Technical Memorandum No. 3
Development of Strategies

INTRODUCTION

The development and selection of strategies will guide the completion of the final plan for BRT service on US 71B. The study committee will be asked to select the most appropriate strategies to guide the consultant in the development of the final detailed plan. Therefore it is crucial that the stakeholders have all information necessary to provide the appropriate guidance.

The first part of this technical memorandum will include a review of bus rapid transit (BRT) and light bus rapid transit (LBRT), followed by a discussion of the nature of a pilot project. A peer review will be discussed next. The following section assesses the potential demand and ridership of a LBRT service, followed by strategies and approaches that can be used to implement some form of BRT. This will include a detailed review of stations, infrastructure needs, vehicles, technology and other issues/needs. Cost estimates will be provided.

BRT

The Federal Transit Administration (FTA) has guidelines for what constitutes BRT.

"Bus Rapid Transit (BRT) is an innovative, high-capacity, lower-cost public transit solution that can achieve the performance and benefits of more expensive rail modes. This integrated system uses buses or specialized vehicles on roadways or dedicated lanes to quickly and efficiently transport passengers to their destinations, while offering the flexibility to meet a variety of local conditions. BRT system elements can easily be customized to community needs and incorporate state-of-the-art, low-cost technologies that attract more passengers and ultimately help reduce overall traffic congestion."[1]

[1] https://www.transit.dot.gov/research-innovation/bus-rapid-transit accessed 6/2/2017

Elements of BRT

The guidelines call for the following elements that can be included in a BRT service:

- **Right of Way** – While optimally BRT will have its own lanes or right of way, that solution is typically found in areas of greater density than can be found in this service area. Many BRT systems start with street running and in some cases they expand to exclusive lane at a later date. (See our discussion of Albuquerque in the peer review.)

- **Enhanced Stations** – Attractive, safe, accessible, and well-lit stations with real time information are important elements. Pathway access is an essential element.

- **Innovative Vehicles** – At a minimum, vehicles should be low floor with two doors for easy access and egress. Typically these vehicles are distinctive and are a part of the branding effort discussed below.

- **Electronic Fare Collection** – Stations can have vending machines, tickets can be purchased or money could be electronically added to a fare card on line are typical functions.

- **Use of Technology** – In addition to fare technology, signal priority, real time information and enhanced communication can be used. Using a reversible or bus only lane will require extensive signalization to ensure that there are no mishaps or accidents due to the contra-flow lane.

- **Improved Express Service** – Stations will be farther apart, service will be more frequent and the travel time will be shorter if signal priority is utilized. Evidence suggests that a significant time saving can be achieved.

- **Enhanced Branding** – Branding that ensures that this service stands out as a rapid, comfortable service. New logo, color scheme, and name are among the rebranding features.

The Nature of a Pilot Project: A Commitment to Doing it Right

The development of a temporary pilot LBRT service requires a careful balance of BRT features with limited funding. A LBRT system can mean many things. At the same time the nature of a pilot projects limits options for a LBRT as it may be difficult to justify expenditures for infrastructure related to a nine to 12 month effort: stations, signalization priority, exclusive lane signage, queue jumping, and signalization, as well as BRT type

vehicles. For example, hiring drivers knowing that employment may be limited to six to 12 months will be a challenge.

In order for a pilot of this nature to be successful however, it should include a minimum level of infrastructure to give the project a chance to succeed. What are the level of infrastructure improvements and vehicles that are willing to be committed to a pilot project, given that much of the infrastructure and vehicles would continue to be useful as part of ORT's overall service even if BRT is not sustainable? Those decisions should be made by the study committee to guide the development of the pilot.

Key issues include the need to "do it right." Without that commitment, the chances for success dwindle significantly.

1. **Technology** - For example, without a commitment to signal prioritization, the service will never come close to gaining the ridership needed to make the service successful. This will take time, a commitment by each city, and a significant investment.

2. **Basic Infrastructure** – One of the essential elements to success includes basic access to the service: accessible pathways, accessible shelters and platforms, crosswalks, pedestrian signalization. With up to 50 stations (both sides of the street), improvements can range from $2,000 to $50,000 per station, with park and ride and transfer stations included.

3. **Vehicles** – With some heavy duty vehicles, costing over $600,000 each and medium duty buses half of that (with lower capacity), the need for 20 or more vehicles may require a significant investment. If Federal funding (80 percent Federal funding) is available, costs of heavy duty buses can be mitigated, but the timeframe for delivery may be up to two years for a heavy duty bus, while much less time is needed for medium duty buses. The opportunity to lease adequate buses in excellent condition is virtually non-existent.

BRT Funding

While a pilot project may be limited in scope due to the difficulty of justifying major infrastructure improvements, there are opportunities for sustainability in the future. Both capital/infrastructure and operating funds may be available from a variety of federal grant programs.

The Capital Investment Grant Program's Small Starts category could meet the funding requirements for infrastructure and vehicles once a decision is made to maintain a service. Project guidelines include:

Project Justification

- mobility
- environmental benefits
- congestion relief
- economic development
- land use
- cost effectiveness (cost per trip)

Local Financial Commitment

- Acceptable degree of local financial commitment including evidence of stable and dependable financing sources

The Small Starts require the transit system to have additional funding available for operations and match for capital and infrastructure. LBRT will require a significant level of Federal and local support. This may be able to be secured through FTA grant programs, the State of Arkansas, local governments and private sector sponsors.

Level of Service and Infrastructure – Decision Points

The nature of a pilot project requires a balance of costs and service. How much does the community wish to support and is that enough to give BRT a chance to succeed? Minimum needs such as appropriate vehicles and level of infrastructure at each station will also have to be weighed.

PEER REVIEW

Peer reviews can be useful in this context to assist in the identification of trends and patterns that might be seen in Northwest Arkansas. The focus of this peer review is on before and after ridership and productivity, infrastructure costs, funding opportunities and other factors related to BRT.

There are no direct peers to Northwest Arkansas as there are many variables that constitute why a transit service performs in the manner that it does. These include:

- Service area size and terrain – Small compact service areas will generate higher productivity, calculated as one way trips per vehicle service hour.
- Large university
- Major employers – Densities can be an advantage.
- Visitor seasonal attractions – Some communities generate higher seasonal

visitor numbers.
- Local population
- Local funding/commitment to transit – Government and private sector
- Fares - Fare free will always generate more ridership.

There are few systems in the country that have implemented a LBRT service. However, of those implemented, there a number of interesting subjects, two of which are highlighted here, with a third being a BRT service:

- Albuquerque, NM – This city has been operating LBRT service for a number of years and is in the process of completing dedicated lanes for a full scale BRT. Their experiences in LBRT and their reasons for expansion will be illustrative.

- Austin, TX – Capital Metro has instituted a number of long LBRT routes in the general flow of traffic. This is also a good example of operating in a shared right of way and in determining potential costs. This service also includes longer routes as will be the case with Northwest Arkansas.

- Eugene, OR – Another university town with a short full scale BRT line.

Unfortunately two other peers (Roaring Fork Transit and Kansas City) did not respond to our requests for information.

Rapid Ride – Albuquerque, NM

Albuquerque in the largest city in New Mexico with a population of just over 500,000. The Albuquerque ABQ Ride system serves some other areas directly adjacent to Albuquerque such as Rio Rancho, North Valley, and South Valley bringing the total service area population to approximately 700,000. Albuquerque lies at the center of the New Mexico Technology Corridor, a concentration of high-tech private companies and government institutions along the Rio Grande. Larger institutions whose employees contribute to the population are numerous and include Sandia National Laboratories, Kirtland Air Force Base, and the attendant contracting companies which bring highly educated workers to a somewhat isolated region. Intel, Tempur-Pedic and Northrop Grumman also have large facilities in the area. Albuquerque is also home to the University of New Mexico, the largest public university in the state.

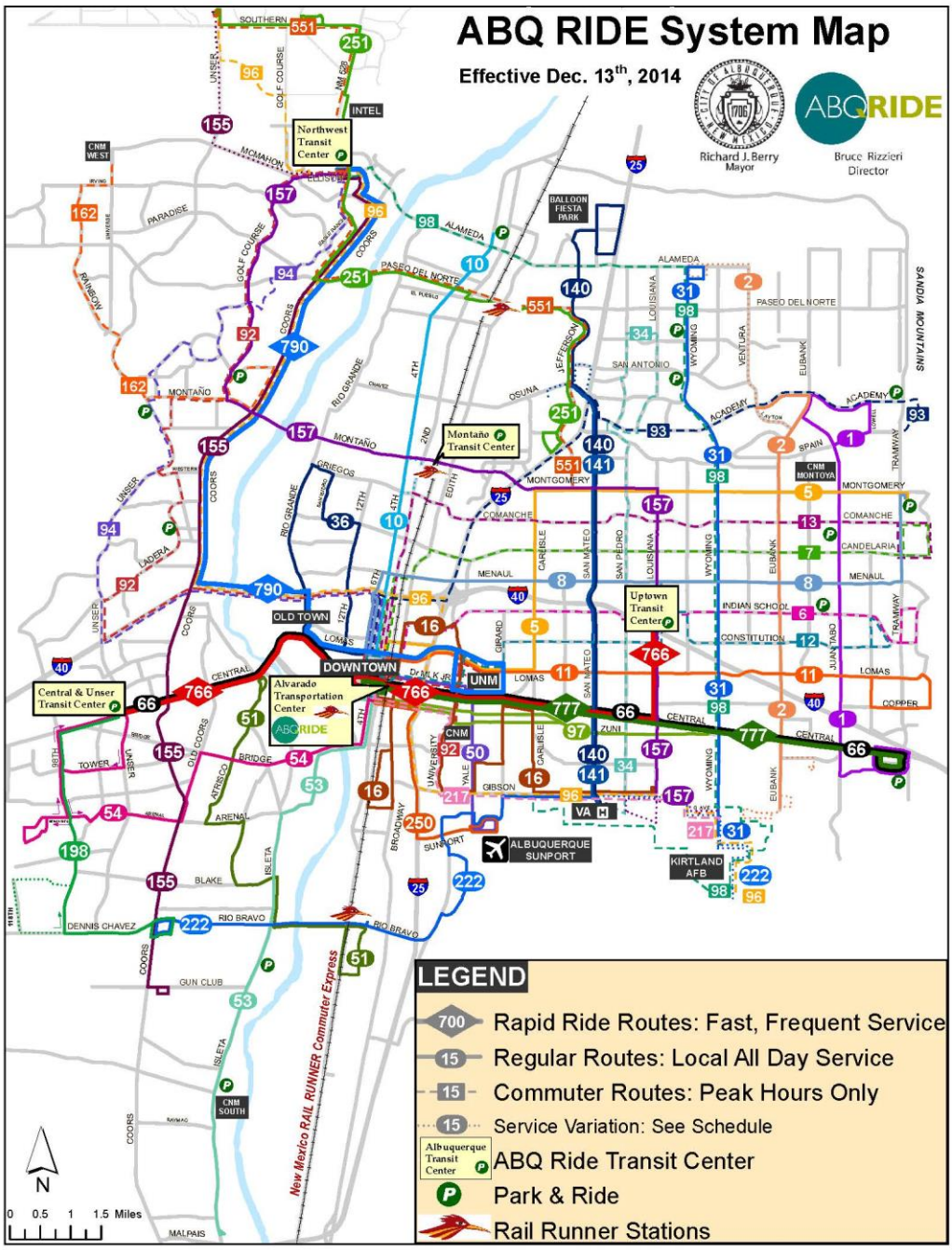
Routes

The Rapid Ride service (LBRT) supplemented local service on 13 miles of a major commercial corridor in the city. The corridor is home to many of the city's major destinations and Rapid Ride currently accounts for over 40 percent of the total ridership

of the system. The City has opted to build full fixed guideway infrastructure for the Rapid Ride system which is aiming to open sometime within late 2017.

Rapid Ride consists of three routes that serve the major commercial corridor in Albuquerque, depicted in Figure 3-1.

Figure 3-1: ABQ Ride System Map



The Red Line - The First Central Ave. Rapid Ride Route

Rapid Ride service began in December 2004 and had over one million boardings within the first year and over five million boardings within the first four years of service, a resulting 60 percent increase in ridership over the existing service in the corridor. The route provides access from the West Side of Albuquerque to:

- BioPark
- Old Town (Connects with the Rapid Ride Blue Line #790)
- Downtown (Connects with the Rapid Ride Green Line #777)
- Presbyterian Hospital (Connects with the Rapid Ride Green Line #777)
- University of New Mexico (Connects with the Rapid Ride Blue Line #790 and the Rapid Ride Green Line #777)
- Nob Hill (Connects with the Rapid Ride Green Line #777)
- NM Expo at the State Fairgrounds (Connects with the Rapid Ride Green Line #777)
- The new International Market
- Uptown shopping area

There is a park and ride lot at each end of the route.

The Blue Line - West Side to UNM Service

In July 2007, the City of Albuquerque and ABQ RIDE implemented Rapid Ride service between Albuquerque's West Side and the University of New Mexico. The Rapid Ride Blue Line #790 route provides access from the West Side to:

- The Northwest Transit Center
- Cottonwood Mall
- SIPI (Southwestern Indian Polytechnic Institute)
- Montano Plaza
- Old Town (Connects with the Rapid Ride Red Line #766)
- The courthouses in Downtown
- University of New Mexico main campus (Connects with the Rapid Ride Red Line #766 and the Rapid Ride Green Line #777)
- UNM Hospital

A park and ride lot is available at the Northwest Transit Center.

The Green Line - Downtown to Tramway Blvd. along Central Avenue

In August 2009, the City of Albuquerque and ABQ RIDE implemented Rapid Ride service that serves Central Ave connecting to downtown. The route provides access from Tramway Boulevard to:

- Downtown (Connects with the Rapid Ride Red Line #766)
- Alvarado Transportation Center (Connects with the Rapid Ride Red Line #766)
- Presbyterian Hospital (Connects with the Rapid Ride Red Line #766)
- UNM (Connects with the Rapid Ride Red Line #766 and the Rapid Ride Blue Line #790)
- Nob Hill (Connects with the Rapid Ride Red Line #766)
- Expo New Mexico (State Fairgrounds) (Connects with the Rapid Ride Red Line #766)

BRT Vehicles

Rapid Ride features 60-foot long, low-floor articulated buses that accommodate up to 86 passengers. The New Flyer buses are diesel electric hybrid.

The buses include a variety of technology:

- An automatic announcement system to notify passengers when the next station is approaching,
- A global positioning system to aid in the transit applications that help passengers locate their bus in real time,
- The latest in security cameras and microphones for the safety of passengers and drivers, and
- Free wireless Internet access. There are "hot spots" on each bus providing Internet access to all passengers.

On the outside, all Rapid Ride buses have a paint scheme that is marketed differently from other ABQ Ride services. Each bus can hold up to three bicycles on a rack.

For the new full BRT service Rapid Ride will be transitioning to a fleet of zero emission battery electric buses. These buses cost $1.1 million per bus. The existing articulated buses cost approximately $700,000 to $800,000.

Most station locations also feature a structure which allows passengers to wait in safety and comfort. The Pueblo-Deco inspired stations are spaced one-half mile to one mile apart at major intersections and activity centers. They have real time information, wind

screens and neon accents in keeping with the historic Route 66 theme. Station design is depicted in Figure 3-2.

Figure 3-2: Rapid Ride Station

Signal Prioritization

Rapid Ride originally tried to use signal prioritization technology. The implementation and upkeep of such technology required a significant commitment and work load for city traffic engineers, one that they did not have staffing levels to support. While most of the buses and intersections are equipped with the technology it is not used. Similarly, for the existing Rapid Ride service, real time next bus information technology was developed and installed at each stop but was turned off due to technical difficulties. The new system will re-implement this technology.

Funding BRT

Current operating funds are provided by a local transit tax. For the updated full BRT project ABQ Ride was the beneficiary of a local bond. The bond was for over $50 million to entice Tesla to move a major facility to the area. When Tesla decided not to move to Albuquerque the city looked for other ways to positively use the bond funds and Rapid Ride full BRT planning had already been completed. Rapid Ride projects have received no state support. Capital costs were matched 80 percent by FTA grant programs.

As noted above the signal prioritization was difficult to maintain. This technology takes a significant commitment from traffic engineering staff to ensure success. It is likely that additional engineering staff will be required to implement this technology in the future. Similarly, the real time bus information requires time and investment from IT staff. Without the commitment and capabilities of IT staff this technology may be hard to maintain.

MetroRapid – Austin, TX

Austin is the capital of Texas and home to the University of Texas. It has a population of approximately one million and is the fastest growing Metropolitan Statistical Area (MSA) in the country. It is home to many large employers particularly in the information technology field and home to many large tourist based events.

The MetroRapid project is a 37.5-mile street-running BRT system along two interconnected corridors: the 21-mile North Lamar/South Congress Corridor (now served by the new MetroRapid 801) and the 16.5-mile Burnet/South Lamar Corridor (now served by the new Metro Rapid 803). Figure 3-3 shows the alignments and station locations of the two MetroRapid corridors.

In FY 2016, the MetroRapid corridors (Routes 801 and 803) were served by 161,670 total annual vehicle hours. The actual operating and maintenance costs in FY 2016 were $14,963,806. Ridership in 2016 was 223,506 and is up 35 percent in 2017 thus far. Ridership in the corridor fluctuated significantly depending on the service alignment. In some areas where the existing service was eliminated and replaced by BRT, corridor ridership decreased by 10 percent. In areas of the corridors where existing services were reduced coupled with the addition of BRT service ridership grew over 30 percent.

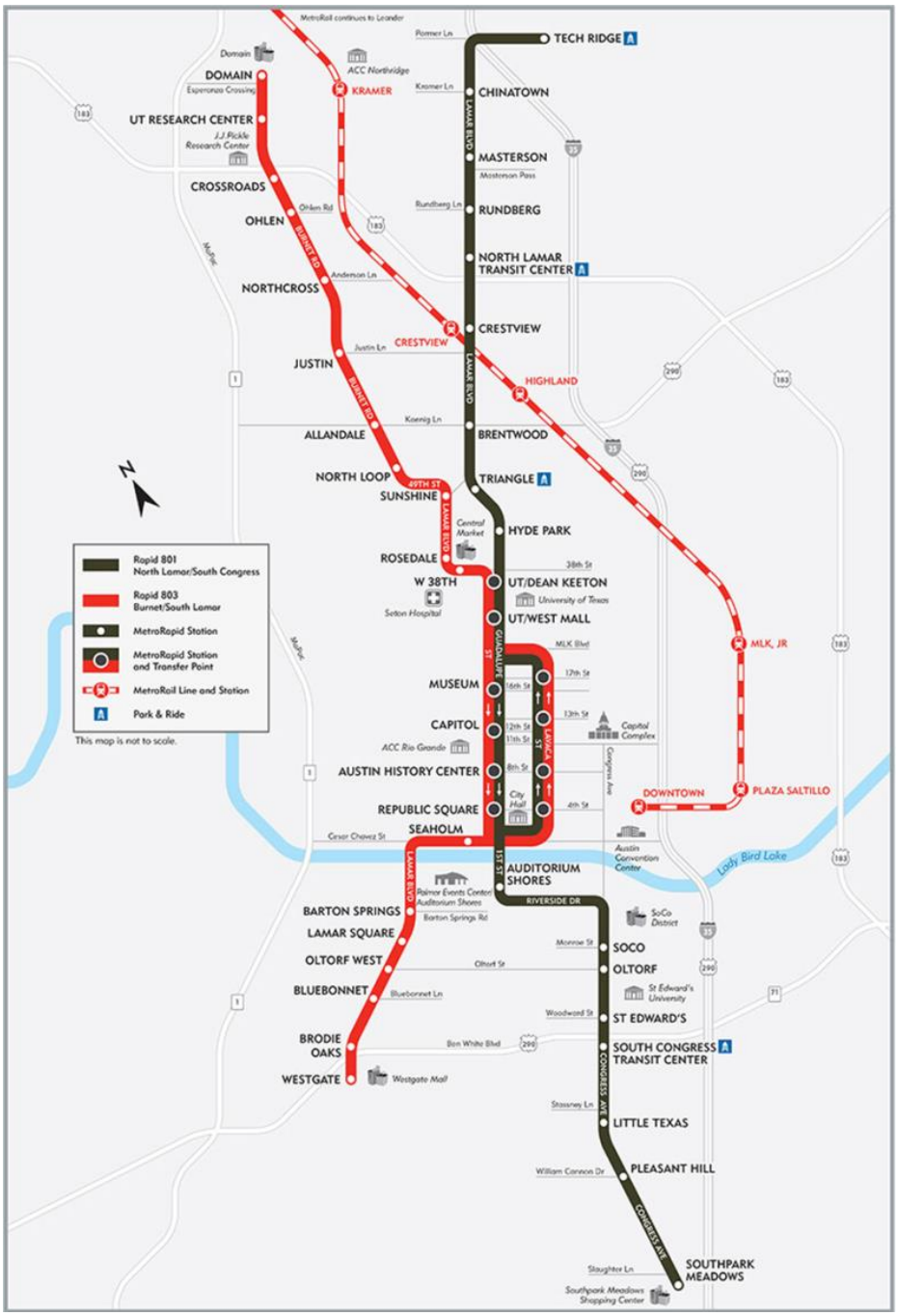
Routes

The North Lamar/South Congress Corridor extends from the North Interstate Highway (I-35) park and ride lot at Tech Ridge to the Southpark Meadows commercial development. The Burnet/South Lamar Corridor extends from the Domain mixed-use center near Loop 1 to Westgate Boulevard and U.S. 290 West.

The two routes operate together over a three-mile segment of Guadalupe Street through Central Austin between 38th Street, north of the University of Texas-Austin, and Cesar Chavez Street at the southern end of Downtown Austin. Within this segment, both routes use transit priority lanes, built concurrently but separately from the approved FTA project, for almost 1.25 miles in each direction downtown. The priority lanes provide for exclusive operation of all Capital Metro routes serving Downtown Austin, with the exception of right-turn only vehicles. The priority lanes were created by converting one

travel lane and some on-street parking. Outside of the downtown couplet, both MetroRapid routes operate in mixed traffic.

Figure 3-3: MetroRapid Service Alignment



Stations

The project implemented 77 new BRT stations: 20 paired and three single stations (two terminus stations and one1 transfer station) in North Lamar/South Congress corridors, and 16 paired and two single terminus stations in Burnet/South Lamar Corridor. There are four paired stations along the downtown priority lanes that are shared by both MetroRapid routes.

The average cost per station is $250,000. All MetroRapid stations are designed with architectural features that distinguish them as a separate brand from local bus stops. All stations provide real-time passenger information displays. MetroRapid service is compliant with requirements of the Americans with Disabilities Act (ADA) and provides for level boarding at all stations through the kneeling features of the 40 new low-floor, branded vehicles.

Vehicles

Capital Metro uses articulated buses on the North Lamar/Congress Route and 40 foot heavy duty buses on the Burnet Road/South Lamar route. The average cost per vehicle is between $600,000 and $800,000. Figure 3-4 illustrates the branding themes for MetroRapid vehicles and stations.

Figure 3-4: MetroRapid Stations

Signal Prioritization

The project included system elements for traffic signals, communication and fare collection. As part of traffic signals it included, upgrading the traffic control system including hardware and software to enable transit signal priority along the BRT corridors

except for Guadalupe and Lavaca Streets through downtown. MetroRapid buses receive priority treatment at 133 of the 160 signalized intersections in both corridors.

The signal priority is not activated in the downtown corridor as the buses have a transit priority lane in downtown. Outside downtown the signal priority treatment consists of extending the green signal whenever a vehicle is one or more minutes late if the light is already green. All 40 vehicles are equipped with transmitters to enable them to send a signal to the traffic control system requesting priority. A central automated dispatch for BRT vehicles, automated vehicle location (AVL), bus arrival prediction software, and real-time passenger display units at all BRT stations is provided. It also includes additional work stations to monitor the system in real time from desktops.

Funding

Capital funding was funded by the Very Small Starts grant (80%). The actual capital cost for the project came in at about $39 million. Based on the actual outcome, roughly 61 percent ($23.7 million) was spent on vehicles, 29 percent ($11.3 million) on design and construction of stations, support facilities and securing temporary construction easements and 10 percent ($3.9 million) on IT systems.

Emerald Express – Eugene, OR

Eugene is a city in Oregon. With a population of approximately 160,000 it is the third largest city in the state. Eugene is home to the University of Oregon and Lane Community College. The city is also noted for its natural environment, recreational opportunities (especially bicycling, running/jogging, rafting, and kayaking), and focus on the arts.

The Emerald Express (EmX) is a BRT system in the Eugene-Springfield metropolitan area. Lane Transit District (LTD) chose bus rapid transit with dedicated right of way after a review process in which several transportation options, including light rail, were considered. It was decided that the BRT option was the best fit for Eugene-Springfield's size and current transportation needs. The first route, named the Green Line, was opened in early 2007, connecting downtown Springfield to downtown Eugene. There are ten stops along the four-mile route, including the University of Oregon. Less than a year later, ridership had doubled in the corridor, and the City of Eugene was nominated for the 2008 Sustainable Transportation Award, and received an honorable mention. In 2015, EmX had 2,673,275 boardings with 35,930 revenue hours and 427,557 revenue miles.

Green Line

The first line of EmX, the Franklin Corridor (or EmX Green Line), began service in January 2007. It runs from Eugene Station in downtown Eugene to the Springfield Station in downtown Springfield, and also serves the University of Oregon. The Green line is four miles long and cost $25 million to design and build. The Green Line replaced Route 11 along the corridor. Rush hour travel times were reduced from 22 minutes down to 16 minutes, about 27 percent. Ridership doubled in the corridor in the first year.

Gateway Line

The route goes along the newly constructed Pioneer Parkway corridor and beyond that to dedicated bus lanes that were integrated into Martin Luther King Jr. Parkway and River Bend Drive during the construction of those roads. Service started in January 2011. This 7.8-mile extension links downtown Springfield to Sacred Heart Medical Center at River Bend. LTD eventually plans to run EmX along all main transportation corridors in the metro area.

Future West Eugene Extension

LTD is currently in the process of planning an expansion of EmX's service into the West Eugene area, connecting it to downtown Eugene and Springfield. The agency finalized the planned route in 2011, after conducting environmental analyses and collecting public comment. In spring of 2011 LTD along with other agencies decided that the west 6th and 7th to 11th corridor was the locally preferred alternative. Construction on the line began in March 2015 and is expected to be complete in late 2017. The FTA awarded $75 million to the project in September 2015, covering most of its total $96.5 million cost. The EmX existing and future system map is depicted in Figure 3-5.

Dedicated Bus Lanes

The EmX system is made up of sections of dedicated bus lanes for most of the route (60 percent), with normal roads in between. The vehicles are given signal priority via ground-loop signaling to the traffic control system, with special traffic signals at intersections. The vehicles have two sets of doors on the left and three on the right, allowing loading from platforms on either side. Most of the right hand side platforms can only accommodate the rear two doors.

Vehicles

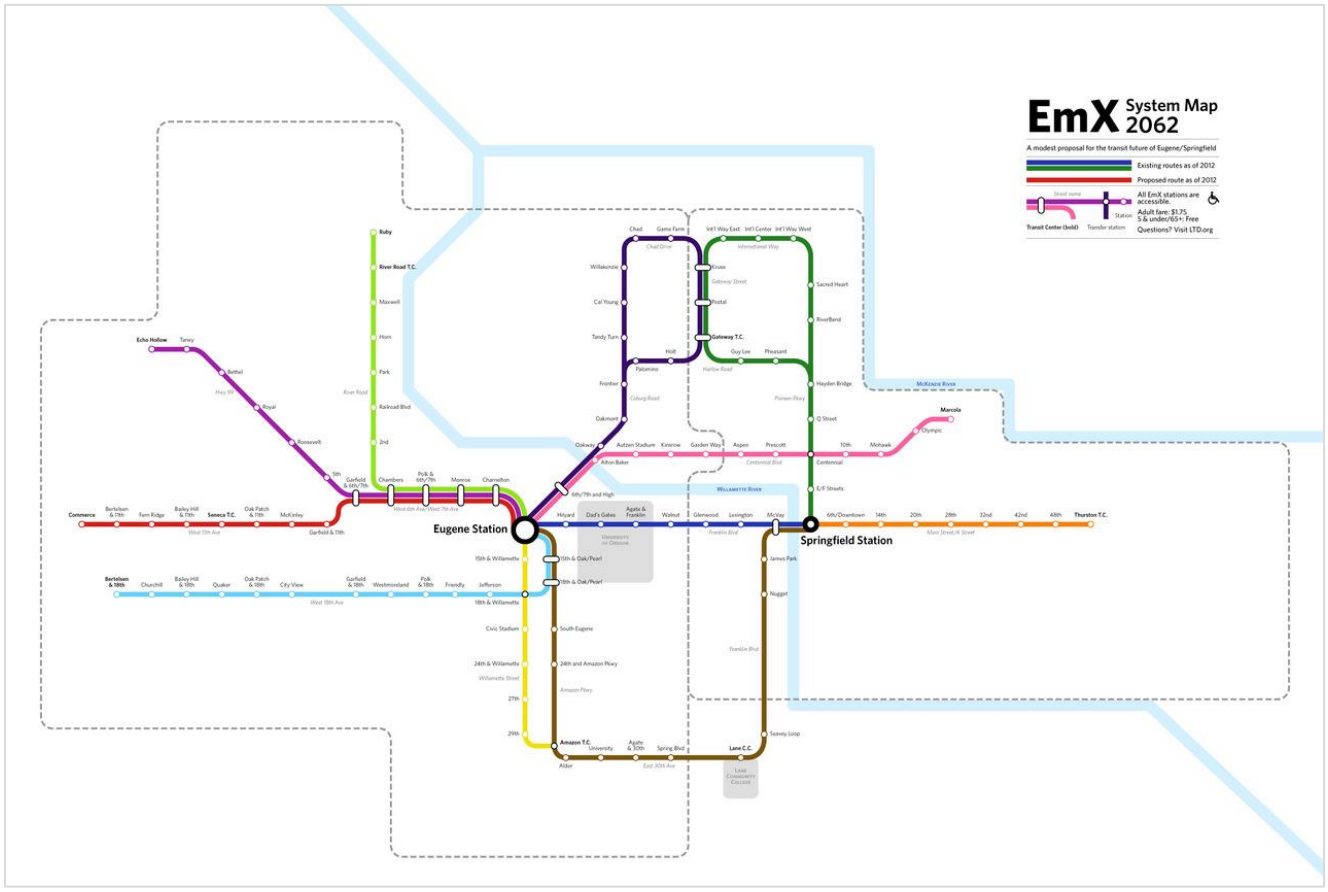
EmX uses articulated 60 foot buses with a capacity of over 80 people. The vehicles are equipped with continuously variable transmission which allows for quick but smooth

acceleration from stops and through the various road segments. Buses cost approximately $1.1 million each. On weekdays, service runs approximately from 6:00 a.m. to 11:00 p.m. Buses arrive every 10 minutes throughout the day, with longer headways during the evening and the first hour of the morning. More limited service operates during the weekend.

Signal Prioritization

In the first month of operation buses had trouble with the signal priority system; buses had to achieve careful positioning to communicate with the signaling loop, and signal priority was not always immediate. Early tests of the system caused the light control systems to crash when signal priority was requested, resulting in blinking reds in all directions until an engineer could reset the terminal. LTD worked with the control software vendor to iron out the bugs.

Figure 3-5: EmX System Map



Stations

Stations are enhanced to reduce dwell times and make boarding as easy as possible. Stations consist of level boarding with premium shelter, tactile band at curb face, lighting improvements, on-platform fare collection, fiber and electric service, trash can, bike parking and in some cases bike storage lockers, routing bicycles behind station locations, railings and ramps, signage pylon, and arrivals screen. Each enhanced station costs approximately $350,000. LTD management stated that the stations are specifically tailored to the type of vehicle they operate and that in hindsight they would have made station location more flexible to accommodate several bus typologies. A station example is depicted in Figure 3-6.

Figure 3-6: EmX Station

The cost to ride EmX is the same as other LTD bus routes, $1.75. Unlike other bus routes, the EmX line uses a proof-of-payment system. Riders must purchase a ticket using the ticket machines located at each station before boarding the bus. On the bus a representative of LTD may ask to see a ticket as proof of payment. Previously purchased day passes are valid on EmX for that day. Single ride tickets must be used within 30 minutes of purchase.

Funding

LTD received significant support from the Federal and state governments for this project as long as they could demonstrate that the BRT system would not negatively impact traffic levels of service in the major roadways. The initial capital expenses included an

80/20 match from the FTA and a significant amount of the local funding for capital costs came from the state. Operational funding comes from a local payroll tax.

Peer Review Summary

The peers in this study have seen tremendous success in the implementation of BRT or LBRT service. Whether the idea was to implement BRT from the start or BRT was seen as a more cost effective and flexible alternative to rail it has increased ridership in the high frequency corridors in each city. Within the first year each city saw 30 percent to 60 percent increases in corridor ridership depending on the service alignment. Table 3-1 shows the operational data for each peer. As shown, cost per hour ranges $98 to $166. Productivity ranges widely with the EmX providing the most trips per hour at over 74, while Rapid Ride provides the most annual trips at over three million.

Table 3-1: BRT Peer Review

System	Boardings	Revenue Hours	Revenue Miles	Operational Expenditures	Base Fare	One Way Trips Per Service Hour	Service MPH	Cost Per Service Hour
Rapid Ride - Albuquerque, NM	3,028,280	54,567	820,829	$6,844,068	$1.00	55.50	15.04	$125.43
MetroRapid - Austin, TX	2,728,970	151,879	1,821,658	$14,963,806	$1.25	17.97	11.99	$98.52
Emerald Express - Eugene, OR	2,673,275	35,930	427,557	$5,965,000	$1.75	74.40	11.90	$166.02

POTENTIAL DEMAND FOR SERVICE

Estimating demand for transit service can be calculated in a variety of ways. This analysis will look at four different analysis techniques:

1. A mode split analysis,
2. Comparative analysis of peer systems,
3. Service elasticities, and

Unfortunately the Northwest Arkansas Regional Planning Commission (NARPC) Traffic Model calculations were not available at this time.

Please note that the potential demand numbers are at full build out, assume signal prioritization, appropriate feeder connections and fully accessible stations.

Mode Split Analysis

Mode split is an informative way to assess the potential demand for transit ridership in a corridor. Mode split specifically addresses the percentage of persons that would use a particular mode. For the transit mode split analysis four separate scenarios are examined:

- One percent mode split is a baseline for typical lighter level transit service. This can be used for an approximate transit service operating on 30 minute to an hour headways with stops every quarter mile.

- Two percent mode split would be indicative of enhanced express bus service with limited stops.

- Three percent mode split would represent a mode split of LBRT service with enhanced transit stations, limited stops, signal technology and fifteen minute headways during peak times.

- Five percent mode split would consist of full BRT with portions of the corridor on dedicated fixed guideway and enhanced signal technology.

Table 3-2 shows the hourly mode split based on NARPC traffic counts at major portions of the corridor. Traffic counts are multiplied by the average passengers per vehicle in the region (1.7). They are show in AM peak (6:00 to 9:00 a.m.), PM peak (4:00 to 7:00 p.m.) and off-peak (9:00 a.m. to 4:00 p.m. and 7:00 p.m. to midnight). As shown, the transit mode split depending on the scenario and time of day can range from about 10 trips an hour to 150 trips per hour during peak times for mode splits representing regular fixed route service to LBRT type service. Demand for service is naturally much higher during

peak travel times and lends itself to a service design that reduces headways during peak hours.

Table 3-2: Transit Mode Split Analysis for US 71B Trips per Hour

Zone	Time	Northbound Transit Mode Split				Southbound Transit Mode Split			
		1%	2%	3%	5%	1%	2%	3%	5%
Bentonville - Wal-Mart Home Office									
	AM Peak	34	69	103	172	26	52	78	130
	PM Peak	54	109	163	271	36	73	109	181
	Off-Peak	7	15	22	37	6	13	19	32
Rogers - Walnut and 8th									
	AM Peak	18	35	53	88	16	31	47	78
	PM Peak	21	42	63	106	13	26	38	64
	Off-Peak	9	18	27	44	9	17	26	43
Lowell - US 71B and Monroe Ave									
	AM Peak	16	32	48	80	13	25	38	63
	PM Peak	22	43	65	109	14	28	42	71
	Off-Peak	8	16	23	39	11	21	32	53
Springdale - US 71B and Robinson Ave									
	AM Peak	18	36	54	90	21	42	63	106
	PM Peak	22	45	67	112	22	45	67	112
	Off-Peak	13	25	38	63	12	25	37	62
Fayetteville - NW Arkansas Mall									
	AM Peak	27	54	81	136	30	61	91	151
	PM Peak	37	75	112	186	36	72	108	181
	Off-Peak	16	32	48	81	15	31	46	77
Fayetteville - US 71B and Lafayette St.									
	AM Peak	10	20	30	51	21	42	63	106
	PM Peak	14	28	43	71	24	49	73	122
	Off-Peak	6	12	18	30	10	21	31	52

Source: NWAPC Travel Model base data for traffic flows

Potential Ridership – Mode Split

In order to determine an average, the consultants used the 2 percent mode split as a conservative estimate. Averaging the numbers in Table 3-2 results in an average number of one way trips per vehicle hour at 34.

Comparative Analysis

Comparing peers to Northwest Arkansas can be helpful in estimating demand for services. Each peer previously mentioned saw a net rise in ridership after implementing BRT service. Within the first year:

- Rapid Ride in Albuquerque saw a 60 percent increase in corridor ridership (Currently the LBRT service account for over 40 percent of the total system ridership for ABQ Ride). Rapid Ride was initially a LBRT service.
- MetroRapid in Austin saw over a 30 percent increase in corridor ridership in portions where existing service was not eliminated. This is a LBRT service.
- Emerald Express in Eugene is a full BRT service that experienced a 50 percent net increase in ridership.

All of these services charge a fare which is not currently being proposed for Northwest Arkansas. Currently the ORT routes that serve US 71B average 10.2 trips per hour and the fare free Razorback Transit (RT) Red Route on US 71B has a productivity of just under 30 trips per hour. Assuming that the current corridor service will remain at some level of service and accounting for the reduction in headways, the increased areas served, enhanced stops and buses, it is reasonable to expect similar usage increases (30 percent to 60 percent) along the US 71B corridor. Using the fare free RT Red Route 30 trips per hour this would result in an increase range from 39 to 48 trips per hour in the corridor.

Service Elasticities

Service elasticities are simple formulas that allow one to predict ridership changes based on fare, service levels and other factors that could decide whether someone will ride or not. In order to use fare elasticities one must have a benchmark of service. Unfortunately there is no baseline for the entire corridor, but there are segments of the service that can be used as a baseline for a particular part of the corridor as reviewed in Technical Memorandum No. 2. Table 3-3 from a similar table in Technical Memorandum No. 2.

Elasticities Based on ORT

The primary ORT routes that operate on part of US 71B are to be used as a baseline for elasticities. As seen on Table 3-3, current ridership on the three ORT routes used as a baseline indicate an average of 10.2 one way trips per hour. Each of these services operate on one hour headways.

Table 3-3: 2016 Operating Statistics of Transit Routes Most Directly Serving US 71B Corridor

	2016** Passenger Trips	2016** Revenue Vehicle Hours	Trips per Vehicle Hour (Productivity)	2016** Revenue Vehicle Miles	Miles per Hour (Operating Speed)
ORT Route Number					
1	42,650	3,441	12.4	46,019	13.4
4	38,584	3,359	11.5	44,015	13.1
11	18,826	3,053	6.2	43,404	14.2
ORT Subtotal	**100,060**	**9,853**	**10.2**	**133,438**	**13.5**
Razorback Transit Route					
Red	254,800	8,610	29.6	113,995	13.2
Corridor Total	**354,860**	**18,463**	**19.2**	**247,433**	**13.4**

**ORT reports on a calendar year basis; Razorback Transit uses fiscal year (July-June).

There are four elasticities that can be used in this scenario:

1. Fare – Reducing fares generates ridership increases. Current base fare for service in this corridor is $1.25. A new pilot project is proposing a free fare structure. This by itself could raise ridership by up to 50 percent. For purposes of this study we will use a conservative estimate of 25 percent. Please note that ultimately a fare may be charged which will decrease ridership for the short term.

2. Frequency – The bus will increase frequency by 400 percent, which should increase ridership by 200 percent

3. Rebranding – Rebranding service can increase ridership by 20 percent.

4. Decreased travel time – The elasticities call for an increase in ridership of 40 percent for every 100 percent decrease in time. For a 33 percent decrease in travel time, 16.5 percent increase will be seen.

The ORT calculations are shown in Table 3-4.

Table 3-4: ORT Service Elasticities Calculations

Baseline one way trips per hour		10.2
Free fare	25%	+2.5
Frequency	200%	+20
Rebranding	20%	+2
Decreased travel time	16.50%	+1.3
Total Potential Productivity		**35.8**

Service Elasticities - Razorback Transit (RT)

There are three elasticities that can be used in this scenario:

1. Frequency – the bus will increase frequency by 33 percent, which should increase ridership by 16.5 percent

2. Rebranding – Rebranding service can increase ridership by 20 percent

3. Decreased travel time – In this category there is no gain in ridership as passengers going to campus would have to transfer, negating any travel time savings from higher spends.

The RT Red Route parallels US 71B and is seen as the closest to a comparable route in terms of geography, fares (free), frequency (20 minutes versus 15 for BRT). The calculations using RT's Red Route as a baseline are as shown in Table 3-5:

Table 3-5: Razorback Transit Red Route Service Elasticity Calculations

Baseline one way trips per hour		29.6
Frequency	17%	+4.9
Rebranding	20%	+5.9
Total Potential Productivity		**40.4**

Summary - Elasticities

Using elasticities in determining changes to ridership, two calculations were use. First ORT was used as a benchmark, followed by RT. The calculations show a range from 35.8 one way trips per vehicle hour up to 40.4 one way trips per vehicle hour.

Summary Potential Ridership

Using three different methods to calculate potential ridership, the study team has calculated potential demand assuming signal priority.

1. Mode Split — 34 one way trips per vehicle hour
2. Comparative Analysis — 34 one way trips per hour
3. Elasticities — 35 – 40 one way trips per hour

In summary, assuming rebranding, good station access and signal prioritization one may expect a productivity of 34 one way trips per hour for weekdays. While initial ridership will be lower ridership will increase as the service gains acceptance. Assuming 42,000

annual weekday service hours, daily ridership may be 5,700 one way trips (Saturday service would operate at one-half the weekday productivity, generating 2,850 daily trips), while annual ridership could be up to 1.4 million one way trips. Adding in the extensions north and south could increase ridership by 500,000 annually.

STRATEGIES AND ALTERNATIVES

The alternatives/strategies are designed to initiate discussion related to the final plan. The alternatives are designed as a starting point and the selection of strategies and alternatives will determine the direction of the plan, making this an essential step in the study. The study committee should provide this direction.

Overview – Decision Points

Throughout this section, the study committee and ORT will be called upon to make key decisions to guide the completion of the project. The strategies will include the following:

- **Pilot Project Service Design** – The route will serve US 71B as that is the corridor that connects each of the cities. The key decisions regarding the route will be the end points.

- **Service Levels and Other Characteristics:**
  - Headways
  - Service hours
  - Days of the week
  - Connections with existing services

- **Identification of Markets Served** - Including local residents, commuters and visitors all benefit from reduced visitor traffic. Local businesses gain by making their services more attractive.

- **Bus Stations** – Bus stops and stations are transit's front door. If they are not safe, accessible and inviting people will be reluctant to use the bus. Locations and spacing as well as needed infrastructure improvements will be identified. The study committee is asked to review the locations of each station.

- **Signal Prioritization** – A complex issue, but it can be accomplished. Each city would have to be involved with an entity to coordinate the signals in the different cities

- **Queue Jumping** – If the service operates north of Bentonville to Bella Vista or the Missouri State line, the possibility exists for queue jumping on the shoulder of US 71.

- **Vehicles** – Heavy duty transit coaches would be most appropriate, but can take up to two years to procure. Medium duty buses are the other option.

- **Financial Issues: Costs and Revenue** – How much should be spent on infrastructure, technologies and vehicles for the pilot project.

- **Real Time Information** – Introduction of a transit app where passengers can determine when a bus will be at their stop either on a smartphone or at the station.

Sustainability

Sustainability is critical to the success of a pilot project. That is, future funding commitments from the public and private sector should be secured prior to implementing a pilot project, assuming the pilot is successful. Without a pathway to sustainability any pilot project would be futile. Diversity is the key to sustainability and the system should secure:

1. Federal funding for vehicles, infrastructure improvements and possibly operating funds,
2. State and local funds to supplement the Federal funding, and
3. Private sector funding in the form of sponsorships and partnerships.

Sponsorships - Public/Private Partnerships (P3)

Sponsorships imply an agreement that benefits all parties. In a sponsorship program, one side receives revenue and support, while the other side receives advertising and promotional benefits commensurate with the cost. In fact, an LBRT service will benefit many businesses by supporting their employee's transit needs as well as bringing customers to their businesses. It is reasonable to ask businesses who will benefit from service to become system sponsors or partners

- **Hotels, major retail, and service sector:** These entities are across the region.

- **Other major employers:** Many employers that hire large numbers of low skilled employees.

- **Any other businesses that wish to advertise their services or company**: If desired, parts or all of buses can be wrapped for advertising purposes.

Transit Sponsorships Opportunities

Transit has a long history of providing advertising on and in buses for additional revenue. Many systems have engaged in advertising over the years, but a sponsorship program is more than simply advertising. Instead of the usual selling of just one form of advertising, the new entity should sell sponsorship packages. Since sponsorship and advertising funds are an important source of local funding, this program can help expand this effort.

Identifying Service

The program is designed to sell a service to both public and private sponsors. Possible services for sale can include:

- Sponsorship Services at Any Level
    - Recognize sponsor on the how-to-ride guide (system map and schedule), website, and other venues.
    - Recognize sponsorship on system literature and advertising.
    - Decal on side or back of bus.
    - Dedicated shuttle.
    - Special promotions sponsorship.

- Higher Level Sponsorship Services (in addition to the above benefits)
    - Company logo on system map.
    - Placing a shelter for customers and/or employees.
    - Placing a stop conducive to customers and/or employees. This could include going into a parking lot and stopping next to the facility.
    - Bus wrap or other advertising inside the bus.

Flexibility

Vehicles and stations should be designed with flexibility in mind. As a small transit system, ORT may have to place other vehicles in BRT service, or use BRT service for other purposes on an as needed/incidental basis. This necessitates using vehicles that can be used for multiple purposes and stations with curb level platforms that any ORT or RT bus can use. Further, if the pilot project is modified in the future or deemed not practical, the stations and vehicles will still be able to be utilized in the system.

Pilot Project

Care should be taken when making decisions regarding the reach of the pilot project. The decision makers should weigh the need for a rapid deployment by compromising on quality and accessibility versus a more deliberate approach with a greater investment commitment. The key question revolves around the level of improvements made in:

1. **Infrastructure** – There are two issues here:

    a. The first is one of level of commitment for a pilot that really requires significant infrastructure improvements to do it right. While simple curb cuts, sidewalk extensions, pads and crosswalks are not expensive, they do not by themselves make a station. For a pilot, it may not be possible to invest $15,000 to $50,000 for bus stations and infrastructure improvements unless there is evidence of sustainability. To the greatest extent possible, stations will be designed to be used even if the BRT does not get funded beyond the pilot.

    b. It is also a matter of timing. Infrastructure improvements can take years and a project that requires infrastructure at 50 bus stations (one on each side of the street) may take time.

2. **Signal Prioritization** – This has never been done before in Arkansas, but has been implemented in other states. This is a time consuming effort requiring coordination between five cities, ORT and the Arkansas Highway and Transportation Department (AHTD).

3. **Reversible or Dedicated Lane** – This has also never been implemented in Arkansas. Reversible lanes (the only option for most of the route alignment) will require a massive signalization effort to ensure that all know which direction the lane is traveling at any given time. These efforts typically require signals every one-quarter mile or less. The many millions of dollars to implement this effort appear to be well beyond the scope of a six months to one year pilot project.

4. **Real Time Bus Information** – Real time bus information on an app and at each station telling customers when the next bus will arrive is an essential ingredient to a BRT service. Real time bus information software, hardware including AVL, station signage, computer packages and development of a mobile application for 20 stops and 20 vehicles is estimated to cost $1 million to $4.5 million depending on the sophistication of the mobile application.

5. **Vehicles** – Types of buses and fuel considerations will be affected by the decisions related to timing and cost. Optimally, heavy duty buses are the best option, however cost and timeliness of a procurement will influence the decision.

Overall Route Structure

In order for the BRT service to be successful it will need a coordinated feeder network. Without question, overlaying a BRT service in the middle of the existing services will require significant changes to the existing route structure which will in many cases need to focus on supporting BRT to some degree. The existing route structure was not designed with the US 71B service in mind. Existing routes that duplicate the BRT will need to refocus. Other routes may be able to complement the BRT by ensuring timed meets and focusing on changes to improve overall ridership. In Technical Memorandum No. 2 the study team identified these routes.

Determining the Route of the LBRT – Markets Served

It has been determined that the route will center on US 71B as this corridor connects each city in the service area, something that does not exist at this time. The needs clearly indicate that there are many user groups/markets that can benefit from this service, including commuters that want to travel between cities and their employers who benefit from this support. Students at the University may be able to expand their housing options and to some surprise, the number of favorable survey respondents that have income of over $100,000 was 130 or 25 percent of the total. This indicates a wide range of commuter interest, vital to the success of the service.

The Route – Decision Points

As a baseline, the service would operate as a minimum from US 71B and Martin Luther King Jr. Boulevard (Fayetteville) in the south to the intersection of US 71B, US 71 and I-49 in the north (Bentonville). There are options for service further north and south. These should be considered by the study committee (Figure 3-7).

1. **How far north:** Traffic backs up at the Missouri state line. A park and ride facility is needed at either Tiger St. in Bentonville (There is a Harps grocery store there), the intersection of I-49 and US 71 (there is a Lowe's) and/or Bella Vista (Harps). There is also a Walmart Super Center just inside Missouri. The possibility of queue jumping north of I-49 will be discussed as a potentially attractive alternative for an LBRT service.

2. **How far south:** Both RT and ORT management favor Martin Luther King Jr. Boulevard. There is a Walmart neighborhood store there, but on a Wednesday at

2:00 p.m. it was very crowded. As currently configured, this location is out of the question. There is a large mostly empty lot (O'Reilly's Auto Parts) at the intersection of Martin Luther King Jr. Boulevard and US 71B with good access. Other options include going 1.7 miles south to the County Correction Center/Tyson Foods and low income housing at the southern end of US 71B. Currently an ORT feeder bus (Route 1) is providing that service. Extending service would eliminate this feeder route as configured.

Both extensions would be viable and have the potential to add considerable ridership to the service.

Days and Hours of Service

It is proposed that this service operate at a minimum: Monday through Friday from 6:00 a.m. to 10:00 p.m. to allow for commuters on a later shift. For the pilot project it is proposed that buses operate on 15 minute headways during peak hours (6:00 a.m. to 9:00 a.m. and 4:00 p.m. to 7:00 p.m.). The committee should determine if the pilot project should operate on Saturday, considering that Saturday service typically draws about one-half the ridership of weekday service.

Service Hours

Service hours and costs are depicted in Table 3-6. These scenarios are based off of the service alignments depicted in Figure 3-7 with a minimum distance of the core route being 56.5 miles round trip and the maximum distance including the extension to both the north and south being 79.3 miles round trip.

Basic Operating Costs

Looking at four scenarios operating costs will be estimated based on a cost of $75.00 per hour, reflective of the cost of using bigger buses for this service. Operating speed will be calculated at 20 miles per hour.

Figure 3-7: Routing Options

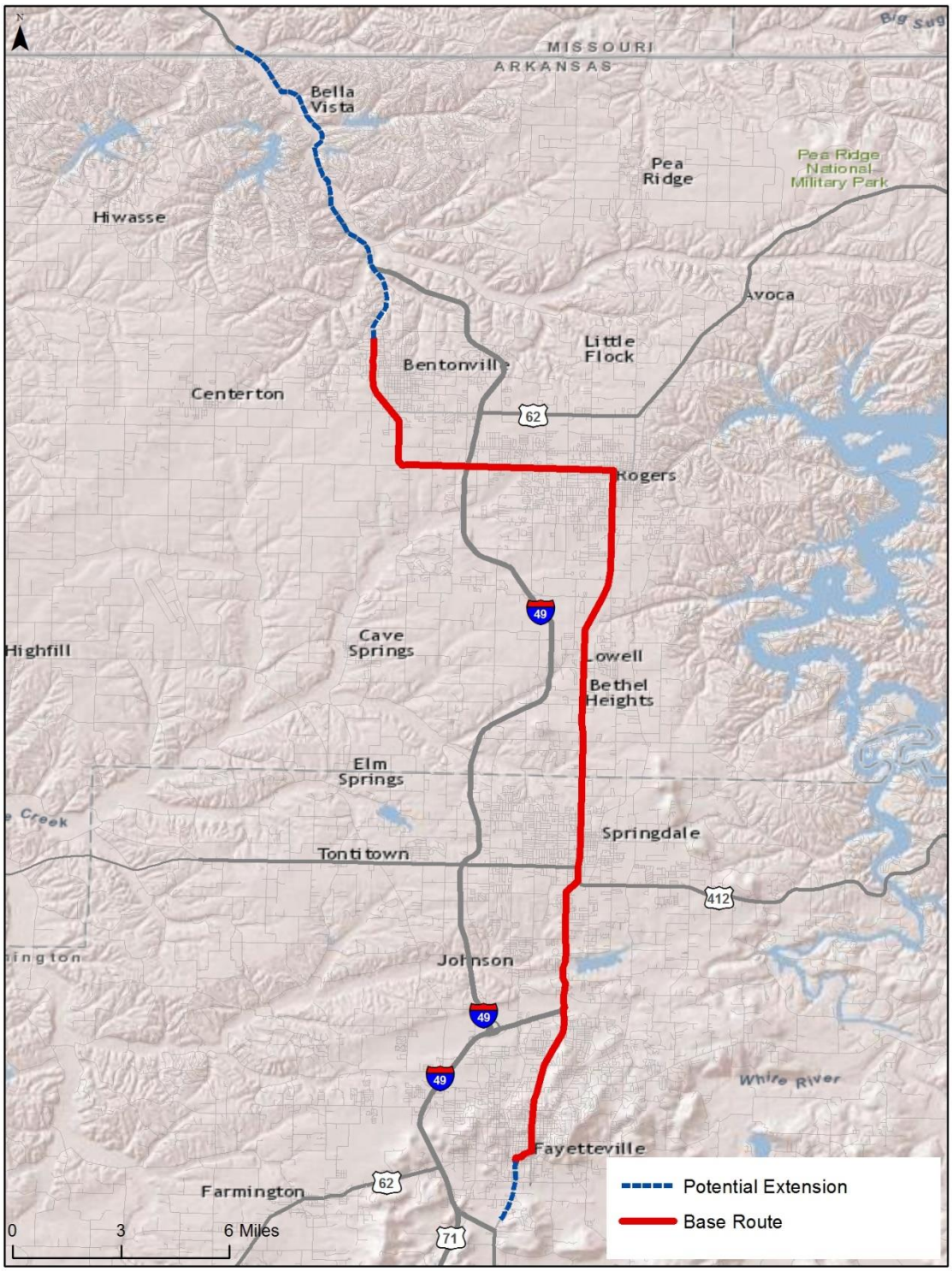


Table 3-6: Route Peak Vehicles, Service Hours, Headways and Operating Costs

	Peak Vehicles	Headways	Annual Revenue Hours	Annual Operating Costs
Weekday Service				
Minimum Distance	17	15 Minute Peak 30 Minute Off-Peak	42,075	$3.16 million
Maximum Distance	24	15 Minute Peak 30 Minute Off-Peak	58,140	$4.36 million
Saturday Service				
Minimum Distance	9	30 Minute	9,063	$679,700
Maximum Distance	12	30 Minute	12,084	$906,300

Stations – BRT's Front Door

The bus station is the nexus of pedestrians, bicyclists, personal vehicles and transit. It is literally transit's front door. It is also the source of the (potential) customer's first impressions. The survey that the study team recently completed indicates that customers want clean facilities, safe and accessible with real time information.

Due to the express nature of this service, stations will be limited. In urban areas stations will typically be one mile apart, while in other areas perhaps two to three miles apart as compared to regular fixed route where stops are typically one-quarter mile apart. Ultimately the system will have a set of stations across the system that are accessible, safe, well-lit, and can meet a variety of needs.

Planning the Stations

The selection of stations and the level of improvements for each are critical aspects of this study. Following are essential elements that will be required of each station:

- **Traffic Signal and Crosswalk** – Every stop should be located where customers can safely cross US 71B and all cross streets. These stations must have access to a traffic signal, crosswalk and curb cut as appropriate. For the pilot project, all stations as necessary will have safe access to a traffic signal and crosswalk.

- **Accessible Pathways** – Sidewalks from the accessible intersection to the station should be in place to allow for safe access. In some cases this will be the

responsibility of the local political jurisdiction and/or AHTD, while in other cases it is the responsibility of the private sector.

- **Protected Left Turns** – In the few instances where the bus will travel off of US 71B, there should be protected left turns (perhaps with a priority). For example, when turning into a park and ride lot or in downtown Fayetteville at the transfer point with RT.

- **Timed Meets** – Where feasible, cross routes and connector buses will have timed meets to ensure a rapid transfer. Many routes will need revision.

- **Bicycle Opportunities** – These can include bike sharing facilities at all major stations, lockers for personal bicycles and of course bike racks on all buses. Stations will also be planned to intersect with the Razorback Greenway (or come close).

- **Real Time Bus Information** – Real time information has become the norm in many transit systems and is an important element of any type of BRT service. The LBRT service should have real time information.

- **Far Side Stations** – Due to signal prioritization, stops should be placed on the far side of the street (after the intersection).

Four Types of Stations

There are four types of stations that may be required in this service:

1. **Major Origin Stations** – This includes stations near single family housing, apartments, senior housing, dormitories and other key origins.

2. **Major Destination Stations** – Some stations will be needed to access major destinations such as downtown Fayetteville, the university, a number of hospitals and major corporations on 71B (most notably Wal-Mart in Bentonville).

3. **Transfer Stations** – These stations will have at least one feeder or other fixed route bus meet. Examples will include the downtown Fayetteville stop mentioned above. It will meet a Razorback Transit bus to ensure rapid access to campus. A number of routes will meet by the Walmart on US 71B and Robinson Ave. in Springdale. That station should also include park and ride. The JB Hunt Headquarters station, for example, is only viable if a feeder is installed.

4. **Park and Ride Stations** – May also include multiple routes and serve as a transfer station as well. Each end of the route will have a park and ride station and many

will be interspersed throughout the service area in Harps, Walmart's, shopping centers, and malls, for example.

Station Costs – Initial Estimates

Initial cost estimates are based on enhancements needed for the pilot. Estimated costs (including signage and technology) are as shown in Table 3-7.

Table 3-7: Station Cost Estimates

10 feet of sidewalk ($17.5 a linear foot) and an 8 foot pad	$1,000
Basic shelter with pad	$15,000 - $20,000
Basic park and ride in an existing lot with shelter	$25,000 - $35,000
Real time bus information and technology	$40,000
Transfer facility and enhanced w/shelter	$100,000 - $200,000

Decisions regarding station amenities and costs for the pilot will be important. Peer BRT stations cost anywhere from $200,000 to $500,000. Creating low cost pilot station environments that can be adapted into higher costs stations will be important. Table 3-8 depicts potential stations and the needed improvements. Figure 3-8 shows the station locations by type. Table 3-8 provides initial estimates which will be refined once the actual station locations are selected. It is estimated that bus station infrastructure improvements will require about $415,000 for minimum improvements needed to ensure a quality image.

Station Decisions

The location of the stations is a critical issue. The study committee is asked to make recommendations related to the locations of bus stations. Table 3-8 and Figure 3-8 above depict the potential stations for consideration. The table details the location, type of stop, infrastructure needs and other station needs. The map depicts where each type of station is located.

Table 3-8: Potential LBRT Stations

Station Location	Distance from MLK Blvd in Fayetteville (Miles)	Type of Station	Accessibility Needs	Other Improvements	Connections - Bus, Greenway
Washington County Facilities	-1.7	Destination		Shelter	
Tysons/Housing	-1.5	Destination	Sidewalk and curb cuts	Cross walk, signal, and Shelter on northbound side	
MLK Blvd. and 71B O'Reilly Auto Parts	0	Park and Ride, Transfer	If in the street a landing pad will be needed. If in the parking lot, pathways will be needed	Shelter	Rte. 1 and 2 , Greenway
Highland Ave. and Dickson St.	1	Transfer	Landing pad	Shelter, space for two buses	Razorback Rte. 61
UAMS and VA	1.6	Destination	Landing pads	Shelters	
Township St. and 71B	3	Origin and Destination	Landing pads on both sides to overcome verge	Shelters	
Rolling Hills Dr. and 71B	3.8	Park and Ride, Transfer	Landing pads on both sides to overcome verge, sidewalk to park and ride lot	Shelters	Rte. 4, and Razorback Rte. 61

Station Location	Distance from MLK Blvd in Fayetteville (Miles)	Type of Station	Accessibility Needs	Other Improvements	Connections - Bus, Greenway
Zion Rd. near Mall	5.4	Destination, Transfer	Sidewalks connecting to mall	Full transfer amenities	Rte. 3, 4, 51, 61. Greenway crosses 1/4 mile north of Zion simple connection
Tyson Dr.	7	Destination and Origins	Landing pads to overcome verges	Shelters	
Robinson Ave. – Walmart	8	Destination, Park and Ride, Transfer	Full transfer center amenities with accessible pathways to streets	Full transfer amenities	Rte. 61, 62, 63, 64. Greenway close by
Maple Ave. - Northwest Med Center	9	Destination, Transfer	Need pads to overcome verges, sidewalk and cross walk	Shelters	Rte. 62
Backus Ave. - Harps, Georges plant	10	Destination, Potential Park and Ride	Sidewalk on northbound side, landing pad on southbound side	Park and ride space in Harps lot	Greenway
Wagon Wheel Rd.	12	Origin	Sidewalks and landing pads	Modest improvements - bench, small shelter	
JB Hunt Dr.	13.5	Destination	Feeder bus service	Modest improvements - bench, small shelter	

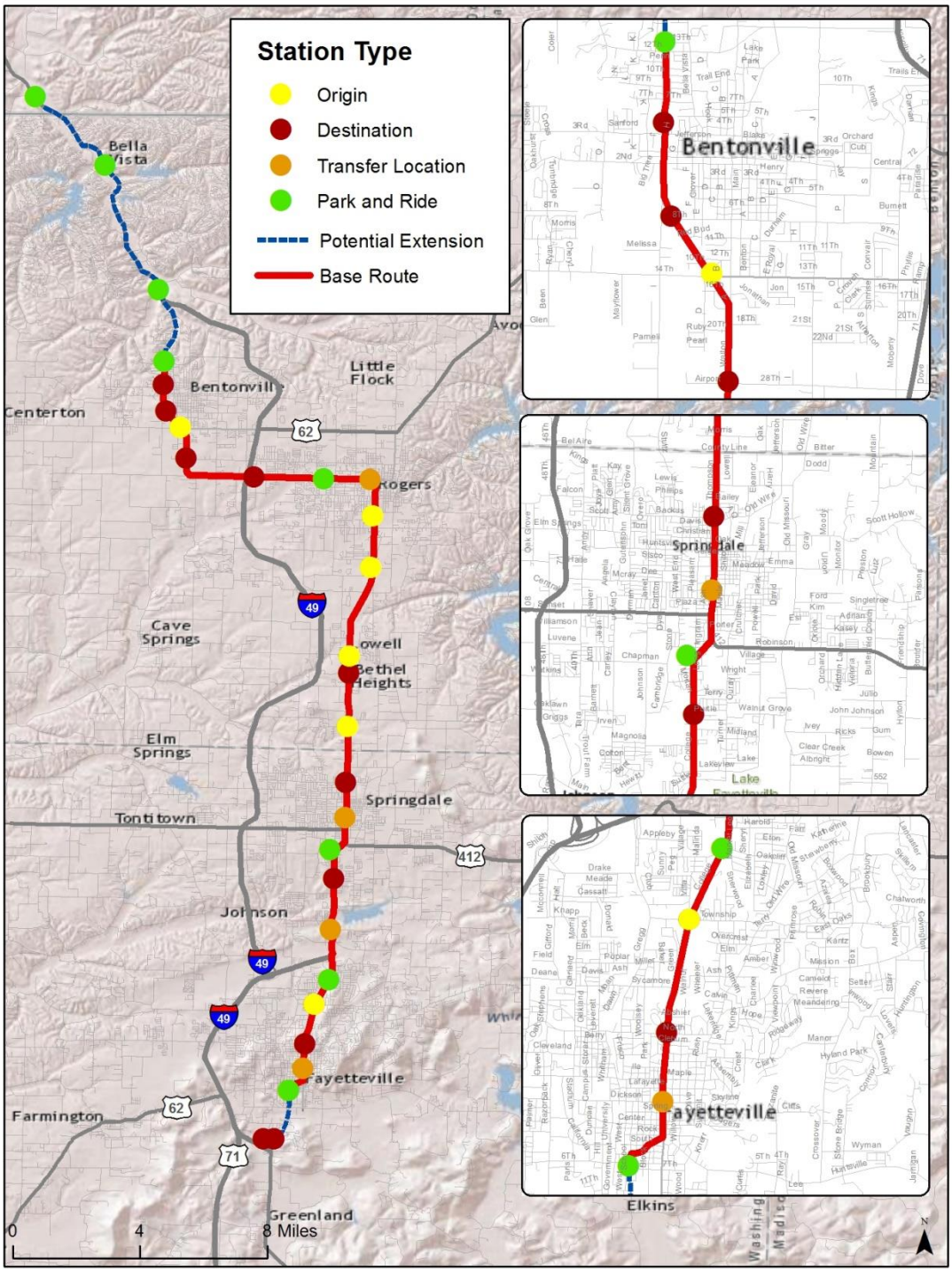
Station Location	Distance from MLK Blvd in Fayetteville (Miles)	Type of Station	Accessibility Needs	Other Improvements	Connections - Bus, Greenway
Monroe Ave.	14	Origin, Destination	Sidewalks, landing pads and crosswalk	Shelters	
West Post Rd	17	Origin	Sidewalks, landing pads and crosswalk	Needs pathway from development	
Ohlrich St.	18.5	Origin	Crosswalk and landing pads		
Walnut St. Rogers	19.8	Origin, Destination, Transfer	Crosswalks and landing pads		
21st St. Frisco Mall and Walmart	21	Park and Ride, Destination	Pathways to parking lot from street if stop in street	Modest improvements - bench, small shelter	
N. 46th St	22.5	Destination	Pathways into south side shopping, and crosswalks		
SE.28th St.	25	Destination			Rte. 11
SE 14th St	26	Origin, Destination			
WM H.O.	26.5	Destination	Sidewalks and crosswalks	Shelters	
WM Logistics	27.3	Destination	Sidewalks and crosswalks	Shelter	
Harps - Tiger Blvd.	28	Park and Ride, Origin	Landing pad and sidewalks on northbound side		Rte. 11
US 71 and I 49 - Lowes	+2.5	Destination, Origin	Landing pads and pathways		
Bella Vista exit.	+6.8	Park and Ride	Exact location TBD	Modest improvements - bench, small shelter	

Station Location	Distance from MLK Blvd in Fayetteville (Miles)	Type of Station	Accessibility Needs	Other Improvements	Connections - Bus, Greenway
State Line Walmart	+9.7	Park and Ride		Modest improvements - bench, small shelter	

* Extension distance from MLK Blvd in Fayetteville

** Extension distance from Tiger Blvd in Bentonville

Figure 3-8: Potential Station Locations



Vehicles

Vehicles associated with BRT type service are typically larger than most and have two or more doors, a low floor (with a ramp for persons with disabilities). Timing of a procurement will be a factor as heavy duty buses may take up to two years to procure, while medium duty body on truck chassis vehicles with lower capacity can be procured more quickly. Options for leased vehicles are few or non-existent at any given time.

Medium Duty Low Floor Bus

Medium duty buses (Figure 3-9) offer much lower capital costs and typically these vehicles can be procured on a shorter timeframe than a heavy duty bus. Unfortunately these vehicles have about 75 percent of the capacity (30 seated with 2 wheelchair spaces and standees) of a heavy duty bus as noted below. The useful life of these vehicles is shorter than a heavy duty bus and in the "out" years of its useful life, medium duty vehicles often need considerable maintenance, especially if subjected to heavy duty service. Finally, the medium duty vehicles are typically not as comfortable as heavy duty buses. These buses cost about $300,000.

Figure 3-9: Medium Duty Low Floor Bus

Heavy Duty Low Floor Bus

RT uses heavy duty low floor buses for its regular fixed route service (Figure 3-10). These buses are generally 35 to 40 feet in length and are designed to last 12 years in heavy duty service. The low floor and wide doors allow for quick and effect boarding and alighting, particularly for a fare free service. These vehicles seat 40 ambulatory person with two spaces for persons using wheelchairs as well as additional room for standees. This vehicle

typology is useful for busy systems needing large capacity vehicles to meet demand. These buses can range from $500,000 to $650,000 per vehicle. [2]

Figure 3-10: Heavy Duty Low Floor Bus

Articulated / High Capacity Bus

Articulated and/or high capacity buses could be used in the service area in the future if ridership accelerates (Figure 3-11). Articulated buses, which can travel throughout the corridor, are typically 60 feet long and bend in the middle. These vehicles are used throughout the world in regular service and in BRT type service. Their total capacity (seated and standing) is over 120 passengers depending on the configuration. These buses could be used in the future if the transportation demand management conditions are met.

Figure 3-11: High Capacity Bus

A true BRT system generally has specialized design, services and infrastructure to improve system quality and remove the typical causes of delay. BRT aims to combine the capacity and speed of light rail or metro with the flexibility, lower cost and simplicity of a bus system. These purpose built vehicles can be 80 feet long and can carry up to 200

[2] 2013 Tri-County Metropolitan Transportation District of Oregon Contract with Gillig LLC. for the Purchase of 40' Diesel Buses

passengers. Their capacity makes them useful in true BRT mode with separated roadway from traffic. Their size can limit their ability to travel on regular roads with mixed traffic. High capacity BRT or articulated buses can costs between $750,000 and $1.6 million.[3]

Summary - Vehicles

Consideration of vehicle size and type (heavy duty or medium duty coach) is a straightforward set of alternatives. Each has their advantages, as the medium duty coach is available much sooner and costs about one-half of the cost of a heavy duty coach, while the heavy duty coach is more comfortable, lasts longer and has about 33 percent greater capacity. Assuming that Federal capital grants are used, the local costs for each bus will be $60,000 for medium duty buses and $120,000 for heavy duty coaches.

Alternative Fuel Types

There are now a variety of fuel and battery choices for transit vehicles. Decisions on the type of fuel chosen are based on a number of factors that decision makers should consider:

- Environmental Policy – There is no question that alternative fuels and batteries can make a difference in the local environment. Decisions are often made on this basis alone.

- Operational – There are a number of operational issues (and costs) associated with alternative fuels, including but not limited to:
    - Infrastructure – Fueling facilities and maintenance equipment, for example.
    - Expertise – Maintenance staff with specialties in electric and hybrid technologies would need to be hired.
    - Availability of specialty repair vendors.

- Financial – Vehicle and on-going costs vary and are a major consideration to the type of vehicle used.

Biodiesel

Transit fleets (for example, Park City Transit in Utah), have been able to successfully use biodiesel. Biodiesel is a renewable, clean-burning diesel replacement made from a diverse mix of feedstocks including recycled cooking oil, soybean oil, and animal fats. Just like petroleum diesel, biodiesel operates in combustion-ignition engines. Essentially no

[3] TCRP Report 118: Bus Rapid Transit Practitioner's Guide

engine modifications are required, and biodiesel maintains the payload capacity and range of diesel. Generally the transit fuel is a mixture of diesel and biodiesel. This is necessary for areas with colder climates, as biodiesel can be difficult to use in colder climates. Biodiesel buses cost the same as regular diesel buses from the manufacturer.[4]

Compressed Natural Gas (CNG)

CNG can be used in place of other fossil fuels. CNG combustion produces fewer undesirable gases. It is safer than other fuels in the event of a spill, because natural gas is lighter than air and disperses quickly when released. The cost and placement of fuel facilities is the major barrier to adoption of CNG as a fuel. It is also why municipal government, public transportation vehicles were the most visible early adopters of it, as they can more quickly amortize the money invested in the new (and usually cheaper) fuel. If a fueling facility is currently available this is a viable alternative. Santa Fe is an example of an all CNG fleet. A typical forty foot low-floor CNG vehicle will cost between $500,000 and $750,000.[5]

Electric Hybrid

A heavy duty hybrid electric bus combines a conventional diesel internal combustion engine propulsion system with an electric propulsion system. Bus batteries store energy and recharge when the bus decelerates. When demand for power exceeds battery capacity, the diesel engine provides extra energy. Hybrid buses have lower emissions than other propulsion types. This technology can be combined with biodiesel for increased environmental benefits. A typical hybrid 40 foot low-floor vehicle will cost between $500,000 and $700,000.[6] This technology would also require a major investment in infrastructure.

Hybrid city buses are best suited to stop-and-go routes where average speed is eight miles per hour. In situations where buses travel longer distances at higher speeds, the hybrid system is less useful because the lithium ion battery harvests power from when the vehicle brakes and when the bus is coasting. These types of buses are used in regular service across the country.

[4] 2013 Tri-County Metropolitan Transportation District of Oregon Contract with Gillig LLC. For the Purchase of 40' Diesel Buses

[5] 2013 Tri-County Metropolitan Transportation District of Oregon Contract with Gillig LLC. For the Purchase of Compressed Natural Gas Buses

[6] 2013 Tri-County Metropolitan Transportation District of Oregon Contract with Gillig LLC. For the Purchase of Hybrid Buses

Electric Battery

Electric battery technology has been improving over the last few years to the point where heavy duty fully electric buses are viable transit vehicles under certain conditions. As charging times decrease and battery ranges increase these vehicles are becoming more attractive. The fuel and preventative maintenance cost are much lower on these vehicles but the initial costs are often greater depending on vehicle size and battery configuration. Denver is an excellent example of the use of this technology. Electric battery bus prices vary greatly depending on the size and battery configuration. Buses can range from $400,000 to $2 million.[7]

Technology

The use of technology is important in a BRT system. Signal prioritization and real time bus locational information are both key ingredients to BRT. Signal prioritization is one of the keys to success and allows a bus to operate at a higher average speed.

Signal Priority

Traffic signal priority is simply the idea of giving special treatment to transit vehicles at signalized intersections. Since transit vehicles can hold many people, giving priority to transit can potentially increase the person throughput (capacity) of a roadway or intersection. A passive priority strategy seeks to favor roads with significant transit use in the area-wide traffic signal timing scheme. Timing coordinated signals at the average bus speed instead of the average vehicle speed can also favor transit vehicles.

By contrast, an active priority strategy involves detecting the presence of a transit vehicle and, depending on the system logic and the traffic situation then existing, giving the transit vehicle special treatment. The system can give an early green signal or hold a green signal that is already displaying. An active system must be able to both detect the presence of a bus and predict its arrival time at the intersection.

Real time control strategies can consider not only the presence of a bus but the bus adherence to schedule and the volume of other traffic. One common strategy is to give priority only to late buses (compared to the scheduled time) but not to early buses. This strategy optimizes schedule adherence (and therefore waiting time) and allows planners to improve running time. Near-side stops can complicate the prediction of intersection arrival times.

[7] Range of costs for E-Bus and Proterra electric battery buses. http://ebus.com/ and http://www.proterra.com/

There are many different options for signal priority logic. Real time, adaptive systems can incorporate information on traffic flow, flow coordination, bus schedule adherence, and prior bus arrival times.

A Complicated Undertaking

Officials of the Arkansas State Highway and Transportation Department (AHTD) state that this will be a major undertaking as it will require each city to coordinate their activities. They further state that each city with a traffic signal along the route is responsible for maintenance of their own signals. It is very likely that the signals in different cities have different software and do not communicate with one another. Also of importance is that the majority of these five cities have coordinated their signals with other signals beyond US 71B in their respective City, including those that are not along the potential bus route. Adding priority to the signals on the route could throw a major kink in their overall system coordination as we have seen in peer cities until staff corrected the problem. So, each city would have to coordinate with each other and ORT in order to be informed of the plan and the potential impacts.

The steps to complete this process include; getting the cities on board, developing and submitting a detailed set of traffic signal plans outlining the priority system details and the modifications that would have to occur at each signal. The AHTD would then review and issue a Traffic Control Device Permit for each signal. Each permit requires the respective mayor's signature. There will likely be multiple people involved in the review and decision.

AHTD has never done this for transit so the timeframes are unknown at this time. The review and permitting process would probably be at least a couple of months due to reviewing traffic signal plans. As far as a timeframe for the actual modifications, there isn't any other system like this in the state, so it is difficult to provide a sound estimate of just how long this might take.

Real Time Information and Apps

BRT systems typically use electronic signs at stations to inform customers of the arrival of the next buses. These types of technology serve to assure the customer of the next arrival and make the service easier to use. While this signage may not be needed at all stations, it should be installed in the busier stations. Destination stations near the end of the line where passengers rarely board a bus will not need real time information, while the stop across the street will need this information. Real time information is also important in a signal priority system as it can tell the computer if a bus is running late and make adjustments in the signalization.

Queue Jumpers

A queue jump lane is a short stretch of shoulder lane that can be combined with traffic signal priority, but does not have to be combined. The idea is to enable buses to bypass waiting queues of traffic and cut in front by getting an early green signal. A special bus-only signal may be required.

In Park City, UT the express buses operate on the shoulder during peak hour with only simple signage and no signal priority. The queue jump lane can be a right-turn only lane, permitting straight-through movements for buses only. A queue jump lane can also be installed between right-turn and straight-through lanes. A similar arrangement can be used to permit a bus to cross traffic lanes to make a left turn immediately after serving a curb-side stop.

At this time, queue jumping has limited applicability along US 71B due to lack of appropriate shoulders, however, US 71 from the northern intersection with I-49 to the Missouri border has large shoulders that could potentially be turned into bus lanes or queue jump lanes. This area also has significant traffic congestion. These approaches would require, as a minimum, signage improvements to allow buses to use the shoulder to move through the traffic signal rapidly. This has never been done before in Arkansas.

AHTD officials believe that there are a number of issues including:

1. Shoulder Construction - The shoulders of US 71 may not be constructed with a section capable of handling bus traffic. If so, this would require reconstruction of the shoulders or overlaying the entire roadway. This will be a significant cost for which funding will have to be identified.

2. Corridor Capacity - This section of the corridor is already at capacity (especially on the south end) and any change in the signal phasing will likely lead to a "breakdown" in the flow of traffic during peak times. BRT however, has the capability to add capacity to the roadway at a much lower cost than adding a lane of traffic.

3. Signalization - The signals within this section are owned and operated by the City of Bella Vista. The AHTD has authority over changes to the operation of the signals, and changes are handled through a Traffic Control Device Permit process which the City can initiate. Any costs associated with changes to the signals will be the responsibility of the City.

4. Timeframe – Unknown at this time, but it will require significant time and money according to AHTD officials.

Study Committee Meeting – Strategies

The consultants will present the strategies to the study committee on June 7th. This meeting and perhaps subsequent discussion will determine the design of the service, from the route, to vehicles and infrastructure, the study committee will provide the guidance needed by the consultant in order to complete the effort. Please plan to attend the meeting.