Lakeville, Burnsville,
Bloomington, Richfield and Minneapolis

TASK 1 REPORT

RECOMMENDED BRT CONFIGURATION FOR THE 35W/HIGHWAY 62 INTERCHANGE

COVERING WEST 66TH STREET TO LAKE STREET

Submitted to the
Minnesota Department of Transportation
by the URS Consulting Team

April, 2004

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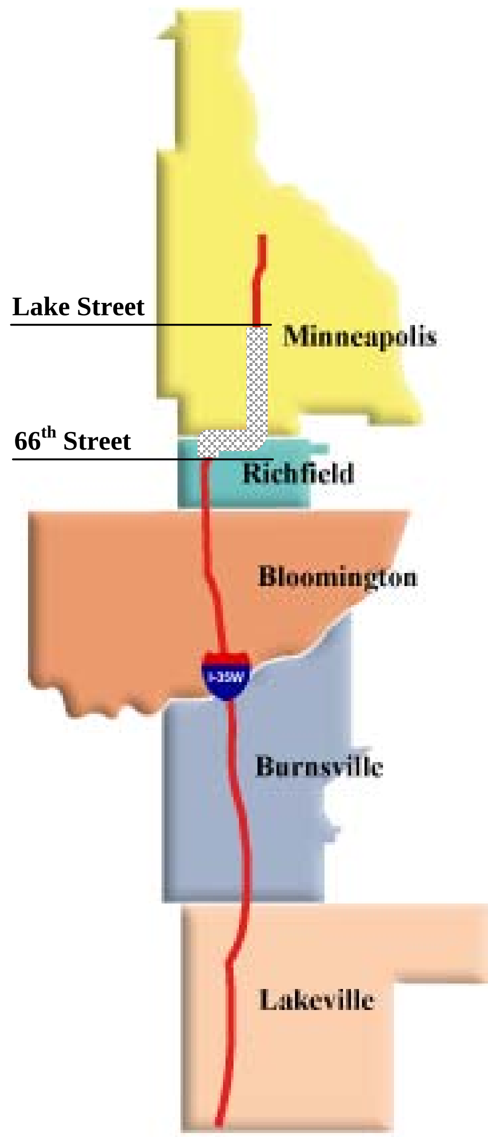
Table of Contents

INTRODUCTION

This report provides guidance to Mn/DOT on the requirements of a bus transitway as it passes through the 35W/Highway 62 interchange. This report is part of a larger study[1] that is assessing Bus Rapid Transit (BRT) service in the I-35W Corridor between Lakeville and Downtown Minneapolis. The full report will be submitted to the Minnesota State Legislature in December 2004 and will recommend an overall approach for implementing BRT in the 35W Corridor.



Bus Rapid Transit, or BRT, is an increasingly popular way of providing reliable and cost-effective public transit service. While BRT features vary from city to city, all Bus Rapid Transit buses operate frequent and quick service with travel times as fast or faster than traveling alone in your car.

In the Twin Cities, a range of Bus Rapid Transit features is being used. These include buses operating on bus shoulder only lanes and the University of Minnesota's Transitway that connects the Minneapolis and St. Paul campuses.

The graphic to the right depicts the study area for the 35W BRT Study. The complete study area extends from Lakeville to Downtown Minneapolis and traverses the cities of Burnsville, Bloomington and Richfield. The portion of the study area that is the focus of this report is shaded in gray on the graphic.

PUBLIC TRANSIT SERVICES IN THE 35W CORRIDOR

The 35W Corridor is one of the most heavily traveled in the Twin Cities and serves 14,000 -15,000 transit riders per weekday[2]. Three public transit operators operate daily scheduled service in the Corridor – Metro Transit, Minnesota Valley Transit Authority, (MVTA) and the City of Prior Lake's Laker Lines service. Southwest Metro Transit, which serves the Cities of Eden Prairie, Chaska and Chanhassen, will occasionally redirect their buses to the 35W Corridor when travel conditions warrant.

[1] Mn/DOT has hired the consulting firm of URS to assist with this study.
[2] Sum of Average Trip Ridership by Hour as provided by Metro Transit.

BRT ALTERNATIVES FOR THE 35W/HIGHWAY 62 INTERCHANGE

Development and evaluation of BRT alternatives for the 35W/Highway 62 interchange was guided by the desire to:

- Allow buses to operate at posted speeds through the 35W/Highway 62 interchange.
- To maximize the vehicle capacity through the interchange.
- To minimize impacts on right-of-way.

Design Options

Three design alternatives were developed following the desired guidelines found in the Geometric Design Code for Transit Facilities on Highways and Streets – Phase I (Interim Guide)[3]. The design alternatives are depicted in the graphic on the following page and are described below:

Design Option 1 - 14' Barrier-Free Lanes

Under this alternative, a separate 14' BRT lane in each direction is established that runs in the center of the freeway. A 2' barrier and a 13' enforcement lane separate the northbound and southbound lanes from each other on each side. Each 14' BRT lane is immediately adjacent to the general-purpose lanes on the rest of the freeway. There is no barrier separating the BRT lane from the general-purpose lanes. The wider 14' lane includes a 2' buffer adjacent to the general–purpose lane.

Bus stations are located between the northbound and southbound BRT lanes and provide vertical access to local bus routes and neighborhoods via stairs and an elevator.

Design Option 2 –Shoulder Running Buses

This option is similar to the current practice of running buses on the 10-foot freeway shoulders in the Twin Cities area. It provides a 13-foot outside shoulder to allow more width to buffer adjacent traffic and to reduce impacts on drainage structures along the shoulder. Buses can only operate on this shoulder at a speed of 15 MPH over the speed of traffic in the general-purpose lanes up to a maximum of 35 MPH[4].

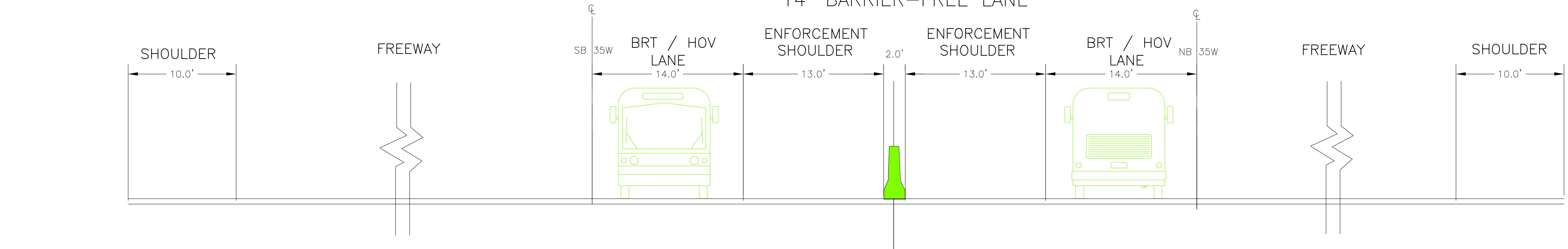
Bus stations are located at the sides of the freeway, either immediately adjacent or just off entrance/exit ramps.

[3] This guide was prepared in July 2002 for the American Association of State Highway and Transportation Officials (AASHTO) Standing Committee on the Highways. The guide was prepared as part of NCHRP Project 20-7, Task 135 under the National Cooperative Highway Research Program , Transportation Research Board.
[4] Minnesota Statutes, Chapter 169.306 Use of Shoulders by buses.

BRT DESIGN OPTIONS FOR THE 35W/HWY 62 INTERCHANGE

OPTION 1

14' BARRIER-FREE LANE

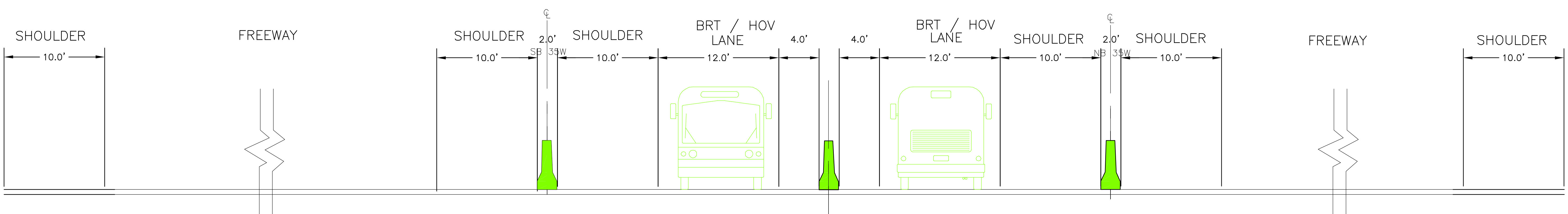


OPTION 2

SHOULDER RUNNING BRT

OPTION 3

BARRIER-SEPARATED LANE



NO.	DATE	BY / CHK.	APPD.	REVISIONS

DESIGNED MRH — DATE 1/19/04
DRAWN — DATE
CHECKED — DATE
APPROVED — DATE

URS

SUBMITTED: DATE: APPROVED: DATE:

BRT TYPICAL SECTIONS
35W BRT STUDY
EXHIBIT A

SCALE: DRAWING NO.: REV.: CONTRACT NO.: SHEET NO.:

Design Option 3 – Barrier Separated Lanes

The barrier-separated lane option creates a BRT lane that runs in the center of the freeway, similar to Option 1, however the BRT lanes are separated from the general purpose freeway lanes by a 2’ barrier.

A 2’ barrier with 4’ shoulders on either side separates the northbound and southbound lanes of the transitway. Buses operate in a 12’ lane that is separated from the general-purpose lanes by a 2’ barrier and a 10’ shoulder on both sides of the barrier.

As with Option 1, bus stations are located between the northbound and southbound BRT lanes and provide vertical access to local bus routes and neighborhoods via stairs and an elevator.

Lane Management Options

In addition to design options for operating BRT service through the 35W/Highway 62 interchange, two options were considered for how the lane could be managed – exclusively as a BRT lane or as a BRT lane shared with High Occupancy Vehicles (HOV).

CRITERIA FOR EVALUATING OPTIONS

Several criteria were used to evaluate the three design options and the two lane use options under consideration for the 35W/Highway 62 interchange as follows:

- Right-of-Way Requirements and Geometric Issues
- Bus Operations
- Traffic Operations and Freeway Capacity
- Air Quality
- Delay and Cost of Delay
- Capital Cost
- Benefit/Cost Analysis

KEY FINDINGS

Right of Way

A significant distinction between the design options is the amount of right of way that is required for each. When compared with the current design plans (Design Option 1 - 14’ *Barrier-Free Lanes*), Design Option 2 –*Shoulder Running Buses,* the right shoulders in the current design plans would need to be increased by at least three feet on each side, for a total increase of six feet. When Design Option 3 – *Barrier Separated Lanes* is compared with the current design plans, an additional 11’ is required on each side of 35W for a total increase in width of 22’.

Design Option 3 – *Barrier Separated Lanes* has a significant impact on right of way needs. Based on the cross-sections analyzed by the URS Team, it appears additional right of way will be required in at least three areas:

- On the south side of the freeway at Lyndale Avenue, a commercial building could be impacted.
- At 35W and 60th Street approximately 8 homes on the east side would need to be acquired to maintain the ramp access from 60th Street.
- At 46th Street an estimated 46 homes would likely be impacted. This would be necessary to maintain the street in front of the remaining homes on the east side of the freeway while providing access to 35W.

Bus Operations

From the perspective of bus operations Options 1 and 3 are comparable in terms of operating speed, while Option 2 is the least favorable option when considering operating speed. This is attributable to the fact that 35 MPH is the maximum speed that buses are allowed to operate on the shoulders. The barrier-separated option (Option 3) limits the ability of buses to enter and exit the BRT lane, which is less favorable from a bus operating perspective.

Overall, Design Option 1 – *Barrier-Free Lanes* is considered the most favorable design option from a bus operations perspective.

Freeway Capacity

The most significant distinction between the two strategies for managing the BRT lane (BRT-Only or Shared BRT/HOV Lane) is the impact on vehicle capacity through the 35W/Highway 62 interchange. By adding HOV vehicles to a BRT lane, the overall capacity of the 35W/Highway 62 interchange will increase approximately 18% - 35%.

Capital Cost

When compared with the current design plans, it is estimated that Design Option 2 – *Shoulder Running Buses* would cost an additional $4 million with Design Option 3 – *Barrier Separated Lanes* estimated to cost an additional $26 million.

RECOMMENDATIONS

Overall, Design Option 1 – *Barrier-Free Lanes* as a shared BRT/HOV lane is the recommended alternative for a bus transitway through 35W/Highway 62 interchange. Key distinctions that led to this recommendation include the following:

- No additional right of way.
- Buses have free access to the BRT lane.
- Buses operate at posted speeds.
- Lowest capital cost.
- Provides enforcement area in shoulders.
- Shared lane increases capacity.

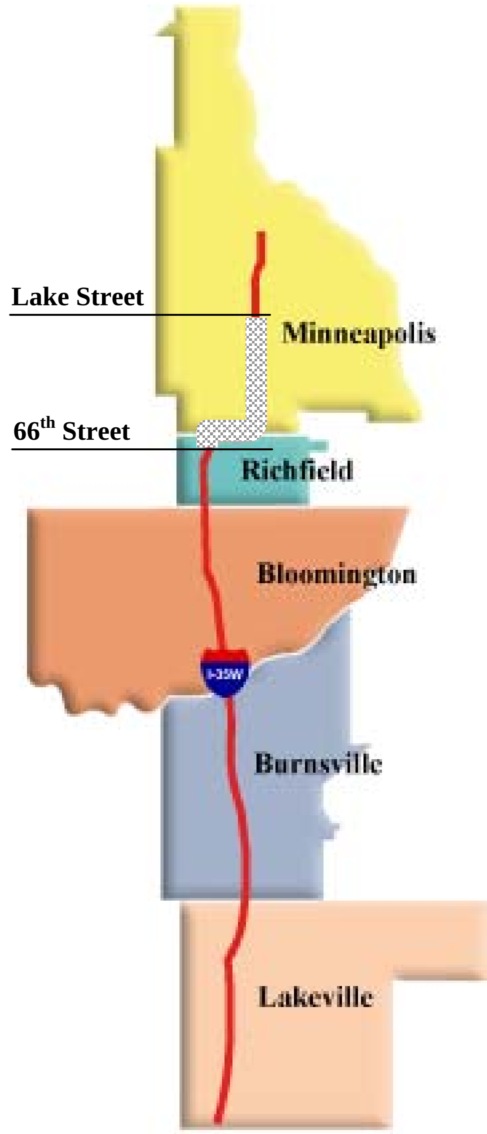
While this report represents the completion of the first phase in the 35W BRT Study, there were a number of observations that were made that Mn/DOT may want to consider at this point as it relates to operating Bus Rapid Transit in the 35W Corridor.

- Operating BRT and HOV's in the same lane significantly increases the number of people that can use one freeway lane. As consideration is being given to 35W access options north of the interchange project area, serious consideration should be given to extending the BRT/HOV lane north to downtown Minneapolis. This would provide continuity for BRT and HOV users and allow for an important transit connection at a future Lake Street Station.
- Mn/DOT's current design plans provide space for a bus station at 46th Street. The 35W/Highway 62 interchange project provides a timely opportunity to accommodate a bus station at 46th Street which is an important element found in Metro Transit's Central South Study.
- Introducing HOV's to the BRT lane runs the risk of slowing bus operating speeds. While it is clear that HOV's can be added to the BRT lane and operating speeds can be maintained, the number of HOV's permitted into the BRT lane should be managed to insure that buses are able to operate at the posted speeds.

INTRODUCTION

This report provides guidance to Mn/DOT on the requirements of a bus transitway as it passes through the 35W/Highway 62 interchange. This report is part of a larger study[1] that is assessing Bus Rapid Transit (BRT) service in the I-35W Corridor between Lakeville and Downtown Minneapolis. The full report will be submitted to the Minnesota State Legislature in December 2004 and will recommend an overall approach for implementing BRT in the 35W Corridor. The full report will also assess the feasibility of BRT service throughout the corridor and document the associated costs and benefits.

The graphic to the right depicts the study area for the 35W BRT Study. The complete study area extends from Lakeville to Downtown Minneapolis and traverses the cities of Burnsville, Bloomington and Richfield. The portion of the study area that is the focus of this report is shaded in gray on the graphic.



The Bus Rapid Transit (BRT) study provides a timely opportunity to further strengthen transit service in the 35W Corridor by planning for BRT service in the corridor. The study, which is being undertaken by the Minnesota Department of Transportation (Mn/DOT), coincides with a number of improvements that are underway or planned in the 35W Corridor including the following:

- Preliminary design is underway for reconstructing the Highway 62/35W interchange that includes 35W between 66th Street and 42nd Street.
- Metro Transit is introducing restructured services in the 35W corridor in 2004.
- Planning and discussions are underway to explore access options between 35W and Lake Street.

This initial report provides an overview of transit services in the 35W corridor, describes BRT services locally and nationally, evaluates design alternatives and lane management alternatives for the Highway 62/35W interchange and concludes with a recommendation for a bus transitway as it passes through the 35W/Highway 62 interchange.

[1] Mn/DOT has hired the consulting firm of URS to assist with this study.

Notes

PUBLIC TRANSIT SERVICES IN THE 35W CORRIDOR

Transit Passengers

The 35W Corridor is one of the most heavily traveled in the Twin Cities and serves 14,000 - 15,000 transit riders per weekday[2]. Three public transit operators operate daily scheduled service in the Corridor – Metro Transit, Minnesota Valley Transit Authority, (MVTA) and the City of Prior Lake's Laker Lines service. The City of Prior Lake service provides commuter express service between the City of Prior Lake and Downtown Minneapolis, MVTA provides service originating south of the Minnesota River and Metro Transit provides service within the 35W Corridor, between the Minnesota River and Downtown Minneapolis. It should also be noted, that Southwest Metro Transit, which serves the Cities of Eden Prairie, Chaska and Chanhassen, will occasionally redirect their buses to the 35W Corridor when travel conditions warrant.

Based on data gathered for Metro Transit's recently completed Central South Transit Study, the number of people using public transit service in the I-35W corridor is concentrated in the morning peak period (6:00 AM – 9:00 AM) and during the evening peak period (3:00 PM – 6:00 PM). Seventy-five percent of all I-35W corridor transit passengers travel through the 35W/Highway 62 interchange during these peak periods. Transit ridership outside of these peak periods falls off dramatically. The charts on the following two pages shows the distribution of transit passengers, by hour, as they travel through the I-35W Corridor.

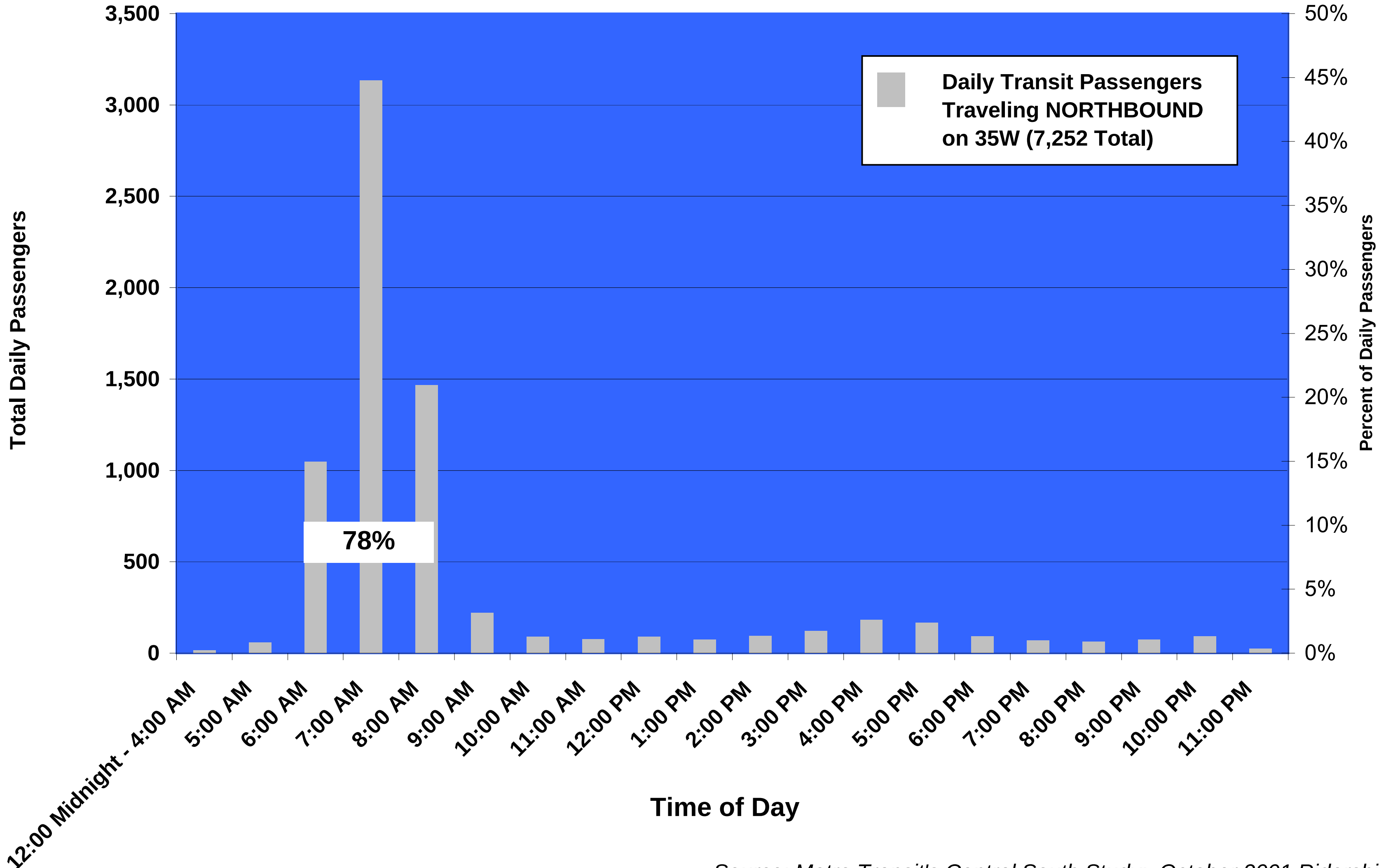
Distribution of Bus Volume During the AM and PM Peak Hour

Another important element of public transit services in the I-35W Corridor is the distribution of bus volumes throughout the Corridor. As noted earlier, Metro Transit, MVTA, the City of Prior Lake and at times, Southwest Metro operate public transit service in the I-35W Corridor. From the south, buses approach the 35W/Highway 62 interchange from a number of different directions and then become concentrated on 35W north of Highway 62. During the peak hour of transit travel in the morning, 29 buses approach the 35W/Highway 62 interchange from the south, then are joined by 4 buses that enter the interchange from eastbound Highway 62[3]. Another 27 buses join the interchange from westbound Highway 62 resulting in 62 buses traveling north on 35W during the morning peak hour. An additional 13 buses join the 35W Corridor at 54th/E. Diamond Lake with 6 buses joining 35W at 46th Street and 6 buses joining 35W at 35th Street, for a total of 87 buses heading into Minneapolis during the morning peak hour. The graphic on page 6 depicts the northbound bus volume during the morning peak hour.

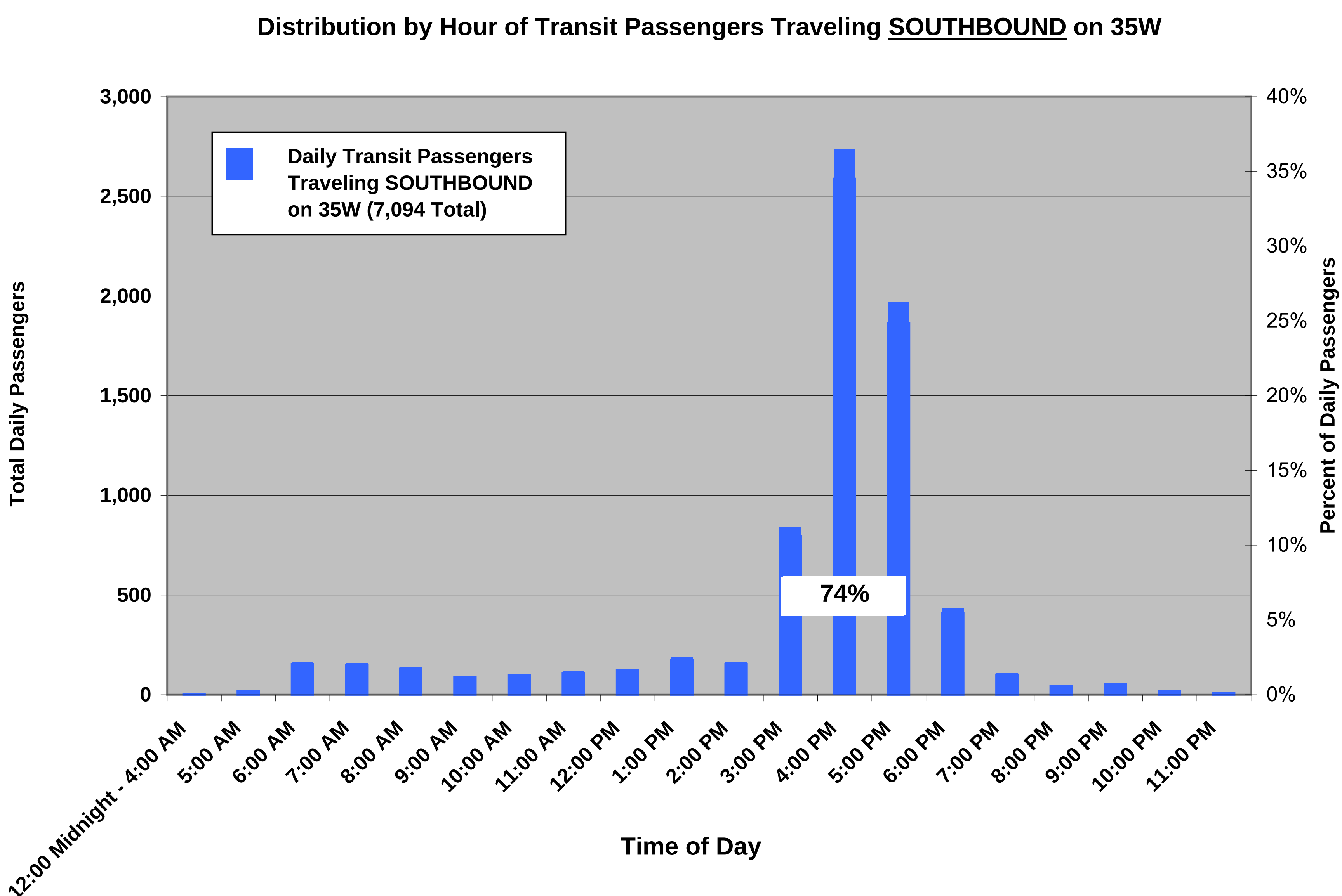
The distribution of southbound bus volume in the afternoon is similar to the morning bus volume. 82 buses depart Downtown Minneapolis during the afternoon peak hour with 4 buses exiting 35W at 35th Street, 6 exiting at 46th Street and 11 buses exiting at 54th/E. Diamond Lake Boulevard. The remaining 61 buses enter the 35W/Highway 62 interchange with 4 heading west on Highway 62, 27 heading east on Highway 62 and 28 heading south on 35W. Southbound bus volume during the afternoon peak hour is shows in the graphic on page 7.

[2] Sum of Average Trip Ridership by Hour as provided by Metro Transit.
[3] Based on Metro Transit's Central South Plan, MVTA and City of Prior Lake's existing services.

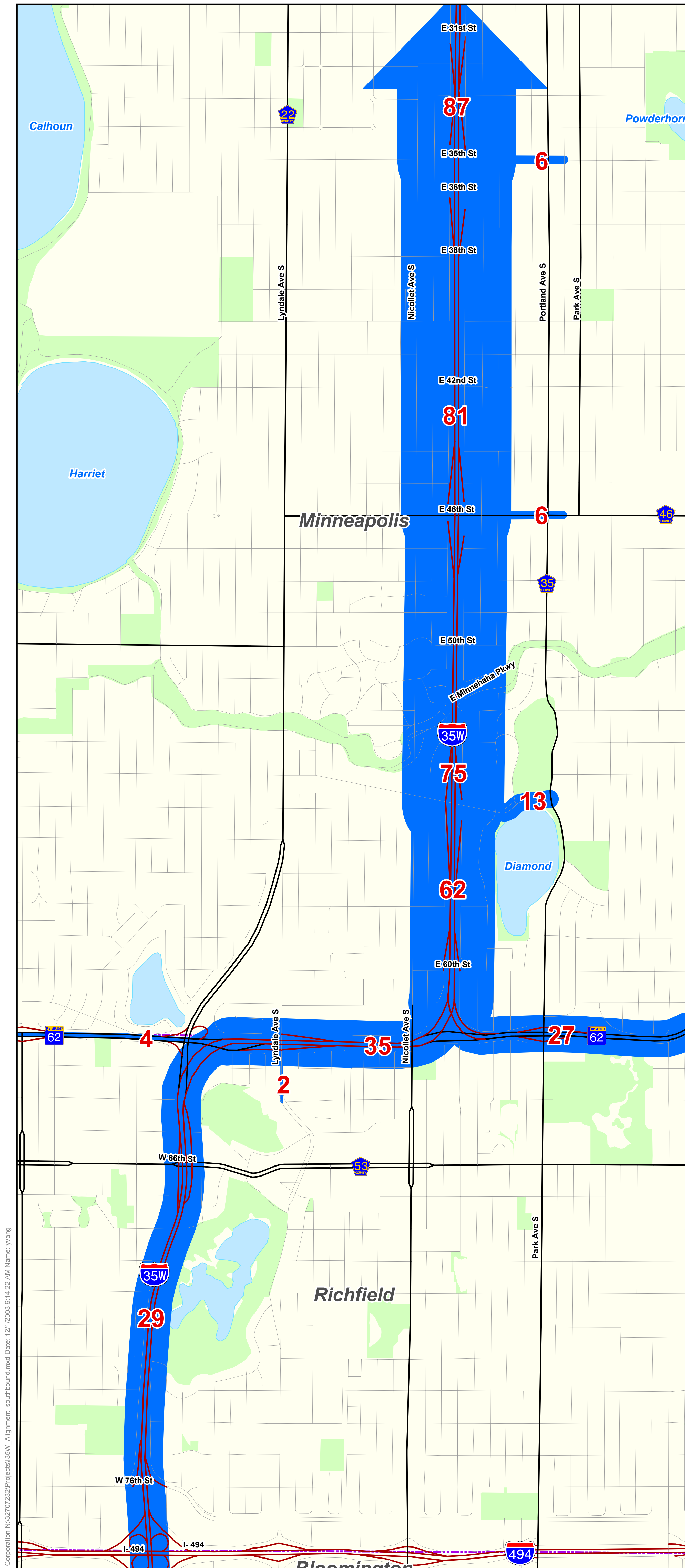
Distribution by Hour of Transit Passengers Traveling NORTHBOUND on 35W



Source: Metro Transit's Central South Study: October 2001 Ridership



Source: Metro Transit's Central South Study: October 2001 Ridership



35W BRT Study

Northbound Bus Volume Through Task 1 Subarea

Maximum Trips in One Morning Peak Hour

Based on Metro Transit's Central South Service Plan

Legend

- Interstate
- State Highway
- Local Roads
- Municipal Boundary
- 87 Maximum Number of Trips in the Afternoon Peak Hour

0 0.25 0.5

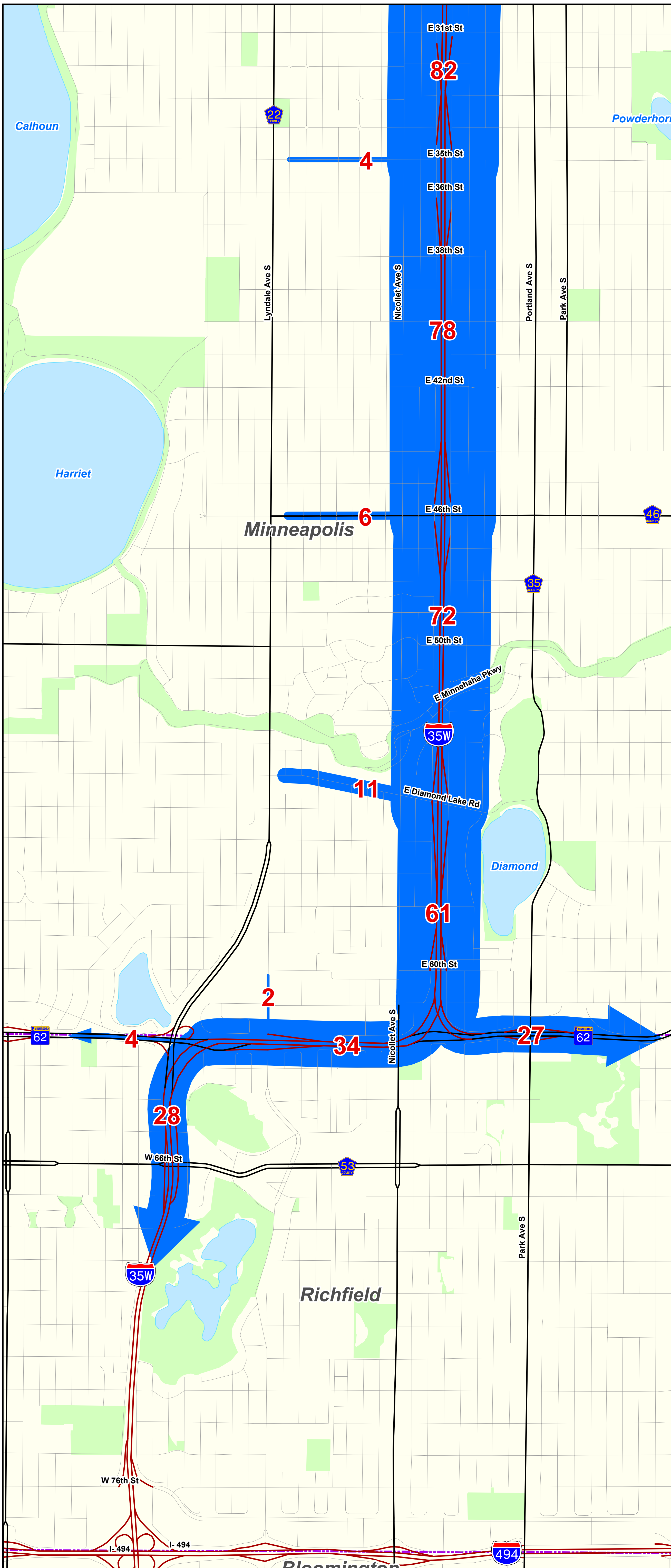
Miles

URS

March 2004

35W BRT Study

Southbound Bus Volume Through Task 1 Subarea



Maximum Trips in One Evening Peak Hour

Based on Metro Transit's Central South Service Plan

Legend

Interstate

State Highway

Local Roads

Municipal Boundary

82 Maximum Number of Trips in the Afternoon Peak Hour

N

0 0.25 0.5

Miles

URS

March 2004

URS Corporation N:\32707232\Projects\35W_Alignment_southbound.mxd Date: 12/1/2003 9:14:22 AM Name: yyang

Service Changes Ahead

Metro Transit has recently concluded a comprehensive study of transit services in the southern metropolitan area that includes the 35W Corridor. Known as the "Central South Study", there were four primary opportunities identified to improve the productivity and efficiency of public transit services in the study area as follows:

- Speed up the system – service is slow due to closely spaced bus stops and slow fare collection.
- Improve service frequency – Given a choice, people will choose more frequent service within reasonable distances.
- Simplify the route structure – The current system is too complex and confusing to existing and potential new riders.
- Enhance midday and weekend service – Increasingly, people need to travel outside the traditional rush hour commute periods.

Metro Transit's Central South Study plan calls for express bus service improvements in the 35W Corridor as follows:

Restructure service to provide all-day, high frequency service along the corridor, allowing customers to drive to park-and-ride lots and catch the next trip rather than having to plan for a specific trip. Convert the local portions of some south Bloomington express routes to shuttles connecting residents with express service. Some local service extensions of express routes will remain where ridership is highest. Stations (some with park-and-ride lots) will provide transit center access to the express service at Bloomington South Transit Center (98th Street), 82nd Street, Southtown, Best Buy headquarters, 76th Street, 66th Street, 46th Street and Lake Street.

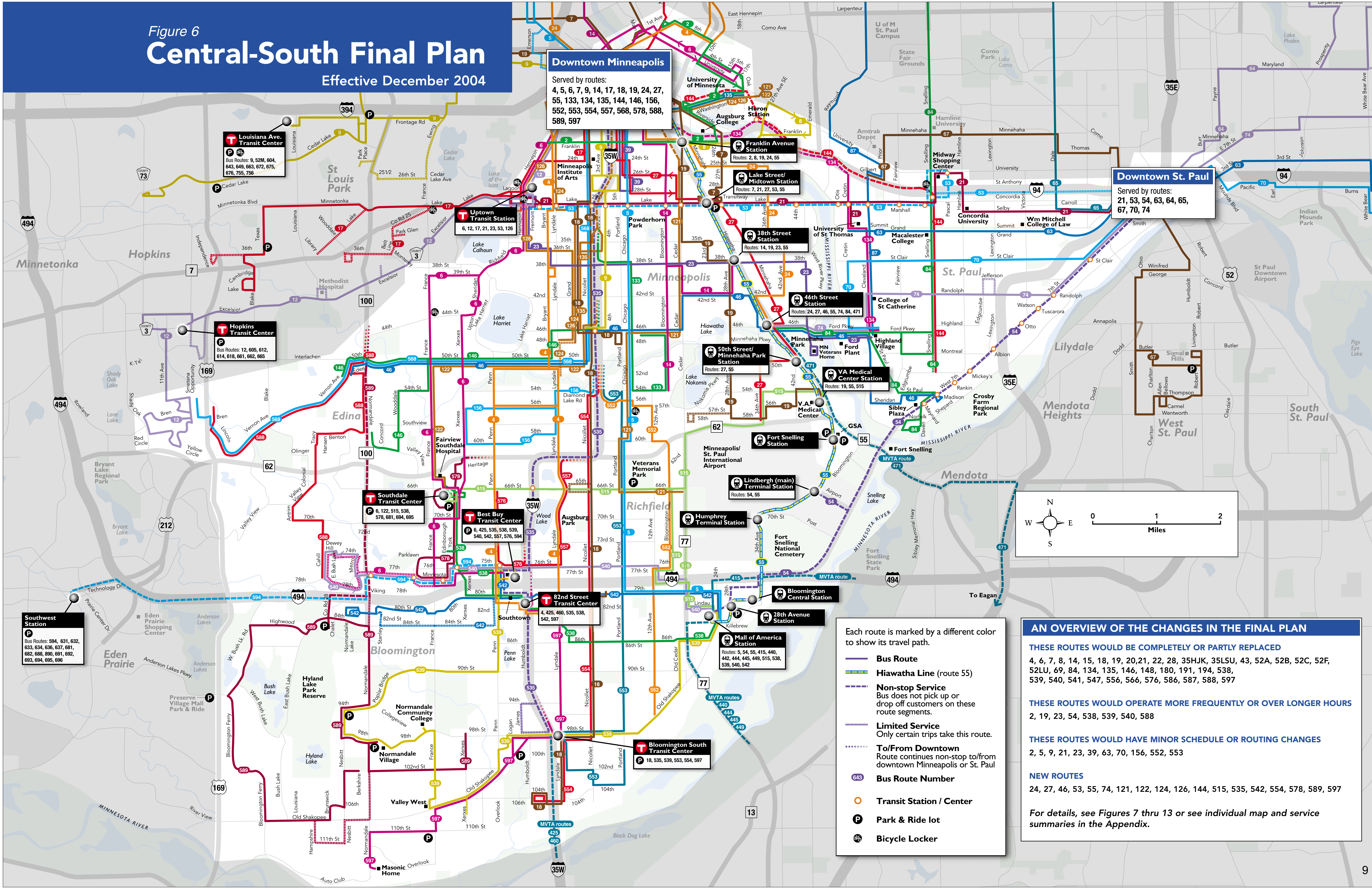
The planned implementation will have two phases. Phase one will introduce the stations, connecting services and limited park and ride lots. The long-term Phase Two would bring extensive exclusive bus lanes, additional (38th Street) or relocated stations (such as at 82nd Street), expanded and additional park–and-rides together with increased frequency to meet the "show up and ride" doctrine.

The graphic on the following page is from Metro Transit's Central South Study and depicts the final plan for bus service in the Central South area. The complete Central South report can be found at http://www.metrocouncil.org/transit/sec5/central-so_plan.htm.

Figure 6

Central-South Final Plan

Effective December 2004



Each route is marked by a different color to show its travel path.

- Bus Route
- Hiawatha Line (route 55)
- Non-stop Service — Bus does not pick up or drop off customers on these route segments.
- Limited Service — Only certain trips take this route.
- To/From Downtown — Route continues non-stop to/from downtown Minneapolis or St. Paul
- 643 Bus Route Number
- Transit Station / Center
- Park & Ride lot
- Bicycle Locker

AN OVERVIEW OF THE CHANGES IN THE FINAL PLAN

THESE ROUTES WOULD BE COMPLETELY OR PARTLY REPLACED

4, 6, 7, 8, 14, 15, 18, 19, 20,21, 22, 28, 35HJK, 35LSU, 43, 52A, 52B, 52C, 52F, 52LU, 69, 84, 134, 135, 146, 148, 180, 191, 194, 538, 539, 540, 541, 547, 556, 566, 576, 586, 587, 588, 597

THESE ROUTES WOULD OPERATE MORE FREQUENTLY OR OVER LONGER HOURS

2, 19, 23, 54, 538, 539, 540, 588

THESE ROUTES WOULD HAVE MINOR SCHEDULE OR ROUTING CHANGES

2, 5, 9, 21, 23, 39, 63, 70, 156, 552, 553

NEW ROUTES

24, 27, 46, 53, 55, 74, 121, 122, 124, 126, 144, 515, 535, 542, 554, 578, 589, 597

For details, see Figures 7 thru 13 or see individual map and service summaries in the Appendix.

Notes

OVERVIEW OF BUS RAPID TRANSIT SERVICE

Bus Rapid Transit, or BRT, is an increasingly popular way of providing reliable and cost-effective public transit service. While BRT features vary from city to city, all Bus Rapid Transit buses operate frequent and quick service with travel times as fast or faster than traveling alone in your car.

In the Twin Cities, a range of Bus Rapid Transit features is being used. These include buses operating on bus shoulder only lanes and the University of Minnesota's Transitway that connects the Minneapolis and St. Paul campuses.

Typically, BRT buses operate on roads and highways that are designed to give them an advantage over cars traveling along the same route. This may be accomplished by operating in exclusive lanes or with other vehicles operating in High Occupancy Vehicle (HOV) lanes.

University of Minnesota Transitway

Advanced technologies often associated with BRT include:

- Up-to-the minute electronic traveler information to alert commuters when the next vehicle is approaching.
- Automated pre-board fare collection methods to speed fare transactions.
- Traffic Signal preemption systems giving BRT vehicles a green light at busy intersections upon detection of an approaching vehicle.

Bus Rapid Transit (BRT) is quickly becoming the mode of choice for commuters in a number of metropolitan areas throughout, Europe, Australia, South America, the U.S. and Canada. North American cities currently operating or planning to operate BRT systems include:

- Boston, MA
- Charlotte, NC
- Cleveland, OH
- Eugene, OR
- Hartford, CT
- Houston, TX
- Miami, FL
- New York, NY
- Pittsburgh, PA
- Seattle, WA
- Ottawa, Ontario
- Vancouver, British Columbia

BRT ALTERNATIVES FOR THE 35W/HIGHWAY 62 INTERCHANGE

Development and evaluation of BRT alternatives for the 35W/Highway 62 interchange was guided by the desire to (1) allow buses to operate at posted speeds through the 35W/Highway 62 interchange; (2) to maximize the vehicle capacity through the interchange, and; (3) to minimize impacts on right-of-way.

Design Options

Five alternatives were considered that included three design options and two options for how a BRT lane could be managed. The design alternatives were developed following the desired guidelines found in the Geometric Design Code for Transit Facilities on Highways and Streets – Phase I (Interim Guide)[4] . Each alternative is described below:

Design Option 1 - 14' Barrier-Free Lanes

Under this alternative, a separate 14' BRT lane in each direction is established that runs in the center of the freeway. A 2' barrier and a 13' enforcement lane separates the northbound and southbound lanes from each other on each side. Each 14' BRT lane is immediately adjacent to the general-purpose lanes on the rest of the freeway. There is no barrier separating the BRT lane from the general-purpose lanes. The wider 14' lane includes a 2' buffer adjacent to the general–purpose lane.

Bus stations are located between the northbound and southbound BRT lanes and provide vertical access to local bus routes and neighborhoods via stairs and an elevator.

Design Option 2 –Shoulder Running Buses

This option is similar to the current practice of running buses on the 10-foot freeway shoulders in the Twin Cities area. It provides a 13-foot outside shoulder to allow more width to buffer adjacent traffic and to reduce impacts on drainage structures along the shoulder. Buses can only operate on this shoulder at a speed of 15 MPH over the speed of traffic in the general-purpose lanes up to a maximum of 35 MPH[5]. Under this alternative, only authorized buses are allowed to operate in the shoulders in accordance with Minnesota Sate Law. Bus stations are located at the sides of the freeway, either immediately adjacent or just off entrance/exit ramps.

Design Option 3 – Barrier Separated Lanes

The barrier-separated lane option creates a BRT lane that runs in the center of the freeway, similar to Option 1, however the BRT lanes are separated from the general purpose freeway lanes by a 2' barrier.

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[4] This guide was prepared in July 2002 for the American Association of State Highway and Transportation Officials (AASHTO) Standing Committee on the Highways. The guide was prepared as part of NCHRP Project 20-7, Task 135 under the National Cooperative Highway Research Program , Transportation Research Board.
[5] Minnesota Statutes, Chapter 169.306 Use of Shoulders by buses.

A 2’ barrier with 4’ shoulders on either side separates the northbound and southbound lanes of the transitway. Buses operate in a 12’ lane that is separated from the general-purpose lanes by a 2’ barrier and a 10’ shoulder on both sides of the barrier.

As with Option 1, bus stations are located between the northbound and southbound BRT lanes and provide vertical access to local bus routes and neighborhoods via stairs and an elevator.

The graphic on the following page shows typical cross-sections for each of the three design options.

Lane Management Options

In addition to design options for operating BRT service through the 35W/Highway 62 interchange, two options were considered for how the lane could be managed – exclusively as a BRT lane or as a BRT lane shared with High Occupancy Vehicles (HOV).

These options only apply to *Design Option 1 – Barrier Free Lane*s and *Design Option 3 – Barrier Separated Lanes* as Minnesota State Law allows only authorized buses to operate in the shoulder, (Design Option 2 – *Shoulder Running Buses*).

<u>BRT Only Lane</u>

Under this option, only buses would be allowed to operate in the BRT lane. If this option were selected, people who car pool (HOV’s) would be required to make their trip in the general-purpose lanes and would receive no preferential treatment for sharing a ride.

<u>Shared BRT/HOV Lane</u>

Buses and HOV’s would operate together in a specially marked lane under this option. This option provides preferential treatment for people who choose to share a ride.

BRT DESIGN OPTIONS FOR THE 35W/HWY 62 INTERCHANGE

OPTION 1

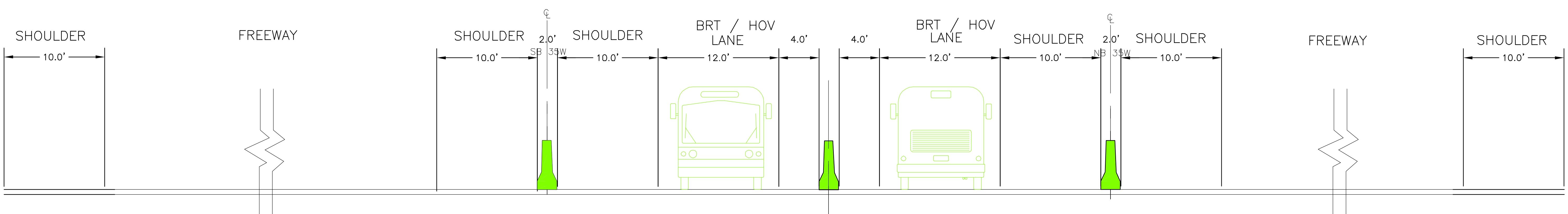
14' BARRIER-FREE LANE

OPTION 2

SHOULDER RUNNING BRT

OPTION 3

BARRIER-SEPARATED LANE



NO.	DATE	BY / CHK.	APPD.	REVISIONS

DESIGNED MRH DATE 1/19/04

DRAWN DATE

CHECKED DATE

APPROVED DATE

URS

SUBMITTED: DATE: APPROVED: DATE:

BRT TYPICAL SECTIONS
35W BRT STUDY
EXHIBIT A

SCALE: DRAWING NO.: REV.: CONTRACT NO.: SHEET NO.:

PLOT DATE: Mar 18, 2004 11:15am DISK FILE NAME: (15.06) R:\33519018\Working\mh\35W\012904\E1.dwg

Notes

CRITERIA FOR EVALUATING OPTIONS

Several criteria were used to evaluate the three design options and the two lane use options under consideration for the 35W/Highway 62 interchange. In this section, each of the options are assessed under the following criteria:

- Right-of-Way Requirements and Geometric Issues
- Bus Operations
- Traffic Operations and Freeway Capacity
- Air Quality
- Delay and Cost of Delay
- Capital Cost
- Benefit/Cost Analysis

Right of Way Requirements and Geometric Issues

The three design options were reviewed for their respective geometric and right of way impacts on the 35W/Highway 62 interchange with the results summarized below.

Design Option 1 - Provides a 13-foot enforcement shoulder plus a 14-foot HOV lane. The American Association of State Highway and Transportation Officials (AASHTO) recommends a shoulder width between 10 and 14 feet. Shoulders used for enforcement need to be on the higher end of this range. The 14-foot HOV lane provides for a recommended buffer space between the general-purpose lane and the HOV users. Design Option 1 was used as the basis for comparison with the other design options as it is the current design option for the 35W/Highway 62 interchange. The URS team reviewed plans dated October 16, 2003 with the notation “SP2782-281”.

Under Design Option 2 – *Shoulder Running Buses*, the right shoulders in the current design plans would need to be increased by at least three feet on each side, for a total increase of six feet. Generally, there are very few problems with increasing the width of the shoulders throughout the 35W/Highway 62 interchange. In the common section of 35W and Highway 62, the retaining walls will need to be moved out by three feet but it appears that adequate right-of-way is available. In the area north of 66th street additional retaining walls will be required due to high fill slopes.

Overall, this design option does not appear to have any significant impact on right of way needs, when compared with Design Option 1.

Design Option 3 – *Barrier Separated Lanes* presents the most significant impact when compared with the current design plans. To fit this option in to the current design plans for the 35W/Highway 62 interchange, an additional 11’ is required on each side of 35W for a total increase in width of 22’.

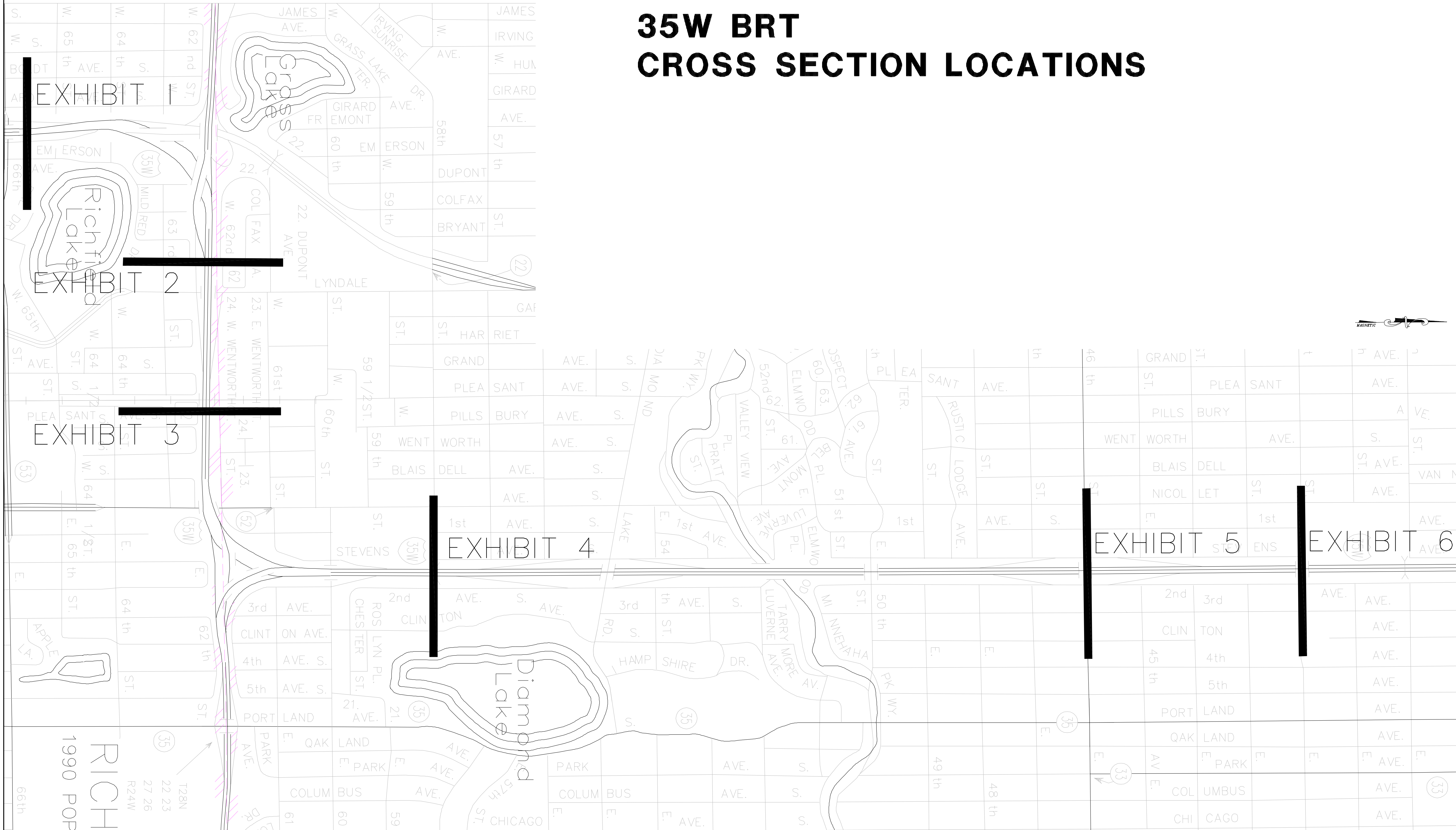
This design option has a significant impact on right of way needs. Based on the cross-sections analyzed by the URS Team, it appears additional right of way will be required in at least three areas:

- On the south side of the freeway at Lyndale Avenue, a commercial building could be impacted.
- At 35W and 60th Street approximately 8 homes on the east side would need to be acquired to maintain the ramp access from 60th Street.
- At 46th Street an estimated 46 homes would likely be impacted. This would be necessary to maintain the street in front of the remaining homes on the east side of the freeway while providing access to 35W.

To fully illustrate the impacts of increasing the width of the freeway through the 35W/Highway 62 interchange, a series of six cross sections were prepared and analyzed. The six cross sections depict all three design options and their relative impact to each other and the 35W/Highway 62 interchange.

The graphic on the following page shows the locations of the six cross section locations and is followed by each of the cross sections.

35W BRT
CROSS SECTION LOCATIONS



NO.	DATE	BY / CHK.	APPD.	REVISIONS

DESIGNED MRH DATE 1/19/04
DRAWN DATE
CHECKED DATE
APPROVED DATE

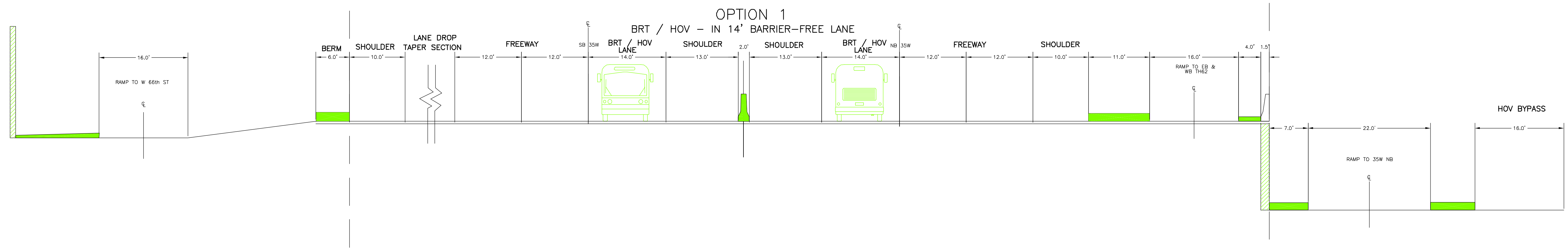
URS

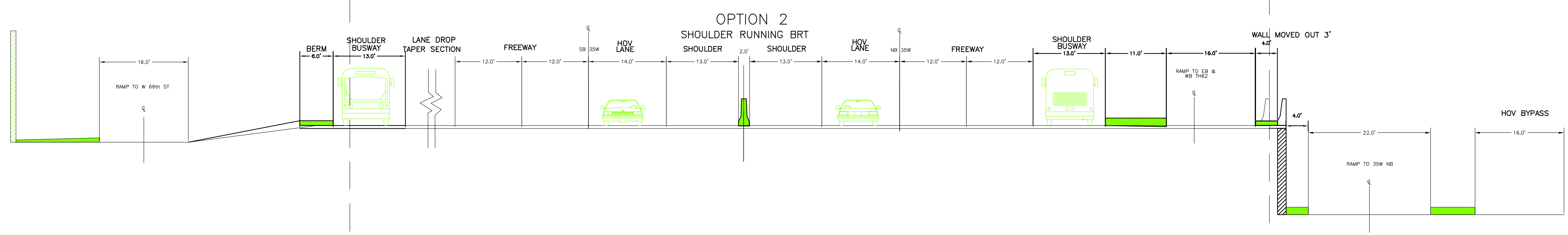
SUBMITTED: DATE: APPROVED: DATE:

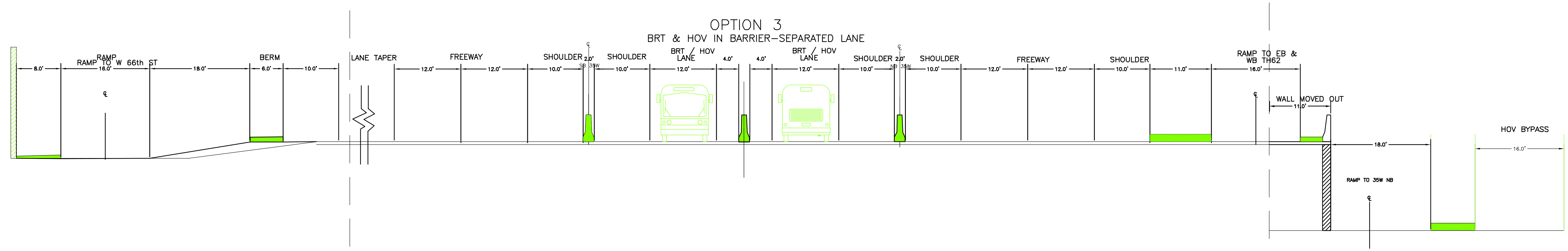
BRT TYPICAL SECTIONS
I-35W BRT STUDY
LOCATION MAP

SCALE: DRAWING NO.: REV.: CONTRACT NO.: SHEET NO.:

EXHIBIT 1 - CROSS SECTIONS AT 66TH ST







NO.	DATE	BY / CHK.	APPD.	REVISIONS

DESIGNED MRH DATE 1/19/04
DRAWN DATE
CHECKED DATE
APPROVED DATE

URS

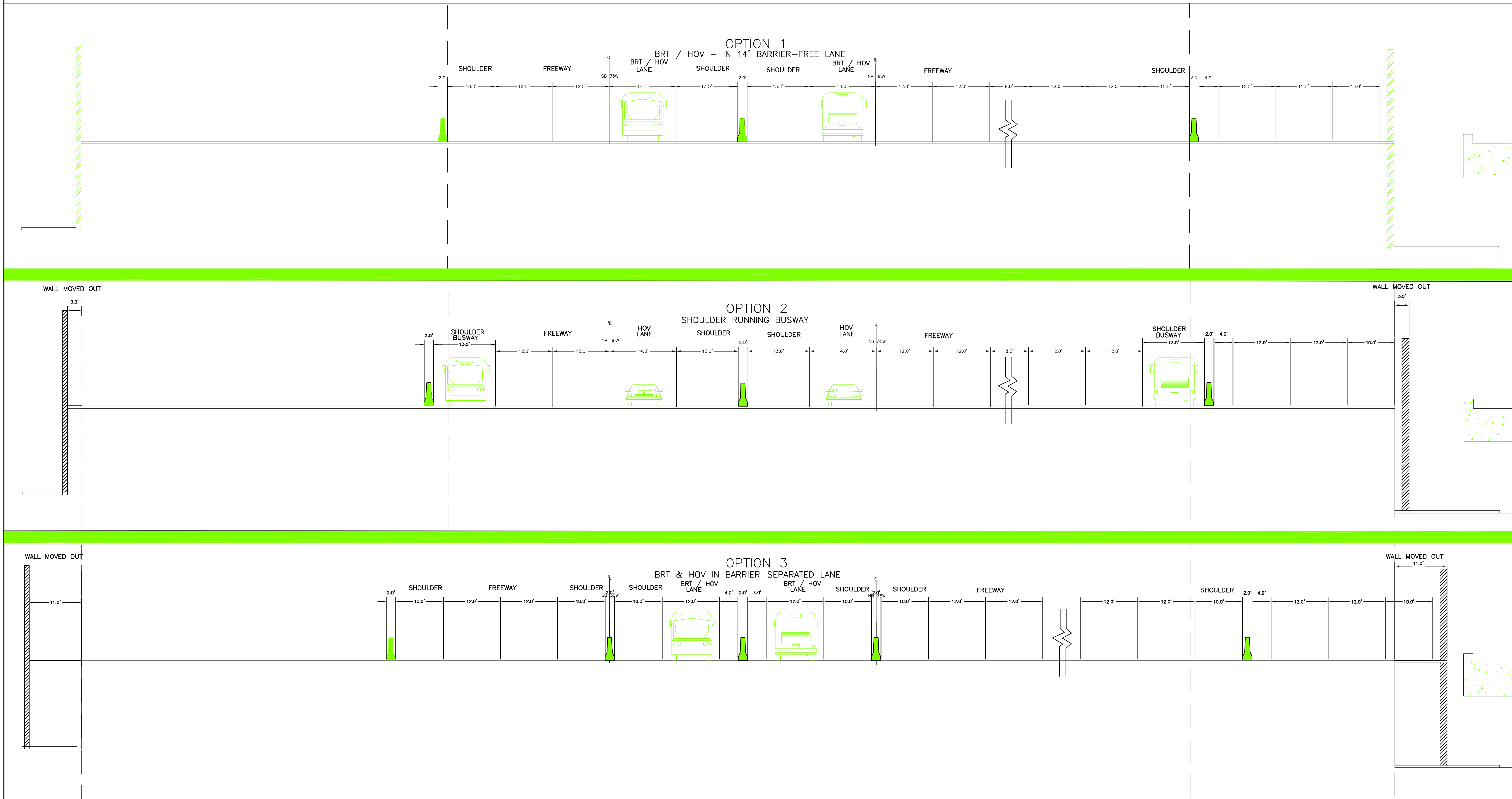
SUBMITTED: DATE: APPROVED: DATE:

BRT TYPICAL SECTIONS
35W BRT STUDY
EXHIBIT I
35W – STATION 408.45.44

SCALE: DRAWING NO.: EXHIBIT I REV.: CONTRACT NO.: SHEET NO.:

PLOT DATE: Feb 19, 2004 11:33am DISK FILE NAME: (15.06) R:\3359018\Working\mh\35W\OPT1.dwg

EXHIBIT 2 - CROSS SECTIONS WEST OF LYNDALE AVE.



NO.	DATE	BY / CHK.	APPD.	REVISIONS

DESIGNED MRH — DATE 1/19/04
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APPROVED — DATE

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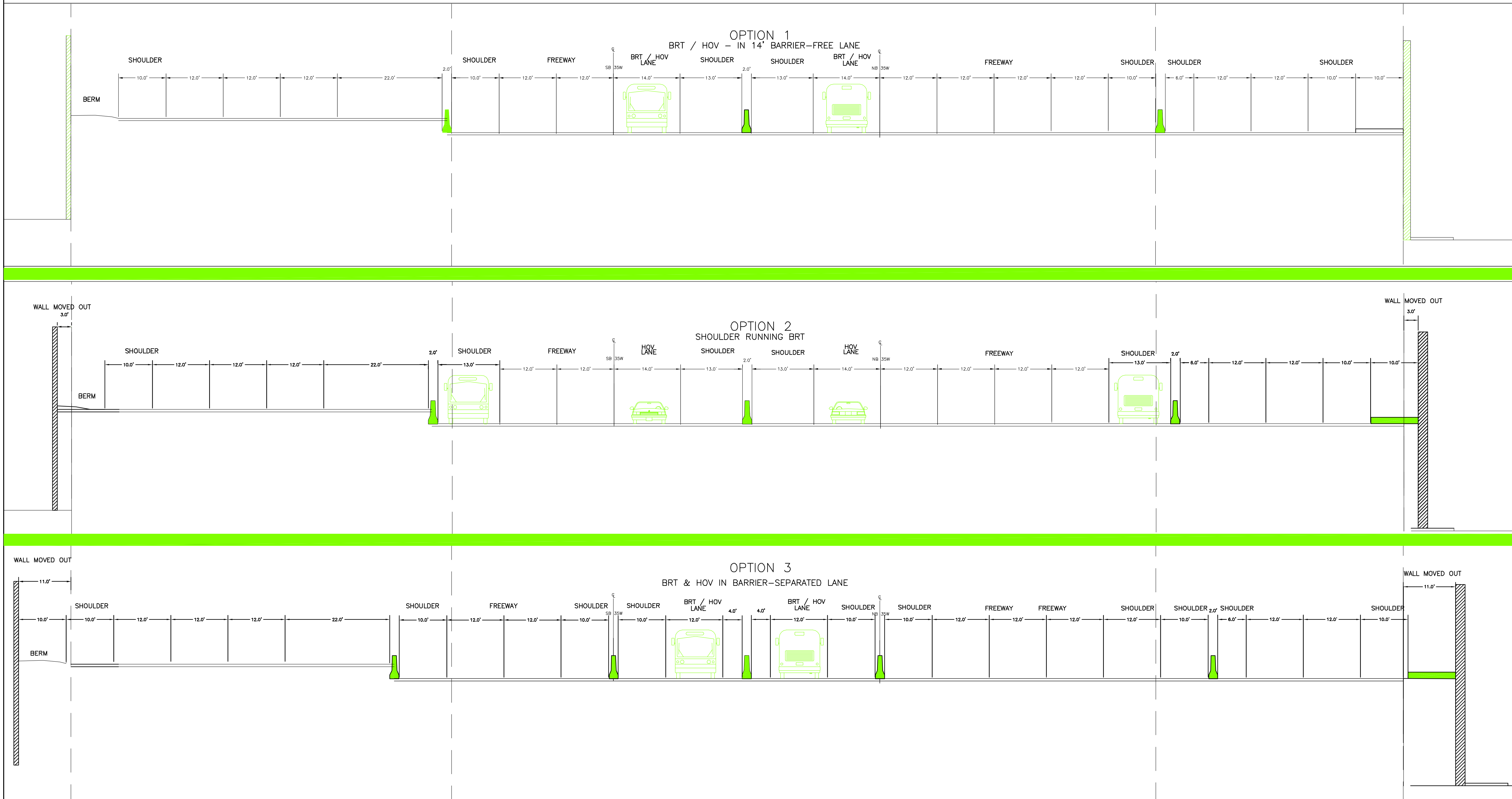
SUBMITTED: | DATE: | APPROVED: | DATE:

BRT TYPICAL SECTIONS
35W BRT STUDY
EXHIBIT 2
35W – STATION 441+29.54

SCALE: | DRAWING NO.: EXHIBIT 2 | REV.: | CONTRACT NO.: | SHEET NO.:

PLOT DATE: Jan 23, 2004 4:10pm DISK FILE NAME: (15.06) R:\33519018\Working\mh\35W\OPT2.dwg

EXHIBIT 3 - CROSS SECTIONS AT PLEASANT AVE.



NO.	DATE	BY / CHK.	APPD.	REVISIONS

DESIGNED MRH DATE 1/19/04
DRAWN DATE
CHECKED DATE
APPROVED DATE

URS

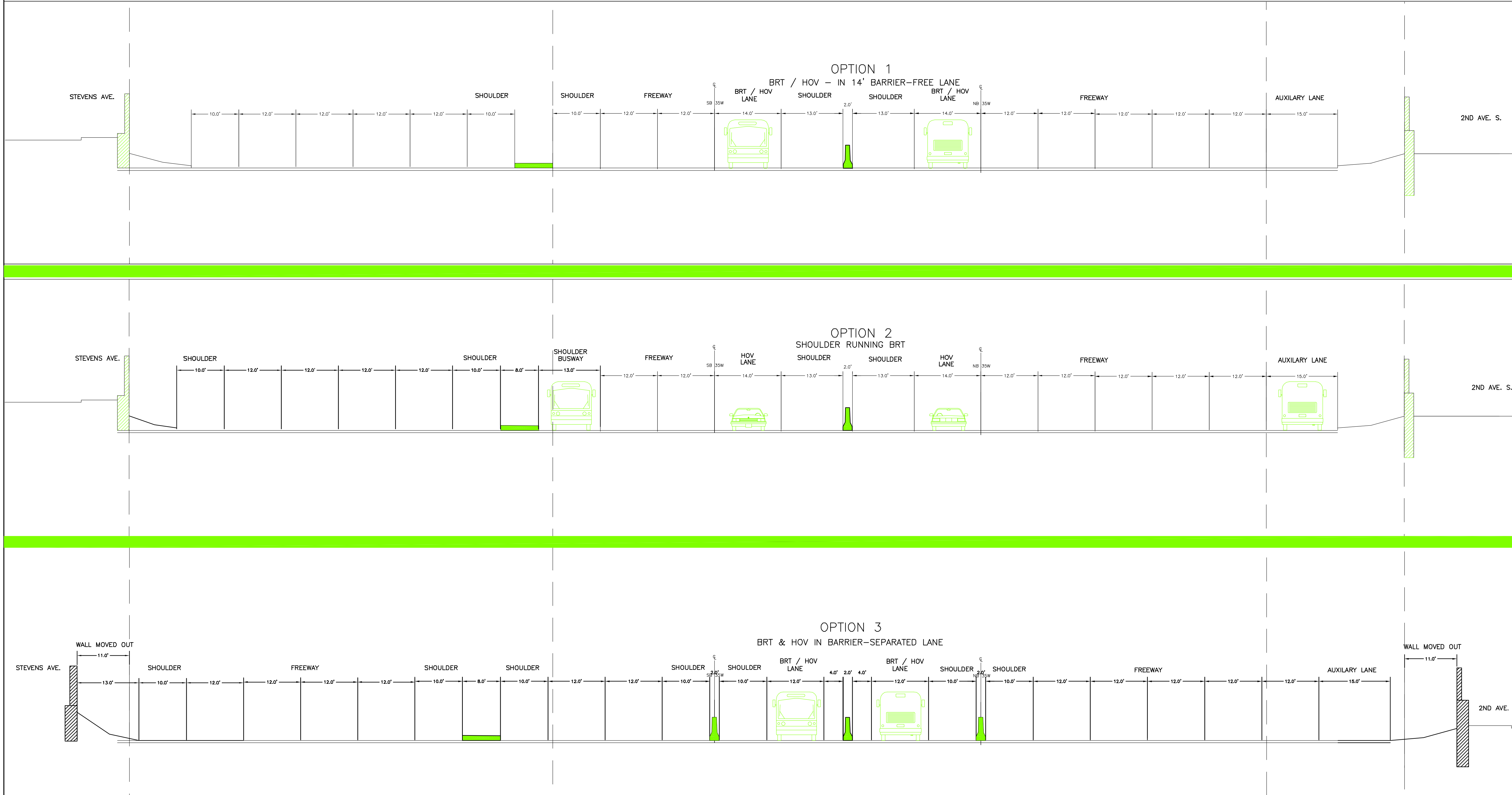
SUBMITTED: DATE: APPROVED: DATE:

BRT TYPICAL SECTIONS
35W BRT STUDY
EXHIBIT 3
35W – STATION 459+12.56

SCALE: DRAWING NO.: EXHIBIT 3 REV.: CONTRACT NO.: SHEET NO.:

PLOT DATE: Jan 23, 2004 4:12pm DISK FILE NAME:

EXHIBIT 4 - CROSS SECTIONS AT 58th ST



PLOT DATE: Jan 19, 2004 2:40pm DISK FILE NAME: (5.06) R:\3359018\Working\mh\35W\OPT4.dwg

NO.	DATE	BY / CHK.	APPD.	REVISIONS

DESIGNED MRH DATE 1/19/04
DRAWN DATE
CHECKED DATE
APPROVED DATE

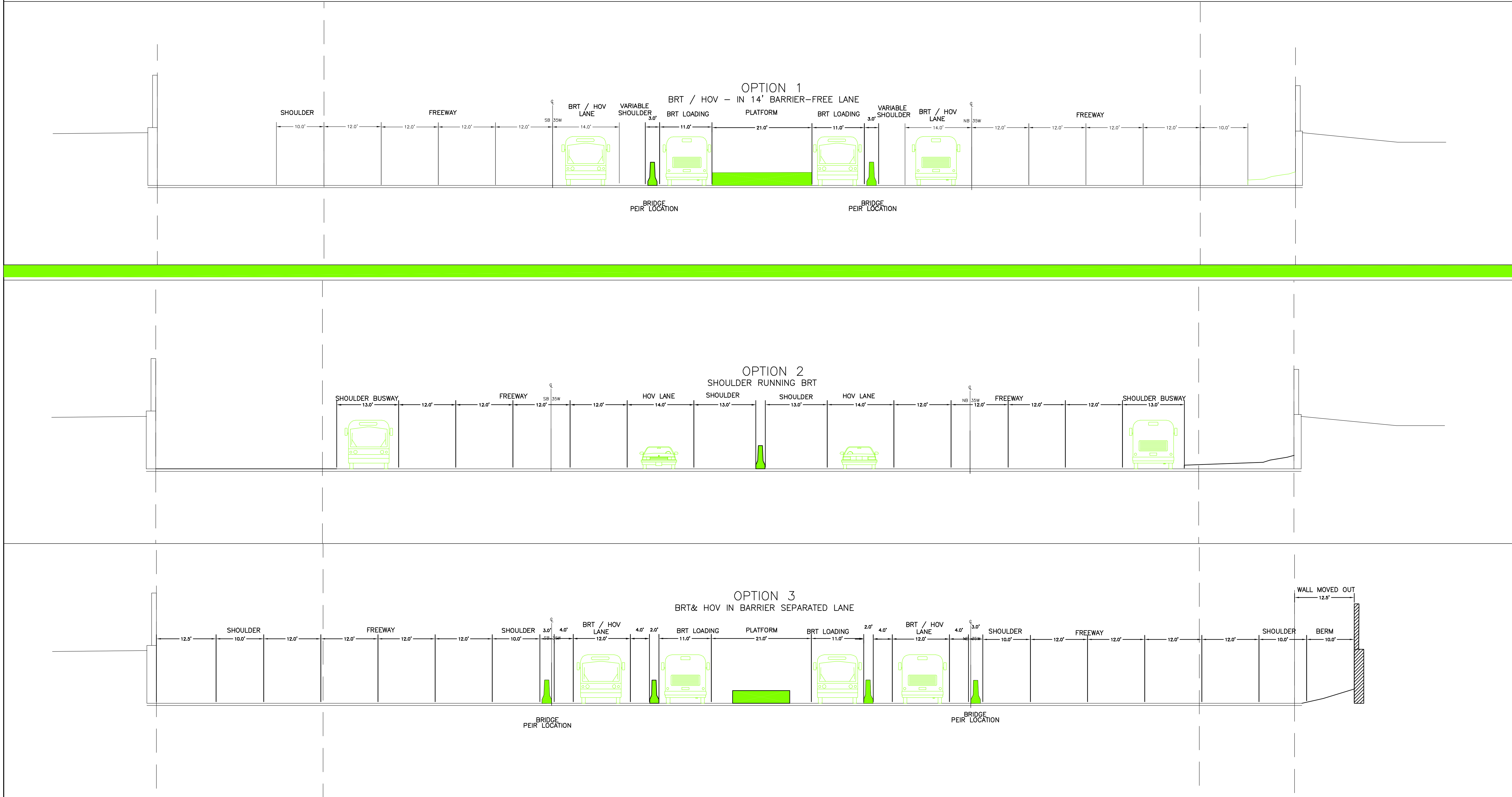
URS

SUBMITTED: DATE: APPROVED: DATE:

BRT TYPICAL SECTIONS
35W BRT STUDY
EXHIBIT 4
35W – STATION 502+82.74

SCALE: DRAWING NO.: EXHIBIT 4 REV.: CONTRACT NO.: SHEET NO.:

EXHIBIT 5 - CROSS SECTIONS AT 46th ST STATION



NO.	DATE	BY / CHK.	APPD.	REVISIONS

DESIGNED MRH	DATE 1/19/04
DRAWN	DATE
CHECKED	DATE
APPROVED	DATE

URS

SUBMITTED: DATE: APPROVED: DATE:

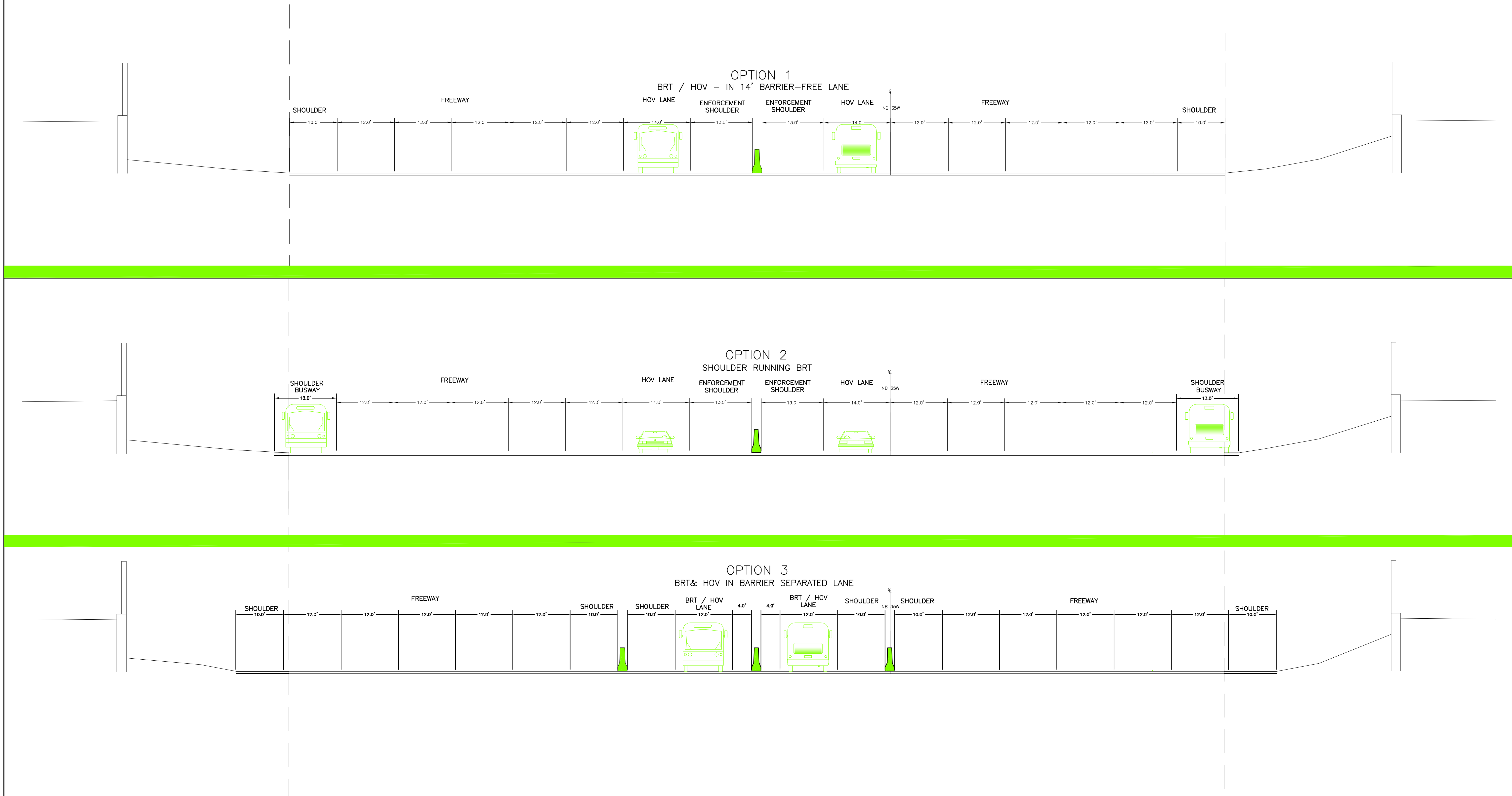
BRT TYPICAL SECTIONS
35W BRT STUDY
EXHIBIT 5
35W – STATION 579+32.53

SCALE: | DRAWING NO.: EXHIBIT 5 | REV.: | CONTRACT NO.: | SHEET NO.:

PLOT DATE: Jan 23, 2004 4:19pm DISK FILE NAME: (15.06) R:\335\9018\Working\mn\35W\OPTS.dwg

EXHIBIT 6 - CROSS SECTIONS AT 42ND ST

NOTE: SIMILAR SECTIONS APPLIES UP TO 41st ST. NORTH OF 41st ST. SECTION WIDENS TO ACCOMODATE PROPOSED INTERCHANGE AT 38th ST.



NO.	DATE	BY / CHK.	APPD.	REVISIONS

DESIGNED: MRH — DATE: 1/19/04
DRAWN — DATE
CHECKED — DATE
APPROVED — DATE

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SUBMITTED: | DATE: | APPROVED: | DATE:

BRT TYPICAL SECTIONS
35W BRT STUDY
EXHIBIT 6
35W – STATION 605+58

SCALE: | DRAWING NO.: EXHIBIT 1 | REV.: | CONTRACT NO.: | SHEET NO.:

PLOT DATE: Feb 19, 2004 10:26am DISK FILE NAME: (5.06) R:\3359018\Working\mh\35W\OPT6.dwg

Following are comments on the impacts associated with each of the six cross-sections as they relate to introducing Design Option 3 – *Barrier Separated Lanes* into the 35W/Highway 62 interchange.

Exhibit 1 – North of 66th Street

This section is just north of 66th Street at station 408+45. On the east side, the retaining wall needs to move out eleven feet and will move into the current ramp from 66th Street to 35W NB. If the ramp were moved over with the same geometrics the alley on the other side of the noise wall would be closed. This would likely require the purchasing of homes in the area. The other alternative would be to remove the HOV bypass lane for this ramp.

The impacts on the west side appear to be minimal at this cross-section. It is also clear that the 66th Street Bridge would need to be wider to accommodate the barrier-separated design.

Exhibit 2 – *West of Lyndale Avenue*

This section is located near Lyndale Ave. at station 441+29. At this location the wall on the east side moves out eleven feet closer to the bridge that carries the ramp from 35W NB to TH 62 EB and the exit ramp from TH 62 EB to Lyndale Ave. If the bridge and the ramp need to be moved over 11 feet then the business in the southwest corner would likely need to be purchased. This is a complicated geometric design for this area and the impact of moving the roadway over could also present some significant design problems such as longer bridge spans. A more detailed study is also needed to see if the local street (W 62nd St) can remain open between Garfield Ave. and Harriet Ave.

On the west side the wall moves out right to the curb of the local street between Lyndale Ave. and Aldrich Ave. So. Due to right-of-way purchases in that block, it appears possible to move the roadway north to provide some space between the wall and the road.

Exhibit 3 - *Pleasant Avenue*

This cross-section is between the railroad and Nicollet Ave. at station 459+12. At this location, walls on each side of the common area need to move out by eleven feet. On the south side the local connection between Pillsbury Ave. So. and Wentworth Ave. So. needs to be move south. There appears to be enough right-of-way to accommodate this move. On the north side the wall gets very close to the existing local street.

Exhibit 4 – *58th Street*

This section is at station 502+82, which is on the north side of East 59th Street.. The west side moves out eleven feet into Stevens Ave. Therefore it is likely that Stevens would have to be changed to a one-way Street to allow access to homes in that area. The east side wall moves out very close to 2nd Ave and does not appear to be in the road as it is on the west side.

Exhibit 5 – *46th Street*

This section is located at the 46th Street Station. This is the widest section needed and requires an additional twelve feet in each direction to accommodate the station over the current Mn/DOT design plans. It appears that the east side is impacted more by this increase but a more detailed development of a layout is needed to do a complete evaluation.

Based on the cross section, it appears that the ramps need to be moved out on the east side and there would not be space to continue 2nd Street So. through the interchange area. Approximately 46 homes on the east side would not have a street access. For purposes of this evaluation, it is assumed that these homes would be purchased.

Exhibit 6- *42nd Street*

The section width narrows up going north of the 46th Street Station. This section in Exhibit 6 is drawn up just south of the 42nd St Bridge. The section of Option 3 is accommodated within the section shown for Option 1 without moving any walls out. This is true until north of 41st. Street when the width is increased for the proposed 38th St. interchange.

Without completely redrawing the layout, it is difficult to fully evaluate the total impact of Design Option 3 – *Barrier Separated Lane*. There is a potential that the barrier separated lane option will not fit as proposed even if an additional twenty-two feet is provided in the 35W/Highway 62 interchange. Several areas need closer evaluation as follows:

- The access points from Highway 62 become more difficult to fit, especially the movement from WB TH 62 to NB 35W. The nose of that merge would be moved over eleven feet to the east, which would affect the degree of curve for the ramp, which is already tight. This would also potentially shorten up the merge distance provided for the Portland Ave on-ramp.
- The WB TH 62 ramp to SB 35W also needs to be adjusted along with the access from EB TH 62 and Lyndale Ave. This area has a very short weave for the 66th Street access and if this option is seriously considered a more in-depth look at the geometrics of this area is necessary.
- The 66th Street ramps may also be a problem area. To maintain ramp access on the east side 2nd Ave So. can not be continued. It is estimated that eight homes along the ramp would have to be purchased to maintain that ramp access.

Bus Operations

<u>Operating Speeds</u>

Design Option 1 – *Barrier-Free Lanes* are expected to operate near or at the posted speed for 35W. This is a critical element to successful BRT service as one of the most important characteristics of BRT service is that it offers people quick service with travel times as fast or faster then traveling alone in their car.

Under Design Option 2 – *Shoulder Running Buses* Minnesota State Law limits bus speeds to 15 MPH over the speed of traffic in the general-purpose lanes up to a maximum of 35-MPH[6]. This significantly increases the travel time for the buses when compared with buses that are operating at the posted speed under the barrier-free or barrier separated options. Potential conflicts may also occur at entrance and exit ramps as well as when buses travel through the 35W/Highway 62 "split" which requires a number of lane shifts from the 35W shoulders. An additional concern with Design Option 2 is that the shoulders may not be available at certain times due to major weather events (e.g. snowstorm) or disabled vehicles parked on the shoulder. While Design Option 2 represents the current practice on 35W, the barrier-free and barrier separated options offer significantly better operating speeds and reliability.

Design Option 3 – *Barrier Separated Lanes* are expected to operate near or at the posted speed for 35W. This is a critical element to BRT service as one of the most important characteristics of BRT service is that it offers people quick service with travel times as fast or faster then traveling alone you their car.

Another consideration for operating speeds is the operation of the BRT lane as a shared lane with HOV's or as a BRT only lane. If only buses were operating in the BRT lane, then buses would easily be able to operate at the posted speed limits. This attributable to the fact that currently 82 buses operates in one hour in a lane that can accommodate up to 2,000 vehicles. Even with accounting for growth in the number of buses over time, there will still be a significant amount of unused capacity in the BRT only lane.

By introducing HOV's to the BRT lane, the unused capacity is taken up by the HOV's and the freeway is more fully utilized. However, this does run the risk of slowing the bus operating speeds. While it is clear that some number of HOV's can be added to the BRT lane (e.g. 1,500 per hour) and operating speeds can be maintained, the number of HOV's permitted into the BRT lane should be managed to insure that buses are able to operate at the posted speeds.

Bus Station Locations

Design Option 1 – *Barrier-Free Lanes* would operate in a center running configuration, whereby buses operate on either side of the median in the center of the freeway. This configuration requires bus stations to be located in the center of the freeway with vertical access provided to local bus routes via stairs and an elevator.

This configuration is consistent with the current design plans that are being considered for a bus station north of the 35W/Highway 62 interchange area at Lake Street. Under this configuration, as buses approach the station, they would move off the BRT lane into an exclusive lane as they enter the station. Just prior to entering the stations, buses would shift to the left allowing them to arrive at the station from the left-hand side. This shift is necessary to permit passenger loading from the right-hand side of the buses, which is how all metro area buses are currently designed.

[6] Minnesota Statutes, Chapter 169.306 Use of Shoulders by buses.

A significant advantage with this center running configuration is its consistency with the design plans for the proposed Lake Street bus station. Additionally, design plans for the 35W/Highway 62 interchange has enough right of way to accommodate a bus station at 46th Street.

Design Option 2- *Shoulder Running Buses* would not be able to take advantage of center bus stations. For this option, two separate stations would need to be built (vs. one under the center running options) at each stop to accommodate the buses operating on the right-hand shoulders. In addition to the added expense of building two stations at each stop, passengers would experience additional time for transferring to local bus routes then if they made the transfer at one central station.

Design Option 3 – *Barrier Separated Lanes* would operate in a center running configuration, whereby buses operate on either side of the median in the center of the freeway. This configuration requires bus stations to be located in the center of the freeway with vertical access provided to local bus routes via stairs and an elevator.

This configuration is consistent with the current design plans that are being considered for a bus station north of the 35W/Highway 62 interchange area at Lake Street. Under this configuration, as buses approach the station, they would move off the BRT lane into an exclusive lane as they enter the station. Just prior to entering the stations, buses would shift to the left allowing them to arrive at the station from the left-hand side. This shift is necessary to permit passenger loading from the right-hand side of the buses, which is how all metro area buses are currently designed.

A significant advantage with this center running configuration is its consistency with the design plans for the proposed Lake Street bus station. Additionally, Mn/DOT design plans for the 35W/Highway 62 interchange allows for enough space in the center of the freeway to accommodate a bus station at 46th Street.

Entering/Exiting the BRT Lanes

An important distinction under Design Option 1 – *Barrier-Free Lanes* is that buses can enter and exit the BRT lane at any point throughout the interchange area. As illustrated in the graphics on pages 6 and 7, buses join 35W in a number of places throughout the interchange area. The absence of barriers allows buses to shift from the general-purpose lanes and into a BRT lane at any point throughout the interchange area. This flexibility allows buses to take advantage of the benefits of the BRT lanes much sooner then if the buses were prevented from entering the BRT lane due to a barrier.

Under Design Option 2- *Shoulder Running Buses*, buses would have generally good access to and from the shoulder running bus lane throughout the interchange area. This option does not provide as much flexibility as is found under Design Option 1 as buses may be restricted in their movements in and around the entrances and exits to ramps. Another factor that could limit the ability of buses to exit/enter the BRT lanes is the presence of vehicles that use the shoulder when their vehicle is broken down or when the shoulder is unavailable due to weather events.

Under Design Option 3 – *Barrier Separated Lanes* buses would only be able to access the BRT lane where gaps are created in the barriers allowing vehicles to enter and exit the barrier separated lanes at designated locations. Based on AASHTO guidelines[7], an opening of approximately 2,000' is required to allow vehicles to enter/exit a barrier separated roadway. Following this guideline, there would be no opportunity to provide for an opening in the 35W/Highway 62 interchange area; openings could only be provided on the northern and southern edges of the interchange area, and then only if those openings are consistent with the future design plans for 35W north and south of the interchange.

Bus Operations Summary

Each option provides its own set of advantages and disadvantages as noted earlier. The table below summarizes the operating characteristics as they relate to bus operations and assigns a numerical value as follows: 1 represents the option that is most favorable; 2 represents the second most favorable option and 3 represents the option that is least favorable.

Ranking of Design Options and Key Bus Operating Characteristics

Operating Characteristic	Option 1 Barrier-Free	Option 2 Shoulder Running	Option 3 Barrier Separated
Operating Speeds	1	3	1
Bus Station Location	1	3	1
Entering/Exiting BRT Lane	1	1	3
Totals	3	7	5

Options 1 and 3 are comparable in terms of operating speed, while Option 2 is the least favorable option when considering operating speed. The bus station location criterion has a similar finding with Options 1 and 3 comparable and Option 2 being the least favorable. For entering and exiting the BRT lane, Options 1 and 2 are comparable with option 3 being the least favorable.

Overall, Design Option 1 – *Barrier-Free Lanes* is considered the most favorable design option from a bus operations perspective.

As to the option of operating as a BRT only lane or operating the lane as a BRT/Shared HOV Lane the following table summarizes the findings.

Ranking of BRT Only vs. Shared BRT/HOV Lane

Operating Characteristic	BRT Only Lane	Shared BRT/HOV Lane
Operating Speeds	1	2
Totals	1	2

[7] This guide was prepared in July 2002 for the American Association of State Highway and Transportation Officials

As noted in the previous discussion, if only buses were operating in the BRT lane, then buses would easily be able to operate at the posted speed limits. By introducing HOV's to the BRT lane it runs the risk of slowing the bus operating speeds. While it is clear that some number of HOV's can be added to the BRT lane (e.g. 1,500 per hour) and operating speeds can be maintained, the number of HOV's permitted into the BRT lane should be managed to insure that buses are able to operate at the posted speeds.

Overall, if buses are able to operate at the posted speeds, then either the BRT Only or the shared BRT/HOV lane would be acceptable.

Traffic Operations

An important distinction between the design options is their ability to safely accommodate enforcement activities throughout the interchange area. Under Design Option 1 – *14' Barrier-Free Lanes* a 13' left hand enforcement area/shoulder is provided for. Under Design Option 2 – *Shoulder Running Buses*, a 13' left hand enforcement area/shoulder is also provided for.

Design Option 3 – *Barrier Separated Lanes* provides for a 10' shoulder between the general purpose lanes and the barrier along with a 10' shoulder between the barrier and the BRT/HOV lane. The 10' shoulders provided in Design Option 3 do not provide a safe enforcement area throughout the interchange.

When compared with the current design plans (Option 1 – *Barrier Free Lanes*), the design elements of Option 2 – *Shoulder Running Buses* and Option 3 – *Barrier Separated Lanes* will have a minimal impact on traffic operations, other than the impacts on enforcement as noted above. Additionally, the design elements of these options will not change either the volume or capacity of the I-35W Corridor. Capacity and volume are impacted by decisions on how the lanes are managed. These impacts are discussed in greater detail in the following section.

Freeway Capacity

The Twin Cities Regional Travel Demand Model[8] and modeling results from the 35W/Highway 62 Interchange project were used as the basis for evaluating the impacts on miles and hours of travel associated with each alternative as they relate to Mn/DOT's current design plans, Design Option 1 – *14' Barrier-Free Lanes.*

The analysis for this study used the previous work as a baseline and developed modeling for Design Option 2- *Shoulder Running Buses* and Design Option 3 – *Barrier Separated Lanes.*

The minimal operational impacts that are anticipated include changes to access points to / from a barrier separated transit facility, or impacts related to bus shoulder operation such as conflicts at entrance and exit ramps, and speed differentials.

[8] This is the accepted travel demand model that is used by the Metropolitan Council for travel demand forecasting.

Overall, operating only buses in the potential BRT lane has a detrimental impact to the VMT and VHT modeling results due to HOV users needing to use the general purpose lanes or to seek alternate routes that require more time and distance. The model results indicate that 5,000 – 7,000 vehicles per day would no longer use the corridor and seek alternate routes and modes.

If HOV’s are not allowed in the BRT lane, VMT increases over the BRT/HOV shared lane options primarily due to vehicles traveling further to avoid the ensuing congestion, along with fewer carpools resulting from the loss of incentive to carpool. Similarly, VHT also increases due to the additional time that people experience when they travel further to avoid the congestion or due to the increased time for those caught in the congestion.

The table below provides the regional VMT and VHT results of the travel demand modeling.

Estimated Daily 2030 VMT and VHT by Lane Use

Distance & Time	No Build	Shared HOV/BRT Lane	Bus Shoulders (with HOV Lanes)	BRT Only Lane
VMT (Miles)	95,716,244	95,763,078	95,763,078	95,821,559
VHT (Hours)	2,796,692	2,787,324	2,787,324	2,799,016

The two tables below illustrate the change in capacity by forcing HOV's into general-purpose lanes. Generally, the capacity of the freeway is reduced by approximately 18 - 35% , which results in an increase in congestion and vehicles diverting from the freeway to other routes or modes of travel. The lane capacities used in the tables and subsequent discussion are from the Twin Cities Regional Travel Demand Model.

Freeway Capacity per Hour

Four General Purpose Lanes & HOV/BRT Lane
NORTH of I-35W / TH 62 Interchange

	General Purpose Lanes					
Lane Use Options	Lane 1	Lane 2	Lane 3	Lane 4	HOV/BRT Lane	Total One-Way Cross Section Capacity
Shared Lane	1,950	1,950	1,950	1,950	1,500	9,300
BRT Only	1,950	1,950	1,950	1,950	87 Buses[9]	7,887

[9] Current maximum buses per hour operated in the 35W/Highway 62 interchange.

Freeway Capacity per Hour

Two General Purpose Lanes & HOV/BRT Lane
SOUTH of I-35W / TH 62 Interchange

Lane Use Options	General Purpose Lanes Lane 1	Lane 2	HOV/BRT Lane	Total One-Way Cross Section Capacity
Shared Lane	1,950	1,950	1,500	5,400
BRT Only	1,950	1,950	87 Buses	3,987

Although the level of detail of this report does not provide operation level analysis, it can be concluded that when HOVs share the general-purpose lanes, they will increase the overall congestion on the freeway and the supporting roadway system.

The regional model shows that some drivers will shift to transit and some HOVs will shift to SOVs due to the absence of the HOV facility. However, the regional model concludes that most HOVs and SOVs will continue as HOVs and SOVs and some will seek other routes.

Assessment of BRT Only Lane vs. Shared BRT/HOV Lane

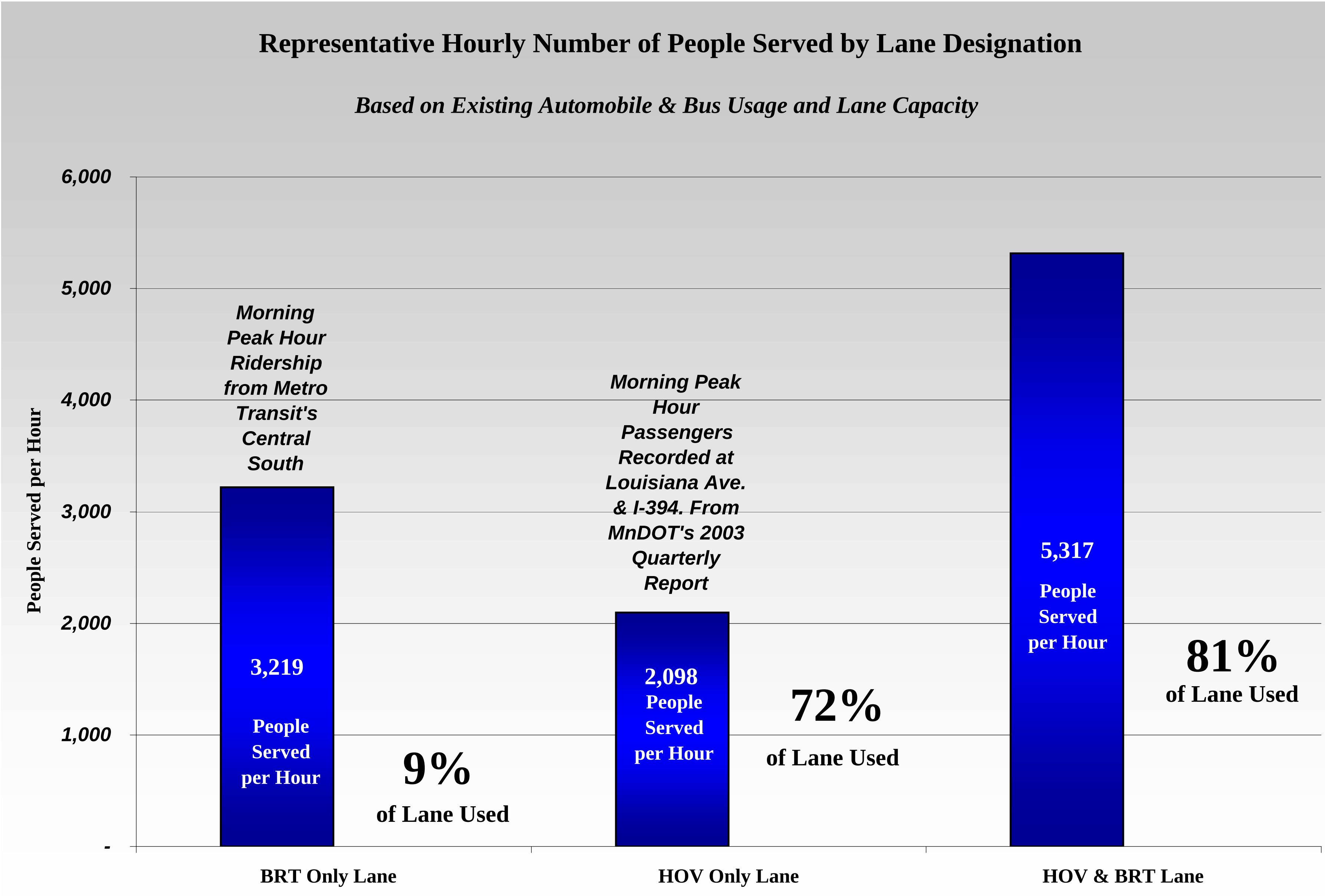
The most significant distinction between these two approaches for managing the BRT lane is the impact on vehicle capacity through the 35W/Highway 62 interchange.

Using the lane capacities from the Twin Cities Regional Travel Demand Model, a typical freeway lane can accommodate up to 1,950 vehicles per hour and an HOV lane can accommodate approximately 1,500 vehicles per hour.

As noted earlier in this report, there is currently a maximum of 87 bus trips that are made in one hour on 35W through the 35W/Highway 62 interchange.

With only 87 vehicles using a lane that can accommodate approximately 1,500 to 1,950 vehicles per hour, a significant amount of unused capacity would exist if no other vehicles were allowed to use the BRT lane. By adding HOV vehicles to a BRT lane, the overall capacity of the 35W/Highway 62 interchange will increase significantly.

The chart on the following page depicts the range in the number of people that can be served by a single lane per hour, depending on how the lane is managed. The chart is based on existing automobile and bus usage along with the lane capacities found in the Twin Cities Regional Travel Demand Model.



Representative Hourly Number of People Served by Lane Designation
Based on Existing Automobile & Bus Usage and Lane Capacity
People Served per Hour
6,000
5,000
4,000
3,000
2,000
1,000
-
Morning Peak Hour Ridership from Metro Transit's Central South
3,219
People Served per Hour
9%
of Lane Used
Morning Peak Hour Passengers Recorded at Louisiana Ave. & I-394. From MnDOT's 2003 Quarterly Report
2,098
People Served per Hour
72%
of Lane Used
5,317
People Served per Hour
81%
of Lane Used
BRT Only Lane
HOV Only Lane
HOV & BRT Lane

The number of transit passengers was calculated by multiplying the maximum number of bus trips in the morning peak hour by the average number of passengers per trip[10]. The number of people using the HOV lane is based on the reported volume[11] of vehicles using the HOV lanes on I-394 at Louisiana Avenue. It is important to note that this figure includes violators which is estimated at 12% of the total number of observed automobiles.

The estimated number of people that could be served in a shared BRT/HOV lane was calculated by adding the number of transit passengers and the number of HOV passengers per hour.

The table below summarizes the calculations that were used to make the chart on the previous page.

Lane Designation	Vehicles	People Served per Hour	Percent of Lane Used	Lane Capacity
BRT Only Lane	87 (131**)	3,219	9%	1,500
HOV Only Lane*	1,074	2,098	72%	1,500
HOV & BRT Lane	1,205	5,317	81%	1,500

** HOV lane volume is based on reported HOV volumes on I-394 at Louisiana Avenue.*
(From MnDOT's 2003 Quarterly Report - 4th Quarter)
*** For purposes of calculating volume, a passenger car equivalence of 1.5 was used for each bus.*
(From the Highway Capacity Manual 2000)

The graphic demonstrates that how the lane is managed can significantly impact the number of people who are served by the lane in one hour.

[10] 37 passengers per bus - Metro Transit's AM peak hour bus capacity from the Central South Transit Study.
[11] HOV lane volume is based on reported HOV volumes on I-394 at Louisiana Avenue from MnDOT's 2003 Quarterly Report – 4th Quarter.

Air Quality

Option 1 – *Barrier Free Lanes* is included in the State Implementation Plan (SIP) and the air quality for this option has already been analyzed for inclusion in the SIP. The focus of our analysis for air quality is the incremental difference from the analysis in the SIP as it relates to the other options being considered for the 35W/Highway 62 interchange.

Ambient air quality is a function of many factors, including climate, topography, meteorological conditions and the production of airborne pollutants by natural or artificial sources. Major airborne pollutants of interest in the 35W/Highway 62 interchange area include carbon monoxide, particulate matter, and ozone.

- *Carbon Monoxide* – Carbon monoxide (CO) is an odorless, colorless gas formed by the burning of fuels containing carbon. Motor vehicles are the principal source of CO emissions in urban areas. Maximum concentrations usually occur near intersections and other areas of traffic congestion, and they decrease rapidly with distance from the source.

- *Particulate Matter* – Particulate matter enters the air from industrial operations, vehicular traffic and other sources, including fireplaces. Most of the particulate matter generated by motor vehicles consists of resuspended road dust. Measurements of particulate matter concentrations include TSP (total suspended particulates), PM_{10} (particles with a diameter less than or equal to 10 micrometers), and $PM_{2.5}$ (particles with a diameter less than or equal to 2.5 micrometers).

- *Ozone* – Ozone (O_3) in the lower atmosphere is a harmful air pollutant and contributes to the formation of smog. It is a secondary pollutant formed by the reaction of volatile organic compounds and oxides of nitrogen in the presence of strong sunlight. Thus, minimizing emissions of those precursor pollutants reduces ozone levels.

- *Volatile Organic Compounds* – Volatile organic compounds (VOC) are a key component in the formation of ozone. These hydrocarbons are emitted or evaporate into the atmosphere from a variety of sources, particularly the storage and combustion of fuels in motor vehicles.

- *Oxides of Nitrogen* – Oxides of nitrogen (NO_X) are another precursor to the formation of ozone. They are produced as the result of high-temperature fuel combustion and subsequent atmospheric reactions. Major sources of NO_X include diesel engines, power plants, refineries and other industrial operations.

For the purposes of this analysis, air quality impacts are defined as the incremental change in Year 2030 regional emissions of CO, VOC, and NO_X when comparing all options to Option 1 – *Barrier Free Lanes*. The relative differences in regional pollutant levels among the options are attributed entirely to changes in daily vehicular emissions. Differences in vehicular emissions are a direct function of the change in daily vehicle-miles traveled (VMT) and pollutant emission rates.

The specific steps in the air quality analysis include the following:

- Identify the impact of each option on the Year 2030 regional VMT.

- Estimate Year 2030 average pollutant emission rates for CO, VOC and NO_X.
- Determine the relative regional pollutant emissions for each option by applying the emission rates to the corresponding changes in regional VMT.
- Compare the relative pollutant emissions to identify potential regional air quality impacts.

The change in regional VMT for each of the options were derived from the Twin Cities Regional Travel Demand Model, (see Traffic Operations and Freeway Capacity Section). Model runs were based on Year 2030 socioeconomic forecasts that reflect the most recent projections, disaggregated to the model traffic analysis zone level.

Comparing the highway network assignments for each option provided an estimate of the change in regional VMT due to mode shift and changes in freeway operations. The resulting net VMT changes were used as the basis of the regional air quality analysis.

Year 2030 emission rates for CO, VOC and NO_X were estimated using the U.S. Environmental Protection Agency (U.S. EPA) MOBILE 6 model with selected parameters adjusted to reflect assumed conditions in the Twin Cities.

Generally, the resultant change in pollutants is small when compared to the entire region's emission inventory; however, operating only buses in the BRT lane does result in an increase in emissions per year. This is directly attributed to the additional miles that people will travel to avoid the congestion that is anticipated on 35W if HOV's are required to use the general-purpose lanes.

The tables on the following page summarizes the results of the Year 2030 regional air quality analysis.

Annual Changes in Criteria Pollutant and Precursor Emissions (Year 2030)

1) Impacts of Bus Shoulders compared to Shared BRT / HOV Lane:

Regional VMT/Year (millions)[1]		Emission Factor (g/mi)[2]				Annual Emissions (tons)[3]								Change in Emissions (tons per year)			
						Shared BRT/HOV Lane				Bus Shoulder				Additional Emissions Associated with Bus Shoulder			
Shared BRT/HOV Lane	Bus Shoulder	CO	NOx	VOC	PM-10	CO	NOx	VOC	PM-10	CO	NOx	VOC	PM-10	CO	NOx	VOC	PM-10
34,936	34,936	13.775	0.375	0.36	0.08	529,427	14,413	13,836	3,075	529,427	14,413	13,836	3,075	0	0	0	0

2) Impacts of BRT Only Lane compared to Shared BRT / HOV Lane:

Regional VMT/Year (millions)[1]		Emission Factor (g/mi)[2]				Annual Emissions (tons)[3]								Change in Emissions (tons per year)			
						Shared BRT/HOV Lane				BRT Only Lane				Additional Emissions Associated with BRT Only Lane			
Shared BRT/HOV Lane	BRT Only Lane	CO	NOx	VOC	PM-10	CO	NOx	VOC	PM-10	CO	NOx	VOC	PM-10	CO	NOx	VOC	PM-10
34,954	34,975	13.775	0.375	0.36	0.08	529,686	14,420	13,843	3,076	530,010	14,429	13,851	3,078	323	9	8	2

1-Source: Vehicles from regional travel demand model
2-Source: MOBILE 6 or EMFAC emission factor model
3-Calculation: Annual Emissions = VMT * 1,000,000 * Emission Factor / 909,000 g/ton
4-Calculation: Change in Emissions = Preferred Alternative Emissions – No-Build Emissions

Benefit/Cost Assessment

A detailed benefit/cost analysis was conducted for each of the alternatives and the complete report can be found in Appendix A.

The benefit/cost analysis was performed to provide a systematic evaluation of the relevant advantages and disadvantages of the BRT options being considered for the 35W/Highway 62 interchange.

Benefits considered in the analysis were assessed relative to Mn/DOT's current design plan[12] and are as follows:

- Vehicle Operating Benefits – *Change in system-wide vehicle miles traveled.*
- Travel Time Benefits – *Change in system-wide hours traveled.*
- Crash Reduction Benefits – *Anticipated reduction in crashes.*
- Operation and Maintenance Cost Savings – *Change in the cost to operate and maintain the facility.*

Costs that were considered included the following:

- Construction Costs – *Capital Cost of Construction*
- Right-of-Way Costs – *Purchase of Additional Right-of-Way and Homes*

It is important to note that, operating and capital costs for transit service were not included in the analysis, as transit services are assumed to be the same for all alternatives.

<u>Delay & Cost of Delay</u>

Design Option 1- *Barrier Free Lanes* and Design Option 3 – *Barrier Separated Lanes* experience the greatest benefit to travel times when a shared BRT/HOV lane is used. This finding accounts for the additional vehicles that operate in the shared BRT/HOV lane when compared with a condition where only buses are permitted in the BRT lane.

Design Option 2 – *Shoulder Running Buses* shows a slightly decreased benefit in travel times which is attributable to the lower operating speeds that buses are required to use while traveling on the shoulders. This option does allow for a separate HOV lane to operate therefore the savings in travel time for HOV's passengers is captured.

The lowest benefit for travel time savings is found when only buses are permitted in the BRT lane and HOV's are required to use the general-purpose lane. This is attributable to the additional congestion that is created by vehicles that choose to use 35W and for the additional time associated with people who choose to take an alternate route due to the increased congestion.

[12] As part of the 35W/Highway 62 interchange project, Mn/DOT has conducted a benefit/cost analysis, which served as the basis for the analysis of the BRT options.

Travel time benefits were quantified by determining the annual number of travel hours associated with each option and used a cost per hour figure of $12.07.

When compared with the current conditions, (all existing infrastructure plus projects that have been committed), the following travel time benefits were quantified:

Barrier-Free/Shared BRT & HOV Lane ....$ 430,900,000
Barrier-Free/BRT Only Lane ....$ 91,300,000
Barrier Separated/ Shared BRT & HOV Lane ....$ 430,900,000
Barrier Separated/BRT Only Lane...$ 91,300,000
Shoulder Running Buses...$ 417,500,000

Capital Cost

Capital costs include construction costs, right-of-way costs and acquisition of homes. As discussed earlier, capital costs for transit service are not included. Also, it is important to note that the capital cost estimate covers the area between 66th Street and 42nd Street and is based on work previously done for the Highway 62/35W project. The capital costs DO NOT reflect the current estimated construction costs.

The option with the lowest capital costs is Design Option 1 – *Barrier-Free Lanes*, followed by Design Option 2 – *Shoulder Running Buses* and then Design Option 3 – *Barrier Separated Lanes*.

The increased capital costs (approximately $25 million) associated with Design Option 3 – *Barrier Separated Lanes* is attributable primarily to the right-of-way costs associated with accommodating the additional 22' of width required for the barrier separated design, acquisition of approximately 46 homes, and to a lesser extent, the additional cost of constructing a 2' concrete barrier throughout the interchange.

Design Option 2 – *Shoulder Running Buses*, requires an additional $4 million which is primarily attributable to reinforcing the shoulders to accommodate the expected level of bus traffic.

Operating the lane as BRT only lane or as a shared BRT/HOV does not have any impact on capital costs.

Following is a summary of the estimated capital costs for each of the design options over the present value baseline estimated costs[13]:

[13] Baseline costs corresponds to estimates record in SRF's memo 'Ben-Cost Analysis I-35W/Hwy 62 Crosstown Memo' dated October 24, 2003. Note that these represent preliminary estimates as of that date, and that actual costs will differ.

Design Option 1 - Barrier-Free Lane *(Baseline)*		
Construction Costs over baseline cost..	$	0
Right of Way Costs over baseline cost..	$	0
Total over baseline cost**..................................**	**$**	**0**
Design Option 2 - Shoulder Running Buses		
Construction Costs over baseline cost..	$	4,000,000
Right of Way Costs over baseline cost..	$	0
Total over baseline cost**..................................**	**$**	**4,000,000**
Design Option 3 - Barrier Separated		
Construction Costs over baseline cost..	$	9,000,000
Right of Way Costs over baseline cost[14]	$	17,000,000
Total over baseline cost**..................................**	**$**	**26,000,000**

On the following page is a summary from the benefit/cost analysis that shows the difference in benefits and costs for each option when compared to the current condition, (all existing infrastructure plus projects that have been committed).

[14] Additional right-of-way costs associated with the barrier-separated design include the costs of acquiring 46 properties. Another 9 properties were not included but may need to be considered.

Summary of Difference in Benefits and Costs for each BRT Option

Cost Figures are Based on the Benefit /Cost Assessment Completed for the 35W/Highway 62 Interchange Project as of October, 2003 and DO NOT Reflect Updated Construction Cost Estimates

As Compared with Current Conditions, (all existing infrastructure plus projects that have been committed).

	1 **Barrier-Free Shared BRT/HOV** *Design Option 1*	2 **Barrier-Free BRT Only Lane** *Design Option 1*	3 **Barrier Separated Shared HOV/BRT** *Design Option 3*	4 **Barrier Separated BRT Only Lane** *Design Option 3*	5 **Shoulder Running Buses** *Design Option 2*
BENEFIT 1: Vehicle Operating Benefits	$ (61,600,000)	$ (98,600,000)	$ (61,600,000)	$ (98,600,000)	$ (61,600,000)
BENEFIT 2: Travel Time Benefits	$ 430,900,000	$ 91,300,000	$ 430,900,000	$ 91,300,000	$ 417,500,000
BENEFIT 3: Crash Reduction Benefits	$ 37,000,000	$ 38,800,000	$ 37,000,000	$ 38,800,000	$ 37,000,000
BENEFIT 4: Incremental Operation & Maintenance Benefits*	$ 21,600,000	$ 21,600,000	$ 20,700,000	$ 20,700,000	$ 21,600,000
COST 1: Construction Costs	$ 178,200,000	$ 178,200,000	$ 186,800,000	$ 186,800,000	$ 182,100,000
COST 2: Right of Way Costs	$ 6,700,000	$ 6,700,000	$ 23,700,000	$ 23,700,000	$ 6,700,000
OTHER: Remaining Capital Value	$ (70,400,000)	$ (70,400,000)	$ (81,800,000)	$ (81,800,000)	$ (71,700,000)
Net Cost of Project	$ 114,500,000	$ 114,500,000	$ 128,700,000	$ 128,700,000	$ 117,100,000
Present Value of Benefits	$ 427,900,000	$ 53,100,000	$ 427,000,000	$ 52,200,000	$ 414,500,000
Net Present Value	$ 313,400,000	$ (61,400,000)	$ 298,300,000	$ (76,500,000)	$ 297,400,000
Benefit / Cost Ratio	3.74	0.46	3.32	0.41	3.54
Rank	1	4	3	5	2

* Operations and maintenance were included under benefits following SRF's b/c memo (October 24,2003), rather than under costs as suggested in OIM documentation

**Numbers are rounded to nearest hundred thousand

***Preliminary costs are for estimating purposes only and are likely to differ from actual construction costs

Application of Evaluation Criteria

To summarize the results of the evaluation two matrices have been developed. The first matrix summarizes the ranking of each design option relative to each of the evaluation criteria. The following numerical assignments were used:

1 = Most Favorable
2 = Second Most Favorable
3 = Least Favorable

If two or more options shared an identical ranking, then they were each assigned the same number. Also, if the criteria did not apply, no ranking was made.

Summary of Evaluation Criteria Rankings for the Three Design Options

Evaluation Criteria	Design Option 1 Barrier-Free	Design Option 2 Shoulder Running	Design Option 3 Barrier Separated
Right-of-Way Requirements and Geometric Issues	1	2	3
Bus Operations	1	3	2
Traffic Operations	1	1	1
Freeway Capacity	2	1	2
Air Quality	NA	NA	NA
Delay	1	3	1
Capital Cost	1	2	3
Benefit/Cost Analysis	1	2	3
TOTALS	**7**	**14**	**14**

As with the design options, a matrix was developed that summarizes the ranking of the options for operating the BRT lane with buses only or as a shared BRT/HOV lane. For this ranking, the following numerical assignments were used:

1 = Most Favorable
2 = Least Favorable

As with the previous matrix, two or more options shared an identical ranking, then they were each assigned the same number. Also, if the criteria did not apply, no ranking was made

Summary of Evaluation Criteria Rankings for BRT Only Lane Operation or Shared BRT/HOV Lane Operation		
Evaluation Criteria	**BRT Only Lane**	**Shared BRT/HOV Lane**
Right-of-Way Requirements and Geometric Issues	NA	NA
Bus Operations	1	2
Traffic Operations	NA	NA
Freeway Capacity	2	1
Air Quality	2	1
Delay	2	1
Capital Cost	NA	NA
Benefit/Cost Analysis	2	1
TOTALS	**9**	**6**

CONCLUSIONS

Design Options

In the previous section a number of criteria were applied to each of the design options. The results indicate that Design Option 1 – *Barrier Free Lanes* is the most favorable of the three design options considered for operating BRT in the 35W/Highway 62 interchange. The elements that distinguished the barrier free option from the others are summarized below:

- Option 1 requires no additional right-of-way. Option 2 – *Shoulder Running Buses* requires an additional 6' in width, while Option 3 – *Barrier Separated Lanes* requires an additional 22' of width. Additional right-of-way is not readily available in the 35W/Highway 62 interchange, nor is there likely to be the necessary political and community support to acquire additional right-of-way.
- The additional width associated with Option 3 – *Barrier Separated Lanes* creates geometric design issues in several areas.
- For bus operations, Option 1 – *Barrier Free Lanes* and Option 2 – *Shoulder Running Buses* both permit buses unfettered access to the BRT lanes. Option 3 – *Barrier Separated Lanes* severely limits the areas where buses can enter and exit the BRT lane.
- Under Option 2 – *Shoulder Running Buses*, buses are limited to a maximum speed of 35 MPH, which creates additional delay when compared with Options 1 and 3.
- The capital cost for Option 1 is the lowest of the three options. Option 2 – *Shoulder Running Buses* requires approximately $4 million in additional capital costs while Option 3 - *Barrier Separated Lanes*, requires approximately $25 million more than Option 1.
- Option 1 – *Barrier Free Lanes* operating as a shared BRT/HOV lane ranked as the top choice on the benefit/cost analysis.

Lane Operations

As to operating the BRT lane as a lane for buses only or as a lane shared with HOV's, the option to operate a shared lane with buses and HOV's is the most desirable. The key elements that suggest operating a shared lane is the most desirable are summarized below:

- A maximum of 88 buses per hour currently use 35W. The typical freeway lane is designed to accommodate 2,000 vehicles in one hour. Limiting the lane to only buses will result in a significant amount of capacity of the lane that will be unused.
- If HOV's are excluded from the BRT lane, they will need to either join the general-purpose lanes or find alternate routes. The traffic modeling completed for this report showed that additional miles and hours (delay) would be incurred as drivers seek alternate routes.
- The additional miles associated with excluding HOV's from the BRT lane results in a slight increase in emissions throughout the region.
- The benefit cost analysis ranked the BRT Only option as the least desirable alternative.

Other Considerations

While this report represents the completion of the first task in the 35W BRT Study, there were a number of observations that were made that Mn/DOT may want to consider at this point as it relates to operating Bus Rapid Transit in the 35W Corridor.

- As indicated in the graphic on page 34, operating BRT and HOV's in the same lane significantly increases the number of people that can use one freeway lane. As consideration is being given to 35W access options north of the interchange project area, serious consideration should be given to extending the BRT/HOV lane north to downtown Minneapolis. This would provide continuity for BRT and HOV users and allow for an important transit connection at a future Lake Street Station.
- Mn/DOT's current design plans provide space for a bus station at 46th Street. The 35W/Highway 62 interchange project provides a timely opportunity to accommodate a bus station at 46th Street which is an important element found in Metro Transit's Central South Study.
- Introducing HOV's to the BRT lane runs the risk of slowing bus operating speeds. While it is clear that HOV's can be added to the BRT lane (e.g. 1,500 per hour) and operating speeds can be maintained, the number of HOV's permitted into the BRT lane should be managed to insure that buses are able to operate at the posted speeds.

APPENDIX A

BENEFIT/COST ANALYSIS

URS

MEMORANDUM

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To:	Mark Ryan	**Copy:**		**File:**	32707.234.0101
From:	Kate Sanderson				
Date:	January 27, 2004				
Subject:	Preliminary 35W BRT Benefit – Cost Analysis				

This memo summarizes benefit – cost analyses for five alternatives proposed under the 35W BRT project. The assumptions and methodologies build on earlier work conducted by another consultant for a related project on the same study area (Draft Memo B/C Analysis I-35W/Hwy 62 Crosstown, SRF 10/24/03) and appear to be consistent with Mn/DOT's procedures[1].

The study area for the project is focused on Interstate 35W south of the city of Minneapolis between 66th and 42nd Streets, and Trunk Highway 62 between Penn and Portland Avenues. These segments are located in the jurisdictions of the Cities of Minneapolis and Richfield.

A benefit – cost analysis is performed to provide a systematic evaluation of the relevant advantages and disadvantages associated with various investment alternatives. Benefits evaluated include travel time and vehicle operating cost savings, crash reduction and maintenance costs benefit. Construction and right of way investments are included as costs and adjusted by the remaining capital value at the end of the evaluation period. All benefits and costs are evaluated for the period of analysis and the value is summed for the present year.

The key event timings for this project are:

- Base Year: The year to which all costs and benefits are discounted was 2003
- Build (expenditure) Year: the analysis assumes that if the project were to be constructed beginning in 2006, it would take four years for completion in 2010. 2008 was used as the expenditure year as it is the mid-point of this range
- First year of operation (benefits begin accruing): 2011 would be the first year of operation that benefits would begin accruing
- Horizon Year: A 20-year analysis period gives 2030 as the horizon year

[1] Except that operations & maintenance is grouped under benefits rather than costs

Five alternatives were considered for the project against a 'base' condition. The base and build (provision of HOV/buses in a median shared lane) condition were described by earlier work (Draft Memo B/C Analysis I-35W/Hwy 62 Crosstown, SRF 10/24/03). This memo distinguishes the scenarios as follows:

0. Base condition
1. Build scenario with shared HOV/BRT in adjacent barrier free median lane
2. Build scenario with BRT only in adjacent barrier free median lane
3. Build scenario with shared HOV/BRT in barrier separated median lane
4. Build scenario with BRT only in barrier separated median lane
5. Build scenario with HOV in adjacent barrier free median lane and shoulder running buses

Statistics for the whole of the region were calculated from the Twin Cities travel demand model to forecast vehicle travel time and vehicle miles traveled. Construction costs, right of way, maintenance and crash benefits were calculated for the project area.

Attachments:
Summary Benefit – Costs
Calculations for each alternative

I-35W BRT Benefit - Cost Analysis Summary

Transportation Alternatives Descriptions	
	BASE **The base scenario consists of all existing infrastructure plus projects that have committed funding.**
	Build **1. Barrier free separated shared HOV/BRT lane (same as SRF's build case)** **2. Barrier free separated HOV lane** **3. Barrier separated shared HOV/BRT lane** **4. Barrier separated shared BRT lane** **5. Shoulder running bus and barrier free separated HOV lane**

Benefits and Costs are discounted to 2003 dollars, and analysed for a 20-year horizon. Note that numbers reflect planning level of analysis. Other B/C studies may use different methodologies, and therefore may not be directly comparable. System wide (or r

BENEFIT 1: Vehicle Operating Benefits = Difference between system wide vehicle miles travelled in the base condition and proposed alternative at the end of analysis period, this is then converted to a dollar value using standard values by vehicle type

BENEFIT 2: Travel Time Benefits = Difference between system wide vehicle hours travelled in the base condition and proposed alternative at the end of analysis period, this is then converted to a dollar value using standard values by vehicle type
BENEFIT 3: Crash Benefits
BENEFIT 4: Incremental Operation & Maintenance Benefits

COST 1: Construction Costs = capital cost of construction
COST 2: Right of Way Costs = purchase of the additional or new right of way

OTHER: Remaining Capital Value = percentage of capital construction cost based on standard values

Summary of difference in benefits and costs for each alternative, as compared to 'base' condition

	1 **Barrier-Free Shared BRT/HOV** *Design Option 1*	2 **Barrier-Free BRT Only Lane** *Design Option 1*	3 **Barrier Separated Shared HOV/BRT** *Design Option 3*	4 **Barrier Separated BRT Only Lane** *Design Option 3*	5 **Shoulder Running Buses** *Design Option 2*
BENEFIT 1: Vehicle Operating Benefits	$ (61,647,280)	$ (98,635,628)	$ (61,647,280)	$ (98,635,628)	$ (61,647,280)
BENEFIT 2: Travel Time Benefits	$ 430,886,288	$ 91,316,643	$ 430,886,288	$ 91,316,643	$ 417,489,618
BENEFIT 3: Crash Reduction Benefits	$ 36,962,813	$ 38,816,018	$ 36,962,813	$ 38,816,018	$ 36,962,813
BENEFIT 4: Incremental Operation & Maintenance Benefits*	$ 21,551,086	$ 21,551,086	$ 20,672,995	$ 20,672,995	$ 21,551,086
COST 1: Construction Costs	$ 178,197,727	$ 178,197,727	$ 186,812,727	$ 186,812,727	$ 182,145,727
COST 2: Right of Way Costs	$ 6,735,785	$ 6,735,785	$ 23,735,785	$ 23,735,785	$ 6,735,785
OTHER: Remaining Capital Value	$ (70,397,071)	$ (70,397,071)	$ (81,810,263)	$ (81,810,263)	$ (71,693,616)
Net Cost of Project	$ 114,536,441	$ 114,536,441	$ 128,738,250	$ 128,738,250	$ 117,187,896
Present Value of Benefits	$ 427,752,908	$ 53,048,119	$ 426,874,817	$ 52,170,028	$ 414,356,237
Net Present Value	$ 313,216,467	$ (61,488,322)	$ 298,136,567	$ (76,568,222)	$ 297,168,341
Benefit / Cost Ratio	3.73	0.46	3.32	0.41	3.54
Rank	1	4	3	5	2

* Operations and maintenance were included under benefits following SRF's previous memo, rather than under costs as suggested in OIM documentation

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 1: Barrier free - HOV + BRT

Key Event Timings	
Base Year	2003
Build (expenditure) Year	2008
First year of operation (benefits begin accruing)	2011
Horizon Year	2030

	Base		Build Alternative	
YEAR	**VHT**	**VMT**	**VHT**	**VMT**
2011	2,143,212	80,142,498	2,134,938	80,191,548
2030	2,796,692	95,716,244	2,787,324	95,763,078
(2030-2011) CHANGES	653,480	15,573,746	652,386	15,571,530

**System-wide statistics reported.*

B/C Analysis Summary	
BENEFITS	**Value(Disc'd)**
1. Travel Time Savings	$ 430,886,288
2: Vehicle Operating Svgs	$ (61,647,280)
3. Crash Benefits	$ 36,962,813
4. Maintenance	$ 21,551,086
TOTAL	**$ 427,752,908**

COSTS	**Value(Dis'd)**
1. Capital (Rdway System	$ 178,197,727
2. Right of Way	$ 6,735,785
Remaining Capital (asset	$ (70,397,071)
TOTAL	**$ 114,536,441**

Benefit/Cost Analysis Results	
BENEFITS	$ 427,752,908
COSTS	$ 114,536,441
B/C Ratio*:	**3.73**

Data Source:
These costs and benefits are all as found in the 'base' and 'build' scenario from SRF's memo
Note that forecasts are linearly interpolated between forecasts for operations start and horizon year

File: M:\Graphics\Projects\32707 I-35W BRT Study\Task 1 Report (PDF)\Original Files\appendix\[rev_bc_35w_030804.xls]Summary Sheet for Report bu

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 1: Barrier free - HOV + BRT

BENEFIT 1: Travel Time Savings (VHT)

YEAR	Daily Base	Daily Build VHT	Annualized Savings Build VHT Savings	'00 cost per hour* $ 12.07	Discounted Value (3.5%)
2011	2,143,212	2,134,938	8,274	36,449,758	27,680,368
2012	2,177,605	2,169,274	8,331	36,703,518	26,930,508
2013	2,211,999	2,203,610	8,389	36,957,278	26,199,710
2014	2,246,393	2,237,946	8,446	37,211,038	25,487,541
2015	2,280,786	2,272,282	8,504	37,464,797	24,793,577
2016	2,315,180	2,306,619	8,562	37,718,557	24,117,402
2017	2,349,574	2,340,955	8,619	37,972,317	23,458,606
2018	2,383,968	2,375,291	8,677	38,226,076	22,816,786
2019	2,418,361	2,409,627	8,734	38,479,836	22,191,549
2020	2,452,755	2,443,963	8,792	38,733,596	21,582,506
2021	2,487,149	2,478,299	8,850	38,987,355	20,989,277
2022	2,521,542	2,512,635	8,907	39,241,115	20,411,489
2023	2,555,936	2,546,971	8,965	39,494,875	19,848,777
2024	2,590,330	2,581,307	9,022	39,748,634	19,300,780
2025	2,624,723	2,615,643	9,080	40,002,394	18,767,148
2026	2,659,117	2,649,980	9,138	40,256,154	18,247,536
2027	2,693,511	2,684,316	9,195	40,509,913	17,741,606
2028	2,727,905	2,718,652	9,253	40,763,673	17,249,026
2029	2,762,298	2,752,988	9,310	41,017,433	16,769,472
2030	2,796,692	2,787,324	9,368	41,271,192	16,302,626
TOTAL					**$ 430,886,288**

*Composite cost per hour based on assumption that autos account for 97%, and trucks 3% , of systemwide traffic on average. Auto occupancies are assumed to be 1.3 during peak periods, and 1.1 off peak.

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 1: Barrier free - HOV + BRT

BENEFIT 2: Vehicle Operating Cost Savings (VMT)

	Daily		Annualized		
YEAR	Base	Build VMT	Build VMT Savings	'cost per mile* $ 0.31	Discounted Value (3.5%)
2011	80,142,498	80,191,548	(49,050)	(5,630,612)	(4,275,952)
2012	80,962,169	81,011,102	(48,934)	(5,617,222)	(4,121,530)
2013	81,781,840	81,830,657	(48,817)	(5,603,831)	(3,972,661)
2014	82,601,510	82,650,211	(48,700)	(5,590,441)	(3,829,148)
2015	83,421,181	83,469,765	(48,584)	(5,577,050)	(3,690,799)
2016	84,240,852	84,289,319	(48,467)	(5,563,660)	(3,557,427)
2017	85,060,523	85,108,873	(48,350)	(5,550,269)	(3,428,855)
2018	85,880,194	85,928,428	(48,234)	(5,536,878)	(3,304,911)
2019	86,699,865	86,747,982	(48,117)	(5,523,488)	(3,185,428)
2020	87,519,535	87,567,536	(48,000)	(5,510,097)	(3,070,247)
2021	88,339,206	88,387,090	(47,884)	(5,496,707)	(2,959,213)
2022	89,158,877	89,206,644	(47,767)	(5,483,316)	(2,852,178)
2023	89,978,548	90,026,199	(47,651)	(5,469,926)	(2,748,998)
2024	90,798,219	90,845,753	(47,534)	(5,456,535)	(2,649,535)
2025	91,617,890	91,665,307	(47,417)	(5,443,145)	(2,553,655)
2026	92,437,561	92,484,861	(47,301)	(5,429,754)	(2,461,230)
2027	93,257,231	93,304,415	(47,184)	(5,416,364)	(2,372,135)
2028	94,076,902	94,123,970	(47,067)	(5,402,973)	(2,286,252)
2029	94,896,573	94,943,524	(46,951)	(5,389,582)	(2,203,464)
2030	95,716,244	95,763,078	(46,834)	(5,376,192)	(2,123,662)
TOTAL					**$ (61,647,280)**

*Composite cost per mile based on assumption that autos account for 97%, and trucks 3% , of systemwide traffic on average.

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 1: Barrier free - HOV + BRT

BENEFIT 3: Crash Benefits

YEAR	Estimated Crash Costs Base	Estimated Crash Costs Build	Build Crash Savings	Discounted Value (3.5%)
2011	9,822,724	6,012,829	$ 3,809,895	2,893,278
2012	9,896,474	6,146,474	$ 3,750,001	2,751,492
2013	9,970,225	6,280,119	$ 3,690,106	2,615,986
2014	10,043,975	6,413,764	$ 3,630,212	2,486,498
2015	10,117,725	6,547,408	$ 3,570,317	2,362,776
2016	10,191,476	6,681,053	$ 3,510,423	2,244,579
2017	10,265,226	6,814,698	$ 3,450,528	2,131,673
2018	10,338,977	6,948,343	$ 3,390,634	2,023,837
2019	10,412,727	7,081,988	$ 3,330,739	1,920,857
2020	10,486,477	7,215,633	$ 3,270,845	1,822,527
2021	10,560,228	7,349,277	$ 3,210,950	1,728,651
2022	10,633,978	7,482,922	$ 3,151,056	1,639,040
2023	10,707,728	7,616,567	$ 3,091,161	1,553,512
2024	10,781,479	7,750,212	$ 3,031,267	1,471,895
2025	10,855,229	7,883,857	$ 2,971,372	1,394,021
2026	10,928,980	8,017,502	$ 2,911,478	1,319,731
2027	11,002,730	8,151,146	$ 2,851,583	1,248,871
2028	11,076,480	8,284,791	$ 2,791,689	1,181,295
2029	11,150,231	8,418,436	$ 2,731,794	1,116,860
2030	11,223,981	8,552,081	$ 2,671,900	1,055,433
TOTAL			**$ 64,817,950**	**$ 36,962,813**

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 1: Barrier free - HOV + BRT

COST 1: Capital (Roadway System)

YEAR	Costs	RCV Value (3.5%)	RCV Factor	Discounted Value (3.5%)	
2008	5,442,500			4,582,439	Signing/Striping/Signals
2008	137,024,000			115,370,531	Major Structures
2008	69,176,500			58,244,757	Roadway
2030	$ 5,442,500	-	-	-	
2030	$ 137,024,000	(0.89)	(121,951,360.00)	(48,172,280)	RCV
2030	$ 69,176,500	(0.70)	(48,423,550.00)	(19,127,895)	
TOTAL				**$ 110,897,552**	

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 1: Barrier free - HOV + BRT

COST 2: Right of Way					
YEAR	ROW Costs	RCV Factor	RCV	Discounted Value (3.5%)	
2008	$ 8,000,000			6,735,785	
2030	$ 8,000,000	(0.98)	(7,840,000.00)	(3,096,896)	RCV
TOTAL				**$ 3,638,889**	

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 1: Barrier free - HOV + BRT

BENEFIT 4: Incremental Operations & Maintenance Costs						
YEAR	Annual Maint. Costs Base	Annual Maint. Costs Build	Major Maint. Costs Base	Major Maint. Costs Build	Build Savings	Discounted Value (3.5%)
2011	188,016	314,423	$ 13,888,500	$ -	$ 13,762,093	10,451,092
2012	188,016	314,423	$ -	$ -	$ (126,407)	(92,749)
2013	188,016	314,423	$ -	$ -	$ (126,407)	(89,612)
2014	188,016	314,423	$ 8,212,800	$ -	$ 8,086,393	5,538,740
2015	188,016	314,423	$ -	$ -	$ (126,407)	(83,654)
2016	188,016	314,423	$ -	$ -	$ (126,407)	(80,825)
2017	188,016	314,423	$ -	$ -	$ (126,407)	(78,092)
2018	188,016	314,423	$ -	$ -	$ (126,407)	(75,451)
2019	188,016	314,423	$ -	$ -	$ (126,407)	(72,900)
2020	188,016	314,423	$ 8,212,800	$ -	$ 8,086,393	4,505,769
2021	188,016	314,423	$ -	$ -	$ (126,407)	(68,053)
2022	188,016	314,423	$ -	$ -	$ (126,407)	(65,751)
2023	188,016	314,423	$ -	$ -	$ (126,407)	(63,528)
2024	188,016	314,423	$ -	$ -	$ (126,407)	(61,380)
2025	188,016	314,423	$ 8,212,800	$ -	$ 8,086,393	3,793,736
2026	188,016	314,423	$ -	$ -	$ (126,407)	(57,298)
2027	188,016	314,423	$ -	$ -	$ (126,407)	(55,361)
2028	188,016	314,423	$ -	$ -	$ (126,407)	(53,489)
2029	188,016	314,423	$ -	$ -	$ (126,407)	(51,680)
2030	188,016	314,423	$ (4,147,965)	$ -	$ (4,274,372)	(1,688,429)
					$ -	
TOTAL						**$ 21,551,086**

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 2: Barrier free - BRT only

Key Event Timings	
Base Year	2003
Build (expenditure) Year	2008
First year of operation (benefits begin accruing)	2011
Horizon Year	2030

	Base		Build Alternative	
YEAR	VHT	VMT	VHT	VMT
2011	2,143,212	80,142,498	2,138,069	80,197,082
2030	2,796,692	95,716,244	2,799,016	95,821,559
(2030-2011) CHANGES	653,480	15,573,746	660,947	15,624,477

**System-wide statistics reported.*

B/C Analysis Summary

BENEFITS	Value(Disc'd)
1. Travel Time Savings	$ 91,316,643
2: Vehicle Operating Svgs	$ (98,635,628)
3. Crash Benefits	$ 38,816,018
4. Maintenance	$ 21,551,086
TOTAL	**$ 53,048,119**

COSTS	Value(Dis'd)
1. Capital (Rdway System	$ 178,197,727
2. Right of Way	$ 6,735,785
Remaining Capital (asset	$ (70,397,071)
TOTAL	**$ 114,536,441**

Benefit/Cost Analysis Results	
BENEFITS	$ 53,048,119
COSTS	$ 114,536,441
B/C Ratio*:	**0.46**

Data Source:

These costs and benefits are all as found in the 'base' and 'build' scenario from SRF's memo
Except for the following:
1. Travel time savings were adjusted based on VHT as calculated from the regional model (run by URS)
2. Vehicle operating savings were adjusted based on VMT as calculated from the regional model (run by URS)
3. Crash benefits were adjusted based on changes in study area VMT from the regional model (run by URS)
Note that forecasts are linearly interpolated between forecasts for operations start and horizon year

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Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 2: Barrier free - BRT only

BENEFIT 1: Travel Time Savings (VHT)

	Daily		Annualized Savings		
YEAR	Base	Build VHT	Build VHT Savings	'00 cost per hour* $ 12.07	Discounted Value (3.5%)
2011	2,143,212	2,138,069	5,143	22,657,744	17,206,552
2012	2,177,605	2,172,855	4,750	20,926,363	15,354,320
2013	2,211,999	2,207,642	4,357	19,194,981	13,607,683
2014	2,246,393	2,242,429	3,964	17,463,600	11,961,618
2015	2,280,786	2,277,215	3,571	15,732,219	10,411,320
2016	2,315,180	2,312,002	3,178	14,000,838	8,952,194
2017	2,349,574	2,346,789	2,785	12,269,457	7,579,847
2018	2,383,968	2,381,576	2,392	10,538,076	6,290,078
2019	2,418,361	2,416,362	1,999	8,806,694	5,078,873
2020	2,452,755	2,451,149	1,606	7,075,313	3,942,391
2021	2,487,149	2,485,936	1,213	5,343,932	2,876,965
2022	2,521,542	2,520,722	820	3,612,551	1,879,089
2023	2,555,936	2,555,509	427	1,881,170	945,412
2024	2,590,330	2,590,296	34	149,789	72,733
2025	2,624,723	2,625,082	(359)	(1,581,592)	(742,005)
2026	2,659,117	2,659,869	(752)	(3,312,974)	(1,501,723)
2027	2,693,511	2,694,656	(1,145)	(5,044,355)	(2,209,211)
2028	2,727,905	2,729,443	(1,538)	(6,775,736)	(2,867,132)
2029	2,762,298	2,764,229	(1,931)	(8,507,117)	(3,478,030)
2030	2,796,692	2,799,016	(2,324)	(10,238,498)	(4,044,332)
TOTAL					**$ 91,316,643**

*Composite cost per hour based on assumption that autos account for 97%, and trucks 3% , of systemwide traffic on average. Auto occupancies are assumed to be 1.3 during peak periods, and 1.1 off peak.

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 2: Barrier free - BRT only

BENEFIT 2: Vehicle Operating Cost Savings (VMT)

YEAR	Daily Base	Daily Build VMT	Annualized Build VMT Savings	Annualized 'cost per mile* $ 0.31	Discounted Value (3.5%)
2011	80,142,498	80,197,082	(54,584)	(6,265,840)	(4,758,351)
2012	80,962,169	81,019,423	(57,254)	(6,572,341)	(4,822,330)
2013	81,781,840	81,841,764	(59,924)	(6,878,843)	(4,876,541)
2014	82,601,510	82,664,105	(62,594)	(7,185,345)	(4,921,571)
2015	83,421,181	83,486,445	(65,264)	(7,491,846)	(4,957,979)
2016	84,240,852	84,308,786	(67,934)	(7,798,348)	(4,986,296)
2017	85,060,523	85,131,127	(70,604)	(8,104,850)	(5,007,029)
2018	85,880,194	85,953,468	(73,274)	(8,411,352)	(5,020,657)
2019	86,699,865	86,775,809	(75,944)	(8,717,853)	(5,027,638)
2020	87,519,535	87,598,150	(78,614)	(9,024,355)	(5,028,405)
2021	88,339,206	88,420,491	(81,285)	(9,330,857)	(5,023,371)
2022	89,158,877	89,242,832	(83,955)	(9,637,358)	(5,012,927)
2023	89,978,548	90,065,173	(86,625)	(9,943,860)	(4,997,445)
2024	90,798,219	90,887,514	(89,295)	(10,250,362)	(4,977,277)
2025	91,617,890	91,709,854	(91,965)	(10,556,864)	(4,952,759)
2026	92,437,561	92,532,195	(94,635)	(10,863,365)	(4,924,207)
2027	93,257,231	93,354,536	(97,305)	(11,169,867)	(4,891,923)
2028	94,076,902	94,176,877	(99,975)	(11,476,369)	(4,856,191)
2029	94,896,573	94,999,218	(102,645)	(11,782,870)	(4,817,281)
2030	95,716,244	95,821,559	(105,315)	(12,089,372)	(4,775,450)
TOTAL					**$ (98,635,628)**

*Composite cost per mile based on assumption that autos account for 97%, and trucks 3% , of systemwide traffic on average.

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 2: Barrier free - BRT only

BENEFIT 3: Crash Benefits				
	Estimated	Estimated		
	Crash Costs	Crash Costs	Build	Discounted
YEAR	Base	Build	Crash Savings	Value (3.5%)
2011	9,821,431	5,877,736	$ 3,943,695	2,994,888
2012	9,895,172	6,007,534	$ 3,887,638	2,852,480
2013	9,968,912	6,137,332	$ 3,831,580	2,716,279
2014	10,042,653	6,267,130	$ 3,775,523	2,586,028
2015	10,116,394	6,396,929	$ 3,719,465	2,461,480
2016	10,190,134	6,526,727	$ 3,663,408	2,342,398
2017	10,263,875	6,656,525	$ 3,607,350	2,228,555
2018	10,337,616	6,786,323	$ 3,551,293	2,119,733
2019	10,411,356	6,916,121	$ 3,495,235	2,015,723
2020	10,485,097	7,045,919	$ 3,439,178	1,916,323
2021	10,558,838	7,175,717	$ 3,383,120	1,821,341
2022	10,632,578	7,305,516	$ 3,327,063	1,730,591
2023	10,706,319	7,435,314	$ 3,271,005	1,643,896
2024	10,780,060	7,565,112	$ 3,214,948	1,561,085
2025	10,853,801	7,694,910	$ 3,158,890	1,481,995
2026	10,927,541	7,824,708	$ 3,102,833	1,406,470
2027	11,001,282	7,954,506	$ 3,046,776	1,334,357
2028	11,075,023	8,084,304	$ 2,990,718	1,265,513
2029	11,148,763	8,214,103	$ 2,934,661	1,199,800
2030	11,222,504	8,343,901	$ 2,878,603	1,137,083
TOTAL			**$ 68,222,981**	**$ 38,816,018**

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 2: Barrier free - BRT only

COST 1: Capital (Roadway System)					
YEAR	Costs	RCV Value (3.5%)	RCV Factor	Discounted Value (3.5%)	
2008	5,442,500			4,582,439	Signing/Striping/Signals
2008	137,024,000			115,370,531	Major Structures
2008	69,176,500			58,244,757	Roadway
2030	$ 5,442,500	-	-	-	
2030	$ 137,024,000	(0.89)	(121,951,360.00)	(48,172,280)	RCV
2030	$ 69,176,500	(0.70)	(48,423,550.00)	(19,127,895)	
TOTAL				**$ 110,897,552**	

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 2: Barrier free - BRT only

COST 2: Right of Way					
YEAR	ROW Costs	RCV Factor	RCV	Discounted Value (3.5%)	
2008	$ 8,000,000			6,735,785	
2030	$ 8,000,000	(0.98)	(7,840,000.00)	(3,096,896)	RCV
TOTAL				**$ 3,638,889**	

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 2: Barrier free - BRT only

BENEFIT 4: Incremental Operations & Maintenance Costs						
YEAR	Annual Maint. Costs Base	Annual Maint. Costs Build	Major Maint. Costs Base	Major Maint. Costs Build	Build Savings	Discounted Value (3.5%)
2011	188,016	314,423	$ 13,888,500	$ -	$ 13,762,093	10,451,092
2012	188,016	314,423	$ -	$ -	$ (126,407)	(92,749)
2013	188,016	314,423	$ -	$ -	$ (126,407)	(89,612)
2014	188,016	314,423	$ 8,212,800	$ -	$ 8,086,393	5,538,740
2015	188,016	314,423	$ -	$ -	$ (126,407)	(83,654)
2016	188,016	314,423	$ -	$ -	$ (126,407)	(80,825)
2017	188,016	314,423	$ -	$ -	$ (126,407)	(78,092)
2018	188,016	314,423	$ -	$ -	$ (126,407)	(75,451)
2019	188,016	314,423	$ -	$ -	$ (126,407)	(72,900)
2020	188,016	314,423	$ 8,212,800	$ -	$ 8,086,393	4,505,769
2021	188,016	314,423	$ -	$ -	$ (126,407)	(68,053)
2022	188,016	314,423	$ -	$ -	$ (126,407)	(65,751)
2023	188,016	314,423	$ -	$ -	$ (126,407)	(63,528)
2024	188,016	314,423	$ -	$ -	$ (126,407)	(61,380)
2025	188,016	314,423	$ 8,212,800	$ -	$ 8,086,393	3,793,736
2026	188,016	314,423	$ -	$ -	$ (126,407)	(57,298)
2027	188,016	314,423	$ -	$ -	$ (126,407)	(55,361)
2028	188,016	314,423	$ -	$ -	$ (126,407)	(53,489)
2029	188,016	314,423	$ -	$ -	$ (126,407)	(51,680)
2030	188,016	314,423	$ (4,147,965)	$ -	$ (4,274,372)	(1,688,429)
					$ -	
TOTAL						**$ 21,551,086**

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 3: Barrier separated - HOV + BRT

Key Event Timings	
Base Year	2003
Build (expenditure) Year	2008
First year of operation (benefits begin accruing)	2011
Horizon Year	2030

	Base		Build Alternative	
YEAR	VHT	VMT	VHT	VMT
2011	2,143,212	80,142,498	2,134,938	80,191,548
2030	2,796,692	95,716,244	2,787,324	95,763,078
(2030-2011) CHANGES	653,480	15,573,746	652,386	15,571,530

**System-wide statistics reported.*

B/C Analysis Summary	
BENEFITS	**Value(Disc'd)**
1. Travel Time Savings	$ 430,886,288
2: Vehicle Operating Svgs	$ (61,647,280)
3. Crash Benefits	$ 36,962,813
4. Maintenance	$ 20,672,995
TOTAL	**$ 426,874,817**

COSTS	Value(Dis'd)
1. Capital (Rdway System	$ 186,812,727
2. Right of Way	$ 23,735,785
Remaining Capital (asset	$ (81,810,263)
TOTAL	**$ 128,738,250**

Benefit/Cost Analysis Results	
BENEFITS	$ 426,874,817
COSTS	$ 128,738,250
B/C Ratio*:	**3.32**

Data Source:
These costs and benefits are all as found in the 'base' and 'build' scenario from SRF's memo
Except for the following:
1. Annual operations costs were factored to increase by 25% due barrier separation (URS assumption - waiting on Mn/DOT info)
2. Additional capital costs due to barrier separation (URS calcs)
3. Additional ROW costs due to barrier separation (URS calcs)
4. RCV different due to different capital and ROW costs
Note that forecasts are linearly interpolated between forecasts for operations start and horizon year

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Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 3: Barrier separated - HOV + BRT

BENEFIT 1: Travel Time Savings (VHT)

YEAR	Daily Base	Daily Build VHT	Annualized Savings Build VHT Savings	Annualized Savings '00 cost per hour* $ 12.07	Discounted Value (3.5%)
2011	2,143,212	2,134,938	8,274	36,449,758	27,680,368
2012	2,177,605	2,169,274	8,331	36,703,518	26,930,508
2013	2,211,999	2,203,610	8,389	36,957,278	26,199,710
2014	2,246,393	2,237,946	8,446	37,211,038	25,487,541
2015	2,280,786	2,272,282	8,504	37,464,797	24,793,577
2016	2,315,180	2,306,619	8,562	37,718,557	24,117,402
2017	2,349,574	2,340,955	8,619	37,972,317	23,458,606
2018	2,383,968	2,375,291	8,677	38,226,076	22,816,786
2019	2,418,361	2,409,627	8,734	38,479,836	22,191,549
2020	2,452,755	2,443,963	8,792	38,733,596	21,582,506
2021	2,487,149	2,478,299	8,850	38,987,355	20,989,277
2022	2,521,542	2,512,635	8,907	39,241,115	20,411,489
2023	2,555,936	2,546,971	8,965	39,494,875	19,848,777
2024	2,590,330	2,581,307	9,022	39,748,634	19,300,780
2025	2,624,723	2,615,643	9,080	40,002,394	18,767,148
2026	2,659,117	2,649,980	9,138	40,256,154	18,247,536
2027	2,693,511	2,684,316	9,195	40,509,913	17,741,606
2028	2,727,905	2,718,652	9,253	40,763,673	17,249,026
2029	2,762,298	2,752,988	9,310	41,017,433	16,769,472
2030	2,796,692	2,787,324	9,368	41,271,192	16,302,626
TOTAL					**$ 430,886,288**

*Composite cost per hour based on assumption that autos account for 97%, and trucks 3% , of systemwide traffic on average. Auto occupancies are assumed to be 1.3 during peak periods, and 1.1 off peak.

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 3: Barrier separated - HOV + BRT

BENEFIT 2: Vehicle Operating Cost Savings (VMT)					
	Daily		Annualized		
YEAR	Base	Build VMT	Build VMT Savings	'cost per mile* $ 0.31	Discounted Value (3.5%)
2011	80,142,498	80,191,548	(49,050)	(5,630,612)	(4,275,952)
2012	80,962,169	81,011,102	(48,934)	(5,617,222)	(4,121,530)
2013	81,781,840	81,830,657	(48,817)	(5,603,831)	(3,972,661)
2014	82,601,510	82,650,211	(48,700)	(5,590,441)	(3,829,148)
2015	83,421,181	83,469,765	(48,584)	(5,577,050)	(3,690,799)
2016	84,240,852	84,289,319	(48,467)	(5,563,660)	(3,557,427)
2017	85,060,523	85,108,873	(48,350)	(5,550,269)	(3,428,855)
2018	85,880,194	85,928,428	(48,234)	(5,536,878)	(3,304,911)
2019	86,699,865	86,747,982	(48,117)	(5,523,488)	(3,185,428)
2020	87,519,535	87,567,536	(48,000)	(5,510,097)	(3,070,247)
2021	88,339,206	88,387,090	(47,884)	(5,496,707)	(2,959,213)
2022	89,158,877	89,206,644	(47,767)	(5,483,316)	(2,852,178)
2023	89,978,548	90,026,199	(47,651)	(5,469,926)	(2,748,998)
2024	90,798,219	90,845,753	(47,534)	(5,456,535)	(2,649,535)
2025	91,617,890	91,665,307	(47,417)	(5,443,145)	(2,553,655)
2026	92,437,561	92,484,861	(47,301)	(5,429,754)	(2,461,230)
2027	93,257,231	93,304,415	(47,184)	(5,416,364)	(2,372,135)
2028	94,076,902	94,123,970	(47,067)	(5,402,973)	(2,286,252)
2029	94,896,573	94,943,524	(46,951)	(5,389,582)	(2,203,464)
2030	95,716,244	95,763,078	(46,834)	(5,376,192)	(2,123,662)
TOTAL					**$ (61,647,280)**

*Composite cost per mile based on assumption that autos account for 97%, and trucks 3% , of systemwide traffic on average.

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 3: Barrier separated - HOV + BRT

BENEFIT 3: Crash Benefits

YEAR	Estimated Crash Costs Base	Estimated Crash Costs Build	Build Crash Savings	Discounted Value (3.5%)
2011	9,822,724	6,012,829	$ 3,809,895	2,893,278
2012	9,896,474	6,146,474	$ 3,750,001	2,751,492
2013	9,970,225	6,280,119	$ 3,690,106	2,615,986
2014	10,043,975	6,413,764	$ 3,630,212	2,486,498
2015	10,117,725	6,547,408	$ 3,570,317	2,362,776
2016	10,191,476	6,681,053	$ 3,510,423	2,244,579
2017	10,265,226	6,814,698	$ 3,450,528	2,131,673
2018	10,338,977	6,948,343	$ 3,390,634	2,023,837
2019	10,412,727	7,081,988	$ 3,330,739	1,920,857
2020	10,486,477	7,215,633	$ 3,270,845	1,822,527
2021	10,560,228	7,349,277	$ 3,210,950	1,728,651
2022	10,633,978	7,482,922	$ 3,151,056	1,639,040
2023	10,707,728	7,616,567	$ 3,091,161	1,553,512
2024	10,781,479	7,750,212	$ 3,031,267	1,471,895
2025	10,855,229	7,883,857	$ 2,971,372	1,394,021
2026	10,928,980	8,017,502	$ 2,911,478	1,319,731
2027	11,002,730	8,151,146	$ 2,851,583	1,248,871
2028	11,076,480	8,284,791	$ 2,791,689	1,181,295
2029	11,150,231	8,418,436	$ 2,731,794	1,116,860
2030	11,223,981	8,552,081	$ 2,671,900	1,055,433
TOTAL			**$ 64,817,950**	**$ 36,962,813**

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 3: Barrier separated - HOV + BRT

COST 1: Capital (Roadway System)

YEAR	Costs	RCV Value (3.5%)	RCV Factor	Discounted Value (3.5%)	
2008	$ 10,231,918			8,615,000	Barrier / assoc costs
2008	5,442,500			4,582,439	Signing/Striping/Signals
2008	137,024,000			115,370,531	Major Structures
2008	69,176,500			58,244,757	Roadway
2030	$ 10,231,918	(0.89)	(9,106,407.02)	(3,597,142)	
2030	$ 5,442,500	-	-	-	
2030	$ 137,024,000	(0.89)	(121,951,360.00)	(48,172,280)	RCV
2030	$ 69,176,500	(0.70)	(48,423,550.00)	(19,127,895)	
TOTAL				**$ 115,915,410**	

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 3: Barrier separated - HOV + BRT

COST 2: Right of Way					
YEAR	ROW Costs		RCV Factor	RCV	Discounted Value (3.5%)
2008	$	20,190,667			17,000,000
2008	$	8,000,000			6,735,785
2030	$	20,190,667	(0.98)	(19,786,853.66)	(7,816,049)
2030	$	8,000,000	(0.98)	(7,840,000.00)	(3,096,896) RCV
TOTAL					**$ 12,822,840**

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 3: Barrier separated - HOV + BRT

BENEFIT 4: Incremental Operations & Maintenance Costs

YEAR	Annual Maint. Costs Base	Annual Maint. Costs Build	Major Maint. Costs Base	Major Maint. Costs Build	Build Savings	Discounted Value (3.5%)
2011	188,016	393,029	$ 13,888,500	$ -	$ 13,683,487	10,391,398
2012	188,016	393,029	$ -	$ -	$ (205,013)	(150,424)
2013	188,016	393,029	$ -	$ -	$ (205,013)	(145,337)
2014	188,016	393,029	$ 8,212,800	$ -	$ 8,007,787	5,484,900
2015	188,016	393,029	$ -	$ -	$ (205,013)	(135,674)
2016	188,016	393,029	$ -	$ -	$ (205,013)	(131,086)
2017	188,016	393,029	$ -	$ -	$ (205,013)	(126,653)
2018	188,016	393,029	$ -	$ -	$ (205,013)	(122,370)
2019	188,016	393,029	$ -	$ -	$ (205,013)	(118,232)
2020	188,016	393,029	$ 8,212,800	$ -	$ 8,007,787	4,461,969
2021	188,016	393,029	$ -	$ -	$ (205,013)	(110,371)
2022	188,016	393,029	$ -	$ -	$ (205,013)	(106,639)
2023	188,016	393,029	$ -	$ -	$ (205,013)	(103,032)
2024	188,016	393,029	$ -	$ -	$ (205,013)	(99,548)
2025	188,016	393,029	$ 8,212,800	$ -	$ 8,007,787	3,756,858
2026	188,016	393,029	$ -	$ -	$ (205,013)	(92,929)
2027	188,016	393,029	$ -	$ -	$ (205,013)	(89,787)
2028	188,016	393,029	$ -	$ -	$ (205,013)	(86,751)
2029	188,016	393,029	$ -	$ -	$ (205,013)	(83,817)
2030	188,016	393,029	$ (4,147,965)	$ -	$ (4,352,978)	(1,719,480)
					$ -	
TOTAL						**$ 20,672,995**

*Maintenance for barrier separated lane will be 25% additional - this may be revised with additional info from MnDOT

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 4: Barrier separated - BRT only

Key Event Timings	
Base Year	2003
Build (expenditure) Year	2008
First year of operation (benefits begin accruing)	2011
Horizon Year	2030

	Base		Build Alternative	
YEAR	**VHT**	**VMT**	**VHT**	**VMT**
2011	2,143,212	80,142,498	2,138,069	80,197,082
2030	2,796,692	95,716,244	2,799,016	95,821,559
(2030-2011) CHANGES	653,480	15,573,746	660,947	15,624,477

**System-wide statistics reported.*

B/C Analysis Summary

BENEFITS	**Value(Disc'd)**
1. Travel Time Savings	$ 91,316,643
2: Vehicle Operating Svgs	$ (98,635,628)
3. Crash Benefits	$ 38,816,018
4. Maintenance	$ 20,672,995
TOTAL	**$ 52,170,028**

COSTS	**Value(Dis'd)**
1. Capital (Rdway System	$ 186,812,727
2. Right of Way	$ 23,735,785
Remaining Capital (asset	$ (81,810,263)
TOTAL	**$ 128,738,250**

Benefit/Cost Analysis Results	
BENEFITS	$ 52,170,028
COSTS	$ 128,738,250
B/C Ratio*:	**0.41**

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Data Source:

These costs and benefits are all as found in the 'base' and 'build' scenario from SRF's memo
Except for the following:
1. Travel time savings were adjusted based on VHT as calculated from the regional model (run by URS)
2. Vehicle operating savings were adjusted based on VMT as calculated from the regional model (run by URS)
3. Crash benefits were adjusted based on changes in study area VMT from the regional model (run by URS)
4. Annual operations costs were factored to increase by 25% due barrier separation (URS assumption - waiting on Mn/DOT info)
5. Additional capital costs due to barrier separation (URS calcs)
6. Additional ROW costs due to barrier separation (URS calcs)
7. RCV different due to different capital and ROW costs
Note that forecasts are linearly interpolated between forecasts for operations start and horizon year

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 4: Barrier separated - BRT only

BENEFIT 1: Travel Time Savings (VHT)

	Daily		Annualized Savings		
YEAR	Base	Build VHT	Build VHT Savings	'00 cost per hour* $ 12.07	Discounted Value (3.5%)
2011	2,143,212	2,138,069	5,143	22,657,744	17,206,552
2012	2,177,605	2,172,855	4,750	20,926,363	15,354,320
2013	2,211,999	2,207,642	4,357	19,194,981	13,607,683
2014	2,246,393	2,242,429	3,964	17,463,600	11,961,618
2015	2,280,786	2,277,215	3,571	15,732,219	10,411,320
2016	2,315,180	2,312,002	3,178	14,000,838	8,952,194
2017	2,349,574	2,346,789	2,785	12,269,457	7,579,847
2018	2,383,968	2,381,576	2,392	10,538,076	6,290,078
2019	2,418,361	2,416,362	1,999	8,806,694	5,078,873
2020	2,452,755	2,451,149	1,606	7,075,313	3,942,391
2021	2,487,149	2,485,936	1,213	5,343,932	2,876,965
2022	2,521,542	2,520,722	820	3,612,551	1,879,089
2023	2,555,936	2,555,509	427	1,881,170	945,412
2024	2,590,330	2,590,296	34	149,789	72,733
2025	2,624,723	2,625,082	(359)	(1,581,592)	(742,005)
2026	2,659,117	2,659,869	(752)	(3,312,974)	(1,501,723)
2027	2,693,511	2,694,656	(1,145)	(5,044,355)	(2,209,211)
2028	2,727,905	2,729,443	(1,538)	(6,775,736)	(2,867,132)
2029	2,762,298	2,764,229	(1,931)	(8,507,117)	(3,478,030)
2030	2,796,692	2,799,016	(2,324)	(10,238,498)	(4,044,332)
TOTAL					**$ 91,316,643**

*Composite cost per hour based on assumption that autos account for 97%, and trucks 3% , of systemwide traffic on average. Auto occupancies are assumed to be 1.3 during peak periods, and 1.1 off peak.

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 4: Barrier separated - BRT only

BENEFIT 2: Vehicle Operating Cost Savings (VMT)					
	Daily		Annualized		
YEAR	Base	Build VMT	Build VMT Savings	'cost per mile* $ 0.31	Discounted Value (3.5%)
2011	80,142,498	80,197,082	(54,584)	(6,265,840)	(4,758,351)
2012	80,962,169	81,019,423	(57,254)	(6,572,341)	(4,822,330)
2013	81,781,840	81,841,764	(59,924)	(6,878,843)	(4,876,541)
2014	82,601,510	82,664,105	(62,594)	(7,185,345)	(4,921,571)
2015	83,421,181	83,486,445	(65,264)	(7,491,846)	(4,957,979)
2016	84,240,852	84,308,786	(67,934)	(7,798,348)	(4,986,296)
2017	85,060,523	85,131,127	(70,604)	(8,104,850)	(5,007,029)
2018	85,880,194	85,953,468	(73,274)	(8,411,352)	(5,020,657)
2019	86,699,865	86,775,809	(75,944)	(8,717,853)	(5,027,638)
2020	87,519,535	87,598,150	(78,614)	(9,024,355)	(5,028,405)
2021	88,339,206	88,420,491	(81,285)	(9,330,857)	(5,023,371)
2022	89,158,877	89,242,832	(83,955)	(9,637,358)	(5,012,927)
2023	89,978,548	90,065,173	(86,625)	(9,943,860)	(4,997,445)
2024	90,798,219	90,887,514	(89,295)	(10,250,362)	(4,977,277)
2025	91,617,890	91,709,854	(91,965)	(10,556,864)	(4,952,759)
2026	92,437,561	92,532,195	(94,635)	(10,863,365)	(4,924,207)
2027	93,257,231	93,354,536	(97,305)	(11,169,867)	(4,891,923)
2028	94,076,902	94,176,877	(99,975)	(11,476,369)	(4,856,191)
2029	94,896,573	94,999,218	(102,645)	(11,782,870)	(4,817,281)
2030	95,716,244	95,821,559	(105,315)	(12,089,372)	(4,775,450)
TOTAL					**$ (98,635,628)**

*Composite cost per mile based on assumption that autos account for 97%, and trucks 3% , of systemwide traffic on average.

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 4: Barrier separated - BRT only

BENEFIT 3: Crash Benefits				
YEAR	**Estimated Crash Costs Base**	**Estimated Crash Costs Build**	**Build Crash Savings**	**Discounted Value (3.5%)**
2011	9,821,431	5,877,736	$ 3,943,695	2,994,888
2012	9,895,172	6,007,534	$ 3,887,638	2,852,480
2013	9,968,912	6,137,332	$ 3,831,580	2,716,279
2014	10,042,653	6,267,130	$ 3,775,523	2,586,028
2015	10,116,394	6,396,929	$ 3,719,465	2,461,480
2016	10,190,134	6,526,727	$ 3,663,408	2,342,398
2017	10,263,875	6,656,525	$ 3,607,350	2,228,555
2018	10,337,616	6,786,323	$ 3,551,293	2,119,733
2019	10,411,356	6,916,121	$ 3,495,235	2,015,723
2020	10,485,097	7,045,919	$ 3,439,178	1,916,323
2021	10,558,838	7,175,717	$ 3,383,120	1,821,341
2022	10,632,578	7,305,516	$ 3,327,063	1,730,591
2023	10,706,319	7,435,314	$ 3,271,005	1,643,896
2024	10,780,060	7,565,112	$ 3,214,948	1,561,085
2025	10,853,801	7,694,910	$ 3,158,890	1,481,995
2026	10,927,541	7,824,708	$ 3,102,833	1,406,470
2027	11,001,282	7,954,506	$ 3,046,776	1,334,357
2028	11,075,023	8,084,304	$ 2,990,718	1,265,513
2029	11,148,763	8,214,103	$ 2,934,661	1,199,800
2030	11,222,504	8,343,901	$ 2,878,603	1,137,083
TOTAL			**$ 68,222,981**	**$ 38,816,018**

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 4: Barrier separated - BRT only

COST 1: Capital (Roadway System)

YEAR	Costs	RCV Value (3.5%)	RCV Factor	Discounted Value (3.5%)	
2008	$ 10,231,918			8,615,000	Barrier / assoc costs
2008	5,442,500			4,582,439	Signing/Striping/Signals
2008	137,024,000			115,370,531	Major Structures
2008	69,176,500			58,244,757	Roadway
2030	$ 10,231,918	(0.89)	(9,106,407.02)	(3,597,142)	
2030	$ 5,442,500	-	-	-	
2030	$ 137,024,000	(0.89)	(121,951,360.00)	(48,172,280)	RCV
2030	$ 69,176,500	(0.70)	(48,423,550.00)	(19,127,895)	
TOTAL				**$ 115,915,410**	

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 4: Barrier separated - BRT only

COST 2: Right of Way

YEAR	ROW Costs	RCV Factor	RCV	Discounted Value (3.5%)	
2008	$ 20,190,667			17,000,000	
2008	$ 8,000,000			6,735,785	
2030	$ 20,190,667	(0.98)	(19,786,853.66)	(7,816,049)	
2030	$ 8,000,000	(0.98)	(7,840,000.00)	(3,096,896)	RCV
TOTAL				**$ 12,822,840**	

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 4: Barrier separated - BRT only

BENEFIT 4: Incremental Operations & Maintenance Costs						
YEAR	Annual Maint. Costs Base	Annual Maint. Costs Build	Major Maint. Costs Base	Major Maint. Costs Build	Build Savings	Discounted Value (3.5%)
2011	188,016	393,029	$ 13,888,500	$ -	$ 13,683,487	10,391,398
2012	188,016	393,029	$ -	$ -	$ (205,013)	(150,424)
2013	188,016	393,029	$ -	$ -	$ (205,013)	(145,337)
2014	188,016	393,029	$ 8,212,800	$ -	$ 8,007,787	5,484,900
2015	188,016	393,029	$ -	$ -	$ (205,013)	(135,674)
2016	188,016	393,029	$ -	$ -	$ (205,013)	(131,086)
2017	188,016	393,029	$ -	$ -	$ (205,013)	(126,653)
2018	188,016	393,029	$ -	$ -	$ (205,013)	(122,370)
2019	188,016	393,029	$ -	$ -	$ (205,013)	(118,232)
2020	188,016	393,029	$ 8,212,800	$ -	$ 8,007,787	4,461,969
2021	188,016	393,029	$ -	$ -	$ (205,013)	(110,371)
2022	188,016	393,029	$ -	$ -	$ (205,013)	(106,639)
2023	188,016	393,029	$ -	$ -	$ (205,013)	(103,032)
2024	188,016	393,029	$ -	$ -	$ (205,013)	(99,548)
2025	188,016	393,029	$ 8,212,800	$ -	$ 8,007,787	3,756,858
2026	188,016	393,029	$ -	$ -	$ (205,013)	(92,929)
2027	188,016	393,029	$ -	$ -	$ (205,013)	(89,787)
2028	188,016	393,029	$ -	$ -	$ (205,013)	(86,751)
2029	188,016	393,029	$ -	$ -	$ (205,013)	(83,817)
2030	188,016	393,029	$ (4,147,965)	$ -	$ (4,352,978)	(1,719,480)
					$ -	
TOTAL						**$ 20,672,995**

*Maintenance for barrier separated lane will be 25% additional - this may be revised with additional info from MnDOT

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 5: Barrier free - HOV with shoulder running BRT

Key Event Timings	
Base Year	2003
Build (expenditure) Year	2008
First year of operation (benefits begin accruing)	2011
Horizon Year	2030

	Base		Build Alternative	
YEAR	**VHT**	**VMT**	**VHT**	**VMT**
2011	2,143,212	80,142,498	2,135,186	80,191,548
2030	2,796,692	95,716,244	2,787,627	95,763,078
(2030-2011) CHANGES	653,480	15,573,746	652,441	15,571,530

**System-wide statistics reported.*

B/C Analysis Summary	
BENEFITS	**Value(Disc'd)**
1. Travel Time Savings	$ 417,489,618
2: Vehicle Operating Svgs	$ (61,647,280)
3. Crash Benefits	$ 36,962,813
4. Maintenance	$ 21,551,086
TOTAL	**$ 414,356,237**

COSTS	**Value(Dis'd)**
1. Capital (Rdway System	$ 182,145,727
2. Right of Way	$ 6,735,785
Remaining Capital (asset	$ (71,693,616)
TOTAL	**$ 117,187,896**

Benefit/Cost Analysis Results	
BENEFITS	$ 414,356,237
COSTS	$ 117,187,896
B/C Ratio*:	**3.54**

Data Source:
These costs and benefits are all as found in the 'base' and 'build' scenario from SRF's memo
Except for the following:
1. Travel time savings were adjusted to simulate shoulder running buses, in 2010 there were 248 hrs additional (over HOV/BRT lane) daily person hours, in 2030, 303 hrs.
2. Additional capital costs due to barrier separation (URS calcs)
3. RCV different due to different capital costs
Note that forecasts are linearly interpolated between forecasts for operations start and horizon year

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Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 5: Barrier free - HOV with shoulder running BRT

BENEFIT 1: Travel Time Savings (VHT)

YEAR	Daily Base	Daily Build VHT	Build VHT Savings	Annualized Savings '00 cost per hour* $ 12.07	Discounted Value (3.5%)
2011	2,143,212	2,135,186	8,026	35,357,182	26,850,653
2012	2,177,605	2,169,525	8,080	35,598,189	26,119,494
2013	2,211,999	2,203,864	8,135	35,839,196	25,407,080
2014	2,246,393	2,238,203	8,190	36,080,202	24,712,980
2015	2,280,786	2,272,542	8,244	36,321,209	24,036,770
2016	2,315,180	2,306,881	8,299	36,562,216	23,378,033
2017	2,349,574	2,341,220	8,354	36,803,223	22,736,361
2018	2,383,968	2,375,559	8,409	37,044,229	22,111,353
2019	2,418,361	2,409,898	8,463	37,285,236	21,502,616
2020	2,452,755	2,444,237	8,518	37,526,243	20,909,764
2021	2,487,149	2,478,576	8,573	37,767,250	20,332,420
2022	2,521,542	2,512,915	8,627	38,008,257	19,770,211
2023	2,555,936	2,547,254	8,682	38,249,263	19,222,775
2024	2,590,330	2,581,593	8,737	38,490,270	18,689,755
2025	2,624,723	2,615,932	8,791	38,731,277	18,170,803
2026	2,659,117	2,650,271	8,846	38,972,284	17,665,576
2027	2,693,511	2,684,610	8,901	39,213,290	17,173,740
2028	2,727,905	2,718,949	8,956	39,454,297	16,694,967
2029	2,762,298	2,753,288	9,010	39,695,304	16,228,936
2030	2,796,692	2,787,627	9,065	39,936,311	15,775,332
TOTAL					**$ 417,489,618**

*Composite cost per hour based on assumption that autos account for 97%, and trucks 3% , of systemwide traffic on average. Auto occupancies are assumed to be 1.3 during peak periods, and 1.1 off peak.

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 5: Barrier free - HOV with shoulder running BRT

BENEFIT 2: Vehicle Operating Cost Savings (VMT)					
	Daily		Annualized		
		Build	Build	'cost per mile*	Discounted
YEAR	Base	VMT	VMT Savings	$ 0.31	Value (3.5%)
2011	80,142,498	80,191,548	(49,050)	(5,630,612)	(4,275,952)
2012	80,962,169	81,011,102	(48,934)	(5,617,222)	(4,121,530)
2013	81,781,840	81,830,657	(48,817)	(5,603,831)	(3,972,661)
2014	82,601,510	82,650,211	(48,700)	(5,590,441)	(3,829,148)
2015	83,421,181	83,469,765	(48,584)	(5,577,050)	(3,690,799)
2016	84,240,852	84,289,319	(48,467)	(5,563,660)	(3,557,427)
2017	85,060,523	85,108,873	(48,350)	(5,550,269)	(3,428,855)
2018	85,880,194	85,928,428	(48,234)	(5,536,878)	(3,304,911)
2019	86,699,865	86,747,982	(48,117)	(5,523,488)	(3,185,428)
2020	87,519,535	87,567,536	(48,000)	(5,510,097)	(3,070,247)
2021	88,339,206	88,387,090	(47,884)	(5,496,707)	(2,959,213)
2022	89,158,877	89,206,644	(47,767)	(5,483,316)	(2,852,178)
2023	89,978,548	90,026,199	(47,651)	(5,469,926)	(2,748,998)
2024	90,798,219	90,845,753	(47,534)	(5,456,535)	(2,649,535)
2025	91,617,890	91,665,307	(47,417)	(5,443,145)	(2,553,655)
2026	92,437,561	92,484,861	(47,301)	(5,429,754)	(2,461,230)
2027	93,257,231	93,304,415	(47,184)	(5,416,364)	(2,372,135)
2028	94,076,902	94,123,970	(47,067)	(5,402,973)	(2,286,252)
2029	94,896,573	94,943,524	(46,951)	(5,389,582)	(2,203,464)
2030	95,716,244	95,763,078	(46,834)	(5,376,192)	(2,123,662)
TOTAL					**$ (61,647,280)**

*Composite cost per mile based on assumption that autos account for 97%, and trucks 3% , of systemwide traffic on average.

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 5: Barrier free - HOV with shoulder running BRT

BENEFIT 3: Crash Benefits

YEAR	Estimated Crash Costs Base	Estimated Crash Costs Build	Build Crash Savings	Discounted Value (3.5%)
2011	9,822,724	6,012,829	$ 3,809,895	2,893,278
2012	9,896,474	6,146,474	$ 3,750,001	2,751,492
2013	9,970,225	6,280,119	$ 3,690,106	2,615,986
2014	10,043,975	6,413,764	$ 3,630,212	2,486,498
2015	10,117,725	6,547,408	$ 3,570,317	2,362,776
2016	10,191,476	6,681,053	$ 3,510,423	2,244,579
2017	10,265,226	6,814,698	$ 3,450,528	2,131,673
2018	10,338,977	6,948,343	$ 3,390,634	2,023,837
2019	10,412,727	7,081,988	$ 3,330,739	1,920,857
2020	10,486,477	7,215,633	$ 3,270,845	1,822,527
2021	10,560,228	7,349,277	$ 3,210,950	1,728,651
2022	10,633,978	7,482,922	$ 3,151,056	1,639,040
2023	10,707,728	7,616,567	$ 3,091,161	1,553,512
2024	10,781,479	7,750,212	$ 3,031,267	1,471,895
2025	10,855,229	7,883,857	$ 2,971,372	1,394,021
2026	10,928,980	8,017,502	$ 2,911,478	1,319,731
2027	11,002,730	8,151,146	$ 2,851,583	1,248,871
2028	11,076,480	8,284,791	$ 2,791,689	1,181,295
2029	11,150,231	8,418,436	$ 2,731,794	1,116,860
2030	11,223,981	8,552,081	$ 2,671,900	1,055,433
TOTAL			**$ 64,817,950**	**$ 36,962,813**

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 5: Barrier free - HOV with shoulder running BRT

COST 1: Capital (Roadway System)

YEAR	Costs	RCV Value (3.5%)	RCV Factor	Discounted Value (3.5%)	
2008	$ 4,688,985			3,948,000	Shoulder costs
2008	5,442,500			4,582,439	Signing/Striping/Signals
2008	137,024,000			115,370,531	Major Structures
2008	69,176,500			58,244,757	Roadway
2030	$ 4,688,985	(0.70)	(3,282,289.50)	(1,296,545)	
2030	$ 5,442,500	-	-	-	
2030	$ 137,024,000	(0.89)	(121,951,360.00)	(48,172,280)	RCV
2030	$ 69,176,500	(0.70)	(48,423,550.00)	(19,127,895)	
TOTAL				**$ 113,549,007**	

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 5: Barrier free - HOV with shoulder running BRT

COST 2: Right of Way					
YEAR	**ROW Costs**	**RCV Factor**	**RCV**	**Discounted Value (3.5%)**	
2008	$ 8,000,000			6,735,785	
2030	$ 8,000,000	(0.98)	(7,840,000.00)	(3,096,896)	RCV
TOTAL				**$ 3,638,889**	

Benefit Cost Analysis for Transportation Alternatives

KS 3-16-04

Alternative 5: Barrier free - HOV with shoulder running BRT

BENEFIT 4: Incremental Operations & Maintenance Costs						
YEAR	Annual Maint. Costs Base	Annual Maint. Costs Build	Major Maint. Costs Base	Major Maint. Costs Build	Build Savings	Discounted Value (3.5%)
2011	188,016	314,423	$ 13,888,500	$ -	$ 13,762,093	10,451,092
2012	188,016	314,423	$ -	$ -	$ (126,407)	(92,749)
2013	188,016	314,423	$ -	$ -	$ (126,407)	(89,612)
2014	188,016	314,423	$ 8,212,800	$ -	$ 8,086,393	5,538,740
2015	188,016	314,423	$ -	$ -	$ (126,407)	(83,654)
2016	188,016	314,423	$ -	$ -	$ (126,407)	(80,825)
2017	188,016	314,423	$ -	$ -	$ (126,407)	(78,092)
2018	188,016	314,423	$ -	$ -	$ (126,407)	(75,451)
2019	188,016	314,423	$ -	$ -	$ (126,407)	(72,900)
2020	188,016	314,423	$ 8,212,800	$ -	$ 8,086,393	4,505,769
2021	188,016	314,423	$ -	$ -	$ (126,407)	(68,053)
2022	188,016	314,423	$ -	$ -	$ (126,407)	(65,751)
2023	188,016	314,423	$ -	$ -	$ (126,407)	(63,528)
2024	188,016	314,423	$ -	$ -	$ (126,407)	(61,380)
2025	188,016	314,423	$ 8,212,800	$ -	$ 8,086,393	3,793,736
2026	188,016	314,423	$ -	$ -	$ (126,407)	(57,298)
2027	188,016	314,423	$ -	$ -	$ (126,407)	(55,361)
2028	188,016	314,423	$ -	$ -	$ (126,407)	(53,489)
2029	188,016	314,423	$ -	$ -	$ (126,407)	(51,680)
2030	188,016	314,423	$ (4,147,965)	$ -	$ (4,274,372)	(1,688,429)
					$ -	
TOTAL						**$ 21,551,086**