AECOM

DIXIE BUS RAPID TRANSIT FEASIBILITY STUDY

A Long-Range Regional Perspective

June 2, 2010

Prepared for

Dixie Metropolitan Planning Organization

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GLOSSARY

Summary of Terms and Acronyms

ADA – Americans with Disabilities Act

AOG – Association of Governments

Auto Captive – Trip makers who do not have access to transit use or have no inclination to use public transit.

AVL – Automatic Vehicle Location

BRT – Bus Rapid Transit

Choice Rider – Trip makers who would use transit under the “right” conditions.

CMAQ – Congestion Mitigation and Air Quality

CNG – Compressed Natural Gas

Dixie MPO – Dixie Metropolitan Planning Organization

DTAC – Dixie Transportation Advisory Committee

DTEC – Dixie Transportation Executive Council

Dwell Times – The time a transit vehicle remains at a given station.

FHWA – Federal Highway Administration

FTA – Federal Transit Administration

GPS – Global Positioning System

HCM – Highway Capacity Manual

Headway – The distance in time that separates two transit vehicles.

Headway Based Control – A type of schedule control that continuously utilizes Transit Signal Priority to advance BRT as quickly as possible through the corridor in order to minimize the travel time.

ITS – Intelligent Transportation Systems

JARC – Job Access Reverse Commute

LAVTA – Livermore Amador Valley Transit Authority

LOS – Level of Service

Mode Split – The number of trips by each mode relative to the total number of trips, expressed as a percentage.

Net Deficit – The total operating expense of a transit system minus the cost recovered through fare box revenues.

Person Trips – The total trips completed by individual persons regardless of whether they occupy the same vehicle.

Queue Jump Lane – A lane reserved for either transit vehicles alone or transit vehicles and vehicles turning right. A queue jump lane allows transit vehicles to bypass traffic queues.

San Joaquin RTD – San Joaquin Regional Transit District

Reno RTC – Reno Regional Transportation Commission

ROW – Right-of-Way

Schedule Based Control – A type of schedule control that is typically used to coordinate the arrival of individual routes for transfer purposes.

TAZ – Traffic Analysis Zone

TCRP – Transit Cooperative Research Program

TIGGER – Transit Investments for Greenhouse Gas and Energy Reduction

TPO – Transportation Planning Office

TSP (Transit Signal Priority) – An operational strategy that is used to facilitate the movement of transit vehicles through signalized intersections along a corridor.

Transit Captive – Trip makers who do not have access to a car and have no choice but to use public transit.

Transitways – A lane dedicated to transit usage which may be either at-grade or grade-separated. They are designed to physically separate transit vehicles from general traffic.

TVM – Ticket Vending Machines

UDOT – Utah Department of Transportation

VRT – Valley Regional Transit

VVTA – Victor Valley Transit Authority

EXECUTIVE SUMMARY

This study evaluated the feasibility of establishing rapid transit service between the City of St. George, Hurricane City, and the new St. George Airport. The study was commissioned by the Dixie Metropolitan Planning Organization (Dixie MPO) to examine Bus Rapid Transit (BRT) – a rubber-tired transit system similar to light rail, but with greater operating flexibility and potentially lower costs.

This study found that BRT service from St. George to Hurricane and to the airport is a viable option for the future that should be preceded by conventional bus services along the corridors.

Transit ridership forecasts for this study were calculated based on population, employment, and trip demand projections estimated by the most recent version of the Dixie MPO regional travel demand model. The travel demand model, and consequently the transit ridership projections, provides expected growth for long-range planning scenarios (year 2035 forecasts).

Although BRT service to Hurricane and the airport is not a viable transit service option in 2010, long-range growth projections for the Washington County urban and urbanizing areas are expected to accommodate a viable BRT system that runs in mixed-traffic. The details of the proposed BRT system are presented in Chapter 7.

The implementation of conventional bus service to Hurricane and the airport is a very logical step toward the future development of BRT service. Lower level transit investments can be gradually improved, allowing BRT to be phased into operation as population and transit demand increase.

Because volatility in growth patterns can impact the timing of 2035 and interim year conditions, BRT ridership forecasts were presented in terms of future planning years as well as socio-economic growth conditions. This allows forecasts to evaluate opportunities to phase in BRT service even if there are some changes to the timing of growth projections assumed by the regional travel demand model.

BRT cannot function effectively without a strong local transit service to support it. The local transit service must expand in parallel with the gradual implementation of a BRT system. As the future overall transit system for Washington County grows, it will need to seamlessly feed and connect to the BRT system.

The expansion of transit service beyond the St. George city boundaries will require changes in the institutional structure of the transit organization. There are various options for creating a transit organization that can address the needs of an intercity transit system. Chapter 9 presents a range of options that should be considered.

Based on the findings of this study, the Hurricane and airport BRT service proposed for the future is expected to meet the ridership thresholds and to require costs comparable to peer systems. Estimates for capital and operational costs of the BRT service to Hurricane and the airport are presented in Chapter 8. Various FTA funding programs exist that can help expand a transit system. FTA funding for capital costs typically requires a 20 to 50 percent local match. FTA funding for operational expenditures requires a 50 percent match after subtracting the operational cost recovered through fare box revenues. Opportunities for local and Federal subsidies for capital and operational costs are presented in Chapter 9.

In summary, the findings of this study suggest that providing BRT service extending between St. George, Hurricane and the airport is a feasible option for the future. The findings also suggest that providing conventional bus service for these corridors should be considered to serve existing transit demand, validate the feasibility of the BRT service, and provide the supporting ridership data needed to justify eventual implementation of BRT service.

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1.0 INTRODUCTION

1.1 Project Objective

According to the 2000 U.S. Census, Washington County is Utah's fastest growing county. Washington County is expected to continue to develop rapidly over the next several decades. Growth in employment and housing will increase congestion and the need for additional transportation facilities. The expected growth of transportation demand in the region will increase the need to expand multi-modal and public transportation options for the Washington County urban and urbanizing areas.

The *2030 Regional Transportation Plan,* dated May 2007, defined a Hurricane Bus Rapid Transit (BRT) route to extend from the intersection of St. George Boulevard and Bluff Street in the City of St. George to River Road, then north along Red Cliffs Drive and Telegraph Road to SR-9, then east along SR-9 to Main Street in Hurricane City. This BRT alignment was identified by the Dixie Metropolitan Planning Organization (Dixie MPO) and the Dixie Transportation Advisory Committee (DTAC), but its feasibility had not been evaluated before this study. The Dixie MPO initiated the Dixie BRT Feasibility Study (hereafter referred to as "study") to provide technical analysis and direction with regard to the feasibility for rapid transit service that connects St. George and Hurricane along this proposed corridor. The study was later expanded to consider rapid transit service from downtown St. George to the future St. George Airport located in the southeast quadrant of the City of St. George.

This study is not intended to be a detailed alternatives analysis, but rather seeks to evaluate the long-range feasibility for the two proposed transit service expansion corridors and to provide guidance to be used in the local decision making process and to serve as a stepping stone for additional planning or environmental studies which may be undertaken in the future. After their acceptance and adoption by the DTAC, it is expected that the conclusions and recommendations of this study will be added to the Dixie MPO Long Range Plan.

1.2 Project Study Area

The BRT corridors considered in this study are shown in Figure 1.1. The study area was defined to encompass the service areas for these corridors and included portions of the City of St. George, Washington City, and Hurricane City, in Washington County, Utah. The study considered socioeconomic and transportation trends for the Washington County urban and urbanizing areas, with evaluation efforts focused on long term transit opportunities for the corridors extending from downtown St. George to Hurricane (along Red Cliffs Drive, Telegraph Road, and SR-9) and from downtown St. George to the new St. George Airport site (along Mall Drive and 3000 East).

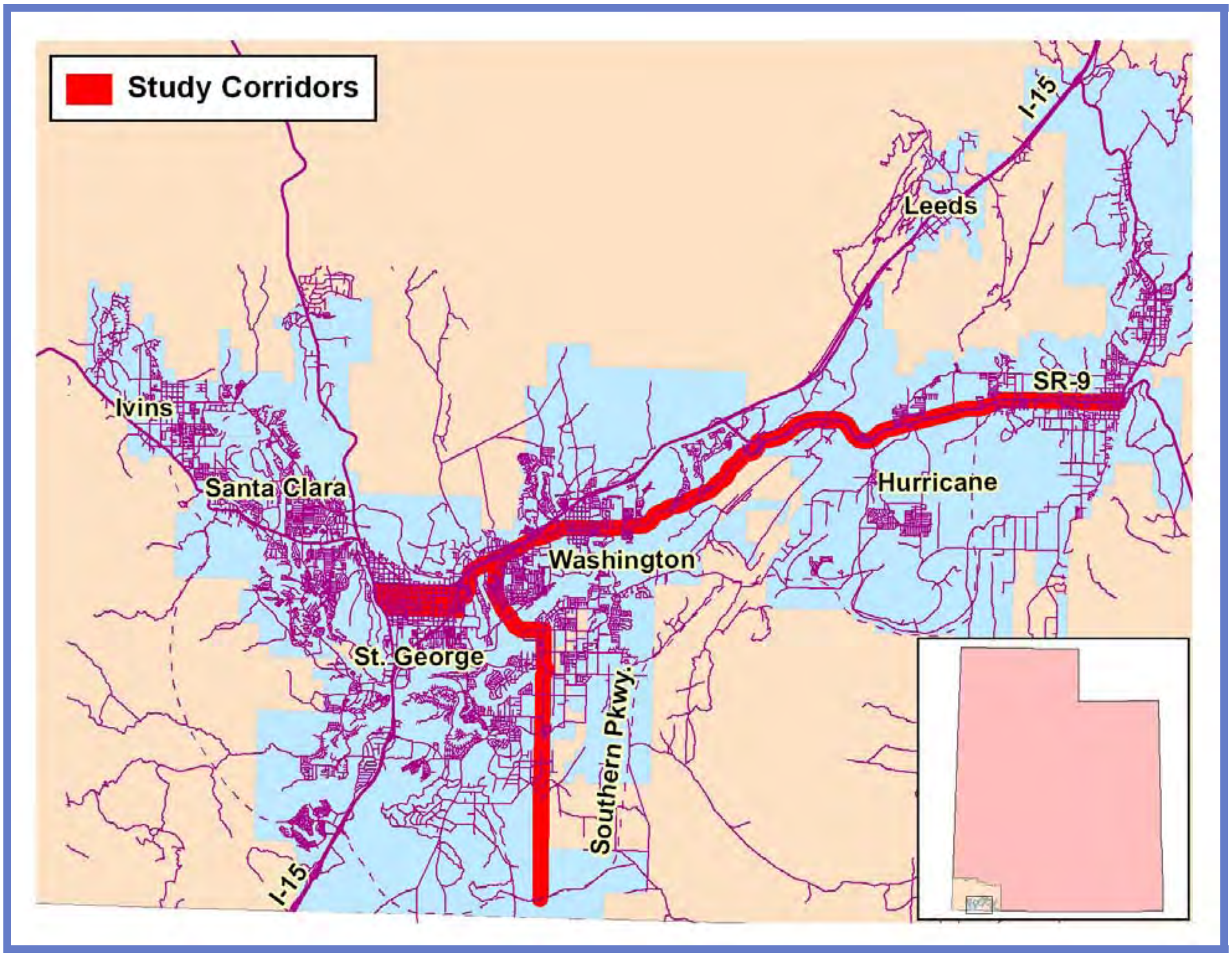

Figure 1.1: Study Area Map

1.3 Literature Review

Several transportation planning studies have been recently completed for the St. George area. However, most of these studies have focused on highway needs. The planning studies that have considered transit for the St. George area have focused on short range transit needs for the region. Very little research has been completed to consider long term needs and opportunities for expanding transit service beyond St. George City. The purpose of this document is to build on previously completed work and provide a long range evaluation for expanding transit service to Hurricane and the new airport. As such, it was important to review and consider the various transit and transportation planning efforts completed for the region. As part of this study the project team completed a literature review that provided background information that allowed this project to avoid performing work already completed by others.

2.0 BUS RAPID TRANSIT

This section defines Bus Rapid Transit and introduces some of its key elements and benefits.

2.1 Definition of BRT

Bus Rapid Transit (BRT) is an integrated system of facilities, equipment, services, and amenities that improve the speed, reliability, and identity of bus transit. BRT is, in many respects, a rubber-tired light rail transit with greater operating flexibility and potentially lower costs.

The Federal Transit Administration (FTA) defines BRT as a "rapid mode of transportation that can provide the quality of rail transit and the flexibility of buses." The Transit Cooperative Research Program (TCRP) Report 90 expanded the definition to "a flexible, rubber-tired form of rapid transit that combines stations, vehicles, services, running ways, and ITS elements into an integrated system with a strong image and identity."

The BRT mode is quickly becoming an effective way to move people efficiently and in a cost effective manner; in terms of both capital and operating costs.

2.2 Benefits of BRT

BRT has been shown to provide significant benefits that could be applied to Washington County, including the following:

- BRT provides operating flexibility since it can operate on arterial streets; in freeway medians, on freeway shoulders and alongside freeways; or other separate right–of-way.
- BRT provides flexibility for extending a line or developing branched services with the existing road infrastructure.
- BRT can effectively provide rapid and local services at a single transit facility.
- Due to improved speed and reliability, BRT can provide the same levels of service as light rail transit. In some cases, BRT can provide the same capacity as light rail transit.
- BRT can be implemented much quicker than rail modes and can be done in phases as the passenger demand dictates. This provides the greatest flexibility in meeting transit demand.

- BRT can be significantly less costly to implement than a rail transit line while providing similar benefits—especially in locations where right-of-way availability is constrained.

- BRT can be effectively integrated into the surrounding environment and can generate significant community development benefits.

2.3 Elements of BRT

According to the Transportation Research Board "BRT applications are designed to be appropriate to the market they serve and their physical surroundings, and they can be incrementally implemented in a variety of environments." The flexibility of BRT is made possible by the various elements of a BRT system. The following sections present the major elements of a BRT system including running ways, stations, vehicles, fare collection, intelligent transportation systems, and service and branding elements.

2.3.1 Running Way

Running ways impact the travel speeds, reliability and identity of a transit system. In the case of a BRT system, options range from mixed traffic lanes to fully grade separated BRT transitways. Signal priority is often used in conjunction with BRT running ways in order to further improve BRT operation. Different types of running ways can be used along different segments of a BRT corridor depending on right-of-way costs and other factors. This flexibility is one of the characteristics that make BRT such an attractive transit alternative.

Mixed Traffic Lanes

Mixed flow traffic lanes are the most basic and typically least expensive form of running way. A BRT system operating with this type of running way is subjected to the same delays experienced by personal vehicles and local buses. With this type of running way traffic may also experience slight delays at BRT stations if no bus pullouts or other means of separating the BRT from traffic are employed.

A few strategies exist for improving BRT travel time when operating in mixed flow conditions. A common strategy is the application of queue jump lanes. Queue jump lanes are generally placed at signalized intersections where traffic experiences longer delays. They allow BRT vehicles to bypass traffic through the

Figure 2.1: Queue Jump Lane

use of a lane reserved for BRT and vehicles turning right. As shown in Figure 2.1 queue jump lanes require special signage for proper control. Queue jump lanes are simple, relatively inexpensive, and effective; however they may interfere with turning movements and require priority control of the signal phases at the intersections where they are implemented.

Designated Lanes

The most common type of running way which provides reliability and travel time savings for BRT systems is the designated lane. Figure 2.2 shows an example of a BRT designated lane. This type of running way provides BRT with a separate lane over a long distance which it typically shares with high occupancy and emergency vehicles. Designated lanes allow the BRT to move faster and more reliably along the corridor. Parking lanes and shoulders are typically used or converted to designated lanes. These lanes can be used by BRT in the peak periods and restricted to parking during off-peak periods. In such cases some safety issues can arise with parked vehicles.

Figure 2.2: Designated BRT Lane

Transitways

Transitways can either be at-grade or grade-separated. Either way they are designed to physically separate BRT from general traffic and are often restricted to the exclusive use of BRT vehicles. As shown in Figure 2.3, transitways are typically located in the median or adjacent to general traffic roadways. Transitways allow BRT to move freely along the corridor providing the most reliable service and avoiding most traffic delays. Transitways represent the most costly BRT running way alternative.

Figure 2.3: At-Grade Transitway

2.3.2 Stations

Stations act as the entry point to the BRT system and therefore are the single most important customer interface. Stations affect accessibility, reliability, comfort, safety, and security, as well as dwell times and system image. BRT station options vary from simple stops with basic shelters to complex intermodal terminals with many amenities.

BRT stations can have a variety of passenger amenities. A greater number of amenities generally increases the station's appeal but the additional amenities also increase the cost. BRT station costs run from approximately $50,000 to $800,000 per station depending on the size and number of components. An incremental development can be a good approach to constructing more appealing stations by adding new amenities as funds become available. Figure 2.4 shows sample schematic of a BRT station and some features that can make stations more attractive and more passenger-friendly.

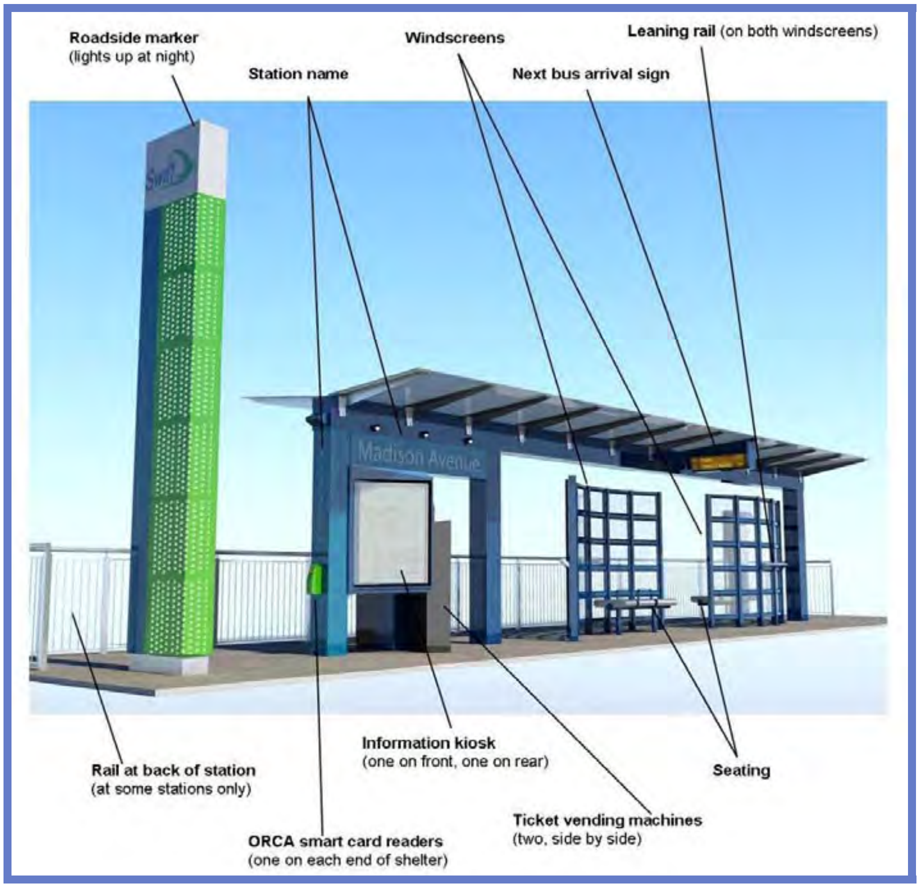

Figure 2.4: BRT Station Example

2.3.3 Vehicles

BRT systems can utilize a wide range of vehicles, from standard buses to specialized vehicles. Vehicle options vary in terms of size, propulsion system, design, internal configuration, and horizontal/longitudinal control, all of which impact system performance, capacity and service quality. Aesthetics, both internal and external, are also important for establishing and reinforcing the brand identity of the system.

The type of vehicle selected for the BRT system can have a big effect on the perception of the overall system. Newer, stylized vehicles can give the impression of a fast, quality service but this can also be achieved with other vehicles at lower cost if funding is limited. An example of a stylized standard BRT vehicle is shown in Figure 2.5.

Figure 2.5: Stylized Standard BRT Vehicle

2.3.4 Fare Collection

Fare collection affects customer convenience and accessibility, as well as dwell times, service reliability and passenger security. The simplest method for collecting fares is the traditional pay-on-board method using cash; this method is also the slowest and may require longer dwell times at stations. Other methods include the use of off-board ticket vending machines or hybrid systems with on-board fare collection and ticket vending machines located at key stations. Newer technologies have also been developed such as electronic fare media (i.e. smart cards) which improve the efficiency of fare collection and thus reduce dwell times. As with newer vehicles, newer fare payment technologies can be used to increase the attractiveness of the BRT system.

The improved quality of service provided by a BRT system can warrant an increased fare over the standard bus fare. Changes in the fare can include an increased flat fare or a differentiated fare, which may be based on trip length or time-of-day.

2.3.5 Intelligent Transportation Systems

A wide variety of Intelligent Transportation Systems (ITS) technologies can be integrated into BRT systems to improve BRT system performance in terms of travel times, reliability, convenience, operational efficiency, safety and security. Some ITS options include the following:

- ***Operations and Maintenance Management –*** Operations and maintenance management includes the ability to collect real-time information about vehicles, schedule and passenger counts. This is achieved by installing sensors on vehicles and/or along the BRT corridor which detect this information and relay it back to a central management location. It is difficult to implement other ITS practices without some degree of prior implementation of operations and maintenance management.

- ***Vehicle Priority –*** Vehicle priority treatment at intersections allows BRT vehicles to move more quickly through intersections by allowing them to make priority calls to the traffic signal controller. Upon receiving these calls the controller terminates the conflicting green phase early to bring up the compatible green phase early ("early green") or extend the compatible green phase ("green extension") to allow the BRT to pass through the intersection with minimal delay or no stopping. This type of ITS treatment can affect the intersection level of service in some cases.

- ***Real-time Passenger Information –*** Providing real-time information to passengers improves the BRT system by increasing the system's reliability and the customer's satisfaction. This information can be made available at stations, on the bus or via personal electronic devices such as computers and cell phones.

2.3.6 Service and Operations

Designing a service plan that meets the needs of the population and employment centers in the area and matches the demand for service is a key step in defining a BRT system. How it is designed can impact system capacity, service reliability, and travel times, including wait and transfer times. The following list summarizes characteristics of a BRT service plan:

- ***Route Length –*** Route length is impacted greatly by the location of major destinations along the corridor. In general longer routes are less reliable, because there are more stations and cross street interaction to cause delays in the overall travel time, but often require fewer transfers than shorter routes. Reliability and transfers can have an impact on customer satisfaction and should therefore be considered when defining route lengths.

- ***Route Structure –*** Route structure depends largely on how the BRT system will interact with other routes within the transit network. A system that utilizes "feeder" routes to extend the BRT service away from the BRT corridor maximizes the utility of a BRT route and can reduce operating costs through system integration; however too many routes can cause customer confusion and reduce the functionality of the transit network.

- ***Service Span –*** BRT service can continue all day or it may be restricted to the peak hours with local bus service taking its place off peak. All-day service allows more complete integration of BRT into the transit network, but may not be feasible if off-peak passenger demand is low.

- ***Service Frequency –*** BRT typically operates with headways ranging from 15 to 20 minutes with peak hour service as frequent as 10 minute headways. The high frequency service and reduced travel time characteristic of BRT cultivates a rapid transit image for the system. Any increase in frequency decreases the amount of time customers have to wait for the BRT. The level of service frequency must be catered to match the demands of the market.

- ***Station Spacing –*** Station spacing is an important element of a good BRT system because fewer stations typically means reduced dwell time delays and faster service. Station spacing becomes especially important in lower density areas where higher speeds can be maintained and travel time reduced.

- ***Schedule Control –*** BRT typically utilizes a headway-based schedule control. This allows operators to travel at maximum speeds while maintaining adequate headway to avoid vehicle bunching; however this method requires more complex coordination between vehicle locations than a schedule-based control which is typically used for standard bus service.

2.3.7 System Identity and Image

Distinctive logos, colors, styling, and vehicle and facility technologies tie all of the various physical and service elements of BRT systems together to establish a system identity and image. Creating a quality system identity and image helps build a strong reputation for a BRT system. The following figures provide examples of what peer transit systems have done to create a positive image for their BRT lines.

Figure 2.6: Las Vegas MAX, BRT Interior

Figure 2.7: Eugene Pioneer EmX, BRT Station

Figure 2.8: Roaring Fork VelociRFTA, BRT Logo

3.0 STAKEHOLDER PARTICIPATION

Because of the regional nature of this study the project team coordinated efforts with key stakeholders, including various communities and agencies impacted by the project. The purpose of this effort was to understand the transportation plans, needs and objectives of the various stakeholders and provide a technical analysis that fits this framework. This section presents the key stakeholders that were identified during the scoping stages of the project and involved in the development of the study. This section also summarizes the stakeholder coordination efforts undertaken for the study as well as insights gained from stakeholder and public participation.

3.1 Project Jurisdiction

Current fixed route transit service in Washington County is limited to the municipal boundaries of the City of St. George. The transit corridors considered in this study cross a number of jurisdictions and thus require partnership and coordination between multiple jurisdictions impacted by the project, including the following jurisdictions:

- Washington County
- City of St. George
- Washington City
- Hurricane City
- SunTran
- Dixie MPO/Five County Association of Governments (AOG)
- Utah Department of Transportation (UDOT)

Other regional jurisdictions not directly crossed by the transit corridors that were also involved in this process included Ivins City and Santa Clara City. Coordination with and involvement of these jurisdictions was achieved through Dixie MPO.

3.2 Stakeholder Participation

A major contributor to the transportation planning efforts in Washington County is the Dixie MPO, comprised of three functioning bodies: 1) staff of the Office of the MPO, the Transportation Planning Office (TPO), and Five County AOG; 2) staff from the cities of Ivins, Santa Clara, St. George and Washington, and from UDOT and Washington County which form the Dixie Transportation Advisory Committee (DTAC), and 3) elected and or appointed officials from the same governmental entities which form the policy body of the MPO, the Dixie Transportation Executive Council (DTEC). With support from the MPO staff, the DTAC identifies long range needs, and plans and projects solutions to meet those needs, which it then recommends to the DTEC for adoption. The DTAC provided oversight and direction for this study and provided a single, formal setting for the project team to coordinate efforts with key project stakeholders. Table 3.1 provides a list of the DTAC members that were involved in the study and the agencies that they represented.

Table 3.1: Dixie Transportation Advisory Committee

DTAC Member	Agency
Voting Members	
Dave Glenn	Ivins City
Jack Taylor	Santa Clara
Larry Bulloch	City of St. George
Mike Shaw	Washington City
Cameron Cutler	City of St. George
David J. Demas	City of St. George
Rick Torgerson	UDOT
Todd Edwards	Washington County
Non-Voting Members	
Kelly Lund	FHWA
Ryan Marshall	SunTran
Elden Bingham	UDOT
Arthur LeBaron	Hurricane City
Dana Meier	UDOT

Source: Dixie MPO website

SunTran is currently the primary transit service provider in Washington County. SunTran is managed and operated by the City of St. George under the oversight of the city's Public Works Department. Because the Director of SunTran (Ryan Marshall) is not currently a voting member of the DTAC and is not regularly involved in their meetings, the project team made additional efforts to involve the participation of SunTran. These efforts included requests for transit data, coordination through meetings, and opportunities for the Director of SunTran to participate in project meetings, reports and updates with the DTAC.

3.3 Public Participation

The project team attended the Dixie Transportation Expo in February 2010 to present this feasibility study to the public. The Expo is an annual event held in February in St. George to present to the public the transportation projects and plans for Washington County.

Although the scope of this study did not include specific outreach to the general public, the Dixie Transportation Expo provided an effective opportunity to introduce the study and gather public responses to the rapid transit concept. The rapid transit service study was presented to the public using display boards and maps. Public responses and comments were collected using questionnaires. An illustration of the boards and the questionnaire form used at the Expo are presented in Appendix B.

The objectives for attending the Dixie Transportation Expo and seeking public feedback included the following:

- Gauge the current pulse of the community regarding transit, how it's working, and how it could be improved.
- Introduce the concept of BRT and ask the public for their opinion about its application in Washington County.
- Introduce the rapid transit corridors being studied and ask the public for feedback.

A total of 79 individuals responded to the questionnaire. A summary of the responses are presented in Appendix B. Key findings from the responses include the following:

- The majority of respondents said it would be "Very Important" ("5" on a scale of 1 to 5) to expand transit service to the New Airport (73% of respondents) and to Hurricane/Washington (60% of respondents).
- The majority of the respondents (61%) would walk ¼ to ½ miles to ride BRT.

- Nine percent (9%) of the respondents use the current transit system. The main reason for not riding transit, as reported by the remaining respondents, was limited transit service.

- Twenty-three percent (23%) of respondents expressed concerns about the BRT system. The main concern expressed was the cost, primarily in terms of tax increases.

4.0 DIXIE AREA PLANNING CONTEXT

The development of a future rapid transit system that meets the unique context of Washington County requires a reliable estimate of future growth and demographic information. It also requires a clear understanding of the existing transit market. This section presents the demographic forecasts and existing transit service conditions that were reviewed to establish the transit market anticipated for the year 2035 planning horizon and to develop and evaluate possible rapid transit service alternatives.

4.1 Socioeconomic Characteristics

Washington County has experienced significant growth over the past several decades that is expected to continue in the future. While some of this growth will occur as infill development in downtown St. George, Washington, and Hurricane, much of the growth will be on the fringe of the current urbanized area, especially along SR-9, near Hurricane, and near the new airport site located on the southeast quadrant of St. George. This continued growth will add congestion and increase the need for transit service.

Population and employment information for Washington County for transportation planning purposes are maintained by the Dixie MPO. The Dixie MPO uses population and employment projections to forecast, through its regional travel demand model, traffic conditions for Long-Range as well as interim scenarios (i.e. Short-Range and Mid-Range scenarios).

Population and employment are two major determinants of transit ridership and are therefore helpful in understanding potential markets for public transit service. Figure 4.1 and Figure 4.2 illustrate the changes in population expected between existing conditions (the travel demand model base year) and long-range planning conditions for the year 2035. Similar figures, illustrating the expected employment growth, are included in Appendix C. More detailed population and employment data are presented later in this report. These figures indicate that Washington County is expected to experience significant growth in the next 25 years. These socioeconomic trends along with corresponding demand growth for transportation infrastructure illustrate the potential future need for rapid transit service in Washington County.

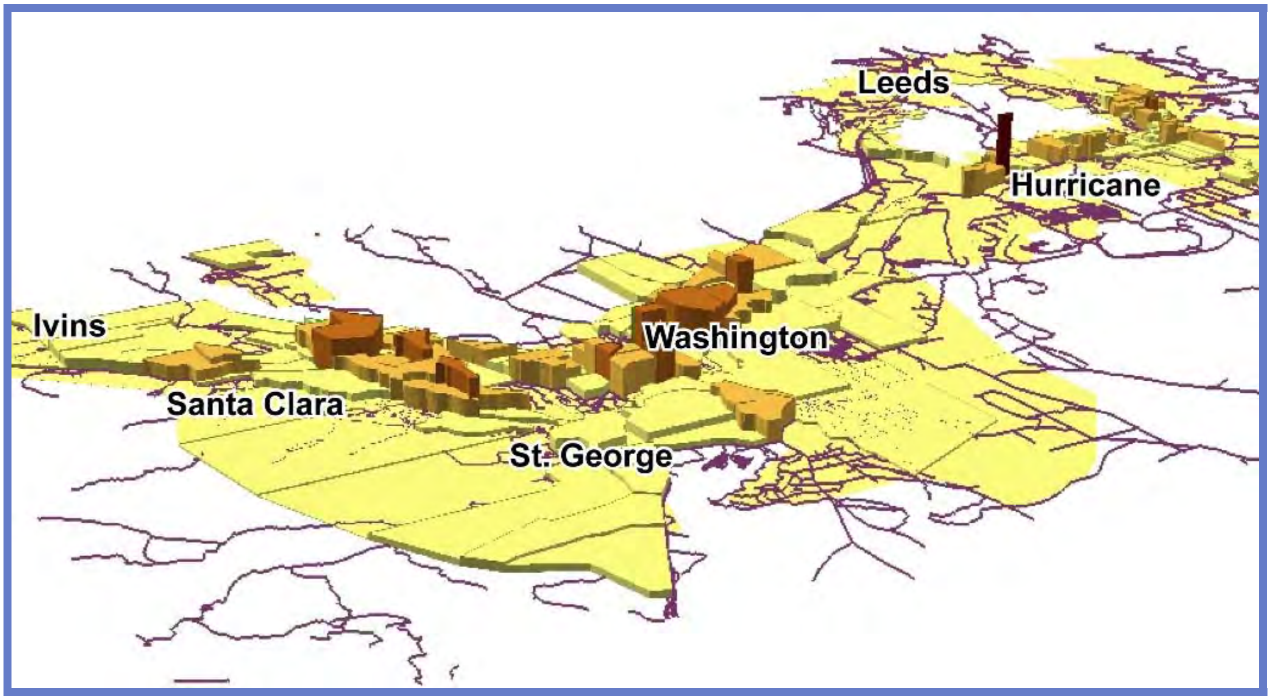

Figure 4.1: 2007 Population Densities

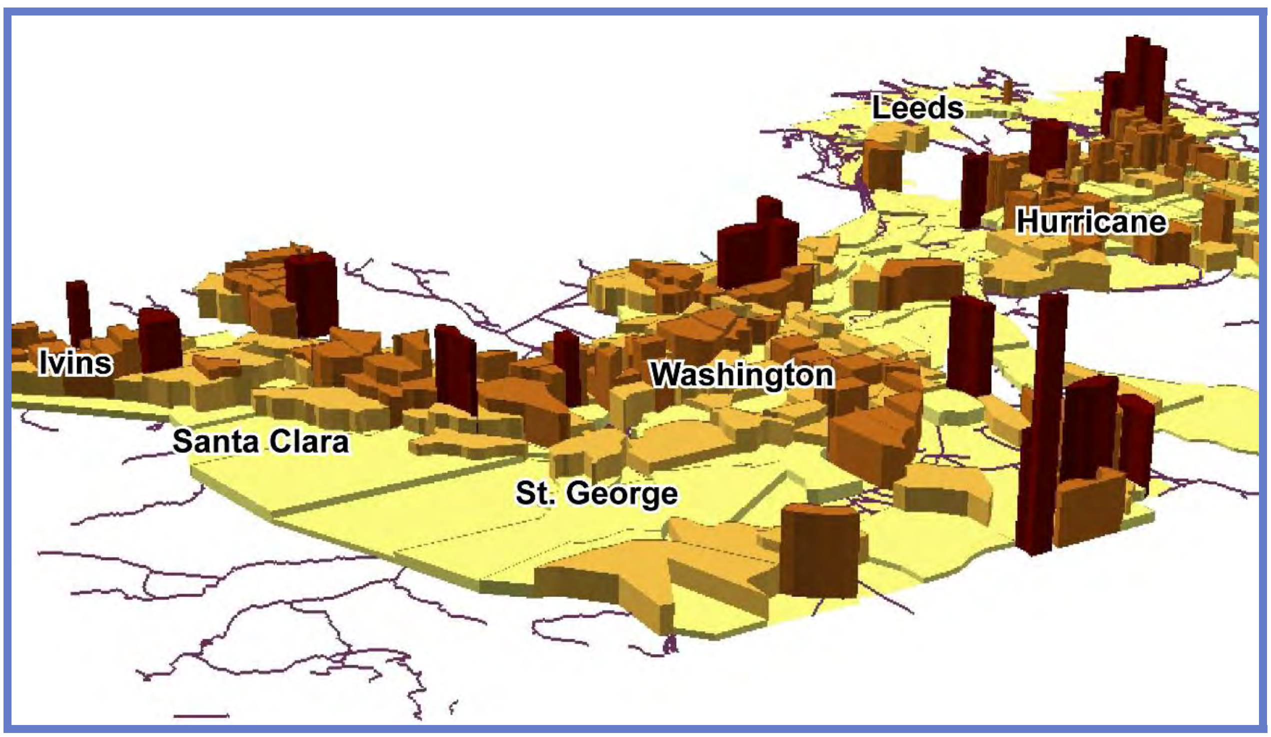

Figure 4.2: 2035 Population Density Forecasts

The analysis performed for this study was based on demographic and trip data obtained from the Dixie MPO regional travel demand model. The data used reflects the latest revision of the model which was updated by the Dixie MPO and released November 30, 2009. The population and employment inputs used by the travel model reflect the location, type, and level of growth anticipated by local and state agencies. However, these projections are subject to land use policy changes, which along with changes to development trends can impact transit ridership. For example, if a BRT system is developed as an efficient strategy to support growth, current land use and development policies can be amended to distribute more growth into the transit corridor, which would in-turn increase the pool of transit users for the BRT system. It should be noted that although land use changes could impact transit ridership forecasts, the evaluation of such changes was outside the scope of this study. The analysis performed for this study was based on data available from the Dixie MPO regional travel demand model.

The timing for the conditions forecasted by the regional travel demand model is also subject to volatility in economic and development trends. This volatility might impact the year in which forecasts are actualized. As such, the interim year conditions forecasted by the regional travel demand model for 2015 and 2025 are referred to in this study as “Short-Range” and “Mid-Range” conditions, respectively. Conditions forecasted for the year 2035 are referred to in this study as “2035” or “Long-Range” conditions. This nomenclature was used to emphasize possible phasing opportunities for rapid transit service without placing undo focus of the date of the Short-Range and Mid-Range forecasts. The socioeconomic forecasts, instead of dates, can therefore be used to evaluate interim conditions and phasing opportunities for BRT service.

4.2 Existing Transit Service

SunTran provides transit service for the City of St. George and currently operates fixed bus routes and paratransit (ADA) service between 6:00 AM and 8:00 PM Monday through Friday and from 8:00 AM to 6:00 PM on Saturday. There is no service on Sundays or major holidays. The system consists of four fixed bus routes currently carrying a total of 320,000 passengers per year. SunTran has experienced significant growth, including 35 percent annual growth since 2003. The existing routes operate on 40-minute headways and provide transit service to downtown St. George, Red Cliffs Mall, Dixie State College, the Dixie Center, and several other commercial and residential areas within the St. George city limits. Figure 4.3 shows the four existing fixed SunTran routes; all of which currently begin and end at the Dixie State College Transit Center located at 100 South and 1000 East in St. George.

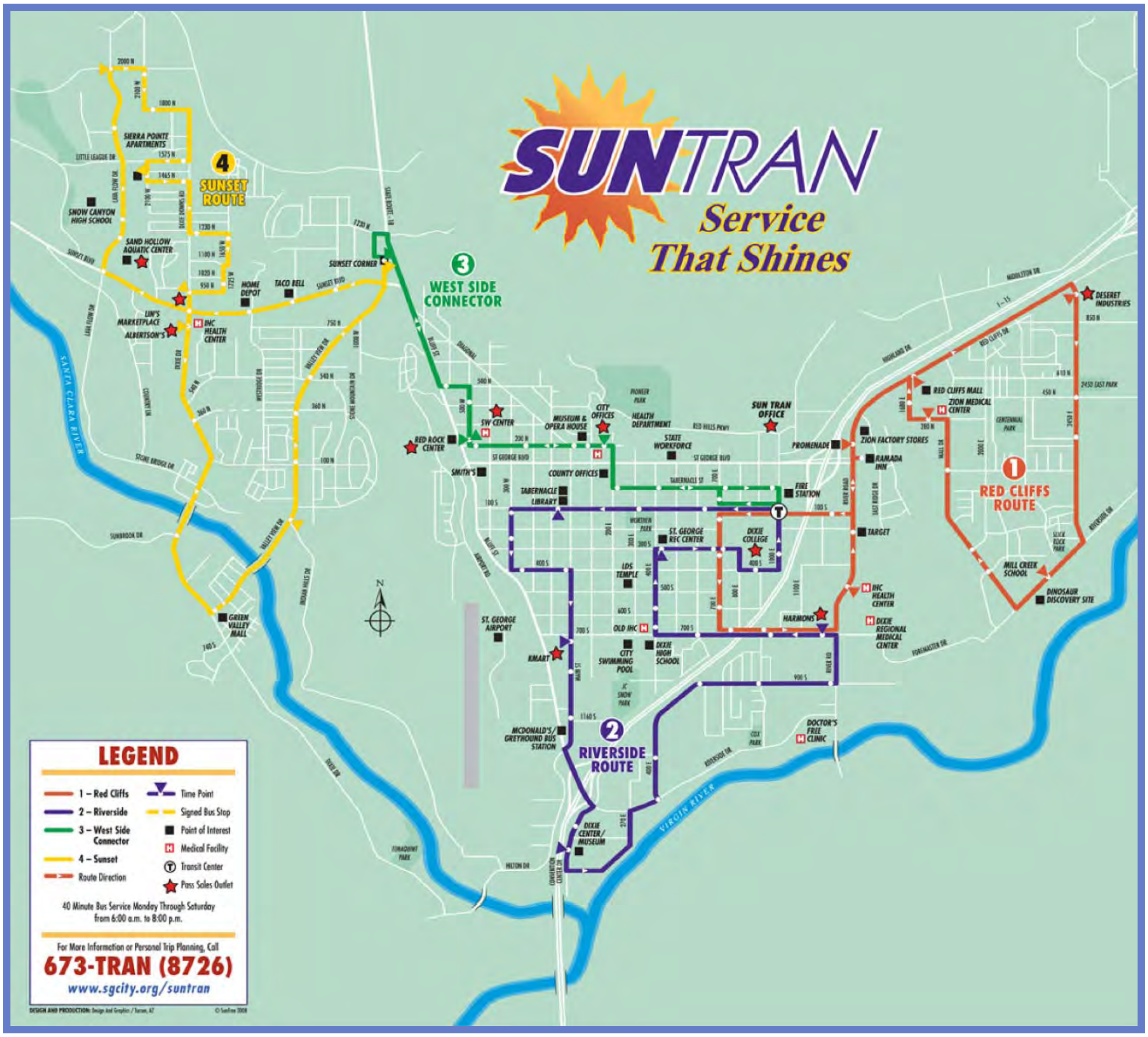

Figure 4.3: Existing SunTran Route Map

Table 4.1 presents existing daily transit ridership for the four fixed routes as well as corresponding population and person trips for the areas which are currently being served by transit. Ridership statistics are for the 2008-2009 SunTran fiscal year. The population and trip data were taken from the Dixie MPO regional travel demand model base year for Traffic Analysis Zones (TAZ) served by the existing SunTran system. TAZs or portions of TAZs were considered served by transit when they were within a ¼ mile walking distance of any of the existing fixed bus routes. Table 4.1 also summarizes mode split estimates for the existing SunTran system. Mode split describes the share of total person trips captured by different traveling mode choices (i.e., vehicle, transit, bike, walk). Transit mode splits for the existing transit system were estimated by dividing daily transit ridership by the total number of person trips estimated for the travel demand model base year (existing) conditions.

Table 4.1: Existing Transit Ridership and Mode Split

	Daily Transit Ridership	Population	Person Trips [1]	Transit Mode Split
Route 1	270	7,717	16,475	1.6%
Route 2	232	7,109	22,881	1.0%
Route 3	342	2,677	8,070	4.1%
Route 4	341	11,388	10,430	3.2%

[1] Dixie MPO Travel Demand Model vehicle trips converted to person trips based on vehicle occupancy of 1.42

The *St. George Urbanized Area Short and Long Range Transit Plan,* dated August 2006, reported annual operating costs that were made up of approximately 30 percent fixed costs and 70 percent variable costs. As reported by SunTran for the 2008-2009 fiscal year, operating costs totaled $961,813 for both fixed route and paratransit (ADA) service. Total hours of operation for this period totaled 24,460. The average cost per hour of operation was approximately $39. The total hours of operation for fixed routes alone were 17,750. The fixed route fare box recovery rate for 2008-2009 fiscal year was 13.8 percent. During this time the fare box recovery rate for the entire transit system, including paratransit service, was 11.0 percent.

4.3 Previous Findings

As mentioned in Chapter 1, several transportation planning studies have been recently completed for the St. George area. To establish a clear understanding of the planning context for the project, this study included a review of transportation and transit reports completed for the region. The literature reviewed as part of this study was identified with input from the Dixie MPO and SunTran to ensure an adequate understanding of the planning context for transit service in Washington County. The following literature was reviewed:

- Dixie MPO Coordinated Transportation Implementation Tool, Aug. 2009
- SunTran Washington Bus Expansion Proposal, June 2009
- St. George Transportation Master Plan, Feb. 2009
- UDOT Eastern Washington County Transportation Study Report, Dec. 2008
- Dixie MPO Model Validation Report, Nov. 2008

- St. George Access Management Policy, Mar. 2008
- UDOT SR-9 Corridor Preservation Agreement, July 2007
- Dixie MPO Regional Transportation Plan, May 2007
- Vision Dixie 2035: Land Use and Transportation Vision Report, Jan. 2007
- St. George Urbanized Area Short Range and Long Range Transit Plan, Aug. 2006
- UDOT Bluff Street Corridor Study, Apr. 2006
- Washington City Transportation Master Plan, Dec. 2005
- Hurricane Transportation Master Plan, Oct. 2004
- Dixie MPO Interim Long Range Plan, June 2004

5.0 ALTERNATIVES DEVELOPMENT

The focus of this study was to evaluate the long range feasibility for rapid transit service extending from downtown St. George to Washington and Hurricane (Hurricane line) and from Downtown St. George to the new airport site located in the southeast quadrant of St. George (Airport line). An understanding of the Dixie Area planning context allowed further development of these alternatives. This section introduces the corridor alignment alternatives, transit service investment alternatives, and evaluation criteria considered as part of the study.

5.1 Corridor Alternatives

This section defines the alignments considered in this study. The Hurricane and Airport alignments are presented separately and then together as a combined BRT system.

5.1.1 Hurricane Line

The intent of the Hurricane line is to provide rapid transit service that extends beyond the boundaries of the City of St. George and into Washington City and Hurricane City. The *2030 Regional Transportation Plan* defined a Hurricane BRT route to extend from the intersection of St. George Boulevard and Bluff Street in the City of St. George to River Road, then north along Red Cliffs Drive and Telegraph Road to SR-9, then east along SR-9 to Main Street in Hurricane City.

Although Red Cliffs Drive, Telegraph Road, and SR-9 represent the only practical alignment that serves the transit needs of this corridor, several alignment alternatives are available for east/west travel through downtown St. George. Those alternative alignments were considered as part of this study and included St. George Boulevard, Tabernacle Street, 100 South, and 700 South. The study team evaluated these alternatives in coordination with stakeholders, including SunTran, and determined 100 South to be the most suitable corridor. Figure 5.1 shows the Hurricane line alignment that was selected and evaluated as part of this study.

The study selected 100 South for east/west travel through downtown St. George because it provides access through (under) I-15 to River Road and Red Cliffs Drive. The 100 South alignment has more available capacity than the other alternatives, and provides convenient, central access to significant transit market areas, which include the businesses and other transit trip generators located along St. George Boulevard, which is within one quarter mile walking distance of the 100 South corridor. It should be noted that although this study recommends the use of 100 South, the analysis performed could be applied to the other alternate alignments if they are deemed more suitable as additional data becomes available.

To facilitate the evaluation of the Hurricane line, this corridor was divided into three roadway segments. Figure 5.1 defines each of these segments. Segment 1 extends from approximately 100 South and Bluff Street to Red Cliffs Drive and Mall Drive in St. George. Segment 2 extends from Red Cliffs Drive and Mall Drive in St. George to 1100 East and Telegraph Road in Washington City. Segment 3 extends from 1100 East and Telegraph Road in Washington City to Main Street in Hurricane City.

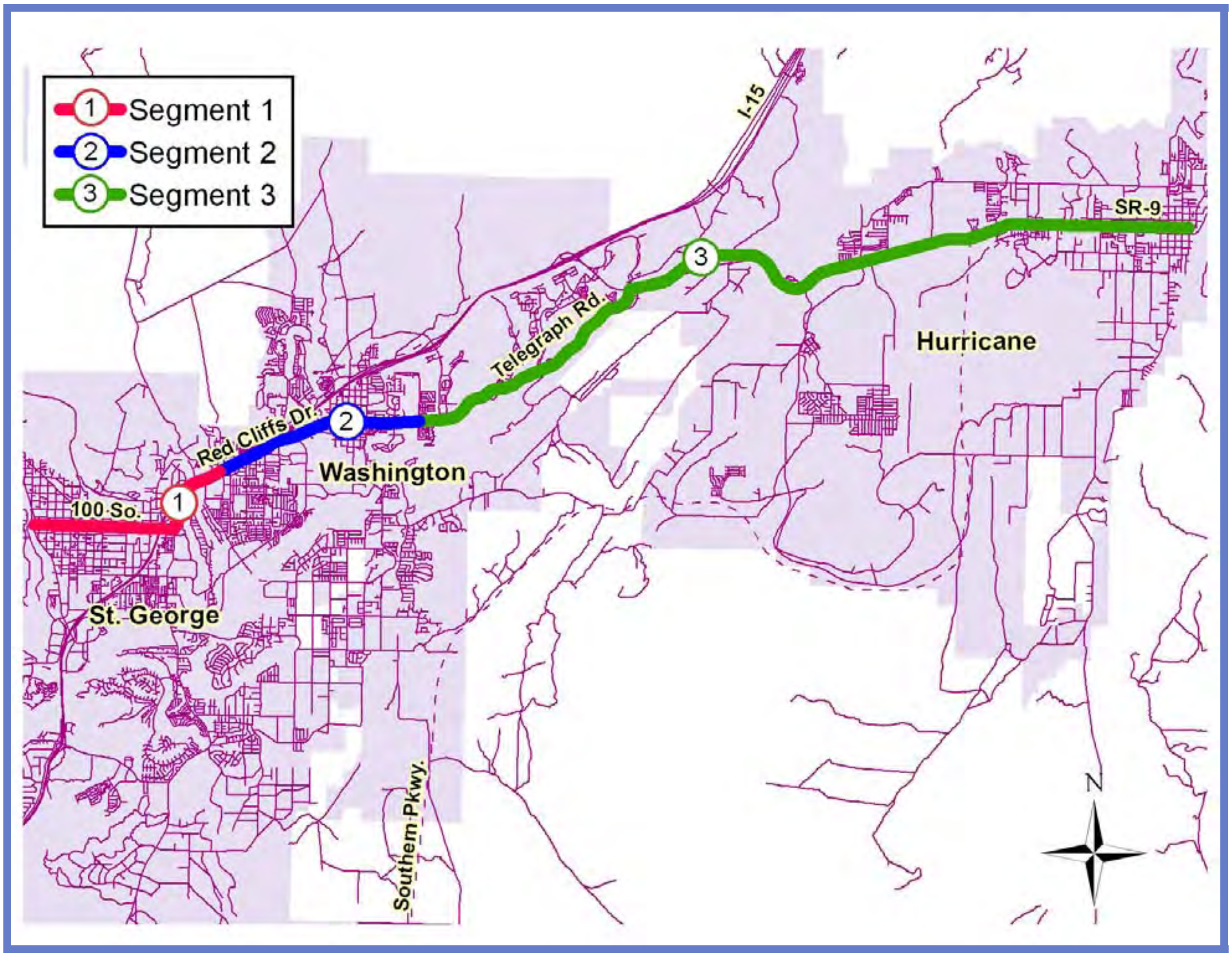

Figure 5.1: Hurricane Line Alignment

5.1.2 Airport Line

The intent of the Airport line is to provide rapid transit service from downtown St. George to the new airport, which is located in the southeast quadrant of St. George and is scheduled to open January 2011. There are various alignments that could be considered to provide BRT service to the airport. The Airport line alignment used in this study was defined during the study scoping process by the City of St. George stakeholders. This alignment connects with the Hurricane line at the intersection of Mall Drive and Red Cliffs Drive and travels south along Mall Drive, across the future Mall Drive bridge, then south along 3000 East to the Southern Parkway and St. George Airport. To facilitate the evaluation and discussion of the Airport line, this segment was defined as Segment 4. As illustrated in Figure 5.2, the Airport line consists of Segment 1 and Segment 4.

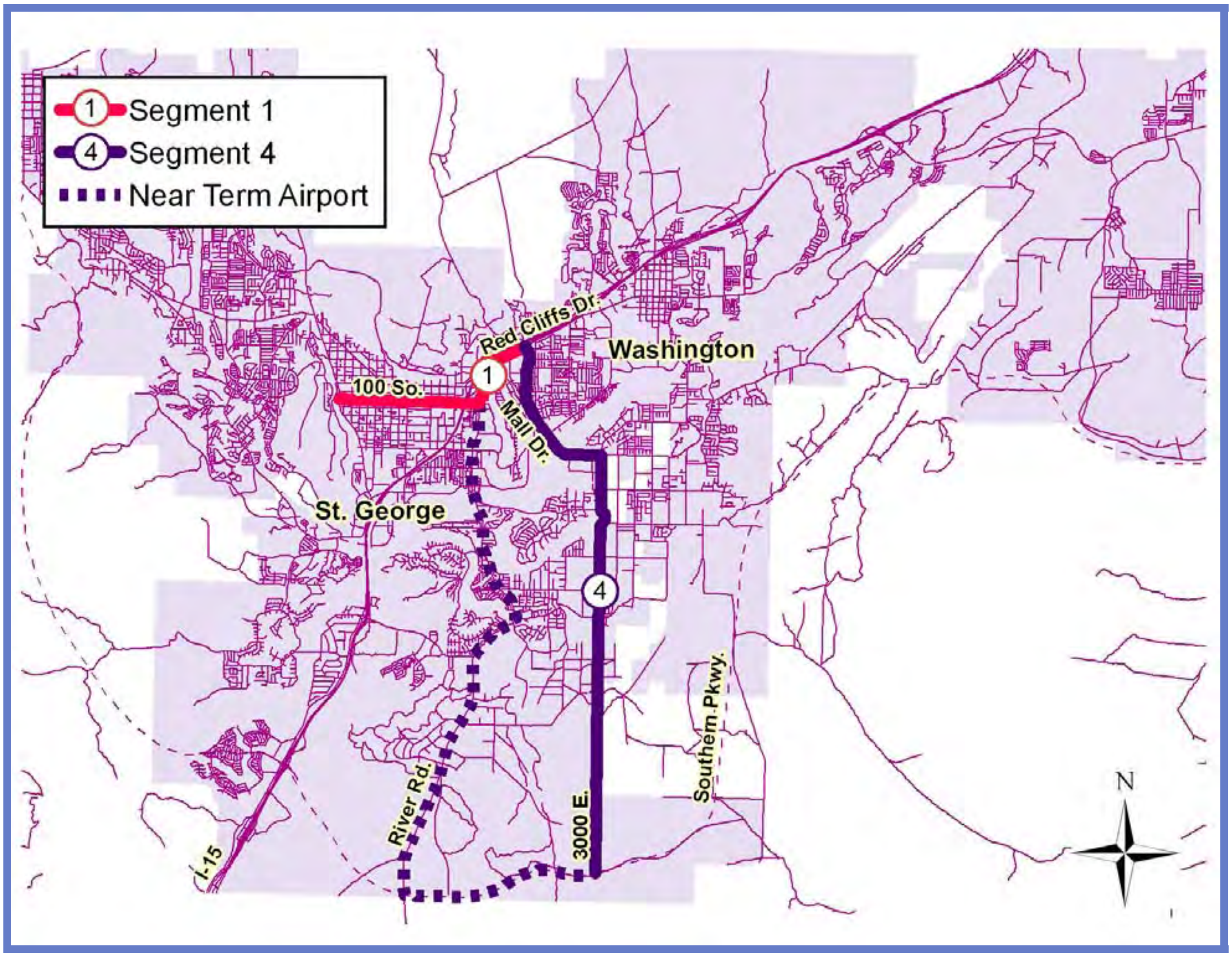

Figure 5.2: Airport Line Alignment

The project team, in coordination with SunTran, identified a near-term alignment as a potential alternative to provide interim transit service from downtown St. George to the new airport. This near term alignment is also illustrated in Figure 5.2 and runs from 100

South to River Road and then along River Road to the Southern Parkway and the new airport. This alignment was selected because it runs through an area that is already developed and provides transit access to residents and businesses along the corridor as compared to an alignment along I-15 which would provide faster service, but limited access points for transit riders. It should be noted that this near-term alignment was not identified for BRT service, but rather as a possible interim expansion of the existing SunTran bus service until the implementation of the Airport BRT line, specifically Segment 4, becomes feasible.

5.1.3 Combined Hurricane and Airport Line

To determine the feasibility of each of the proposed BRT corridors based on their own merits, the Hurricane and Airport lines were evaluated as standalone projects. If both lines are implemented, the performance and benefits of the combined system is expected to be greater than the sum of its parts. As such, this study presents a combined system alternative in addition to the standalone alternatives for the Hurricane and Airport lines.

5.1.4 Potential Future Corridor Alternatives

Other major corridors in the Washington County urban and urbanizing area could provide potentially feasible alternatives or additional service options for rapid transit service. Although the scope of this study did not include an evaluation of additional transit corridors, the project team worked with stakeholders to identify possible future corridors. These corridors should be considered in future long-range transit planning efforts as possible routes for transit or rapid transit service. The additional transit corridors identified are illustrated in Figure 5.3 and include the following:

- St. George Airport to Hurricane (via SR-7/Southern Parkway)
- Santa Clara/Ivins to the new St. George Airport site (via Jacob Hamblin/Western Parkway)
- Santa Clara/Ivins to downtown St. George (via Snow Canyon Parkway)
- Santa Clara/Ivins to downtown St. George (via Sunset Boulevard)

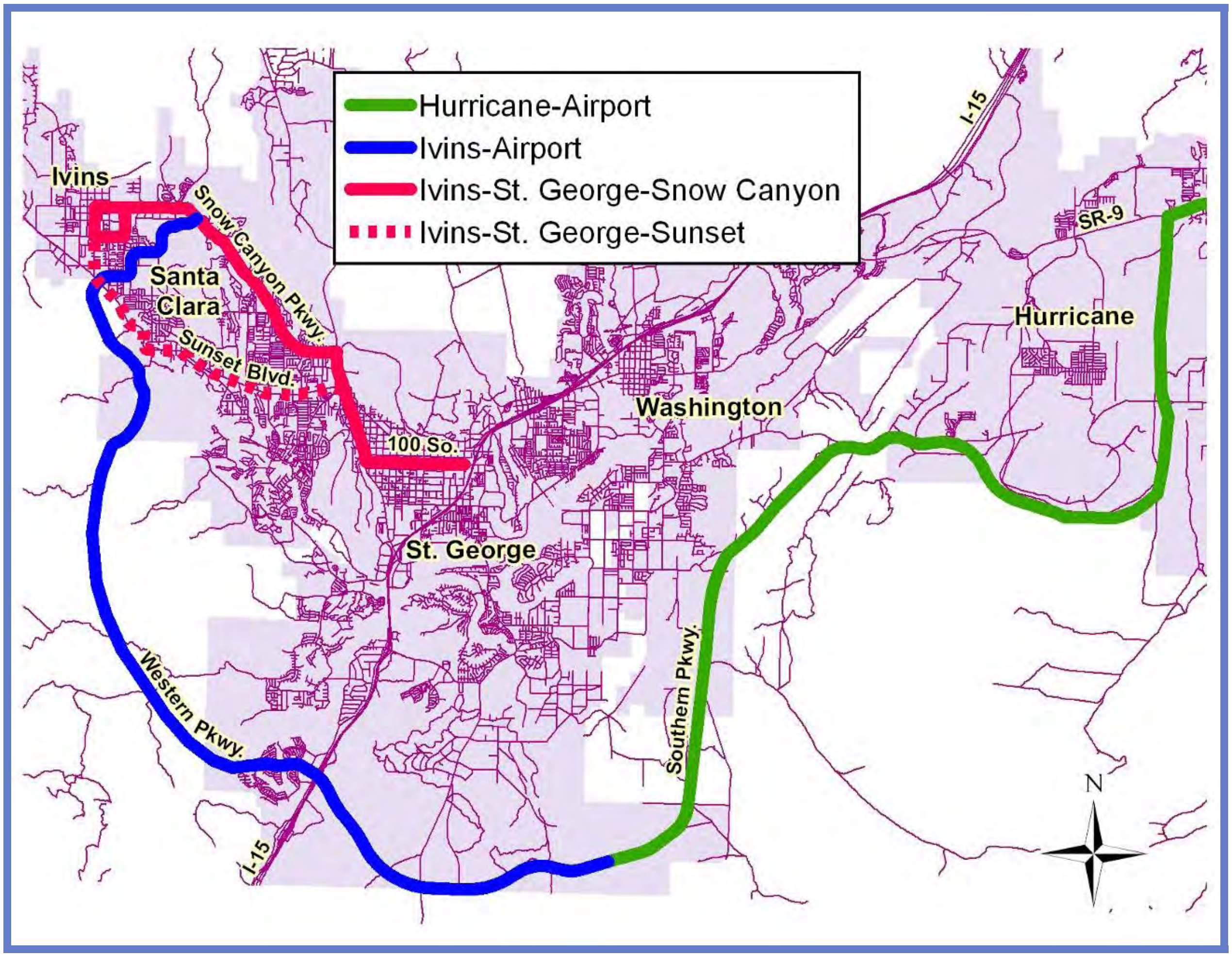

Figure 5.3: Potential Future Corridors

5.2 Service Investment Alternatives

This study defines four levels of transit service investment and considers their applicability to the Hurricane and Airport lines. These tier or investment alternatives were not meant to be restrictive. Instead, the alternatives were intended to show how varying levels of investment can impact capital and operating costs, ridership, and the feasibility for phasing and implementation of a BRT system for the proposed transit service expansion.

5.2.1 Expanded Bus Service

This level of service investment could include an expansion of the existing SunTran bus service into Washington City, Hurricane City and the new airport site. This service could include service ranging from commuting routes operating during peak morning and evening demand periods to all day bus service with headways of 20-60 minutes. This level of system investment was considered for phasing opportunities, so it was not analyzed in detail.

5.2.2 Basic BRT Service

This level of service investment is sometimes referred to as BRT "lite" and is considered a minimum investment to achieve the benefits of BRT. This alternative could include:

- Substantial transit stations or shelters. These are generally larger than standard bus shelters and usually designed to contribute to the "branding" of the line.
- Low-floor vehicles and level boarding to minimize the amount of dwell time at stops by facilitating passenger entry into the vehicle, with particular benefit for passengers with special needs such as wheelchairs or walkers.
- Branded vehicles and stations providing a unique identity for BRT service to allow casual transit users to identify the system easily.
- High frequency service (15 minute or shorter) to allow patrons to arrive randomly without having to consult a schedule.
- Mixed flow running ways (the BRT vehicles operate in mixed flow within general traffic lanes).
- Traffic signal priority and signal coordination for improved travel times.
- Queue jump lanes as needed to allow BRT vehicles to bypass traffic queues at congested intersections.

5.2.3 Moderate BRT Service

This level of service investment focuses on incremental improvements to both right-of-way for vehicles and passenger amenities at stations. This alternative could include:

- Larger stations to accommodate more passengers with additional seating and amenities such as bicycle parking.

- Enhanced station investment such as landscaping, special paving, or way-finding signage.
- Off-board fare collection to allow passenger to enter and exit through any door, consequently reducing time at stations/stops.
- Real time arrival information system (e.g. Next bus technology)
- Dedicated side-running lanes for BRT vehicles as needed to minimize the amount of time BRT vehicles are delayed by general traffic.
- Higher frequency (10 minute) peak service with higher capacity vehicles.

5.2.4 Full BRT Service

This level of service investment takes into consideration a full light-rail concept but with rubber tired vehicles. This alternative could include:

- Major station investment to accommodate large pedestrian traffic and passenger loads.
- More amenities for passengers, such as information kiosks, newspaper racks, wireless access, or other amenities not common to bus transit.
- At-grade median running in dedicated lanes that are horizontally separated from general traffic conditions.
- Full signal priority at intersections to maintain a minimum operating speed.

5.2.5 Other Service Investment Alternatives

The service investment alternatives discussed above are not the only options for transit service for the Hurricane and Airport lines, but provide points of reference in the wide range of possible BRT systems that can be implemented and improved upon over time. The advantage of implementing a BRT system is the ability to phase the investment and transition from a “low” to a “higher” BRT system. However, for implementation of the “Basic” or higher BRT service, it is important that the system features avoid the resemblance of an ordinary bus service.

5.3 Feasibility Criteria

To determine the viability of a BRT system for the Hurricane and Airport lines, the study considered market, system and corridor conditions for the project. This section discusses some of the key evaluation criteria used to determine the feasibility of the alternatives developed.

5.3.1 Market Requirements

BRT works best in areas with concentrated population, employment and commercial centers, where transit is easily accessible. The study evaluated the market conditions and estimated ridership forecasts using land use and trip generation forecasts from the regional travel demand model.

For purposes of this study, the travel market for Washington County was defined to be made up of the three primary types of trip makers, including the following:

- "Auto captive" – these trip makers do not have access to transit use or have no inclination to use public transit.
- "Transit captive" – these trip makers do not have access to a car and have no choice but to use public transit.
- "Choice rider" – these trip makers would use transit under the "right" conditions.

Currently most transit users in Washington County are "transit captives." A primary purpose of BRT (and measure of a successful BRT) is to attract "choice riders" with an improved product. Attraction of more "choice riders" requires provision of a better transit product, better pricing, disincentives to car use, or some combination of these measures.

5.3.2 Transit System Requirements

BRT requires an area-wide transit system with good coverage and service frequency. The overall transit system must be significant enough to feed and support the BRT system. As such, each BRT line should not be more than 10-20 percent of the total system operating costs.

5.3.3 Corridor Specific Requirements

Roadway congestion typically drives the need for running way requirements. Congested corridors require prioritization of BRT through the use of exclusive bus lanes, intersection prioritization, etc, to ensure rapid and reliable transit service. Roadway segments with a Level of Service (LOS) of D through F generally require exclusive running ways in order to meet the operational requirements of a BRT, while segments operating at LOS C may not require exclusive BRT running ways and could benefit from less costly alternatives such as queue jump lanes and signal prioritization improvements. Segments operating at higher levels of service (LOS A and B) could also benefit from queue jump lanes and intersection improvements when intersection LOS for peak periods is D or worse.

Phasing can be utilized to build toward BRT service by initially providing bus transit system for the corridor with continually improving service features (headways, stops, fare collection, etc). FTA requires service providers to prove the “need” of the BRT through ridership numbers for the corridor. The typical threshold for a BRT line is 3,000 daily riders. Although this threshold does not have to be reached before the implementation of BRT, some level of actual corridor ridership will need to be presented to FTA to demonstrate BRT as a viable transit service. Therefore, phasing-in transit service for the BRT corridor will be needed to establish and prove to FTA that corridor specific ridership requirements will be met.

5.3.4 Peer System Comparison

Comparable BRT projects provide valuable insight into what feasible BRT systems look like. The BRT projects summarized in the following tables have characteristics that are applicable to the Washington County area. Table 5.1 summarizes the characteristics for overall transit systems (including local and feeder bus service) for agencies/entities currently operating or with plans to operate BRT service in the near future. Table 5.2 summarizes the elements and characteristics of the individual BRT systems. Table 5.3 summarizes the performance measures for the BRT systems. These performance measures can be compared to the Hurricane and Airport line measures presented later in this report to determine the viability of the proposed BRT lines compared to peer systems.

Table 5.1: Peer BRT Comparison – Overall Transit System Characteristics

System Location (System Name)	Region or City Population	Transit System	Operating Budget (millions)	BRT Project Status
Eugene (EmX)	224,049	Lane Transit	$35.5	Operating
Salt Lake City (3500 S. MAX)	887,600	Utah Transit Authority	$108.5	Operating
Aspen (VelociRFTA)	n/a	RFTA	n/a	Design
Mesa (Link)	460,000	Valley Metro	n/a	Operating
Stockton (Metro Express)	313,392	San Joaquin RTD	$34.7	Design
Livermore (RT 10 BRT)	552,624	LAVTA	$14.5	Construction
Fort Collins (Mason MAX)	206,757	Transfort	$8.5	Design
Flagstaff (Mt Links BRT)	124,953	NAIPTA (Mt.Line)	$5.7	Design

Table 5.2: Peer BRT Comparison – BRT System Characteristics

System Location (System Name)	Total Length (miles)	Exclusive Lanes (miles)	Station Spacing (miles)	Vehicle	Service Frequency (peak)	Signal Priority; Method of Detection	Capital Cost (millions)
Eugene (EmX)	4.0	2.7	0.50	60' Flyer BRT Hybrid	10	Yes; GPS	$23.50
Salt Lake City (3500 S. MAX)	10.0	1	0.67	40' Van Hool	15	Yes; Bus Emitters	$15.00
Aspen (VelociRFTA)	38.8	15	4.30	40' Gillig BRT	10	Yes; Bus Emitters	$44.00
Mesa (Link)	12.0	0	0.80	65' New Flyer	15	Yes	$32.00
Stockton (Metro Express)	7.2	0	0.50	TBD	10	Yes	$9.70
Livermore (RT 10 BRT)	12.0	0	0.35	Diesel-Hybrid	10	Yes	$21.70
Fort Collins (Mason MAX)	5.0	3.8	0.36	TBD	10	Yes	$82.00
Flagstaff (Mt Links BRT)	5.8	1.3	0.24	Diesel-Hybrid	10	Yes	$10.40

Table 5.3: Peer BRT Comparison – BRT System Performance Measures

System Location (System Name)	Daily Riders	Riders per Mile	Travel Time Reduction	Capital Cost per Mile (millions)	Annual Operating Cost (millions)	Annual Op. Cost (mil) Per Rider
Eugene (Pioneer EmX)	5,220	1,305	-	$5.88	$1.84	$1.15
Salt Lake City (3500 S. MAX)	4,100	410	38%	$1.50	-	-
Aspen (VelociRFTA)	3,700	95	-	$1.13	$5.17	$4.58
Mesa (Link)	1,200	100	-	$2.67	$1.38	$3.77
Stockton (Metro Express)	4,000	556	-	$1.35	-	-
Livermore (RT 10 BRT)	4,500	375	36%	$1.81	$1.24	$0.90
Fort Collins (Mason MAX)	3,900	780	-	$16.40	$1.62	$1.36
Flagstaff (Mt Links BRT)	4,150	716	-	$1.79	$0.79	$0.62

6.0 RIDERSHIP FORECASTS

Ridership forecasting is an essential task in determining the feasibility of a BRT system. Forecasts were used to size system features, develop service plans, estimate system costs, and determine implementation and phasing strategies. This section presents the methodology and results for ridership forecasts completed for the study. Ridership forecasts presented here consider the Hurricane and Airport lines as both stand alone and combined systems.

6.1 Methodology

Ridership projections for the Hurricane and Airport lines were estimated for Short-Range, Mid-Range, and Long-Range socioeconomic conditions. As presented in Section 4.1, the Dixie MPO regional travel demand model provides socioeconomic land use projections for the Washington County urban and urbanizing areas. The model applies land use information into the traditional four-step demand estimation process (Trip Generation, Distribution, Mode Split, and Assignment) to forecast future transportation conditions. The regional travel demand model was updated and released on November 30, 2009 by the Dixie MPO for use in this study. Although past versions of the regional travel demand model included some transit considerations, they were limited and were not included as part of the updated model data provided for this study. As such, the results provided by this model were assumed (for purposes of forecasting transit ridership) to have skipped the mode split stage of the four-step process (i.e. the model assigned all trips to the personal vehicle travel mode).

Transit ridership for the BRT corridors were estimated through off-model calculations that reworked the travel demand model's mode split and assignment steps of the four-step demand estimation process. This process adapted the model's trip table (origin/destination) output to represent person trips instead of vehicle trip (assuming 1.42 persons per vehicle). Mode split and transit route assignments were then modified based on proximity to the BRT corridors and origin/destination characteristics of the trip.

To assign trips to the BRT system based on proximity and origin/destination characteristics, the project area was divided into four "Regions" (Region 1 through Region 4) that correspond to the BRT line segments described in Section 5.1 of this document (Segment 1 through Segment 4). Figure 6.1 illustrates each of these four Regions. The area covered by these four Regions is defined as the "Service" area. The service area for the Hurricane line is comprised of Regions 1, 2, and 3, while the service area for the Airport line is comprised of Regions 1 and 4.

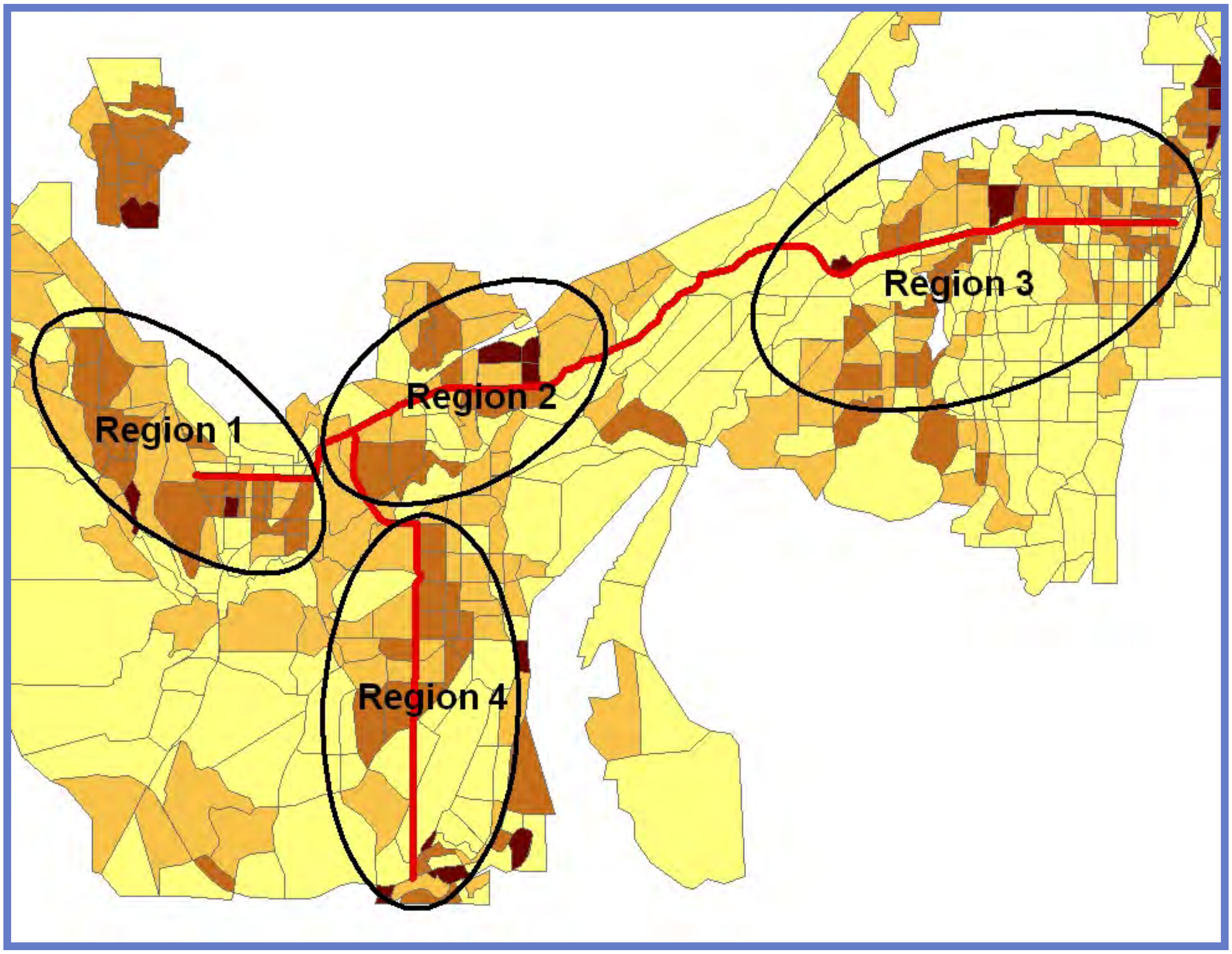

Figure 6.1: BRT Regions

Each Region was further delineated into three “Zones” based on the proximity to the study BRT lines. These zones represent different transit market segments based on corresponding levels of convenience for arriving and departing from the BRT lines. The three zones were identified as Walk, Transit, and Drive zones and defined as follows:

- **Walk Zones** were defined as areas where a trip’s origin or destination is within walking distance of a BRT line. Walking distance was defined to be ½ mile or less from a BRT line/station. It should be noted that BRT service customers are generally willing to walk longer distances than the ¼ mile walking distance typical for local bus services. Trips made to/from these zones are most convenient and include “choice rider” as well as “transit captive” market segment customers.

- **Transit Zones** were defined as areas where local bus lines could likely provide transit service in the future as part of an overall transit system. These zones include areas with high projected job and/or population densities (generally greater than 9 or 10 persons/acre) and within approximately 5 to 10 minutes (bus transit speeds) of a BRT station. Trips made within Transit Zones are not as convenient as those made within Walk Zones and include a lower number of "choice rider" market segment customers.
- **Drive Zones** were defined as areas located outside the Walk and Transit Zones, but within 10 minutes (vehicle speeds) of a BRT station. Trips made to/from these zones are the least convenient and include primarily "transit captive" market segment customers and some "choice riders" making longer/commute trips.

It should be noted that the zone names defined above were selected for convenience only and are intended to illustrate the proximity of each zone to the BRT line and stations. These names were not intended to define travel mode. Travel modes for these zones are not restricted to their corresponding zone names. BRT trips originating in the Transit Zone, for example, could begin with a bike ride to the BRT station.

The regions and zones identified above were overlaid on the regional travel demand model to allow each Traffic Analysis Zone (TAZ) to be assigned to a corresponding region and zone. Where needed, TAZs were split to meet the criteria defined above and were labeled by Zone-Region (i.e., the label "Walk-1" would be a TAZ located within a Walk Zone and in Region 1). After defining the model TAZs and grouping the corresponding trip table data, BRT ridership was estimated based on the percentage, or capture rate, of person trips traveling from one zone to another that could be expected to use the BRT service to complete the trip. Capture rates varied based on the origin and destination zone. For example, a trip originating and terminating in a Walk Zone was expected to have a higher BRT capture rate than a trip originating and/or terminating in a Transit Zone.

The capture rates used for the system are summarized in a matrix included in Appendix D. Different capture rates were used for the various service investment alternatives considered as part of this study. The capture rate assumptions for the alternatives considered are included in Appendix D.

6.2 Population and Employment Forecasts

Employment and housing data were collected from the Dixie MPO regional travel demand model and grouped by Region and Zone. Housing data was converted into population by using a factor of 2.76 persons per household (as reported in the 2000 Census for St. George, Washington and Hurricane). Table 6.1 presents the population for the Short-Range, Mid-Range, Long-Range planning conditions. Table 6.2 presents the projected number of jobs for the same time periods. It should be noted that the values presented do not encompass the entire regional travel demand model, but rather only the values for the BRT system service area.

Table 6.1: Population Projections by Region

	Acres	Population		
		Short-Range	Mid-Range	Long-Range
Region 1	29,472	146,143	171,434	217,179
Region 2	10,070	37,682	67,722	98,750
Region 3	28,691	38,750	65,084	98,055
Region 4	20,392	29,078	51,378	77,252
Total	88,625	251,653	355,617	491,236

Table 6.2: Employment Projections by Region

	Acres	Employment		
		Short-Range	Mid-Range	Long-Range
Region 1	29,472	64,382	78,362	94,738
Region 2	10,070	38,128	49,575	63,742
Region 3	28,691	21,812	33,113	43,662
Region 4	20,392	18,578	42,933	77,952
Total	88,625	142,900	203,983	280,094

Table 6.3 reports Long-Range socioeconomic forecasts for the BRT corridor (within ½ mile of a BRT line/station). Households and jobs located within the BRT corridor will generate the highest levels of transit ridership and will receive the highest level of service from the BRT system. These zones also represent areas that could benefit most from transit oriented land use policies and related development.

Table 6.3: Long-Range BRT Corridor Population and Employment Projections

"Walk" Zone	Acres	Population	Jobs
Region 1	2,312	13,449	24,498
Region 2	2,107	13,194	10,517
Region 3	3,569	19,490	12,586
Region 4	5,881	24,110	20,783
Total	**13,869**	**70,243**	**68,384**

Note: Acres, Population, and Jobs for "Walk" Zones only (Approximately ½ mile buffer along BRT Corridor)

Table 6.4 compares the future socioeconomic characteristics of the BRT corridors (within ½ mile of a BRT line/station) for Short-Range, Mid-Range, and Long-Range scenarios. As this table illustrates, significant growth is expected along the proposed BRT corridors. Even though BRT service is not currently viable, the growth expected for these corridors makes rapid transit service feasible in the future.

Table 6.4: BRT Corridor Population and Employment Growth

		Acres	Short-Range[a]	Mid-Range[a]	Long-Range[a]
Hurricane Line	Population	7,987	33,399	39,134	46,134
	Jobs		37,586	42,978	47,601
Airport Line	Population	5,881	6,741	14,654	24,110
	Jobs		2,271	9,674	20,783

Note: Population and Jobs for "Walk" Zones only (Approximately ½ mile buffer along BRT Corridor)
[a] Values are totals

6.3 Hurricane Line Forecasts

Ridership was estimated for the Short-Range, Mid-Range, and Long-Range conditions for the Hurricane line using the methods previously described. Table 6.5 and Table 6.6 present the daily and peak hour ridership forecasts for this corridor. As shown, much of the growth is expected to occur in Region 3 (Hurricane). Detailed capture rate assumptions and zone-to-zone ridership tables are presented in Appendix D. It should be noted that the ridership forecasts for Short-Range and Mid-Range conditions were based on the "Basic BRT" service investment level capture rate assumptions while the

Long-Range (2035) ridership forecasts were based on the "Moderate BRT" service investment level (see Section 5.2 for a description of service investment levels).

The ridership forecasts presented in Table 6.5 represent a BRT capture rate of 2.5 percent of the total Long-Range (2035) trips generated within the service area for the Hurricane line. BRT capture rates for Short-Range and Mid-Range forecasted conditions were estimated at 1.8 percent and 1.7 percent, respectively. The relative capture is smaller for the Mid-Range condition than for the Short-Range condition because the population and employment growth is TAZ specific and not necessarily linear across all TAZs (i.e., higher growth in Transit and Drive Zones, which have lower transit capture rates than Walk Zones, can result in overall lower capture rate than forecasted conditions with higher growth for Walk Zones).

Table 6.5: Daily Ridership Forecast – Hurricane Line

	Daily Ridership Forecast		
	Short-Range	Mid-Range	Long-Range
Region 1	1,463	1,513	2,407
Region 2	1,148	1,203	1,667
Region 3	1,357	1,764	3,183
Total Daily Ridership	3,968	4,479	7,258

Table 6.6: Peak Hour Ridership Forecast – Hurricane Line

	Peak Hour Ridership Forecast		
	Short-Range	Mid-Range	Long-Range
Region 1	170	177	275
Region 2	112	116	160
Region 3	124	161	289
Total Peak Hour Ridership	406	453	724

6.4 Airport Line Forecasts

Ridership was estimated for the Short-Range, Mid-Range, and Long-Range conditions for the Airport line using the methods previously described. Table 6.7 and Table 6.8 present the daily and peak hour ridership forecasts for this corridor. As with the Hurricane line, the ridership forecasts for the Airport line for Short-Range and Mid-Range forecasted conditions were based on the "Basic BRT" service investment level capture rate assumptions while the Long-Range (2035) ridership forecasts were based on the "Moderate BRT" service investment. Detailed capture rate assumptions and zone-to-zone ridership tables are presented in Appendix D.

The ridership forecasts presented in Table 6.7 represent a BRT capture rate of 2.0 percent of the Long-Range (2035) trips generated within the service area for the Hurricane line. BRT capture rates for Short-Range and Mid-Range forecasted conditions were estimated at 1.1 percent and 1.3 percent, respectively.

Table 6.7: Daily Ridership Forecast – Airport Line

	Daily Ridership Forecast		
	Short-Range	Mid-Range	Long-Range
Region 1	928	1,081	1,859
Region 4	419	941	2,297
Total Daily Ridership	1,347	2,022	4,157

Table 6.8: Peak Hour Ridership Forecast – Airport Line

	Peak Hour Ridership Forecast		
	Short-Range	Mid-Range	Long-Range
Region 1	99	116	192
Region 4	32	79	204
Total Peak Hour Ridership	131	195	396

The project team reviewed the socio economic assumptions and trip table data for the travel demand model TAZ that encompassed the new airport (airport TAZ) to verify that it accounted for trips generated beyond the boundaries of the model (particularly airport emplaned passengers). For the Long-Range (2035) conditions, the airport TAZ accounts for 2,700 jobs and 10,800 corresponding daily vehicle trips. Additionally, the model provides additional trips (5,400 daily vehicle trips) that were manually defined in the model to reflect the unique nature of the airport. Based on a comparison of the above stated trip generation figures and the number of emplaned passengers forecasted by the *St. George Municipal Airport Environmental Impact Statement*, dated May 2006 (117,700/yr for 2020), the analysis completed for this study assumed that the trip generation calculations of Dixie MPO regional travel demand model accounted for trips generated by emplaned passengers.

6.5 Combined BRT System

Ridership was estimated for the Short-Range, Mid-Range, and Long-Range conditions for the combined Hurricane and Airport BRT lines (combined BRT system) using the methods previously described. The combined BRT system forecasts considered expected ridership assuming the implementation of both the Hurricane and Airport lines, whereas the previous sections considered ridership forecasts assuming the implementation of only one of these BRT lines.

Table 6.9 and Table 6.10 present the daily and peak hour ridership forecasts for the combined BRT system corridors. Ridership forecast assumptions are consistent with those for the stand alone Hurricane and Airport lines; however, the combined BRT system considers additional trips captured by providing concurrent service to all of the study Regions (Region 1 through Region 4). For example, the combined BRT system provides service from the Airport (Region 4) to Hurricane (Region 3) which is not available with either of the stand alone BRT lines.

Table 6.9: Daily Ridership Forecast – Combined BRT System

	Daily Ridership Forecast		
	Short-Range	Mid-Range	Long-Range
Region 1	1,789	1,992	3,105
Region 2	1,435	1,591	2,238
Region 3	1,425	1,909	3,504
Region 4	772	1,474	3,188
Total Daily Ridership	**5,421**	**6,966**	**12,036**

Table 6.10: Peak Hour Ridership Forecast – Combined BRT System

	Peak Hour Ridership Forecast		
	Short-Range	Mid-Range	Long-Range
Region 1	213	237	359
Region 2	143	157	218
Region 3	134	180	327
Region 4	62	132	305
Total Peak Hour Ridership	**552**	**705**	**1,210**

The ridership forecasts presented in Table 6.9 represent a BRT capture rate of 2.4 percent of the Long-Range (2035) trips generated within the service area for the combined BRT system. BRT capture rates for Short-Range and Mid-Range forecasted conditions were estimated at 1.8 percent.

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7.0 PROPOSED BRT SYSTEM

This section summarizes the physical and service characteristics of a possible BRT system. The proposed system was based on year 2035 (Long-Range) forecasts. As such, this section also describes some phasing options and possible features that can be added over time.

7.1 Service Plan

A transit service plan is a key element of a BRT system. It affects a variety of system elements that ultimately impact the system's level of service and operating costs. The project team evaluated the forecasted ridership demand for the proposed BRT lines and determined that the system could support service headways of 15 minutes during peak periods and 30 minutes during off-peak periods. These service frequencies were consequently used to develop a potential service plan that was in-turn used to evaluate financial and operating characteristics of the BRT service. Separate service plans were developed for the Hurricane and Airport lines. These service plans demonstrate how the system would operate if service for only one of these alternatives was pursued. A third service plan was conceptualized for the combined Hurricane and Airport system. It is important to note that there are a variety of service plans that could be developed to meet the transit ridership demands of any given system. The service plans presented in this section represent viable options based on Long-Range projections, but could be modified to better address the needs of the system as it is developed.

7.1.1 Hurricane Line Service Plan

Table 7.1 summarizes the service plan for the Hurricane line. This service plan consists of 15 minute headways for peak periods and 30 minute headways during off-peak periods and would require a maximum of eight active buses.

Table 7.1: Service Plan – Hurricane Line

Time of Day			Headway (Min.)	Vehicles Required	Revenue Vehicle Miles	Revenue Vehicle Hours
6:00 AM	to	7:00 AM	30	4	80	4
7:00 AM	to	9:00 AM	15	8	321	16
9:00 AM	to	4:00 PM	30	4	562	28
4:00 PM	to	6:30 PM	15	8	401	20
6:30 PM	to	8:00 PM	20	6	181	9
8:00 PM	to	11:00 PM	30	4	241	12
				Daily Total	1786	89

7.1.2 Airport Line Service Plan

Table 7.2 summarizes the service plan for the Airport line. This service plan consists of 15 minute headways for peak periods and 30 minute headways during off-peak periods and would require a maximum of six active buses.

Table 7.2: Service Plan – Airport Line

Time of Day			Headway (Min.)	Vehicles Required	Revenue Vehicle Miles	Revenue Vehicle Hours
6:00 AM	to	7:00 AM	30	3	49	3
7:00 AM	to	9:00 AM	15	6	198	12
9:00 AM	to	4:00 PM	30	3	346	21
4:00 PM	to	6:30 PM	15	6	247	15
6:30 PM	to	8:00 PM	20	5	123	8
8:00 PM	to	11:00 PM	30	3	148	9
				Daily Total	1,111	68

7.1.3 Combined BRT System Service Plan

Table 7.3 summarizes the service plan for the combined Hurricane line and Airport line system. This service plan consists of 15 minute headways for peak periods and 30 minute headways during off-peak periods and would require a maximum of 14 active buses. This service plan assumes that both the Hurricane and Airport lines provide overlapping service in Region 1 (Mall Drive to downtown St. George) and could change depending on how the two lines operate and interact. For example, running a single service line into downtown St. George (no overlapping service) with transfer points where the Hurricane and Airport lines intercept and assuming the same level of ridership would reduce the number of active buses to 12, revenue miles to 2,522, and revenue hours to 134.

Table 7.3: Service Plan – Combined BRT System

Time of Day			Headway (Min.)	Vehicles Required	Revenue Vehicle Miles	Revenue Vehicle Hours
6:00 AM	to	7:00 AM	30	7	132	7
7:00 AM	to	9:00 AM	15	14	529	28
9:00 AM	to	4:00 PM	30	7	926	49
4:00 PM	to	6:30 PM	15	14	661	35
6:30 PM	to	8:00 PM	20	11	312	17
8:00 PM	to	11:00 PM	30	7	397	21
				Daily Total	**2,956**	**157**

7.2 Running Way

This section presents running way requirements and recommendations for the BRT system. Running way recommendations were identified based on forecasted transit needs for the system as well as future roadway congestion projected by the Dixie MPO regional travel demand model. Potential needs for corridor preservation along service highways are also presented.

7.2.1 Roadway Level of Service

Running way requirements for the proposed BRT corridors are primarily driven by ridership forecasts (presented in Chapter 6) and level of service conditions for the corridors. Congested corridors require prioritization of BRT over other vehicle traffic modes (i.e., exclusive bus lane, etc.) to ensure rapid and reliable transit service (see Section 5.3 for a discussion of evaluation criteria). Table 7.4 summarizes Long-Range (2035) peak period Level of Service (LOS) for the proposed BRT corridors. The LOS is based on the 2000 Highway Capacity Manual (HCM) methodology for travel speeds (HCM Chapter 15). Travel speeds and posted speed limits were used as reported by the regional travel demand model for 2035 conditions, which includes the implementation of all planned improvements along the corridors being considered.

Table 7.4: Long-Range (2035) Roadway Segment Level of Service

Region	Segment	From	To	Speed Limit (mph)	Length (Miles)	Peak Volume (2-way)	Peak Period LOS
Region 1	100 South	Bluff Street	700 East	35	1.36	865	B
		700 East	River Road	35	0.71	1,072	B
	River Rd	700 South	Eastridge Dr	40	0.58	1,728	C
	Red Cliffs	Eastridge Dr	Mall Drive	40	0.62	1,576	C
Region 2	Red Cliffs	Mall Drive	Green Springs	40	1.25	1,089	B
	Telegraph	Green Springs	600 West	35	0.30	941	B
		600 West	300 East	25	0.78	1,078	A
		300 East	1100 East	45	1.08	1,412	C
Region 3	Telegraph	1100 East	SR 9	45	3.57	1,300	A
	SR 9	Telegraph	SR 7	55	5.68	4,719	B
		SR 7	1150 West	40	1.78	2,510	C
		1150 West	100 East	35	1.31	1,473	C
Region 4	Mall Dr	Red Cliffs	40 North	35	0.70	797	A
		40 North	3000 East	40	1.66	1,708	A
	3000 East	Mall Drive	2450 East	40	2.05	1,176	B
		2450 East	Airport	40	3.75	n/a	n/a

A BRT system's fast service is one of its main drawing factors. In order for a BRT system to be appealing to potential choice riders it must be competitive with personal vehicles in terms of travel time. BRT systems experience many of the same delays experienced by personal vehicles, especially when they operate in mixed flow running ways. However, they may also experience additional delays from acceleration and deceleration (approach delay) and dwell (stopped) times at stations.

The four fixed routes currently operated by SunTran have an average operating speed of 13 miles per hour (mph). A target average operating speed for a BRT system is 20 mph. Traffic conditions forecasted by the regional travel demand model for 2035 conditions indicate that the BRT corridors can accommodate average operating speeds of 20 mph. The BRT system presented in this chapter assumes BRT service with minimum average operating speeds of 20 mph. Changes to expected roadway conditions (such as failure to implement planned roadway improvements assumed by the regional travel demand model) may impact operating speeds and require modifications to the BRT system.

Table 7.5 breaks down roadway segments through each of the four project regions. The travel times were obtained from the travel demand model for 2035 traffic conditions. The BRT travel times were calculated as is the total travel time through each region plus the additional delays of 0.75 minutes per station.

Table 7.5: BRT Travel Time and Average Speed

	Segment	From	To	Dist. (Mi.)	Travel Time (Min.)	Stops	BRT Travel Time (Min.)	Avg BRT Speed (mph)
Region 1	100 South	Bluff Street	700 East	1.36	3	6	12	16
		700 East	River Road	0.71	2			
	River Road	700 South	Eastridge Dr	0.58	2			
	Red Cliffs	Eastridge Dr	Mall Drive	0.62	1			
Region 2	Red Cliffs	Mall Drive	Green Springs	1.25	2	4	10	20
	Telegraph	Green Springs	600 West	0.30	1			
		600 West	300 East	0.78	2			
		300 East	1100 East	1.08	2			
Region 3	Telegraph	1100 East	SR 9	3.57	5	8	27	27
	SR 9	Telegraph	SR-7	5.68	8			
		SR-7	1150 West	1.78	4			
		1150 West	100 East	1.31	4			
Region 4	Mall Drive	Red Cliffs	40 North	0.70	1	9	22	22
		40 North	3000 East	1.66	3			
	3000 East3	Mall Drive	2450 East	2.05	4			
		2450 East	Airport	3.75	7			

7.2.2 Running Way Characteristics

The ridership forecasts, presented in Chapter 6, for Long-Range conditions warrant BRT service; however, they are lower than the threshold typical for BRT systems with side or median running lanes dedicated to rapid transit buses. The Long-Range traffic conditions forecasted by the regional travel demand model (Table 7.4) also suggest that dedicated lanes are not justified for the proposed BRT corridors. Because of the combination of BRT ridership and roadway conditions forecasted for the BRT corridors, the proposed BRT system was defined to run in mixed flow traffic lanes.

Mixed flow running ways are subject to the same delays experienced by personal vehicles, therefore, TSP and queue jump lanes should be implemented as needed to allow BRT vehicles to bypass traffic queues at intersections and maintain a minimum average operating speed of 20 mph. Examples of how queue jump lanes operate with an existing traffic signal are presented in Figure 7.1 and Figure 7.2. Queue jump lanes could be implemented at 100 South and River Road and St. George Boulevard and River Road in St. George and some of the major intersections along Telegraph Road in Washington City. Strategies for improving travel times could also include bypass lanes for future ramp meters, if any, along SR-9. Other priority treatments, such as exclusive lanes (2-way or bi-directional) and peak period bus/car pool lanes, could also be considered for some segments of the congestion and delays that prove to be greater than now projected.

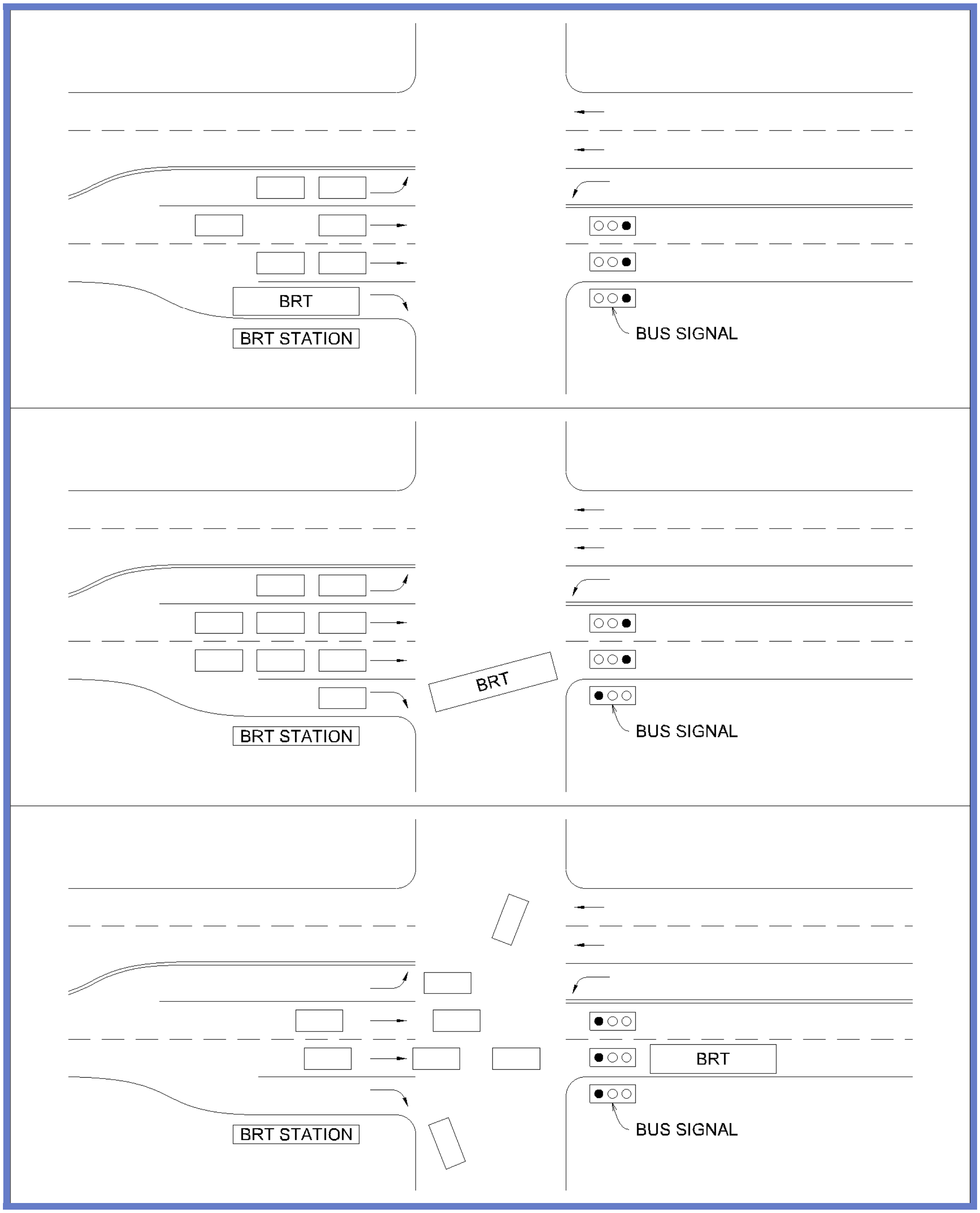

Figure 7.1: Queue Jump Lane – Option A

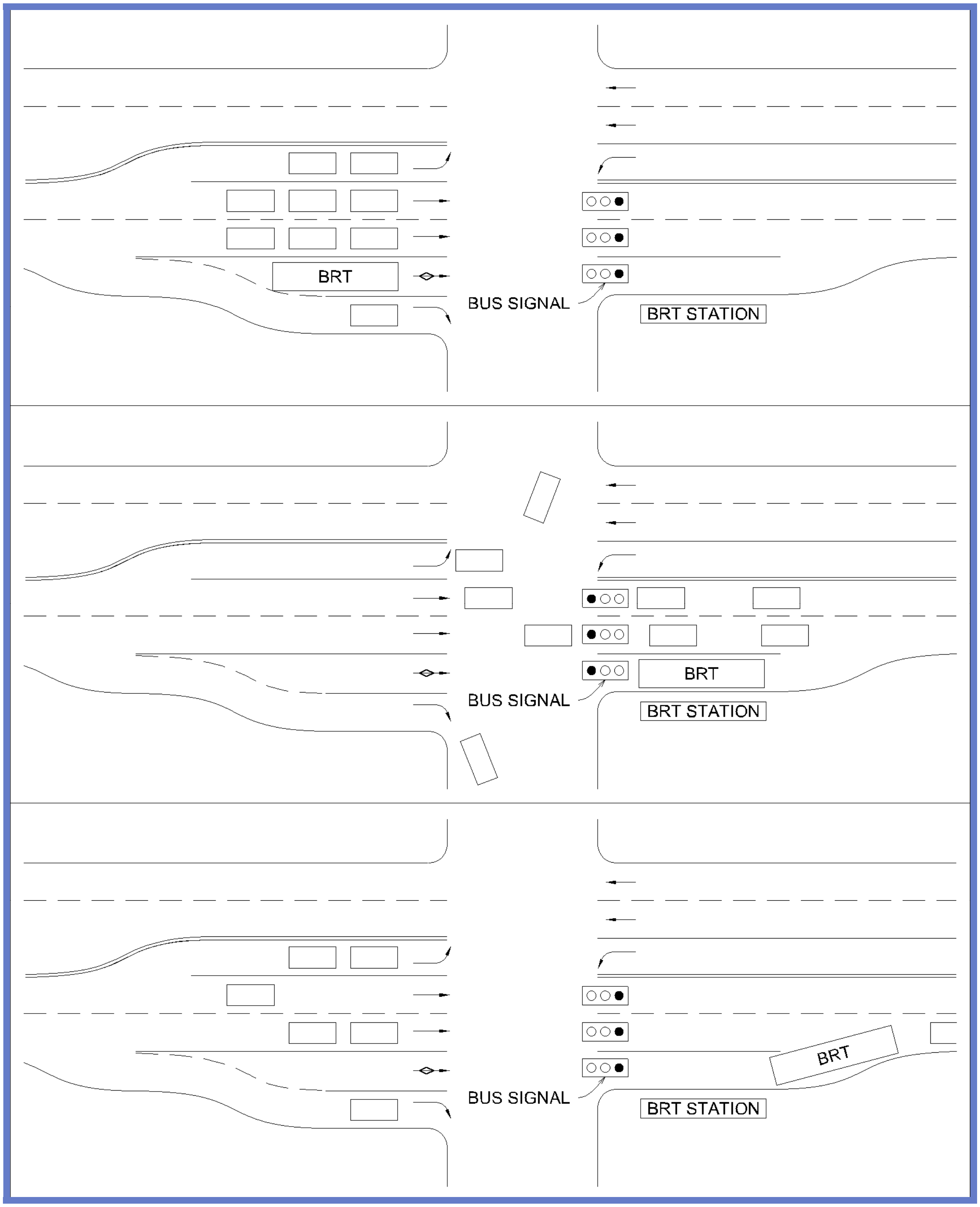

Figure 7.2: Queue Jump Lane – Option B

The running way characteristics defined for the proposed BRT system included queue jumps at ten locations. These improvements were defined for capital cost estimate purposes only. More detailed traffic and intersection conditions will need to be evaluated in the future to identify specific intersections and detailed design requirements (and cost estimates) for the implementation of queue jump lanes, TSP, and other strategies to prioritize BRT service.

7.2.3 Corridor Preservation

Based on the running way characteristics presented above, corridor-wide right-of-way preservation is not anticipated for the Hurricane and Airport lines beyond the preservation needs anticipated to accommodate general growth traffic. However right-of-way preservation will be required for some stations (see Section 7.3) and BRT vehicle priority improvements, such as queue jump lanes. While queue jump lanes can often be constructed without the need for additional roadway width or right-of-way, some locations along the Hurricane and Airport lines may require additional right-of-way. More detailed traffic and intersection conditions will need to be evaluated in the future to identify key intersections and detailed design requirements for the implementation of, or corridor preservation for, BRT queue jump lanes.

7.3 Stations

Stations are a critical component of the BRT system because they affect accessibility, reliability, comfort, safety, security, dwell times, and system image. This section presents requirements and recommendations for station elements that should be considered as part of the Hurricane and Airport lines. Potential needs for right-of-way preservation at BRT stations are also presented.

7.3.1 Station Locations

BRT stations should be spaced at least half mile apart in very dense areas, but preferably one mile or more apart whenever possible and practical. Providing longer spacing between stations (fewer stations than a local bus system) reduces dwell time delays for BRT vehicles and consequently faster service. For the areas of highest employment and housing densities in downtown St. George, stations could be spaced at half mile increments. Other locations should provide one mile spacing between stations. The northernmost sections of Telegraph Road and westernmost sections of SR-9 are not expected to see high densities of employment and housing development. For these sections of the Hurricane line, stations should be limited as needed to serve points with significant ridership demand. Figure 7.3 shows possible locations for BRT stations. The exact location for these stations will require more detailed evaluation including considerations for intersection treatments and right-of-way constraints.

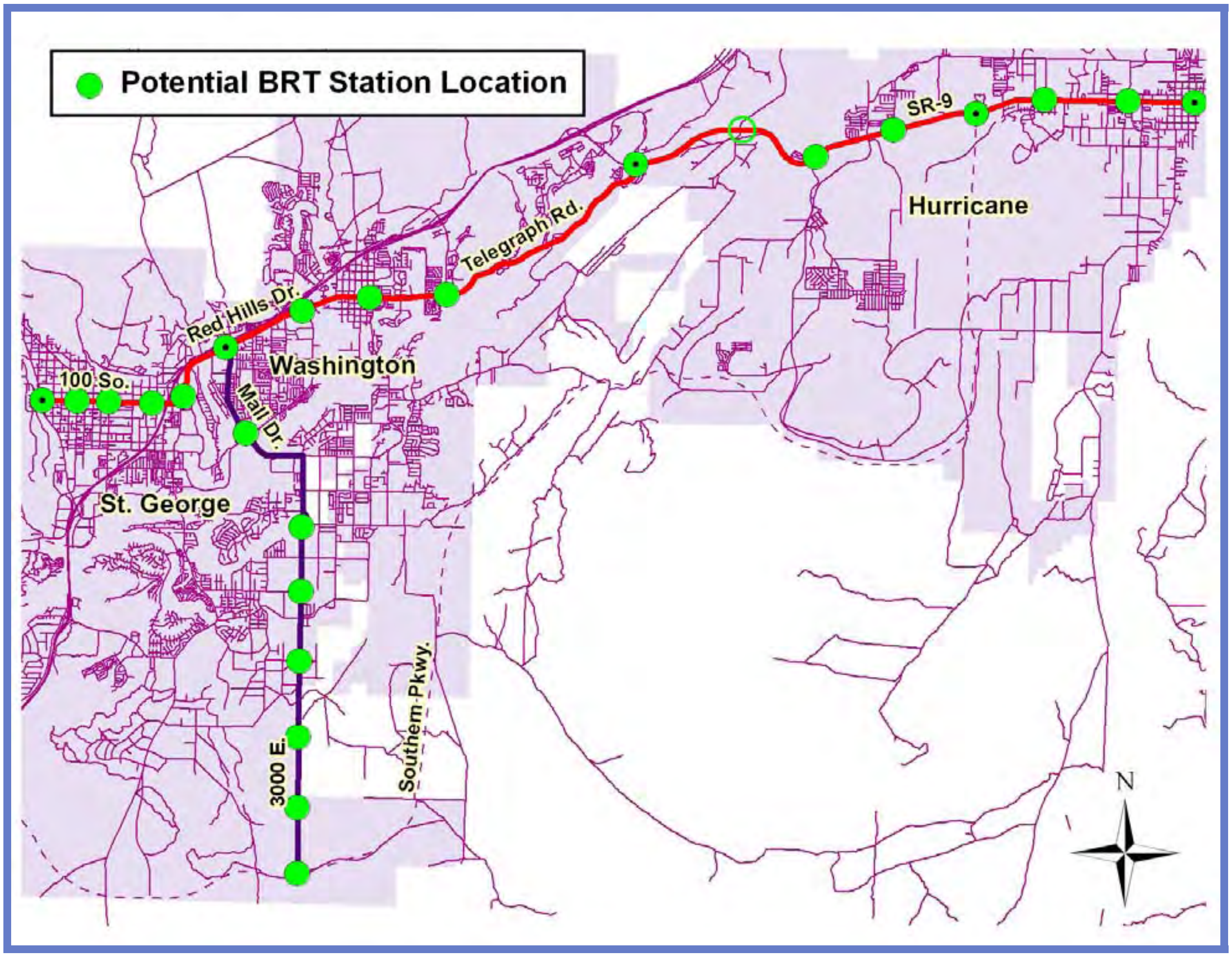

Figure 7.3: BRT Corridor Stations

The station located on SR-9 at approximately 5300 West in Hurricane was defined as a temporary or potential special event station. For 2035, this location was forecasted to have relatively low levels of employment, commercial, and housing densities compared to other areas along the proposed BRT corridors. However, at the present time (2010) this location has relatively high employment levels and represents a significant destination. A station near the Washington County Fairgrounds should therefore be considered for near-term or interim transit service between St. George and Hurricane, but will need to be reevaluated as growth patterns change. This station could also provide seasonal or special event access to events held at the Washington County Fairgrounds.

7.3.2 Station Characteristics

The proposed BRT system should provide substantial transit stations or shelters. These stations should be larger than standard bus shelters and should be designed to contribute to the "branding" of the line. Station branding should provide a unique identity for BRT service and allow casual transit users to identify the system easily. Some BRT stations have a marker, either standalone or integrated into the shelter, which aids in identifying the system brand. An example of the type of station that should be provided for the proposed BRT system is presented in Figure 7.4.

Figure 7.4: MAX BRT Station, Kansas City, KS

As the BRT system grows, stations could be phased into larger facilities to accommodate more passengers. These larger facilities could include additional investment such as additional seating, bicycle amenities, landscaping, special paving, or way-finding signage. Phasing opportunities could also include off-board fare collection to reduce dwell time at stations. Stations could also provide real time arrival information systems.

Figure 7.5 presents planning level BRT station characteristics and dimensions that could be applied to system arterial and collector (at-grade) streets including 100 South, 3000 East, River Road, Red Cliffs Drive, Telegraph Road, and at-grade portions of SR-9. Although these characteristics provide planning level guidance, more detailed site specific design will need to be completed in the future to identify specific dimensions and amenity requirements for BRT stations.

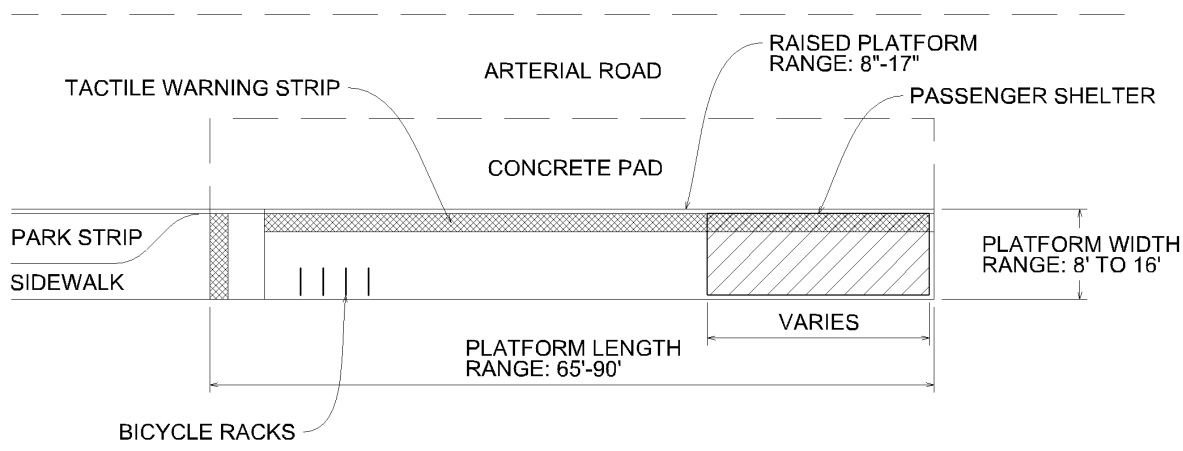

Figure 7.5: BRT Station Characteristics

UDOT is currently completing a preliminary engineering and corridor preservation study for SR-9. That study runs between I-15 and the future intersection of SR-9 and the Southern Parkway (SR-7). The BRT study project team coordinated efforts with the SR-9 project team to facilitate the consideration and discussion of possible transit needs for SR-9. Although the final design configuration for SR-9 was not available at the time of this study, several of the possible scenarios being considered include a grade-separated expressway that connects I-15 to the future Southern Parkway. Although shared traffic flow conditions for freeway-type facilities are not best suited for rapid transit service, station provisions can be implemented to minimize approaching and dwell time delays for stations located along such corridors. Figure 7.6 and Figure 7.7 present possible design layouts that could be constructed along future interchange ramps. The guiding principle for the design of BRT is that the stations need to provide safe and convenient access to riders and need to minimize travel time delays for the rapid transit vehicle.

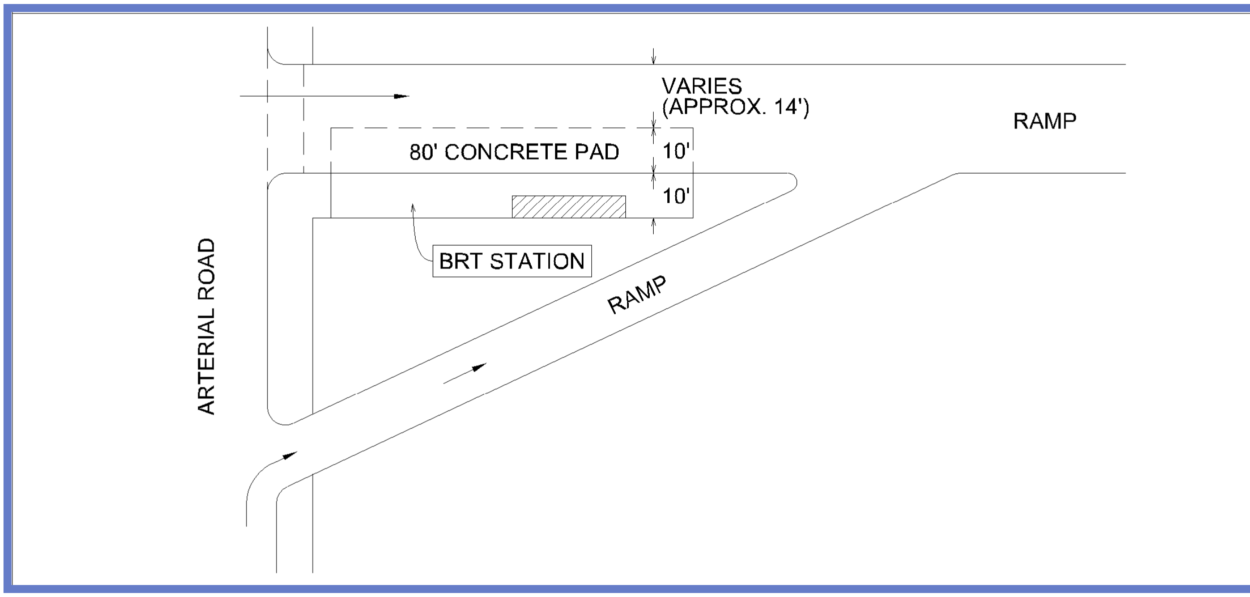

Figure 7.6: Interchange BRT Station – Option A

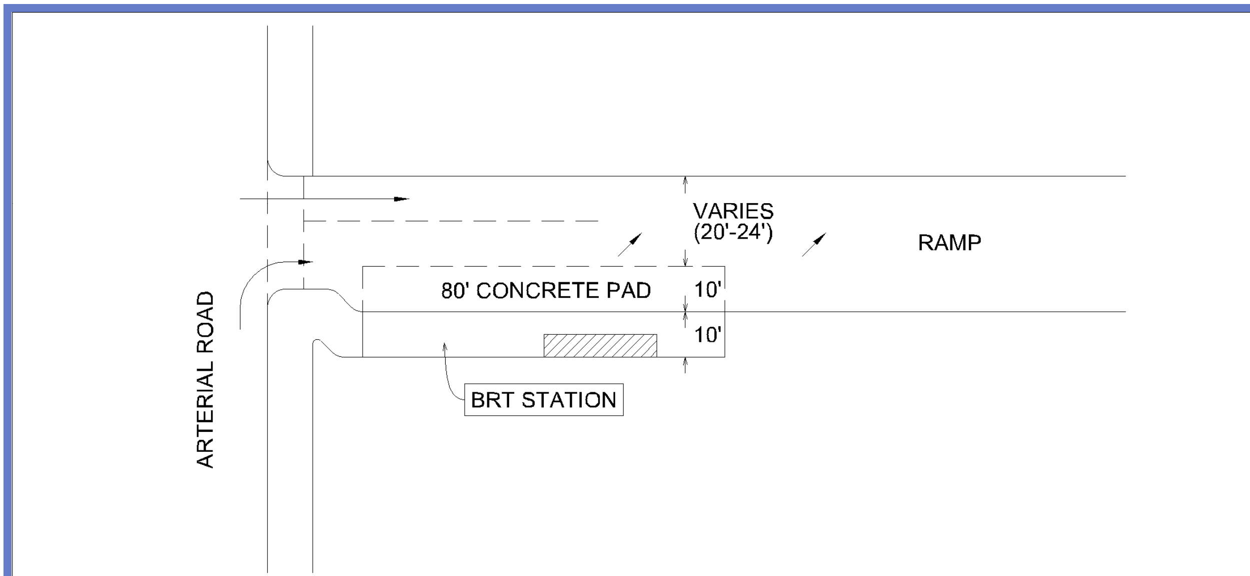

Figure 7.7: Interchange BRT Station – Option B

The Dixie State College Transit Center currently serves as the beginning and end point for all the SunTran bus routes. As the regional transit system evolves this transit center will need to be supplemented with (or possibly replaced with) a new intermodal transit center that provides access to transit users and transfer opportunities for various routes. Implementation of the proposed BRT system should consider a new or additional intermodal hub at a centralized location along the BRT corridors; preferably at the intersection of the Hurricane and Airport lines.

Parking accommodations are not generally provided for BRT stations. However, for locations with a high number of expected park and ride transit users, consideration should be given to provide parking amenities. Some of these locations could include the corridor termini and the intermodal hub as well as key intersections such as Southern Parkway/SR-9 and Telegraph Road/SR-9. Table 7.6 presents the parking demand estimates and corresponding area needs for these park-and-ride stations.

Table 7.6: Parking Demand Estimates

Location	Approx. Number of Parking Stalls	Approx. Total Area (acres)
St. George Terminus	200	2
Intermodal Hub	200	2
SR-9/Telegraph Rd.	100	1
SR-9/Southern Pkwy.	200	2
Hurricane Terminus	150	1½

7.3.3 Right of Way Preservation

Based on the station characteristics presented above, right-of-way preservation will be required for some stations, particularly those with parking accommodations. For planning purposes, right-of-way needs for these locations could include one acre for every 100 to 150 parking stalls. BRT stations without park and ride accommodations can generally be accommodated without additional right-of-way needs. However, where possible, these stations could benefit from an additional 4 to 10 feet to accommodate the characteristics defined in Figure 7.5. More detailed evaluation of site specific station locations and right-of-way constraints will need to be evaluated in the future. However, local agencies should consider future station characteristics as part of roadway improvement projects and possibly as part of future private development along the BRT corridors.

7.4 Vehicles

The BRT vehicles are one of the most visible components of a BRT system. Conventional and stylized vehicles can be utilized and branded to provide a unique identity for BRT service, which allows casual transit users to identify the system easily.

Dwell times can be minimized by facilitating passenger boardings into the vehicle. Low-floor vehicles and level boarding platforms enhance boarding efficiency and provide particular benefit to passengers with special needs such as those using wheelchairs or walkers. The service plan presented above assumes 40 foot long standard buses. As demand increases these vehicles could be upgraded to 60 foot articulated vehicles. Figure 7.8 shows an example of a 40 foot vehicle and Figure 7.9 shows a 60 foot vehicle.

Figure 7.8: Cedar Avenue BRT, Minneapolis
40 foot Stylized Standard Vehicle

Figure 7.9: VIVA, Las Vegas
60 foot Conventional Articulated Vehicle

Various fuel alternatives exist for BRT vehicles including diesel, compressed natural gas, and gasoline. The type of fuel selected can have an impact on fuel consumption, pollution and noise. Hybrid vehicles are also available and are particularly advantageous in urban settings with regular starts and stops, offering better performance and improved fuel economy.

Table 7.7 presents the number of vehicles required to operate each BRT line. Vehicle fleet requirements were calculated based on the service plan presented earlier (Section 7.1). Spare vehicles are required to allow for vehicle maintenance without disrupting operations. The industry standard is to use a 15 percent spare ratio. Spare vehicles presented in Table 7.7 were calculated to be 15 percent of revenue vehicles.

Table 7.7: BRT Fleet Requirements

	Hurricane Line	Airport Line	Combined BRT System
Peak Vehicle Use	8	6	14
Off-Peak Vehicle Use	4	3	7
Revenue (Active) Vehicles	8	6	14
Spare Vehicles	2	1	3
Total Vehicles	**10**	**7**	**17**

8.0 FINANCIAL ANALYSIS

An analysis of costs, revenues, and possible subsidies is critical to determining the viability of any BRT system. This section evaluates the estimated capital and operating costs associated with the BRT system presented in this study. Subsidies and revenues are introduced and then discussed in more detail in Chapter 9.

It is important to note that the financial figures and analyses presented in this study are in 2010 dollars (2010 currency values). Inflation or time-value of money adjustments were not applied.

8.1 Components of Financial Analysis

Financial considerations for transit projects are generally separated into capital improvement and operating needs. This section introduces capital and operating cost components of BRT transit systems. Revenues expected from paying transit users (fare box revenues) cover a portion of operating costs. However, capital investment and revenue subsidies are generally required to build and operate transit systems. Subsidies are explored briefly here and again in more detail in Chapter 9.

8.1.1 Capital Costs

Capital costs are often one-time costs needed to build and/or improve a transit system. They include right-of-way acquisition and construction for running ways, as well as expenditures to acquire vehicles, stations, and other equipment necessary to build and/or improve a system. Table 8.1 and Table 8.2 present typical capital costs for BRT systems. Table 8.1 presents high level capital costs based on the type and length of the BRT system. Table 8.2 presents typical capital costs for individual components of the BRT system.

Table 8.1: General Capital Costs by Mile

BRT Type	Cost Range	Key Features
Rapid Bus (BRT Lite)	\$0.5 to \$3.0 Million per Mile	BRT vehicles, traffic signal priority, enhanced shelters, image & branding
Bus Rapid Transit (Full Featured)	\$5 to \$25 Million per Mile	High capacity BRT vehicles, exclusive lanes, dedicated stations, off-board fare collection

Table 8.2: General Capital Costs by Element

BRT Elements	Cost Range	Key Features & Options
Vehicles	$500,000 to $1,000,000 each vehicle	**Size:** standard 40' or 60-65' articulated **Fuel:** diesel, CNG, hybrid-electric **Styling:** standard, customized BRT
Stations	$50,000 to $200,000 for enhanced shelter $300,000 to $800,000 for designated station	**Enhanced shelters:** unique design, larger size, special sun and wind screens, branding marker **Stations:** large size with special design, seating areas, TVMs, real-time information, etc.
Exclusive Transit Lanes	$5 to $15 million per mile of exclusive lanes	**Least cost:** restriping and minor widening to create designated BRT lane (may be peak only) **Highest cost:** separated median guide way with dividers, landscaping, median stations (incl. ROW)
Ticket Vending Machines	$50,000 to $100,000 each	Capability for credit/debit cards, smart cards and other payment options
Transit Signal Priority	$2,000 to $10,000 per intersection	Requires AVL/GPS equipped buses, detection by vehicle emitters or roadway loops.

8.1.2 Operating Costs

Operating costs are annually reoccurring costs whereas capital costs are often one-time costs. Operating costs include costs to run and maintain the transit system. Table 8.3 presents operating costs for systems comparable to the system presented in this study. These values provide insights into the potential cost to operate the Hurricane and Airport lines.

Table 8.3: Operating Cost Comparison

System	City (State)	Population	Peak Buses	Operating Expense (millions)	Cost per Hour
Cache Valley	Logan, (UT)	76,187	17	$4.16	$60.77
VVTA	Victor Valley, (CA)	200,436	21	$8.02	$65.11
The Bus	Merced, (CA)	110,483	26	$8.94	$73.63
VRT	Boise, (ID)	272,625	35	$8.83	$82.31
LAVTA	Livermore, (CA)	552,624	47	$14.47	$89.75
Ben Franklin	Richland, (WA)	153,851	67	$31.11	$91.91
Transfort	Fort Collins, (CO)	206,757	23	$8.54	$94.56
Reno RTC	Reno, (NV)	303,689	60	$34.72	$96.85
Salem Transit	Salem, (OR)	207,229	59	$27.27	$104.94
Lane Transit	Eugene, (OR)	224,049	96	$35.46	$111.59
San Joaquin RTD	Stockton, (CA)	313,392	92	$34.70	$114.81
	Average	**238,302**	**49**	**$19.66**	**$89.66**

Source: 2008 National Transit Database - Agency Profiles

Based on the comparable systems an operating cost rate of $90 per operating hour was used to estimate the cost to operate the Hurricane and Airport lines as components of the potential expanded future transit system. This cost is considerably higher than the approximately $40 per operating hour costs of the existing SunTran system. It should be noted that the hourly cost of $90 is expected for the BRT system presented for the year 2035, which would be part of an overall regional transit system with 50 to 80 operating buses. Rates comparable to the existing SunTran costs ($40/hr) could be applied to initial traditional bus service expansions. Operating costs of approximately $70 per hour of operation (similar to those experienced by the Cache Valley system) could be applied to the initial phases of the BRT system, depending on the size of the overall system. The focus of this study was to evaluate the long-range feasibility of a BRT system, therefore this document reports operating cost estimates based on the higher $90 per hour of operation and the corresponding service plan presented in Chapter 7.

8.1.3 Fare Box Revenue and Subsidies

Revenues from fares will usually cover approximately 20 percent of the costs of operating small to medium size BRT systems. The current fare box recovery rate for SunTran is 13.8 percent. To evaluate the financial feasibility of the BRT service a fare box recovery rate of 20 percent was assumed. The remaining 80 percent of operating costs were assumed to be covered through local subsidies. FTA subsidies are available to cover 50-80 percent of capital investment needs for systems like the proposed BRT lines. Subsidy options for operations and capital investment costs are discussed further in Section 9.3.

Estimated operating costs and capital investments required for the Hurricane and Airport lines and the combined system alternatives are summarized in Sections 8.2 through 8.4. The unit costs used to calculate the capital investment for each alternative were taken from Table 8.2 and the *Bus Rapid Transit Practitioner's Guide*.

8.2 Hurricane Line Financial Analysis

This section presents operating costs and capital investments required for the Hurricane line. Table 8.4 presents operating cost estimates for the Hurricane line based on operating costs of $90 per hour of operation. Table 8.5 presents the capital investment needed to build the Hurricane line as presented in this document.

Table 8.4: Operating Cost Estimate – Hurricane Line

Daily Operating Costs	$8,010
Annual Operating Costs	$2.44 Million
Daily Riders (2035)	7,258
Operating cost per Rider	$1.10

Table 8.5: Capital Cost Estimate – Hurricane Line

	Unit	Quantity	Unit Cost	Capital Cost
Vehicles	Each	10	$700,000	$7,000,000
Stations	Each	32	$100,000	$3,200,000
Signal Priority	Mile	19.0	$50,000	$950,000
Queue Jump	Intersection	10	$100,000	$1,000,000
Other Corridor Improvements	Mile	19.0	$100,000	$1,900,000
Contingency	30%	1	$4,215,000	$4,215,000
			Total:	**$18,265,000**

8.3 Airport Line Financial Analysis

This section presents operating costs and capital investments required for the Airport BRT line. Table 8.6 presents operating cost estimates for the Airport line based on operating costs of $90 per hour of operation. Table 8.7 presents the capital investment needed to build the Airport BRT line as presented in this document.

Table 8.6: Operating Cost Estimate – Airport Line

Daily Operating Costs	$6,075
Annual Operating Costs	$1.85 Million
Daily Riders (2035)	4,157
Operating cost per Rider	$1.46

Table 8.7: Capital Cost Estimate – Airport Line

	Unit	Quantity	Unit Cost	Capital Cost
Vehicles	Each	7	$700,000	$4,900,000
Stations	Each	26	$100,000	$2,600,000
Signal Priority	Mile	11.4	$50,000	$570,000
Queue Jump	Intersection	5	$100,000	$500,000
Other Corridor Improvements	Mile	11.4	$100,000	$1,140,000
Contingency	30%	1	$2,913,000	$2,913,000
			Total:	**$12,623,000**

8.4 Combined BRT System Financial Analysis

This section presents operating costs and capital investments required for the combined Hurricane and Airport lines. Table 8.8 presents operating cost estimates for the combined BRT system line based on operating costs of $90 per hour of operation. Table 8.9 presents the capital investment needed to build the combined Hurricane and Airport lines as presented in this document.

Table 8.8: Operating Cost Estimate – Combined BRT System

Daily Operating Costs	$14,085
Annual Operating Costs	$4.30 Million
Daily Riders (2035)	12,036
Operating cost per Rider	$1.17

Table 8.9: Capital Cost Estimate – Combined BRT System

	Unit	Quantity	Unit Cost	Capital Cost
Vehicles	Each	17	$700,000	$11,900,000
Stations	Each	46	$100,000	$4,600,000
Signal Priority	Mile	27.2	$50,000	$1,360,000
Queue Jump	Intersection	10	$100,000	$1,000,000
Other Corridor Improvements	Mile	27.2	$100,000	$2,720,000
Contingency	30%	1	$6,474,000	$6,474,000
			Total:	**$28,054,000**

9.0 PHASING AND IMPLEMENTATION

This section presents opportunities to implement the BRT system recommendations presented earlier. Implementation strategies discussed include potential governing structures for expanding service beyond the City of St. George, possible sources to fund BRT and transit service expansion in Washington County and opportunities to phase in and support BRT service.

9.1 Institutional Structure

The institutional structure defines how decisions are made and services funded within a transit organization. Currently SunTran is governed and operated by the City of St. George as a division of the Public Works department. The expansion of transit service beyond the City of St. George and into neighboring communities will require changes to the institutional structure of the transit organization.

Although some stakeholders and decision makers may have pre-existing ideas or even directives regarding what future institutional arrangements should be considered, it is generally useful for stakeholders to examine the full range of alternatives for governance and funding structures. The intent of this study, as it relates to institutional structure, is to provide a range of options that have worked elsewhere and could be considered as BRT service is implemented. The following four basic alternatives are presented as a range of options that could be considered as transit service expands beyond the boundaries of the City of St. George:

- Separate service and funding (taxing) areas
- Transit oversight agency
- Regional transportation authority
- Regional transit authority

These structure alternatives can be executed in a number of arrangements, such as the following:

- Joint powers authority,
- State legislation (e.g., special district or powers added to an existing agency),
- Inter-agency agreements, etc.

For example, a joint powers agreement has been used in some areas to allow two or more separate public/transit service organizations to operate collectively. If St. George, Washington, and Hurricane each chose to provide their own separate local bus service, the three cities could execute some type of joint powers agreement to collaborate for the implementation and operation of the BRT lines, which expand beyond the limits of the separate local service entities. Because there are so many ways to execute the arrangements between various entities, the following section defines, in general terms, some structural options. Arrangements for executing these structures are beyond the scope of this study. Legal and policy resources should be consulted to determine the best arrangement for executing any one of these structure alternatives.

9.1.1 Separate Service and Funding Areas

In the separate service funding areas alternative, each individual transit agency provides service that is focused on a jurisdiction from which the local funding is collected. See Figure 9.1 for an illustration of this structure alternative. This type of structure could be applied, for the proposed BRT system, at the county level. It could also be applied within each municipality involved, but would need to be supplemented with some type of inter-agency agreement. The advantages of this simple form are that the service is responsive to the jurisdiction responsible for its funding, and there is a perceived return-to-source benefit derived from the funding.

Figure 9.1: Separate Service and Funding Areas Structure

9.1.2 Transit Oversight Agency

The transit oversight agency alternative provides for an oversight agency that coordinates various jurisdictions, which in turn provide transit services. See Figure 9.2 for an illustration of this structure alternative. The oversight agency may provide long-range planning and (sometimes) customer information services. The oversight agency may also provide a regional fare revenue clearinghouse. The role of a regional operator is often distinguished by its operation of a regional rapid transit (typically rail) system, and by the provision of regional route services that are often inter-jurisdictional (such as commuter buses).

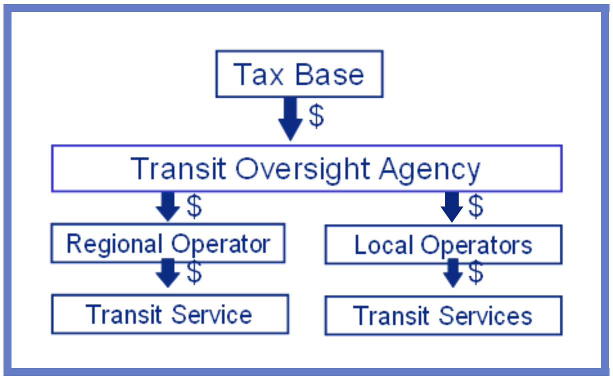

Figure 9.2: Transit Oversight Agency Structure

9.1.3 Regional Transportation Authority

The regional transportation authority alternative generally involves greater discretion over funding, and therefore more direct involvement in planning, service standards, and capital construction. See Figure 9.3 for an illustration of this structure alternative. On the one hand, funding is not returned as directly to the source; on the other hand, greater regional efficiency and equity are claimed for the regional allocation of funds. These issues differ by region, based on legislation and local policy. A transportation authority, as opposed to a transit authority, may also include bridges, parking, or highway projects. Responsiveness and the local control of service are maintained through separate local and regional transit operators.

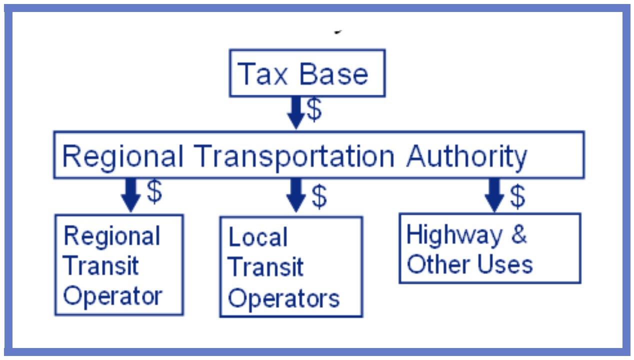

Figure 9.3: Regional Transportation Authority Structure

9.1.4 Regional Transit Authority

The regional transit authority alternative (not illustrated) consists of a simple relationship between a regional tax base and a single regional transit operator. With this structure the regional transit authority operates all transit service (local and regional) for the service area. This structure is currently used along Utah's Wasatch Front area through the Utah Transit Authority and on a smaller scale in Cache Valley by the Cache Valley Transit District.

9.2 Funding

Much of the funding needs associated with a transit system can be addressed with various FTA programs. Some federal programs only fund capital needs while others fund both capital needs and operations. Most transit systems also utilize FTA formula operating funds. These FTA funds are based on a formula that includes the regional population and the amount of transit service. The funds will therefore increase somewhat over time as the region and the transit system grow, but will be a smaller share of the overall cost.

Most federal programs require a local match. In most cases the match for capital needs is 20 percent local. The typical match for operations funding is 50 percent of the net deficit, which is the total cost of operations minus any portion recovered through fare box revenues. Table 9.1 summarizes key FTA programs that are applicable to this system.

Table 9.1: FTA Funding Programs

FTA Program	Capital Cost Split (Federal/Local)	Operational Cost Split (Federal/Local)
Small Starts (Sec. 5309)	80/20	N/A
Bus Funding (Sec. 5309)	80/20	N/A
Urban Formula (Sec. 5307)	Varies	Varies
JARC (Sec. 5316)	80/20	50/50
New Freedom (Sec. 5317)	80/20	50/50
Rural and Small Urban (Sec. 5311)	80/20	50/50

Currently, there are also some Federal funds available through new programs, including economic stimulus funds and TIGGER (greenhouse gas) grants. Other sources of capital funds include other FTA and flexible Federal transportation funds (such as the CMAQ program). These funds are usually programmed at the regional level and can be very competitive because they can be used for a variety of transit and roadway capital needs. State funds may also be a potential capital fund source.

9.2.1 FTA Capital Assistance Programs – Section 5309

A primary source of external funding for BRT projects is FTA's Small Starts program. This program was established by Congress through the most recent Reauthorization bill and was designed to fund smaller bus and rail rapid transit projects. The maximum FTA funding under this program is $75 million. Most of the funding to-date has been directed to BRT projects with some funding for local streetcar projects. Up to 80 percent of the project cost is eligible for FTA program. In recent years, FTA has been encouraging project sponsors to seek only a 50 percent FTA share, particularly for the larger rail projects in the New Starts program. However, recent projects approved for Small Starts have been frequently able to secure 80 percent funding. Table 9.2 shows some of these projects and the funding proposed by FTA.

Table 9.2: FTA Small Starts Projects

BRT Project	Regional Population	Total Cost (millions)	FTA Small Starts (millions)	FTA Other (millions)	State (millions)	Local (millions)
Flagstaff (Mt Links BRT)	124,953	$10.4	$6.24	$1.89	$0.18	$2.10
Livermore (RT 10 BRT)	100,000	$21.7	$10.93	$6.40	$2.42	$1.91
Stockton (Metro Express)	290,409	$9.7	$2.81	$5.11	$1.00	$0.82
Eugene (Pioneer EmX)	220,000	$37.0	$29.59	-	$5.40	$2.00
Fort Collins (Mason MAX)	136,509	$82.0	$65.58	-	$8.56	$7.84

In order for a transit project to qualify for Small Starts funding the project must have either 50 percent fixed guideways or 10 minute peak and 15 minute off-peak headways. The service plans presented in Chapter 7 have 15 minute peak and 30 minute off-peak headways and might not qualify for Small Starts funding. However, the regulations for obtaining Small Starts funding could change by the time BRT is feasible in Washington County or the service plan could be changed to meet the required headways. Therefore, Small Starts funding should not be excluded from the possible funding options.

Similar to the Small Starts Program, the Section 5309 Bus Funding program is limited to the capital needs of a transit system. This program provides capital assistance for buses, bus-related equipment, paratransit vehicles and construction of bus-related facilities. The Bus Funding program could be used to fund many elements of the proposed BRT system such as vehicles, stations, transit centers or other major capital expenses. Other transit organizations within Utah have benefitted from this program. Park City Transit has used funds from this program to expand their bus fleet.

Public bodies and agencies are eligible applicants for Section 5309 funding. FTA administers Section 5309 funding directly to local public bodies and agencies.

9.2.2 FTA Urbanized Area Formula Program – Section 5307

The Urbanized Area Formula Funding program makes Federal resources available to urbanized areas and to Governors for transit capital and operating assistance in urbanized areas and for transportation related planning. Urbanized areas with a population between 50,000 and 200,000 receive funding based on population density. The Governor approves the allocation of Section 5307 funding.

9.2.3 FTA JARC Program – Section 5316

The Job Access and Reverse Commute (JARC) program was established to address the needs of welfare recipients and low-income individuals seeking to obtain and maintain employment; however, this program also seeks to transport residents of urbanized and non-urbanized areas to suburban employment opportunities. Thus, this program also aims to facilitate reverse commute opportunities.

The reverse commute aspect of this program is the most applicable to the proposed Hurricane line, which would connect St. George and Hurricane. JARC funding could be applied, even before BRT is warranted, to provide a reverse commute transit route between St. George and Hurricane, which would serve suburban employment opportunities in Hurricane. Such a route was mentioned in the *Dixie Coordinated Transportation Implementation Tool,* dated August 2009. Furthermore, this funding could also be used to implement transit service to the airport.

Unlike FTA Capital Assistance funds JARC funds can also be used to subsidize operations. The typical local match for JARC funds used to subsidize operations is 50 percent of the net deficit.

Currently there is a lot of competition for statewide JARC funds; however, St. George falls under the category of “Small Urban,” which is classified as an area with a population between 50,000 and 200,000. Only St. George and Logan fall in this category in Utah, which means less competition. SunTran could compete for JARC funding for the Airport line as a small urban area, however the Five County Association of Governments would need to compete for statewide funding for a transit route to Hurricane. All JARC funding is administered by UDOT.

9.2.4 FTA New Freedom Program – Section 5317

The New Freedom program seeks to provide tools to help Americans with disabilities overcome existing transportation barriers and seek integration into the work force and full participation in society. Overall, the purpose of this program is to enhance mobility.

New Freedom funding has been used for a variety of projects from funding mobility management strategies to building ADA accessible amenities such as transit stops. These funds are also applicable to systems transporting seniors.

New Freedom funds may be more applicable to paratransit and transit lines feeding the BRT system. However, these funds could potentially be used to fund aspects of BRT stations and BRT vehicles that are intended to enhance system accessibility. In the near term, New Freedom funding could be used to implement a transit line from St. George to Hurricane and the new airport site in much the same way as the JARC funding. The two funding options could be combined to provide an accessible, reverse commute transit link between St. George and Hurricane and St. George and the airport as the Washington County moves toward a more comprehensive transit system.

Like JARC funds, New Freedom funds can be used to subsidize transit operations and capital costs. New Freedom Funding is administered by UDOT in the same way as JARC funds.

9.2.5 FTA Rural Area Funding Program – Section 5311

The Rural and Small Urban Area Funding Program was established to address the following five goals:

- Enhance the access of people in nonurbanized areas to health care, shopping, education, employment, public services, and recreation;
- Assist in the maintenance, development, improvement, and use of public transportation systems in rural and small urban areas;
- Encourage and facilitate the most efficient use of all Federal funds used to provide passenger transportation in nonurbanized areas through the coordination of programs and services;
- Assist in the development and support of intercity bus transportation
- Provide for the participation of private transportation providers in nonurbanized transportation to the maximum extent feasible.

Section 5311 funding can be used for both capital and operating expenses in much the same way as JARC and New Freedom funds. Like the JARC and New Freedom programs the Section 5311 program has limitations on the types of projects that can qualify for funding. Projects funded by the Section 5311 program are restricted to nonurbanized areas, which FTA defines as areas with a population less than 50,000.

Additionally, the area receiving the funding typically must be outside the MPO boundaries.

The proposed Airport line does not qualify for Section 5311 funding because it does not serve a nonurbanized area. The proposed Hurricane line, however, serves both a nonurbanized area, Hurricane, and a small urban area, St. George. The *Utah State Management Plan* produced by UDOT's Public Transit Team states that "Section 5311 projects may include transportation to and from urbanized areas." Therefore, the Hurricane line may qualify for Section 5311 funding.

The application process for Section 5311 funding is much more involved than for JARC and New Freedom funding. Prior to applying for funding the applicant must conduct and document a feasibility study which must address the following:

- The need for a public transportation system in the planning area
- Community support for a public transportation system
- The extent of commitment from local organizations and existing transportation providers to coordinate services
- Documentation or projected revenues and expenses
- Financial and managerial capabilities of the applicant
- The extent to which the project will comply with federal regulations concerning Equal Employment Opportunity, Title VI, Disadvantaged Business Enterprise, Section 13(c) and Section 504/ADA.

The applicant must then show local area adoption of the project including public support and dedicated local match funding sources. Section 5311 funding requires the same local match as the JARC and New Freedom programs, 20 percent for capital costs and 50 percent of the net deficit for operational costs. All Section 5311 funding is administered by UDOT and is allocated for five year periods during which time UDOT monitors the project to ensure FTA regulations are met.

9.2.6 Local Funding

While many BRT projects have been able to secure external funding, local match funds are typically needed. At a minimum, local funds will likely need to cover 10-20 percent of the project's capital cost and 50 percent of the net initial deficit for operations. In the longer term, it is likely that nearly all of the operating costs will need to be funded from local sources. Therefore, it is necessary to identify some possible sources for local match funds.

Sources of local funds vary, with a local sales tax being common for larger areas. In its long-range plan, Dixie MPO has included a quarter cent sales tax, a five percent fuel tax and vehicle registration fees as funding sources for transportation. Portions of each of these, or equivalents, may be allotted to fund transit activities. Various other sources have been used by transit organizations including: city general funds, redevelopment funds, business licensing fees, parking fees, development fees, and hotel and resort contributions.

9.3 Phasing

The proposed transit expansion should be phased to transition from a commuter or traditional bus service to a low and then higher BRT system. The BRT system can be implemented in phases as ridership demand dictates. Phasing the Hurricane and Airport BRT lines also allows the system to provide supporting ridership data as BRT becomes feasible. Some form of actual transit ridership data is often required by FTA before it awards capital investment funds for the development of BRT service. The typical threshold for BRT service is 3,000 daily riders. Study ridership forecasts indicate that the Hurricane line would meet the BRT ridership threshold by the time Short-Range growth conditions are reached.

Consideration should be given to provide bus transit service along the proposed Hurricane line and “near-term” Airport line alignments before BRT thresholds are met. Implementing transit service along these corridors will help phase in the BRT system. This service will also help validate ridership demand and provide the supporting ridership data to develop more refined forecasts and eventually implement the Basic or Moderate BRT transit level presented in this document. One possibility for phasing in the future BRT system is presented in Table 9.3.

Table 9.3: Phasing of Service Alternatives

Level of Investment	Service Frequency	Daily Riders	Service Period (Time-of-Day)
Expanded Bus	30-60 min.	500	Commute only or limited all-day service
Expanded Bus	30 min.	1000	All-day service
Expanded Bus to Basic BRT	15-20 min.	3000	More frequent commute service
Basic BRT to Moderate BRT	10-15 min.	5000+	More frequent all-day service

9.3.1 Interim Airport Service

Currently, there is no transit service to the southeast quadrant of St. George. Interim bus service should be implemented to begin phasing toward a BRT line that would serve the new airport. The focus of this study was to evaluate the long-term feasibility of rapid transit service. As such, the short-term recommendations provided in the *St. George Urbanized Area Short Range and Long-Range Transit Plan*, dated August 2006 (Short-Range Plan), should be considered as detailed bus service to the new airport is defined and implemented. It should be noted that the near-term alignment defined for this study in coordination with SunTran (see Figure 5.2) differs from the “express route” alignment presented in the 2006 Short-Range Plan. The near-term alignment defined for this study could be provided in place of or in addition to the express route along I-15. However, the analysis completed for the Short-Range Plan may need to be refined accordingly.

9.3.2 Interim Hurricane Service

The future implementation of a BRT service to Hurricane requires interim transit service to be initialized. As mentioned above, the focus of this study was to evaluate the long-term feasibility of rapid transit service. Minimal short-term analysis has been completed regarding transit service to Hurricane. Some analysis was completed as part of the development of the *Dixie Coordinated Transportation Implementation Tool,* dated August 2009. However, further analysis will be required to define and implement a near-term bus service plan for this alignment. If possible, the interim service route to Hurricane should be provided along the same corridor defined in this study.

9.3.3 Overall Transit System

While there are opportunities to phase in transit service in the proposed BRT corridors, development of these two corridors should proceed in parallel with improved transit in the region. An expanded transit system meets several needs, it:

- Provides a base level of transit service as the region grows
- Ensures that most of the region has reasonable access to the BRT corridor
- Satisfies FTA requirements for financial and service capacity

The planned size of the future regional transit system is a local decision based on the potential availability of local operating funds. As models, other peer systems average about 2 peak buses per 10,000 in population (and range from 1 to 4 buses per 10,000 persons). Today, SunTran has less than 1 peak bus per 10,000 persons. With future growth expected to reach a population greater than 400,000, the system could grow to at least 80 peak buses based on the peer system average. This would represent a tenfold increase from current levels. FTA generally requires that BRT systems make up no more than 10 to 20 percent of total transit system operating budget. As overall transit service for the region expands over time, the transit system will need to provide more frequent service and also new lines that provide more direct service and better coverage. For example, some existing one-way loop routes could be converted into separate two-way lines as resources allow.

9.3.4 System and Land Use Integration

The future overall transit system for Washington County needs to weave the BRT mode into the local bus network. As the overall transit system grows and changes, it will be important to maintain seamless connections and transfer opportunities that maximize the potential travel market for transit service. Bus routes should be configured to feed rather than duplicate the BRT service.

To maximize transit's potential to capture higher shares of the travel market, it is important to coordinate planning efforts for the overall transit service with land use and zoning policies. To the extent possible, higher density growth should be located proximate to major transit corridors such as the BRT corridors considered in this study. Pedestrian access elements of developments and BRT stations should also be closely coordinated to enhance the attractiveness of transit service to "choice riders".

APPENDIX

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APPENDIX A: REFERENCES

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APPENDIX B: STAKEHOLDER PARTICIPATION

The following figures were displayed at the Dixie Transportation Expo to summarize the Dixie BRT Feasibility Study.

Figure B.1: BRT Overview Board

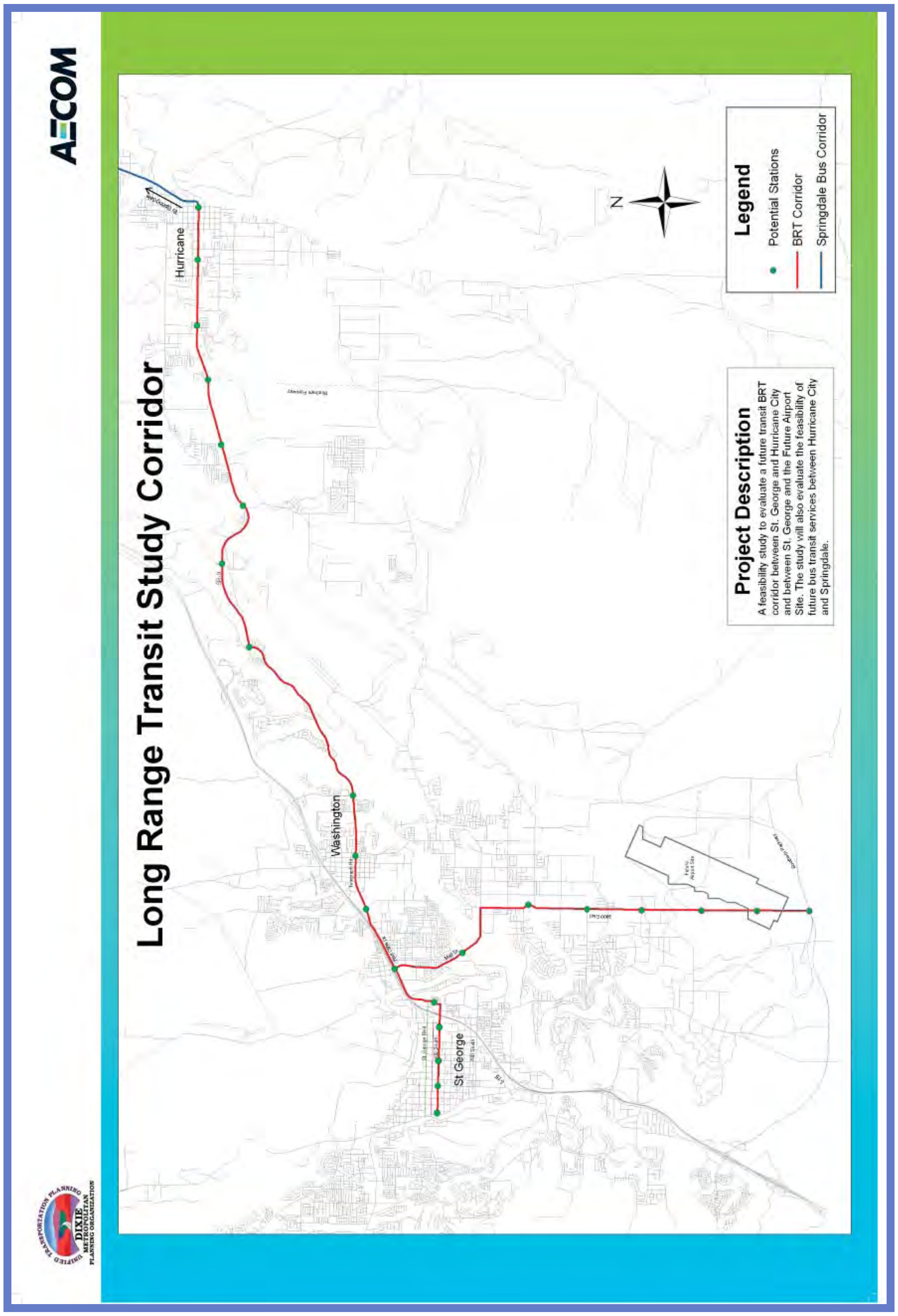

Figure B.2: St. George BRT Corridor Board

The following tables summarize the results of the public survey taken at the Dixie Transportation Expo.

Table B.4: Transit Improvements Responses

Transit Improvements	Faster Service	More Frequent Service	Better Stations	Service to Hurricane / Washington	Service to New Airport	Service to Zion Nat. Park
Respondents	48	53	52	53	67	66
Non-Respondents	31	26	27	26	12	13
Total 1's	4	1	1	3	1	0
% of Respondents	8%	2%	2%	6%	1%	0%
Total 2's	3	3	2	1	0	3
% of Respondents	6%	6%	4%	2%	0%	5%
Total 3's	12	10	13	9	6	14
% of Respondents	25%	19%	25%	17%	9%	21%
Total 4's	11	19	11	8	11	21
% of Respondents	23%	36%	21%	15%	16%	32%
Total 5's	18	20	25	32	49	28
% of Respondents	38%	38%	48%	60%	73%	42%
Avg. of Respondents	3.8	4.0	4.1	4.2	4.6	4.1

Ratings range from 0=Not Important to 5=Very Important

Table B.5: Travel to BRT Responses

Travel to BRT	Total	.25-.50 mile walk	5-10 min. transit	5 min. drive
Survey Respondents	79	48	21	15
Percent	100%	61%	27%	19%

Table B.6: Transit Riders Responses

Riding Transit	Total	Transit Riders
Survey Respondents	79	7
Percentage	100%	9%

Table B.7: Work Characteristics

Respondent Place of Work Characteristics	Total	St. George	Washington	Hurricane	Retired	Other
Survey Respondents	79	16	2	2	47	12
Percentage	100%	20%	3%	3%	59%	15%

Table B.8: Living Characteristics

Respondent Place of Living Characteristics	Total	St. George	Bloomington	Sun River	Washington	Hurricane	Santa Clara	Ivins	Green Valley	La Verkin	Other
Survey Respondents	79	22	15	7	3	3	2	5	4	1	17
Percentage	100%	28%	19%	9%	4%	4%	3%	6%	5%	1%	22%

Table B.9: Reasons for Not Choosing Transit

Reasons for Not Choosing Transit	Non-Transit Riders	Personal Vehicle	Inconvenient	No Need	No Service	Other	No Response
Survey Respondents	72	10	8	6	17	3	28
Percentage	100%	14%	11%	8%	24%	4%	39%

Table B.10: Concerns with the BRT System

BRT System Concerns	Total	No Response	"Yes" Respondents	"No" Respondents	Cost	Traffic Impacts	Environmental Concerns	Ridership	Bicycle Access	Other
Survey Respondents	79	10	18	51	7	2	3	1	2	3
Percentage	100%	13%	23%	65%	39%	11%	17%	6%	11%	17%

Table B.11: Concerns with Transit Corridors

Transit Corridor Topics	Total	No Response	"Yes" Respondents	"No" Respondents	Traffic Impacts	Cost	Increase Service Area	Bicycle Access	Other
Survey Respondents	79	15	11	53	2	2	5	2	0
Percentage	100%	19%	14%	67%	18%	18%	45%	18%	0%

APPENDIX C: DIXIE PLANNING AREA CONTEXT

The following figures show the 2007 and 2035 employment densities, respectively.

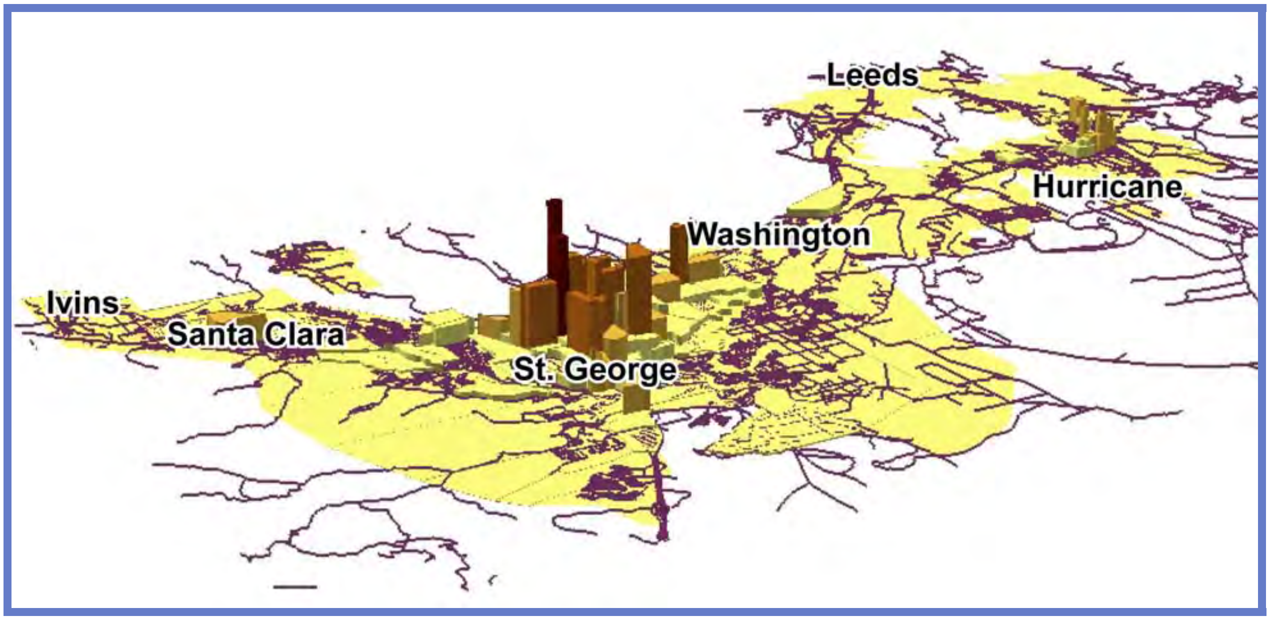

Figure C.1: 2007 Employment Densities

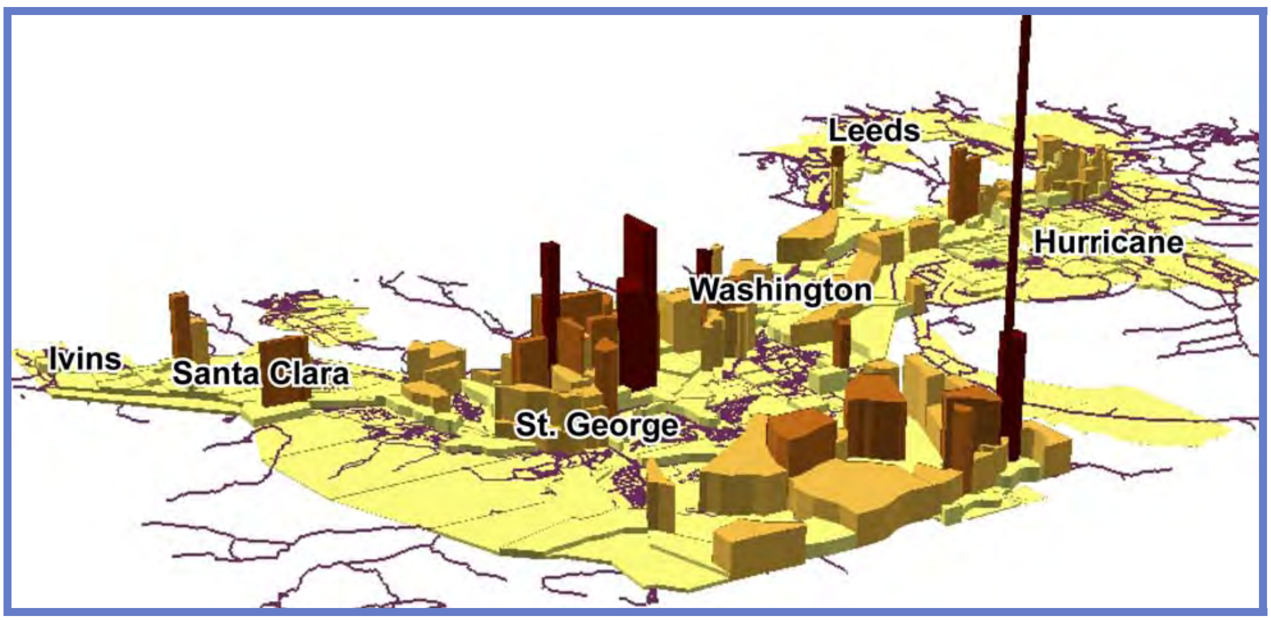

Figure C.2: 2035 Employment Densities

APPENDIX D: RIDERSHIP FORECASTS

The following matrices summarize the capture rates used for the BRT service investment alternatives.

Table D.1: Basic BRT Mode Split (Capture Rates)

		Origination											
	Zone #	BRT-1	Transit-1	Drive-1	BRT-2	Transit-2	Drive-2	BRT-3	Transit-3	Drive-3	Walk-4	Transit-4	Drive-4
Destination	Walk-1	1%	1%	0%	6%	3%	1%	8%	4%	2%	6%	2%	0%
	Transit-1	0.5%	0%	0%	3%	1%	1%	4%	2%	1%	2%	1%	1%
	Drive-1	0%	0%	0%	1%	1%	0%	2%	1%	0%	0%	1%	0%
	Walk-2	6%	3%	1%	2%	0%	0%	7%	4%	3%	6%	3%	1%
	Transit-2	3%	1%	0.5%	0%	0%	0%	4%	2%	1%	3%	2%	0%
	Drive-2	1%	0.5%	0%	0%	0%	0%	3%	1%	0%	1%	0%	0%
	Walk-3	8%	4%	2%	7%	4%	3%	2%	2%	0%	5%	2%	1%
	Transit-3	4%	2%	1%	4%	2%	1%	2%	0%	0%	2%	1%	0%
	Drive-3	2%	1%	0%	3%	1%	0%	0%	0%	0%	1%	0%	0%
	Walk-4	6%	2%	0%	6%	3%	1%	5%	2%	1%	2%	1%	0%
	Transit-4	2%	1%	0.5%	3%	2%	0%	2%	1%	0%	1%	0%	0%
	Drive-4	0%	0.5%	0%	1%	0%	0%	1%	0%	0%	0%	0%	0%

Table D.2: Moderate BRT Mode Split (Capture Rates)

		Origination											
	Zone #	BRT-1	Transit-1	Drive-1	BRT-2	Transit-2	Drive-2	BRT-3	Transit-3	Drive-3	Walk-4	Transit-4	Drive-4
Destination	Walk-1	2%	1%	0%	8%	4%	1%	10%	6%	2%	8%	2%	0%
	Transit-1	1%	0%	0%	4%	1%	1%	6%	2%	2%	2%	1%	1%
	Drive-1	0%	0%	0%	1%	1%	0%	2%	2%	0%	0%	1%	0%
	Walk-2	8%	4%	1%	3%	0%	0%	8%	5%	4%	8%	3%	1%
	Transit-2	4%	1%	0.5%	0%	0%	0%	5%	4%	1%	3%	2%	0%
	Drive-2	1%	0.5%	0%	0%	0%	0%	4%	1%	0%	1%	0%	0%
	Walk-3	10%	6%	2%	8%	5%	4%	3%	3%	0%	6%	3%	1%
	Transit-3	6%	2%	2%	5%	4%	1%	3%	0%	0%	3%	2%	0%
	Drive-3	2%	2%	0%	4%	1%	0%	0%	0%	0%	1%	0%	0%
	Walk-4	8%	2%	0%	8%	3%	1%	6%	3%	1%	3%	2%	0%
	Transit-4	2%	1%	0.5%	3%	2%	0%	3%	2%	0%	2%	0%	0%
	Drive-4	0%	0.5%	0%	1%	0%	0%	1%	0%	0%	0%	0%	0%

The following tables present the zone-to-zone ridership for the BRT system. The Short-Range and Mid-Range forecasts used the Basic BRT capture rates to project the ridership. The Long-Range forecast used the Moderate BRT capture rates.

Table D.3: Short-Range Zone-to-Zone BRT Trips

		Origination												Total
	Zone #	Walk-1	Transit-1	Drive-1	Walk-2	Transit-2	Drive-2	Walk-3	Transit-3	Drive-3	Walk-4	Transit-4	Drive-4	Destinations
Destination	Walk-1	438	82		277	45	36	117	72	38	206	62	-	1,373
	Transit-1	82			60	6	9	52	32	18	27	9	14	308
	Drive-1				35	5		35	21		-	6		101
	Walk-2	278	60	34	459	-		59	48	49	191	37	19	1,234
	Transit-2	46	6	5	-			11	8	5	23	5	-	109
	Drive-2	36	9					24	12		11	-		91
	Walk-3	118	52	35	60	11	24	416	171		26	6	12	930
	Transit-3	73	32	21	48	8	12	171			12	4	-	381
	Drive-3	38	18		49	5					7	-		117
	Walk-4	208	27	-	192	23	11	26	13	7	68	14		588
	Transit-4	63	9	6	38	5	-	6	4	-	14			145
	Drive-4	-	14		19	-		12	-					44
Total Originations		1,381	308	100	1,235	108	92	929	379	116	584	143	44	**5,421**

Table D.4: Mid-Range Zone-to-Zone BRT Trips

		Origination												Total
	Zone #	Walk-1	Transit-1	Drive-1	Walk-2	Transit-2	Drive-2	Walk-3	Transit-3	Drive-3	Walk-4	Transit-4	Drive-4	Destinations
Destination	Walk-1	437	82		260	49	49	116	75	52	300	82	-	1,502
	Transit-1	82			55	8	12	59	36	25	45	18	17	358
	Drive-1				35	6		45	26		-	12		125
	Walk-2	261	55	34	448	-		68	54	51	235	59	21	1,288
	Transit-2	50	8	6	-			20	14	8	37	13	-	156
	Drive-2	49	12					44	21		21	-		148
	Walk-3	117	59	45	68	20	44	566	241		55	17	18	1,250
	Transit-3	76	36	26	54	14	21	242			27	10	-	507
	Drive-3	52	25		51	8					19	-		155
	Walk-4	303	46	-	236	37	21	55	27	19	341	63		1,147
	Transit-4	83	18	12	60	13	-	17	10	-	63			275
	Drive-4	-	17		21	-		18	-					56
Total Originations		1,510	358	124	1,289	155	147	1,250	505	154	1,144	273	57	**6,966**

Table D.4: Long-Range Zone-to-Zone BRT Trips

		Origination												Total
	Zone #	Walk-1	Transit-1	Drive-1	Walk-2	Transit-2	Drive-2	Walk-3	Transit-3	Drive-3	Walk-4	Transit-4	Drive-4	Destinations
Destination	Walk-1	836	163		334	64	59	145	114	60	467	90	-	2,333
	Transit-1	163			72	9	15	101	41	64	67	27	23	582
	Drive-1				35	8		56	61		-	19		179
	Walk-2	336	72	35	648	-		84	68	78	360	75	25	1,781
	Transit-2	65	10	8	-			35	35	12	54	21	-	238
	Drive-2	60	15					83	27		36	-		221
	Walk-3	146	101	55	84	34	83	1,156	481		113	43	27	2,325
	Transit-3	115	42	61	68	35	27	482			69	33	-	932
	Drive-3	61	64		79	12					36	-		252
	Walk-4	471	67	-	361	54	36	113	68	36	1,091	256		2,552
	Transit-4	91	28	19	75	21	-	44	33	-	256			567
	Drive-4	-	22		25	-		27	-					74
Total Originations		2,344	583	178	1,781	237	220	2,325	929	250	2,549	565	75	**12,036**

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