Technical Memorandum #2

Review of Vehicle Technology

This document briefly summarizes the vehicle technologies that are being used today on commuter rail, express bus, and bus rapid transit (BRT) services in North America. This information will assist in the evaluation of alternatives as part of the Red Rock Corridor Alternatives Analysis Update.

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1. INTRODUCTION

In the 2007 Red Rock Corridor Alternatives Analysis, four transit technologies passed an initial screening: light rail transit (LRT), bus rapid transit (BRT), commuter rail, and express bus. In a second screening, LRT and BRT were dropped from the analysis due to the conclusion that there was no space in the TH 61 right of way to dedicate to either mode. Additionally, in the case of LRT, it was concluded that the transit ridership potential in the corridor was not sufficient to warrant LRT, presumed to be more expensive based on historical experience. Commuter rail and express bus options were the focus of the remainder of the study and the subsequent Commuter Bus Feasibility Study in 2009.

In the Alternatives Analysis Update, the BRT option was reconsidered with the assumption that it would rely on bus-only shoulder lane operation during periods of congestion and operate in mixed traffic during periods of free or nearly free-flow traffic. The AAU explored opportunities for travel time enhancements through improvements such as dedicated bus ramps connecting the highway to the park and ride lots.

The express bus and commuter rail options developed in the AAU differed from the options developed in the 2007 Red Rock Corridor Alternatives Analysis in a few key ways. In the AAU, service south of Hastings was included in both the express bus and commuter rail options. In the express bus option, the new service was developed as an overlay to the existing routes in the corridor.

This memo provides a comparison of the vehicles of express bus, BRT, and commuter rail in order to illustrate how they differ and how they were characterized in the option development and evaluation. Each vehicle technology is discussed below.

2. EXPRESS BUS VEHICLES

A. EXAMPLES

Express bus services are frequently offered using coach buses. Coach buses were assumed to be used for the express bus service option in the Red Rock AAU because of the long, intercity trips involved and the predominant use of highways for travel. Coach buses are manufactured by companies such as MCI and VanHool.

Figure 1 – Typical Coach Bus

Coach buses are commonly used for intercity bus services and charter buses. It is assumed that coach buses would be used for the express bus service options. Metro Transit has coach buses in its fleet.

B. FEATURES

Coach buses can have the following features:

- Bathrooms
- Wheelchair lifts
- Wi-Fi
- Video screens
- Lights
- Lean back chairs
- Luggage storage

The features are typically consistent with what passengers would need for longer journeys.

C. CAPACITY

The number of seats on a coach bus can vary based on seat spacing, whether there are wheelchair accessibility features, and whether there is a bathroom. For the purpose of this AAU, it is assumed that coach buses have 50 seats per vehicle.

D. CAPITAL COSTS

A recent coach bus purchase by Metro Transit included unit costs of $550,000. Coach buses typically cost around $600,000 in other jurisdictions. For the purpose of this study, it is assumed that coach buses will cost $600,000 each.

E. OPERATING COSTS

It is assumed that it will cost $132.84 per revenue hour to operate a coach bus. This is the reported unit cost in the National Transit Database for Metro Transit's bus services in 2011 escalated to 2013 dollars. A more refined unit cost associated with express bus services was not available from the NTD or Metro Transit.

F. FUTURE DIRECTIONS

There is not a body of literature on the future of coach buses, but it is expected that coach buses could benefit from advances in propulsion systems to make them more fuel efficient, that there will be advances in making them more wheelchair accessible, and that new technology will make it easy and less expensive to install fare collection equipment on coach buses. Given the storage capacity and hauling ability of coach buses, there are also opportunities for coach bus service to serve supplementary purposes, such as the delivery of goods or the hauling of a large number of bicycles.

3. BRT VEHICLES

A. EXAMPLES

High quality BRT vehicles are being manufactured by Nova, Flyer Industries, NABI buses, Gillig, and MCI. Some cities have opted for European manufacturers such as Van Hool and Irisbus.

B. FEATURES

The vehicles used for high-quality bus rapid transit (BRT) services are a key component of their success, having an impact on service identify, customer satisfaction, community acceptance, and operational efficiency.

Figure 2 – AC Transit Bus, Oakland Area, CA

A service identify can be provided through the use of colors in the livery of the bus or in distinctive vehicle shapes. Often, the colors and shapes of the buses are different from those on the regular fleet so that the BRT services stand out. This coloring can be extended to other elements of the BRT service, such as stations. The establishment of a unique identify may also come with the use of a special name for the BRT service.

Another aim of a BRT bus is to improve customer satification. The inclusion of bicyle hangers, comfortable seating, wifi, televisions, tables, as well as sufficient space for easy circulation around the inside of the vehicle and frequent availability of seats are all intended to improve people's perceptions of the service and its vehicles.

Figure 3 – RapidRide BRT Bus, Seattle Area, WA

There are also ways that a BRT vehicle can contribute to the community acceptance of an option. By making use of propulsion systems that are more efficient, noise and air pollution can be reduced.

BRT vehicles can also improve the operational efficiency of a service through the use of large doors. While the use of large doors, or even the use of a greater number of doors than is typical cuts down on the number of seats available, it can speed the boarding and alighting process. This is particularly valuable on high-use services which experience a large number of boardings and alightings and correspondingly large dwell times.

Figure 6 – On-Board Passenger Information

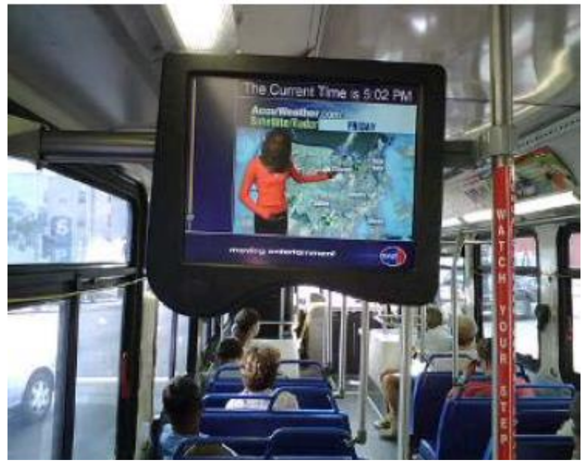

Figure 5 – On-Board Information and Advertising

Figure 4 – Metro Rapid, Los Angeles Area, CA

C. CAPACITY

The ridership demand on BRT lines can vary significantly from 1,000 to 20,000 passengers per hour or more. The use of high capacity vehicles, such as articulated buses, with a total capacity of at least 65 seats, is essential on high-demand routes. Several BRT systems in Europe and Asia are starting to use double articulated vehicles which are about 83 feet in length and have a seating capacity of over 120. The use of larger vehicles for BRT services contributes to its distinctive identity for attracting ridership, while the extra capacity is helpful for operational efficiencies. Many of the external designs have evolved from the standard articulated bus and now aim to duplicate the look of LRT vehicles and include curved noses, wheel covers and larger doorways.

Figure 7 – B-Line Bus, Vancouver Area, BC

The key choice factor in the design of the interiors of BRT vehicles is the length of the average trip and turnover of customers along routes. If most of the trips are longer and there is not much turnover of customers (i.e., ons and offs), vehicles designs will provide more seating. If most trips are short and there is high turnover of customers, the vehicle designs usually attempt to maximize capacity and ease of circulation rather than seating capacity.

Figure 8 – Double Deck Bus, BC Transit, Victoria Area, BC

Figure 9 – Zum Bus, Brampton Transit, ON

Figure 10 – Silver Line Bus, Los Angeles Area, CA

Figure 12 – VIVA bus, York Region, ON

Figure 11 – MAX Line, Las Vegas

For the purpose of this study, it is assumed that an enhanced 40-ft bus will be used for the BRT service, similar to the Red Line BRT. A typical seating capacity on this type of bus is 35, and this will be used in the AAU.

D. CAPITAL COSTS

The range of capital costs for different types of buses used in BRT systems are summarized below.

Table 1 – Typical Capital Costs of Regular 40 ft, Articulated, Enhanced BRT, and Double Deck Buses

Bus Type	Typical Cost
Regular 40 ft Bus	$475,000
Regular 60 ft Articulated Bus	$650,000 to $750,000
Enhanced 40 ft Bus	$800,000
Double Deck Bus	$850,000 to $900,000

Sources: Bus Suppliers and APTA Data (2011)

For the purpose of this study, it is assumed that enhanced 40-ft vehicles will be used on BRT services in the Red Rock Corridor. Given that the proposed BRT services for the corridor would operate in tandem with express bus services, the ridership forecasts indicate that the ridership loads could be accommodated by a 40 ft bus. An enhanced 40 ft bus is also what is used on the Red Line. The cost estimate in the table above for this type of bus, $800,000, will be used in the cost analysis.

E. OPERATING COSTS

It is assumed that it will cost $132.84 per revenue hour to operate a coach bus. This is the reported cost in the National Transit Database for Metro Transit's bus services in 2011 escalated to $2013.

F. FUTURE DIRECTIONS

It may be desirable to convert some or all of the Metro Transit bus fleet to an alternative propulsion system in the future if there were significant operation and cost benefits to doing so. These sorts of systemwide maintenance decisions have to be made at the fleet-level rather than at the route level.

Metro Transit may also want to think ahead about the branding of this transitway. The Cedar Avenue BRT line has been branded as the Red Line, and some consideration should be given to the right color for the Red Rock corridor and how this color should be used in the design of vehicles and stations.

Finally, providing desks, reading lights, and wi fi on public transit vehicles is proving to be a popular service, as it allows passengers to make productive use of the time they spent traveling.

4. COMMUTER RAIL VEHICLES

A. EXAMPLES

There are a number of manufacturers of commuter rail cars which supply the North American market. These companies include the following:

- Bombardier (cars used in Montreal, Minneapolis-St Paul, Toronto)
- Hyundai-Rotem (cars used in Boston);
- Kawasaki (cars used in New York City);
- Alstom (cars used in Montreal); and
- Nippon Sharyo (cars used in Los Angeles).

B. FEATURES

Commuter rail options for the Red Rock corridor would operate on existing railroad tracks, mainly owned by CP and BNSF, which are regulated by the Federal Railroad Administration (FRA).

Figure 13 – Seattle Modern Sounder Bi-Level Trains with Locomotive

The vehicles would therefore have to conform to FRA regulations regarding vehicle weight and crashworthiness.

Figure 14 - GO Transit Bombardier Bi-level Coaches, Toronto, Canada

Modern commuter rail trains either operate with locomotives that pull and push passenger cars or consist of self-powered vehicles that can be linked together. While there are a range of propulsion options, electrically powered units offer benefits such as quicker acceleration, lower engine noise, and fewer emissions, and several systems that currently rely on diesel locomotives are aiming to electrify their systems for these reasons. The capital costs of electric systems are generally higher than those of systems that use locomotives, and that is one of the reasons why they are less common. Nonetheless, electrically powered trains can have lower operating/maintenance costs than diesel powered trains, depending upon the length of the corridor served, number of stations, cars per train, and frequency of service.

Figure 15 - West Coast Express, Vancouver, BC, Canada

Both types of systems are compatible with bidirectional operation and bi-level vehicles. Bi-directional operation provides for convenient turnarounds at terminals and is made possible in systems that use locomotives with the use of a cab car. Many commuter trains operating in North America employ bi-level vehicles to provide additional seating capacity, enhanced energy-efficiency, and lower costs per passenger. This could also potentially reduce station construction costs by reducing the required length of platforms.

Figure 16 – External View of Bi-Level Coach (Caltrain)

Modern commuter rail vehicles are being designed and equipped to be more user-friendly in order to attract more customers, to reduce energy use, and to reduce capital and operating/maintenance costs. These commuter rail vehicles may do the following:

- Provide modern and attractive interiors and exteriors;
- Provide flexible and comfortable seating arrangements to accommodate different customers and provide capacity adjustments;
- Accommodate programming such as music concerts or lectures on board;
- Accommodate dining cars;
- Offer large windows;
- Use efficient dynamic braking systems that include electric regeneration and reduce maintenance costs;
- Include advanced safety systems;
- Provide on-board Wi-Fi;
- Allow level boarding that is ADA compliant; and
- Provide displays for important passenger information.

As a standalone project, it is unlikely that the Red Rock Corridor would justify the electrification of the corridor. The introduction of high-speed rail would likely require electrification as well as the construction of a dedicated passenger rail track along the entire corridor. For the purpose of this study, it is assumed that a trainset similar to that used on the Northstar commuter rail will be used.

C. CAPACITY

Different rolling stock options provide a range of passenger capacities, from 162 seated passengers per car with bi-level coaches to 90 seated passengers per car with the single-level multiple units. Cars can also accommodate standing passengers, if necessary, although this is generally undesirable given that trips on commuter rail systems are typically longer than most people would like to stand.

The Northstar commuter rail cars have seating for 145 passengers each, [1] and a capacity of 150 seated passengers will be the capacity that will be assumed during the AAU analysis.

D. CAPITAL COSTS

In the Gateway Corridor AAU, a cost estimate of $10.7 million was assumed for a trainset made up of a locomotive and two passenger cars. Contingency of 5% of this cost was added to the overall cost estimate. This estimate and contingency factor will be used in this AAU.

[1] Metro Transit website

E. OPERATING COSTS

As described in the Technical Memorandum #3 Operating and Maintenance Cost Evaluation, a three-point cost model will be used to develop cost estimates for commuter rail services.

Table 2 – Unit Costs of the Three-Point O&M Cost Model for Commuter Rail

	Revenue Hours Unit Cost	Revenue Miles Unit Cost	Vehicles Unit Cost
Unit Costs	$292.77	$4.56	$408,062.60

F. FUTURE DIRECTIONS

Accidents on commuter rail lines in recent years will likely continue to impact political acceptance of new commuter rail projects and the regulation of commuter rail service by the FTA and FRA. The need for safety might impact track availability rules, allowable track speeds, and vehicle size, all of which could limit the services that could be offered in the Red Rock Corridor and increase the cost.

The future of HSR will have a large impact on commuter rail service. There is the potential for commuter rail to piggy-back on HSR investments and reduce overall costs, although this has yet to be proven in any North American jurisdiction. HSR may require electrification, which in turn will require more expensive commuter rail rolling stock, and it may use up track access time that would otherwise be available to commuter rail. The AAU assumes no High Speed Rail.

The future of freight traffic could have a large impact on the feasibility of commuter rail along lines such as the Red Rock Corridor. Freight traffic has been enjoying a revival in recent years (except for a slight decline during the recent recession), and this is likely to make the railroads more cautious about providing track time to passenger rail and/or enable them to ask for higher access fees and more concessions.

5. SUMMARY

In the AAU for the Red Rock Corridor, an additional mode to the commuter rail and express bus modes analyzed in the original AA will be considered, so this memo discussed vehicle characteristics for BRT. In the previous studies on commuter bus, little information was provided in terms of the cost of vehicles, so this information was provided in this AAU. In addition, past studies did not have actual cost data for commuter rail vehicles from the Northstar commuter rail system, but these are now available for this AAU.

Table 3 – Summary of Vehicle Assumptions for AAU Analysis

	No Build (Current Conditions)	Express Bus	BRT	Commuter Rail
Capital Cost per Vehicle ($2013)	$600,000	$600,000	$600,000 for express route vehicles and $800,000 for BRT vehicles	$10.7 million (per train set consisting of one locomotive and two passenger cars)
Seating per Vehicle	50	50	50 for express route vehicles and 35 for BRT vehicles	300
Operating Cost per Vehicle Revenue Service Hour ($2013)	$132.84	$132.84	$132.84	$292.77
Operating Cost per Vehicle Revenue Service Mile ($2013)	n/a	n/a	n/a	$4.56
Operating Cost per Vehicle ($2013)	n/a	n/a	n/a	$408,062.60

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