

ASSESSING BUS RAPID TRANSIT (BRT) AS AN ALTERNATE,
MODE OF TRANSPORTATION,
FOR DALLAS COUNTY

by

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Abstract

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Traffic congestion in the Dallas County area continues to worsen while transportation funding continues to decline. Even if funding was available it is no longer possible to build our way out of congestion. The Dallas County area has reached a crucial stage in which new innovative methods are required to address congestion. This paper will propose the integration of an alternative mode of transportation known as Bus Rapid Transit (BRT). The analysis performed in this study will utilize the methodology developed by the Institute for Transportation and Development Policy to identify a potential BRT corridor in Dallas County. Existing transportation policies that have been developed by planning agencies in the area to address mobility will be evaluated and case studies of cities that have incorporated BRT will be examined. The analysis will identify that the corridors do exist in the Dallas County area that would benefit from BRT.

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Chapter 1

Introduction

The Dallas-Fort Worth area is described as one of America's fastest-growing cities in the country (US Census. June 2012) and is currently the fourth-largest metropolitan area (US Census. 2012) in the United States with an approximated population of 6.5 million and is estimated by the North Central Texas Council of Governments (NCTCOG) to increase to 9.8 million by 2035 (NCTCOG. 2013). This unprecedented growth has resulted in an increase in automobile usage that has made traffic congestion worse in Dallas County as will be evident in the 'Dallas County' section of this report. The undesired effects that manifest from congestion include but are not limited to travel delays, the inability to estimate travel times, inefficient fuel consumption, and air pollution. The Metroplex has approached a stage in which it no longer can continue to build new transportation infrastructure to accommodate the rapid population growth. According to the NCTCOG's Metropolitan Planning Organization (MPO), even with the current funding appropriated towards transportation improvements, congestion will continue to worsen and will result in an estimated 45 percent increase in travel time (NCTCOG. 2013).

The public transportation options currently available to residents, workers and visitors in Dallas County include conventional bus transport, express bus service, light rail, commuter rail, toll roads, and high-occupancy vehicle (HOV) lanes. Despite these various modes of transportation, the size of Dallas County may not provide all residents with a transit option that fits their particular needs. These residents may have a desire to use public transportation but are compelled to use their automobiles, which is an underlying source to the congestion problem. An alternative transit system which can conceivably benefit Dallas County and aid in mitigating traffic congestion is a high-

capacity bus rapid transit system (BRT) that can be linked to existing managed lanes or serve as an extension to existing transit corridors. BRT is defined as:

A flexible, high performance rapid transit mode that combines a variety of physical, operating and system elements into a permanently integrated system with a quality image and unique identity. (CBRT. 2009)

According to Levinson (2007) many cities consider BRT as an alternative rapid transit mode for the many benefits that it provides. These benefits include the following:

1. BRT is a system that can be implemented quickly and incrementally.
2. BRT has the ability to be the most flexible rapid transit mode for cost-effectively serving a broad variety of urban and suburban environments and markets.
3. BRT can operate on arterial streets, freeway medians, freeway shoulders, alongside freeways, and tunnels.
4. BRT can accommodate express and local services on a single facility.
5. BRT can provide sufficient transport capacity for most urban corridors.
6. BRT can be less costly to implement than a rail transit line while providing similar benefits.
7. BRT has little additional implementation costs over local bus service where it runs on streets and highways.
8. BRT can generate significant urban development benefits.

A BRT system could reduce the time it would take residents to reach destinations in Dallas County by utilizing the many features that comprise BRT, such as segregated bus lanes and intelligent transportation systems. The successful integration of BRT into the existing public transportation system has the potential to reduce the number of automobiles on existing roadways by providing a rapid service that appeal to resident's needs that are not provided through existing transport services.

Dallas County does not currently have this type of transportation because it is not offered by the Dallas Area Rapid Transit (DART) authority, who operates the public transportation system in the area and other surrounding counties. Instead of considering an economically feasible and flexible system such as BRT it would appear that DART is concentrating its efforts on light rail transit (LRT) or transit services with similar characteristics to BRT. There may be areas in Dallas County that would benefit from the features offered by BRT that are located within the DART service area. The inherent question that this paper attempts to answer, is whether there is an area within Dallas County that can incorporate a BRT system and if so, where?


Dallas County

The Dallas County area identified in Figure 1-1 is the second largest populated county in the State of Texas with a land area of 880 square miles and is currently the ninth largest populous county in the United States (U.S. Census. 2012). Dallas County is comprised of 26 cities and its population is estimated to increase approximately 25 percent between 2013 and 2035 (Figure 1-1). Employment is expected to increase 31 percent between 2013 and 2035, which will further increase the population growth in Dallas County as more people from surrounding areas seek new job opportunities.

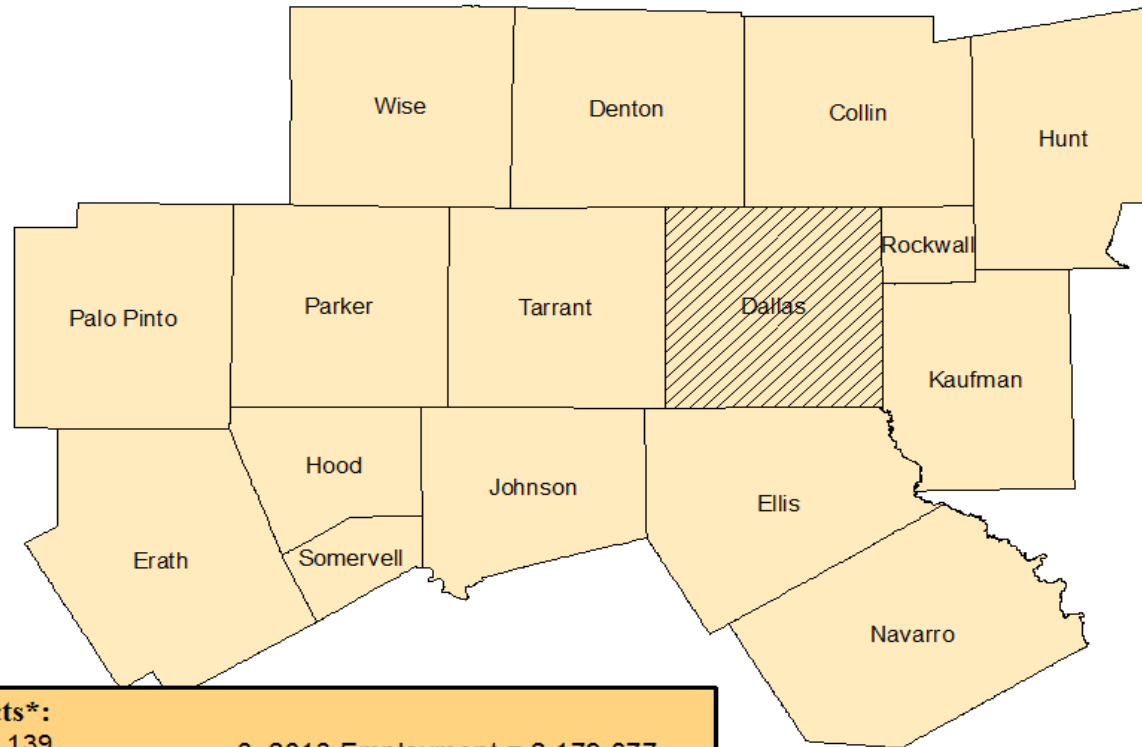
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North Central Texas Region - County Location

Legend

 Study Area

0 5 10 20
Miles



Dallas County Quick Facts*:

- | | |
|--|--------------------------------|
| 1. 2000 Population = 2,368,139 | 8. 2013 Employment = 2,179,877 |
| 2. 2013 Population = 2,466,027 | 9. 2035 Employment = 2,854,287 |
| 3. 2035 Population (estimate) = 3,125,282 | |
| 4. 2013 Vehicle Miles of Travel (Daily) = 69,471,713 | |
| 5. 2035 Vehicle Miles of Travel (Daily) = 96,203,999 | |
| 6. 2013 Vehicle Hours Spent in Delay (Daily) = 558,151 | |
| 7. 2035 Vehicle Hours Spent in Delay (Daily) = 949,291 | |



*Source: NCTCOG - Mobility 2035; Texas State Data Center; US Census

August 1, 2013

Figure 2-1-1 North Central Texas Region

As the population growth increases, the number of vehicles on the road will also increase. According to the Department of Motor Vehicles (DMV. 2001 & 2012), the number of motor vehicle registrations in Dallas County in year 2000 was 1.7 million, and in 2012 this number was just over 1.9 million. The vehicle miles of travel (VMT) and vehicle hours spent in delay are estimated to increase as shown in Figure 1-1, which will effect the level of service (LOS) of roadways throughout the area. This has a direct affect on motorists in terms of travel time which currently takes 45 percent longer to complete due to congestion according to the MPO (NCTCOG. 2013). The LOS is a letter designation (A through F) assigned to roadways that describes the traffic flow on a particular road. For example, roads that are designated as A, B, or C, typically are capable of travelling at the posted speed limits with little interference from vehicles, whereas a LOS of F implies that the volume of traffic on a roadway exceeds the capacity of a road which causes vehicles to experience stop and go movement.

According to the US Census Bureau, in 2011 approximately 79 percent of workers in Dallas County drove to work alone while only 11 percent carpooled. The percentage of all workers who used public transportation in Dallas County to work in 2011 was 2.8 percent (Figure 1-2). The average one-way commute to work for people living in Dallas County in 2011 was 25.8 minutes and 6.1 percent of all workers had a commute of 60 minutes or more (Figure 1-3).

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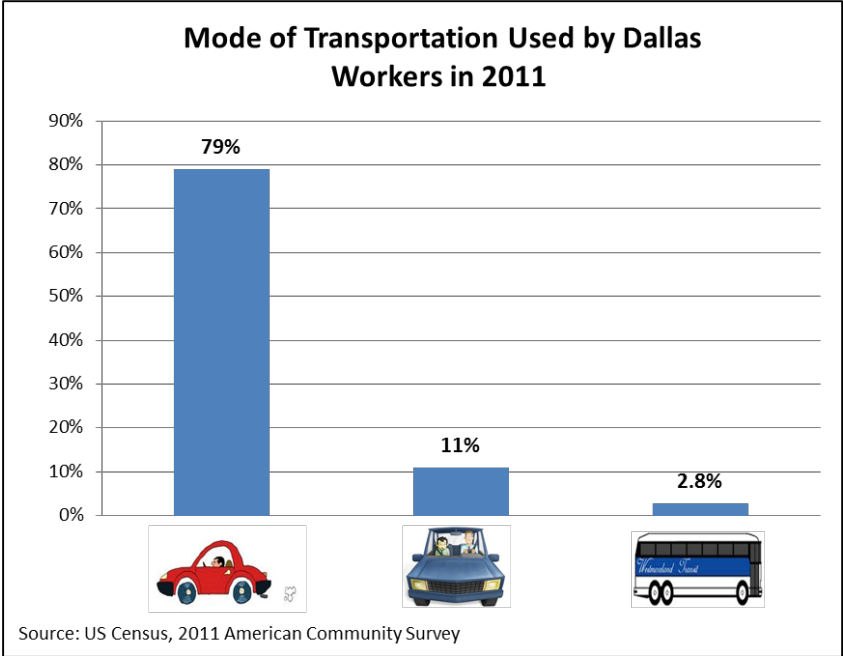


Figure 2-2 Travel Mode Used by Dallas Workers

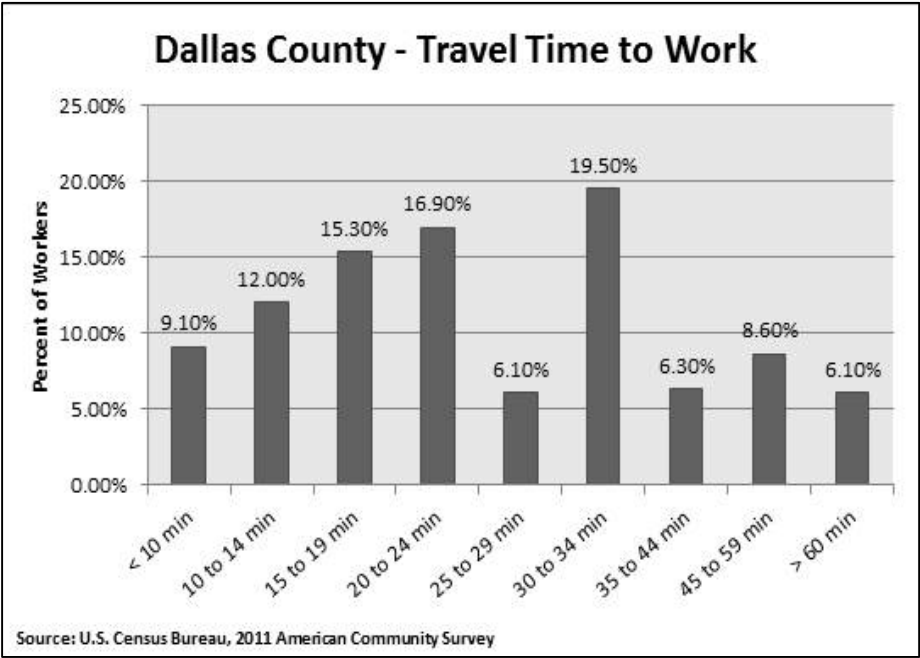


Figure 1-3 Travel Time to Work

Existing DART Services

It is important for communities to understand how BRT is defined because several existing systems incorporate some or several elements of BRT such as; bus-only roadways, vehicles, an integrated network of routes and corridors, enhanced stations, superior customer service, high platforms, pre-board fare collectors, specific branding, limited stops, of which not all communities incorporate everything (Davis. 2013). DART has not utilized all of the unique characteristics that makeup BRT. DART's express and rapid bus service for example utilize some but not all of the elements that make a complete BRT system. A review of each element will be presented in Chapter 2 of this report. These transit services offered by DART are arguably inferior because they do not use the multitude of BRT elements which make it superior to other transport options. Another transportation option offered by DART is LRT which can be costly to construct and is limited to very few corridors in which it can operate, resulting in a system that does not meet the broader transportation needs of Dallas County. In addition, the current economic setting does not warrant the attention that DART has given to light rail transit (LRT). BRT may be an economically viable alternative that can benefit a large array of riders and with strong marketing and political support; this system can brand Dallas County as a BRT mecca.

Research goals

The objectives of this study include evaluating what DART and the NCTCOG have proposed in regards to addressing the issue of congestion and through this literature review process gauge the level of support that each organization has for BRT. In addition, case studies of other cities within the United States that have integrated a BRT system will be studied and from these, identify the impacts BRT has had to its region. Additionally, this report will analyze transportation related data to identify

congested areas within Dallas County and determine where transit service is slow, overcrowded, or unreliable. This analysis will provide a list of roadway corridors that may benefit from the integration of a BRT system. Large concentrations of employment and/or residential areas that a BRT can interconnect will be examined and an action plan will be formulated in identifying a potential BRT line in Dallas County. The utilization of high occupancy vehicle (HOV)/managed lanes as part of a potential BRT corridor will also be studied.

This report will be limited to performing a demand analysis of Dallas County and not include other aspects typically involved when planning for BRT, which includes operational design, physical design, finance, impact assessment and implementation.

The goal of this study is to identify an area in Dallas County that could benefit from the integration of a BRT system, which would add to the transport choices that residents have throughout Dallas County. The integration of a BRT system in conjunction with other transit systems has the potential to further reduce the number of automobiles on roadways and alleviate traffic congestion.

Chapter 2

Bus Rapid Transit (BRT)

A solution utilized by other states and countries to address mobility issues is Bus Rapid Transit (BRT). According to Arias et al (2007) a BRT serves as a high quality bus based transit system that transports riders rapidly, comfortably, and is a cost-effective urban mobility alternative. These elements are delivered through the use of segregated right-of-ways, rapid (fewer stops) and frequent operations, excellent marketing and customer service (Figures 2-4 and 2-5). Similarly, Levinson (2003) identifies BRT as a flexible, rubber tired form of rapid transit that combines stations, vehicles, services, running ways, and Intelligent Transport System (ITS) elements into an integrated system

with a strong identity. A BRT system according to Arias et al (2007) emulates the performance and amenities that a rail-based transit system offers at a lesser cost. The results of case studies performed by Levinson (2003) concluded that BRT systems were implemented primarily because of lower costs and larger operating flexibility as compared to rail transit.



Figure 2-4A BRT Characteristics

Note: a) Segregated lanes allow vehicles to bypass congested areas. b) Vehicles and landscaping can promote new development and enhance communities.



Figure 2-4B BRT Characteristics

Note: c) Vehicle emulates LRT cars. d) BRT stations can provide amenities such as seating, climate-controlled shelter and designs can enhance the area.

The major elements of a BRT system identified by Diaz (2009) and Levinson (2003) include: running ways; stations; vehicles; fare collection; Intelligent Transportation

Systems (ITS); Service and Operations Plan; and unique features (e.g. vehicles) that differentiate a BRT system from other transit modes, also known as branding. ITS improves transportation system performance through the use of communication technologies. There are various ITS applications for BRT systems and they include the following (Diaz. 2009):

- Transit Vehicle Prioritization: BRT vehicles are given priority when passing through intersections or sections of roadway.
- Intelligent Vehicle Systems: Provides a BRT vehicle with automated controls for steering, speed control, and stopping to reduce the frequency and severity of crashes and collisions.
- Operations Management Systems: Enhances BRT operations by increasing service reliability, improving operating efficiencies and reduces travel time through the use of software that aides agencies with driver scheduling, dispatching, and vehicle assignment.
- Passenger Information Systems: Provides customers with BRT information which can lessen the burden on staff who provide information to the public.
- Safety and Security Systems: Improves safety and security and reduces response time to incidents.
- Electronic Fare Collection: Simplifies and increases efficiency amongst riders.

The types of lanes utilized by a BRT system include curb lanes, reserved lanes, or mixed traffic lanes (i.e. pedestrian and vehicles) which are known in the industry as running ways and depending on the type of lane used, are considered a key component to the rapid and reliable service that BRT is known for. The stations act as the entry points into

a BRT system and are considered by Diaz (2009) key to customer interface because they provide a link between the system and its customers. Stations also play a major role in distinguishing a BRT system through visual and physical characteristics. The vehicles can vary in many ways which can also establish the identity of a BRT system. The vehicles are where customers spend most of their time and it is the vehicle that non-customers will see most of. The fare collection types also vary and can affect customer convenience and accessibility. According to Diaz (2009), fare collection can affect ridership which affects revenue. The goal of the fare collection system is to promote rapid boarding, which reduces dwell times. The last three elements (ITS, Service and Operations Plan, and Branding) affect performance, service and the perception of BRT systems, all of which are important to the success of BRT.

Case Studies

There are many areas throughout the United States that have implemented BRT into its region and some of these cities as discussed by Levinson (2003) include; Pittsburg, PA, Los Angeles, CA; Hartford, CT; and Boston, MA. The following synopsis presents the various ways in which BRT has been implemented in these cities and the affect they have had according to Levinson (2003).

BRT Case Study: Pittsburgh, Pennsylvania

The City of Pittsburgh has a BRT system known as the South, East, and West Busways, which is comprised of approximately 16.1 miles of bus service lanes. These busways serve approximately 20 percent of Allegheny County's daily transit riders of which the City of Pittsburgh is part of. The busways link the South, East, and West communities to the city center which has provided travelers significant savings in passenger travel time. The average speed on each busway is between 30 and 40 mph, though no comparison against conventional bus routes was provided in this case study, it

is understood that by integrating BRT elements previously mentioned, the average speed of buses will increase.

The Pittsburgh population at the time this case study was written was approximately 1.7 million, of which 400,000 lived within the city. The central business district (CBD) employed an estimated 140,000 workers and during each peak hour of travel, approximately 60,000 people entered or left this area, and from this, 60 percent used public transport. The city's emphasis on public transportation was originally triggered by community reaction to proposed highway improvements. Since the 1950's traffic congestion had been increasing on the Penn Lincoln Parkway in Pittsburgh and the costs associated with rebuilding the Parkway with new infrastructure, disruption to existing service that would result from construction, and a 7-year completion date were unacceptable to the local community.

In a joint effort made up of the state, county, Port Authority Transit (PAT), and the city, busways were proposed as an alternative transit strategy in response to the communities concerns with the proposed highway improvements. This strategy was considered economically feasible, practical, politically viable, and easy to implement. The busways are two-lane, bus-only access roadways with no intersections except for bus access points. The design of the busways allowed for future conversion to light-rail transit if required. Design speeds for East and West busways was 60 mph and 50 mph on the South busway.

Stations along the busways provide adequate shelter for passengers and are compliant with the Americans with Disabilities Act (ADA). Some of the stations featured weather protective shelters with an aesthetically pleasing design. Some of the passenger amenities found within the stations included newspaper boxes, bike racks, telephones, customer service, security phone system, and general transit information.

The vehicles for the busway system comprised of three types of buses:

- 35-foot bus with a seating capacity of 33-36 seats
- 40-foot bus with a seating capacity of 39-53 seats
- 60-foot articulated bus with a seating capacity of 63 seats

All vehicles were equipped with multiple doors on one side and several of the vehicles had either low floor or high floors. Low floor buses allow for quicker boarding and alighting of passengers according to Kantor (2006). A few of the buses at this time ran on compressed natural gas while the remaining fleet of vehicles ran on diesel with reduced emissions.

According to Levinson (2003) marketing efforts began prior to the busways opening. Segments of the East Busway for example were toured by various community groups that had participated in the planning process, brochures were distributed, and free busway service was offered the weekend prior to opening.

The opening of the three busways has reduced travel times significantly because each busway is able to bypass congested roads and tunnels. Table 2-1 identifies the peak period travel time savings associated with each busway. Travel time reliability has also improved for each busway. The savings from travel times has made it possible for the Port Authority to provide additional bus trips and has resulted in lower operating costs. The East Busway had an operating and maintenance cost of \$0.95 per passenger, compared to the \$3.22 for the LRT/Streetcar service according to Levinson (2003).

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Table 2-1 Summary of Busways

BUSWAY SUMMARY (2002)				
	SOUTH BUSWAY	MLK JR. EAST BUSWAY	WEST BUSWAY	EAST BUSWAY EXTENSION
Year Opened	1977	1983	2000	2003 (est)
Length	4.3 mi	6.8 mi	5.0 mi	2.3 mi
Capital Cost	\$27 million	\$113 million	\$275 million	\$62.8 million
Peak Period Travel Time Savings (Minutes)	6-11	21-24	25-26 ¹	Not Available
Bus Routes	16	36	14	Not Available
No. of Stations/Stops	8	6	6	4
Weekday Ridership	13,000	28,000	7,000	13,600 (est)
Daily Bus Trips (Two-Way)	500	1,000	250	Not Available
Average Speed	40 mph-Express 30 mph-Local	41 mph-Express 30 mph-Local	42 mph-Express 30 mph-Local	
The busways have saved riders approximately 6 to 25 minutes in travel time. For example, a bus ride to downtown from the East Busway terminal in Wilkinsburg used to require 20 to 60 minutes of travel time and now only takes 9 to 13 minutes of travel time.				

Source: Levinson (2003)

Note: 1) A.M. Inbound One Way

The development cost for the various busways was approximately \$415 million for the 16.1 miles of completed busway which equates to \$25.8 million per mile. Table 2-4 list the various costs associated with each busway. The high cost per mile for the West busway can be attributed to the rehabilitation of a rail tunnel and hilly terrain.

Maintenance costs according to Levinson (2003) were \$475,000 per year for the South Busway or approximately \$110,000 per mile. The East Busway maintenance costs were \$724,000 per year or \$107,000 per mile. Table 2-2 list the various development costs associated with each busway (Levinson. 2003).

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Table 2-2 Development Costs

Busway Costs			
Busway	Miles	Cost (Millions)	Cost/Mile (Millions)
South	4.3	\$27	\$6.30
East	6.8	\$113	\$16.60
West	5	\$275	\$55.00
Total	16.1	\$415	\$25.80

Source: Levinson (2003)

The benefits produced from the implementation of these busways include; providing riders faster and more reliable services; reduced operating costs; and it has helped communities by encouraging development. The busways have saved passengers approximately 6 to 25 minutes in travel time and improved access to major employment, commercial, entertainment, educational, and retail locations. For example, a bus ride to downtown Pittsburgh from the East Busway terminal in Wilkinsburg used to take 20 to 60 minutes of travel time, and with the new busway the time has been reduced to 9 or 13 minutes. Each busway serves as an extended bypass of congested roads and tunnels in the area with speeds between 30 and 40 mph. The incorporation of the busways has improved the appearance of communities through the integration of new landscaping, lighting, and stations. The enhanced appearances have attracted new development in the area. Approximately 59 new developments between 1980 and 1990 took place adjacent to or were within 1500 feet of busway stations which equated to a 6-minute walk. The value of the new developments was \$302 million of which \$225 million involved new construction. It was estimated that \$242 million of new development was clustered at stations. The most common uses surrounding these stations according to Levinson (2003) were retail, office, residential, and medical.

A comparison study between the City's busway and light rail system was performed. From this study it was determined that the capital and operating costs per trip was less for busways (Levinson. 2003). The study did not include comparisons between existing bus services and new BRT system. The comparisons included the City of Pittsburgh's South and East Busways and light rail lines in the following cities: Buffalo, Pittsburgh, Portland, and San Diego. Table 2-3 list the cost comparisons between these two transportation systems. The author acknowledges that the City of Buffalo and Pittsburgh's rail lines have a subway section which contributed to increased construction costs.

Table 2-3 Bus and Light Rail Comparison

Bus System and Light Rail Comparison (1989 Dollars)						
System	System Length (miles)	Capital Cost (Millions)	Weekday Ridership	Ridership (per mile)	Capital Costs/Mile (Millions)	Operating Cost (per trip)
Light Rail						
Buffalo	6.4	\$565	30,000	4,700	\$88	\$1.27
Pittsburgh	10.5	\$523	18,000	1,700	\$50	\$1.63
Portland	15.1	\$233	19,000	1,300	\$15	\$1.03
Sacramento	18.1	\$184	14,000	800	\$10	\$1.68
San Diego	20.4	\$183	27,000	1,300	\$9	\$0.97
Average	14.1	\$338	21,600	1,960	\$35	\$1.31
Busway						
Pittsburgh East	6.8	\$138	29,000	4,300	\$20	\$0.47
Pittsburgh South	4	\$38	18,000	4,500	\$9	\$0.61
Average	5.4	\$88	23,500	4,400	\$15	\$0.54

Source: Levinson (2003)

The analysis concluded that evidence exists that identifies busways as having an advantage over light rail. The conclusions from this comparison study include the following (Levinson. 2003):

- Busways have carried as many riders as LRT. Busways can operate within short distances and still provide an acceptable level of service; they carry more riders per mile of guideway.
- Busways have an operating cost advantage. They can cost less than half as much per passenger to operate than light rail. From this study it can be shown that an \$80 million BRT carries as many riders as a \$310 million LRT.
- BRT can be alluring to development since it emulates many LRT characteristics.
- BRT is simple to operate and maintain. BRT provides greater operational flexibility than LRT (e.g. the ability to skip stops or to not stop at any stations along the corridor if the passenger demand warrants it).

BRT Case Study: Los Angeles, California

The Los Angeles area is the second largest region in the United States with an urbanized population of 15 million people at the time this report was published. It is estimated that 9.6 million lived in Los Angeles County and 3.7 million lived within the city, while the CBD has over 200,000 workers. The region's transportation system is made up of freeways; commuter rail; light rail transit; local bus service; express bus service; and BRT bus service. The San Bernadino Busway is a 12-mile corridor that was built at a cost of \$57 million; it carries more than 18,000 bus riders each day at speeds of over 40 mph. There is also the Harbor Transitway which is 11-miles and serves over 9,500 riders each day at speeds over 30 mph. The Los Angeles County Metropolitan Transportation Authority's (LACMTA) Metro Rapid service is a 26-mile line along Wilshire/Whittier Boulevard and a 14-mile line along the Ventura Boulevard Line.

The planning background of the Metro Rapid Program was conceived as the result of a 1998 county referendum that outlawed future underground construction. The delays and cost overruns associated with the Red Line subway at this time led to the referendum and forced the city and county to consider other transportation alternatives.

Their attention moved to improving the bus system and establishing BRT. There were several reasons why BRT was chosen by the city and county according to Levinson (2003):

- The public was dissatisfied with the slow bus service
- The average bus speeds had declined 12% since the mid-1980s
- Upon examination by the Los Angeles Department of Transportation it was found that a bus was stopped half of the time it was in service

The Metropolitan Transit Authority (MTA) compared the various costs associated with various modes of transportation that included; Subway, Monorail/Elevated Rail, Light Rail, and Busway to put a perspective on how much each system would cost. Table 2-4 lists the various costs associated with each option. The cost identified in the table below includes the costs of new vehicles, replacing streets on rights of way; adding landscaping; construction; stations; maintenance yards; and parking facilities.

Table 2-4 Busway and Rail Transit Costs

Busway and Rail Transit Costs	
Subway	\$300 million/mile
Monorail or Elevated Rail	\$125 million/mile
Light Rail	\$75 million/mile
Busway	\$10-20 million/mile

Source: Levinson (2003)

In 1999 the Metro Rapid Program was initiated. The MTA's Board of Directors directed staff to conduct a feasibility study in response to a visit to Curitiba, Brazil by MTA and City of Los Angeles officials. The study recommended that the MTA and the City of Los Angeles conduct a demonstration project along two or three arterials that could potentially benefit from BRT. Twelve key attributes were chosen that best represented the Curitiba system. Six of these were included in the Phase I demonstration and the

remaining would be included in the Phase II system expansion. Table 2-5 lists the attributes and the phases.

Table 2-5 Curitiba BRT Attributes

Curitiba BRT System Attributes		
Attributes	Phase I Demonstration	Phase II Expanded System
Simple Route Layout	Yes	Yes
Frequent Service	Yes	Yes
Headway-based Schedules	Yes	Yes
Less Frequent Stops	Yes	Yes
Level Boarding and Alighting	Yes	Yes
Color-coded Buses and Stations	Yes	Yes
Bus-Signal Priorities		
Exclusive Lanes	No	Yes
Higher Capacity Buses	No	Yes
Multiple Door Boarding and Alighting	No	Yes
Off-Vehicle Fare Payment	No	Yes
Feeder Network	No	Yes
Coordinate Land Use Planning	No	Yes

Source: Levinson (2003)

The purpose of the Metro Rapid Bus Demonstration according to Levinson (2003) was to offer a rail-type transit service connecting the Red Line to destinations in the outlying areas. The vehicle types utilized for this program included low-floor buses with a capacity of 40 passengers. The buses ran on compressed natural gas and were painted specific colors to distinguish them from other buses and the stations were color coordinated to match the BRT vehicles. The vehicles were also equipped with bus signal priority transponders, automatic vehicle location, and automatic passenger counters.

The first phase of the Metro Rapid Program had seven objectives that included:

- Reducing Passenger Travel Times
- Increasing Service Reliability
- Increasing Corridor Ridership
- Attracting New Riders
- Improving Fleet and Station Appearance
- Improving Service Effectiveness
- Building Positive Community Relations

According to Levinson (2003) the program was a success. The operating speed, service quality, ridership, and customer response all exceeded expectations with negligible negative impacts on the remaining transportation system and general traffic.

The improved operating speeds of the vehicles resulted in travel time savings of approximately 25 percent in each corridor. Table 2-6 lists the bus speed improvements at each corridor. A study was conducted to determine which of the attributes contributed to the speed improvements and the investigation concluded that the bus signal priority system was responsible for one third of the increase and remaining elements such as wider stop spacing accounted for the remaining two thirds.

Table 2-6 Bus Speed Improvements

Bus Operating Speed Improvements		
Operating Speeds	Wilshire/Whittier Corridor	Ventura Corridor
Overall Improvement	29%	23%
Eastbound (Range)	31% (18-40%)	20% (11-29%)
Westbound (Range)	28% (21-32%)	27% (16-34%)

Source: Levinson (2003)

Delays on Ventura Boulevard were reduced from 1.8 to 0.9 minutes per mile and on Wilshire/Whittier Boulevards delays were reduced from 2.4 to 0.9 minutes per mile. Ridership on the two corridors increased approximately 25 to 33 percent (Table 2-7).

Table 2-7 Ridership Data

Ridership Data				
Total Unlinked Ridership	Wilshire/Whittier Corridor		Ventura Corridor	
	Before	After	Before	After
Local	39,708	55,946	10,800	4,650
Limited	23,785	—	—	—
Metro Rapid	—	28,207	—	9,000
Total Ridership	63,493	84,153	10,800	13,650
% Corridor Ridership				
Local	63%	66%	—	34.10%
Limited/Metro Rapid	—	20,666	—	65.90%
% Increase	—	32.60%	—	26.40%

Source: Levinson (2003)

Surveys were distributed before and after Metro Rapid to assess rider perceptions, behavior, and profiles. Some of the findings from this survey include the following:

- Customers felt a significant improvement in service performance and quality.
- All attributes of the BRT system increased but the largest increases recorded from the survey were for cleanliness, travel time on the bus, and frequency of buses.
- A large number of riders from neighborhoods that were considered low transit ridership areas south of Ventura Boulevard on Route were now using the new service.
- The Metro Rapid service has drawn non-traditional riders. Most of the passengers were existing transit users but 17 percent either used a non-transit mode or did not use this particular service trip before. Most of the riders reported income levels below \$15,000 annually, while 13 percent

reported incomes above \$50,000 versus just 6 percent for local conventional buses.

- One quarter of riders for BRT and conventional bus are from households with at least two automobiles.
- Approximately one quarter of Ventura Riders connected to the Metro Red Line to complete their journey which means that the BRT line is acting as an extension of the rail system.

According to Levinson (2003) the Metro Rapid program survey reached two conclusions; Customers perceive Metro Rapid as superior to existing bus services and Metro Rapid has increased its ridership by providing an additional transportation alternative. The overall cost for Phase 1 which includes stations and bus signal priority was \$8.3 million or approximately \$200,000 per mile. The operating cost of Phase 1 was approximately \$12.7 million or \$300,000 per mile. Further refinement of the Metro Rapid system can decrease these costs by as much as \$2 to \$3 million according to Levinson (2003).

There has been a shift in transit priorities in Los Angeles County according to Levinson (2003). The emphasis area in Los Angeles County has changed from rail to bus transit as is evident by the future planned Metro Rapid bus lines.

BRT Case Study: Hartford, Connecticut

The City of Hartford incorporated a BRT system known as the New Britain-Hartford Busway. The 9.6 mile busway line services the Hartford West Corridor which includes New Britain, Newington, West Hartford, and Hartford. The busway was scheduled to begin operations in 2007. These towns account for more than a quarter of the residents of Hartford County with a population of 225,000. The towns contain approximately 200,000 jobs which makes up about 40 percent of the county's total.

The congestion and safety deficiencies of the corridor led to a study that was completed in 1999. In the study a variety of roadway and transit options were reviewed and concluded with a recommendation that a busway with minor upgrading of Interstate 84 and select arterial improvements be adopted as the preferred option.

The study included the review of six alternatives. These alternatives briefly included the following:

1. A no build case scenario in which no improvements are made to the existing system.
2. The utilization of TSM/TDM strategies, and Transit Operations. These strategies and operations would be incorporated throughout the corridor and the TDM improvements would be focused on downtown Hartford. TSM improvements would include traffic operations and safety improvements while transit operation enhancements would include local and express bus service modifications and intermodal transportation centers.
3. Freeway Reconstruction and Operations includes improvements to areas that contain left entrance and exit ramps, partial interchanges and locations where auxiliary lanes would relieve congestion. This alternative also included the incorporation of ITS strategies such as Ramp Metering, Arterial Signal Coordination, and Incident Management.
4. The fourth alternative examined the use of LRT, Busway and Commuter Rail for various parts of the corridor. The following are the alignments that were reviewed:
 - New Britain/Plainville to Hartford Rail Right of Way: Commuter Rail, Light Rail, or Busway

- I-84 Right of Way: Light Rail or Busway
 - Farmington Avenue: Light Rail
5. Adding an HOV lane along the corridor that would operate like the HOV system in the Capital Region on Interstate 91 north and Interstate 84 east of the Connecticut River.
 6. Adding an additional general purpose freeway lane.

The cost associated with the busway located along the railroad rights-of-way had an estimated cost of \$75 million compared to \$150 million for an LRT Line along the same right of way. Costs were much higher for both a busway and LRT along I-84.

Estimated riders for each alternative were also examined for each alternative. The New Britain Busway had the largest number of transit riders, with 28,700 total daily corridor riders and 8,800 new riders estimated for year 2020 as compared to 27,200 total and 7,300 new riders for an LRT Line along the same alignment. The New Britain-Hartford Busway would carry 11,600 peak-period riders, including 4,300 new riders, as compared with 10,700 total and 2,800 new peak-period riders for an LRT Line in the same corridor.

The New Britain-Hartford Busway was selected as the preferred alternative because it had higher estimated ridership, low capital costs, higher overall speeds, and greater operating flexibility when compared to other options.

The adopted busway is located along the Amtrak/Conrail Railroad and an abandoned rail right-of-way. The 9.6 mile busway will have 18 grade separations and 8 signal protected grade crossings. The stations will have two covered platforms for loading and unloading passengers as well as weather protection, lighting, landscaping and bike racks. The projected ridership in 2020 is estimated to be 22,300 and more than half of the riders would be former motorists according to Levinson (2003).

The New Britain-Hartford Busway according to Levinson (2003) represents a mid-size metropolitan's response to providing rapid public transportation. The adoption of this busway system is a major change in policy through the Connecticut Department of Transportation by considering the use of multi-modal approaches rather than highway-only solutions.

BRT Case Study: Boston, Massachusetts

The City of Boston has a BRT system known as the Silver Line which is approximately 4.1 miles in length and connects Dudley Square, South Station, and the South Boston Seaport. The Silver Line at the time of this case study was Boston's fifth rapid transit line. The Boston area as of 2003 had approximately 3,000,000 residents of which 700,000 lived within the City of Boston. The Boston CBD employment is over 265,000. It is one of the largest and most dense areas in the region. The CBD according to Levinson (2003) relies on public transport, with an emphasis on rail transit. The concept of this new line emerged in 1998 when the Massachusetts Bay Transportation Authority (MBTA) combined the Washington Street improved bus service and the South Piers Transitway into a single system.

The Silver Line is broken into three sections. The first section provides service from South Station to World Trade Center Tunnel/Seaport District. This section is mainly a 1.1 mile tunnel and was scheduled to begin service in 2004. Costs for this section are estimated at \$600 million. The second section will provide service from Dudley Square to Downtown Crossing. This section is a 2.2 mile surface route which was schedule to open in 2002. Costs estimates for this section including low-floor articulated buses is \$50 million. The last section will provide service from New England Medical Center to South Station Tunnel. This section is a 0.8 mile tunnel which was to be completed by 2011. Cost estimates for this section are \$700 million. The high project costs for the two

sections are directly related to the complex tunnel construction required as the Silver Line will travel below the Fort Point Channel and the Green Line.

According to Levinson (2003) the reason the City utilized a BRT system in lieu of another transit type is because of its ability to service a broader area without large additional investments. The Silver Line system uses exclusive bus right-of-ways such as tunnels or bus lanes in conjunction with routes operating in general traffic. In downtown, buses will use tunnels with underground stations which provide intermodal connectivity. The vehicles comprise of 60-foot long articulated buses with a low-floor design and three sets of double doors. The buses will carry an estimated 100 passengers and include the latest onboard communication systems. Each vehicle is estimated to cost \$1.5 million. Ridership estimates in 2005 were estimated to be 40,000 and by 2025 the ridership is forecast to be more than 65,000 riders daily which with the complete three section system.

Many challenges were encountered during the development and implementation process of this system. The street network and development patterns were particularly challenging. Boston's street patterns reflected nearly 400 years of growth and development with right-of-ways that varied in width. Using BRT principles, the Silver Line incorporated priority lanes with surface stations on roadways with sufficient right-of-way and operates in mixed traffic lanes where it is not possible to provide priority lanes.

Case Study Summary

From the four case studies presented the reoccurring theme associated with integrating BRT included; the increase in average bus speeds; reduced travel times; improvement of surrounding communities through the incorporation of stations, lighting, and landscaping; ridership increased; and the cost of incorporating BRT was economically feasible versus LRT.

Existing Transportation Planning Approaches in DFW

The increase in urban congestion has resulted in the need to develop new transportation solutions and the NCTCOG and DART have adopted various policies and programs identified in the Metropolitan Transportation Plan (NCTCOG) and the Transit System Plan (DART) to address this issue. The Regional Transportation Council (RTC) which serves as the policy body of the MPO has recognized that the region cannot build additional infrastructure to sustain the population growth and is showing its support of adopting new measures through its approval of the long range transportation plan (NCTCOG. August 2013). Similarly, the 2030 Transit System Plan (TSP) developed by DART also identifies the need for new transportation solutions, and has made mobility its long range goal for its service area and beyond (DART. 2006).

In lieu of building additional roadway capacity in many areas of Dallas-Fort Worth, the MPO's Metropolitan Transportation Plan (MTP), *Mobility 2035 – 2013 Update* (NCTCOG. 2013) is utilizing measures to improve the efficiency of the transportation system by managing and reducing congestion. This entails the use of technology and operational strategies that would optimize the current roadway system. The recommendations and strategies proposed by DART's Transit System Plan (TSP) include the incorporation of additional managed HOV lanes, enhanced and rapid bus corridors, rail service and further improvement of paratransit services.

The DART service area (Figure 2-6) is made up of 13 member cities which encompass approximately 700 square miles. The future growth forecasts in the DART service area between 2005 and 2030 is expected to increase 12 percent for population and 30 percent for employment (DART. 2013). The majority of the population growth will take place outside the DART service area while approximately 50 percent of employment will be located within the areas that DART maintains.

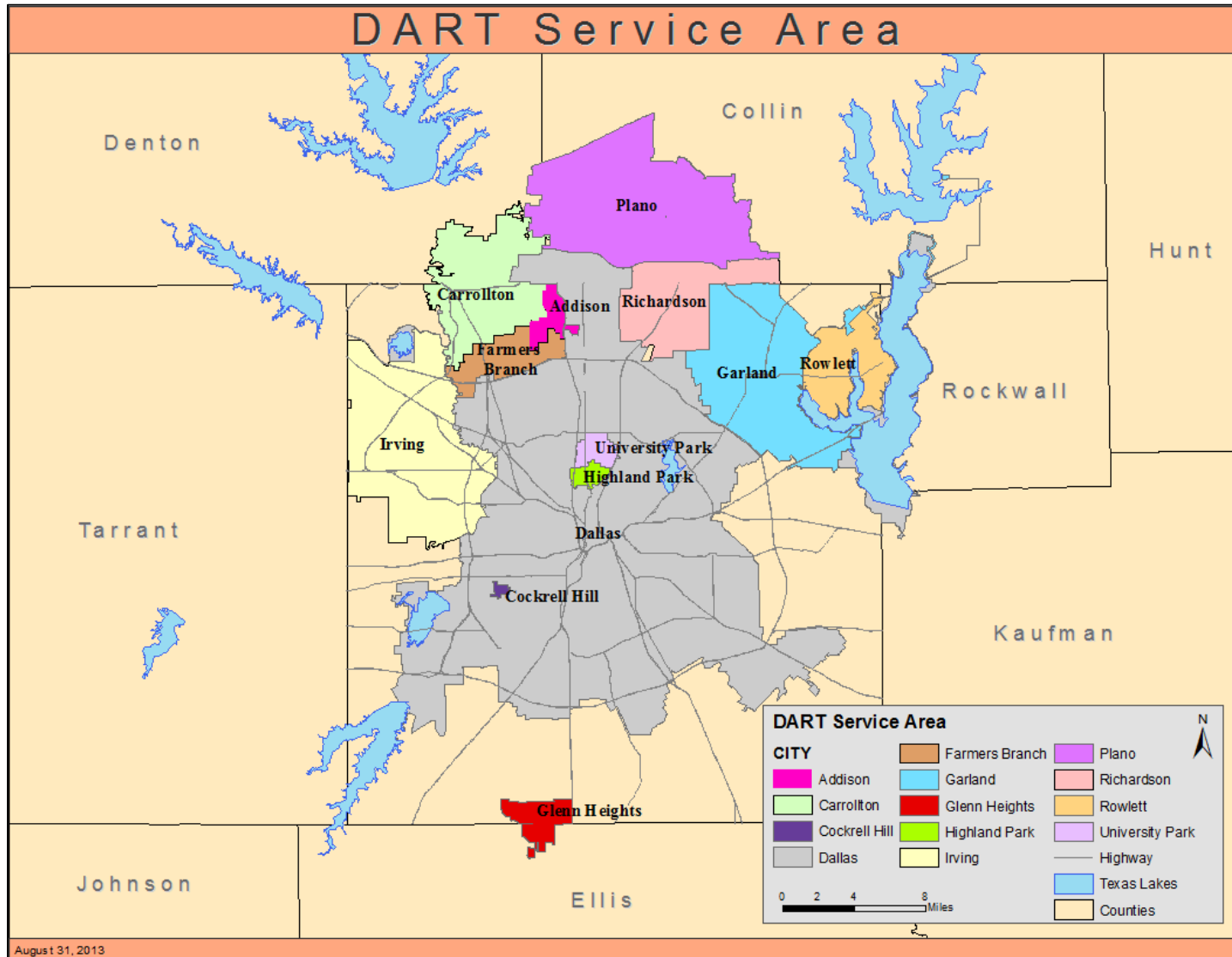


Figure 2-6 DART Service Area

According to NCTCOG (2013), the Dallas-Fort Worth area is classified as a Transportation Management Area (TMA) because its urbanized area exceeds a population of 200,000 as determined by the US Census Bureau. TMAs are subject to special planning and programming requirements. Transportation plans under a TMA are required to follow a continuing and comprehensive transportation planning process in cooperation with state and public transportation operators. In addition, the metropolitan planning area of north central Texas is required by federal law to develop a Congestion Management Process (CMP) which is a method for managing traffic congestion.

The strategies proposed in the MTP to address congestion include Travel Demand Management (TDM), Transportation System Management (TSM), Intelligent Transportation Systems (ITS), and Sustainable Development, which are part of the CMP. The TSP also identifies TDM, TSM, and ITS as part of its recommendations and strategies.

TDM is considered a key congestion management strategy according to NCTCOG (2013) and DART (2006). The NCTCOG and DART define this strategy as changing the travel behavior of the public in order to attain an efficient transportation system. Rather than building additional infrastructure, TDM manages the number of trips by providing efficient modes of transportation such as rail, bus, carpools, vanpools, and bicycling which would reduce the number of single occupancy travel. The result of increasing the number of passengers on these alternative modes of transportation is improved mobility and accessibility in the metropolitan planning area which can be measured as a reduction in congestion. Higher occupancy travel alternatives such as rail transit and (HOV)/managed lanes are more efficient modes of transportation because of their ability to carry more people which has a higher impact on the number of automobiles on the roadway network as opposed to other alternatives previously described

(NCTCOG.2013). Toll roads and HOV/managed lanes are defined by NCTCOG as corridors that are built and maintained through user fees, or tolls. On a tollway for example drivers pay a toll to use all lanes while on a HOV/managed road the lanes are typically constructed in the medians of existing corridors and drivers pay a toll to use these particular lanes.

The following are TDM programs identified in the MTP and TSP that are considered cost effective and that can be implemented expeditiously with outcomes identified in the aforementioned paragraph:

- Employer Trip Reduction Program: program that advertises alternatives to commuting alone.
- Rideshare Programs: program that uses carpool, ride match services, and vanpools to reduce the number of vehicles on the roads.
- Transportation Management Associations: public/private organizations that address congestion issues through the implementation of TDM strategies (e.g. transit voucher programs)

Another method described in the MTP and TSP for alleviating congestion is the TSM strategy which aims to enhance the transportation infrastructure by improving traffic flow, safety, capacity, and system reliability. According to NCTCOG (2013) and DART (2006) these projects are small scale and low-cost improvements that can be implemented quickly. The following are some of the TSM strategies identified in both plans:

- Street Improvements (DART): Improvements to principal streets used by DART services.

- Intersection Improvements (NCTCOG): Arterial improvements such as turning lanes, grade separations, pavement striping, and signage are a few of the suggested enhancements that can improve traffic flow.
- Signal Improvement Program (DART & NCTCOG): Installation of new traffic control equipment to replace outdated control devices which cannot accommodate advanced signal timing plans.

The ITS strategy identified by DART (2006) and NCTCOG (2013) is described as a technology used in transportation infrastructure and vehicles which aims to improve operations and as a result improve travel conditions for customers. The ITS goals identified by the NCTCOG and DART include the following:

- Providing customers with real-time information so that they can make safe, coordinated, and better use of the roadway network.
- Providing operators with system information that would enable them to respond and track conditions of various modes of transportation. This would enable operators to manage incidents that arise thus making the transit network safe.

Another tool identified in the MTP is sustainable development, which can increase mobility by providing more transportation choices and supporting existing communities by promoting transit-oriented and mixed-use development. Mixed-use development contains commercial and residential uses in the same building while transit-oriented development encourages pedestrian activity by integrating a rail station at the center of a community. The ideal development is mixed-use which is designed to encourage biking/walking from the station and surrounding areas (NCTCOG. 2013). DART also promotes sustainable development as a way of controlling growth patterns that involves focusing on population increases within the central regions of the DFW area

(DART. 2006). The City of Dallas for example plans to concentrate its efforts to target development and infill in its southern areas. This strategy would strengthen ridership on the DART network and produce targeted growth and development around DART rail stations. The TSP explains that concentrating on inward growth rather than sprawl will produce shorter trips that can be made by walking, bicycling, or using transit which would also reduce congestion. Identifying viable alternative transportation modes is also considered in the decision making process of the MTP. A few of the sustainable development programs identified in the MTP include:

- Sustainable Development Funding Program: The program issues calls for projects and upon review, funds a variety of plans that include mixed-use development, infill, and transit-oriented development.
- Alternative Future Program: Increase the number of areas in the region including Dallas County in which sustainable development projects may be built.
- Center for Development Excellence: Designed to aid discussion regarding long-term growth issues such as transportation. This program supports mixed use, infill and transit-oriented developments.

The policies in the MTP recommend that public transportation needs be met by existing transportation authorities (e.g. DART, The T) through a comprehensive approach which would maximize current transportation resources. The growth expected in population and employment will increase congestion by a factor of five according to the TSP which is why a comprehensive approach that addresses congestion will have the greatest positive impact to Dallas County and surrounding areas.

DART's Transit System Plan

The highest levels of congestion within the DART service area according to DART (2006) will be in the northern areas. One of the key components according to the TSP to resolve current and future mobility issues is to continue efforts of shifting people from single occupancy vehicles (SOV) to high occupancy vehicles (HOV). The expansion of the HOV lane system is a top priority in the region to combat congestion.

Within the TSP, four areas were identified as focus areas for future planning. These areas of interest to DART include:

- Downtown Dallas and Surrounding Urban Areas
- North Crosstown Corridor
- Airport Access
- Southern Sector Growth.

The emphasis on these particular areas according to DART (2006) is due to the importance of these areas on future transit system expansion. These four focus areas create a baseline from which DART can work from.

Downtown Dallas is becoming a center of mixed-used development with plans to add more households, retail and entertainment. The transportation needs identified in the TSP for this area according to DART (2006) includes a second light rail transit (LRT) alignment (Figure 2-7) which is based on demand, operating efficiency, and transit capacity. The surrounding areas of downtown are becoming core urban neighborhoods due in part to revitalization and redevelopment which could provide an opportunity to expand the modernized streetcar system and provide mobility and economic development benefits in the area, including the Dallas Central Business District (CBD).

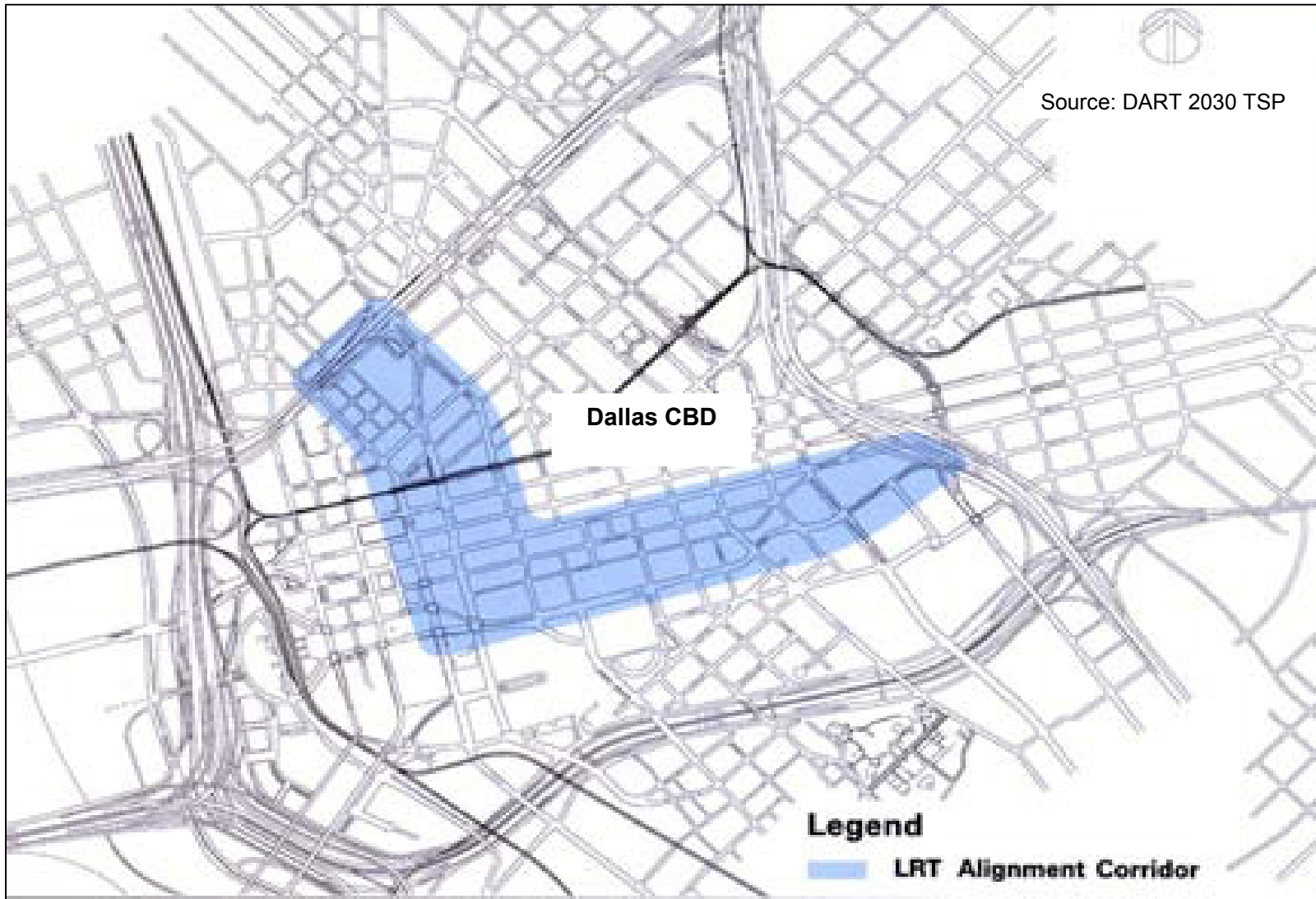


Figure 2-7 Second Light Rail Alignment

The North Crosstown Corridor is one of DART's most congested areas according to DART (2006). Multiple employment centers attract a large number of trips each day, and while DART does provide bus services to these areas a higher-capacity transit connection is needed to link existing and planned rail to these areas. In year 2030, a 25,000 peak hour person trip capacity shortfall on east-west travel corridors in the area is projected. This shortfall would result in traffic congestion and increased traffic on arterial roads as freeway congestion increases. In order to address these future needs, DART examined two options, bus and rail. The bus alternative involved the incorporation of a rapid or express bus service level along three corridors; Cotton Belt, Kansas City Southern-Burlington Northern Santa Fe, and LBJ/Inwood. From the analysis of these two alternatives it was decided that an express rail service along the Cotton Belt corridor and a limited-stop express bus service that would utilize future managed HOV lanes of LBJ Freeway would be the best option for the area (Figure 2-8).

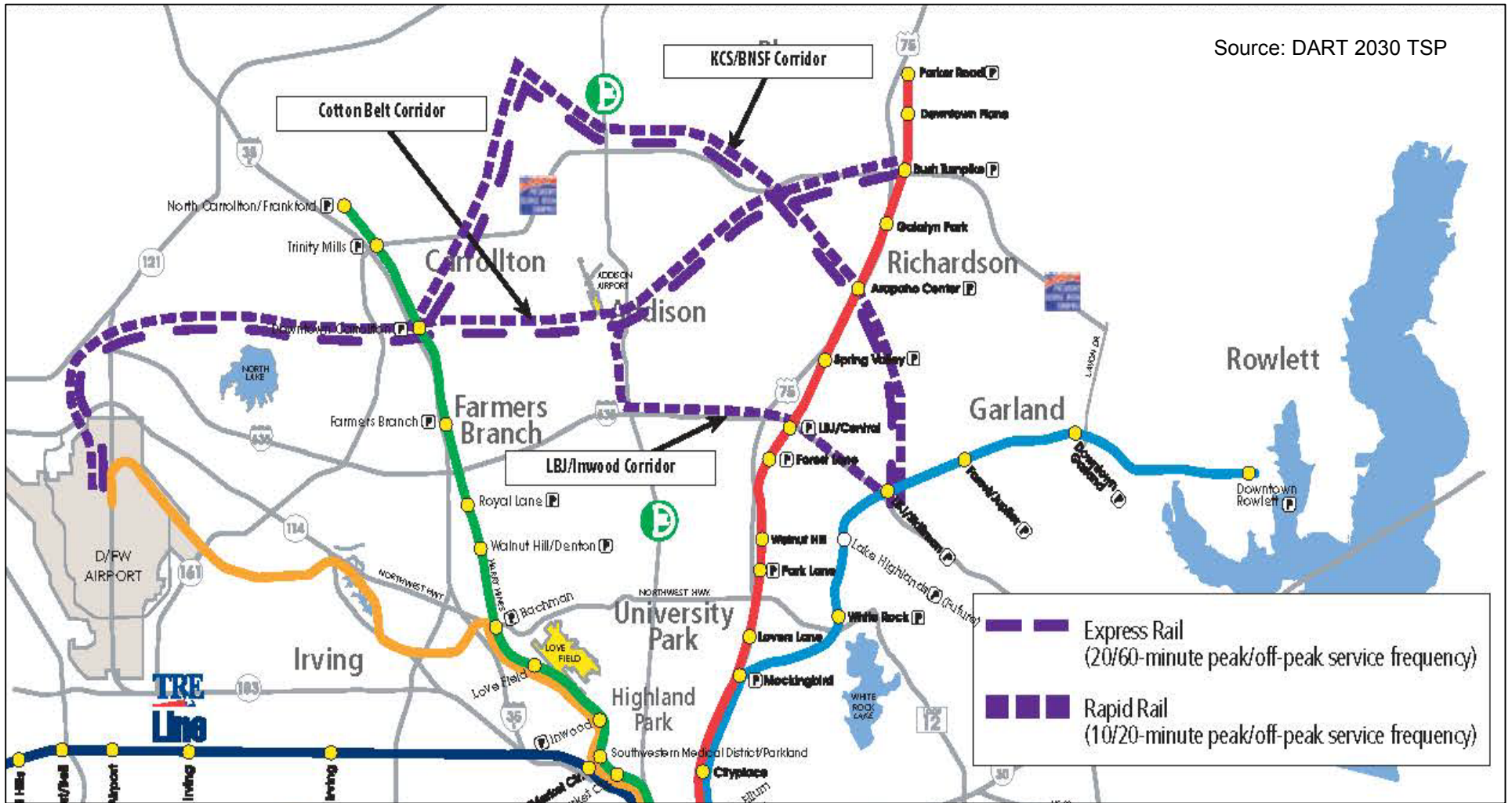


Figure 2-8 North Crosstown Corridor

Airport access to DFW International Airport and Dallas Love Field are considered a priority to DART's future expansion according to DART (2006). The TSP recommends a bus shuttle service that would provide a connection to Dallas Love Field and light rail service for DFW International airport (Figure 2-9).

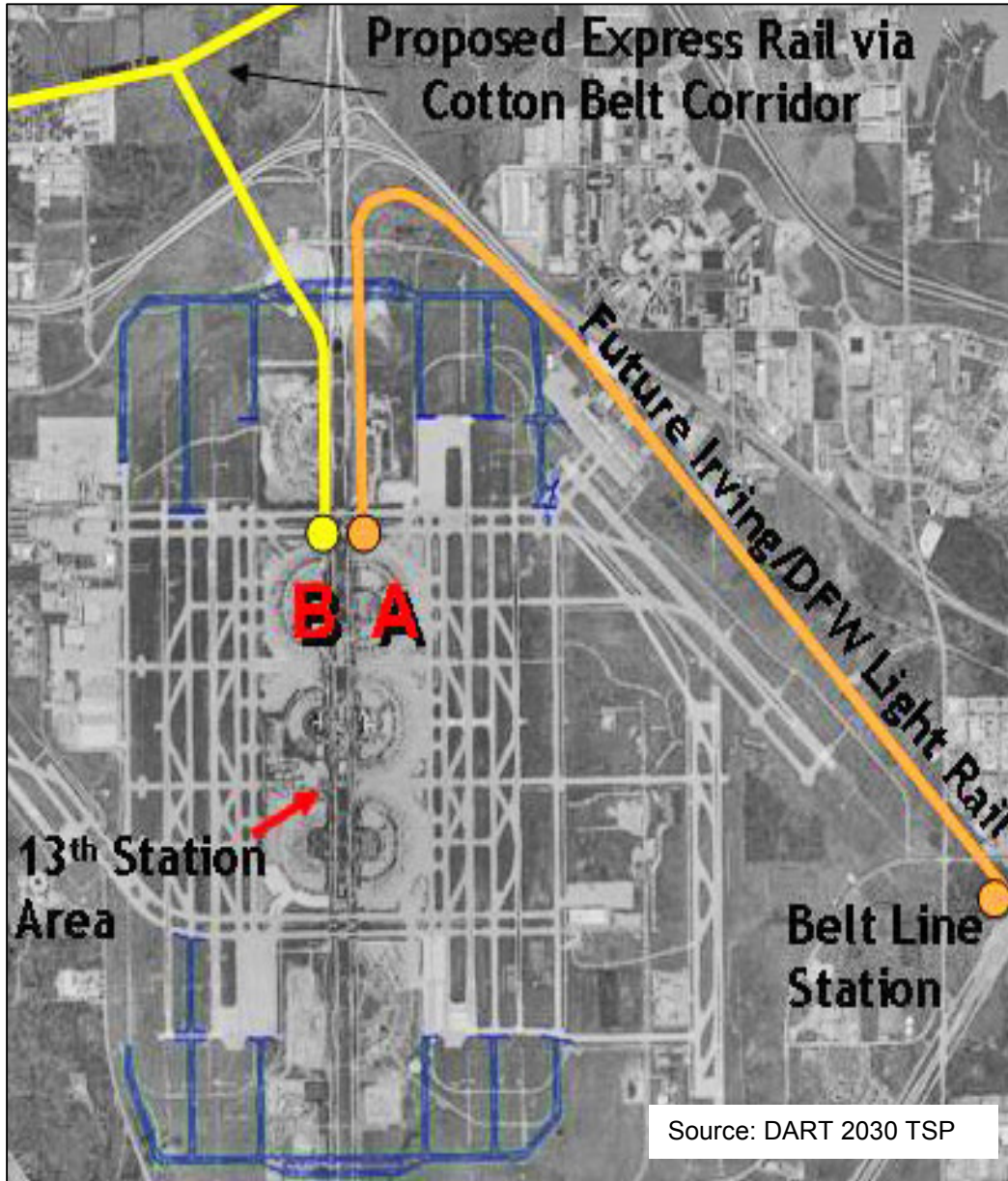


Figure 2-9 Rail Access to DFW

The southern sector encompasses areas south of the Trinity River and IH30. These areas comprise mainly of vacant and underutilized land which provides the city additional growth capacity. The TSP for the southern areas of Dallas includes the integration of comprehensive bus coverage and the expansion of light rail. These future rail stations will provide transit-oriented and economic development opportunities for the area in which residents currently makeup one-third of the jobholders. The lack of employment opportunities in the area makes transit connections important in order to provide a balance of jobs and housing.

Future Plans for Bus Transit

According to DART (2006) the major modes of transit service within the DART system that makeup a large portion of the capital expenditures are bus and rail. DART plans to invest nearly \$1 billion over the next 20 years towards the bus capital program which involves the periodic replacement of its vehicle fleet and maintenance. The light rail system will consume the majority of capital expenditures over the next 20 years with an estimated investment of \$3.4 billion as DART continues its expansion of this mode of transportation. DART has an estimated \$101.6 million programmed for HOV facilities over the next 20 years. The operating expenses makeup the largest component of DART's program. The bus service operating expenses which includes all bus service types according to the TSP will be reduced as this transit mode is replaced with rail service.

The recommendations and strategies listed in the TSP as it relates to mobility include the addition of 116 miles of permanent managed HOV lanes (Figure 2-10). DART believes that HOV is important for the following reasons (DART . 2006):

- HOV lanes provide time savings for buses, and other vehicles, which would result in a competitive advantage over main lanes in the same corridor and provide faster and reliable transitway for DART buses
- HOV lanes provide another option mobility option for DART customers
- HOV lanes are a cost-effective way for DART to move people effectively and contributes to enhanced mobility
- HOV lanes preserve travel time savings and trip reliability
- HOV lanes generate revenue to pay for operation and maintenance costs
- HOV lanes provide an alternate route around major events (e.g. emergency response vehicles that need to bypass congestion)

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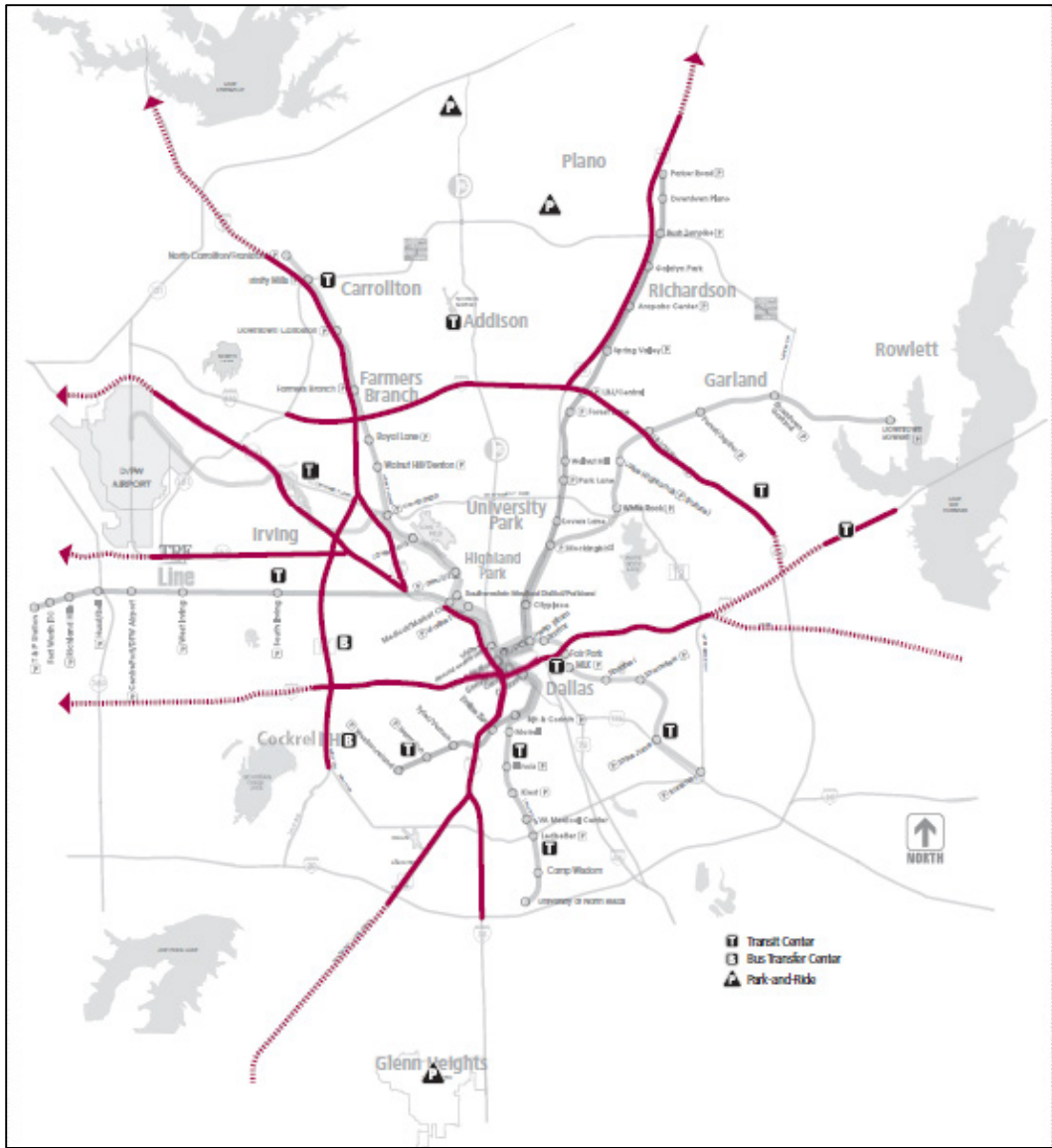


Figure 2-10 2030 Managed HOV Lanes

Additionally, DART plans to incorporate 77 miles of enhanced and 20 miles of rapid bus service corridors in order to provide riders a higher level of service (Figure 2-11). Other goals include reinforcing and adding new express bus service for key radial and crosstown travel.

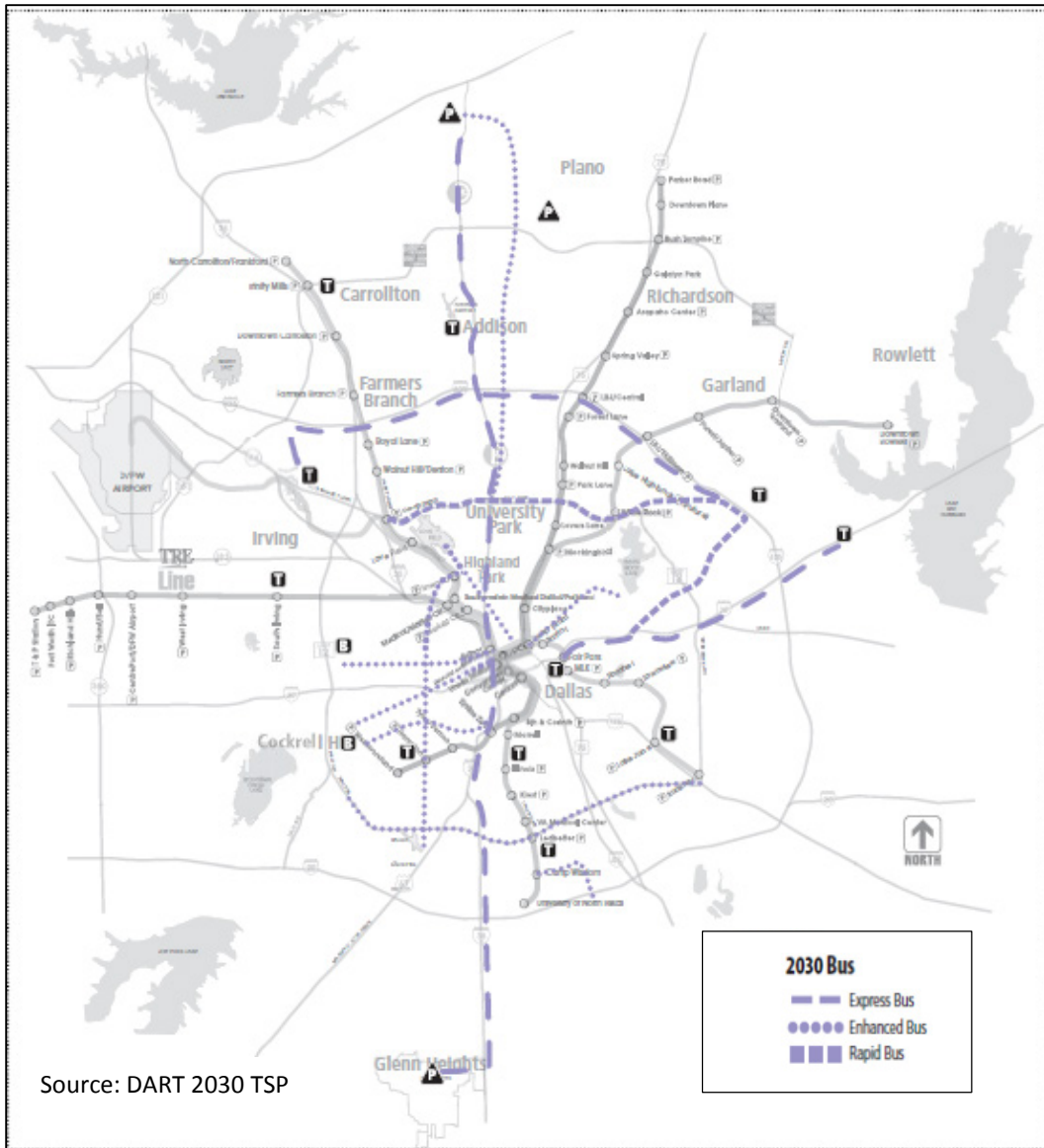


Figure 2-11 2030 Bus Routes

The existing bus network according to the TSP carries more than 40 million people annually. In 2005 the network carried approximately 150,000 daily riders. The various functions that the DART bus routes perform include the following:

- Local Routes: Delivers passengers to various locations throughout a neighborhood

- Express Bus Routes: Routes that are nonstop between outlying facilities and downtown Dallas or employment centers
- Feeder Routes: Connects passengers from local areas to a transit or rail station
- Crosstown Routes: Provides passengers a regional level of travel that crosses the DART service area
- Circular Routes: High frequency service between transit facilities and high-density employment or retail centers

The bus recommendations identified in the TSP are service strategies for specific corridors. Each strategy requires various degrees of technology and capital investments to improve mobility. Rapid corridors require larger investment than Enhanced corridors according to DART because of the exclusive bus guideway, ITS and vehicle type. In 2030 with the implementation of the proposed service strategies the bus network is estimated to carry nearly 250,000 daily riders. The service strategies identified in the TSP and proposed goals are:

- Express Bus Service: Strengthen specific radial corridors not serviced by rail and improve crosstown services
- Enhanced Bus Service: Consolidate the through-traffic of a corridor into one route
- Rapid: Provide faster and reliable service

According to DART (2006) the TSP recommends strengthening key radial express bus corridors that are not served by rail and improve on existing crosstown services such as the Dallas North Tollway, Interstate Highway 30 (IH30) East, Lyndon B Johnson Freeway (LBJ), and Interstate Highway 35 East (IH35E) South. The

improvements made to the LBJ route are projected to carry more than 16,000 additional riders a day.

The enhanced bus corridors will provide service in core transit corridors which are typically radial and have multiple routes. This system will consolidate the through traffic of a specific corridor into one route and restructure local service to act as feeders to the enhanced corridor. The enhanced bus system is expected to add 20,000 riders as a result of the fewer stops and faster travel times that will be offered. The TSP is recommending 77 miles of enhanced bus corridors within the DART service area and will be located within Loop 12 because the areas within this corridor are the most urban areas with the highest ridership.

The rapid bus service is similar to enhanced bus service. Each uses limited stops and high frequency service. What makes rapid service different is its service is faster and reliable. The average operating speed of a rapid bus is between 20 and 29 mph according to DART (2006). The key characteristic of this type of system is the segregated bus lane that serves all or part of a route. The TSP makes reference to the success of the Metro Rapid Program in Los Angeles, California. The Rapid Program incorporated enhancements such as bus signal priority, low floor buses, headway rather than timetable-based schedules, and fewer stops which resulted in reduced passenger travel times by as much as 29 percent. The reduced travel time also resulted in a 40 percent increase in ridership. Headway is the distance or time between vehicles and by having a short headway most riders would become accustomed to the short wait and as a result would not consult a bus time schedule (Niquette. 2007). Other parameters that rapid service utilizes is ITS and TSM improvements to improve operations. Vehicles could be designed for easy access and could include level boarding, multiple doors, and payment

options to speed the boarding time. Stations could include special designs and real time transit information.

The TSP recommends two bus rapid bus corridors be located along Northwest Highway and Ferguson (Fig 2-11 for rapid bus corridors). The amount of investment required for these two rapid corridors would be higher than in enhanced bus corridors because of the incorporation of exclusive bus lanes. Table 2-8 identifies the bus corridor recommendations and capital costs identified in the 2030 TSP.

Table 2-8 Bus Corridor Recommendations

CORRIDOR	FROM	TO	MILE	CAPITAL COST
EXPRESS				
East RL Thornton	Downtown Dallas	Lake Ray Hubbard Transit Ctr	N/A	Strengthen Existing Svc
Stemmons Frwy	Downtown Dallas	Glenn Heights Park & Ride	N/A	Strengthen Existing Svc
Dallas North Tollway	Downtown Dallas	Northwest Plano Park & Ride	N/A	Strengthen Existing Svc
LBJ Frwy	South Garland Transit Center	Las Colinas	25	\$2,900,000
		Subtotal	25	\$2,900,000
ENHANCED				
Simpson Stuart/Bonnie View	Blue Line	IH 20	2.9	\$3,200,000
Ledbetter	Loop 12/Kiest	Buckner Station (Green Line)	14.4	\$16,400,000

Table 2.8—Continued

Singleton	Downtown Dallas	Bernal Transfer Location	6	\$6,800,000
Fort Worth	Downtown Dallas	Cockrell Hill Transfer Location	5.6	\$6,300,000
Jefferson	Downtown Dallas	Cockrell Hill Transfer Location	8.2	\$9,300,000
Hampton	Red Bird Transit	Inwood Station (Green Line)	10	\$11,400,000
Cedar Springs	Downtown Dallas	Love Field	6.4	\$7,200,000
Gaston	Downtown Dallas	Grand Avenue	5.9	\$6,800,000
Preston	Northwest Hwy	Northwest Plano Park & Ride	17.1	\$19,400,000
		Subtotal	76.5	\$86,800,000
RAPID				
Northwest Hwy	South Garland Transit Center	Bachman Station	13.8	\$47,900,000
Ferguson	South Garland Transit Center	Downtown Dallas Via IH 30 HOV Lanes	6.3	\$21,900,000
		Total	121.6	\$159,500,000

Note: Enhanced and Rapid Bus Capital Cost does not include vehicle cost; however, the financial plan does account for additional bus purchases beyond the regular fleet replacement program. Capital costs are based on typical per mile costs for TSM, ITS and passenger facilities related improvements. Express bus costs reflect new vehicles for new service in this corridor. Source: DART 2030 Transportation System Plan

The rail system for DART currently carries over 60,000 people daily according to DART (2006). It plans to double the size of the rail network and describes this mode of transportation as the “backbone” of the DART system. The 2030 TSP recommends five rail projects which includes approximately 43 miles of rail. Table 2-9 identifies the bus corridor recommendations and capital costs shown in the 2030 TSP.

Table 2-9 Rail Corridor Recommendations

CORRIDOR	FROM	TO	MILES	CAPITAL COST ESTIMATE (2005\$)
RAPID RIDE				
Scyene	Lawnview Station	Masters Drive	4.3	\$249,000,000
West Oak Cliff	Westmoreland Station	Red Bird Line	4.3	\$242,000,000
Southport	Blue Line/Camp Wisdom	Southport/IH 20	2.9	\$180,000,000
West Dallas	Downtown Dallas	Loop 12 Area	6	\$400,000,000
		Subtotal	17.5	\$1,071,000,000
EXPRESS RAIL				
Cotton Belt	North Central/Red Line	DFW Airport	25.7	\$465,000,000
Cotton Belt Mitigation				Up to \$50,000,000
		Subtotal	25.7	\$515,000,000
		Total	43.2	\$1,586,000,000

Note: Capital Costs are estimated based on order of magnitude per mile estimates comparable to prior DART experience. Costs are subject to refinement during subsequent, more detailed studies.

NCTCOG and DART's Standpoint on BRT

According to the NCTCOG (2013) the MPO supports BRT as one of its many mobility options. The MTP identifies it as a service type with a multitude of applications in the region. The MPO believes this system has the ability to decrease travel times through signal prioritization, priority queuing, and fixed guide ways. An important element of a BRT system that is realized by the MPO is its ability to be implemented financially at various stages and physically to future fixed-rail guide way systems. The TSP according to DART (2006) does not make reference specifically to BRT but does make mention to similar bus service systems that have similar characteristics as was described in the aforementioned section.

Project Preparation

According to Arias et al (2007) a new system begins with an entity taking the initiative to recommend a plan that they believe is required to improve a city's public transport system. This recommendation can come from an assortment of groups such as; the private sector, a civil servant, a political official, or a citizen. The author identifies these entities as the catalyst and without this; the possibility of improved transportation can go unnoticed. Once this catalyst is in place the political will and commitment must be in place in order to make the proposed system a reality. There are several methods in which to inform public officials of the potential for a new transportation system. These methods include site visits to areas in which public transportation systems were a success as was done in the City of Los Angeles according to Levinson (2003); touring the city's existing public transportation system can identify problems by experiencing it first-hand, visits from elected officials who participated in implementing a successful public transportation system; and a feasibility study. The momentum generated by having the support of the political body is important as these officials have a better understanding of

their communities needs and can discuss issues with opposition groups and/or special interests on a much more personal level.

Once support is established an analysis must first be performed to identify the areas that would benefit a new public transit system such as BRT. The demand analysis according to Arias et al (2007) is the technical foundation for most of the subsequent planning design work. The following sections will discuss the methodology described by Arias et al (2007) which will be used in identifying a potential BRT line in Dallas County.

Planning for BRT

Arias et al (2007) describe six major areas of planning for a BRT system. These areas include: Project Preparation; Operation Design; Physical Design; Integration; Business Plan; Evaluation and Implementation. As was communicated in Chapter 1 this study will focus on a subset of the project preparation process which is performing a demand analysis.

Arias et al (2007) outline the steps required when identifying a BRT system in an urbanized area. This approach is also shared by Levinson (2003) and Machemehl (2009). The first step begins with determining the city's demand profile for daily trips. A demand analysis of Dallas County roadways will identify potential BRT corridors through the use of transportation-related data obtained from the North Central Texas Council of Governments (NCTCOG) and Dallas Area Rapid Transit (DART). The demand profile will identify the size of customer demand along the existing corridors. Levinson (2007) expands on this by stating that there should at least be one or more anchors and a large tributary area that would sustain a BRT system. The author believes that an urban population should exceed 750,000 and the central business district employment should be at least 50,000 before a BRT system is considered. Dallas County exceeds these requirements with a 2010 population of 2,368,139 and a central business district with

138,224 employees. However, he does mention that large universities or other outlying activity centers may support a BRT system. To improve the ridership of a BRT Machemehl (2009) explains that the goal is to minimize travel distances and travel times to large portions of a population. Arias (2007) explains that if a study area has no history in mapping its transport demand through modeling software, then the authors outline a process in collecting basic travel data.

Analysis Procedure

The first step in a demand analysis is to analyze the existing public transport services and the conditions in which they operate. Mapping the existing transit routes provides an initial indication of the areas with the greatest transit demand. Roads which carry the most bus routes do not always correspond to the highest number of public transport passengers on a given corridor. Typically there is a strong correlation between large numbers of public transport routes and high passenger flows. The principal data required per Arias et al (2007) is:

- The routes of current transit services
- The number of passengers using each route
- The transit vehicle speeds on each route

The next step is to acquire traffic counts and bus occupancy surveys. Determining the number of buses with their estimated occupancy rates will yield an estimation of a corridor's existing demand. When acquiring traffic counts Arias et al (2007) suggests first determining where the traffic counts should be collected. In an ideal situation the survey will be located so that the most trips can be captured with minimal resources. The traffic counts should not just include buses but rather all vehicles which will aid designers when important BRT decisions regarding the allocation of limited ROW is required. By including all traffic into the study, the number and types of vehicles can

give the designer an indication of the probable traffic impact of dedicating lanes to buses. Furthermore, by including all traffic, this information can give the designer an indication of how many passengers could potentially switch from private transport to public transport. Another form of data that should be acquired is occupancy surveys which will provide the average number of passengers in the vehicles at any given time. This form of data should be categorized and collected by vehicle type.

The third step identified by Arias et al (2007) is mapping congestion points and existing bus speeds along possible BRT corridors. This data will aid in calculating the benefits of the new system. BRT systems should be located on the most congested routes. One of the main reasons BRT is more efficient than other systems is because segregated right of ways removes buses from traffic congestion. If average bus speeds in a corridor are high, shifting to a BRT system is not likely to bring a significant improvement in bus speeds. According to Levinson (2003), one of the key lessons learned from the case studies described in Chapter 2 is that BRT should be rapid.

The first three steps in the aforementioned paragraphs will capture the transit demand in the study area. A boarding and alighting survey on each public transport line should be completed next if possible. This step requires that the surveyor ride the entire length of each major transit line during rush hour and record how many people are getting on and off the vehicle at each stop. The speed of the vehicle should also be recorded. This survey will identify how many passengers are on each bus line at different parts of their journey. This data will allow designers to avoid station congestion.

Once the boarding and alighting survey is completed the next step is to aggregate the data. By adding the ridership at each stop along all existing routes, the total passengers likely to use the system at any given point can be determined. From this data the designer can determine which routes should be incorporated into the

proposed BRT system. This quantitative analysis will utilize ArcGIS and Microsoft Excel software to compile and generate various forms of data which includes: traffic volume, passenger volume, speed, demographic and land use. This data will distinguish and establish potential BRT corridors within the study area.

DART Analysis Procedure

The quantitative study will begin as described by Arias et al (2007) with the analysis of the existing public transport services provided by DART along with a review of the existing demographic, economic, and social conditions in Dallas County (e.g. major employment areas within the city can project the location and times of day when public transportation will be required). GIS shape files of existing transport modes such as conventional bus, express bus, and light rail routes will be obtained from DART in order to generate general GIS maps of the transport services provided within the study area.

According to Arias et al (2007) the roadways which carry the most bus routes do not necessarily equate to routes with the largest public transport passengers. However, there is a strong correlation between routes which have a high number of bus routes and large passenger flows. These maps will identify areas with the greatest transit demand.

Once the conventional bus transit route structure is known the next step is to acquire traffic counts and bus occupancy surveys as is described by Arias et al (2007). This data will be obtained from the NCTCOG and/or DART which will include the following: number of buses, number of vehicle types (e.g. van, car, motorcycle, etc.), and occupancy surveys which will provide an estimated number of passengers within all buses and vehicles. From the raw data obtained, summary tables and graphs can be generated that identifies what the vehicle and passenger movement is in peak and off-peak periods, bus speeds, or ridership volume along a corridor. A reasonable estimate of the size of total public transport demand on corridors can be determined by multiplying

the total transit vehicles at the peak hour with the average total passengers per transit vehicle. This data can be graphed utilizing MS Excel to determine the vehicle/passenger movement in peak and non-peak periods. The analysis will produce a total demand figure for a given corridor and identify which routes are carrying the most passengers. Arias et al (2007) explain that planning professionals are ultimately seeking the maximum load on the critical link, which is measured in passengers per peak hour per direction (pphpd) of existing usage. The pphpd can be calculated as:

$$PPHPD = VPH * CAP$$

Or

$$PPHPD = 60 / INT * CAP$$

Where,

CAP = maximum capacity per vehicle or train

VPH = Vehicles Per Hour

INT = Interval, in minutes

The critical link is the area of a potential BRT corridor that is carrying the highest volume of existing public passengers.

Once the demand has been calculated, the existing bus speeds along potential BRT corridors can be determined which will aid in the selection process. If the speeds on a corridor are higher than a bus rapid transit system, it is not likely to make significant improvements in bus speeds.

Corridor Selection

Once the demand analysis is complete, the next step involves selecting the corridor. Arias et al (2007) explain various techniques when selecting a corridor, which includes recording road and right-of-way widths throughout each potential corridor. The availability of the right-of-way is an important decision that must be considered during the

early stages of determining how the running ways will be configured to serve a particular corridor according to Diaz (2009). Certain areas may have narrow road widths such as central business districts and historical centers, which may pose challenges to BRT development. The data collected will enable the generation of a comparison table between the existing roadway conditions and what is required for a BRT lane.

Other areas that are considered typical corridors for BRT are arterials according to Machemehl (2009) because population densities are generally higher near arterials, arterials tend to be used by existing bus or paratransit systems, and they tend to include destinations to businesses and shopping areas.

Limitations

The limitations that may arise during the initial preparatory work of the demand analysis will be the accessibility and/or availability of the data required to perform the analysis described by Arias et al (2007). Such limitations can result in modifying the methodology previously described in a manner that utilizes the available data to reach a similar outcome.

Analysis

The analysis begins with mapping the existing transit routes located in Dallas County. As was identified in the aforementioned 'Analysis Procedure' section, mapping the existing routes provides an initial indication of the areas with the greatest transit demand. DART has 122 existing bus routes in its service area and they are categorized into the following groups with the number of routes associated with each:

- Local Bus Route: 27 routes
- Express Bus Route: 9 routes
- Suburban Bus Route: 15 routes
- Crosstown Bus Route: 20 routes

- To Rail Station Route: 50 routes
- Rapid Ride Route: 1 route

Figure 4-12 is a map of the existing bus routes operated by DART in Dallas County. As is evident by the map, the existing bus system identified in green is concentrated within central and northern Dallas County.

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DART Bus Service - Dallas County

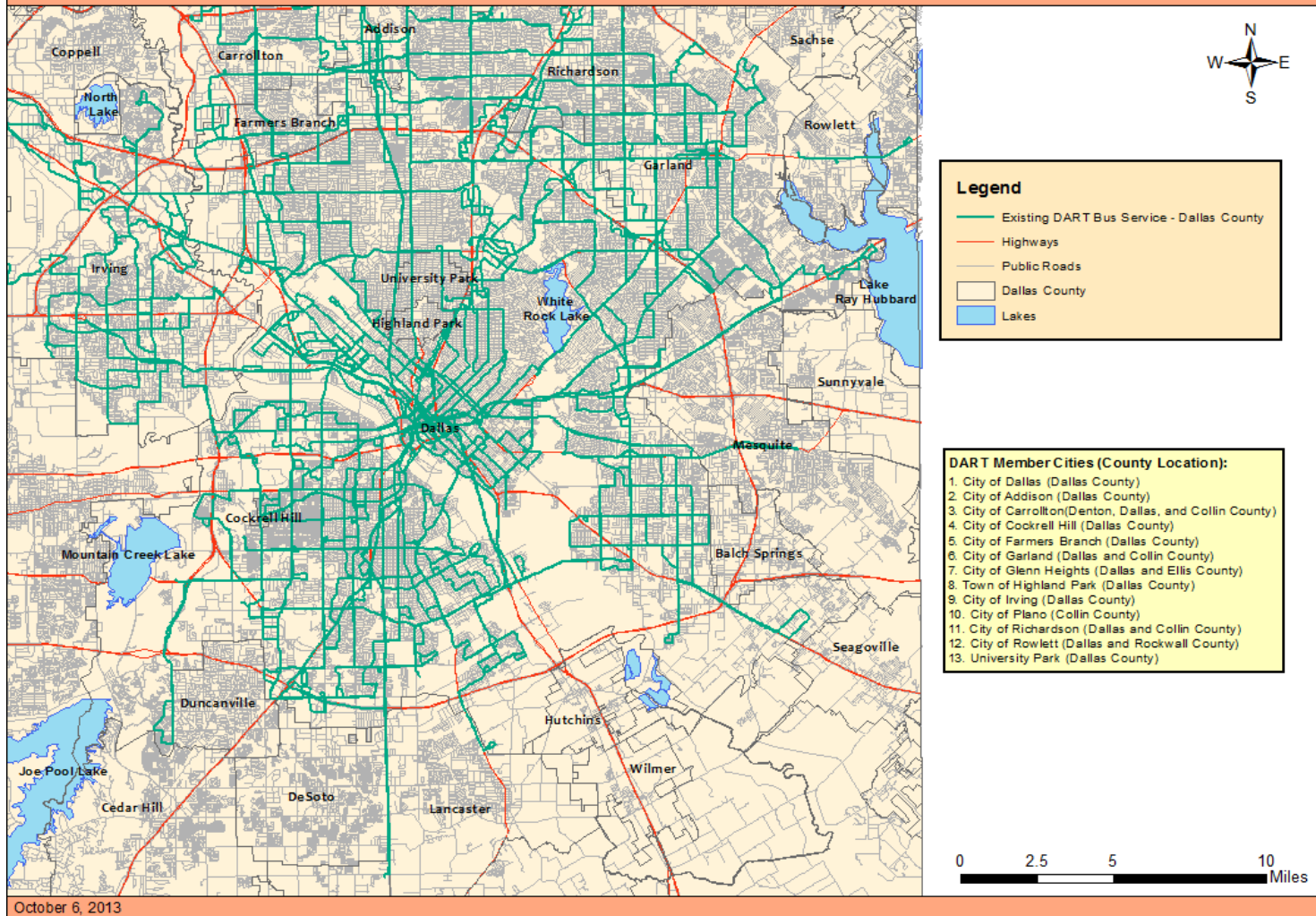


Figure 4-12 DART Bus Network

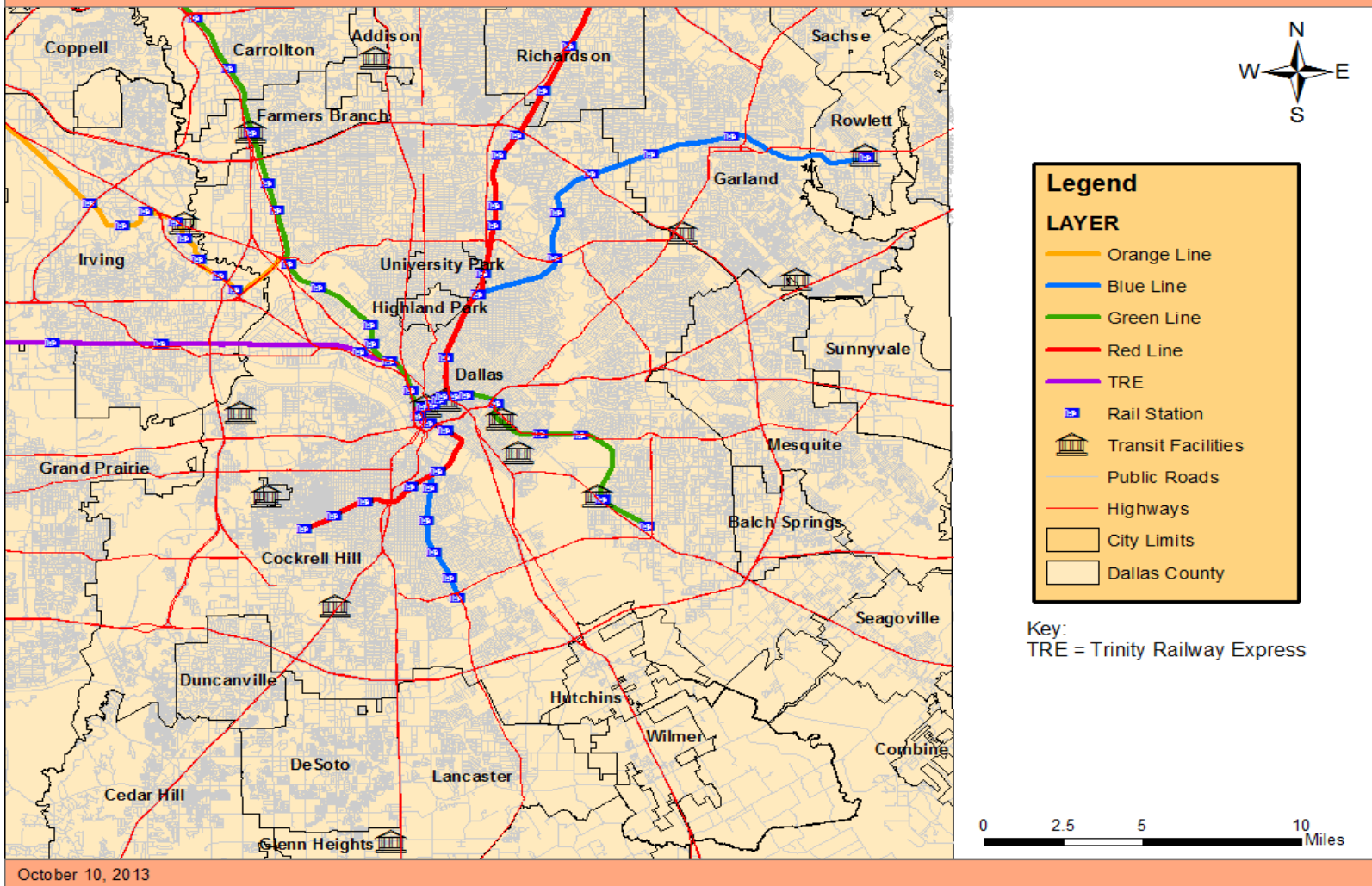
The rail service currently operated by DART in Dallas County comprises of 5 rail lines that are identified as:

- DART Rail Red Line
- DART Rail Blue Line
- DART Rail Green Line
- DART Rail Orange Line
- Trinity Railway Express

These rail lines can be seen in Figure 4-13. The rail lines link central Dallas County to Fort Worth, Denton, Irving, Richardson/Plano, and Garland. These same rail lines only extend a small portion into southern Dallas County as can be seen in the figure below.

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DART Rail Service - Dallas County



Legend

LAYER

- Orange Line
- Blue Line
- Green Line
- Red Line
- TRE
- Rail Station
- Transit Facilities
- Public Roads
- Highways
- City Limits
- Dallas County

Key:
TRE = Trinity Railway Express

Figure 4-13 DART Rail Network

The locations of bus and rail in Dallas County can be attributed to population and employment. Figures 4-14 and 4-15 represent the population and employment densities in Dallas County. The 2012 population density map shows strong concentrations in northern Dallas County.

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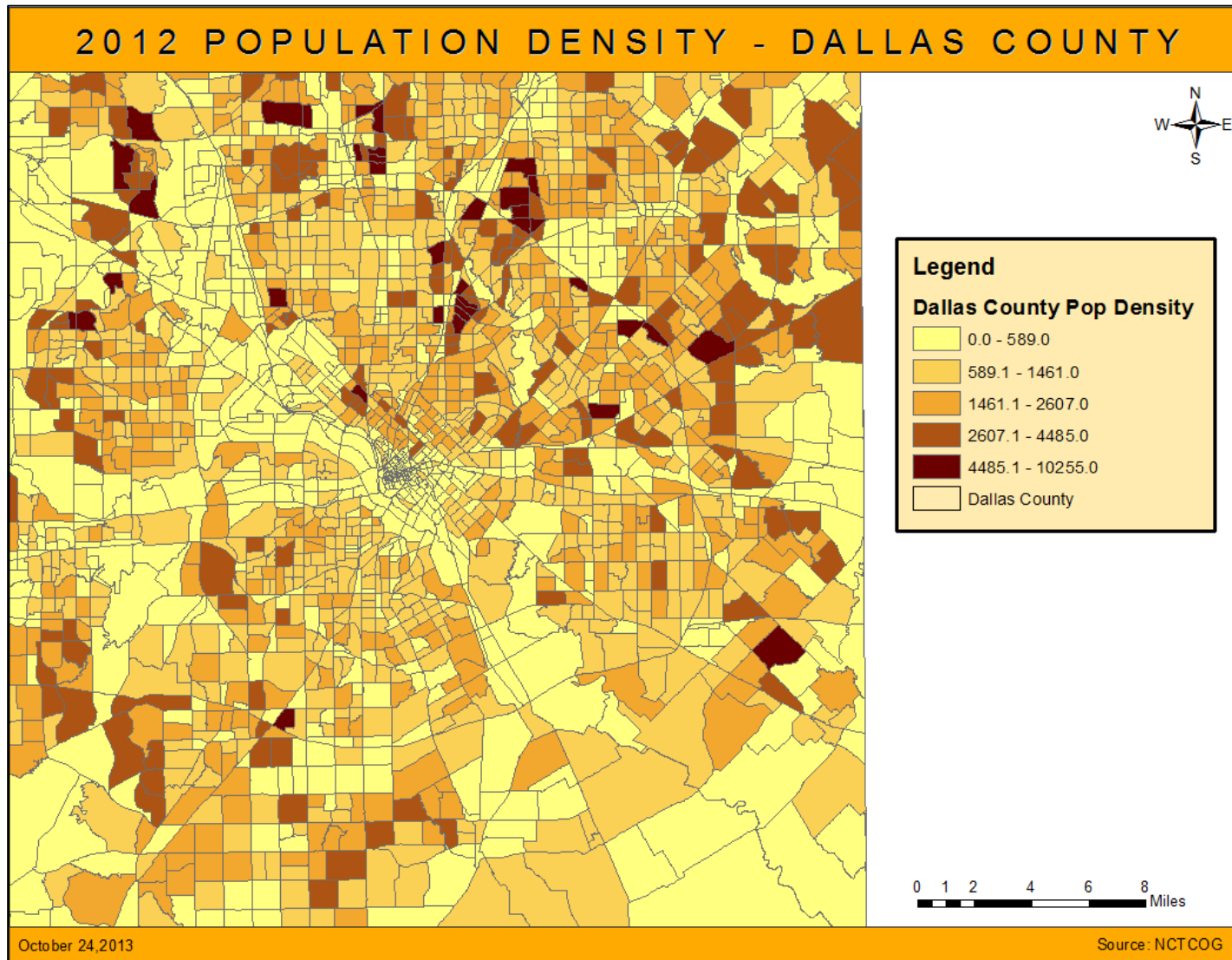
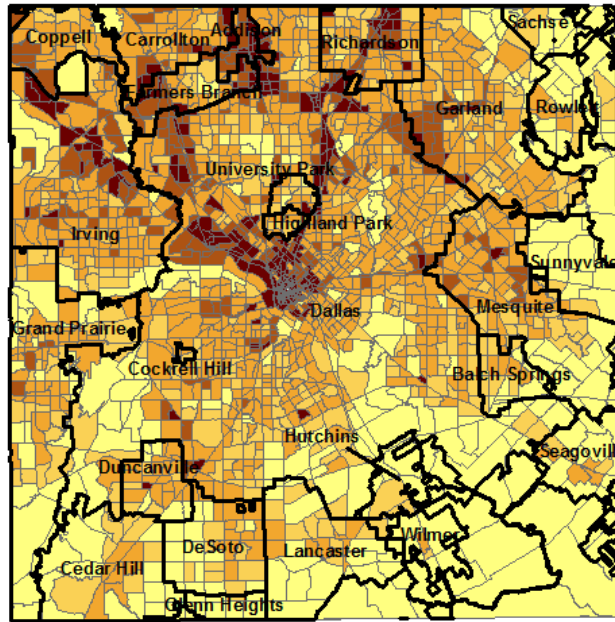


Figure 4-12 2012 Population Density

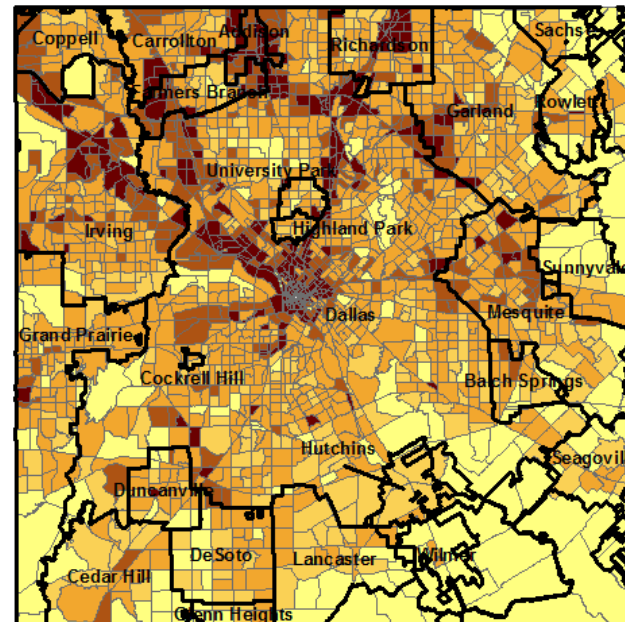
The employment density map shows 2013 and 2035 employment density changes that are anticipated to occur in a 22 year span in Dallas County. From Figure 4-15 it is clear that large concentrations of employment are located in northern Dallas County. A swath of heavy employment radiates northwest from the Dallas Central Business District to Coppell in both maps.

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2013 & 2035 Employment Density - Dallas County

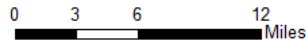
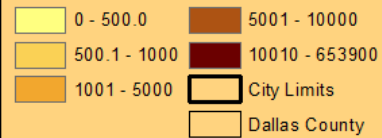


2013



2035

Legend



October 12, 2013

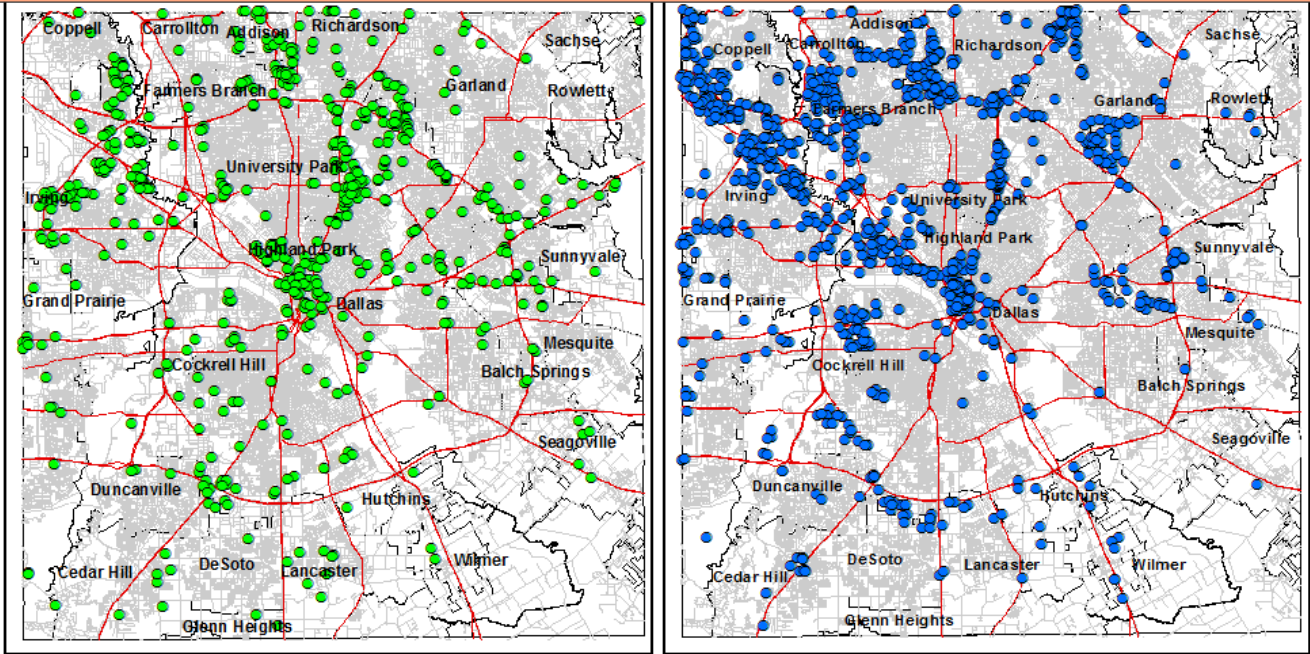
Source: NCTCOG

Figure 4-15 Employment Density

Further review of residential and commercial developments (Figure 4-16) in the study area coincides with employment and population data. The majority of the developments in the figure are existing, while the remaining few comprise of additions that are either under construction or planned to be built in the future. The commercial development map clearly follows the same growth pattern as the employment density map (Figure 4-15), whereas the residential developments are concentrated within the city center and northern parts of Dallas County.

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Residential & Commercial Developments - Dallas County

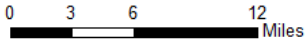


RESIDENTIAL

COMMERCIAL

Legend

- Residential Development
- Commercial Development
- Highways
- Public Roads
- City Limit
- Dallas County



October 16, 2013

Source: NCTCOG

Figure 4-16 Residential & Commercial Development

From these maps it is clear that DART has strategically located these existing transit routes in the areas identified in Figures 4-12 and 4-13 because these areas have the greatest transit demand. From this initial study of the current transit services provided in the area, Arias et al (2007) proceed to the next step, which is to evaluate traffic counts and bus occupancy data to estimate the area's existing demand. Existing ridership data provided by DART was examined and the top three bus routes from each bus category were identified and tabulated as can be seen in Table 4-10.

Table 4-10 Existing Ridership

Top 3 Local Bus Routes (3 of 27 bus routes)				
<i>Table 4-10-Continued</i>		Average Weekday Riders	Average Saturday Riders ¹	Average Sunday Riders ¹
Jefferson/Bexar Street	11	4402	2421	1741
Woodmeadow-S Garland	164	3163	1820	1073
Ann Arbor/Lakewood	19	2728	1621	915
Top 3 Express Bus Routes (3 of 9 bus routes)				
Bus Route	Line	Average Weekday Riders	Average Saturday Riders ²	Average Sunday Riders ²
Lake Ray Hubbard Express	283	1021	N/A	N/A
Glenn Heights Express	206	974	N/A	N/A
Addison TC Express	205	763	N/A	N/A
Top 3 Suburban Bus Routes (3 of 15 bus routes)				
Bus Route	Line	Average Weekday Riders	Average Saturday Riders	Average Sunday Riders
DT Garland/Lake Ray Hubbard TC	378	1090	629	211
Lookout-Plano Rd/Forest Lane Sta	360	932	380	249
Addison TC-Collin County College	350	927	389	N/A ³
Top 3 Crosstown Buses (3 of 19 bus routes)				

Bus Route	Line	Average Weekday Riders	Average Saturday Riders	Average Sunday Riders
DT Garland/Royal Lane Station	486	2926	1474	1428
Buckner Station/South Garland	467	2809	1240	848
SW Ctr Mall-Buckner Station	466	2749	2427	1209

Notes:

1. The top 3 local bus routes for weekend riders were the same for weekday riders.
2. Express bus routes do not operate on weekends
3. Sunday data was not available for all routes.

From the information provided on Table 4-10 a map was produced identifying these specific bus routes (Figure 4-17). From this map the various bus routes appear to accommodate population densities within the CBD, northeast regions, and areas in the south of Dallas County. However, these top bus routes do not correlate with the major employment densities identified on the northwest side of Dallas County per Figure 4-15 or the commercial densities which may imply that workers are utilizing other modes of transportation in these areas.

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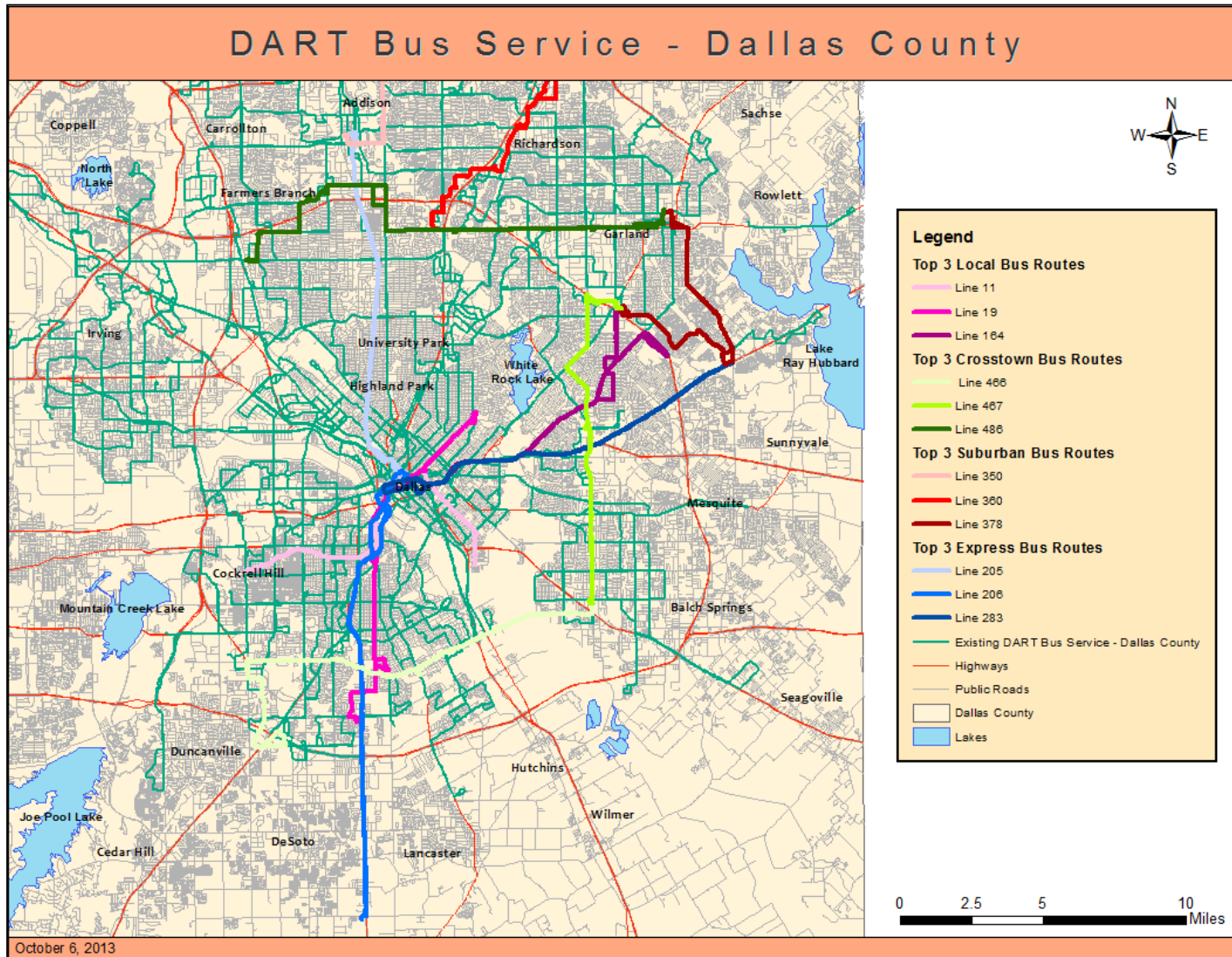


Figure 4-17 Top 3 Bus Routes

The number of traffic volume data collected by the NCTCOG is quite extensive. According to Arias et al (2007) it is ideal to have not just bus counts but also the number of vehicle by type (e.g. van, truck, etc.). The NCTCOG provided an excel file of all traffic counts in the Metroplex area and all traffic data was in terms of 24-hour counts. The file received did not contain traffic volume by type of vehicle for all corridors nor did it contain occupancy counts. The NCTCOG does manage an online system that is updated periodically that does contain traffic volume by type of vehicle for some of the corridors in the Metroplex, but not all. This analysis utilized the file received from the NCTCOG to identify heavily used corridors from the data provided. An overlay of the traffic volume counts from the table provided along with the, 'Top 3 Bus Routes' map was generated and identifies that the major traffic volume in the area is carried by all major highways as can be seen in Figure 4-18. The traffic counts with large volumes outline the major highway network (e.g. IH 635, IH 30, IH 20 etc.) but make it difficult to identify other major roadways that may have large concentrations of traffic. roadways that may have large concentrations of traffic.

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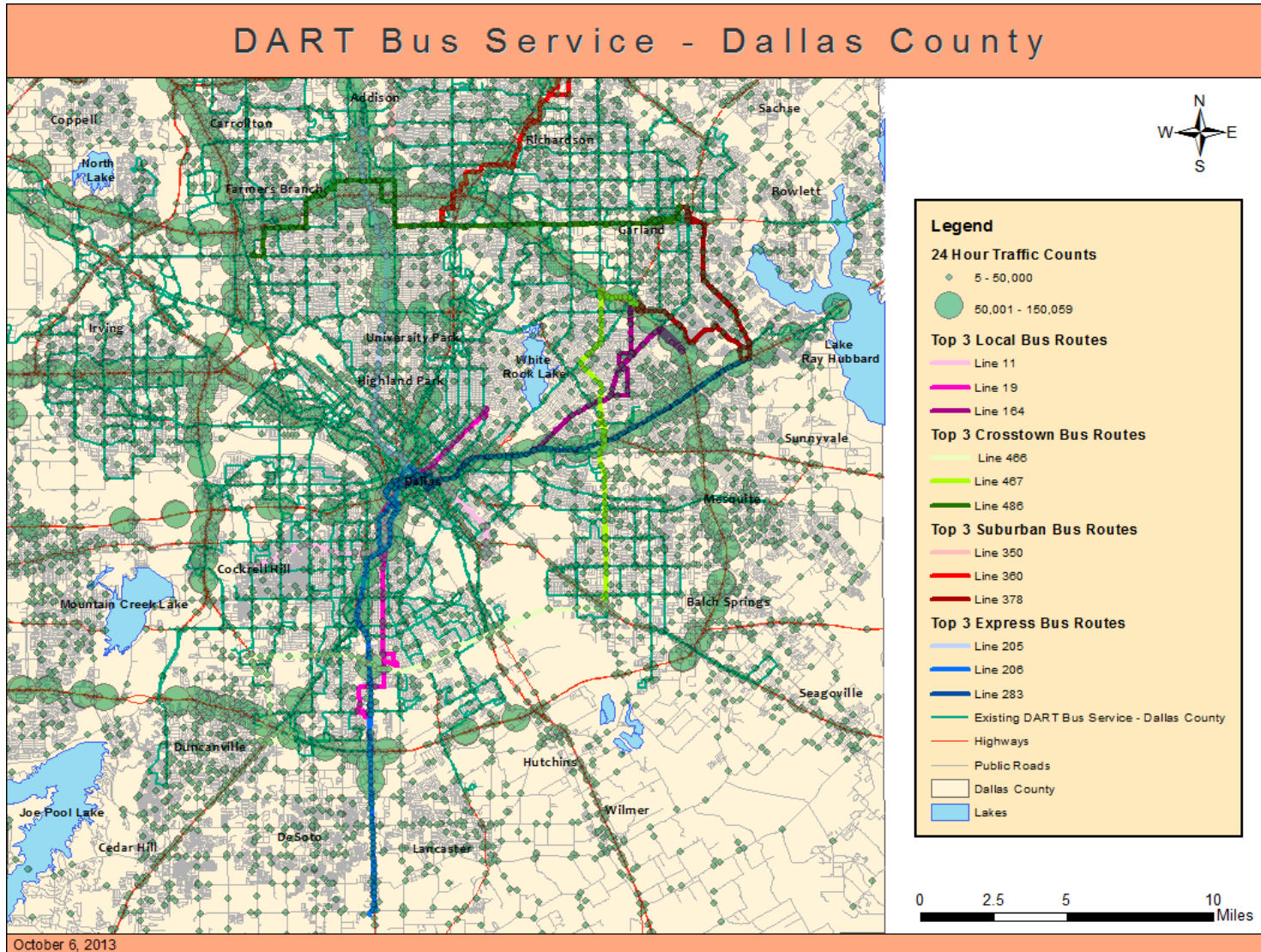


Figure 4-18 Top 3 Bus Routes with Dallas County Traffic Count

In order to identify these non-highway corridors the traffic volume data was further refined. The excel file with all traffic volume was sorted and all highways were removed so that the table only had non-highway roadways. This tabulated data was then imported into GIS in order to map the traffic count data (Figure 4-19). At first it appears that high concentrations of traffic volume are located in the northern areas of Dallas County, specifically Addison and Carrollton. With so many data points on the map it is difficult to ascertain the exact locations within this area. By going to the GIS attribute table for the traffic counts shapefile the data can be sorted to determine which areas carried the most traffic volume in descending order.

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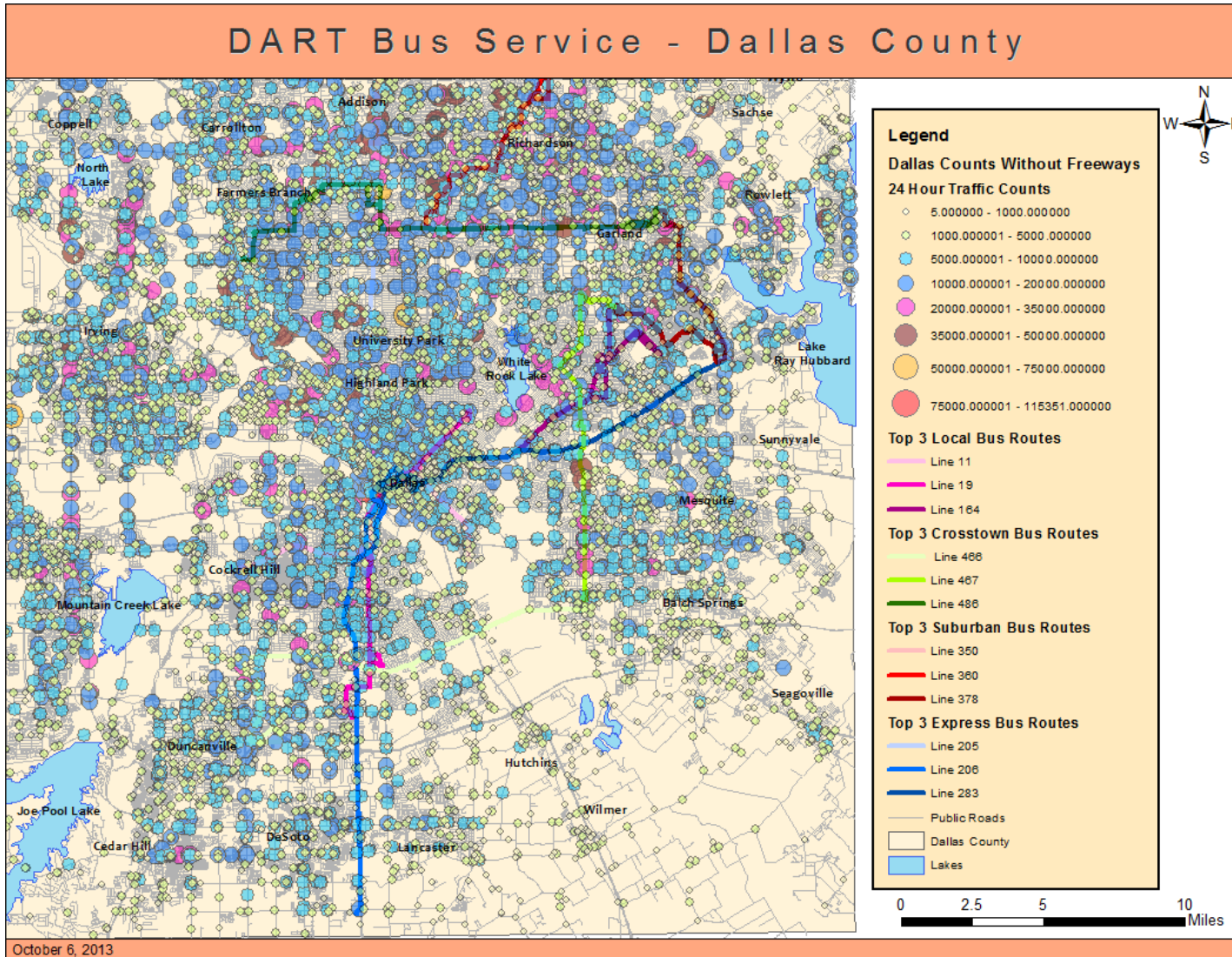


Figure 4-19 Top 3 Bus Routes with Traffic Counts (Excluding Highways)

The following table represents a partial edited view of the attribute table with traffic counts in descending order from GIS. This particular table only shows the top ten traffic count points, and though further examination, a pattern of the areas with the most traffic counts along specific roadways can be extracted and mapped onto GIS.

Table 4-11 GIS Attribute Table

ID	Roadway	From_	To_	Dir	Count24hr	City
21529	ROCK ISLAND RD	ROY ORR BLVD	HARDROCK ST	E	60834	Grand Prairie
21528	ROCK ISLAND RD	ROY ORR BLVD	HARDROCK ST	W	58992	Grand Prairie
33803	Lemmon	Frontage Us 75 SB	Frontage US 75 NB	B	56820	Dallas
27100	PRESTON	ALPHA	PRESTON VIEW	B	54973	Dallas
27101	PRESTON	SPRING VALLEY	HIGH COURT	B	54412	Dallas
27084	MIDWAY	ALPHA	SIMMONTON	B	52468	Farmers Branch
27095	PRESTON	DILBECK	ALPHA	B	51963	Dallas
27061	NORTHWEST	THACKERY	HILLCREST	B	51431	Univ Park
27085	MIDWAY	SIGMA	ALPHA	B	48725	Farmers Branch
16117	MOCKINGBIRD	LRT NC	MCMILLAN AVE	B	48598	Dallas

Key: B = Both

From the attribute table several of the major traffic count points were extracted by the number the road name appeared in the table. For example: Midway, Preston, and Beltline Road were reoccurring names from the attribute table identifying areas with the highest levels of traffic volume. Since these road names appeared quite often in the attribute table a pattern was identified and recorded. From Table 4-11, for example, Midway Rd is identified several times, indicating that large traffic volume is traveling along this corridor and makes up a good portion of the top traffic count points in the table.

The major roads identified from the attribute table were located using GIS and mapped as can be seen in Figure 4-20. From this map and using the legend it is quite clear that Preston, Beltline and Midway carry a large amount of traffic. Local bus routes do operate along these roads but the average ridership is low compared to the other routes. The existing bus routes that operate along Preston, Beltline and Midway with their average ridership includes:

- Route 36: Average Weekday Ridership is 1,354
- Route 350: Average Weekday Ridership is 927
- Route 400: Average Weekday Ridership is 2,185
- Route 488: Average Weekday Ridership is 2,216

The traffic volume along these routes is between 20,000 and 75,000 vehicles within a 24-hour period. Clearly, many of these motorists are not utilizing the public transportation offered to them for reasons unknown.

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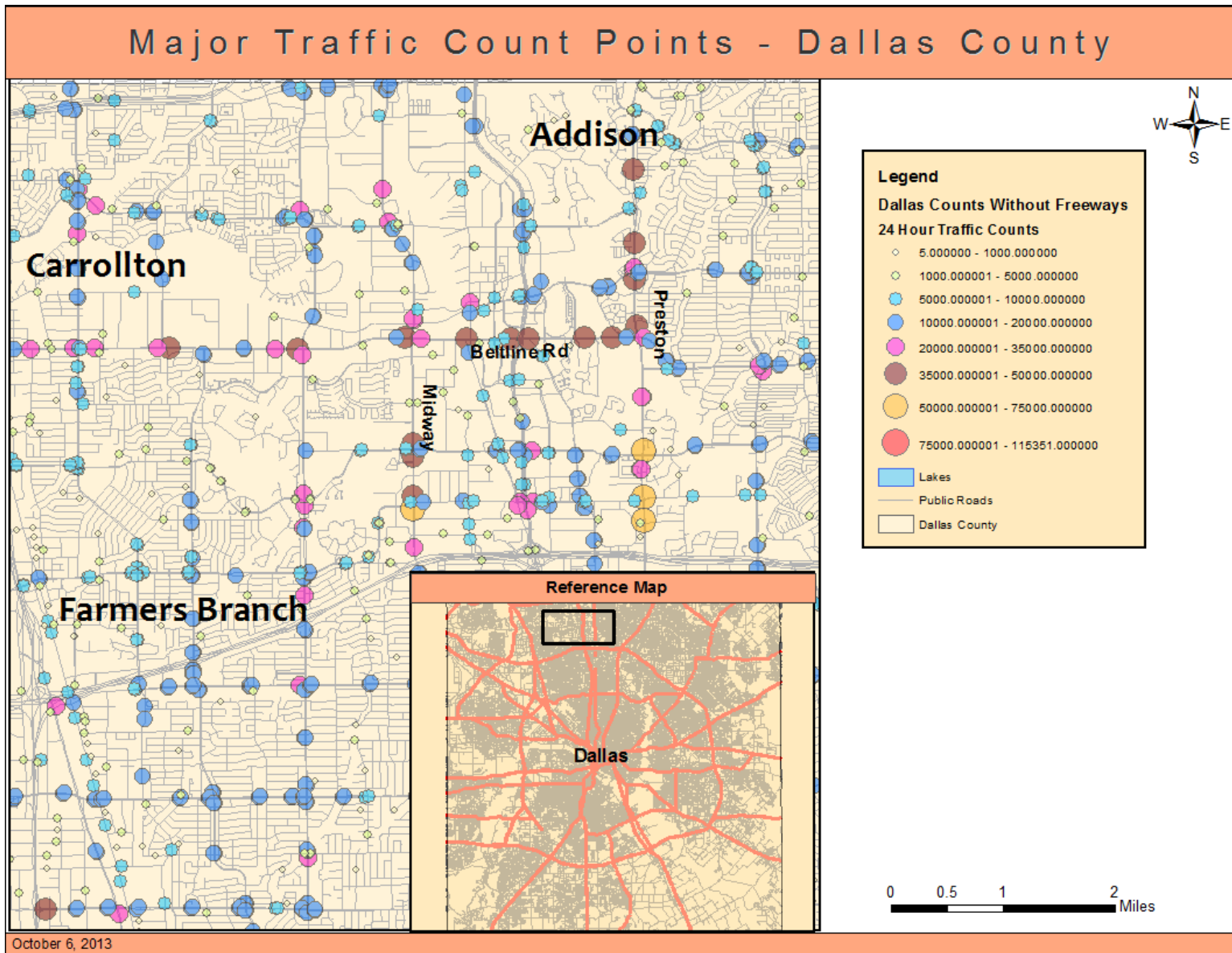


Figure 4-20 Major Traffic Count Points in Dallas Count

The average speed of the buses would need to be evaluated to determine whether the amount of traffic occurring in this area has impacted the existing public transportation in the area. The average bus speeds were unattainable from DART nor were boarding and alighting data available. DART has just recently integrated new technology that would enable the collection of boarding and alighting data electronically but the system is still fairly new and DART is in the process of beta testing and calibrating the system.

Summary of Analysis

The use of demographic, ridership, and traffic count data identified various patterns amongst the Dallas County transportation network. From this data it was possible to filter and identify specific roads as potential BRT corridors. The filtering process involved the review of demographic data, bus ridership, and traffic volume counts to identify an area that would serve as a good candidate for BRT. Through this filtering process three corridors were identified; Beltline Rd, Midway Road, and Preston Road. These corridors had high traffic volume counts and low bus ridership in an area that is heavily urbanized. The Beltline corridor interconnects Carrollton, Richardson, and Garland in the east/west direction with over 15 miles of existing roadway infrastructure that can potentially accommodate a BRT line. Midway and Preston Road each travel north/south and link Frisco, The Colony, Carrollton, and Dallas which sandwiches the Dallas North Tollway. The integration of a BRT line along these two north/south directional corridors can potentially provide congestion relief to the tollway by providing motorists with an alternative mode of transportation for the area. The Beltline corridor could act as an extension of the DART rail lines that run mainly north/south, thus giving motorists additional options when trying to travel throughout Dallas County and surrounding areas.

This area would require further study to confirm whether BRT is an appropriate system which is beyond the scope of this report. Such items would include, for example, a study of the right of way available along these corridors to determine whether a segregated busway could be accommodated or whether existing lanes could be made into bus only roadways. These are but a few of the additional items that would need to be further studied but that discussed by Arias et al (2007).

Chapter 5

Conclusion

The outcome of the analysis was the result of utilizing a methodology developed by the Institute for Transportation & Development Policy for any city that does not have traffic modeling software readily available. This analysis procedure simplifies and provides an approximate estimation of the demand for an area. This provides the user an expedited process to get a preliminary understanding of an area's existing transportation network. The analysis procedure is also very flexible as not all data is required in order to produce a result. In fact, what happens is that outcome of the analysis is a rough estimate but can be further refined though the incorporation of additional data. For example, in this particular study the average speed of the buses and the board/alighting data were unavailable which did not obstruct the continuation of the analysis but rather produce a slightly coarser result.

The transportation network in Dallas County is heavily travelled and is in much need of an innovative and economically feasible system that will remove vehicles from roadways by providing a rapid and reliable transit system. From the case studies reviewed it was evident that the integration of BRT was a success. The outcomes produced from incorporating BRT into the study areas included: improved travel times; increase in average speed; increase in ridership; enhanced surrounding areas through

the incorporation of landscaping and BRT stations which promoted new development. The case studies also made comparisons of BRT to LRT which DART appears to have adopted as its preferred mode of transit according to the TSP. It was concluded from these case studies that LRT was an inflexible and more expensive option than BRT. The ability of BRT to adapt to the dynamic changes in travel patterns, population, and employment make it an attractive alternative.

The traffic congestion in Dallas County will only continue to worsen as the population continues to grow and expand. The funding shortfalls currently being felt by all local agencies in Dallas County and the region for transportation related projects should not favor transit systems that are too cost prohibitive. Even if funding was available, the traditional mindset to add additional infrastructure is no longer realistically possible because of land constraints. With existing roadways already in place it would be to our advantage to utilize this infrastructure with a transit system that can mesh without requiring the addition of new roads.

Bus rapid transit is a cost-effective alternative solution to mobility issues in any part of the world. Its rise as an effective option can be related to low infrastructure costs, its ability to operate without subsidies and, its ability to be implemented within a short period (e.g. 1 to 3 years). This system should be given more attention as a viable and innovative option which could address the congestion issue that continues to plague the Dallas County area.

Appendix A

Acronyms

ADA: Americans Disabilities Act
BRT: Bus Rapid Transit
CBD: Central Business District
CMP: Congestion Management Process
DART: Dallas Area Rapid Transit
DFW: Dallas/Fort Worth
DMV: Department of Motor Vehicles
GIS: Geographical Information System
HOV: High Occupancy Vehicle
INT: Interval
ITS: Intelligent Transportation Systems
LBJ: Lyndon B. Johnson
LOS: Level of Service
LRT: Light Rail Transit
MBTA: Massachusetts Bay Transportation Authority
MPO: Metropolitan Planning Organization
MTA: Metropolitan Transit Authority
MTP: Metropolitan Transportation Plan
NCTCOG: North Central Texas Council of Governments
PAT: Port Authority Transit
PPHPD: Passengers Per Peak Hour Per Direction
ROW: Right-Of-Way
RTC: Regional Transportation Council
SOV: Single Occupancy Vehicles
TDM: Travel Demand Management
TMA: Transportation Management Area

TSM: Transportation System Management

TSP: Transit System Plan

VMT: Vehicle Miles of Travel

VPH: Vehicles per Hour

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Biographical Information

Prior to pursuing his Master's in City and Regional Planning at the University of Texas at Arlington, Frank obtained experience in the structural engineering industry for almost ten years as a project manager designing commercial buildings, churches, government facilities and educational institutions. He is a licensed professional engineer in the State of Texas and has experience designing with wood, steel, concrete and light gauge material. He has extensive experience working with multiple consulting agencies from project conception to construction administration. He obtained his undergraduate degree in Civil Engineering from the University of Texas at Arlington in 2003. Frank is currently a transportation planner with the North Central Texas Council of Governments.