Highway Transitway Corridor Study

Final Report

Prepared for: Metropolitan Council

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May 2014

SRF No. 7994

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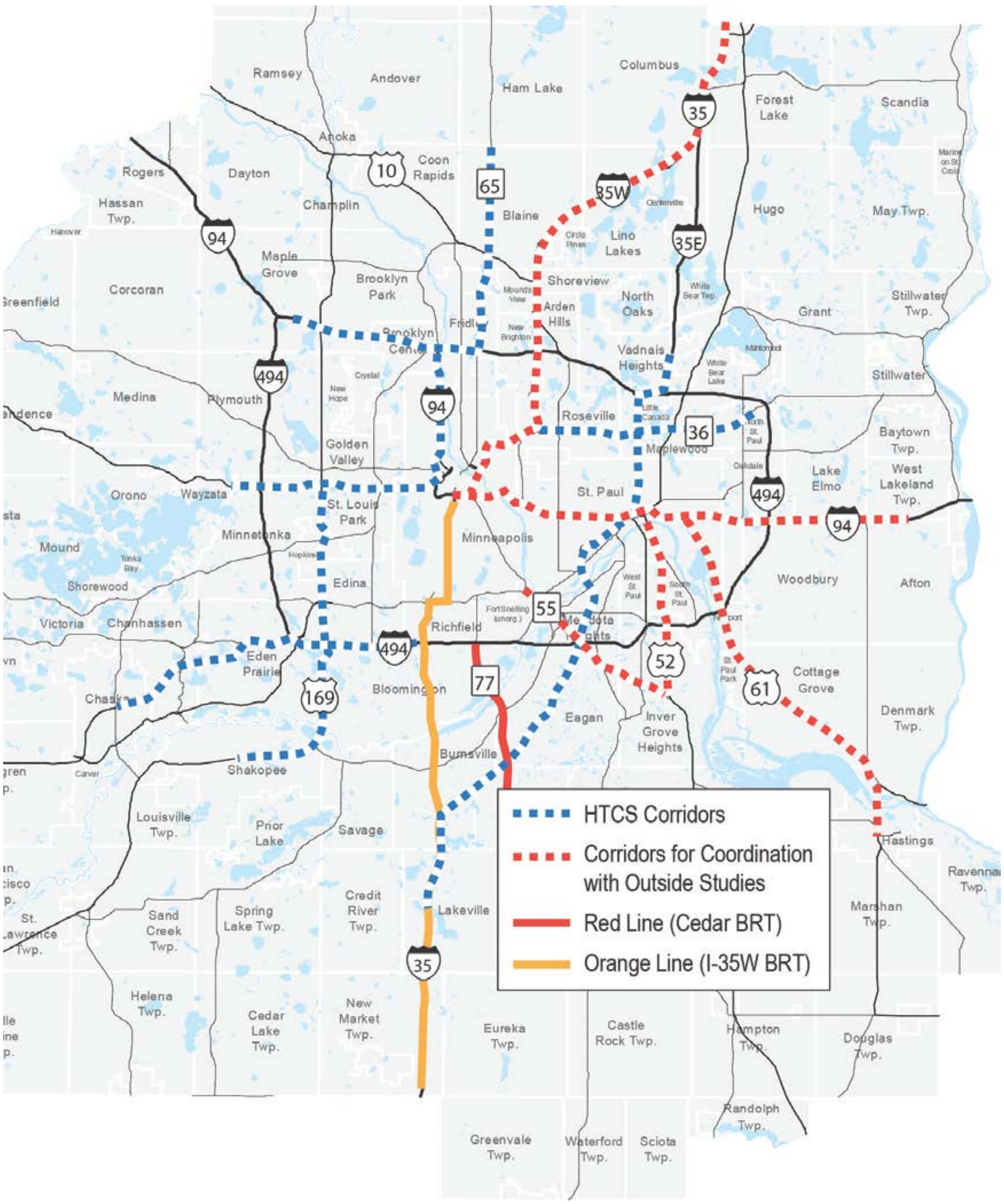
Introduction

The Metropolitan Council initiated the Highway Transitway Corridor Study (HTCS) to examine the potential for all-day, frequent, station-to-station, Highway Bus Rapid Transit (BRT) along eight Twin Cities corridors. The corridors are shown in blue on Figure 1. The figure also identifies other corridors that are being studied or have been studied for Highway BRT through studies led by other agencies.

Figure 1: Highway Transitway Corridor Study Corridors



Why were these corridors selected for the study?

The Metropolitan Council's 2030 *Transportation Policy Plan* (TPP) recommends a mix of investments in the transitway system for the Twin Cities region, including commuter rail, light rail transit (LRT), dedicated busways, BRT on both arterial streets and highways, and express bus corridors with transit advantages. Prior to adopting the 2030 TPP, the Metropolitan Council completed the *Transit Master Study* to determine the feasibility of transitway investments along an extensive list of corridors in the region. At the time, only LRT and dedicated busway were analyzed for relative demand and costs when compared across corridors.

In the 2030 TPP, a number of transitway corridors in the region remain undetermined in terms of identification of a preferred mode and alignment. The TPP recommends further study of these corridors. The Highway Transitway Corridor Study focused on these corridors to determine the potential for Highway BRT. The corridors studied included:

- I-94
- Highway 65
- I-35E North
- Highway 36
- I-35E South
- Highway 169
- Highway 212
- I-394

Who was involved in the study?

The Metropolitan Council initiated the Highway Transitway Corridor Study; however, a large group of stakeholders from various agencies were part of the year-long study. At the beginning of the study, several stakeholder committees were formed to help guide the study.

Technical work undertaken during the study was directed by a Project Management Team (PMT). The PMT met monthly and was made up of staff from Metropolitan Council, Metro Transit, Minnesota Department of Transportation (MnDOT), counties, and suburban transit providers. The role of the PMT was to provide technical direction and guidance on all aspects of the study, including the study process.

In addition to the PMT, study assumptions, analysis, and results were also vetted through a larger Technical Advisory Committee (TAC). The TAC was made up of technical staff from transit service providers and other agencies charged with the implementation of services and/or facilities and land use plans along the study corridors including Metropolitan Council; Metro Transit; MnDOT; suburban transit providers; Anoka, Carver, Dakota, Hennepin, Ramsey, Scott and Washington Counties; and a representative group of cities at various stages of urban development including the cities of Blaine, Eagan, Maple Grove, Maplewood, Minneapolis, Plymouth, Prior Lake, St. Paul, Shakopee and White Bear Lake.

During the early stages of the study, a stakeholder workshop for staff and elected/appointed officials for all communities located along the study corridors was held. The workshop provided an opportunity to receive corridor specific input on the location of potential routes and stations as well as to engage the participants on the BRT characteristics that they valued the most.

What is Highway BRT?

The purpose of Highway BRT is to provide fast, frequent, all-day service that is cost-effective in serving high-demand regional population, employment, and transit nodes in highway corridors. Highway BRT is a practical approach to developing improved transit service that fits within highway infrastructure and serves regional transit demand where cost of transitway alternatives, such as light rail, are prohibitive. The Regional Transitway Guidelines defines Highway BRT station-to-station service as:

> "A coordinated set of routes that stop at all or most stations in the Highway BRT corridor, which is defined by stations and runningway infrastructure. It provides service seven days a week, 16 hours per day, and at least every 10 minutes during peak periods with lower frequencies during mid-day and evenings."

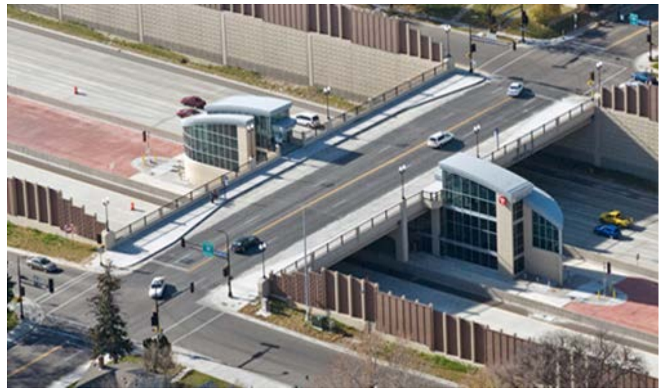
Key elements of Highway BRT that were included in the study are described on the following pages. The end of this report includes an evaluation based on five goals and 12 evaluation measures. The five goals are:

1. Provide mobility benefits and respond to trip patterns/needs and deficiencies for markets identified in the purpose and need
2. Provide affordable, effective transportation improvements
3. Meet 2030 *Transportation Policy Plan* ridership goals
4. Seamlessly integrate with existing systems and provide valuable regional connections
5. Support area development plans, forecast growth assignment, redevelopment potential

Stations

Three different BRT station types were used as part of the study. These include online, inline and offline stations.

- **Online stations** are located within the runningway and BRT vehicles can access a station without leaving the runningway. In most cases, the station is located in the median of the highway; however, it could be located on the side of the highway in unique circumstances.



- **Inline stations** are located adjacent to the runningway and usually require BRT vehicles to exit the runningway to access a station. Few or no turns are required for inline stations as they are typically located on the access ramps of the highway.

- **Offline stations** are located away from the runningway and always require BRT vehicles to leave the runningway and travel some distance to access a station. Sometimes this is to access a nearby park-and-ride facility that is not directly adjacent to the runningway.

During the concept development of alternatives it was assumed that the majority of stations would be inline except where the location of an existing park-and-ride facility required an offline station or if the interchange configuration did not allow for an inline station. Inline stations were chosen over online stations for the majority of locations, because online stations are generally the most expensive station type to construct and are only cost-effective for the highest demand stations. As most of the corridors included in this study are not likely to have major freeway reconstruction for many years, the study assumed it would be more cost effective to retrofit Highway BRT corridors with inline or offline stations than to reconstruct interchanges to include offline stations.

Highway BRT stations were assumed to have the premium amenities included at other transitway stations in the region. Shelters are assumed to be structured buildings similar in concept to those developed as part of the METRO Red Line BRT project, but scaled slightly smaller. These shelters are anticipated to be enclosed and provide on-demand heating for waiting customers. It is assumed that all station shelters would be the same size.

Highway BRT stations would include off-board fare collection. Passengers would purchase a ticket at a ticket vending machine on the station platform rather than pay through a farebox on the bus. This allows passengers to board through any vehicle door which speeds up the boarding process. The study assumes one ticket vending machine at each Highway BRT station in each direction. Passengers with Go-To Cards could also pay using an on-board validator affixed inside each vehicle door.

Other station amenities include:

- Litter receptacles
- Static signage for stop/route/system and way-finding information
- Real-time vehicle arrival and departure information signage
- Security cameras
- Emergency telephones
- Station lighting
- Push-button radiant heating
- Bicycle racks/facilities

The study assumed station platforms would be designed with 11-inch platforms to accommodate level-boarding. In a level-boarding environment, station platforms are built up to the same level as the floor of a transit vehicle. Level boarding, when coupled with now standard low-floor buses, eliminates the need to step up onto the bus. An example of level boarding can be found at light rail stations in the Twin Cities and on the METRO Red Line. Level boarding enables faster boarding and alighting of all passengers, especially passengers with limited mobility.

Runningways

Highway BRT runningways may include dedicated busways, MnPASS lanes, bus-only shoulders and/or mixed traffic lanes. The appropriate runningway is determined by the placement and type of station(s) used and the proximity of stations to each other. The study assumes that Highway BRT vehicles would travel in mixed traffic on the highways. Buses would travel in the outside lanes to provide smooth transitions to and from station locations. For highways that currently have bus-only shoulders, BRT buses would use these shoulders during congested times of day under MnDOT and Metro Transit's and other regional transit provider's operational requirements. The operational requirements are as follows:

- Buses may only use bus-only shoulders when mainline speeds are 35 miles per hour or less
- Buses may only exceed the speed of mainline traffic by 15 miles per hour
- The maximum allowable travel speed on the bus-only shoulder is 35 miles per hour

- Buses traveling on the shoulder must yield to vehicles entering the shoulder as well as any vehicles merging or existing at an interchange ramp or intersection

MnPASS or Dynamic Shoulder Lanes

The study assumed BRT vehicles would not use MnPASS or dynamic shoulder lanes. Existing and planned MnPASS or dynamic shoulder lanes in the Twin Cities region run adjacent to the center median, farthest from entering and exiting traffic. The study assumed BRT vehicles would not use these lanes because the majority of stations identified for the corridors are assumed to be inline, requiring BRT vehicles to exit the mainline highway to access them. This would make using the MnPASS or dynamic shoulder lanes difficult, especially during congested times, due to having to merge across all lanes of the highway to access a station. Existing or planned MnPASS or dynamic shoulder lanes would still allow for a substantial transit advantage for express buses in the corridors. Further consideration of MnPASS or dynamic shoulder lanes could occur in future corridor-specific studies and the results of this study do not preclude this consideration for Highway BRT services.

Vehicles

Highway BRT vehicles would have a unique look distinct from regular local and express service, similar to those used on the METRO Red Line, and would be designed to allow for faster boarding and alighting. The study assumes 40-foot premium vehicles with low-floors and two doors. An on-board Go-To Card validator would be provided at each vehicle door to allow passengers to board and alight through both doors at once. Future study phases may determine added features on these buses such as enhanced customer information or other features.

What were the key points that the study found?

The end of this report includes a description of the evaluation the eight corridors and some key findings from the study. Some of the high-level points from those key findings are presented here.

- Station types can impact the effectiveness of this type of service, but they also have a huge implication on costs. The challenges of station types and design will need to be a key focus of corridor specific studies.
- MnPASS provides a significant advantage to transit, especially peak service such as express bus. Its application in Highway BRT is dependent on a number of other factors, including the above-mentioned station types.
- The pedestrian environment and development patterns will dictate the long-term effectiveness of this type of service. Transit-friendly development patterns will lead to greater success.
- Frequency of service is important for delivering a Highway BRT experience, but less frequent service (every 30-60 minutes) can be effective as a solution in lower-demand corridors or as a strategy to help build transit demand. Express bus service is also important in this regard.

What was studied for each corridor?

The study included three distinct project phases: Existing Conditions, Transit Market Analysis, and Concept Development and Evaluation. The following sections give a brief overview of the main tasks associated with each phase.

Existing Conditions

The first phase in the study was to determine existing conditions for each of the study corridors. Existing conditions that were documented for each corridor included:

- Population living within two miles of all full-access local interchanges along the corridor (2010 Census)
- Employment within employment centers (contiguous areas with 7,000 or more jobs and job density of ten or more jobs per acre)
- Existing transit routes
- Park-and-ride usage (Metro Transit, Minnesota Driver and Vehicle Services, and Wisconsin Department of Transportation data)
- Roadway characteristics and travel volumes
- Congestion conditions (Regional Transportation Management Center data)

Transit Market Analysis

The second phase in the study was to conduct a transit market analysis. The purpose of this analysis was to help identify the corridor segments with the strongest potential for all-day, frequent BRT service and preliminary station locations.

First, a quantitative screening analysis of existing and future demographics and transit infrastructure was conducted for all eight study corridors. The analysis identified an appropriate population and employment density needed to support a station. The results of this analysis determined the appropriate length of the study corridors as well as identified candidate station locations.

Second, a qualitative review of each corridor's characteristics was performed to fine-tune the results of the screening analysis. The topics reviewed included existing physical conditions, employment centers, planned transit and infrastructure improvements, and concentrations of low-income and transit-reliant populations in each corridor. Guided by the station spacing guidelines from the Metropolitan Council's Regional Transitway Guidelines, the information gathered from the screening analysis and the high-level corridor review were used in tandem to recommend preliminary Highway BRT station locations for the study.

The results of the transit market analysis were presented at the Stakeholder Workshop to regional policy makers, elected officials, transit officials, and their associated staff members. The feedback received at the Stakeholder Workshop resulted in adjustments to several corridors and station locations.

Concept Development

The third phase of the study was focused on developing concept plans for each corridor. The purpose of this task was to identify the costs and ridership of station-to-station BRT service. For each corridor, capital infrastructure and operating plans were developed. The costs associated with stations in downtown were not included as part of this study. Ridership was estimated for each corridor using the operating plans developed.

Concept Plans

For each corridor, station types and runningway assumptions were determined. As described earlier, the majority of stations were identified as inline stations. To provide improved travel times and minimize delays due to merging in and out of traffic to access stations, it was recommended that Highway BRT vehicles use the outside travel lanes. For corridors that currently have or will have bus-only shoulders, BRT vehicles would use these shoulders during congested times of day.

Once the concept plans were defined for each corridor, capital costs were estimated. Capital cost estimates include the initial expenditure to build the system and typically include corridor construction, stations and technology systems, operations and maintenance facilities, vehicles, and right-of-way acquisition. It should be noted that the majority of study corridors had very low cost corridor construction costs for two reasons. First, little additional right-of-way was required for stations, and second, the concept plans assumed the service would run in mixed traffic, requiring little additional corridor infrastructure. However, some corridors required improvements such as online stations and/or transit-only ramps to allow BRT vehicles to access station platforms, and therefore had higher corridor construction costs.

"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 limited scope of this study were also included in the cost estimates.

Operating Plans

Operating plans for each corridor were focused on new Highway BRT station-to-station service along with some minor modifications to local routes to provide better connectivity to stations and eliminate redundancy. Span of service and frequency assumptions for Highway BRT station-to-station service are generally consistent with the guidelines for Service Operations presented in the Regional Transitway Guidelines (February 2012, Metropolitan Council).

The study assumed that service would be operated seven days a week with a 16-hour span of service (for example 6 a.m. – 10 p.m.) on weekdays and Saturdays and 13 hours (for example 7 a.m. – 8 p.m.) on Sundays. It is assumed that service frequency would be every 15 minutes on weekdays and during the day on Saturdays, and every 30 minutes on Saturday evenings and Sundays. Existing express routes are generally assumed to remain in place in each corridor, which results in a combined frequency that exceeds the 10-minute peak period frequency guideline proposed in the Regional Transitways Guidelines. Highway BRT routes are assumed to stop at each proposed BRT station at all times throughout the day.

Both peak hour and off-peak period transit travel times were estimated for each corridor as follows:

- Station-to station travel times were based on assumed average peak and off-peak speed between each station (25-35 mph during peak periods; 45 mph during off-peak periods).
- BRT station-to-station service was assumed to use bus-only shoulder lanes during the peak periods.
- One minute of dwell time (i.e. the time spent loading and unloading passengers into and out of the transit vehicle) was assumed for each inline and online station stop.
- Five minutes of travel and dwell time was assumed for each offline station stop.
- Station-to-station travel times were compared to existing express route travel times to test for reasonableness.

Operating plans were developed for each corridor using transit travel time estimates, service frequency assumptions, and typical layover time (i.e. a cushion of time at the end of a route that ensures on-time departure for the next trip and provides the driver a break between trips). Specific routings through downtown Minneapolis and St. Paul were not identified for any of the study corridors. Downtown travel times were estimated based on current travel times in the two downtowns.

Operating and maintenance costs for each corridor were estimated using methodology recently defined for the Robert Street, Nicollet-Central and Midtown Corridor Alternatives Analysis studies. Fiscal year (FY) 2011 Metro Transit cost data was used to develop unit costs and adjusted for inflation and to account for unique Highway BRT operations.

Ridership Forecasts

Forecast Year 2030 ridership was estimated for each corridor using the Twin Cities Regional Travel Demand Model. Ridership forecasts were based on land use and development assumptions consistent with the Metropolitan Council's Regional Development Framework and local comprehensive plans as of January 2012. As part of the model validation process, the region was divided into study corridor or sub-corridor districts so mode choice and travel patterns could be analyzed.

The following set of ridership information was developed for each corridor:

- **Corridor Bus Route Ridership**: number of trips taken on local or express route (but not BRT station-to-station route) in the study corridor; must use at least one non-downtown Highway BRT station and utilize a significant portion of the Highway BRT runningway.
- **Highway BRT Station-to-Station Ridership**: number of trips taken on the proposed Highway BRT all-day station-to-station route in the study corridor.
- **Transitway Total**: combined total of "corridor bus route ridership" and "highway BRT station-to-station" ridership.
- **Percent Transit Reliant Ridership**: percentage of "station-to-station" rides taken by persons from zero-car households.

- **New Transit Riders**: estimated number of new riders that would choose to use "highway BRT station-to-station" service rather than making a trip by automobile.
- **Current Year Ridership with Build Alternative**: estimated number of riders on "highway BRT station-to-station" service assuming all concept plan improvements were implemented in current year (2010 data).

Sensitivity Tests

In addition to estimating ridership for each of the corridors, sensitivity tests were conducted to help understand how corridor routing, station locations, and frequencies might impact ridership. The sensitivity tests fall into two categories: changes to a Highway BRT station-to-station service route and changes to Highway BRT station-to-station service frequencies.

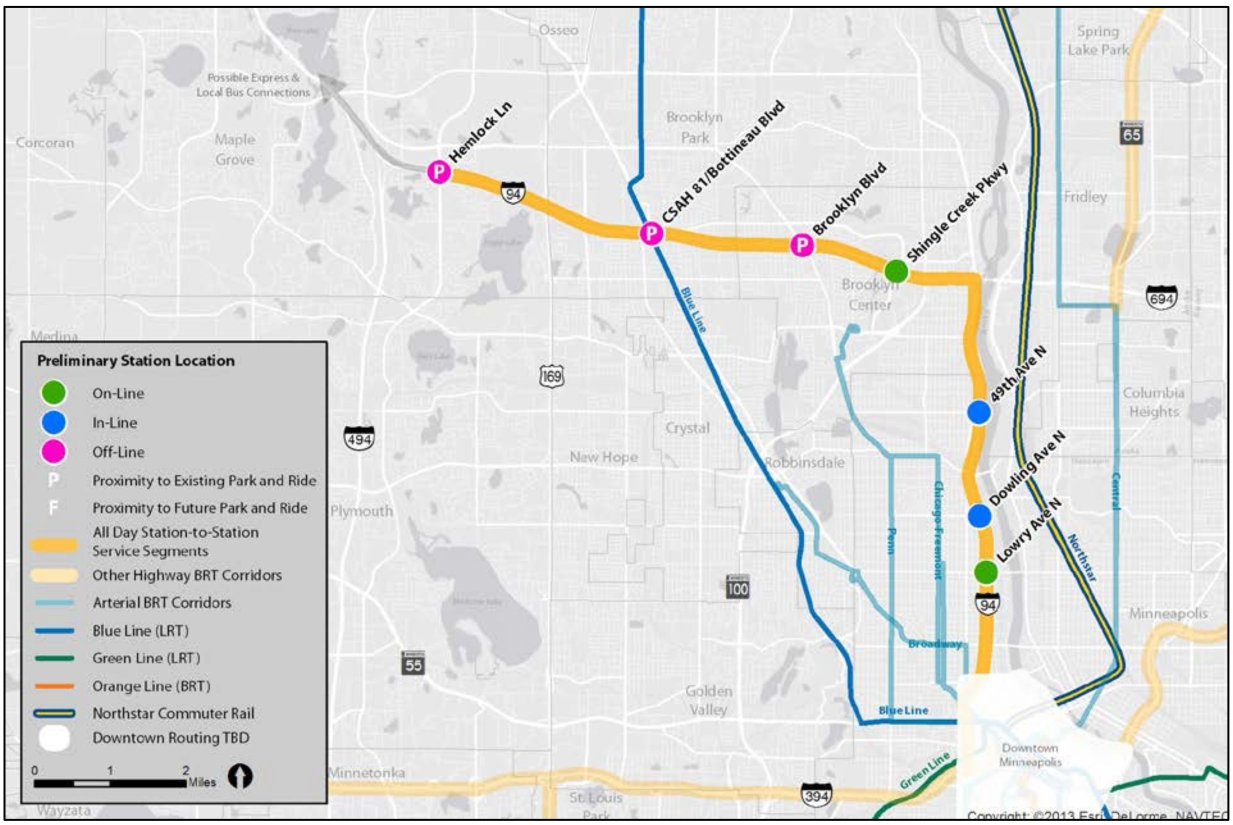
Corridor Summaries

Profiles of the eight Highway BRT corridors included in the study are presented in the following section. Each profile includes: a corridor map showing station locations; an operating plan with service frequencies; key information on the cost to build, operate and maintain the corridors; and forecasted ridership.

I-94 Corridor

The I-94 corridor runs from Hemlock Lane (Maple Grove Transit Station) in Maple Grove to downtown Minneapolis, as shown in Figure 2. The corridor has a total of seven stations and is 14.7 miles long. The concept would directly connect with the planned Bottineau LRT line at the offline County Highway 81/Bottineau Boulevard station. It would also provide service to the park-and-ride at Maple Grove Transit Station and the two planned park-and-rides at County Highway 81/Bottineau Boulevard and Brooklyn Boulevard. This concept includes the cost of constructing a new or expanded park-and-ride facility at Maple Grove Transit Station due to limited space in the current park-and-ride facility.

Figure 2: I-94 Corridor



I-94 Corridor (continued)

Operating Characteristics

Peak-Period End-to-End Travel Time	44 minutes
Off-Peak End-to-End Travel Time	40 minutes
Required Fleet	7 peak vehicles, 2 spare vehicles
Background Local and Express Bus Service Adjustments	• Eliminate Route 781 midday service • Improve Route 787 midday service frequency (provides a connection at the Hemlock Lane Station to other Maple Grove Transit park-and-ride locations)

Capital Costs (2013$)

Cost Categories	Costs
Corridor Construction	$5,040,000
BRT Stations	$48,154,000
BRT Maintenance Facility	$2,700,000
Right of Way	$792,000
Vehicles	$5,508,000
Soft Costs	$16,404,000
25% Contingency	$19,650,000
Corridor Total Cost	**$98,248,000**

Operating and Maintenance Costs (2012$)

Item	Costs
Highway BRT Station–to-Station Service	$5,096,000
Background Bus Changes (Net)	$121,000
Total Operating and Maintenance Costs Increase over No Build	**$5,217,000**

Ridership Data

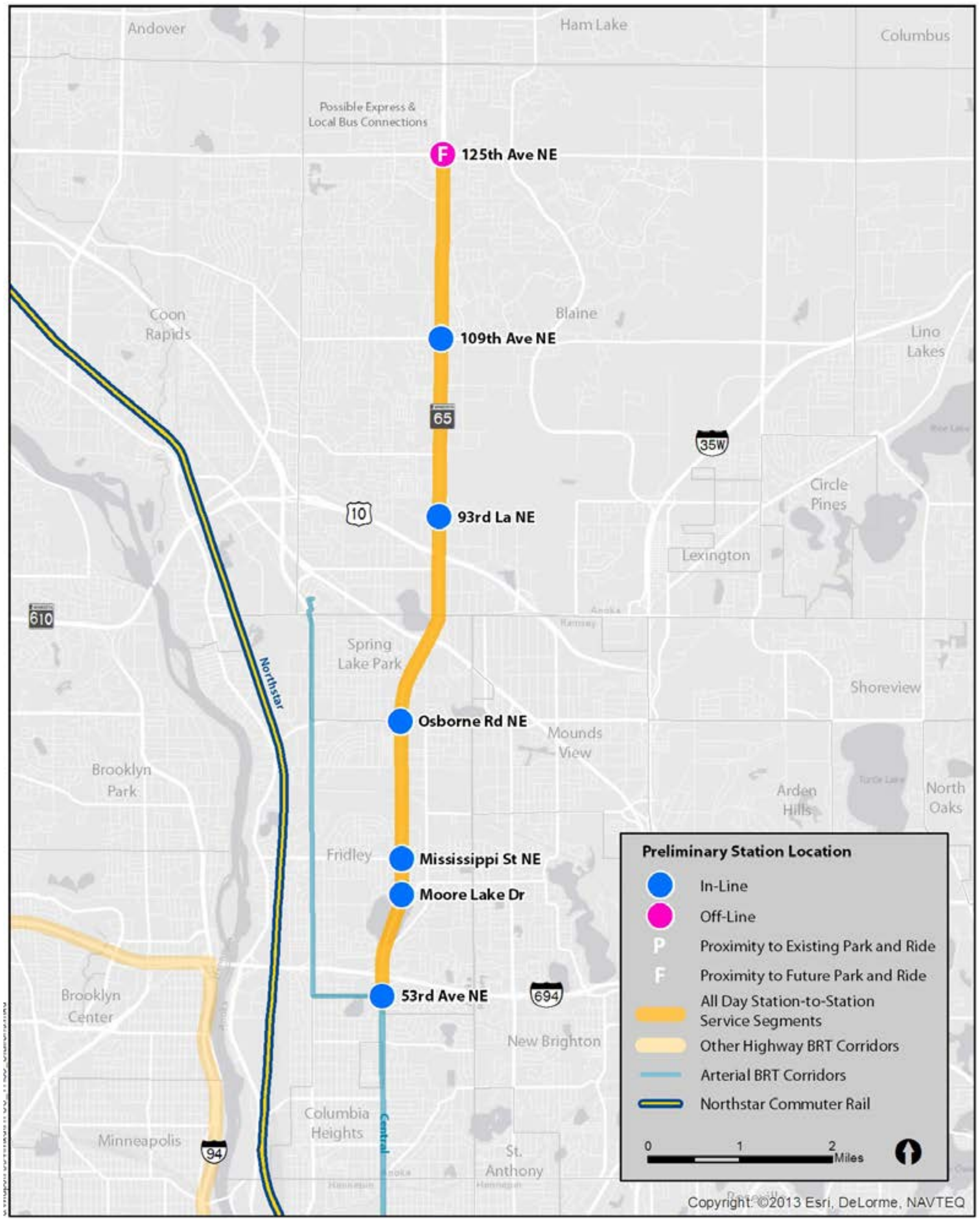
Existing Service (2010)	No Build (2030)	2030		
Corridor Bus Routes	Corridor Bus Routes	Station-to-Station Service	Corridor Bus Routes	**Transitway Total**
8,200	9,300	5,400	8,300	**13,700**

Descriptor	Data
Percent transit reliant ridership (station-to-station service)	45%
Current year ridership on station-to-station service with build alternative (2010)	2,600 riders
New transit riders	1,400 riders

Highway 65 Corridor

The Highway 65 corridor runs from 125th Avenue in Blaine to 53rd Avenue NE between Columbia Heights and Fridley, as shown in Figure 3. The corridor has a total of seven stations and is 9.3 miles long. The concept would directly connect with the planned Central Avenue Arterial BRT line at the 53rd Avenue NE station. It would also provide service to a planned park-and-ride near 125th Avenue NE in Blaine.

Figure 3: Highway 65 Corridor



Highway 65 Corridor (continued)

Operating Characteristics

Peak-Period End-to-End Travel Time	26 minutes
Off-Peak End-to-End Travel Time	23 minutes
Required Fleet	5 peak vehicles, 1 spare vehicle
Background Local and Express Bus Service Adjustments	• New circulator route between 125th Avenue NE BRT station and downtown Anoka via Highway 14 • Per prior Arterial BRT service plans, new Central Avenue Arterial BRT service, Route 10 frequency changes and Route 59 service elimination

Capital Costs (2013$)

Cost Categories	Costs
Corridor Construction	$0
BRT Stations	$11,815,000
BRT Maintenance Facility	$2,400,000
Right of Way	$0
Vehicles	$3,672,000
Soft Costs	$4,234,000
25% Contingency	$5,531,000
Corridor Total Cost	**$27,652,000**

Operating and Maintenance Costs (2012$)

Item	Costs
Highway BRT Station–to-Station Service	$3,241,000
Background Bus Changes (Net)	$407,000
Total Operating and Maintenance Costs Increase over No Build	**$3,648,000**

Ridership Data

Existing Service (2010)	No Build (2030)	2030		
Corridor Bus Routes	Corridor Bus Routes	Station-to-Station Service	Corridor Bus Routes	Transitway Total
0	600	800	400	**1,200**

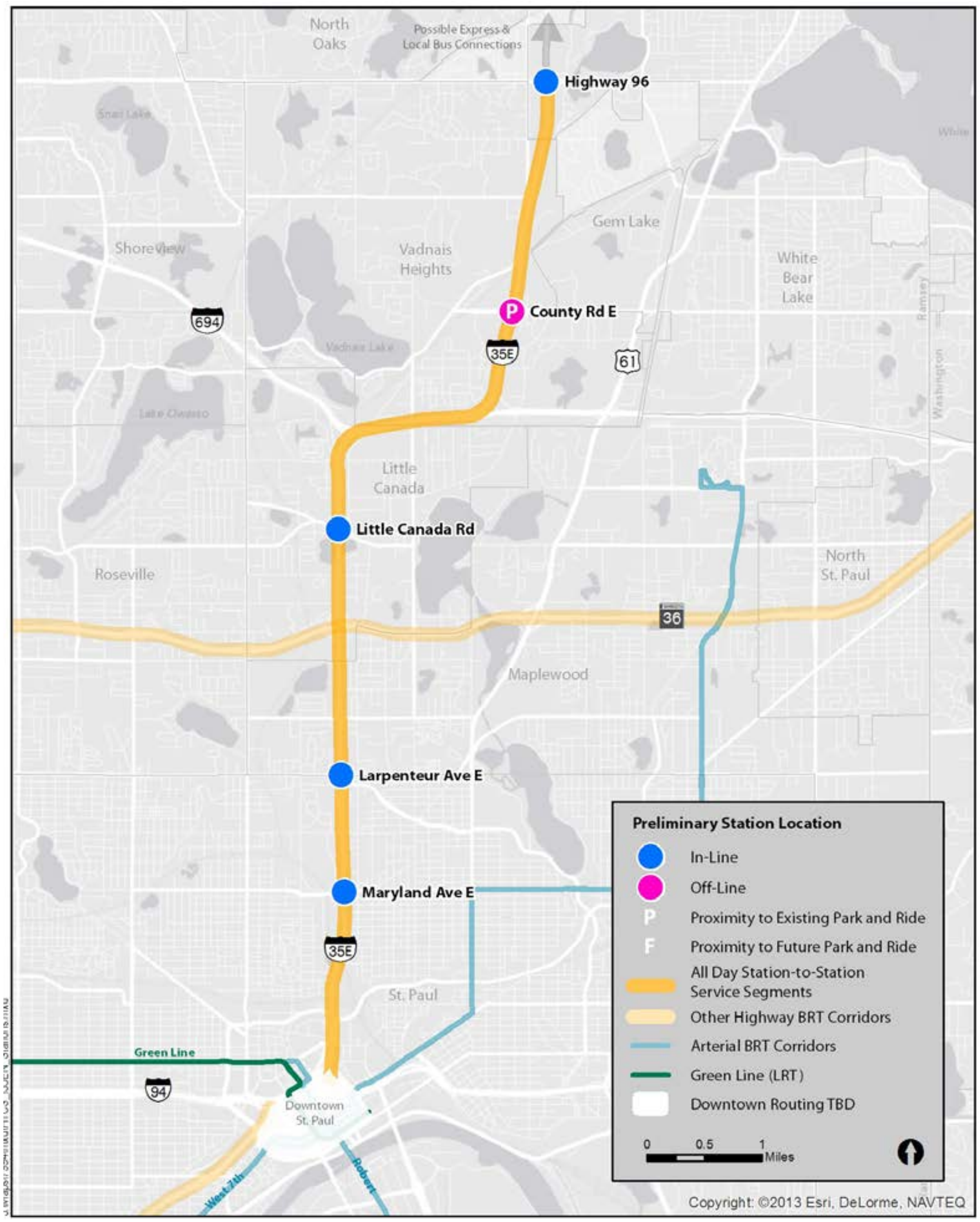
Descriptor	Data
Percent transit reliant ridership (station-to-station service)	26%
Current year ridership on station-to-station service with build alternative (2010)	400 riders
New transit riders	700 riders

During a sensitivity test, the Highway 65 corridor was extended and routed via I-94 to downtown Minneapolis. The test assumed the Highway 65 BRT would stop at the concept I-94 Lowry Station before terminating in downtown Minneapolis. The adjusted routing and connectivity produced a large increase in station-to-station service ridership in the Highway 65 corridor. When routed via I-94, peak and off-peak ridership is nearly four times as large as the original routing; illustrating that downtown Minneapolis is a strong transit anchor.

I-35E North Corridor

The I-35E North corridor runs from Highway 96 in White Bear Lake to downtown St. Paul, as shown in Figure 4. The corridor has a total of five stations and is 10.7 miles long. The corridor would provide service to the future park-and-ride at County Road E in Vadnais Heights and connecting bus service to White Bear Lake.

Figure 4: I-35E North Corridor



I-35E North Corridor (continued)

Operating Characteristics

Peak-Period End-to-End Travel Time	32 minutes
Off-Peak End-to-End Travel Time	28 minutes
Required Fleet	5 peak vehicles, 1 spare vehicle
Background Local and Express Bus Service Adjustments	• New circulator along Highway 96 to downtown White Bear Lake • Per prior Arterial BRT service plans for Robert Street Arterial BRT, Route 68 service frequency changes

Capital Costs (2013$)

Cost Categories	Costs
Corridor Construction	$0
BRT Stations	$9,701,000
BRT Maintenance Facility	$2,400,000
Right of Way	$0
Vehicles	$3,672,000
Soft Costs	$3,633,000
25% Contingency	$4,852,000
Corridor Total Cost	**$24,258,000**

Operating and Maintenance Costs (2012$)

Item	Costs
Highway BRT Station–to-Station Service	$3,694,000
Background Bus Changes (Net)	$407,000
Total Operating and Maintenance Costs Increase over No Build	**$4,101,000**

Ridership Data

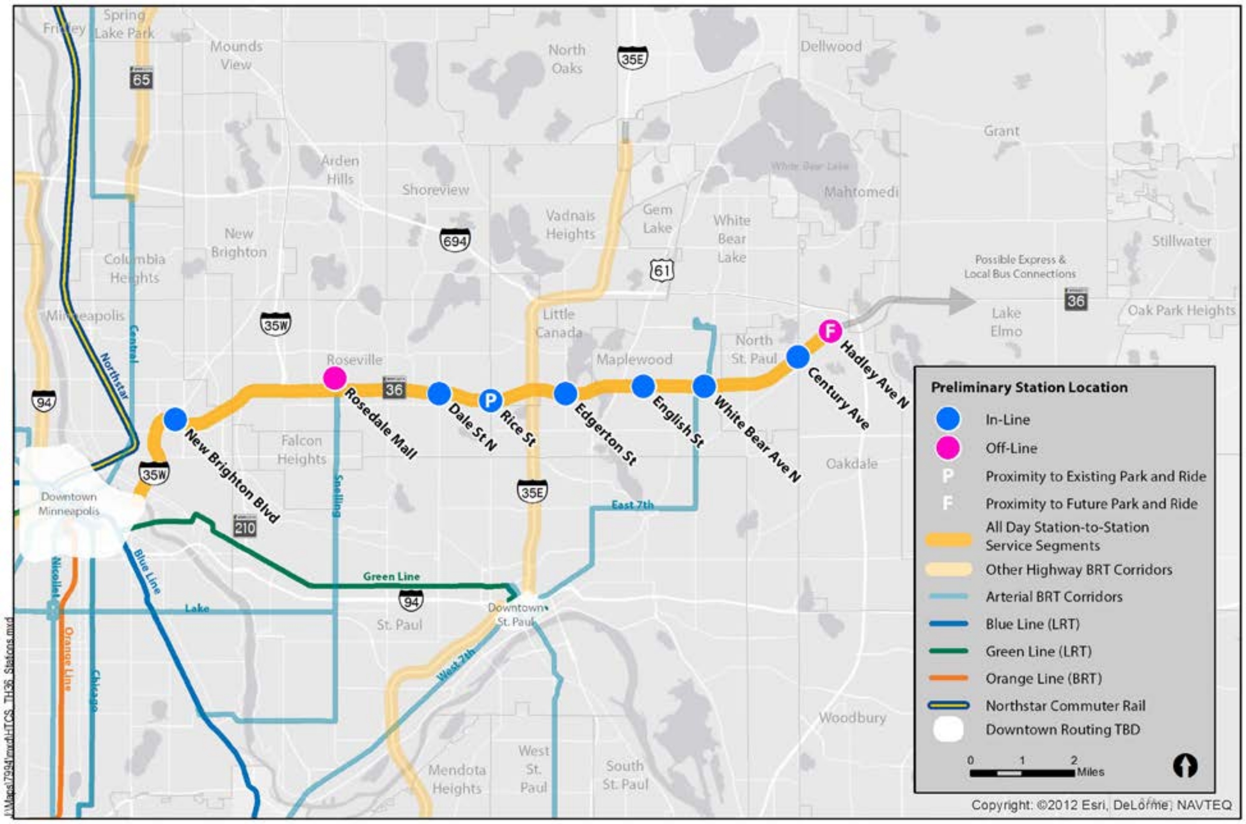
Existing Service (2010)	No Build (2030)	2030		
Corridor Bus Routes	Corridor Bus Routes	Station-to-Station Service	Corridor Bus Routes	**Transitway Total**
180	300	2,500	900	**3,400**

Descriptor	Data
Percent transit reliant ridership (station-to-station service)	35%
Current year ridership on station-to-station service with build alternative (2010)	1,300 riders
New transit riders	500 riders

Highway 36 Corridor

The Highway 36 corridor runs from Hadley Avenue in Oakdale to downtown Minneapolis, as shown in Figure 5. The corridor has a total of nine stations and is 17.7 miles long. The concept would directly connect with the planned East 7th Street Arterial BRT line at the inline White Bear Avenue station and with the Snelling Avenue Arterial BRT line at the offline Rosedale Transit Center. It would also provide service to the Hwy 36 & Rice Street Park-and-Ride lot and a potential park-and-ride lot at Hadley Avenue[1].

Figure 5: Highway 36 Corridor



[1] Park-and-ride lot at Hadley Ave currently not identified in regional plans

Highway 36 Corridor (continued)

Operating Characteristics

Peak-Period End-to-End Travel Time	47 minutes
Off-Peak End-to-End Travel Time	42 minutes
Required Fleet	8 peak vehicles, 2 spare vehicles
Background Local and Express Bus Service Adjustments	• New circulator route between Hadley Avenue BRT station and downtown Stillwater • Eliminate Route 264 midday service • Per prior Arterial BRT service plans, new East 7th Avenue and Snelling Avenue Arterial BRT service and service frequency changes to existing Route 84. • Per Green Line corridor bus service plans, frequency changes to Routes 65 and 87

Capital Costs (2013$)

Cost Categories	Costs
Corridor Construction	$402,000
BRT Stations	$18,533,000
BRT Maintenance Facility	$3,000,000
Right of Way	$1,584,000
Vehicles	$6,120,000
Soft Costs	$6,954,000
25% Contingency	$9,149,000
Corridor Total Cost	**$45,742,000**

Operating and Maintenance Costs (2012$)

Item	Costs
Highway BRT Station–to-Station Service	$5,716,000
Background Bus Changes (Net)	$115,000
Total Operating and Maintenance Costs Increase over No Build	**$5,831,000**

Ridership Data

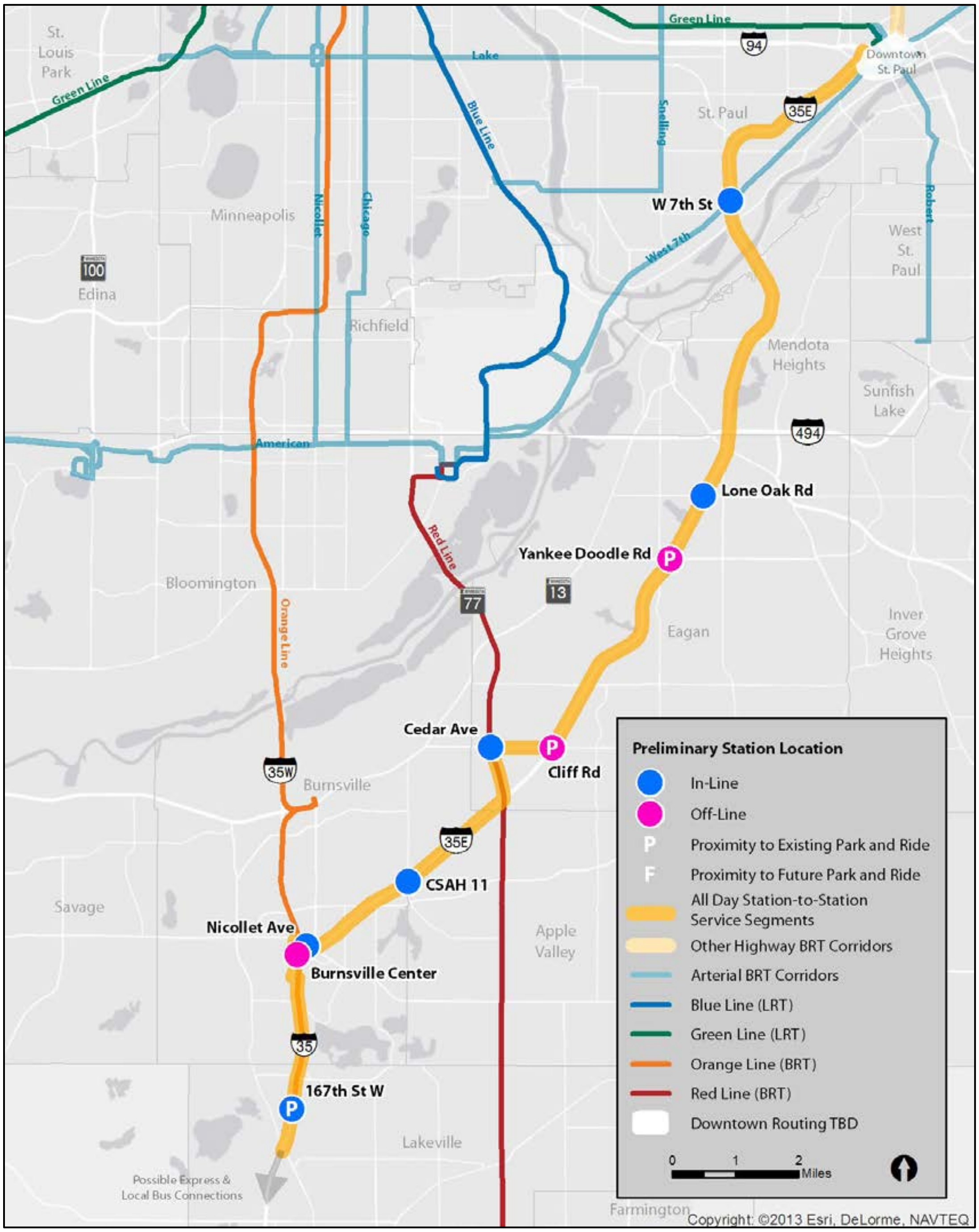
Existing Service (2010)	No Build (2030)	2030		
Corridor Bus Routes	Corridor Bus Routes	Station-to-Station Service	Corridor Bus Routes	**Transitway Total**
1,800	2,100	9,300	2,100	**11,400**

Descriptor	Data
Percent transit reliant ridership (station-to-station service)	35%
Current year ridership on station-to-station service with build alternative (2010)	5,200 riders
New transit riders	1,300 riders

I-35E South Corridor

The I-35E South corridor runs from the Kenrick Avenue Park-and-Ride lot at 167th Street West in Lakeville to downtown St. Paul, as shown in Figure 6. The corridor has a total of nine stations and is 24.3 miles long. The corridor would provide connections to the METRO Red Line and the planned METRO Orange Line as well as the planned West 7th Street Arterial BRT. It would also provide service to the Eagan Transit Station and the Blackhawk Park-and-Ride lot.

Figure 6: I-35E South Corridor



I-35E South Corridor (continued)

Operating Characteristics

Peak-Period End-to-End Travel Time	73 minutes
Off-Peak End-to-End Travel Time	57 minutes
Required Fleet	11 peak vehicles, 3 spare vehicles
Background Local and Express Bus Service Adjustments	• Route 426 extension to Burnsville Center • Per prior Arterial BRT service plans, new West 7th Street Arterial BRT service, Route 54 elimination

Capital Costs (2013$)

Cost Categories	Costs
Corridor Construction	$0
BRT Stations	$13,723,000
BRT Maintenance Facility	$4,800,000
Right of Way	$0
Vehicles	$8,568,000
Soft Costs	$5,708,000
25% Contingency	$8,200,000
Corridor Total Cost	$40,999,000

Operating and Maintenance Costs (2012$)

Item	Costs
Highway BRT Station–to-Station Service	$7,542,000
Background Bus Changes (Net)	$407,000
Total Operating and Maintenance Costs Increase over No Build	$7,949,000

Ridership Data

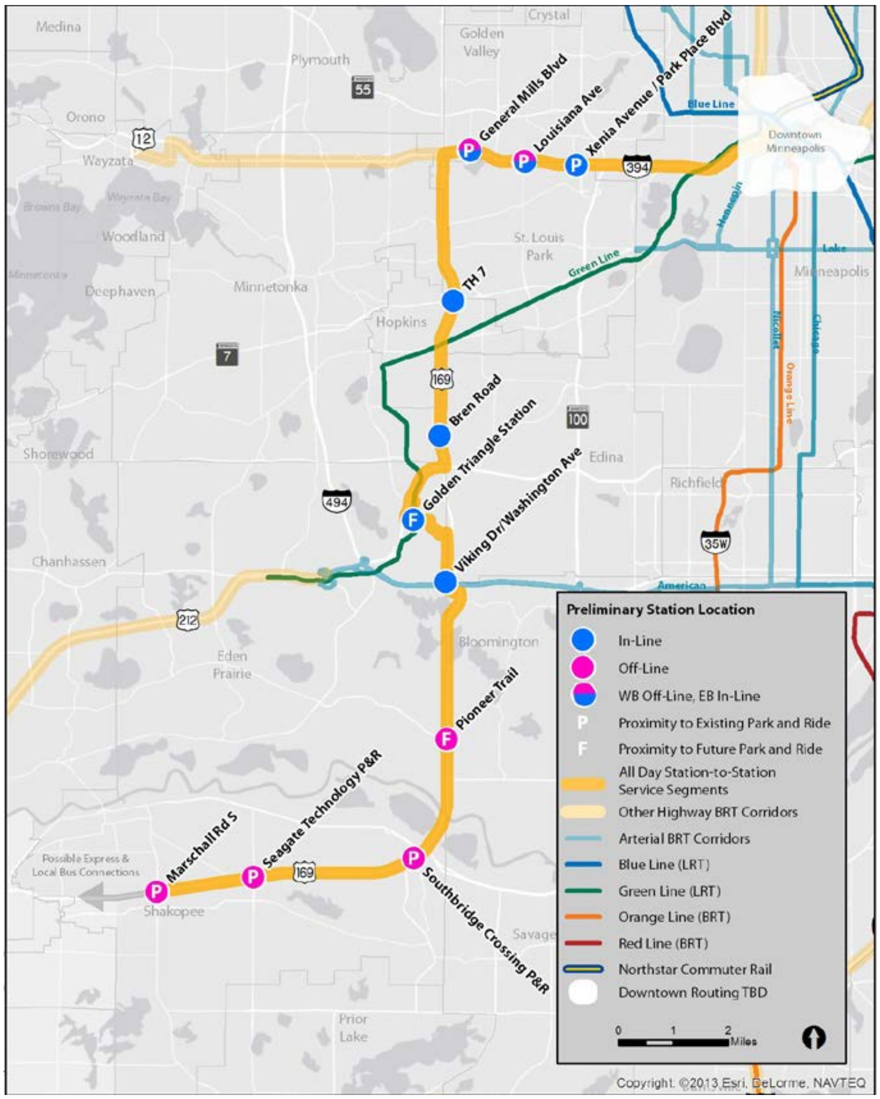
Existing Service (2010)	No Build (2030)	2030		
Corridor Bus Routes	Corridor Bus Routes	Station-to-Station Service	Corridor Bus Routes	Transitway Total
800	1,500	4,000	1,700	5,700

Descriptor	Data
Percent transit reliant ridership (station-to-station service)	38%
Current year ridership on station-to-station service with build alternative (2010)	2,500 riders
New transit riders	1,200 riders

Highway 169 Corridor

The Highway 169 corridor runs from the park-and-ride at Marschall Road Transit Station in Shakopee to downtown Minneapolis, as shown in Figure 7. The corridor is made up of eight Highway 169 stations, three I-394 stations and is 26.9 miles long. The corridor would provide connections to the planned METRO Green Line Extension (Southwest LRT)[2] and the planned American Boulevard Arterial BRT line. It would also provide service to existing park-and-ride lots at Southbridge Crossing, Seagate Technology and Marschall Road as well as the planned park-and-ride lot at Pioneer Trail.

Figure 7: Highway 169 Corridor



[2] For Highway 169, the connection with the METRO Green Line Extension was moved from the Golden Triangle Station to the Hopkins Station in a sensitivity test. The routing change produced minimal change in station-to-station service ridership; both peak and off-peak ridership remained almost constant on the Highway 169 corridor.

Highway 169 Corridor (continued)

Operating Characteristics

Peak-Period End-to-End Travel Time	88 minutes
Off-Peak End-to-End Travel Time	69 minutes
Required Fleet	14 peak vehicles, 3 spare vehicles
Background Local and Express Bus Service Adjustments	• Routes 17, 615, 667, 668 extended to serve Highway 7 BRT station • Per Scott County Operations and Capital Plan, new express service from Marschall Road in Shakopee to downtown Minneapolis • Per prior Arterial BRT service plans, new American Blvd. Arterial BRT service

Capital Costs (2013$)

Cost Categories	Costs
Corridor Construction	$229,000
BRT Stations	$15,081,000
BRT Maintenance Facility	$5,100,000
Right of Way	$0
Vehicles	$10,404,000
Soft Costs	$6,337,000
25% Contingency	$9,288,000
Corridor Total Cost	**$46,439,000**

Operating and Maintenance Costs (2012$)

Item	Costs
Highway BRT Station–to-Station Service	$8,895,000
Background Bus Changes (Net)	$0
Total Operating and Maintenance Costs Increase over No Build	**$8,895,000**

Ridership Data

Existing Service (2010)	No Build (2030)	2030		
Corridor Bus Routes	Corridor Bus Routes	Station-to-Station Service	Corridor Bus Routes	Transitway Total
2,900	3,400	7,800[3]	4,200	**12,000**

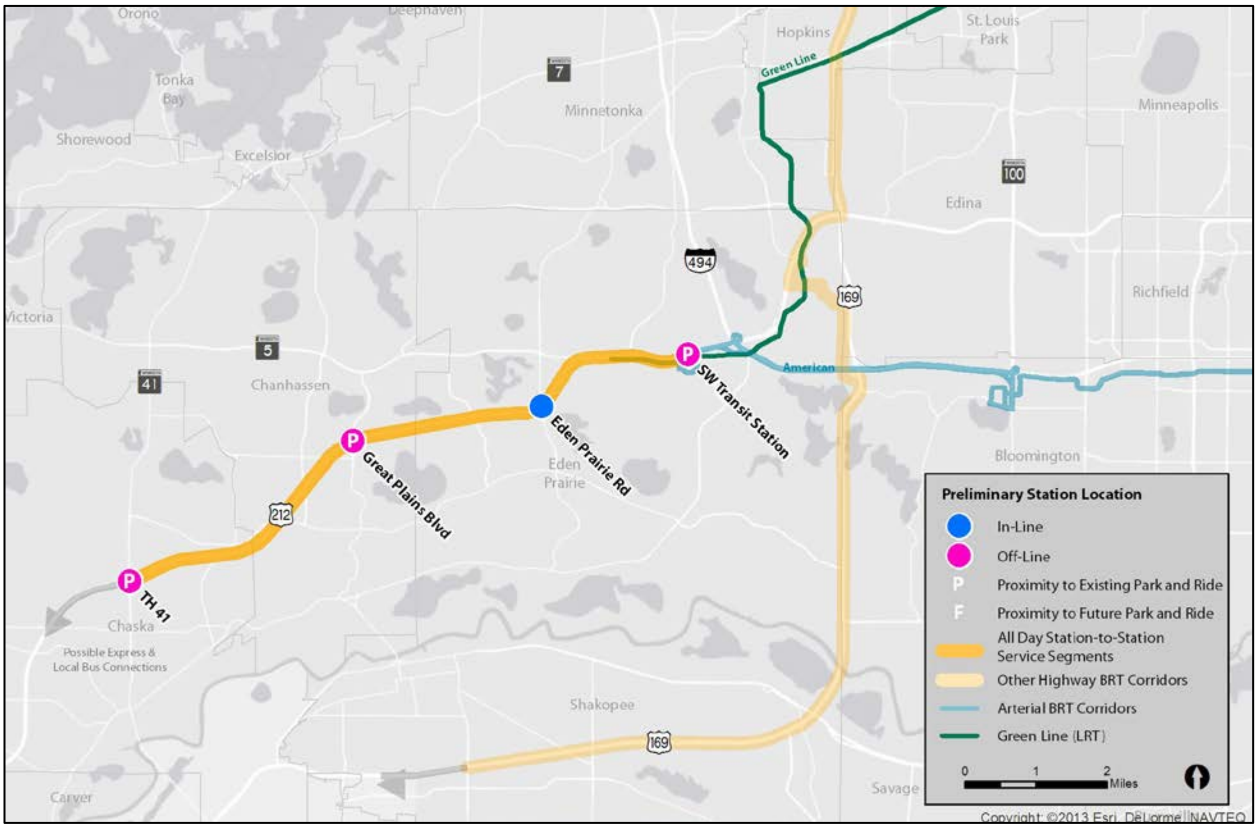
Descriptor	Data
Percent transit reliant ridership (station-to-station service)	33%
Current year ridership on station-to-station service with build alternative (2010)	4,600 riders
New transit riders	2,000 riders

[3] Station-to-station ridership between common stations (General Mills Blvd, Louisiana Ave, and Xenia/Park Place) was split evenly between the I-394 and Highway 169 corridors.

Highway 212 Corridor

The Highway 212 corridor runs from the park-and-ride at East Creek Station in Chaska to the SouthWest Transit Station in Eden Prairie, as shown in Figure 8. The corridor has four stations and is 9.0 miles long. The corridor would provide connections to the planned METRO Green Line Extension (Southwest LRT) providing service to downtown Minneapolis and St. Paul and the planned American Boulevard Arterial BRT line. It would also provide service to existing park-and-ride lots at SouthWest Village and at SouthWest Station.

Figure 8: Highway 212 Corridor



Highway 212 Corridor (continued)

Operating Characteristics

Peak-Period End-to-End Travel Time	27 minutes
Off-Peak End-to-End Travel Time	23 minutes
Required Fleet	5 peak vehicles, 1 spare vehicle
Background Local and Express Bus Service Adjustments	• Reduce Route 698 service • New Chanhassen circulator services (2 routes)

Capital Costs

Cost Categories	Costs
Corridor Construction	$0
BRT Stations	$3,989,000
BRT Maintenance Facility	$1,800,000
Right of Way	$0
Vehicles	$3,672,000
Soft Costs	$1,834,000
25% Contingency	$2,824,000
Corridor Total Cost (2013$)	**$14,119,000**

Operating and Maintenance Costs

Item	Costs
Highway BRT Station–to-Station Service	$3,094,000
Background Bus Changes (Net)	-$497,000
Total Operating and Maintenance Costs Increase over No Build	**$2,597,000**

Ridership Data

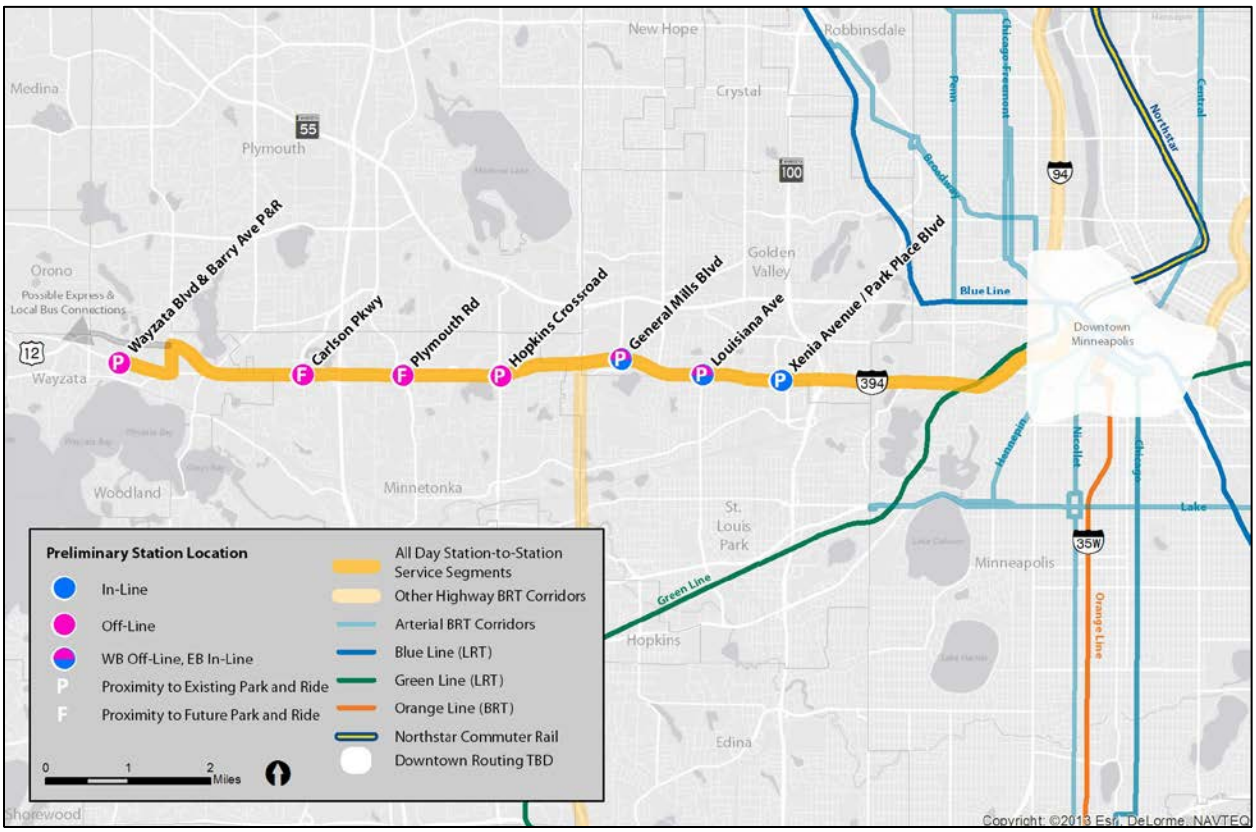
Existing Service (2010)	No Build (2030)	2030		
Corridor Bus Routes	Corridor Bus Routes	Station-to-Station Service	Corridor Bus Routes	**Transitway Total**
2,300	2,400	600	3,200	**3,800**

Descriptor	Data
Percent transit reliant ridership	29%
Current year ridership with build alternative (2010)	400 riders
New transit riders	300 riders

I-394 Corridor

The I-394 corridor runs from the park-and-ride at Wayzata Boulevard and Barry Avenue in Wayzata to downtown Minneapolis, as shown in Figure 9. The corridor has a total of seven stations and is 12.6 miles long. The corridor would provide service to the existing park-and-ride at Wayzata Boulevard and Barry Avenue, a future park-and-ride at Carlson Parkway, a future transit center near Ridgedale Mall at Plymouth Road, and the existing park-and-ride lots at Hopkins Crossroad, General Mills Boulevard, Louisiana Avenue, and Park Place Boulevard.

Figure 9: I-394 Corridor



I-394 Corridor (continued)

Operating Characteristics

Peak-Period End-to-End Travel Time	58 minutes
Off-Peak End-to-End Travel Time	45 minutes
Required Fleet	9 peak vehicles, 2 spare vehicles
Background Local and Express Bus Service Adjustments	• Eliminate Route 675 • New circulator service between Mounds and Central Avenue/County Highway 101 Station • New circulator service at Highway 55/I-494 to Plymouth • Per Southwest Blue Line LRT service plans, service changes to Routes 615, 604 and 9, and new Route 601 service

Capital Costs (2013$)

Cost Categories	Costs
Corridor Construction	$0
BRT Stations	$20,547,000
BRT Maintenance Facility	$3,300,000
Right of Way	$0
Vehicles	$6,732,000
Soft Costs	$7,133,000
25% Contingency	$9,428,000
Corridor Total Cost	**$47,140,000**

Operating and Maintenance Costs (2012$)

Item	Costs
Highway BRT Station–to-Station Service	$5,075,000
Background Bus Changes (Net)	-$1,892,000
Total Operating and Maintenance Costs Increase over No Build	**$3,183,000**

Ridership Data

Existing Service (2010)	No Build (2030)	2030		
Corridor Bus Routes	Corridor Bus Routes	Station-to-Station Service	Corridor Bus Routes	**Transitway Total**
3,400	6,500	6,600	7,800	**14,400**

Descriptor	Data
Percent transit reliant ridership (station-to-station service)	37%
Current year ridership on station-to-station service with build alternative (2010)	3,600 riders
New transit riders	1,600 riders

How were the corridors evaluated?

At the beginning of the study, five goals were identified for use in later evaluation stages of the study. The five goals are:

1. Provide mobility benefits and respond to trip patterns/needs and deficiencies for markets identified in the purpose and need
2. Provide affordable, effective transportation improvements
3. Meet 2030 *Transportation Policy Plan* ridership goals
4. Seamlessly integrate with existing systems and provide valuable regional connections
5. Support area development plans, forecast growth assignment, redevelopment potential

To evaluate the eight corridors, technical evaluation measures were developed for each of the identified goals. The measures were scored on a three-point scale (i.e., a total maximum score of three points per evaluation measure). The results of the evaluation are shown below. Ridership is based on 2030 unless otherwise noted.

Key to Symbols

● Strongly supports goal (3 points) ◑ Supports goal (2 points) ○ Does not support goal (1 point)

		I-94	Hwy 65	I-35E North	Hwy 36	I-35E South	Hwy 169	Hwy 212	I-394
Goal 1: Provide mobility benefits and respond to trip patterns/needs and deficiencies for markets identified in the purpose and need.									
1	Guideway total ridership	●	○	○	●	◑	●	○	●
2	Growth in guideway total ridership	◑	○	◑	●	◑	●	○	●
3	Off-peak hour ridership and reverse-commute direction	●	●	○	◑	●	●	●	●
4	Transit-reliant ridership	●	○	◑	◑	◑	◑	○	◑
5	Minority residents in the service area	●	○	●	◑	○	○	○	○
Goal 2: Provide affordable, effective transportation improvements.									
6	Cost effectiveness	◑	○	◑	●	◑	◑	○	●
Goal 3: Meet Transportation Policy Plan (TPP) ridership goals.									
7	Station-to-station ridership	◑	○	○	●	◑	●	○	●
8	New transit riders	●	◑	○	◑	◑	●	○	●
Goal 4: Seamlessly integrate with existing systems and provide valuable regional connections.									
9	2010 Trips with the build alternative	◑	○	○	●	◑	●	○	●
10	Connections to existing or planned high frequency transitways	○	○	○	◑	●	◑	○	○
Goal 5: Support area development plans, forecast growth assignment, redevelopment potential									
11	Forecast growth in population	○	○	○	○	○	◑	●	○
12	Forecast growth in employment	●	○	◑	○	○	◑	◑	○
	TOTAL	●	○	○	●	◑	●	○	●

Based on the evaluation results, the corridors were placed into categories showing the potential feasibility of all-day, station-to-station BRT service, Table 1. The corridors identified in the "High" category represent those that had the highest technical score in the evaluation. Those four corridors strongly support the goals for the study. These corridors are: I-394, Highway 36, Highway 169, and I-94.

Table 1: Potential for All-Day, Station-to-Station BRT Service

Potential Rating	Corridors
High	• Highway 36 • Highway 169 • I-394 • I-94
Moderate	• I-35E South
Low	• Highway 65 • I-35E North • Highway 212

It is important to note that while four corridors ranked the highest in the evaluation, these corridors need to be vetted with local partners and need more detailed study and analysis before moving forward as priorities in adopted regional plans, similar to other transitway corridors in the region. The purpose of the analysis in this study was to help identify which corridors out of the eight being studied showed the highest demand for all-day, station-to-station BRT service.

Comparisons to other Potential Highway Transitways in the Region

There are a number of other transitways in the region that have been evaluated or are currently being evaluated for their potential for Highway BRT station-to-station service in the region. To assess how these corridors compare to the eight study corridors, the study's technical evaluation measures will be applied to the other regional corridors, to the extent that data is available. Once these studies are completed and information becomes available, a table will be provided as Addendum A that includes this comparison. An important consideration is that some of the measures for the other regional corridors cannot be compared to this study's data in a consistent manner and thus a comparative evaluation with recommendations will not be applied to these corridors. However, the available data provides a helpful basis for comparison of the relative rankings.

What were some of the key findings of the study?

The study is a high-level comparative evaluation of eight corridors in the Twin Cities metropolitan area. The purpose of this evaluation, along with comparable information for other transitway corridors, was to determine the feasibility of all-day, frequent, station-to-station BRT service in these corridors and to identify some key principles that can be used as a foundation for future planning studies of BRT in the region. While corridor specific results were compiled, several more general findings were discovered through the study. These key findings are described in more detail in the following sections.

Station Types

Through the study, it was determined that the most cost-effective station type is an inline station. Inline stations are preferred because they offer a significant time savings by not requiring BRT vehicles to leave the freeway and use local roads to access a station, as would be necessary for an offline station. While online stations also provide similar travel time benefits, they are often located in the median lane of a highway, requiring significant reconstruction of the highway. Online stations are generally the most expensive station type to construct and are only cost-effective for the highest demand stations.

Most of the corridors included in this study are not likely to have major freeway reconstruction for many years. As such, retrofitting these corridors to accommodate Highway BRT services is the most feasible option for implementation. It is typically much easier to retrofit an inline or offline station than an online station into a highway corridor. Online stations require the reconstruction of the highway interchange and this is often not feasible or is cost-prohibitive without planned freeway reconstruction. However, this issue could be explored in more detail through corridor-specific studies, and innovative options may be feasible.

MnPASS Lanes

In the Twin Cities, MnPASS lanes are located in the median lanes of a highway. MnPASS lanes are the preferred runningway option for express transit service, which typically has only one or two stops outside the central business district. However, MnPASS lanes are not the preferred runningway option for Highway BRT station-to-station service, unless online stations are used. BRT station-to-station service stops at all transit stations along a BRT corridor. Having various types of stops (online, inline, offline) requires BRT vehicles to cross several lanes of traffic to access stations, resulting in travel time delays and impacts to vehicular traffic.

Because the majority of stations assumed for the study are inline, the concept design concluded that BRT station-to-station service should operate along bus-only shoulders during the peak periods and in mixed traffic during the off-peak periods. This eliminates the need for BRT vehicles to weave in and out of traffic lanes to access various station types.

The study does not preclude the use of MnPASS lanes or online stations for other corridors if demand is warranted and conditions allow for it. However, the transit operations in MnPASS lanes with online stations would require consecutive stations in the corridor to operate in the same way or allow for substantial distance and time to cross lanes of mixed traffic (generally about 2 miles or more).

Location of Park-and-Ride Facilities

Existing and planned park-and-ride sites were evaluated in the study in terms of capacity, use and geographic distribution of users. Key findings related to park-and-ride site locations to consider in future corridor planning include:

- End of line stations and park-and-ride facilities should be located in close proximity to major destinations (employment centers, developments, etc.).
- Park-and-ride facilities should be located where they can be served by inline stations to minimize additional travel time.
- Park-and-ride facilities should be located near major intersecting roadways to provide good access.

Pedestrian Environment at Station Locations

In general, the pedestrian environment around the highway interchanges in the corridors in this study was identified as challenging or non-existent. There are few sidewalks or trails and connectivity is limited for those that do exist. Very few walk-up passengers can be expected if these conditions are not improved. Thus, the implementation of transit stations would need to be closely coordinated with local transportation improvements and design to insure that pedestrian connections are provided if the station is intended to serve more than just park-and-ride customers.

Development Patterns

Land use plays a key role in determining the success of a transitway investment. Denser, high-activity land uses are considered more conducive to transit use than low-density uses. The proposed station locations in the eight corridors were placed to take advantage of existing and planned land uses, such as employment centers and park-and-rides, to the extent possible. However, much of the land use surrounding many station locations is relatively low density. Communities along these corridors would be encouraged to support future BRT and other transit investments by encouraging planned development and forecasted growth around potential station locations. Concentrating development, people, households, and jobs at these locations will produce more transit-friendly land use patterns and set the stage for future successful transitways. This would be an important step of coordination between local governments doing land use planning and the agencies planning potential transitway investments. The sooner this coordination can occur, the better positioned a corridor will be to become a transitway investment priority.

Frequency of Service

During the study, several sensitivity tests were completed to determine the impact that certain operating changes would have on ridership. Two of the tests completed looked at the impact that increasing or decreasing frequency would have on ridership. The first test analyzed changes in ridership if off-peak frequencies decreased from 15 minutes to 30 minutes (i.e., an off-peak bus passes through a station twice an hour instead of four times an hour). The second test analyzed changes in ridership if peak frequencies increased from 15 minutes to ten minutes (i.e., a peak bus passes through a station six times an hour instead of four times an hour).

Off-peak station-to-station service ridership decreased across the corridors by 30 to 58 percent when off-peak frequencies were decreased from 15 minutes to 30 minutes. This reduction in service frequency resulted in an annual operating and maintenance reduction between 24 and 27 percent.

Peak Highway BRT station-to-station service ridership increased across the corridors by 14 to 38 percent when peak frequencies were increased from 15 minutes to 10 minutes. When frequency was increased from 15 minutes to 10 minutes, annual operating and maintenance costs increased between 15 and 18 percent. Increasing frequency also impacted the number of peak buses required between 40 and 60 percent. This would also impact capital costs due to the need for additional vehicles to operate the service.

Providing a high level of service frequency should be balanced with other constraints, such as the cost to operate and maintain a higher level of service. For corridors where ridership levels may not warrant Highway BRT level of service, it may make sense to explore the possibility of a less frequent transit service tailored to serving the demand in the corridor cost-effectively. In addition, all corridors may want to consider phasing improvements in transit service (i.e. introducing increasingly higher levels of service over time) by creating initial demand by providing basic accessibility and facilities. For example, a limited number of mid-day transit trips may be a starting point, followed by station-to-station service at 30 minute frequencies after initial demand is established and proven effective. If the route is continually successful, frequencies could be increased during the peak period and eventually expanded to 15 minute all-day Highway BRT level of service. Matching the appropriate level of service to the demand for transit service ensures regional transit investments are as cost-effective as possible.

Express Transit Market Demand

Many of the eight corridors are, and will continue to be, strong markets for express bus service that connects suburban locations to large employment centers, like downtown Minneapolis. For example, while this study demonstrated that Highway 212 has low potential for Highway BRT station-to-station level service (e.g. 600 trips per day), the corridor's Corridor Bus Route ridership, made up of all express routes, was strong (e.g. 3,200 trips per day).[4] Future studies should examine how to support and grow this ridership market in the study corridors.

What are the next steps after the study?

The study provided a strong foundation for identifying the corridors with the greatest potential for all day station-to-station Highway BRT. While concept plans were developed and costs and ridership were estimated for the eight corridors, the corridors that ranked the highest in the evaluation should undergo additional, more detailed study and vetting with local communities and policymakers for consideration in adopted plans.

[4] Not all Corridor Bus Route ridership estimates reflect only express route ridership. Most corridors have a mix of local service and express routes. Please see Tech Memo 3 for a list of routes included in the Corridor Bus Route ridership estimates.