent by 2035. These ridership numbers are slightly higher than ridership numbers for the Mineral Point Road alignment.

Table 20: West Corridor - Odana Road Capital Costs

Alignment Configuration	Odana – Corridor BRT
Side Running Lane Improvements	$1.15 M
Median Running Lane Improvements	$0
TSP	$0.79 M
ROW Acquisition	$0.1 M
Station Costs	$12.13 M
Fleet Costs (includes 20% spare factor)	$13.0 M
Transfer Point Reconstruction Costs	$2.16 M
Soft Costs	$5.38 M
Unallocated Contingency Costs	$3.26 M
Total Construction Costs (2016 $)	**$37.97 M**

Table 21: West Corridor - Odana Road Operating and Maintenance Costs

	Corridor BRT
BRT Operating Costs	$2.7 M
BRT Maintenance Costs	$1.8 M
Reductions to Local Service	-$1.1 M
Total O&M Costs	**$3.4 M**

Table 22: West Corridor - Odana Road Ridership

Opening Year (2016)	8,930
Future Ridership (2035)	9,790
TOD Enhanced Ridership (2035)	10,760

South Corridor

Runningway

The South Corridor is 5.5 miles long. The alignment begins at the Capitol Square and runs west along State Street, W. Gorham Street and touches the eastern side of the University of Wisconsin – Madison's campus. It travels south on N. Park Street until turning west on Badger Road and running through the South Transfer Point. The route follows Fish Hatchery Road south until Caddis Bend in Fitchburg.

The Transit Corridor Study analyzed both a Fixed Guideway BRT and a Corridor BRT configuration for this alignment. In the Fixed Guideway Configuration over 60 percent of the corridor operates in a median fixed guideway runningway. In the Corridor BRT configuration over 75 percent of the corridor operates in side running lanes. The total length of each runningway type is shown in Table 23. The location of each type of runningway configuration is shown in Figure 25.

Major destinations along this route include:

- Capitol Square
- University of Wisconsin – Madison
- Meriter and St Mary's Hospitals
- Villager Shopping Center
- Fitchburg

Table 23: South Corridor Runningway Lengths

	Corridor BRT	Fixed Guideway BRT
One-Way Corridor Length (miles)	**5.50**	**5.50**
Fixed Guideway Length	-	3.40
Side Running Length (miles)	4.20	1.10
Mixed Traffic Length (miles)	1.30	1.00

Cross sections in Appendix O show how median running fixed guideways and side running lanes could fit into the current right-of-way in a typical location along the South Corridor.

Figure 25: South Corridor Runningways and Station Locations

South Corridor Stations

The South Corridor contains 15 stations per direction spaced on average 0.4 miles apart. Characteristics for each station are shown in Table 24. The large majority of the stations are small stations. All stations use a curbside platform configuration. Almost half of the stations are farside stations. There are 19 unconstrained stations, adding to the estimated amount of purchased right-of-way necessary for this alignment. Bram Street is the only midblock station.

Table 24: South Corridor Station Characteristics

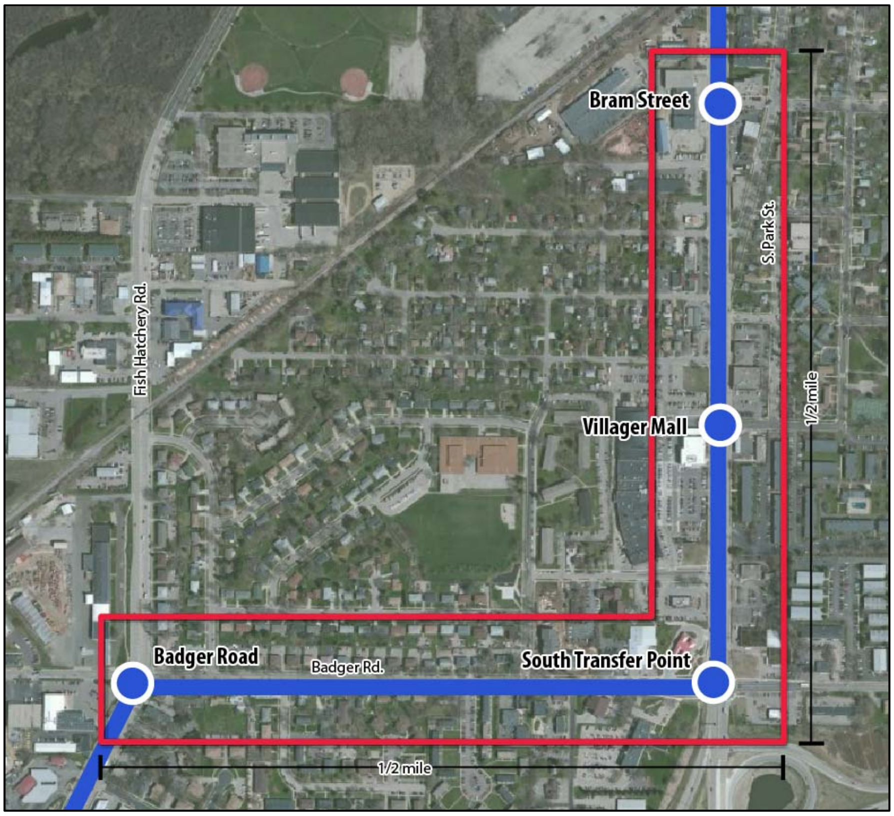
Direction	Station Name	Shelter Size	Platform Type	Platform Location	Constrained/ Unconstrained Site
INBOUND	Capitol Square South	Existing*	Existing	Existing	Existing
	State Street	Existing	Existing	Existing	Existing
	Bassett Street	Medium	Curbside	Farside	Constrained
	Park Street (@ Johnson)	Large	Curbside	Farside	Unconstrained
	Regent Street	Large	Curbside	Farside	Constrained
	W. Washington Avenue	Small	Curbside	Farside	Unconstrained
	Erin Street	Small	Curbside	Farside	Constrained
	Olin Avenue	Small	Curbside	Farside	Constrained
	Wingra Creek	Small	Curbside	Farside	Unconstrained
	Bram Street	Small	Curbside	Midblock	Constrained
	Villager Mall	Small	Curbside	Farside	Unconstrained
	South Transfer Point				
	Badger Road	Small	Curbside	Farside	Unconstrained
	Greenway Cross	Small	Curbside	Nearside	Unconstrained
	Post Road	Small	Curbside	Farside	Unconstrained
	Caddis Bend	Small	Curbside	Farside	Unconstrained
OUTBOUND	Capitol Square North	Existing	Existing	Existing	Existing
	State Street	Existing	Existing	Existing	Existing
	Bassett Street	Large	Curbside	Farside	Constrained
	Park Street (between Uni. & Johnson)	Large	Curbside	Farside	Unconstrained
	Regent Street	Small	Curbside	Farside	Unconstrained
	W. Washington Avenue	Small	Curbside	Farside	Unconstrained
	Erin Street	Small	Curbside	Farside	Constrained
	Olin Avenue	Small	Curbside	Farside	Constrained
	Wingra Creek	Small	Curbside	Nearside	Unconstrained
	Bram Street	Small	Curbside	Midblock	Unconstrained
	Villager Mall	Small	Curbside	Farside	Unconstrained
	South Transfer Point	TP** - Large	TP	N/A	Unconstrained
	Badger Road	Small	Curbside	Nearside	Unconstrained
	Greenway Cross	Small	Curbside	Farside	Unconstrained
	Post Road	Small	Curbside	Far	Unconstrained
	Caddis Bend	Small	Curbside	Nearside	Unconstrained

Note: *Existing = Existing Shelters will be retained in this location and do not add to the cost estimate, **TP = Transfer Point

Transfer Point

The Transit Corridor Study assumed the South Transfer Point would be expanded in its existing location or relocated close by, as shown in Figure 26. The Transit Corridor Study assumes a new transfer point would need a site approximately 1.5 acres in size.

Figure 26: Potential Relocation Area for the South Transfer Point



Travel Time Estimates

The Transit Corridor Study's travel time estimates for the South Corridor are shown Table 25. The best comparable existing peak-period transit route in the South Corridor is Route 47. Currently, traveling on Route 47 from the Capitol Square to Caddis Bend takes 38 minutes. The proposed South Corridor alignment offers a 21 percent travel time savings over the Route 47.

Table 25: South Corridor Travel Time Estimates

BRT One-way Travel Time (minutes)	30
Current One-way Peak Transit Travel Time (minutes)	38
Projected Travel Time Savings (minutes)	8
Percent of Travel Time saved using BRT	21%
Current Peak Drive Time (minutes)	16

Transit Signal Priority (TSP)

The Transit Corridor Study assumed TSP technology can be implemented at the 17 intersections shown in Table 26.

Table 26: South Corridor - Intersections Recommended for Further Consideration of TSP

Street 1	Street 2
Mifflin Street	Wisconsin Avenue
Carroll Street	Main Street
Mifflin Street	Carroll Street/State Street
Carroll Street	W. Washington Avenue
Main Street	Pinckney Street/King Street
Main Street	Martin Luther King Blvd., Jr.
State Street	W. Dayton Street
State Street	Johnson Street
State Street	Gorham Street
Park Street	W. Washington Avenue
Park Street	Regent Street
Park Street	Hughes Place
Park Street	Badger Road
Fish Hatchery Road	Ann Street/Emil Street
W. Badger Road	Fish Hatchery Road
Fish Hatchery Road	Post Road
Caddis Bend	Fish Hatchery Road

Major Changes to Local Bus Service

The Transit Corridor Study assumed major route changes to three existing Metro Transit routes as part of BRT implementation in the South Corridor. The affected routes and the proposed operational changes are shown in Table 27 and Table 28. In all cases replacing or changing these local routes with BRT service provides increased or similar frequencies in the corridor during peak hours, the midday and the evening.

Table 27: South Corridor – Affected Local Routes

Route	Existing Service	Peak Hours	Midday	Evening
5	All day service between the South and East Transfer Points via the Capitol Square	30	30	60
44/48	Run between Fitchburg (south of Caddis Bend) and the UW campus	30	n/a	n/a

Table 28: South Corridor - Proposed Operational Changes to Affected Local Routes

Route	Operational Change	Peak Hours	Midday	Evening
BRT	**All day service between High Point Road and Capitol Square**	**10**	**15**	**30**
5	Service between the Capitol Square and the South Transfer Point replaced with BRT	Replaced		
44/48	Replace service north of Caddis Bend with BRT. Routing south of Caddis Bend remains the same	30	n/a	n/a

Redevelopment Potential

Park Street has been ripe for redevelopment for many years and there are numerous plans that outline the development potential. Development activity in the corridor has picked up in recently. Multiple developments are either complete, under construction, or have received the necessary approvals to begin construction. In fact, one mixed use development was recently completed in the area with no parking for residents. BRT would likely significantly enhance the redevelopment potential of this corridor.

Based on the analysis in the *Infill and Redevelopment Assessment*, the South Corridor has the potential to add approximately 1,120 housing units and 1.3 million square feet in commercial development. The location of the BRT stations will improve the potential for redevelopment for the following sites identified in the *Infill and Redevelopment Assessment:*

Station Location	Redevelopment Site
West Washington Avenue	• Meriter Hospital's potential medical office building located on the Triangle
Erin Street	• Underutilized sites north of Erin Street on the east side of Park Street
Olin Avenue	• Wingra Triangle
Wingra Creek	• Wingra Triangle • Former Thorstad site
Villager Mall	• Villager Mall
South Transfer Point	• Comstock Tires and adjacent properties on the corner of Park Street and Badger Road
Post Road	• Multiple sites on either side of Fish Hatchery Avenue to the north and south

South Corridor Results

The South Corridor total estimated capital cost for building Fixed Guideway BRT is $54.89 million and the total estimated capital cost for building Corridor BRT is $29.92 million, as shown in Table 29. Total annual costs to operate the BRT service is $3.6 million, with the proposed local service changes saving $0.9 million, resulting in a total net annual operating and maintenance cost of $2.7 million for both configurations. Opening year daily ridership for the alignment is projected to be 6,150 riders and that estimate is expected to grow 13.8 percent by 2035. Assuming TOD influences, daily ridership is expected to grow by 13 percent by 2035. No differences in ridership are anticipated between the Fixed Guideway BRT and Corridor BRT configurations as the service plan assumptions and station locations are the same for both options.

Table 29: South Corridor Capital Costs

Alignment Configuration	Fixed Guideway	Corridor
Side Running Lane Improvements	$0.48 M	$1.79 M
Median Running Lane Improvements	$18.59 M	$0
TSP	$0.7 M	$0.7 M
ROW Acquisition	$1.1 M	$1.1 M
Station Costs	$5.23 M	$7.14 M
Fleet Costs (includes 20% spare factor)	$12.76 M	$10.64 M
Transfer Point Reconstruction Costs	$2.16 M	$2.16 M
Soft Costs	$8.64 M	$4.14 M
Unallocated Contingency Costs	$5.53 M	$2.56 M
Total Construction Costs (2016 $)	**$55.19 M**	**$30.23 M**

Table 30: South Corridor Operating and Maintenance Costs

BRT Operating Costs	$2.3 M
BRT Maintenance Costs	$1.3 M
Reductions to Local Service	-$.9 M
Total O&M Costs	**$2.7 M**

Table 31: South Corridor Daily Ridership

Opening Year (2016)	6,150
Future Ridership (2035)	7,000
TOD Enhanced Ridership (2035)	7,900

East Corridor

Runningway

The East Corridor begins at the Capitol Square and runs east along E. Washington Avenue It accesses Madison College via Wright Street and then returns to E. Washington Avenue via Stoughton Road. The alignment ends at East Towne Mall. Only Corridor BRT was analyzed for this alignment. The alignment is configured with approximately half side running lanes and half mixed traffic lanes, as shown in Table 32. The location of each type of runningway configuration is shown in Figure 27.

Major Destinations along this route:

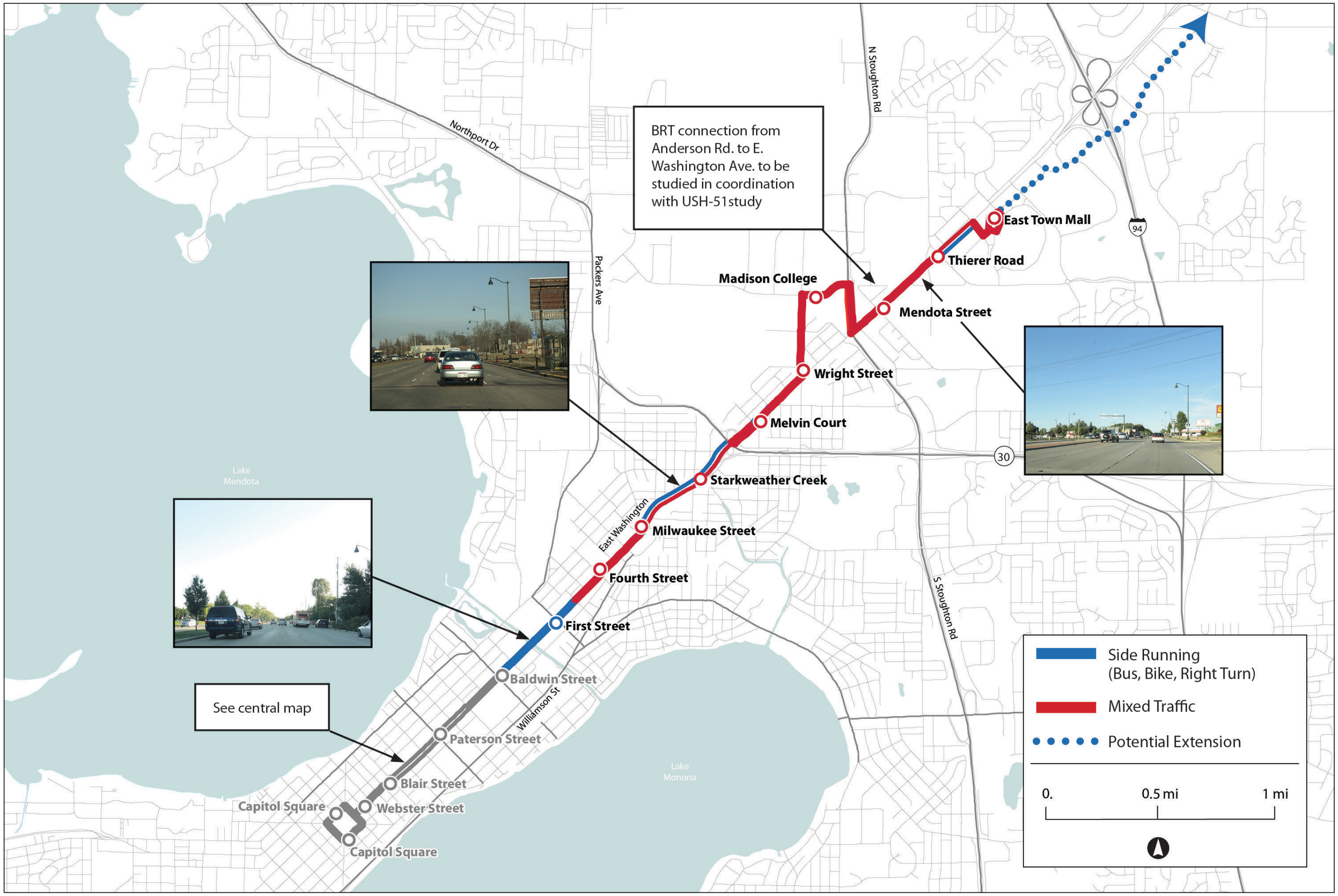
- Capitol Square
- The Isthmus
- Madison College
- East Towne Mall

Table 32: East Corridor Runningway Lengths

One-Way Corridor Length (miles)	6.28
Side Running Length (miles)	3.00
Mixed Traffic Length (miles)	3.28

Cross sections in Appendix O show how median side running lanes could fit into the current right-of-way in a typical location along the East Corridor.

Figure 27: East Corridor Runningways and Station Locations



East Corridor Stations

The East Corridor contains 15 stations per direction spaced on average 0.5 miles apart. Characteristics for each station are shown in Table 33. Approximately one half the stations are small stations and a little less than a quarter are medium shelters. Half of the stations are farside stations. There are 18 unconstrained stations in this corridor, adding to the estimated amount of purchased right-of-way necessary for this alignment.

Table 33: East Corridor Station Characteristics

Direction	Station Name	Shelter Size	Platform Type	Platform Location	Constrained/ Unconstrained Site
INBOUND	Capitol Square South	Existing	Existing	Existing	Existing
	Webster Street	Medium	Curbside	Farside	Unconstrained
	Blair Street	Small	Curbside	Nearside	Unconstrained
	Paterson Street	Medium	Curbside	Farside	Unconstrained
	Baldwin Street	Small	Curbside	Farside	Constrained
	First Street	Medium	Curbside	Farside	Unconstrained
	Fourth Street	Medium	Curbside	Nearside	Unconstrained
	Milwaukee Street	Medium	Curbside	Farside	Constrained
	Starkweather Creek	Small	Curbside	Nearside	Unconstrained
	Melvin Court	Small	Curbside	Farside	Unconstrained
	Wright Street	Small	Curbside	Nearside	Unconstrained
	Madison College	Large	Curbside	Nearside	Unconstrained
	Mendota Street	Small	Curbside	Farside	Constrained
	Thierer Road	Small	Curbside	Farside	Unconstrained
	East Towne Mall				
OUTBOUND	Capitol Square North	Existing			
	Webster Street	Medium	In-Lane	Farside	Constrained
	Blair Street	Small	Curbside	Nearside	Unconstrained
	Paterson Street	Medium	Curbside	Farside	Constrained
	Baldwin Street	Small	Curbside	Farside	Constrained
	First Street	Small	Curbside	Nearside	Constrained
	Fourth Street	Small	Curbside	Nearside	Constrained
	Milwaukee Street	Large	Curbside	Farside	Unconstrained
	Starkweather Creek	Small	Curbside	Farside	Unconstrained
	Melvin Court	Small	Curbside	Farside	Unconstrained
	Wright Street	Small	Curbside	Farside	Unconstrained
	Madison College	Large	Curbside	Farside	Unconstrained
	Mendota Street	Small	Curbside	Farside	Unconstrained
	Thierer Road	Small	Curbside	Farside	Unconstrained
	East Towne Mall	Large	Curbside	N/A	Constrained

Note: *Existing = Existing Shelters will be retained in this location and do not add to the cost estimate

Transfer Point

The East Corridor alignment does not connect directly to a transfer point.

Travel Time Estimates

The Transit Corridor Study's travel time estimates for the Easts Corridor are shown in Table 34. The best comparable existing transit route to compare to the proposed BRT alignment is the Route 6. Currently, traveling on the Route 6 from the Capitol Square to the East Towne Mall, via Madison College, takes 32 minutes. The proposed East Corridor alignment offers a 19 percent travel time savings over the Route 6.

Table 34: East Corridor Travel Time Estimates

BRT One-way Travel Time (minutes)	**26**
Current One-way Peak Transit Travel Time (minutes)	32
Projected Travel Time Savings (minutes)	6
Percent of Travel Time saved using BRT	19%
Current Peak Drive Time (minutes)	19

Transit Signal Priority (TSP)

The Transit Corridor Study assumed TSP technology can be implemented at the 16 intersections shown in Table 35.

Table 35: East Corridor Intersections Recommended for Further Consideration of TSP

Street 1	Street 2
Mifflin Street	Wisconsin Avenue
Carroll Street	Main Street
Mifflin Street	Carroll Street/State Street
Washington Avenue	Webster Street
Carroll Street	W. Washington Avenue
Main Street	Pinckney Street/King Street
Main Street	Martin Luther King Blvd., Jr.
Washington Avenue	Paterson Street
Washington Avenue	Baldwin Street
E. Washington Avenue	Aberg Avenue NB Ramps
E. Washington Avenue	Wright Street
Wright Street	Anderson Street
Anderson Street	Stoughton Road
E. Washington Avenue	Lien Road
E. Washington Avenue	Thierer Road/Portage Road
E. Washington Avenue	Eagan Road

Major Changes to Local Bus Service

The Transit Corridor Study assumed major route changes to three existing Metro Transit routes as part of BRT implementation in the East Corridor. The affected routes and the proposed operational changes are shown in Table 36 and Table 37. In all four cases replacing these local routes with BRT service provides increased frequencies in the corridor during peak hours, the midday and evening.

Table 36: East Corridor – Affected Local Routes

Route	Existing Service	Peak Hours	Midday	Evening
6	Runs from the West Transfer Point to the East Transfer Point via the Capitol Square	15	30	30
25	Two AM outbound and two PM inbound trips between the Capitol Square and the American Center	2 trips per peak period	n/a	n/a
26	Run in the midday from East Towne Mall to the American Center	n/a	60	n/a

Table 37: East Corridor - Proposed Operational Changes to Affected Local Routes

Route	Operational Change	Peak Hours	Midday	Late Evening
BRT	**All day service between East Towne Mall and the Capitol Square**	**10**	**15**	**30**
6	Replace service between the Capitol Square and East Towne Mall		*Replaced*	
13	Realign this route to run from the Capitol Square to E. Washington Avenue and Milwaukee Street	30	60	60
25	Replaced with all-day Route 26 service		*Replaced*	
26	Add service in the peak periods and increase service frequency	60	60	n/a

Redevelopment Potential

There is an abundance of redevelopment potential that has been defined in the *Capitol East District Plan*, a City of Madison district planning document, for which BRT would be a major driver for implementation. Almost every BRT station would have a positive impact on the redevelopment potential of adjacent properties.

Based on the analysis in the *Infill and Redevelopment Assessment*, the East Corridor has the potential to add approximately 4,000 housing units and 3.4 million square feet in commercial development. The location of the BRT stations will improve the potential for redevelopment for the following sites identified in the *Infill and Redevelopment Assessment:*

Station Location	Redevelopment Site
Webster Street	• City owned surface parking lot
Blair Street	• Multiple sites on either side of East Washington Avenue
Paterson Street	• Multiple sites on either side of East Washington Avenue
Baldwin Street	• Multiple sites
First Street	• Underutilized strip mall on the corner of First Street • Marling Lumber
Milwaukee Street	• Union Corners
Starkweather Creek	• Multiple small sites on either side of East Washington Avenue
Melvin Court	• Multiple sites clustered around the intersection of East Washington Avenue and Highway 30
Wright Street	• Two sites on the corner of Wright Street and East Washington Avenue
Mendota Street	• Significant redevelopment sites, primarily on the south side of East Washington Avenue
Thierer Road/East Towne Mall	• East Towne Mall redevelopment

East Corridor Results

The total estimated capital cost for building Corridor BRT in the East Corridor is $23.66 million, as shown in Table 38. Total annual costs to operate the BRT service is $3.0 million, with the proposed local service changes saving $1.0 million, resulting in a total net annual operating and maintenance cost of $2.0 million. Opening year daily ridership for the alignment is projected to be 3,530 riders and that estimate is expected to grow 13.8 percent by 2035. Assuming TOD influences, daily ridership is expected to grow by 24 percent by 2035.

Table 38: East Corridor Capital Costs

Alignment Configuration	East – Corridor BRT
Side Running Lane Improvements	$1.27 M
Median Running Lane Improvements	$0
TSP	$0.69 M
ROW Acquisition	$0.11 M
Station Costs	$8.09 M
Fleet Costs (includes 20% spare factor)	$8.27 M
Transfer Point Reconstruction Costs	$0
Soft Costs	$3.36 M
Unallocated Contingency Costs	$2.03 M
Total Construction Costs (2016 $)	**$23.82 M**

Table 39: East Corridor Operating and Maintenance Costs

BRT Operating Costs	$1.8 M
BRT Maintenance Costs	$1.2 M
Reductions to Local Service	-$1. M
Total O&M Costs	**$2.0 M**

Table 40: East Corridor Daily Ridership

Opening Year (2016)	3,530
Future Ridership (2035)	4,170
TOD Enhanced Ridership (2035)	5,180

North Corridor

Runningway

The North Corridor is 4.31 miles long. It begins at the Capitol Square and runs east on E. Washington Avenue. It then travels through the Yahara Busway, described below, and connects to Sherman Avenue It continues along Sherman Avenue until Northport Drive. The majority of the corridor runs in mixed traffic lanes. The total length of each type of runningway is shown in Table 41. The location of each type of runningway configuration is shown in Figure 28.

Major Destinations along the North Corridor route include:

- Capitol Square
- The Isthmus
- Northgate Mall
- Dane County Job Center
- Northside Town Center

Table 41: North Corridor Runningway Lengths

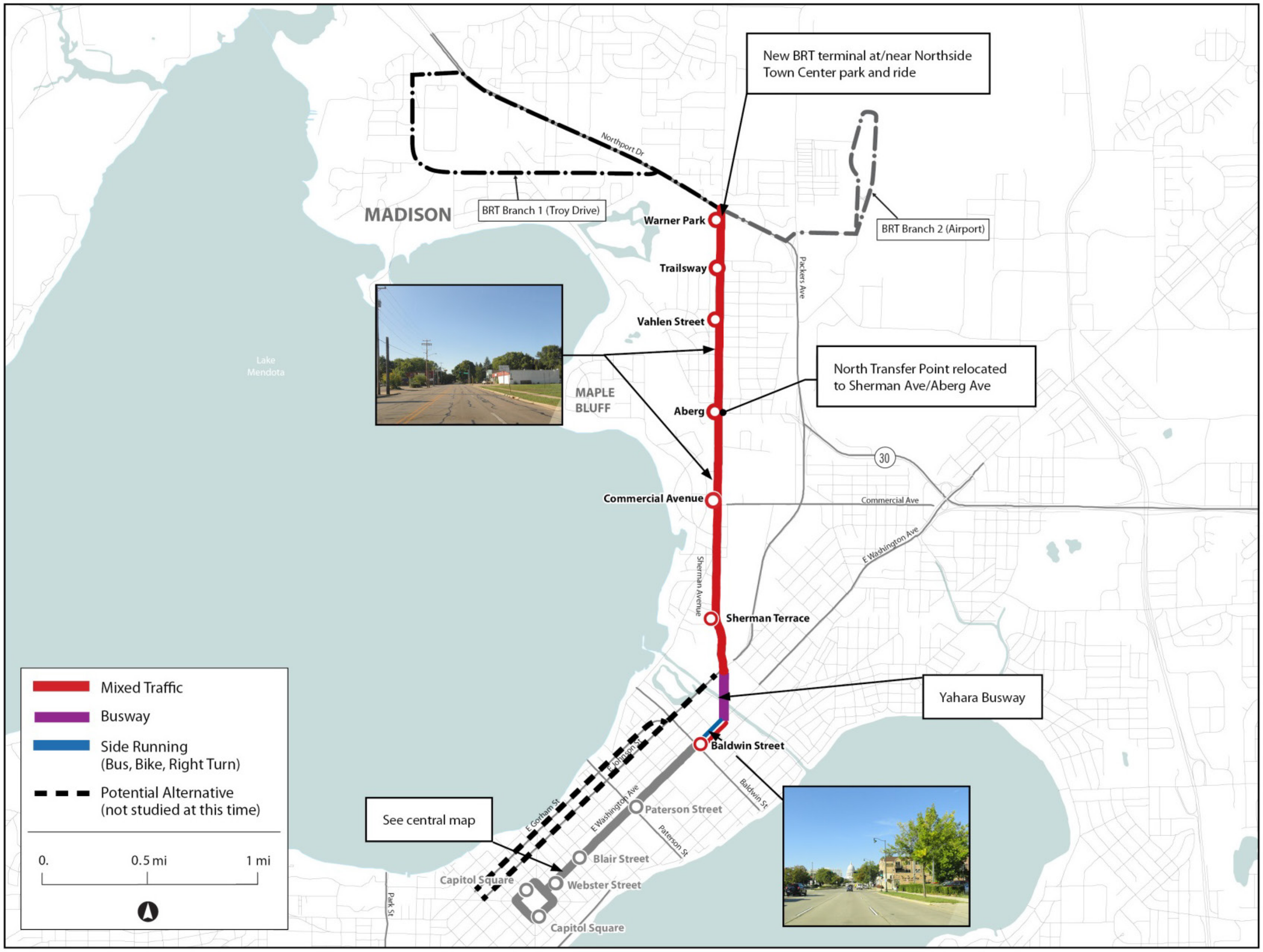
One-Way Corridor Length (miles)	4.31
Fixed Guideway Length - Yahara Busway (miles)	0.30
Side Running Length (miles)	1.50
Mixed Traffic Length (miles)	2.51

The Yahara Busway

The Yahara Busway is a short fixed guideway section that would need to be constructed and would only be accessible to BRT vehicles. The busway would connect E. Washington Avenue to Fordem Avenue adjacent to the existing railroad. Currently, the existing railroad tracks run diagonally across the Yahara River between E. Washington Avenue and E. Johnson Street. The location of the Yahara Busway is labeled on Figure 28. Several alternative routings were explored, including Johnson and Gorham Streets, Baldwin Street, First Street, North Street, Aberg Avenue, and Anderson Street. The Oversight Committee chose to study this short section of fixed guideway to avoid the congested and/or circuitous routing of these alternatives while maintaining the Sherman Avenue routing north of Johnson Street. The Yahara Busway reduces average travel times by an estimated one to two minutes compared to the First Street alternative, while improving reliability by eliminating turns at high-volume intersections and eliminating two railroad crossings. Although the Yahara Busway is a short fixed guideway section, the North Corridor configuration is still considered Corridor BRT.

The design of the Yahara busway would likely include one bus-only lane in each direction with unsignalized access at E. Washington Avenue and access to Fordem Avenue provided as the fourth leg of the intersection. A new bridge and at-grade railroad crossing would be required. A short, single-lane signalized section over the Yahara River may be effective at reducing the cost and footprint of the bridge while discouraging unauthorized access.

Figure 28: North Corridor Runningway Types and Station Locations



North Corridor Stations

The North Corridor contains 10 stations per direction spaced on average 0.4 miles apart. Characteristics for each station are shown in Table 42. The majority of the stations call for small shelters and a curbside platform configuration. The majority of stations are farside stations. There are 15 unconstrained stations on this alignment, adding to the estimated amount of purchased right-of-way necessary for this alignment.

Table 42: North Corridor - Shelter Characteristics

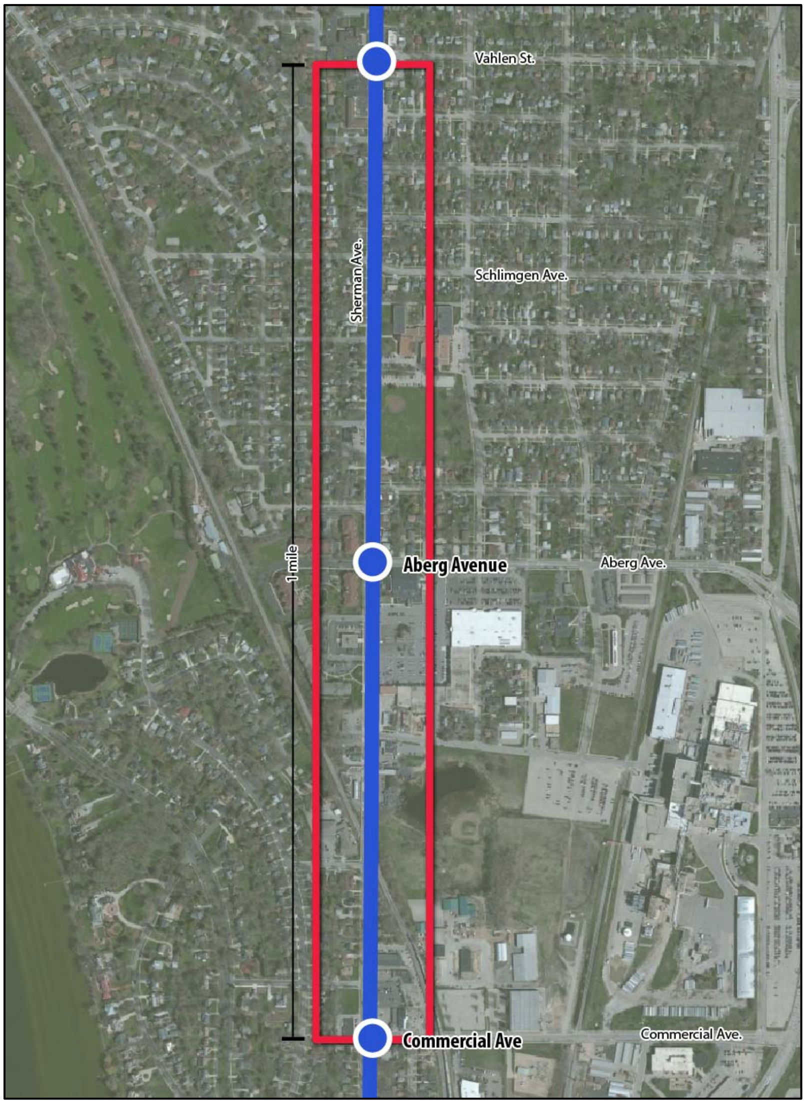
	Station Name	Shelter Size	Platform Type	Final Platform Location	Constrained/ Unconstrained Site
INBOUND	Capitol Square South	Existing*	Existing	Existing	Existing
	Webster Street	Medium	Curbside	Farside	Unconstrained
	Blair Street	Small	Curbside	Nearside	Unconstrained
	Paterson Street	Medium	Curbside	Farside	Unconstrained
	Baldwin Street	Small	Curbside	Farside	Constrained
	Sherman Terrace	Medium	Curbside	Midblock	Unconstrained
	Commercial Avenue	Small	Curbside	Nearside	Unconstrained
	Aberg Avenue	TP - Large	TP	N/A	Unconstrained
	Vahlen Street	Small	Curbside	Farside	Unconstrained
	Trailsway	Small	Curbside	Nearside	Unconstrained
	Warner Park	Large	Curbside	TBD**	Unconstrained
OUTBOUND	Capitol Square North	Existing	Existing	Existing	Existing
	Webster Street	Medium	Pull-out	Midblock	Constrained
	Blair Street	Small	Curbside	Nearside	Unconstrained
	Paterson Street	Medium	Curbside	Farside	Constrained
	Baldwin Street	Small	Curbside	Farside	Constrained
	Sherman Terrace	Medium	Curbside	Midblock	Unconstrained
	Commercial Avenue	Small	Curbside	Nearside	Constrained
	Aberg Avenue	TP - Large	TP	N/A	Unconstrained
	Vahlen Street	Small	Curbside	Farside	Unconstrained
	Trailsway	Small	Curbside	Farside	Unconstrained
	Warner Park	Large	Curbside	TBD**	Unconstrained

Note: *Existing - The existing shelters at the Capitol Square are retained and therefore are not included in the Transit Corridor Study cost estimate. **TBD – Final platform location to be determined.

Transfer Point

The Transit Corridor Study assumed the North Transfer Point would be relocated within one-half mile of the Aberg Avenue Station along Sherman Avenue, as shown in Figure 29; The Transit Corridor Study assumes a new transfer point would require approximately 1.5 acres of land. It also assumes that all routes currently serving the North Transfer Point would be rerouted to the new location.

Figure 29: Potential North Transfer Point Relocation Area



Travel Time Estimates

The Transit Corridor Study's travel time estimates for the North Corridor are shown in Table 43. The existing transit route used to compare to the proposed BRT alignment is a combination of the Route 2 and the Route 22. Currently, traveling on the Route 2 from the Capitol Square to the North Transfer Point, then transferring to Route 22, and finally departing at Warner Park takes 31 minutes. The proposed North Corridor alignment offers a 42 percent travel time savings over the Route 2 to Route 22 option, primarily due to less circuitous routing and the elimination of the transfer.

Table 43: North Corridor Travel Time Estimates

BRT One-way Travel Time (minutes)	18
Current One-way Peak Transit Travel Time (minutes)	31
Projected Travel Time Savings (minutes)	13
Percent of Travel Time saved using BRT	42%
Current Peak Drive Time (minutes)	15

Transit Signal Priority (TSP)

The Transit Corridor Study assumed TSP technology can be implemented at the 13 intersections shown in Table 44.

Table 44: Intersections Recommended for Further Consideration of TSP

Street 1	Street 2
Mifflin Street	Wisconsin Avenue
Carroll	Main Street
Mifflin Street	Carroll Street/State Street (RT)
Washington Avenue	Webster Street
Carroll	W. Washington Avenue
Main Street	Pinckney Street/King Street (LT)
Main Street	Martin Luther King Blvd., Jr.
Washington Avenue	Paterson Street
Washington Avenue	Baldwin Street
Fordem Avenue	Johnson Street
Sherman Avenue	Aberg Avenue
Sherman Avenue	Commercial Avenue
Sherman Avenue	Schlimgen Avenue

BRT Operating Plans

The North Corridor is the only corridor in the study with an operating plan that assumes BRT vehicles will leave the main BRT alignment and travel into surrounding areas. This service pattern was chosen by the Oversight Committee to improve service to the neighborhoods nearby Warner Park and Troy Drive and to the Dane County Regional Airport. The Transit Corridor Study assumes two BRT branches. BRT Branch 1 serves Troy Drive and Northport Drive using a loop similar to Route 22. BRT Branch 2 serves the Dane County Airport via Darwin Road. The routes of both branches are shown on Figure 28.

Alternating BRT trips serve each branch, meaning service along the branches is half as frequent as the service along the rest of the North Corridor alignment. For example, in the peak hour BRT branches will have a service frequency of 20 minutes while the rest of the north-south route has 10-minute service. No additional capital costs are associated with the North Corridor BRT branches beyond Warner Park, but it does effect the fleet requirement. 7 buses are required to provide service to the North Corridor alignment and alternating trips to the two extension areas. Both BRT branches are factored into the operating and maintenance cost estimates for the corridor.

Major Changes to Background Bus Service

The Study assumed major route changes to four existing Metro Transit routes as part of BRT implementation in the North Corridor. The affected routes and the proposed operational changes are shown in Table 45 and Table 46. Generally, replacing these local routes with BRT service provides increased frequencies in the corridor during peak hours, the midday and late evening. However, some of the route changes in the areas served by the BRT branches do minimally reduce frequencies and coverage in surrounding neighborhoods. The deletion of Route 29 results in a loss of some limited peak-period coverage north of Delaware Boulevard; however it provides much higher frequencies throughout the day on Sherman Avenue to the Northside Town Center park and ride. Replacing Route 22 with BRT Branch 1 reduces frequencies along Northport Dr. and Troy Dr. from 15 minutes to 20 minutes in the peak period.

Table 45: North Corridor – Affected Local Routes

Route	Existing Service	Peak Hours	Midday	Evening
20	East Towne Mall to Dane County Regional Airport and North Transfer Point	30	30	30
22	North Transfer Point to Northport Dr. and Troy Dr.	15	30	30
27	North Transfer point to the UW campus	30		
29	Two trips per peak period from the Lakeview area to the UW campus	2 trips per peak period	n/a	n/a

Table 46: North Corridor - Proposed Operational Changes to Affected Local Routes

Route	Operational Change	Peak Hours	Midday	Evening
BRT Branch 1*	**All day North Corridor BRT service branching to serve Troy Dr. and Northport Dr.**	**20**	**30**	**60**
BRT Branch 2*	**All day North Corridor BRT service branching to serve the Dane County Airport**	**20**	**30**	**60**
20	Replace the airport portion of the alignment with BRT Extension 2	*No Change*		
22	Replaced with BRT Extension 1	*Replaced*		
27	Replaced with BRT service	*Replaced*		
29	Replaced with BRT service	*Replaced*		

***** BRT Branches 1 and 2 combine for 10, 15, and 30-minute frequencies along the BRT corridor.

Redevelopment Potential:

Based on the analysis in the *Infill and Redevelopment Assessment*, the North Corridor has the potential to add approximately 600 housing units and 260,000 square feet in commercial development. The location of the BRT stations will improve the potential for redevelopment for the following sites identified in the *Infill and Redevelopment Assessment:*

Station Location	Redevelopment Site
Commercial Avenue	• Lakewood Plaza Shopping Center
Aberg Avenue	• Northgate Shopping Center and adjacent properties
Warner Park	• Northside Town Center

North Corridor Results

The total estimated construction cost for building Corridor BRT in the North Corridor, including vehicles, is $25.67 million, as shown in Table 47. Total annual costs to operate the BRT service is $3.0 million, with the proposed local service changes saving $1.1 million, resulting in a total net annual operating and maintenance cost of $1.9 million. Opening year daily ridership is projected to be 3,370 riders and that estimate is expected to grow 12.8 percent by 2035. Assuming TOD influences, daily ridership is expected to grow by 12 percent by 2035.

Table 47: North Corridor Capital Costs (2016$)

Alignment Configuration	North Corridor BRT
Side Running Lane Improvements	$0.65 M
Yahara Busway	$2.36 M
TSP	$0.6 M
ROW Acquisition	$1.09 M
Station Costs	$6.12 M
Fleet Costs (includes 20% spare factor)	$8.27 M
Transfer Point Reconstruction Costs	$2.16 M
Soft Costs	$4.02 M
Unallocated Contingency Costs	$2.55 M
Total Construction Costs (2016 $)	**$27.82 M**

Table 48: North Corridor - Annual Operating and Maintenance Costs (2012$)

	Corridor BRT
BRT Operation Costs	$1.8 M
BRT Maintenance Costs	$1.2 M
Reductions to Local Service	-$1.1 M
Total O&M Costs	**$1.9 M**

Table 49: North Corridor - Daily Ridership Projections

Opening Year (2016)	3,370
Future Ridership (2035)	3,800
TOD Enhanced Ridership (2035)	4,270

Corridor and System Summary

Table 50 through Table 55 shows a side by side summary of each corridor's attributes, travel times, capital costs, operating and maintenance costs, and ridership projections. Table 56 through Table 58 shows a summary of capital costs, operating and maintenance costs, and annual system ridership projections assuming the full build out of the proposed BRT system. In the system tables, overlapping corridor segments are removed while an overall maintenance facility component is added. Also for the system values, individual corridor ridership projections are adjusted to reflect overlapping segments.

Table 50: Corridor Attributes

Corridor	NORTH	SOUTH		EAST	WEST		
Type of Runningway	**Corridor**	**Fixed Guideway**	**Corridor**	**Corridor**	**Mineral Point - Fixed Guideway**	**Mineral Point - Corridor**	**Odana - Corridor**
One-way Corridor Length (miles)	4.31	5.50	5.50	6.28	7.76	7.76	8.61
Fixed Guideway Length (Miles)	0.30	3.40	-	-	4.30	-	-
Side Running Length (Miles)	1.50	1.10	4.20	3.00	2.10	5.10	2.70
Mixed Traffic Length (Miles)	2.51	1.00	1.30	3.28	1.36	2.66	5.91
Number of Stations per direction	11	16	16	15	17	17	19
Average distance between stations (miles)	0.43	0.37	0.37	0.45	0.49	0.49	0.48
Fleet Required (includes 20% spare factor)	7	9	9	7	11	11	11
Number of Intersections with TSP	13	17	17	16	20	20	24

Notes:

- Average distance between stations = Corridor length / (number of stations - 1)

Table 51: Corridor Travel Times

Corridor	Corridor Length (Miles)	BRT One-way Travel Time (minutes)	Current One-way Peak Transit Travel Time (minutes)	Projected Travel Time Savings (minutes)	Current Peak Drive Time (minutes)
North	4.31	18	31	13	15
South	5.50	30	38	8	16
East	6.28	26	32	6	19
West: Mineral Point	7.76	37	48	11	23
West: Odana	8.61	40	48	8	29

Notes:

- BRT One-way travel time: Total Travel Time = bus time in motion + traffic signal delay time + station dwell time
- Current One-way Peak Travel Time and Projected Travel Time Savings calculated using existing comparable transit routes (see below)
- Current Peak Drive Time based on Google Traffic estimates

Existing Comparable Transit Routes

- North: Route 2, from Capitol Square to North Transfer point combined with Route 22, from North Transfer Point to North Town Center
- South: Route 47, from Capitol Square to Caddis Bend
- East: Route 6 from Capitol Square to East Towne Mall, via Madison College
- West: Mineral Point - Route 57 from Capitol Square to West Transfer Point and Route 67 and Route 67, from West Transfer Point to West Towne Mall
- West: Odana- Route 2, from Capitol Square to West Transfer Point, and Route 67, from West Transfer Point to West Towne Mall

Table 52: Capital Costs

Corridor	NORTH	SOUTH		EAST	WEST		
Type of Runningway	Corridor	Fixed Guideway	Corridor	Corridor	Mineral Point - Fixed Guideway	Mineral Point - Corridor	Odana - Corridor
Side Running Lane Improvements	$0.65 M	$0.48 M	$1.79 M	$1.27 M	$0.9 M	$2.18 M	$1.15 M
Median Running Lane Improvements	$2.36 M	$18.59 M	$0	$0	$21.37 M	$0	$0
TSP	$0.6 M	$0.7 M	$0.7 M	$0.69 M	$0.76 M	$0.76 M	$0.79 M
ROW Acquisition	$1.09 M	$1.1 M	$1.1 M	$0.11 M	$2.23 M	$1.11 M	$0.1 M
Station Costs	$6.12 M	$5.23 M	$7.14 M	$8.09 M	$8.23 M	$9.56 M	$12.13 M
Fleet Costs (includes 20% spare factor)	$8.27 M	$12.76 M	$10.64 M	$8.27 M	$15.6 M	$13.0 M	$13.0 M
Transfer Point Reconstruction Costs	$2.16 M	$2.16 M	$2.16 M	$0	$2.16 M	$2.16 M	$2.16 M
Soft Costs	$4.02 M	$8.64 M	$4.14 M	$3.36 M	$10.75 M	$5.09 M	$5.38 M
Unallocated Contingency Costs	$2.55 M	$5.53 M	$2.56 M	$2.03 M	$6.96 M	$3.13 M	$3.26 M
Total Construction Costs (2016 $)	**$27.87 M**	**$55.19 M**	**$30.23 M**	**$23.82 M**	**$68.96 M**	**$36.99 M**	**$37.97 M**

Notes:

- Unit costs in 2012 dollars inflated at 3% per year to 2016 dollars
- Side Running Lane Improvements = $60 x length of route
- Median Running Lane Improvements = $550-$1000x length of route
- ROW Acquisition = $7 x square foot of needed space
- Station costs include the following types of items (varies by station location)
  - Shelters
  - Platform construction
  - Street signage
  - Automated signage
  - Traffic control
  - Parking
  - TVMs
  - Site improvements
- Fleet costs = $1M - $1.2M x peak fleet required per alignment + 20% spare factor
- Transfer Point base reconstruction = $1,600,000, additional charges relate to allocated contingency costs
- Unallocated contingency costs = Total Capital Costs per corridor x 15%
- No cost added to individual corridors for system maintenance facility requirements

Table 53: Corridor BRT O&M Costs (2012$)

Corridor	North	South	East	West: Mineral Point	West: Odana
Corridor Length	4.31	5.50	6.28	7.76	8.61
Annual Revenue BRT Bus Miles	291,000	258,000	294,000	364,000	404,000
Annual Revenue BRT Bus Hours	23,000	30,000	24,000	35,000	35,000
Vehicle Operations Costs	$1.8 M	$2.3 M	$1.8 M	$2.7 M	$2.7 M
Vehicle Maintenance Costs	$412,000	$365,000	$417,000	$515,000	$571,000
Non-Vehicle Maintenance	$401,000	$484,000	$403,000	$584,000	$594,000
BRT Maintenance Premium	$103,000	$91,000	$104,000	$129,000	$143,000
TVM Maintenance	$80,000	$66,000	$86,000	$139,000	$153,000
Station Maintenance	$41,000	$63,000	$59,000	$67,000	$76,000
Police/Fare enforcement	$152,000	$195,000	$153,000	$229,000	$229,000
Total O&M Costs (2012 $)	**$3.0 M**	**$3.6 M**	**$3.0 M**	**$4.4 M**	**$4.5 M**

Notes:

- 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). See the System tab for the span of service.
- Vehicle Operations Costs = BRT Annual Revenue Bus Hours x $75.61 (2011 Metro Transit Unit Cost)
- Vehicle Maintenance Costs = BRT Annual Revenue Miles x $1.39 (2011 Metro Transit Unit Cost)
- Non-Vehicle Maintenance Costs = 18.07% x (Vehicle Operations Costs + Vehicle Maintenance Costs)
- Premium for Articulated Buses = Annual BRT Revenue Bus-Mile x $0.35
- TVM Maintenance = Number of TVMs x $6,500
- Station/Stop Maintenance = Number of Directional Stops x $2,000
- Police/Fare Enforcement = BRT Annual Revenue Bus Hours x $6.50

Table 54: O&M Costs for Local Bus Service Changes (2012$)

Corridor	North	South	East	West: Mineral Point	West: Odana
Corridor Length	4.31	5.50	6.28	7.76	8.61
Annual Revenue Bus Miles	-134,000	-94,000	-133,000	-126,000	-123,000
Annual Revenue Bus Hours	-9,000	-8,000	-9,000	-10,000	-10,000
Vehicle Operations Related Costs	-$732,000	-$654,000	-$673,000	-$762,000	-$742,000
Vehicle Maintenance Costs	-$190,000	-$133,000	-$189,000	-$179,000	-$174,000
Non-Vehicle Maintenance Costs	-$167,000	-$142,000	-$156,000	-$170,000	-$166,000
Total O&M Cost Changes (2012$)	-$1.1 M	-$0.9 M	-$1.0 M	-$1.1 M	-$1.1 M

Notes:

- 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). See Table 2 for the proposed system frequency and span of service.
- Vehicle Operations Costs = Change in Annual Revenue Bus Hours x $75.61 (2011 Metro Transit Unit Cost)
- Vehicle Maintenance Costs = Change in Annual Revenue Miles x $1.39 (2011 Metro Transit Unit Cost)
- Non-Vehicle Maintenance Costs = 18.07% x (Change in Vehicle Operations Costs + Change in Vehicle Maintenance Costs)

Table 55: Corridor Ridership Projections

	Average Daily Ridership			Annual Ridership		
Corridor	**Opening Year Ridership Projection (2016)**	**Future Ridership Baseline Projection (2035)**	**TOD Adjusted Future Ridership Projection (2035)**	**Opening Year Ridership Projection (2016)**	**Future Ridership Baseline Projection (2035)**	**TOD Adjusted Future Ridership Projection (2035)**
North	3,370	3,800	4,270	0.86 M	1.16 M	1.30 M
South	6,150	7,000	7,900	1.87 M	2.13 M	2.41 M
East	3,530	4,170	5,180	1.08 M	1.27 M	1.58 M
West: Mineral Point	8,780	9,670	10,650	2.27 M	2.95 M	3.25 M
West: Odana	8,930	9,790	10,760	2.72 M	2.99 M	3.28 M

Notes:

- Existing ridership is based on 2011 Metro Ridership data and used a 1/8 mile buffer around existing bus stops to create an existing baseline ridership for the proposed alignments.
- Opening Year (2016) and Future (2035) Ridership Projections are based on current land use patterns.
- TOD Adjusted Future Ridership Projections are based on transit oriented development (TOD) at key station areas.
- The West - Mineral Point Road alignment projections includes riders from the relocated West Transfer Point.

Table 56: System Summary – Capital Costs

	MINERAL POINT OPTION		ODANA OPTION
	Full System Corridor BRT	Fixed Guideway BRT in West & South Corridors	Corridor BRT
North Segment	$10.6 M	$10.6 M	$10.6 M
South Segment	$13.6 M	$33.5 M	$13.6 M
East Segment	$8.9 M	$8.9 M	$8.9 M
West Segment	$18.2 M	$41.7 M	$18.8 M
Central Segment	$7.0 M	$7.0 M	$7.0 M
Subtotal	$58.3 M	$101.7 M	$59.0 M
Required Fleet Costs	$40.2 M	$44.9 M	$40.2 M
Contingency Costs	$8.7 M	$15.3 M	$8.8 M
Bus Maintenance Facility	$30.0 M	$30.0 M	$30.0 M
TOTAL SYSTEM CAPITAL COSTS (2016 $)	**$137.2 M**	**$191.8 M**	**$138.0 M**

Notes:

- System maintenance facility cost for fleet of 34 articulated vehicles
- Required Fleet Costs for the Fixed Guideway option assumes right and left-side doors. Corridor BRT assumes right-side doors only.
- Segment Descriptions
  - North Segment = Runningway and stations north of Baldwin Street
  - South Segment = Runningway and stations south of Park Street
  - East Segment = Runningway and stations east of Baldwin Street
  - West Segment = Runningway and stations west of Park Street
  - Central Segment = Runningway and stations between Park Street and Baldwin Street

Table 57: System Summary – Annual Operating and Maintenance Costs

	MINERAL POINT OPTION		ODANA OPTION
	Full System Corridor BRT	Fixed Guideway BRT in West & South Corridors	Corridor BRT
BRT System O&M Costs	$13.8 M	$13.8 M	$13.9 M
O&M Background Bus Cost Changes	-$4.1 M	-$4.1 M	-$4.1 M
Net O&M BRT Costs (2012 $)	$9.7 M	$9.7 M	$9.8 M

Table 58: System Summary – Annual System Ridership Projections

	MINERAL POINT OPTION		ODANA OPTION
	Full System Corridor BRT	Fixed Guideway BRT in West & South Corridors	Corridor BRT
Annual Opening Year Ridership Projection (2016)	4.7 M	4.7 M	4.8 M
Future Ridership Baseline Projection (2035)	5.2 M	5.2 M	5.2 M
TOD Adjusted Future Ridership Projection (2035)	6.0 M	6.1 M	6.0 M

Evaluation of Project Goals

The Oversight Committee created nine goals for the assessment of how well BRT might fit in Madison. How well the corridors fulfill each goal is presented below.

Goal 1: Reduce Travel Times

The first goal of the proposed BRT system was to reduce the time transit passengers currently spend traveling from point A to point B along Madison's four primary transit corridors. The Transit Corridor Study evaluated this goal by comparing the travel time estimates for the proposed BRT system to existing peak transit travel times in the four corridors. Travel time savings for each of the study's alignments are shown below in Table 59 and represent the time it takes to travel from one end of the corridor to the other. The North Corridor sees the largest time savings, cutting the alignment's current end to end travel time almost in half. The other four alignments also see significant travel time savings, ranging from 17 to 23 percent. The proposed BRT configurations clearly fulfill the committee's first project goal in all four corridors.

Table 59: Travel Time Savings

Alignment	Corridor Length (Miles)	BRT One-way Travel Time (minutes)	Current One-way Peak Transit Travel Time (minutes)*	Projected Travel Time Savings (minutes)	Time Savings (%)
North	4.31	18	31	13	**42%**
South	5.50	30	38	8	**21%**
East	6.28	26	32	6	**19%**
West: Mineral Point	7.76	37	48	11	**23%**
West: Odana	8.61	40	48	8	**17%**

Note: See the description of each corridor for the existing routes chosen for the current one-way peak transit travel time comparison.

Goal 2: Attract New Transit Riders

The second goal for the proposed BRT system was to attract new passengers to the system. This goal was evaluated by comparing the number of new riders attracted to each corridor. As discussed early in this study, each alignment's ridership projection includes a projection of the number of new riders attracted by BRT's comfort, convenience, and reliability. The projections for each corridor, based on the improvements in frequency, speed, and comfort, are shown in Table 60. The west and south alignments show the highest level of new riders, each drawing over 1,000 estimated new daily riders apiece. The South alignment is also fairly successful at attracting new riders in comparison to the other corridors, with 713 new transit riders. It makes sense that the west and south alignments have the largest estimates of new riders, because both travel through the downtown and the UW-campus area. This area has some of the highest ridership in the existing system as well as some of the city's highest levels of population density, both factors that provide a strong base for ridership projections.

Table 60: New Transit Riders - Daily Ridership

Alignment	New Riders Attracted by BRT Service	Total BRT Ridership (2016)	% of New Riders
North	430	3,370	13%
South	713	6,150	12%
East	331	3,530	9%
West: Mineral Point	1,150	8,780	13%
West: Odana	1,170	8,930	13%

Note: Ridership forecasts are presented for each individual corridor. System-wide ridership forecasts are shown in Table 58

Goal 3: Improve connections between low income and/or transit dependent neighborhoods and centers of employment and activity

The third goal of the project was to improve the connections between low income and/or transit dependent neighborhoods and centers of employment and activity in the Madison area. To measure how well the proposed system achieved this goal the Transit Corridor Study compared existing transit travel times to travel times on the proposed BRT system between a sample of origins located in low income and/or transit dependent areas to an employment or activity center. Origin locations were chosen from areas that had a high concentration of low income populations or if they had a large percentage of households that do not own cars[2]. Origin locations also are within 1/3 of a mile of an existing transit route. Destinations were assigned to locations with high concentrations of employment and/or popular shopping destinations[3].

The twelve origin and destination pairs and both the existing and BRT travel times are shown in Table 61. The origin and destination locations are shown on Figure 30. For origins not located directly on a proposed BRT line, it was assumed the passenger would travel to a transfer point via an existing local bus route and then transfer to the BRT line. Travel time estimates were calculated in the midday.

[2] ACS 2010 5-year summary file data was used to locate high concentrations of low income populations and areas with large percentages of households that do not own cars.

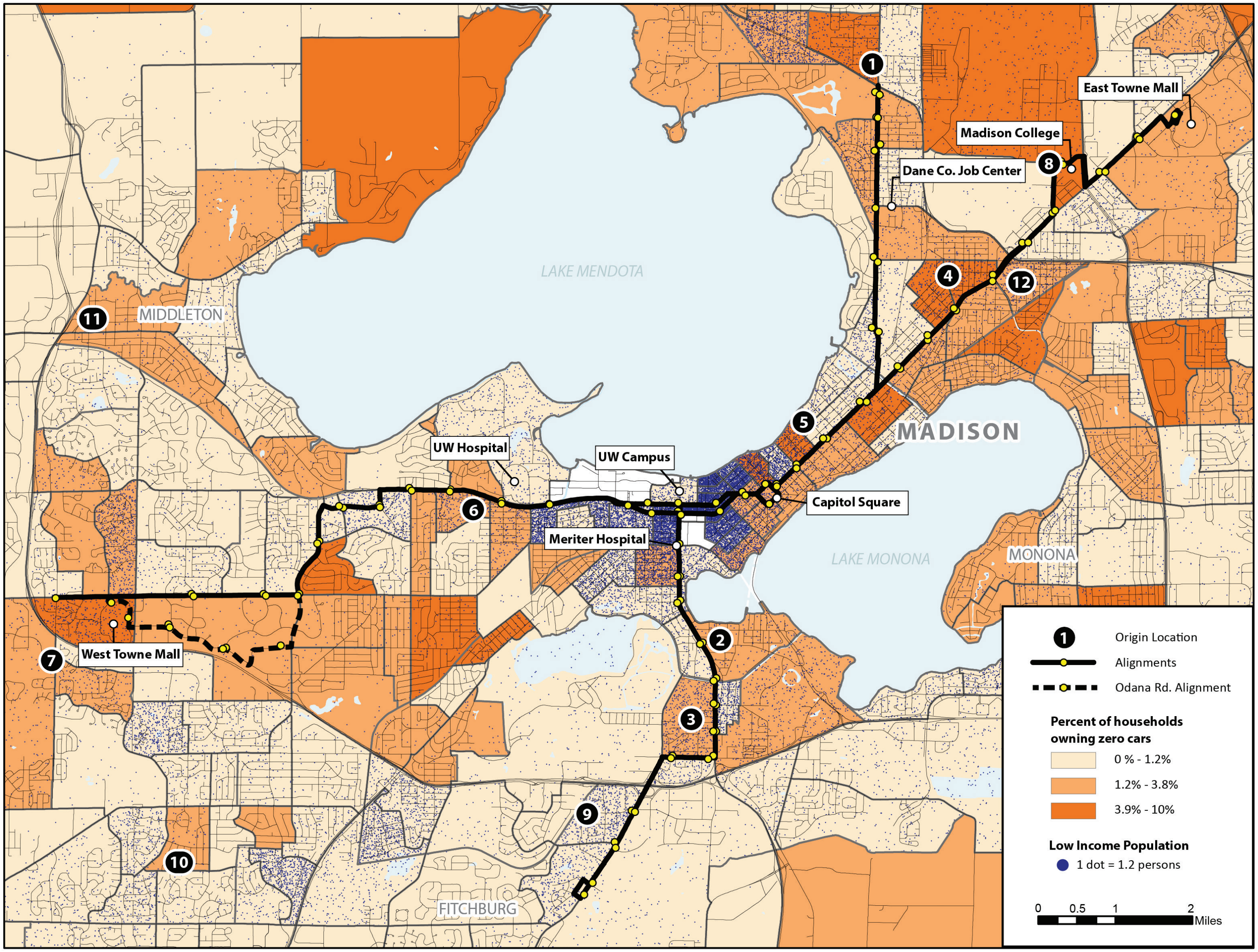
[3] The 2010 Longitudinal Employer-Household Dynamics (LEHD) data from the US Census Bureau was used to locate area with high employment concentrations.

Table 61: Low Income/Transit Dependent Origin Destination Pairs

	Origin Intersection		Closest Corridor	Major Employment and/or Shopping Area	Existing transit in-vehicle travel time (minutes)	Proposed in-vehicle service travel time (minutes)	Difference (minute)	% Time Savings
1	Thackeray Rd	N Sherman Ave	North	Meriter Hospital	41	24	-17	41%
2	W Olin Ave	Lowell St	South	Dane County Job Center	36	23	-13	36%
3	Cypress Way	Dane Street	South	Madison College	44	30	-14	32%
4	E Johnson St	North Street	East	East Towne Mall	20	15	-5	25%
5	E Gorham St	N Paterson St	East	West Towne Mall	48	38	-10	21%
6	Shepard Terrace	Kendall Avenue	West	Capitol Square	16	13	-3	19%
7	Watts Road	S High Point Rd	West	Capitol Square	41	35	-6	15%
8	Wright St	Anderson St	East	Capitol Square	19	18	-1	5%
9	Luann Ln	Greenway Cross	South	West Towne Mall	33	32	-1	3%
10	Sara Rd	Putnam Rd	West	UW Campus	38	38*	0	0%
11	University Ave	Parmenter St	West	UW Hospitals and Clinics	36	36*	0	0%
12	Milwaukee St	Portland Pkwy	East	UW Campus	25	25*	0	0%

*Note: Using existing local routes would be faster than using BRT to make this trip; therefore it is assumed passengers would continue to use local routes and would not see a difference in travel times.

Figure 30: Low Income/Transit Dependent Origin Destination Pair Locations



When the existing and proposed travel times were compared, the proposed system provided an average 15 percent travel time savings. While passengers at certain origin locations would still be better served by local routes (pairs 10, 11, and 12), the large majority of these trips would be faster using the proposed BRT system. Of the nine origin/destination pairs that experience a faster travel time by using the proposed system, seven pairs experience significant decreases in travel times ranging from 15 to 41 percent time savings. Looking at these twelve pairs, it can be concluded that the proposed system does a good job of improving connections between low income and/or transit dependent neighborhoods and centers of employment and activity.

Goal 4: Provide expanded carrying capacity

The fourth goal for the project was to provide expanded carrying capacity to the current transit system. The Transit Corridor Study measured the proposed system's ability to provide expanded carrying capacity by comparing existing carrying capacities to the proposed BRT system's carrying capacities at eight screen line locations along the corridors. Two types of screen line locations were assigned to each corridor, one location closer to Madison's downtown and one location closer to end of the proposed BRT lines. Carrying capacities were calculated at each location by multiplying the number of buses passing through the screen line per hour by the carrying capacity of each bus. The study assumes the 40-foot buses currently used by Metro Transit can carry a maximum of 53 people (38 seated plus 15 standees). The study assumes a 60' articulated BRT vehicle can carry a maximum of 84 people (59 seated plus 25 standees). Existing passenger capacities and proposed passenger capacities at all size screen line locations are shown in Table 62. The large percent increases between the existing system's carrying capacity and the carrying capacities possible with BRT plus existing local service demonstrate that implementing a BRT system as a complement to local service would greatly increase the transit system's carrying capacity at all eight locations during both the peak hour and the midday. The greatest gains in carrying capacity in all four corridors are seen in the midday when existing service is at its lightest. All parts of the proposed system would see expanded carrying capacities with the implementation of the proposed BRT system.

Table 62: Existing versus Proposed Passenger Capacity per Hour

		Hourly Passenger Capacities						% Increase	
Corridor	**Screen Line Location**	**Existing Peak**	**Existing Midday**	**BRT Peak**	**BRT Midday**	**BRT + Existing Peak**	**BRT + Existing Midday**	**Peak Hour**	**Midday**
West	University Ave. at Midvale Blvd.	636	212	504	336	1,140	548	**79%**	**158%**
South	S. Park St. at Wingra Dr.	212	106	504	336	716	442	**238%**	**317%**
East	E. Washington Ave. at Milwaukee St.	795	212	504	336	1,299	548	**63%**	**158%**
North	Sherman Ave. at Aberg Ave.	318	106	504	336	822	442	**158%**	**317%**

Source: Existing Peak and Midday passenger capacities based on 2010 Transit Service Frequencies.

Note: The BRT Peak and Midday frequencies do not take into account local bus service changes proposed in the Transit Corridor Study, therefore some small reductions in the passenger capacity percent increase may occur.

Goal 5: Improve operational efficiencies

Besides slow travel times, a common complaint about Metro Transit's existing operations is overcrowded buses. Metro Transit tracks the routes in the existing local bus system that are consistently reported as overcrowded. The eight commonly overcrowded routes are listed below in Table 63. On the whole, the majority of these eight routes run parallel or very close to the proposed BRT alignments, meaning the proposed system's expanded carrying capacity, discussed in Goal 4, would help improve operational efficiencies by reducing the need for extra buses to be deployed.

Table 63: Commonly Overcrowded Routes

Commonly Overcrowded Routes	Located in BRT Corridors	Specific Overload Location	Will new BRT system alleviate overcrowding?	Reasoning
2	West & North	University Avenue Corridor	Yes	The BRT system significantly increases capacity in the University Avenue Corridor.
4	South & North	Mills Street	Most likely	Increasing the service level on Park Street is likely to attract some ridership currently on Route 4.
6	East, South	UW Campus, East Washington Avenue, Madison College	Yes	Midday service at Madison College is increased from hourly to every 15 minutes. East Washington Avenue and N. Park Street capacity is increased.
14	West East	University Avenue, East Washington Avenue	Yes	Frequent service to Hill Farms relieves loading on Route 14 and allows it to be rerouted from Sheboygan Avenue to Regent Street. High peak-period loads to the East Transfer Point will likely continue.
15	West & East	University Avenue Corridor, East Washington Avenue	Yes	Frequent service to Hill Farms relieves volume on Route 15 and allows it to be rerouted from Sheboygan Avenue to Old Middleton Road. High peak-period loads to the East Transfer Point will likely continue.
28	North	Johnson and Gorham Streets	Not likely	Johnson and Gorham Streets are not served by the BRT alignments studied, although some volume north of Johnson Street may be relieved
38	East	UW Campus, Jenifer Street, Broom/Bassett Streets	No	The areas generating overloads are not served by the BRT system.
71/72	West	Middleton/ University Avenue	Not likely	Middleton is not directly served by the BRT system, although some loading along University Avenue may be relieved.

Goal 6: Provide an enhanced image for transit service

The Transit Corridor Study's proposed system provides an enhanced image of transit by holding the system's planned stations and vehicles to very high design standards. The stations proposed in the study are intended to be the system's primary identity element and will project a feeling of physical permanence similar to that of an LRT station. Cost estimates for the stations include highly visible elements such as large, lighted station markers and public art. Proposed shelter designs are shown earlier in the report in Figure 8 through Figure 11.

Also, the fixed guideways proposed in the West and South Fixed Guideway BRT configurations would add to the visual impact of the stations and heighten the public's awareness of the system. The proposed BRT vehicles will also be uniquely branded to differentiate them from local bus service and help call attention to the improved transit service. Overall, the distinctive design features of both the system's stations and vehicles will improve the image of transit in the area.

Goal 7: Improve the comfort and convenience of the transit experience

The Transit Corridor Study's BRT system improves the comfort and convenience of the transit experience through both its proposed operating plan and through the amenities offered at the station locations and onboard the BRT vehicles. First, the operating plan ensures the system is convenient by running at high frequencies throughout the day. With a bus passing by each station every ten minutes during the peak hours and every fifteen minutes during the midday, customers will be able to rely on the system without consulting complicated schedules and without fear of missing a bus. Using the screen line locations discussed in Goal 4, Table 64 shows that with the proposed BRT service overlaid on top of the existing local bus service is provides increased frequencies across the entire system. The increase in frequencies is especially large at the locations furthest away from the downtown area.

The planned amenities at the BRT stations and onboard the BRT vehicles also increase comfort and convenience for passengers. The option for off-board fare payment is easy and automatic with smart card readers at every station and it also speeds service by decreasing the time spent waiting for passengers to pay as they board. Dynamic signage placed at medium and large stations take away the mystery of when the next bus will arrive. Onboard the vehicles, passengers could use the proposed wi-fi service and those making multi-modal trips will be able to store their bicycles on board, keeping them safe and dry. These amenities in conjunction with the system's frequent operating plan will offer a very high level of comfort and convenience to transit passengers.

Table 64: Local Peak Frequencies versus Proposed BRT Frequencies

Corridor	Screen Line Location	Existing Avg Peak Frequencies (minutes)	Existing Avg Midday Frequencies (minutes)	Proposed BRT Peak Frequencies (minutes)	Proposed BRT Midday Frequencies (minutes)	BRT + Existing Peak (Minutes)	BRT + Existing Midday (Minutes)
West	University Ave. at Midvale	5	15	10	15	3	8
South	S. Park St. at Wingra Dr.	15	30	10	15	6	10
East	E. Washington Ave. at Milwaukee St.	15	30	10	15	3	8
North	Fordem Ave. at Sherman Ave.	< 15	30	10	15	6	12

Note: The Proposed BRT Peak and Midday frequencies do not take into account local bus service changes proposed in the Transit Corridor Study, therefore some small increases in the BRT + Existing frequencies may occur.

Goal 8: Integrate well with the existing and planned transit system

The proposed system is designed to be integrated into the existing transit service. It augments existing peak hour routes and increases the all-day service. It connects with three of the four major transfer points. Local service is intended to use the BRT stations, or stops close by, so riders can transfer or take whichever bus comes first. For people who do not live or travel to destinations directly on the BRT corridor, they may still benefit from the improvements. For instance, many people in southwest Madison take local service to the West Transfer Point, then transfer to continue their journey to downtown Madison. BRT would save them a substantial amount of time over transferring to Route 2 or Route 6.

The proposed system also fulfills multiple goals for public transit as stated in the MPO's 2035 Regional Transportation Plan Update, the first and foremost being to study and plan for the implementation of a high-capacity rapid transit service in the Madison area. As described above, the proposed system would also incrementally improve and expand local bus service through service extensions and increased frequencies, another goal from the 2035 Regional Transportation Plan update. Lastly, also in line with the plan update, the proposed system has the ability to improve express commuter service from peripheral neighborhoods.

Goal 9: Enhance opportunities for transit-oriented development (TOD)

The ninth goal of the proposed BRT system is to facilitate and support infill redevelopment along the corridor routes. Based on CARPC's analysis in *The Infill and Redevelopment Assessment*, the BRT system will have a positive impact on infill redevelopment with the potential to add a total of 7,200 housing units and 7,110,000 square feet in commercial space over the long term depending on market demand (see corresponding market study). The majority of this development is anticipated to occur in the short (0-10 years) and mid-term (10-20 years). If the West Corridor uses the Odana Road alternative, the total potential housing units will increase to 8,340 and the total commercial space will increase to 7,880,000 square feet. Of the four routes, the BRT system could have a significant impact on the redevelopment in the East Corridor.

Route	Housing Units	Commercial Space (SF)
East Corridor	4,020	3,410,000
West Corridor	1,460	2,280,000
South Corridor	1,120	1,290,000
North Corridor	600	260,000
Total	**7,200**	**7,110,000**
Alternative Routes Total*	**8,340**	**7,880,000**

Source: *Infill and Redevelopment Assessment*, CARPC. See Appendix M.

Note:* West Corridor Odana Road Alternative provides additional development potential (1,140 housing units and 640,000 square feet of commercial space

Table 65: Evaluation Summary

	Goal	Result
1.	**Reduce travel times**	17% - 42% reduction in in-vehicle transit travel time using BRT service.
2.	**Attract new transit riders**	9% - 13% of estimated BRT riders expected to be new transit users.
3.	**Improve connections between low income and/or transit dependent neighborhoods and centers of employment and activity**	Average of 15% savings in in-vehicle transit travel times for trips between low income/transit dependent areas to major destinations using BRT service.
4.	**Provide expanded carrying capacity**	78% - 158% increase in peak period carrying capacities along major corridors and 158% to 317% increase in midday carrying capacities.
5.	**Improve operational efficiencies**	Likely able to relieve overcrowding on 5 of 8 current problem routes.
6.	**Provide an enhanced image for transit service**	Identification of BRT runningways, unique stations and vehicles will positively influence the image of transit service within the community.
7.	**Improve the comfort and convenience of the transit experience**	3 to 6 minute blended (local + BRT) peak service frequencies along key points versus current level of 5 to 15 minutes. Station and on-vehicle amenities as well.
8.	**Integrate well with the existing and planned transit system**	Connecting service to BRT lines identified to serve outlying and off-line destinations.
9.	**Enhance opportunities for transit-oriented development (TOD)**	Significant infill opportunities provided.

Madison BRT: Next Steps

Implementing BRT in Madison will require close coordination among major stakeholders to complete the project development process. The City of Madison and Metro Transit will have significant roles in completing design, construction and operation of any BRT configurations selected for implementation. BRT is well suited for incremental development, so identifying key stages and the funding arrangements for each stage is a logical first step toward implementation. Overall system benefits will accrue immediately upon implementation, so early action that builds upon community interest and support will be well received. Metro Transit, the City of Madison, the public, and others should generally be comfortable with the concepts that involve major changes to the transit system or transportation network.

Identification of BRT Stages

One of the first steps toward implementation of BRT in Madison will be to identify the most promising corridors and segments for further consideration. Regional and city stakeholders need to select one or more corridors for initial development based on the balance of costs and benefits. Once the corridors are prioritized, each should be assessed individually to determine if stages will be required within the corridors to build out the full alignment. Staging might be required to tie-in with other local construction initiatives, jurisdictional issues, limited funding or development that will be coming in forward years.

Detailed Design and Environmental Analysis

This study has identified and tested several BRT concepts for potential implementation in Madison. Planning assumptions were carefully reviewed with stakeholders to ensure reasonable test conditions were in place, but before proceeding to implementation, concept designs need to be replaced with detailed design activities. This will include design of the runningways and stations including all of the components necessary to operate and maintain the BRT service. The detailed engineering phase is the basis for final cost estimates as well as assessment of impacts related to any environmental analysis that may be required locally. Detailed drawings for each construction segment will need to be prepared showing all design requirements including any right of way needs. One of the key components within this work will be station locations and designs.

Funding

Financing BRT projects can be accomplished through mechanisms and programs similar to those used for other transit initiatives. Most major transit improvements are financed with combinations of local, state, and federal funds and some level of debt financing.

On the federal level, there is no specific funding program related specifically to BRT projects. Major high capacity transit projects from BRT to light rail, commuter rail, and subway/elevated urban rail systems have utilized funds from the Federal Transit Administration (FTA) through the New Starts program, and funding is very competitive across the country.

Within the New Starts program is the Small Starts program that is aimed at providing assistance to lower cost BRT and streetcar projects. Projects need to be less than $250 million in total, with the federal share at less than $75 million. Competition for Small Starts funding is also very competitive with awards from the FTA based on overall project ratings. These BRT projects do not need to be operated in their own right-of-way and can be corridor-based, but need to include specific elements like BRT branding, frequent service, and transit signal priority. A project using Small Starts funds would need to conform to a specific project development process, including Alternatives Analysis, Project Development, Project Construction Grant Agreement, and Construction. Some of the results from this study may be used for the Alternatives Analysis phase. Federal funding from Urbanized Area Formula Grants and the Bus Capital program has also been used for BRT projects. However, funding under the Formula Grant program completes locally with other transit system needs including bus fleet procurement and major vehicle and facility overhauls.

State and local funds may also be available to implement BRT in Madison. Direct state appropriations, revenue backed bonds and local tax or assessment districts may be available to help finance the system. Formation of a regional transit authority (RTA) would help facilitate implementation by providing a solid local funding base. RTAs are currently allowed in many states, but are not allowed in Wisconsin. RTA enabling legislation was enacted in 2009 and rescinded in 2011. Funding for BRT and other transit service through an RTA would likely be from a sales tax in a district encompassing the metropolitan area.

Community Engagement

The conceptual design activities have raised local interest in possible BRT design and operations. To go beyond this level will require broader engagement of the local community to reach agreement on service and design details. There should be opportunities to discuss the BRT concepts at the neighborhood level under the upcoming City of Madison Transportation Master Plan process. Additional focused outreach should be conducted as part of the detailed design activities. Topics should include station locations, station designs, program requirements, BRT service configurations, and local bus connections.

BRT Supportive Policies

Land use and parking policies are areas that can be supportive of BRT investment by helping to generate and accommodate potential riders. Land use planning around station areas should begin as early as possible to engage the neighborhoods and business community in crafting a vision for transit-supportive development. A blend of trip generator and trip attractor land uses can support all-day, two direction BRT service. Land use policies or zoning regulations may need to be adjusted to encourage high density and transit-oriented development.

Parking availability at stations will also influence ridership especially at outlying stations. Neighborhood parking policies and identification of regional park and ride opportunities also needs to be clarified before implementation.

In the short term, broader transportation policies and priorities may be reviewed to facilitate incremental steps toward BRT. For instance, transit service change concepts may prioritize fast, direct, ridership-stimulating investments over competing service coverage expansions and commuter services, which are also important. Transit speed and reliability improvements like transit signal priority, in-lane bus stops, and bus-only lanes may be included in road reconstruction and channelization projects.

Branding

Branding a BRT service gives it a unique identity locally. This identity can be used to market the service as something clearly different than other local transit services and build customer loyalty and support. To jump start this effort it will be necessary to identify:

- Who is the target audience?
- What makes BRT sellable to the audience?
- How to communicate to the audience?

Likely components of the branding strategy include:

- Name of service
- Color schemes and logos
- Features to highlight
- Customer information components
- Publication materials

Transit Signal Priority

The preliminary review of potential application of transit signal priority along the proposed BRT corridors in Madison has identified where slack time is available on non-TSP phases that could be transferred to TSP phases. Ninety-nine signalized intersections along the BRT corridors were reviewed to identify available slack time. Fifty-eight were recommended for further consideration of TSP to benefit BRT operations. A thorough review of those intersections should be completed prior to design activities to ensure that buses will benefit from the investment and traffic flow will not be negatively impacted in a significant way. A pilot study is recommended to prove the concept of TSP.

Local Bus System Redesign and Transit Facilities

The implementation of BRT service in Madison needs to incorporate a thorough review of all the other transit services and facilities within the area. As BRT services are overlaid within corridors, some existing services will be modified or replaced by BRT. The level of service for remaining routes and the determination of whether they are through-routed or modified to become BRT feeders needs to be carefully evaluated to meet the community needs. Extensive public involvement for this service redesign should be considered.

As part of this review, the locations and sizing of the transfer points should be evaluated to ensure these continue to function as needed within the overall metro system. The gravity of expanding or relocating a transfer point cannot be overstated. Along with this review, opportunities to add park and ride facilities in strategic locations around the community should be evaluated. Park and ride could greatly enhance peak period ridership on the BRT system.

The vehicles envisioned for BRT service in Madison are 60-foot articulated vehicles not currently operated by Metro. Adding these vehicles to the fleet will cause several concerns that should be analyzed prior to implementation. Parallel on-going studies, such as the Bus Size Study, are investigating these constraints in more detail.

Transit Operations

Metro Transit makes extensive use of route interlines to maximize driver scheduling efficiency. Introduction of BRT service with unique vehicles will disrupt the current scheduling patterns along some key corridors. Before BRT implementation it will be necessary for Metro staff to evaluate the overall scheduling process to identify the full impact of BRT implementation. Locations and policies related to driver relief, layover and recovery time may also need to be reviewed to ensure smooth integration of BRT service.

Sustainable Communities Planning

Implementation of BRT in Madison will have a positive impact on a number of sustainable communities' principles by expanding transportation choices within the community and supporting transit-oriented development. The potential for BRT to impact other key livability measures including reduction in vehicle miles traveled (VMT) and emissions within the area, along with the potential to increase the proportion of low income households within a 30 minute commute, will need to be further evaluated before implementation.

Potential Future Extensions

The BRT system evaluated in this document represents a network that can be implemented within the time-frame of the Regional Transportation Plan, with a horizon year of 2035, and be supported by existing land uses and transit ridership. However, future extensions are possible as shown Figure 20. With sufficient funding and support, some of these extensions could also be brought online before 2035. The future extensions would expand the BRT network into areas not served by the four primary corridors (Middleton, southwest Madison, Fitchburg, east Madison, and northeast Madison), and also extend lines into planned transit oriented development areas (University Research Park Phase 2 and Nine Springs neighborhood).