Fall 12-15-2012

Employment Decentralization and Bus Rapid Transit in an Edge City Corridor: Veterans Boulevard in Greater New Orleans

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Employment Decentralization and Bus Rapid Transit in an Edge City Corridor:
Veterans Boulevard in Greater New Orleans

A Thesis

Submitted to the Graduate Faculty of the
University of New Orleans
In partial fulfillment of the
requirements for the degree of

Master of Urban and Regional Planning
Transportation Planning and Land Use & Urban Design

By

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B.A. Louisiana State University, 2009

December, 2012

Table of Contents

Index of Figures

Index of Tables

Abstract

The continued decentralization of employment in U.S. regions has led to the emergence of large employment centers outside of traditional Central Business Districts. Edge Cities in particular, with their high office space densities, significantly influence surrounding land uses and regional commuting patterns. However, existing transit systems tend to be oriented to historic Central Business Districts and the level of service for transit in suburban areas remains considerably below that of central cities. Adequately serving suburban Edge Cities with transit is critical in maintaining and improving access to jobs by transit and mitigating automobile congestion.

This study explores the suitability of a Bus Rapid Transit system along the Veterans Boulevard corridor in Greater New Orleans. It does this by analyzing residential and employment densities and existing commuting patterns along the corridor. It also explores the potential impact of BRT improvements on transit ridership in the corridor.

Employment Decentralization, Bus Rapid Transit, Density Thresholds, Latent Demand, Transit Elasticities, Suburban Transit

1.0 Purpose of the Study

1.1 Introduction

Employment decentralization in the last several decades has led to the emergence of job-rich employment subcenters and Edge Cities in most American metropolitan areas. By definition, employment and population densities in these areas are significantly higher than their suburban surroundings (Garreau, 1991; McMillen, 2001). Because of such relatively high densities, these areas can potentially support Bus Rapid Transit (BRT) service. However, transit service supplied (i.e. coverage, frequency, and access to jobs) in suburban areas is typically worse than that of central cities and most service is still oriented to the metropolitan Central Business District (CBD) (Tomer, Kneebone, Puentes, & Berube, 2011; Brown & Thompson, 2008b). As suburban areas continue to attract jobs and become more diverse, with greater concentrations of low-income households and households headed by individuals above the age of 65, there is a growing need for better transit service in these areas. There is also a need for a larger presence of sustainable forms of transportation, like public transit, in regions suffering from high congestion and/or air pollution resulting from automobiles.

This study will analyze residential and employment densities along the Veterans Boulevard corridor in Greater New Orleans and compare these densities to suggested thresholds for Bus Rapid Transit service identified by a literature review. This study will also examine current commuting patterns and evaluate latent demand for locally-serving BRT in this corridor. The corridor is anchored by the Metairie Central Business District (CBD), the second largest employment center in the region and an Edge City as defined by Lang and others (Plyer & Campanella, 2010; Lang, Sanchez, & Oner, 2009) It is currently home to the highest ridership bus route in Jefferson Parish, the E1 – Veterans bus route. This study will conclude by estimating ridership of a BRT system implemented in place of the current Veterans bus route.

1.2 Research Objectives

The purpose of this study is to explore if urban densities in the Veterans Boulevard corridor can support Bus Rapid Transit (BRT) and if current commuting patterns justify a locally-serving service orientation versus a Central Business District (CBD) orientation. It also aims to quantify ridership impacts resulting from transit service improvements attributable to BRT.

The primary objective of this study is to explore whether or not decades of employment decentralization have created Edge Cities and suburban corridors dense enough to support locally-serving, Bus Rapid Transit (BRT). This will be addressed by analyzing residential and employment densities along an existing transit route serving the corridor surrounding the Metairie CBD in Jefferson Parish, Louisiana. The findings of this objective will contribute to existing literature on the relationships between employment decentralization, urban structure morphology, and transit density thresholds.

A secondary objective is to explore current commuting patterns in the area surrounding the Metairie CBD in order to assess the latent demand for work-related transit trips beginning and ending in the Veterans Boulevard corridor. Despite decades of employment decentralization in American metropolitan areas, in most regions suburban rapid transit service is overwhelmingly oriented to the central city CBD. This study aims to explore the efficacy of this service orientation in an increasingly decentralized urban landscape.

Finally, this study will attempt to project changes in transit ridership attributable to service improvements associated with BRT, specifically travel time and frequency. Other aspects of BRT, such as the type of running way, vehicle capacity and boarding features, station comforts, and branding will not be directly modeled as there are many potential scenarios and specific recommendations are beyond the scope of this thesis. Instead, as existing research has done, they will be accounted for by applying a ratio of 1.25 to the ridership projections after accounting for changes in travel time and frequency (Li, Li, Miller, & Zhang, 2011). Potential BRT ridership is predicted in order to explore the effect of BRT service improvements in an area with relatively low transit level of service. The greatest increases in transit patronage generally occur following drastic increases in service (Evans, 2004). In this manner, dense suburban areas with relatively poor service represent areas of significant potential for future transit ridership (Guo, 2011). Findings of this research will contribute the post-Katrina body of literature through

addressing the potential to reverse the trend of increasing congestion delay and auto-dependence in the region since 2005 by focusing on a transit under-served suburban employment center (Schrank, Lomax, & Eisele, 2011).

1.3 Rationale

Why Transit Service in Edge Cities?

Unbridled employment decentralization is regarded by many planners as a detriment to the urban vitality of a region. The decentralization of jobs to auto-oriented suburban employment centers with poor transit service is especially troublesome as it creates a vicious cycle of increasing congestion and further employment decentralization (Cervero, 1986). In the 1980's the growth of suburb-to-suburb commuting, which typically has the shortest travel time of intra-metropolitan commute flows, helped to keep average metropolitan commute times stable (Lee, Jong, & Webster, 2006). However, from 1980 to 1990 the suburb-to-suburb commute experienced the highest increase in travel time in twelve of the largest U.S. metropolitan areas and by 2000, average U.S. metropolitan commute times had increased substantially (Lee, Jong, & Webster, 2006; Gordon, Lee, & Richardson, 2004). In order to effectively mitigate this trend towards increasing congestion and employment decentralization, transit must better serve auto-oriented, suburban employment centers which represent an increasingly larger share of all metropolitan employment.

Aside from population size, the most significant contributor to metropolitan job sprawl is commuting cost, or congestion (McMillen & Smith, 2003). As congestion in historic Central Business Districts (CBDs) has increased, dense concentrations of employment and residents, known as Edge Cities, have emerged in the suburbs of virtually every American region, especially so in regions with high commuting costs. Unlike traditional CBDs and pre-WWII suburban centers, Edge Cities are typically auto-oriented and have much more rapidly become victim to congestion. These types of Edge Cities are also sometimes known as Transit Under-Served Areas (TUSAs), or "areas in a metropolitan region with a development density not as high as downtown, but also not as low as most suburban communities" (Guo, 2011, 3). While historic CBDs already have high transit penetration rates, TUSAs' relatively low transit penetration rates and high

densities indicate a potentially unrivaled market for mode shift to transit. Because of the high responsiveness of commuters to transit service improvements, service improvements in these dense areas can greatly increase transit ridership in the region.

Why New Orleans? Why Veterans Boulevard?

New Orleans is the focus of the study because of its unique position post-Katrina. The physical damage to local infrastructure and buildings, along with ensuing demographic shifts, has led to considerably lower transit patronage and higher congestion in the region (Schrank, Lomax, & Eisele, 2011). Transit service provided and consumed remains significantly lower than before Katrina and much of the transit-dependent population that remained in the region post-Katrina has relocated to suburban areas with poorer transit service (GCR Inc., 2011) (U.S. Census Bureau, 2012a&b). This dispersed transit-dependent population has likely shifted to other modes because of the lesser quality of transit service in suburban areas. Re-capturing this population, as well as new choice riders, in transit under-served areas may be an effective way to reverse the current trend of increasing congestion and auto-dependence in the region.

Table 1.1 Change in Distribution of Carless Households in New Orleans Region, 2000-2011

Year	Region	Orleans Parish		Outlying Parishes	
2000	76,747	51,435	67%	25,312	33%
2006	29,710	12,505	42%	17,205	58%
2007	30,499	14,646	48%	15,853	52%
2008	34,594	17,706	51%	16,888	49%
2009	43,000	23,297	54%	19,703	46%
2010	46,485	26,768	58%	19,717	42%
2011	49,345	28,041	57%	21,304	43%
Note: Region defined as 7-parish 2010 MSA definition					
Source: U.S. Census Bureau, 2000 Census, Table H044; U.S. Census Bureau, 2006-11 American Community Surveys, Table B25044					

New Orleans was also selected because of South Louisianans' overwhelming desire for more compact, walkable areas better served by transit, as expressed in surveys conducted as part of the "Louisiana

Speaks" planning process organized by the Center for Planning Excellence (CPEX) after Hurricanes Katrina and Rita devastated South Louisiana in 2005 (Center for Planning Excellence, 2006).

Veterans Boulevard was selected because local officials have expressed an interest in bringing Rapid Transit to the corridor (New Orleans Regional Planning Commission, 2012). The corridor also has relatively high employment and residential densities for Jefferson Parish (Plyer & Campanella, 2010). It is anchored by the Metairie CBD, which was determined to be an Edge City by this author, following the methodologies of Lang, Sanchez, & Oner (2009). This methodology will be discussed later in section 3.3.

Why Bus Rapid Transit?

Bus Rapid Transit (BRT) was selected for analysis because it is a cost-effective means of radically improving transit service which has been shown to attract both captive and choice riders (Diaz & Hinebaugh, 2009). BRT is especially applicable to suburban corridors that do not have the focus and density to make rail-based transit a cost-effective investment. BRT has similar capacity to most existing rail-based transit systems in North America and can similarly foster economic development if appropriately integrated with surrounding land uses. But BRT is advantageous because of its lower cost, flexibility, and ability to be implemented quickly and incrementally (Levinson, Zimmerman, Clinger, & Rutherford, 2002). BRT also has lower carbon dioxide emissions than rail-based forms of rapid transit which rely on electric propulsion fueled by fossil fuels (Vincent & Jerram, 2006).

BRT has been shown to be most successful in corridors with a mix of different land uses and relatively high residential and/or employment densities. Additionally, the presence of a major activity center, such as a Central Business District, along the BRT corridor has been shown to be a primary determinant of the success of a BRT system (Puget Sound Regional Council, 1999). The Veterans Boulevard corridor seems to embody all of these characteristics. Though the Metairie CBD is the only major mixed-use area along the corridor, the remaining portions of the corridor are comprised of commercial and residential uses of varied intensity (Burk-Kleinpeter, Inc., 2001; Jefferson Parish, 2007). In terms of density, in 2010 the corridor had high residential densities relative to the rest of the region and in 2008 was home to several regional job clusters identified by a report on Job Sprawl (Social Explorer, 2012; Plyer &

Campanella, 2010). Still, more quantitative data is necessary to determine how this area stacks up compared to BRT guidelines and standards.

Table 1.2 Job Clusters along Veterans Boulevard Corridor

Job Cluster	Jobs	Jobs/Square Mile
Vets/Causeway/I-10	29,586	12,673
Vets/Clearview	9,525	6,659
Kenner/Williams	8,373	6,835
Vets/Oaklawn/Bucktown	5,141	3,388
Vets/David	4,874	6,504
Lakeview/West End	1,312	579
Source: Plyer & Campanella, 2010		

1.4 Study Area

The study area for this research is the service area of the current "E1 – Veterans" bus route operated by Jefferson Transit (JeT) in Jefferson and Orleans parishes of the New Orleans-Metairie-Kenner, LA Metropolitan Statistical Area (MSA). For purposes of this research, the service area is defined as a half-mile Euclidean radius away from the bus route, excluding portions of the route on Interstate 10 as these areas are not serviceable.

The study area more or less follows Veterans Boulevard, a high-capacity, urban arterial that is flanked on either side by relatively intense commercial development. It is anchored by the Metairie Central Business District (CBD), a significant employment center in the region, and extends in one direction to the Cemeteries bus transfer station in New Orleans, and Williams Boulevard in Kenner in the other.

The majority of the study area is former backswamp and was developed after Veterans Boulevard was constructed in 1955 (Campanella, C., 2008). A prototype of post-WWII planning, the area is extremely automobile-oriented and land uses remain highly segregated. Commercial uses are concentrated along major streets and multi-family housing serves as a buffer between this commercial development and interior single-family residential uses (Jefferson Parish, 2007). Despite such suburban design, the area has relatively high residential densities and is situated in Jefferson Parish which has relatively small lot

sizes, especially compared to the more peripheral St. Tammany Parish (Campanella, R., 2008; U.S. Census Bureau, 2012c).

Table 1.3 Median Lot Sizes of Occupied, Single-Family Housing Units in New Orleans Region

Parish	Median Lot Size (acres)
Orleans	0.13
Jefferson	0.14
St. Tammany	0.39
Source: U.S. Census Bureau, 2009 American Housing Survey, Table 2-3	

Figure 1.1 Study Area Regional Context

1.5 Research Questions

RQ1: What are the residential and employment densities along the Veterans Boulevard corridor? According to existing literature, are these densities supportive of Bus Rapid Transit?

Hypothesis: The residential densities barely meet or do not meet the minimum thresholds suggested by existing literature for Bus Rapid Transit but the employment densities exceed such minimum thresholds.

RQ2: Is there latent demand in the study area for work-based trips on locally-serving Bus Rapid Transit? Phrased differently, are there many commuters residing and employed in the corridor but considerably fewer utilizing transit? Are those currently commuting by transit best characterized as transit dependent?

- In 2010, how many commuters in the study area both resided and worked within a walkable distance of the Veterans Bus Route? What areas in Orleans and Jefferson parishes have the highest densities of employment for commuters residing within a half mile of the Veterans Bus Route?
- In 2006-2010, how many commuters residing in the study area commuted by transit? Compared to all commuters residing in the study area, are transit commuters disproportionately transit-dependent, or members of low-income or carless households?

Hypothesis: There are considerably more commuters that reside and work within a walkable distance of the Veterans bus route than utilize transit. Those currently using transit are best characterized as transit-dependent.

RQ3: How much would the E1 – Veterans bus route ridership increase if Bus Rapid Transit (BRT) service improvements were implemented?

Hypothesis: Transit ridership will increase greatly because BRT conditions are a drastic improvement from current, baseline conditions.

2.0 Methodology

The research questions stated above will be addressed by both qualitative and quantitative analyses, with a heavier emphasis on the quantitative. First, a review of existing literature on the relationship between residential and employment densities and Bus Rapid Transit (BRT) will be presented. Then, using Geographic Information Systems (GIS) analysis, densities in the study area will be assessed using findings from the literature review for BRT supportive densities. Next, commuting patterns for the study area will be compiled and analyzed using GIS analysis. Finally, a direct demand elasticity model will be utilized to predict change in bus ridership attributable to BRT service improvements along the Veterans Boulevard corridor. Data utilized will be the most recent so as to take into account post-Katrina demographic and transit service changes.

2.1 Research Question One

RQ1: What are the residential and employment densities along the Veterans Boulevard corridor? According to existing literature, are these densities supportive of Bus Rapid Transit?

Hypothesis: The residential densities barely meet or do not meet the minimum thresholds suggested by existing literature for Bus Rapid Transit but the employment densities exceed such minimum thresholds.

Methodology

The methodology for this question will be broken into two parts. The first part uses GIS software, specifically ArcMap 10, to analyze the residential and employment densities of the E1 - Veterans bus route corridor. The second part involves a literature review of existing research on density thresholds and standards suggested for Bus Rapid Transit service. The intended outcome of this literature review is a table summarizing ranges of residential and employment densities supportive of Bus Rapid Transit. This table will then inform the evaluation of densities in the E1- Veterans bus route corridor in order to answer the research question.

For the first part of the question a shapefile representing the E1 – Veterans bus route was manually created in ArcMap using the route map provided on Jefferson Transit website. Geographic boundaries for the New Orleans and Metairie Central Business Districts (CBDs) were also created manually from boundaries provided by the Greater New Orleans Community Data Center and New Orleans Regional Planning Commission (Bonaguro, 2004; Burk-Kleinpeter, Inc., 2001).

Part One Procedure

Data Sources

The data utilized for this part of the research question was retrieved from the U.S. Census Bureau's American FactFinder and OnTheMap applications (U.S. Census Bureau, 2012d&e). Total residential populations for all census blocks in the study area was retrieved from Table P1 of the 2010 Census using American FactFinder. Total employment populations for all census blocks in the study area was retrieved from the 2010 Area Profile analysis of work locations for all primary jobs using OnTheMap Version 6. This employment data is provided by the Census Bureau in partnership with state labor agencies and is partially synthetic. The raw data is minimally manipulated to maintain both individual confidentiality and statistically valid commuting patterns. The dataset is available for all years from 2002 to 2010 and is based on employment data from the second quarter of each year (April-June).

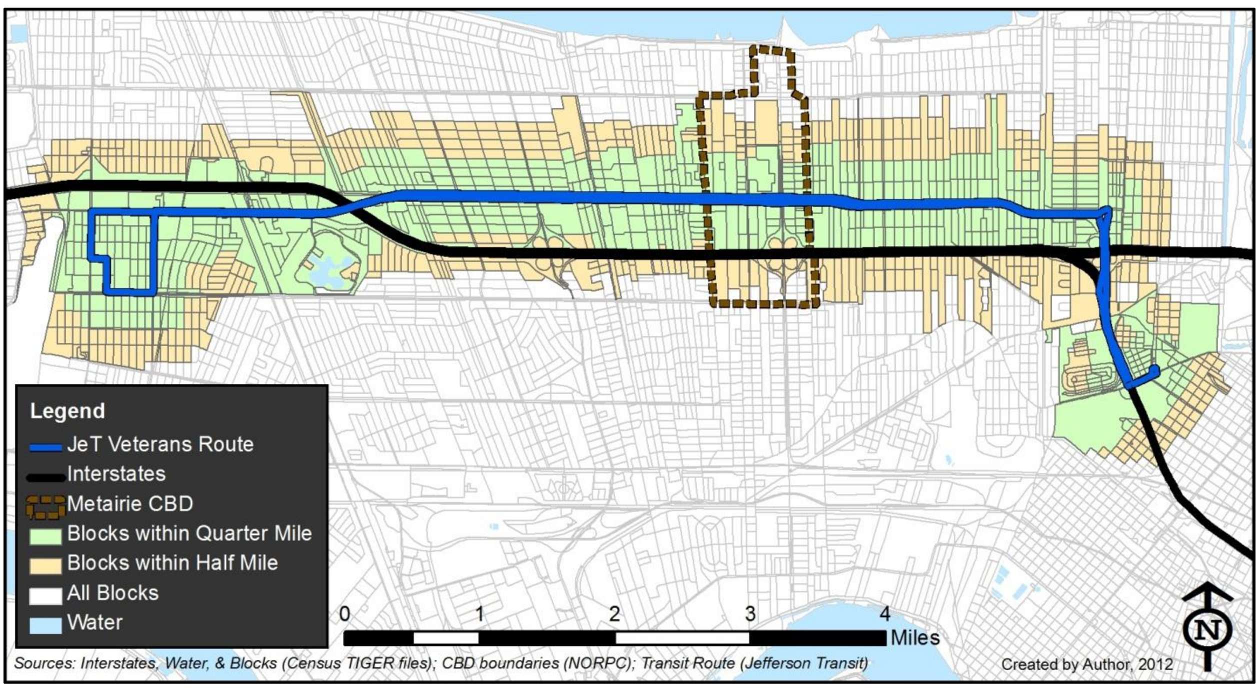
GIS shapefiles for census blocks, water, and roads layers were downloaded from the Census Bureau's 2010 TIGER dataset.

Study Area and Unit of Analysis

The study area for this research question is all census blocks that intersect a half mile Euclidean buffer away from the E1 – Veterans bus route, excluding the census block that comprises the Louis Armstrong New Orleans International Airport (MSY). This block has no residents and all jobs in this block are not actually located in the study area as the portion of the block that intersects the buffer is a runway.

Because all data retrieved for this part of the question is available at the census block, this fine-grain unit of analysis will be used. For the residential density, all block-level data within a quarter mile and half mile buffer of the bus route was aggregated. While a quarter mile is the industry standard for transit service corridors, recent evidence suggest that higher quality service like BRT may attract riders residing as far away as a half mile and that densities at the half mile distance are a better predictor of ridership (Cervero & Guerra, 2011; Nelson\Nygaard Consulting Associates, 2010; Johnson, 2003). Similarly, for employment density all block-level data within a half mile and quarter mile buffer of the bus route was aggregated separately. While some research shows that employment density within a quarter mile is the most significant predictor of ridership, this study will employ both quarter and half mile distances (Cervero & Guerra, 2011).

Figure 2.1 Study Area Census Blocks, 2010



In addition to corridor density, station area densities are important in predicting ridership. This is especially true of Bus Rapid Transit systems which have longer stop-spacing than conventional bus routes. The procedures utilized in the corridor analysis were duplicated for station areas, defined as half-mile radial buffers away from the identified stop locations. Stop locations were identified by using

Lakeside Mall as a starting point and identifying areas of high commercial activity every half mile or so in either direction. Stop-spacing for BRT varies but is typically no less than every half mile.

Figure 2.2 Selected Station Areas

GIS Analysis

The tabular population data from American Factfinder and employment point data exported from OnTheMap were uploaded into ArcMap and joined to the census block layer separately, using an attribute join and spatial join respectively. A half-mile and quarter-mile Euclidean (as-the-crow-flies) buffer was created using the buffer tool in ArcMap. All census blocks intersecting the half mile and quarter mile were selected and used to create separate layers.

The intersection procedure selected some blocks that only have a portion of their land area within either buffer. In an attempt to avoid counting residents or jobs in portions of these blocks outside of the buffer, a geographic ratio for each buffer was created that divides the land area (acres) of the census tract that is contained within the buffer by the total land area (acres) of the census tract. This assumes even distribution of jobs across the census block. These ratios were then multiplied by both total residents and employees within the block.

Using the statistics tool in the attribute table, the total number of residents and employees in the half mile buffer and total number of employees in the quarter mile buffer was extracted. To calculate the residential and employment densities these totals were divided by the land area total of all census blocks, or portions thereof, that were contained within the respective buffer. Furthermore, for the sake of discussion, a map was made which shows the employment and residential density of each census block in the study area. This will help to understand how the population and employment is concentrated throughout the corridor and what areas may be more appropriate for stations.

Part Two Procedure

Data Sources

This part of the question will be answered by a literature review of academic papers regarding density thresholds and white papers regarding density standards used in Bus Rapid Transit (BRT) studies throughout North America. White papers will come from consulting firms, transit agencies, and non-profit/advocacy groups.

Unit of Analysis

The literature review will focus on two units of analysis: the corridor and station area.

Analysis

The anticipated result of the analysis of existing literature is a table summarizing relevant findings and conditions. The table will display the residential and employment densities suggested for BRT corridors and station areas. This part of the research question will inform the discussion of the findings from the first part of this question regarding densities in the E1 – Veterans bus route corridor.

2.2 Research Question Two

RQ2: Is there latent demand in the study area for work-based trips on locally-serving Bus Rapid Transit? Phrased differently, are there many commuters residing and employed in the corridor but considerably fewer utilizing transit? Are those currently commuting by transit best characterized as transit dependent?

- In 2010, how many commuters in the study area both resided and worked within a walkable distance of the Veterans Bus Route? What areas in Orleans and Jefferson parishes have the highest densities of employment for commuters residing within a half mile of the Veterans Bus Route?
- In 2006-2010, how many commuters residing in the study area commuted by transit? Compared to all commuters residing in the study area, are transit commuters disproportionately transit-dependent, or members of low-income or carless households?

Hypothesis: There are considerably more commuters that reside and work within a walkable distance of the Veterans bus route than utilize transit. Those currently using transit are best characterized as transit-dependent.

Methodology

In order to answer this research question, Origin-Destination data and Journey to Work data for the study area were analyzed in a GIS environment, specifically ESRI's ArcMap Version 10. All commuters whose work trips begin and end in the study area were assumed to be potential transit riders, following the methodology of a somewhat similar project studying transit demand in suburban activity centers in the Philadelphia region (Casello, 2007). Latent demand for locally-serving BRT is thus described as the difference between all potential transit riders residing in the corridor and the actual number of transit riders residing in the study area.

For both parts of the question a shapefile representing the E1 – Veterans bus route was manually created in ArcMap using the route map provided on Jefferson Transit website. Geographic boundaries for the

New Orleans and Metairie Central Business Districts (CBDs) were also created manually from boundaries provided by the Greater New Orleans Community Data Center and New Orleans Regional Planning Commission (Bonaguro, 2004; Burk-Kleinpeter, Inc., 2001).

Part One Procedure

Data Sources

The Origin-Destination data utilized for this study is the Census Bureau's LEHD (Longitudinal Employment-Household Dynamics) Origin-Destination Employment Statistics (LODES) Version 6 dataset. This dataset is provided by the Census Bureau in partnership with state labor agencies and is partially synthetic. The raw data is minimally manipulated to maintain both confidentiality and statistically valid commuting patterns. The dataset is available for all years from 2002 to 2010 and is based on employment data from the second quarter of each year (April-June).

Data for this study was retrieved from the Center for Economic Studies' OnTheMap Version 6 application. Using the Distance/Direction analysis type, data was retrieved for primary jobs in 2010, based on the commuter's home (origin) block group. 2010 data was selected because it is the most recent data and is assumed to be the best representation of current, post-Katrina trends. The primary job, the job in which public or private workers gain the majority of their income, was selected because it only counts each commuter once and this is the same type of job the Census Bureau uses in its Journey to Work questionnaire. Block groups were selected as the unit of analysis because they are the smallest geography available. Home locations were selected because this research question aims to understand how many workers residing in the study area work in the study area and other parts of the region. It is important to note that while the block group was the smallest geography available for analysis, the output assigns employment destinations at the smaller, block level. This is beneficial because it allows for more precise analysis of the work end of the trip, which is assumed to have a smaller service area radius (0.25 miles) than the home end of the trip (0.5 miles).

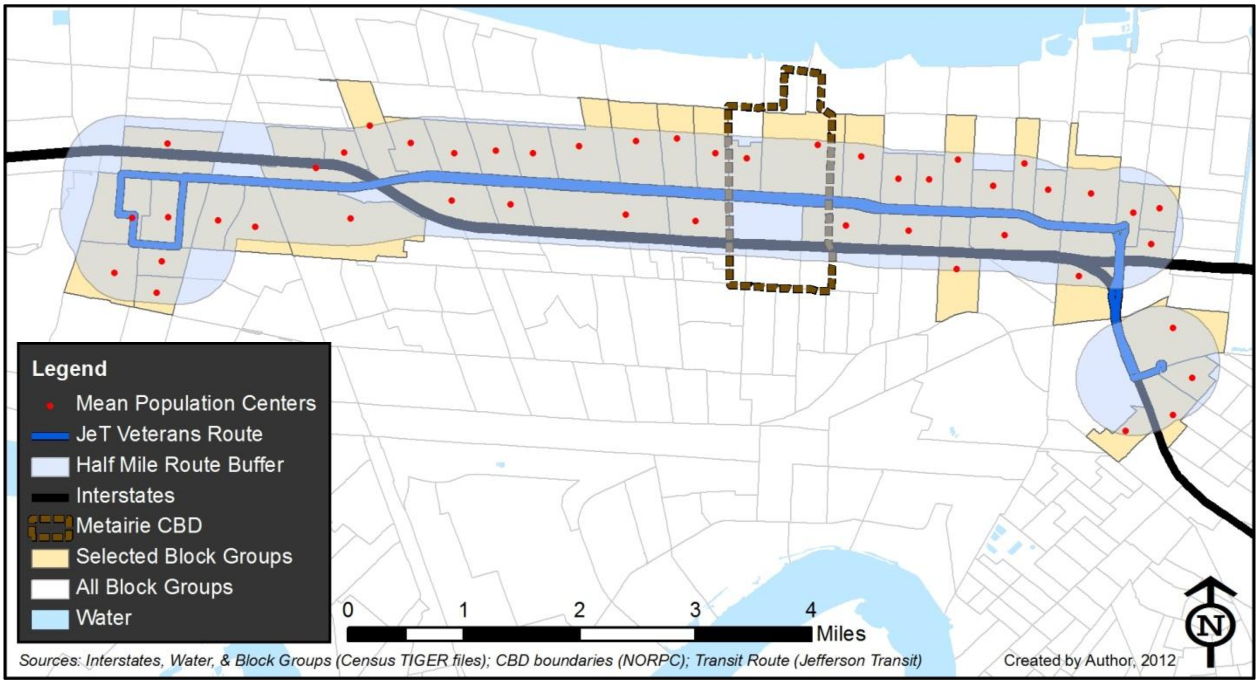
The output of the OnTheMap application was block-level, origin-destination point data for each block group selected in the study area. These data had to be extracted for each block group separately. After exporting these data as shapefiles, they were uploaded into ArcMap and merged into one single shapefile and a dissolve was performed to aggregate and sum up all data at the census block level.

Study Area and Unit of Analysis

The study area for this research question had to be manipulated in order to accommodate a block group unit of analysis, the smallest unit of analysis supported by OnTheMap. In order to do this, 2010 Census data and census geography shapefiles were uploaded into ArcMap. Those census block groups with population centroids within a half mile radius of the E1 - Veterans bus route were selected to represent the residential (origin) study area. The population centroid criterion was used as opposed to simply selecting all block groups because it was assumed to better capture those within the service area (0.5 miles). Though some block groups may intersect the half mile buffer, the majority of its population may not be within the service area.

The first step in determining the block groups to be selected was to create a half mile buffer from the E1 - Veterans bus route. This was done in ArcMap and excluded the portion of the route operating on Interstate 10, where passenger boarding/alighting is not possible. After this was done, all census block groups intersecting the buffer were selected for further analysis. For these block groups, the mean population centroid was calculated using the Mean Center tool and total population data at the block level from the 2010 Census. As the map below shows, the final census block groups selected were almost exclusively those adjacent to the bus route. One block group that met these qualifications was excluded because it was physically isolated by a grade-level section of Interstate 10. See the appendix for a table listing of the block groups selected to represent the residential (origin) study area.

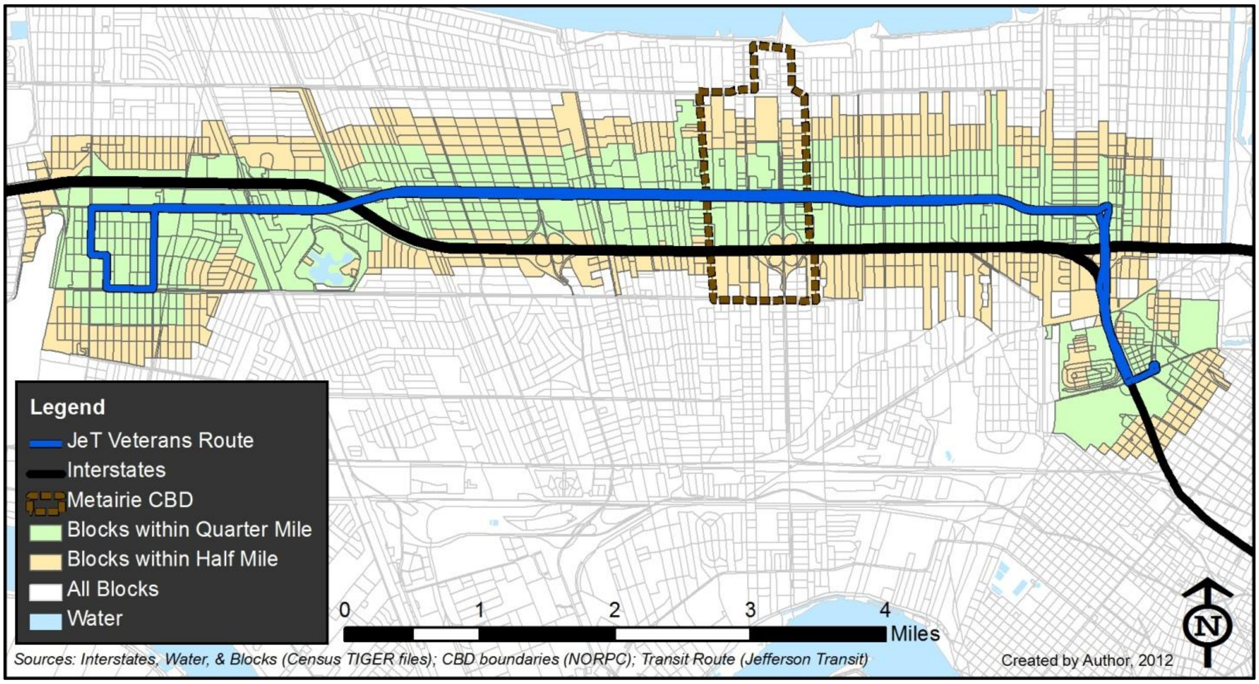
Figure 2.3 Study Area Residential (Origin) Block Groups, 2010



After identifying the census block groups that represent the residential (origin) study area, it was necessary to select the census blocks that represent the employment (destination) study area. Instead of using just a half mile buffer away from the E1 – Veterans bus route, a quarter mile Euclidean buffer was employed as well. This was done in order to allow for dual analysis. Existing research suggests that a quarter mile radius may be more appropriate for the work trip than a half mile (Cervero & Guerra, 2011).

Because data is not available below the census block level and these areas are already extremely precise, all blocks within these Euclidean buffers were selected. An exception is the airport census block which was excluded because of its large size and concentration of jobs away from the study area. The portion of this block in the study area is actually just part of a runway. The census blocks selected to represent the employment (destination) study area for this research question are shown below.

Figure 2.4 Study Area Employment (Destination) Blocks, 2010



GIS Analysis

After the residential (origin) and employment (destination) study areas and units of analysis were determined and the appropriate data was retrieved, GIS analysis was performed to determine how many of the commuters residing in the study area census block groups were also employed in the study area census blocks.

After merging and dissolving the origin-destination data for the residential (origin) study area block groups, the total commuters residing the employment area was calculated using the Statistics tool in the Attribute table. The only remaining procedure was to calculate the number of these commuters that were employed in census blocks within a half and quarter mile. Since the origin-destination was point data, the first step was to assign all data to the census blocks. After doing this, the number of jobs in a selected block was multiplied by a geographic ratio, calculated as the land area (acres) of the census block intersecting the buffer divided by the total land area (acres) of the entire census block. This ratio was deemed necessary in order to maintain a buffer-specific analysis and avoid overcounting data in intersecting blocks in which a small portion of the total land area is within the buffer, especially irregularly

shaped or unusually large blocks. The ratio assumes an even distribution of jobs across the census block.

After the ratio was applied, all blocks that intersected the half mile and quarter mile buffer were aggregated separately in order to determine the number of study area commuters that were employed within these buffers.

In order to address the part of the question that asks what areas in Orleans and Jefferson parishes have high employment (destination) concentrations of study area workers, the origin-destination data aggregated at the census block level was further aggregated at the census tract level for these two parishes. The results were then mapped to show how many residents were employed in each census tract relative to the land area of the tract.

Part Two Procedure

Data Sources

The data used to answer this part of the question included 2010 TIGER shapefiles from the Census Bureau and 2006-2010 American Community Survey (ACS) data. Specifically, the Journey to Work data for census tracts in the study area were retrieved. The tables downloaded from American FactFinder are summarized below.

Table 2.1 Selected American Community Survey "Journey to Work" Tables

Table	Title	Universe
B08301	Means of Transportation to Work	Workers 16 years and over
B08141	Means of Transportation to Work by Vehicles Available	Workers 16 years and over in households
B08122	Means of Transportation to Work by Poverty Status the Past 12 Months	Workers 16 years and over for whom poverty status is determined
B08119	Means of Transportation to Work by Workers' Earnings in the Past 12 Months (In 2010 Inflation-Adjusted Dollars)	Workers 16 years and over with earnings
C08134	Means of Transportation to Work by Travel Time to Work	Workers 16 years and over who did not work at home
Source: U.S. Census Bureau, American Community Survey, 2006-2010		

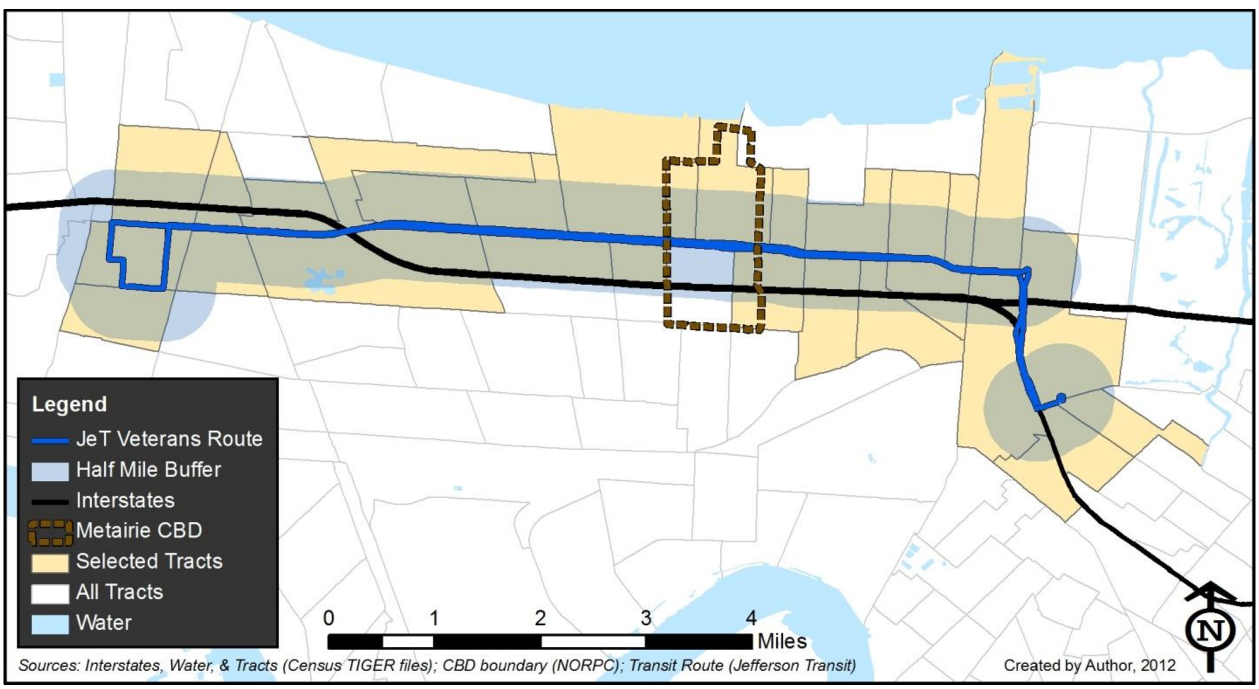
Study Area and Unit of Analysis

The study area for this part of the question is adapted from the former part of the question but the unit of analysis is changed to the census tract since this is the smallest geography available from the 5-year estimates from the American Community Survey. The census tracts selected were those that contained any block group in the residential (origin) study area for the former part of the research question. This was done to maintain validity when discussing the study area.

Because census tract data is an aggregation of data from block groups, some of the selected census tracts contain block groups outside of the study area defined in the former part of the question. While this inherently limits the precision of the latent demand analysis, general conclusions can still be made based on ranges of data.

The map below illustrates the boundaries of all of the census tracts containing residential block groups from the former part of the question.

Figure 2.5 Study Area Residential (Origin) Tracts, 2010



Analysis

After the data was retrieved from American FactFinder, all data was aggregated for two groups: all commuters and public transit commuters. Data was aggregated to represent the study area as a whole. Once aggregated, the data was formatted into a table and percentages and ratios were calculated in order to compare the characteristics of public transit commuters to all commuters in the study area.

2.3 Research Question Three

RQ3: How much would the E1 – Veterans bus route ridership increase if Bus Rapid Transit (BRT) service improvements were implemented?

Hypothesis: Transit ridership will increase greatly because BRT conditions are a drastic improvement from current, baseline conditions.

Methodology

This question will be addressed using a sketch-planning approach. It will rely exclusively on existing transit service conditions and direct demand elasticities to predict Bus Rapid Transit ridership resulting from service improvements. The methodology is based on two similar sketch-planning studies for BRT implementation, one hypothetical and one practical. The hypothetical study was conducted by ICF International, a consulting firm, and was published by the National Cooperative Highway Research Program (NCHRP) in April 2011 (Ang-Olson & Mahendra, 2011). The practical study focused on the Van Ness Boulevard Corridor in San Francisco and was conducted and published by the California PATH Program of the University of California, Berkeley in May 2011 (Li,Li, Miller, & Zhang, 2011).

Procedure

There are three primary models used to forecast transit ridership: the four-step based demand model, the direct ridership model, and the elasticity model. Of these, the elasticity model is utilized for this study as it is the simplest and most appropriate for studying BRT impacts on an existing transit route.

While the four-step based demand model is the most comprehensive method of estimating ridership changes it was abandoned because it requires a reliable and fully calibrated regional planning model. This is beyond the scope of this thesis and more typical of detailed, feasibility analyses. The direct ridership model is simpler than the previous model, using ridership data from transit routes with similar service characteristics, socioeconomics, and other characteristics to estimate ridership of a new or improved route, assuming ridership is a function of these characteristics. This model was abandoned because it requires extensive data collection and calibration. The elasticity model estimates ridership changes in existing transit corridors based on baseline conditions and the responsiveness (demand elasticities) of travelers to service changes like travel time and frequency. This model was selected because of its simplicity and applicability to the Veterans Boulevard corridor where transit already exists and baseline conditions are known.

"Ridership elasticity is defined as the change in ridership corresponding to a 1% change in fare, travel time, or service frequency (Li, Li, Miller, & Zhang, 2011, 35)." Thus, the ridership elasticities in this study are direct elasticites, measuring the change in one mode based on characteristics of that mode. Unlike cross-elasticities, direct elasticities do not aim to predict mode shift based on changes in the attributes of one mode.

Within the elasticity model framework there are three primary methods of applying elasticities: the shrinkage factor method, the midpoint arc method, and the log arc method. Of these, the midpoint arc method is the most commonly used and has similar results to the more complex log arc method. Thus, this is the method utilized in this study. The shrinkage factor is typically only used for small changes and thus was not considered. The formula for the midpoint arc method is shown on the next page.

Midpoint arc method:

$$R_2 = R_1\left(\frac{(E-1)X_1 - (E+1)X_2}{(E-1)X_2 - (E+1)X_1}\right)$$

Where:

$E = elasticity\ value\ for\ service\ attribute$

$R_1 = base\ ridership$

$R_2 = estimated\ future\ ridership$

$X_1 = base\ value\ of\ serice\ attribute\ (e.g. travel\ time\ minutes)$

$X_2 = future\ value\ of\ serice\ attribute$

In order to apply the midpoint arc elasticity method, the direct elasticities being applied and their respective values need to be determined. In the National Cooperative Highway Research Program (NCHRP) Report, Van Ness Study, and similar literature, the only elasticities measured in estimating BRT ridership are travel time and service frequency.

Regarding ridership elasticity with respect to travel time, national research has shown elasticity values ranging from -0.3 to -0.7 with the most typical value being -0.4 (Kittelson & Associates, 2007). Elasticity values below -0.5 are only used for work-based trips. Some researchers using the more conservative -0.4 add -0.1 to account for increased reliability (Ang-Olson & Mahendra, 2011; Cambridge Systematics, 2009). Thus, this study will use -0.5 for the travel time elasticity value, representing the conservative -0.4 and -0.1 for increased reliability.

Regarding ridership elasticity with respect to increased frequency, national research has shown elasticity values to be more consistent, ranging from 0.3 to 0.5 with the typical value being 0.4 (Kittelson & Associates, 2007). 0.4 is utilized in the NCHRP report and Van Ness Study and will be used for this study as well (Ang-Olson & Mahendra, 2011; Li, Li, Miller, & Zhang, 2011).

Table 2.2 Elasticity Model Parameters

Parameter	Range	Typical	Selected
Travel Time	-0.3 to -0.7	-0.4	-0.5
Frequency	-0.3 to -0.5	-0.4	-0.4

After the travel time and frequency elasticities are applied to estimate a new ridership figure, an additional 25% increase is calculated in order to account for the many additional benefits of BRT, summarized in the table below. This is done because the elasticity method has been shown to underestimate the attractiveness of BRT by a margin of 15-25% (Li, Li, Miller, & Zhang; Kittelson & Associates, 2007). When the BRT service improvements are substantial, such as envisioned in the Veterans Boulevard corridor, a 25% additional increase in estimated ridership is justified (Li, Li, Miller, & Zhang, 2011).

Table 2.3 Estimated Additional Ridership Impacts of BRT Components

Component	Additional Percent Increase	Share of Total Potential Increase
All Components (Subtotal)	21.25	85%
Running ways	5	20%
Stations	3.75	15%
Vehicles	3.75	15%
Service patterns	3.75	15%
ITS applications	2.5	10%
Branding	2.5	10%
BRT component synergy (when subtotal is 60% or more)	3.75	15%
Total	25	100%
Source: Kittelson & Associates, 2007		

Study Area and Unit of Analysis

The study area for this research question is the service area of the E1 – Veterans bus route. The E1 – Veterans bus route operated by JeT runs almost the entirety of Veterans Boulevard and crosses into New Orleans at the Cemeteries transfer station. The unit of analysis is the route itself, measured in ridership.

Data Sources and BRT Assumptions

With the elasticities and formula established, the only step remaining is to determine the inputs for the formula. The data necessary for inputs are the baseline service conditions and future service conditions resulting from BRT implementation for the E1 – Veterans bus route.

Baseline travel time and frequency conditions were derived from the posted timetables on the Jefferson Transit website. The annual transit ridership on the E1 – Veterans bus route along the Veterans Boulevard corridor was retrieved from Jefferson Transit (JeT) by means of a public records request. 2010 ridership data will be utilized because it will allow for accurate comparison to commuting trends and automobile Average Daily Traffic (ADT) along the corridor, both most recently available for 2010. According to JeT, annual ridership on this route in 2010 was 487,880.

For baseline travel time and frequency conditions, only conditions during peak periods were considered. Peak periods were defined as 7:00-9:00 AM and 4:00-6:00 PM. Because the E1 - Veterans bus route only operates one bus per run, any run with a departure/arrival time in a peak hour was considered to be a run operating during peak hours. The route schedule was obtained from the Jefferson Transit website and the derived, peak hours schedule can be found in the appendix, along with calculated travel times and frequencies. Following methodologies from similar studies, weekends and holidays were ignored.

Travel time is defined as the average time it takes a bus to travel from the beginning to the end of its route in peak hours. In this case, the E1 – Veterans bus route takes an average of 40 minutes to make one trip during the weekday, peak-hour period. Thus, the baseline travel time is 40 minutes. Frequency is defined as the average headway, or time between buses, at any given stop on the bus route. In this case, the E1 – Veterans bus route has an average headway of 24 minutes during the weekday, peak-hour period. Thus, the baseline frequency is 24 minutes.

With the baseline input data retrieved and calculated, the remaining input data necessary are the future conditions associated with BRT implementation.

Regarding future frequency, this study will assume that the average peak-hour headway for the future E1 – Veterans bus route will be reduced to ten minutes, a reduction of 58%. This headway was selected

because a transit route must maintain at least ten minute headways during peak hours in order to truly be considered BRT (Victoria Transport Policy Institute, 2012).

Determining future travel times is more complex and because this study does not address the specific type of running ways scheme to be implemented in the Veterans Boulevard corridor, two scenarios were developed based on different running way treatments and associated travel time improvements. The first scenario assumes the implementation of busways on partially grade-separated right-of-way for the majority of the route. The second assumes the implementation of bus lanes on both sides of Veterans Boulevard for the majority of the route. These bus lanes could come from the conversion of existing lanes or adding new lanes to the roadway and dedicating them to buses.

BRT systems recently implemented in the United States show travel time reductions ranging from approximately 25% to 50% (Levinson, et al., 2003). Of these, BRT systems with busways operating on partially grade-separated right-of-way typically experience travel time savings of 2 to 3 minutes per mile over the previous bus service while BRT systems with dedicated bus lanes on arterial streets typically save 1 to 2 minutes per mile (Levinson, et al., 2003).

It is important to note that many BRT systems only operate on dedicated running ways for portions of a given route (Diaz & Hinebaugh, 2009). While it is probable that vehicles on this proposed BRT system will operate in mixed traffic along some portions of the route, determining the specific alignment and running way treatment (e.g. type and span) of the entire corridor is beyond the scope of this thesis. Therefore, the lower end travel time savings per mile will be used in both scenarios. Given that the existing bus route on Veterans Boulevard is approximately 10 miles in length, a travel time reduction of 1 minute per mile under the bus lane scenario translates into a 10 minute, or 25%, reduction in travel time. A travel time reduction of 2 minutes per mile under the busway scenario translates to a 20 minute, or 50%, reduction in travel time.

Both scenarios will assume that all of the BRT components illustrated in Table 2.3 will be implemented. This includes: safe, attractive, and accommodating stations with ticketing machines, seating, transit system information, and real-time displays of next bus arrival times; BRT vehicles; stop spacing that is

longer than local buses; Transit Signal Priority (TSP), an element of Intelligent Transportation Systems (ITS); and branding of the BRT vehicles and service. As mentioned previously, the implementation of all of these components allows for an additional 25% increase in ridership estimates, after calculating ridership based on demand elasticities.

All baseline and future conditions are summarized in the table below.

Table 2.4 Elasticity Model Parameters

Baseline Ridership:	487,880
Elasticities:	
Travel Time	-0.5
Frequency	-0.4
Baseline Conditions:	
Travel Time (minutes)	40
Frequency (minutes)	23
Future BRT Conditions:	
Travel Time (minutes)	30 (Bus Lane) or 20 (Busway)
Frequency (minutes)	10
BRT Multiplier:	25%

3.0 Review of Literature

3.1 Employment Decentralization

The majority of research on urban sprawl has focused on residential sprawl, often downplaying the importance of job sprawl, or employment decentralization. This relative disregard has been justified by arguing that employment decentralization is largely dependent on residential settlement patterns and that employment tends to cluster because of agglomeration economies (Lopez & Hynes, 2003; Galster, et al., 2001). However, the fact remains that employment decentralization is associated with many urban problems and must be better understood in order to address these problems (Glaeser & Kahn, 2001; Smith & Zenou, 2003).

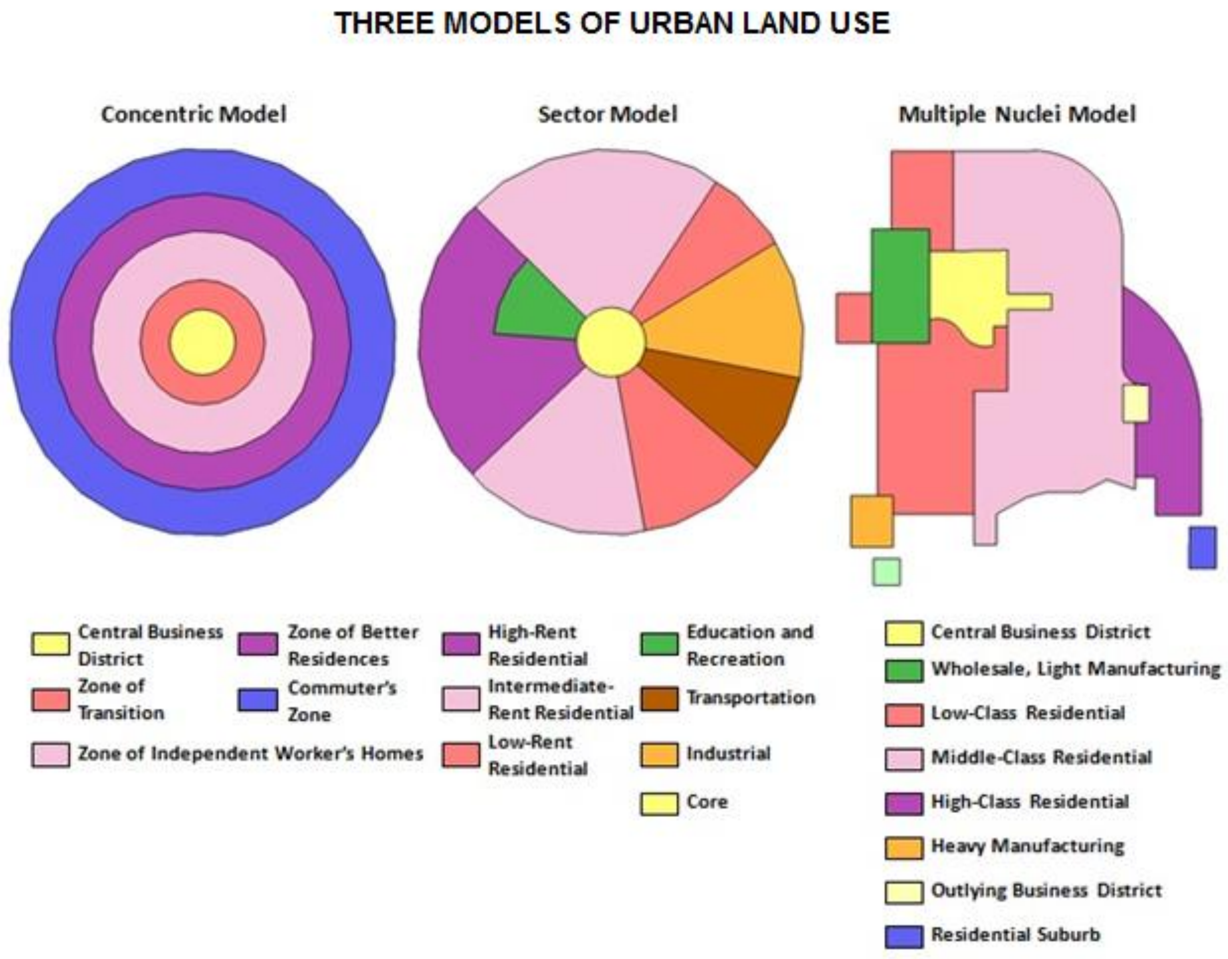
The main problem with employment decentralization is that it promotes automobile dependence and its associated ailments. The increasing location of jobs in areas poorly served or not served at all by transit increases reliance on the automobile for commuting and other trip purposes. This in turn increases Vehicle Miles Traveled (VMT) and increases greenhouse gas emissions (Ewing, Pendall, & Chen, 2002). The location of jobs in more distant, automobile-dependent areas also means that workers without access to cars have less access to employment and other destinations. Even for workers that do have access to a car, the decentralization of jobs means that they will pay more in commuting costs (Sanchez, Brenman, Ma, & Stolz, 2008). While there is some evidence that low-income workers are following the exodus of jobs to the suburbs, the fact remains that many of these areas a poorly served by transit and that jobs continue to decentralize beyond suburbs (Raphael & Stoll, 2010).

Another issue with emplyoment decentralization is the fact that it is self-perpetuating. The location of jobs in increasingly peripheral areas expands the “commute shed” for workers, encouraging residential settlement in areas beyond traditional centers, thus facilitating further urban sprawl (Jackson, 1987; Brueckner, 2000). Furthermore, the urban design of suburban job centers, at both the micro and macro level, hinders the viability of transit in the immediate future. While the auto-oriented urban design of the centers discourages transit use, perhaps worse is that the physical dispersion of employment centers makes transit unviable in many situations (Frank & Pivo, 1994).

Origins of Decentralization: Emergence of Subcenters and Polycentricity

The earliest models of urban spatial structure were monocentric, with the Central Business District (CBD) anchoring cities and influencing surrounding land uses. In Burgess' Concentric Model, developed in the 1920's, the CBD is surrounded by a zone of transition in which land uses are undergoing conversion to more intensive commercial uses as the city grows and the CBD expands. The zone of transition is also home to first-generation immigrants and the poor. Following the zone of transition, zones are overwhelming residential with housing values increasing with distance from the CBD. Hoyt's Sector Model, developed in the 1930's, maintained a monocentric approach but attempted to better address the role of transportation by focusing on wedges radiating away from the CBD, presumably along major thoroughfares, railroads, and transit lines. It assumes that land uses tend to cluster based on land values. In the case of housing, high-value housing would typically locate near high value uses like education and avoid low-value land uses like industrial and low-value housing (University of North Carolina Charlotte, 2007).

Figure 3.1 Three Models of Urban Land Use



Created By Author from University of North Carolina Charlotte, 2007

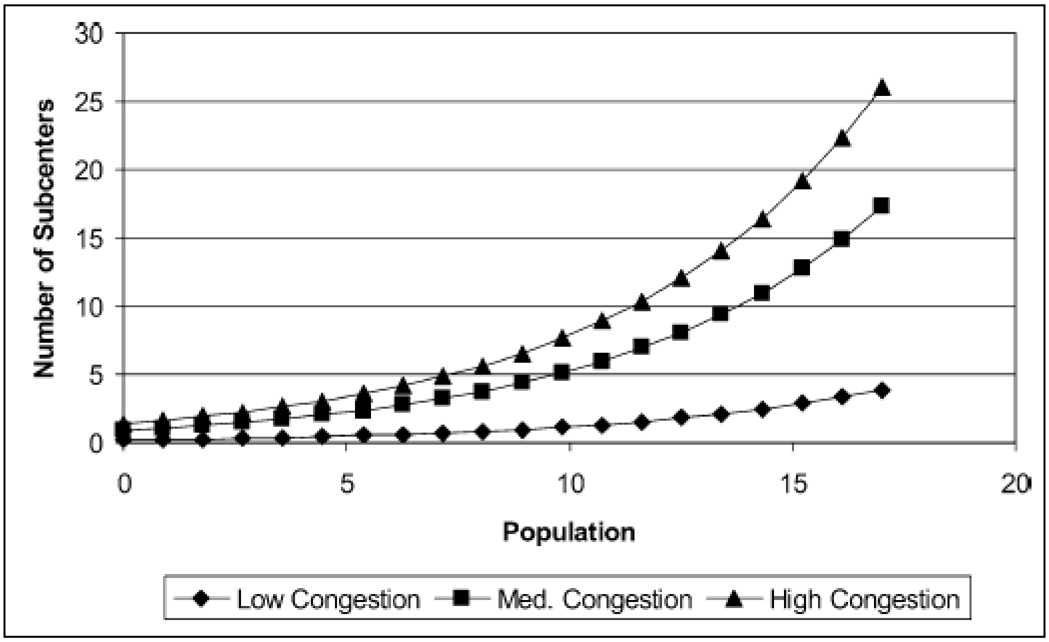
Eventually though, large American metropolitan areas began to see employment subcenters emerge. In 1945, Harris and Ullman realized this and proposed the Multiple Nuclei Model, a polycentric model that attempted to address the emergence of employment subcenters and their influence on metropolitan land use (University of North Carolina Charlotte, 2007). While this model seems appropriate for most American metropolitan areas today, some argue that more sprawling regions like Los Angeles are beyond polycentricity and are giving way to dispersion, or minimal clustering (Gordon & Richardson, 1996). Regardless, it is important to understand why and how subcenters emerge.

Employment subcenters, the distinguishing characteristics of polycentric regions, are defined as contiguous areas of urban development where employment density is significantly higher than

surrounding areas and high enough to cause local rises in population density and land values(Giuliano, Agarwal, & Redfearn, 2008). These subcenters typically arise for the same reasons that gave rise to Central Business Districts (i.e. agglomeration economies, internal and external scale economies of production, and diseconomies of transportation). Over time, the CBD can become a victim of its own success as externalities (e.g. congestion and high rents) can outweigh the benefits of agglomeration for some industries or firms. Firms which still value the benefits of agglomeration economies will then tend to locate or relocate in emerging subcenters (Giuliano, Agarwal, & Redfearn, 2008).

This can create a vicious cycle wherein the economic success of an employment subcenter spawns the development of yet another subcenter. In fact, research shows a very strong correlation between the number of subcenters in an urban area and the population and commuting costs of region. Analysis of 62 urban areas indicates that these two factors explain 80% of the variation in the number of subcenters. It is posited that a region with low congestion develops its first subcenter at a population of 2.68 million and its second at a population of 6.74 million while a region with moderate to high congestion is virtually guaranteed to have at least one subcenter and develop its second subcenter at lower population thresholds (McMillen & Smith, 2003).

Figure 3.2 Relationship between Subcenters and Population Size



Source: McMillen & Smith, 2003

But what accounts for the actual location of employment subcenters? Most research points to the actions of local governments and developers. Intra-metropolitan variations in taxation and land use regulation are thought to be significant determinants (Fujita, 1989; Sullivan, 1986). Developers are also thought to play a large role in the migration of firms to new locations as they provide the initial investment in these areas (Henderson & Mitra, 1996; Anas, Arnott, & Small, 1998).

Concentrated versus Dispersed Decentralization

Employment decentralization is often discussed under a different appellation, job sprawl. The terms are often used interchangeably as both are defined as the location and relocation of firms away from the Central Business District to suburban or exurban areas. Job sprawl, though, has an overwhelmingly negative connotation amongst planners and is most often discussed in terms of its negative externalities like spatial mismatch and automobile dependency.

Many studies attempting to quantify job sprawl are rather one-dimensional, measuring job sprawl by calculating the shares of metropolitan employment contained within radial buffers of incremental

distances from the CBD (Glaeser, Kahn, & Chu, 2001; Stoll, 2005; Kneebone, 2009; Raphael & Stoll, 2010). This methodology assumes a monocentric urban structure which has not applied to most American metropolitan areas for quite some time (Weitz & Crawford, 2012). Operating under a monocentric assumption, these studies find that employment is rapidly decentralizing in American regions, an otherwise well-established phenomenon. Their methodologies ignore intra-metropolitan variation and changes in employment concentration outside of the CBD. So while CBDs are obviously losing their share of metropolitan employment, it is rarely explored whether non-CBD employment centers are increasing their shares or if widespread dispersion is occurring.

There is a considerable dearth of existing literature on these two aspects of employment decentralization: concentration, in new or existing centers outside of the CBD; or dispersion, across the region (Giuliano, Agarwal, & Redfearn, 2008). However, the distinction between concentration and dispersion is an important one to make because they each have very different effects on urban spatial structure and commuting patterns. For instance, concentration, especially along corridors, is much more favorable to high quality transit service which can reduce automobile dependency and increase accessibility for carless households.

What literature does exist on the subject is limited to case studies of selected metropolitan areas, overwhelmingly in the West and Northeast (Giuliano, Agarwal, & Redfearn, 2008). More comprehensive analysis of all major metropolitan regions appears to be hindered by the need to identify all employment centers in a region. A standard methodology for this identification process has yet to emerge though the most common method is to create a parametric model that identifies all contiguous areas that meet thresholds set for employment density and total employment (Giuliano & Small, 1991; Anderson & Bogart, 2001; Lee, 2007; Giuliano, Agarwal, & Redfearn, 2008). A more nuanced and complex alternative is to create a model that identifies areas that represent significant deviations in employment and/or residential densities from their surroundings (McMillen & Smith, 2003). The latter method is more cumbersome and may identify relatively insignificant clusters because of low-density surroundings.

The most comprehensive study on concentration and dispersion amidst employment decentralization was performed fairly recently, in 2007. It studied the change in employment shares of CBDs, all other centers,

and the remaining area of a region from 1990 to 2000 for six regions: New York; Los Angeles; Boston; Portland; San Francisco; and Philadelphia. Its findings were mixed: CBDs remained strong in New York and Boston; Los Angeles and San Francisco saw the share of employment for non-CBD centers increase, and Portland and Philadelphia saw a higher share of employment being dispersed (Lee, 2007). This suggests that there may be considerable variation within the United States and that there are likely many local forces that contribute to the spatial distribution of employment.

In regions like Los Angeles and San Francisco, where employment is growing and becoming more concentrated in suburban centers, transit has a unique opportunity to serve these areas and address the externalities associated with employment decentralization like automobile dependency and spatial mismatch.

Edge Cities

Despite a relative lack of research exploring the distribution of employment decentralization within U.S. metropolitan areas (concentration versus dispersion), there has been rather extensive research that focuses on the distribution and decentralization of one particular employment type: office jobs. The rationale behind studying office jobs is that a large proportion of job growth occurs in this sector. In some regions, almost half of all new jobs are in office buildings (U.S. Bureau of Labor Statistics, 2003). Another rationale is that office buildings are the last element of central cities to suburbanize, after residential, retail, and other commercial activities (Muller, 1975; Leinberger, 1996).

In 1991, Joel Garreau published *Edge Cities*, which popularized the notion of emerging suburban clusters of office space. Garreau adopted Edge City criteria from earlier research which required a minimum of 5 million square feet of office space and 600 thousand square feet of retail in a singly cluster (Garreau, 1991). However, later research found that this definition meant that Edge Cities accounted for less than 5% of all U.S. office space (Lang, 2003. In 2003, Lang published Edgeless Cities, reducing the criteria for Edge Cities and established a typology based on unique geographies (Lang, 2003).

Later, in 2009 Lang, Sanchez, and Oner built upon Lang's foundation by expanding the typology and identifying the shares of office space in each type for 13 metropolitan areas. This more recent typology includes five types of Edge Cities in addition to the CBD, or downtown: secondary downtowns, urban envelopes, edge cities, edge city corridors, and edgeless cities (Lang, Sanchez, & Oner, 2009). Secondary downtowns are defined as the centers of major suburbs that had emerged as relatively focused commercial centers by the early 20th century, with the example of Bethesda, Maryland as an example. Urban envelopes are areas immediately surrounding downtowns which have relatively high office space densities because of expansion from the CBD. Edge Cities are non-CBD clusters with more than 5,000,000 square feet of office space which are surrounded by low-density environments. They differ from secondary downtowns in their automobile-oriented design and extremely high densities relative to their surroundings. Edge City Corridors are linear clusters, following major transportation routes and averaging densities similar to Edge Cities. They are usually anchored by secondary downtowns or Edge Cities. Edgeless Cities represent a major concentration of office space employment but lack focus, often spread across vast areas (Lang, Sanchez, & Oner, 2009). The tables below summarize characteristics of these Edge City types and show their shares of all office space in 13 metropolitan areas studied.

Table 3.1 Edge City Typology Characteristics

Typology	Scale	Office Density	Basic Units	Boundary	Average Office Space Density (Sq. Ft./Sq. Mile)
Downtown (CBD)	Concentrated	Very High to High	City Blocks	Sharp	7,500,000
Secondary Downtown	Concentrated	High to Medium	City Blocks	Intermediate	3,500,000
Urban Envelope	Buffer/Ring	Low	Neighborhoods	Fuzzy	2,000,000
Edge City	Concentrated	Medium to Low	Freeway Interchanges	Fuzzy	2,000,000
Edge City Corridor	Linear	Low	Freeway Frontage Roads	Fuzzy	2,000,000
Edgeless Cities	Dispersed	Very Low	Municipalities or Counties	Indeterminate	20,000
Source: Lang, Sanchez, & Oner, 2009					

Table 3.2 Distribution of Metropolitan Office Space by Edge City Typology

Metropolitan Area	Downtown (%)	Secondary Downtown (%)	Urban Envelope (%)	Edge City (%)	Edge City Corridor (%)	Edgeless (%)
Atlanta	6.7	0	38.6	16.4	0	38.4
Boston	38.7	0	4.6	6.7	0	50.1
Chicago	49.2	0	0.8	10.7	0	39.4
Dallas-Ft. Worth	20.6	6.5	0	17.3	21.7	33.9
Denver	27.3	0	0	21.9	0	50.8
Detroit	17.2	0	1.6	27.1	0	54.1
Houston	22.8	0	3.3	33.9	5.4	34.7
Los Angeles	16.1	13.6	0	15.6	8.7	46
Miami	8.7	5	0	14.2	0	72.1
New York	54.5	6.8	0	6.3	0	32.3
Philadelphia	29.6	4	2.1	10.1	0	54.3
San Francisco	39.2	6.7	0.3	14.4	0	39.4
Washington, D.C.	22.7	1.5	18.4	23.3	11.6	24
Source: Lang, Sanchez, & Oner, 2009						

What the findings of Lang and others indicate, as with similar studies of employment concentrations in subcenters, is that there is significant variation by region. Many areas lack Secondary Downtowns, Edge City Corridors, and Urban Envelopes. While New York and Chicago have large shares in their CBDs, office space in most other regions is more decentralized in other types of centers.

Of particular interest to this thesis is a concluding remark by Lang and others. Upon finding that the percentage of office space in edgeless cities is significant in most areas, the authors found it worth merit to calculate the percentage of edgeless city office space located in areas supportive of rail-based transit, using density thresholds outlined by Pushkarev and Zupan (1977). Unsurprisingly, their findings varied significantly by region, but an important take away from their findings is that in some regions, such as Los Angeles and San Francisco, about one quarter to one third of office space in edgeless cities is located in areas with densities that support high-capacity rail service (Lang, Sanchez, & Oner, 2009).

3.2 Transit and Employment Decentralization

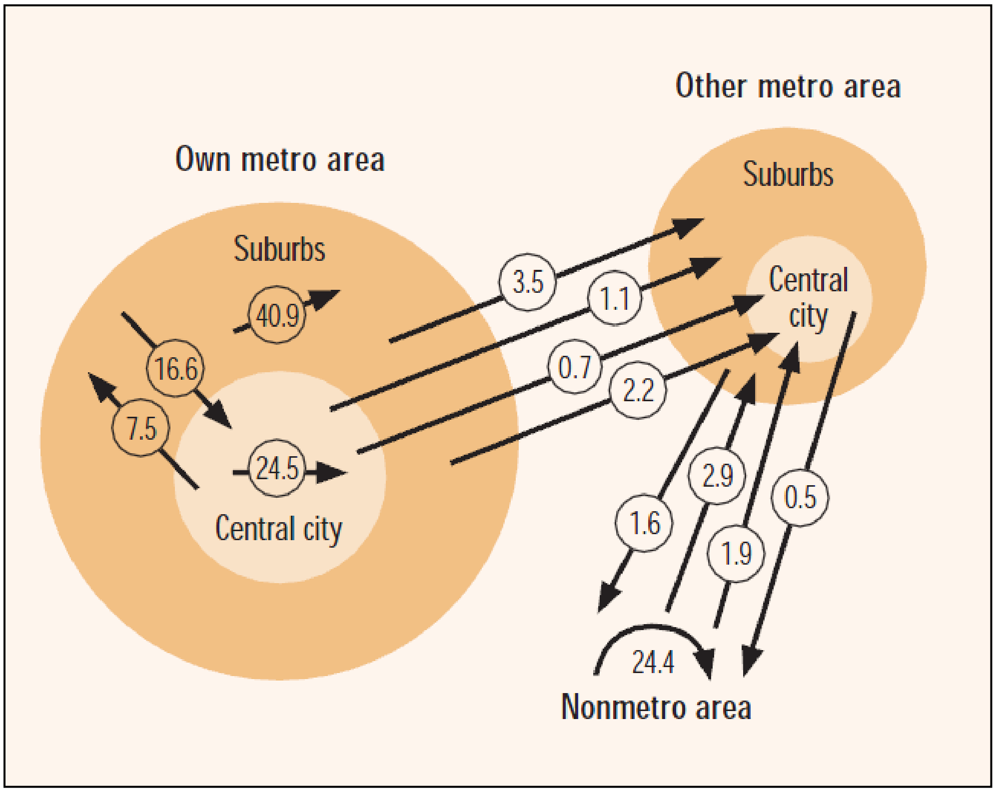
While commuting trips only account for 20% of all trips, they account for 60% of transit trips (Pisarski, 2006; American Public Transit Association, 2010). Therefore, the success of transit is highly dependent on its ability to capture the work trip.

Metropolitan Commuting Patterns and Transit Service Trends

From 1990 to 2000, commute travel times in the United States increased slightly. When disaggregated, travel times are the greatest for suburban residents and lower for central city residents (Pisarski, 2006). When analyzed by the workplace though, travel times are greater for those that work in Central Business Districts than those that work in other employment centers (Lee, 2006). While this likely indicates that suburb to central city commute trips suffer from the greatest travel times, this type of commuting is becoming less common.

Increasingly, metropolitan work trips have their origins and/or destinations in suburban areas (Pisarski, 2006). The suburb to central city commute is now dwarfed by the suburb to suburb commute, illustrating the decentralization of employment. The two greatest trends from 1990 to 2000 are the growth in suburb to suburb commuting and the so called “reverse commute,” from central city to suburb. From 1990 to 2000, suburb to suburb commuting rose from 44% to 46% of all metropolitan commutes while central city to suburb commuting rose from 8% to 9% (Pisarski, 2006). Clearly, polycentricity is having an effect on commuting patterns.

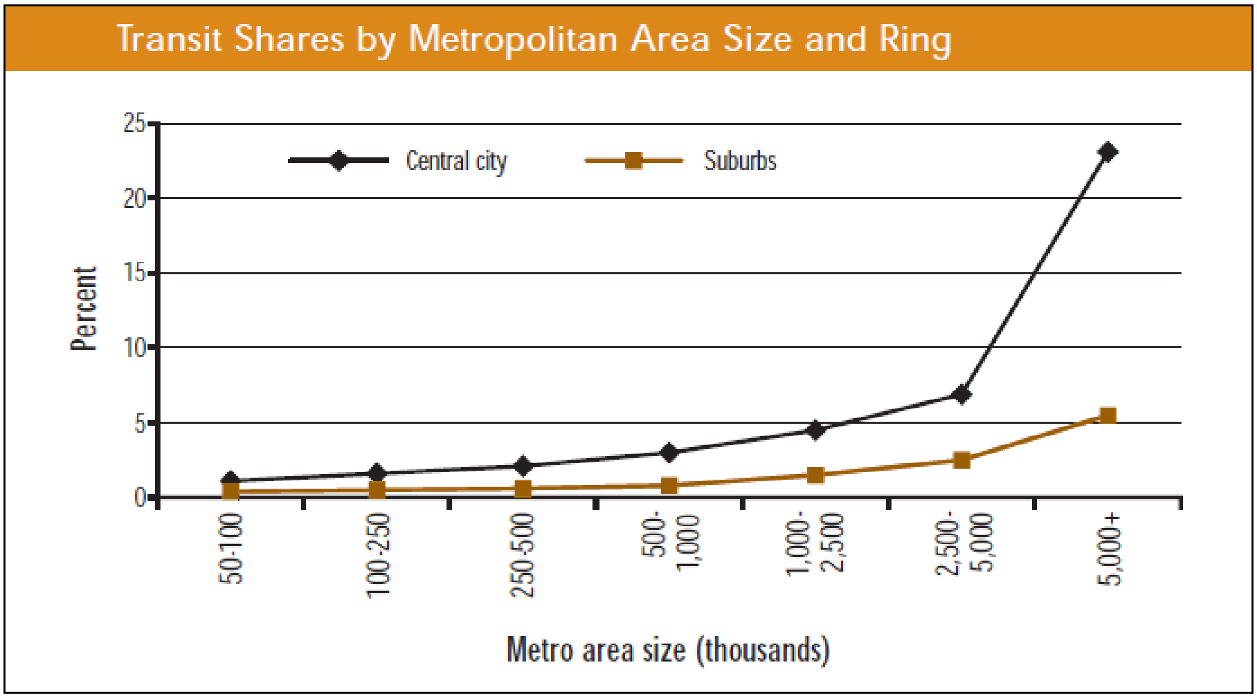
Figure 3.3 Intra- and Inter-Metropolitan Commuting Flows, 2000



Source: Pisarski, 2006

Commuting trends from 2000 also show that transit mode shares in regions tend to be correlated with the overall size of the metropolitan area, with transit shares increasing rapidly after 2.5 million. Trends also show that suburbs tend to have transit mode shares well below their central city counterpart in metropolitan regions of all sizes (Pisarski, 2006).

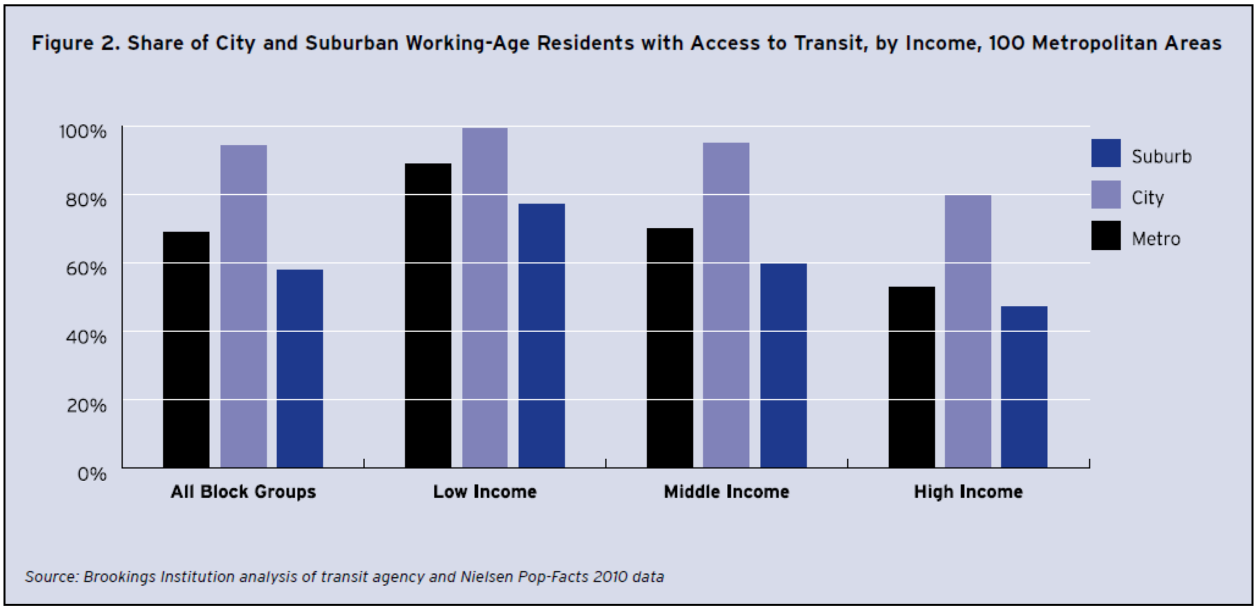
Figure 3.4 Transit Mode Shares by Metropolitan Size for Central Cities and Suburbs



Source: Pisarski, 2006

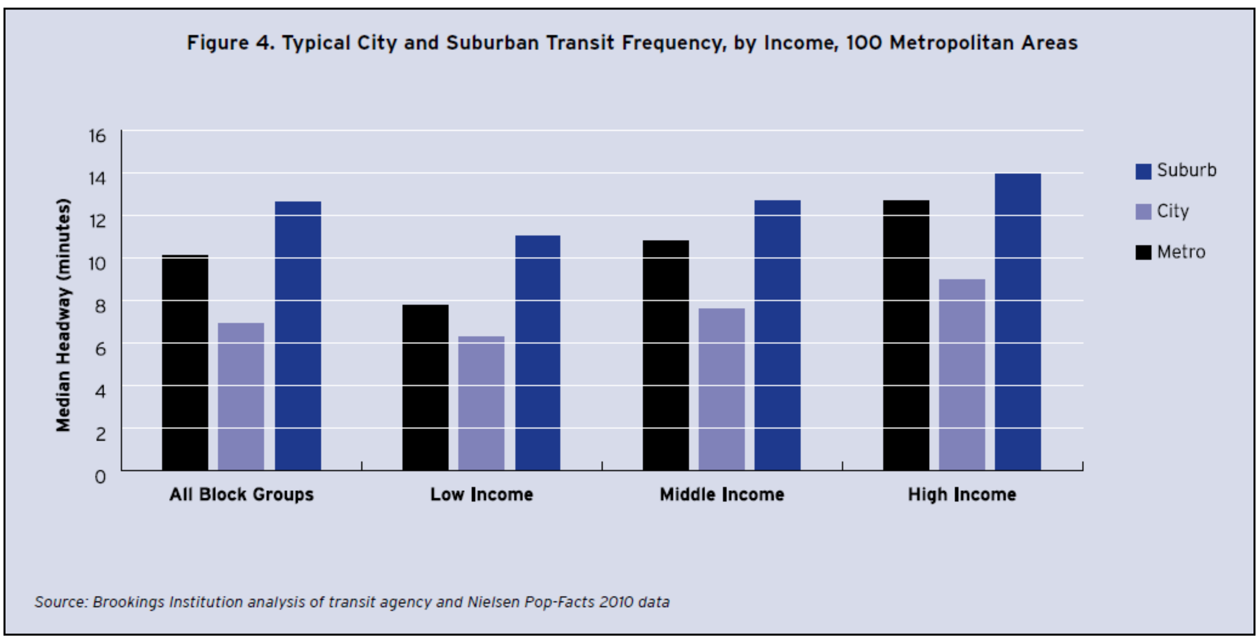
Recent research shows that despite decreasing commuting into and out of the Central Business District (CBD), transit service in most regions is still oriented to the CBD (Brown & Thompson, 2008b). While this service orientation provides central city residents with relatively good access to both central city and suburban areas, it limits accessibility for suburban residents. A recent report by the Brookings Institution found that suburban commuters have less access to transit and suffer from significantly longer headways (lower frequencies). As a result, suburban commuters utilizing transit only have access to about 20% of all metropolitan jobs within a 90 minute commute while their central city counterparts have access to nearly double that amount (Tomer, Kneebone, Puentes, & Berube, 2011).

Figure 3.5 Access to Transit by Income, U.S. Metros, Cities, and Suburbs



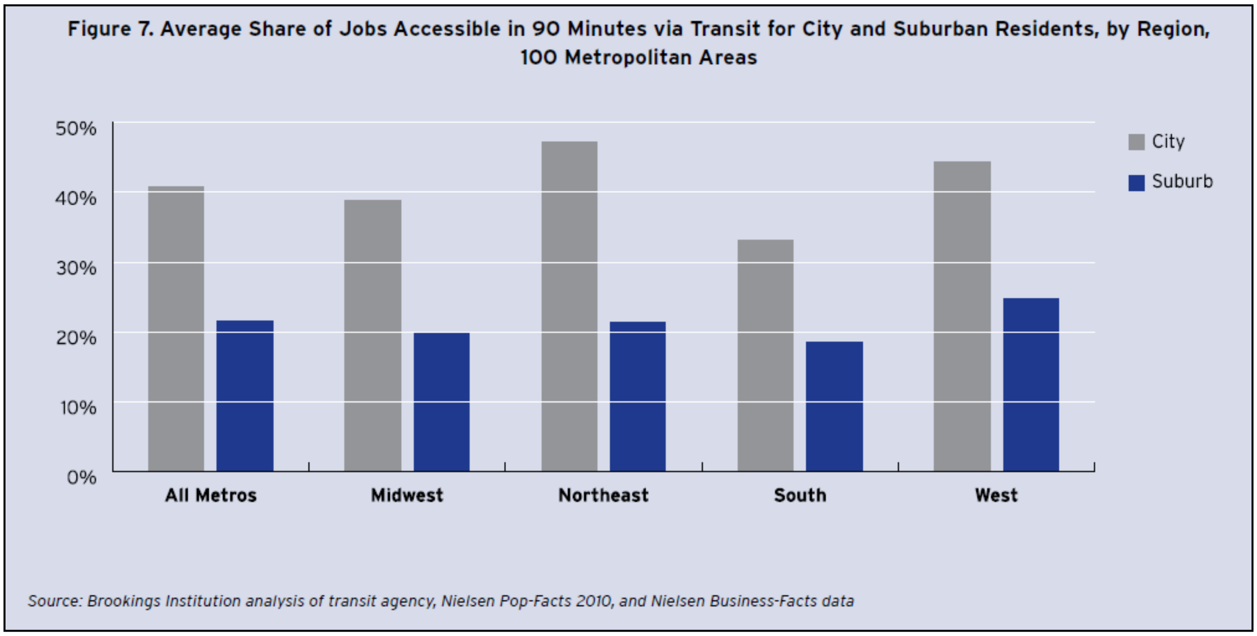
Source: Tomer, Kneebone, Puentes, & Berube, 2011

Figure 3.6 Transit Frequency by Income, U.S. Metros, Cities, and Suburbs



Source: Tomer, Kneebone, Puentes, & Berube, 2011

Figure 3.7 Job Accessibility by Transit, U.S. Cities and Suburbs



Source: Tomer, Kneebone, Puentes, & Berube, 2011

Much of the accessibility issues associated with suburban transit are thought to be related to the service orientation of routes and whether or not they adequately address the distribution of employment and commuting patterns in a region (Brown & Thompson, 2012). Recent research has shown that, despite an increasingly polycentric metropolitan environment, most routes in U.S. metropolitan areas are still oriented to the Central Business District. Furthermore, this research shows that Metropolitan Statistical Areas (MSAs) with fewer transit routes oriented to the CBD perform better in ridership, service productivity, and cost-effectiveness (Brown & Thompson, 2008b).

Analysis of the 1995 Nationwide Personal Transportation Survey (NPTS) shows that while transit trips account for almost 10% of all trips in urban areas within the largest MSAs, it accounts for less than 2% in suburban and second city areas of these MSAs (Polzin, Chu, & Rey, 2000). While service characteristics undoubtedly affect the mode share of transit in “non-urban” areas, the most common explanation given for low transit patronage in these areas is that surrounding densities do not support transit (Polzin, Chu, & Rey, 2000). However, this explanation and the overall role of density in explaining ridership is increasingly being challenged by those that argue the level of service and orientation of service are more important factors (Mees, 2010; Brown & Thompson, 2012).

Table 3.3 Transit Mode Shares by MSA Size and Urban Classification

MSA Size (000)	Urbanization Classification					Total
	Rural	Town	Suburb	Second City	Urban	
Outside MSA	0.21	0.27	n/a	0.18	0.07	0.23
Under 250	0.24	0.36	0.51	0.94	n/a	0.62
250-500	0.08	0.05	0.39	1.1	n/a	0.48
500-1,000	0.05	0.37	0.64	1.6	2.71	0.88
1,000-3,000	0.11	0.23	0.61	1.46	3.1	1.01
3,000+	0.09	0.42	1.62	1.43	9.74	3.77
Total	0.18	0.3	1.16	1.22	8.26	1.81
Source: Polzin, Chu, & Rey, 2000						

Transit Service in Polycentric Regions: A New, Multi-Destination Approach

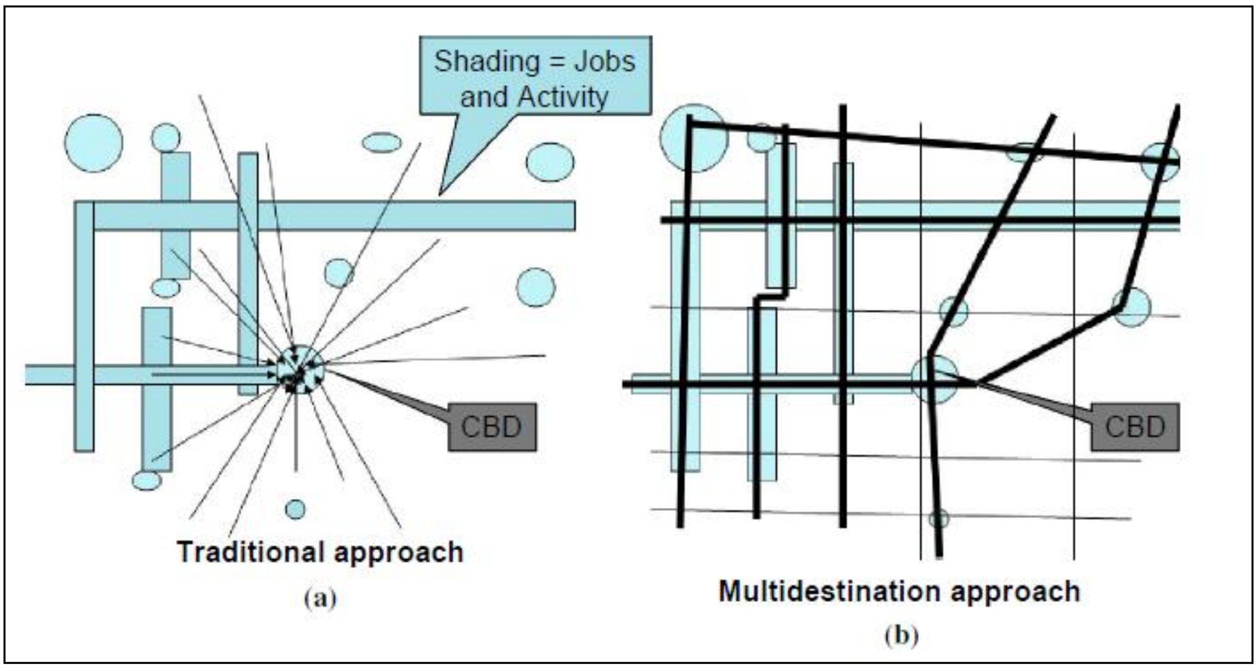
The primary role of transit is to connect people to destinations. Historically, this meant transit service assumed a monocentric form, with lines radiating away from Central Business District (CBD) to the suburbs. But beginning in the mid-20th century, as American regions began to decentralize, transit mode shares began to decline nationwide (Brown & Thompson, 2008c). Seemingly in spite of this decentralization, it has been argued that the most effective way to maintain or build transit ridership is to better connect suburban neighborhoods to the CBD (Pushkarev & Zupan, 1977; Cervero & Zupan, 1996). It has also been argued that attempts to serve decentralized, auto-oriented suburbs are futile as the urban form of these areas discourages walking; a necessity at the origin and destination end of transit trips (Meyer & Gomez-Ibanez, 1981).

While many planners lament employment decentralization as a hindrance to the viability of transit, there are many adaptations transit can make to be more viable in a polycentric environment. Cervero and Beutler point to many operational changes like deviated routes, dedicated busways, timed-transfers, small vehicle shuttles, etc. that can improve the level of service of transit in more suburban areas (Cervero & Beutler, 1999). While these operational considerations are important in a polycentric region, there is a more fundamental change in transit service which has recently garnered significant attention. That fundamental change is a shift in the orientation of transit routes. It is argued that transit systems should evolve from systems with a primarily monocentric, CBD-focused service orientation to systems

with a polycentric, multi-destination orientation that more accurately reflects contemporary urban structure and commuting patterns.

This argument is fueled by a growing body of literature suggesting that the density of employment around transit stations and along corridors is more important in predicting ridership and productivity than access to the Central Business District (Kuby, Barranda, & Upchurch, 2004; Downs, 2004; Brown & Thompson, 2008c; Brown & Thompson, 2008a). In polycentric regions, and thus most American regions, this means abandoning the traditional service orientation to the Central Business District in favor of an orientation that better reflects the more dispersed nature of metropolitan employment centers and residential settlement. This practice of orienting transit service to non-CBD destinations has been referred to as a "multi-destination" service orientation approach and is illustrated below.

Figure 3.8 Multidestination vs. Traditional Transit Service Orientation



Source: Brown & Thompson, 2008b

Empirical studies on the mismatch between service orientation and metropolitan structure are only beginning to emerge but the findings of this research tend to support a multi-destination approach. A study of nine transit agencies from 1983 to 1998, found that agencies that adapted to increasingly

dispersed employment patterns with more multi-destination routes were more effective and equitable and nearly as efficient as agencies with more radial routes (Thompson & Matoff, 2003).

A case study of transit in metropolitan Atlanta from 1973 to 2003 found that while the decentralization of employment in the region during this time period negatively impacted transit ridership, models developed indicated that extending service to suburban employment centers would have resulted in increased ridership (Brown & Thompson, 2008c). This study also notes that most ridership growth in U.S. metropolitan areas is coming from routes serving suburban employment concentrations. The authors point to Portland, Oregon where the most heavily travelled bus route is along an arterial road “lined with strip malls, big-box retail outlets, regional malls and the like, 5 miles east of the CBD” and an extension of its light rail line to its western suburbs increased total system patronage by 16% with only a 9% increase in service (Brown & Thompson, 2008c, 19).

Another study by Brown and Thompson (2012) compared transit service and land use characteristics of Broward County, FL and Tarrant County, TX. These counties are distinct in both urban structure and transit service. Broward County lacks a dominant CBD and most of the area was built to accommodate automobiles, while Tarrant County has a relatively strong CBD which was built in the streetcar era. And while both counties have experienced rapid employment decentralization, they have taken different approaches in service orientation. Broward County has implemented a multi-destination service orientation and Tarrant County continued a radial, CBD-focused service orientation. Broward County’s multi-destination approach resulted in ridership per capita 400% greater than that of Tarrant County, which follows the more traditional, CBD-oriented service orientation. It is thus hypothesized that a route structure which adequately connects origins and destinations is more important for ridership than the urban design of the origins and destinations (Brown & Thompson, 2012).

Other research on the role of transit in polycentric regions corroborates this notion that there is a spatial mismatch between origins and destinations. A study on sprawling Los Angeles County found that while its many subcenters are well served and connected by transit, the connection of workers, especially low-income and minority workers, to these areas is woefully inadequate (Modarres, 2003). Research on yet another polycentric region, Philadelphia, found that in order to significantly increase transit modal splits in

its suburban activity centers, transit service between these centers and within each center must be improved and better coordinated (Casello, 2007).

3.3 New Orleans Case Study

Employment Decentralization in New Orleans

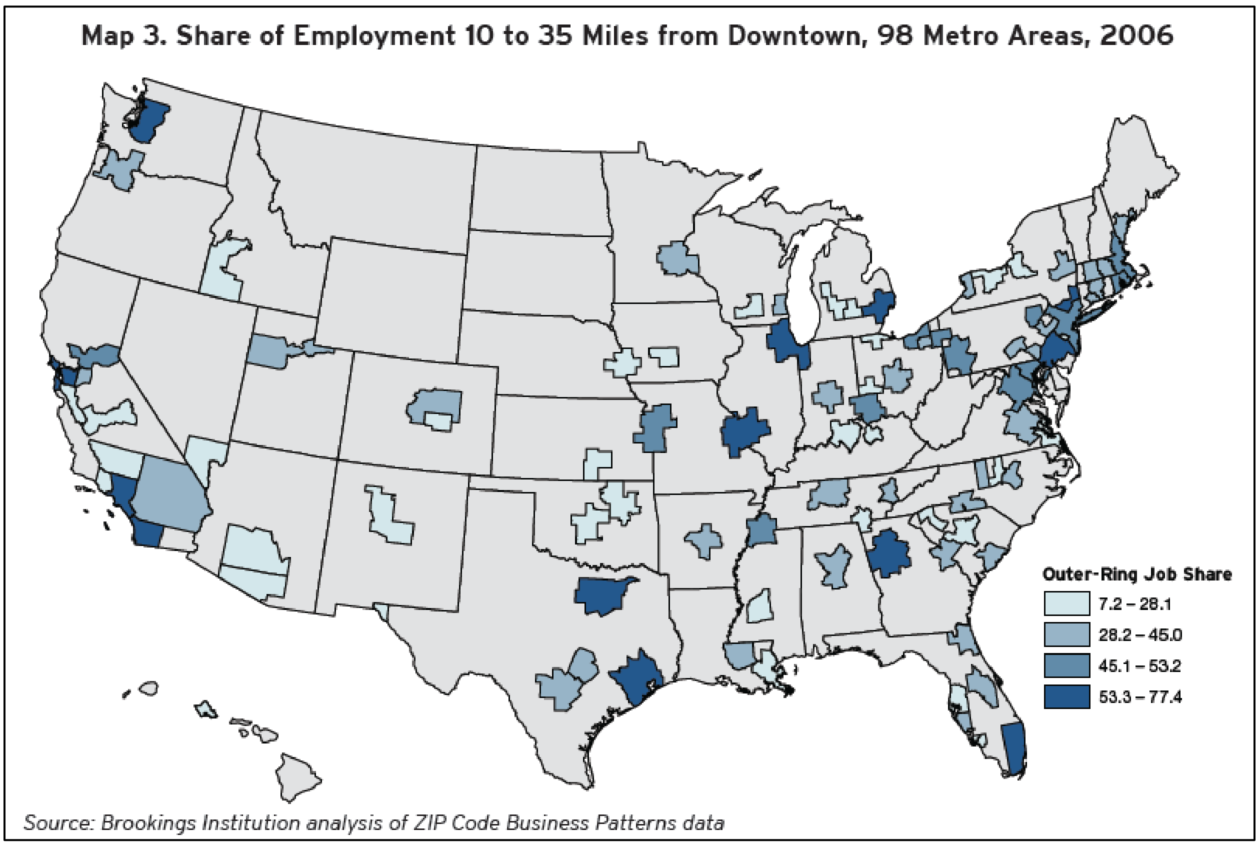
New Orleans, like virtually all American regions, has experienced extensive employment decentralization in recent decades. A 2001 study attempting to identify employment subcenters in six metropolitan areas found that New Orleans has two distinct subcenters in addition to the New Orleans Central Business District (CBD): the Causeway/Veterans Boulevard intersection (Metairie CBD) and the intersection of Airline Highway and Williams Boulevard near the airport (McMillen, 2001). Appropriately, these two subcenters in New Orleans represent the two major suburban growth poles created in Jefferson Parish in the mid-20th century. Prior to the construction of Lakeside Mall in Metairie in 1960's and the Louis Armstrong International Airport (MSY) in Kenner in the 1940's these areas were very sparsely populated. The former was a backswamp and the latter a small agricultural community (Campanella, C., 2008).

Of course, the 2001 study also found that of the six areas studied, New Orleans was the most centralized (McMillen, 2001). The notion that the New Orleans region has a relatively strong Central Business District is supported by other literature as well. In Joel Garreau's 1991 seminal work, *Edge Cities*, he observes that the CBD was home to 16.2 million square feet of office space, approximately 69% of the metropolitan total (Garreau, 1991). Another study, attempting to develop a typology for metropolitan land use patterns, classified New Orleans as a "Compact, Core-dominant" region based on 14 sprawl indices (Cutsinger & Galster, 2006). However, all of these studies are based on data from the early 1990's and it is highly likely that job sprawl has eroded the New Orleans CBD's share of all jobs. In fact, recent research makes this argument.

A report by the Brookings Institution shows that from 1998 to 2006 New Orleans experienced rapid job decentralization. As with the previous study, the authors found that employment in New Orleans is relatively centralized when compared to other regions (see Figure 3.9). However, though New Orleans'

share of jobs within three miles of the CBD and within three to ten miles were considerably higher than the average for all 98 metros in both years, these shares dropped significantly and the region experienced one of the largest increases in the share of jobs beyond ten miles of the CBD (Kneebone, 2009). Of course, the impact of Hurricane Katrina cannot be overlooked as the 2006 data would show a region in recovery, especially in the central city. Still, the notion of increasing job decentralization since the 1990's is corroborated by another study that found a second employment center emerged in the region in 2000. Prior to 2000, this study showed only one employment center, the New Orleans CBD (Marlay & Gardner, 2010).

Figure 3.9 Share of Employment in Outer-Rings of U.S. Metropolitan Areas, 2006

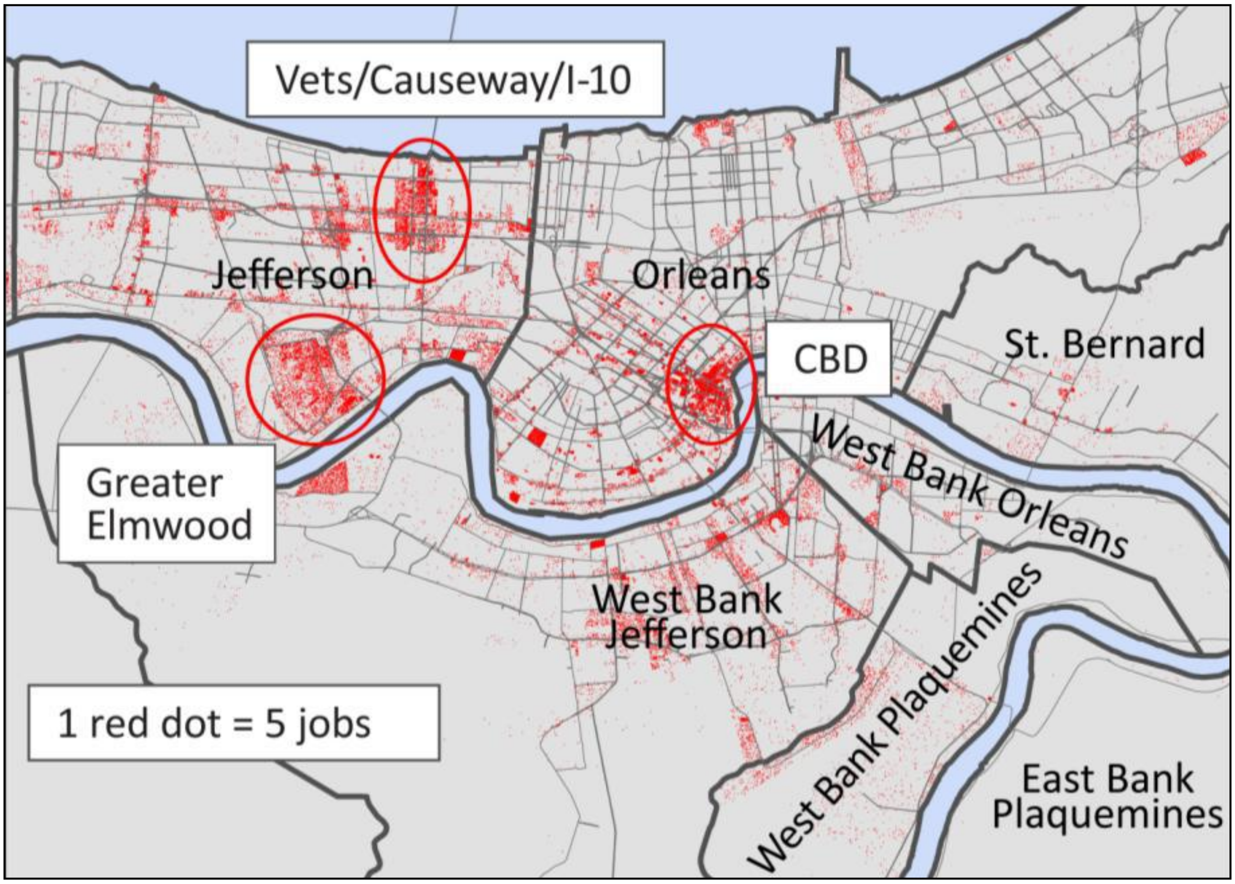


Source: Kneebone, 2009

In 2010, the Greater New Orleans Community Data Center (GNOCDC) released a report illustrating the distribution of jobs in Jefferson and Orleans parishes, seeking to determine the degree to which spatial mismatch exists between residential and employment concentrations in the region. The report finds the

New Orleans CBD and Metairie CBD to be the main employment centers in the region, with the Elmwood area also being home to many jobs (Plyer & Campanella, 2010).

Figure 3.10 Distribution of Employment in New Orleans Metro Core, 2008



Source: Plyer & Campanella, 2010

Following the methodologies outlined by Lang, Sanchez, & Oner (2009) in their work identifying Edge City typologies, it was determined that the Metairie CBD meets the office space density necessary to be considered an Edge City (see appendix for map). Lang, Sanchez, & Oner used office space data from *Black's Guide* to calculate office space density but this data source has been unavailable since 2010 (Lunsford, 2010). Therefore, a proxy was developed for office space, using local employment data from the Census' OnTheMap application. This employment data was uploaded into a GIS environment and each "office" job was multiplied by 150 square feet, or the low-end estimate that each modern-day office worker requires (Miller, 2012). "Office" jobs were defined by the NAICS classifications suggested by CB Richard Ellis, reproduced in Table 3.4 (Jones & Shams, 2010). All employment data for each census

block was retrieved as point data and assigned to 0.5 x 0.5 mile blocks in a grid overlaying the New Orleans Region, again attempting to follow the methodology of Lang, Sanchez, & Oner (2009). While the aforementioned authors went a bit further in creating a continuous raster surface and iso-lines, the methodology for doing so was not provided and it was not deemed necessary to reach the desired conclusion, that the Metairie CBD has Edge City office densities.

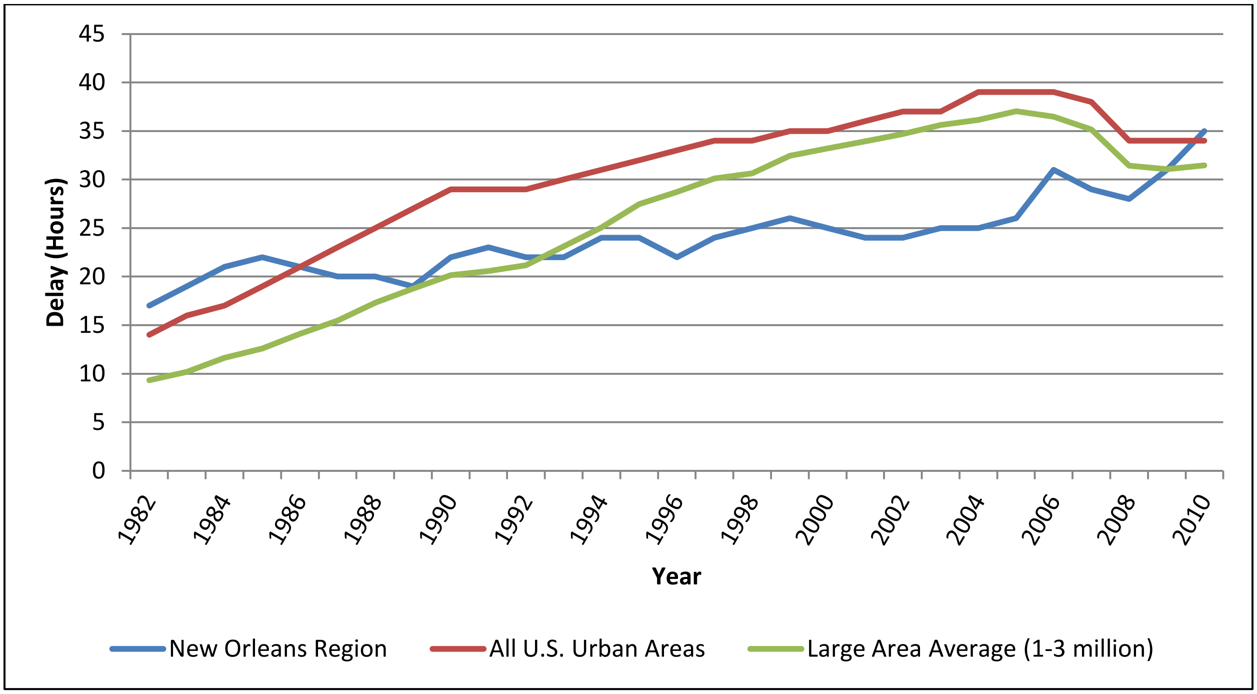
Table 3.4 National Office Employment

NAICS Employment Categories	Level (000s)	% of Total U.S. Employment
Total Employment	130,078	100.0
Office-Using Employment	26,997	20.8
Information	2,206	1.7
Financial Activities	7,152	5.5
Finance and Insurance	5,271	4.1
Real Estate and Rental and Leasing	1,430	1.1
Professional and Business Services	16,375	12.6
Professional, Scientific and Technical Services	7,453	5.7
Management of Companies and Enterprises	1,844	1.4
Administrative and Support, Waste Management and Remediation Services	7,078	5.4
Other Services	1,244	1.0
Source: Jones & Shams, 2010		

Post-Katrina Congestion and Transit Service

Post-Katrina New Orleans is a prime example of the relationship between congestion and transit ridership. A 2011 report by the Texas Transportation Institute (TTI) shows that, nationally, the growth in traffic congestion has tapered off since 2005 and the national economic recession. Yet despite this national trend, the level of congestion in New Orleans increased substantially during this time period (Schrank, Lomax, & Eisele, 2011).

Figure 3.11 Annual Delay per Auto Commuter, New Orleans Metro, 1982-2010



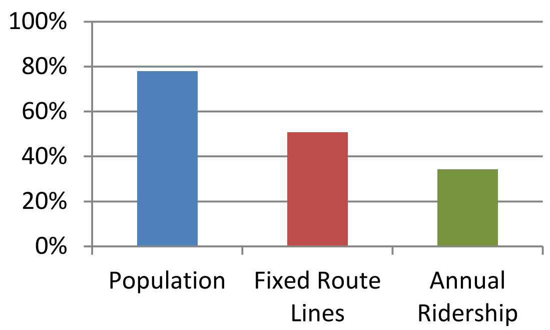
Created by author from Schrank, Lomax, & Eisele, 2011

The TTI report shows that, like the nation, congestion delay in New Orleans grew from 1982 to 2005, but it grew at a much slower pace than the nation or regions of similar size. Since the early 1990's its congestion levels have been below the national average and average of large cities. Apparently, this trend had reversed by 2010 when congestion delay in New Orleans increased to record levels, with peak hour commuters experiencing, on average, 35 annual hours of congestion delay. This figure is 40% higher than 2005 and significantly higher than the average for regions of its size. Unlike most regions, which saw congestion improve after the recession, New Orleans' congestion actually worsened after the recession.

This time period obviously coincided with the recovery from Hurricane Katrina and the decline of transit service in the region. A report by GCR Inc. shows that while the 2009 population of New Orleans was 78% of pre-Katrina level, the number of fixed route transit lines at the time was only 51% of the pre-Katrina figure and annual ridership was 34% of pre-Katrina figure (GCR Inc., 2011). It also showed that the level of service on those routes in operation was substantially worse in 2010, with only 9 routes

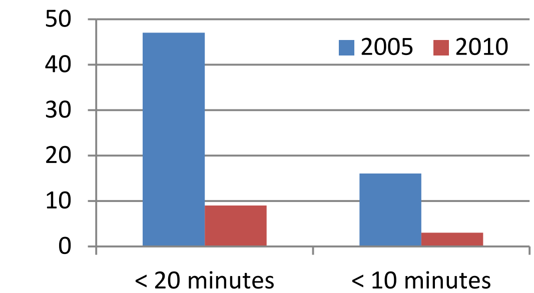
operating with headways under 20 minutes compared to 47 before Katrina and only 3 routes operating with headways under 10 minutes compared to 16 before Katrina.

Figure 3.12 Population and RTA Transit Service as Percent of Pre-Katrina Totals, 2009



Source: GCR Inc., 2011

Figure 3.13 Change in Number of RTA High-Frequency Routes, 2000-2010

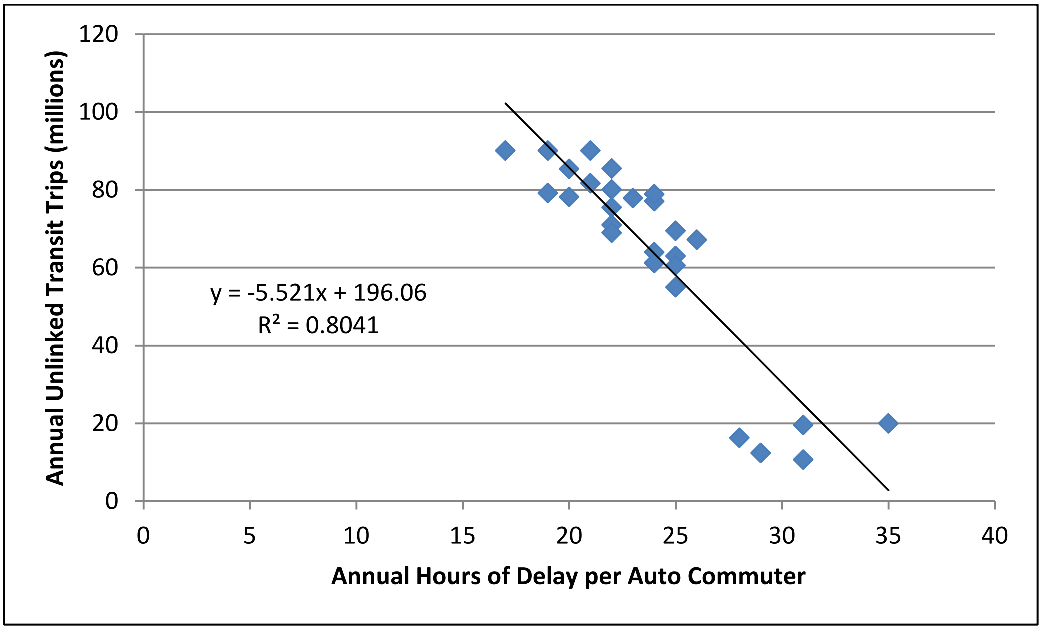


Source: GCR Inc., 2011

According to the Texas Transportation Institute, if public transit were completely eliminated in 2010, large urban areas like New Orleans could expect a 7% increase in total congestion delay hours (Schrank, Lomax, & Eisele, 2011). This number is highly dependent on the service consumed in an urban area and Hurricane Katrina showed that this estimate may be rather conservative for New Orleans.

While public transit did not completely disappear after Katrina, congestion increased dramatically despite a smaller population. The graph below shows the relationship between the annual hours of congestion delay per commuter and annual transit passenger trips for New Orleans for all years from 1982 to 2010. Transit trips decreased by 64% from 2004 to 2010 with the hours of congestion delay per commuter increasing 40%. There appears to be a strong relationship between transit patronage and traffic congestion.

Figure 3.14 New Orleans Metro Congestion Delay and Transit Patronage by Year, 1982-2010



Source: Created by author using data from Texas Transportation Institute and National Transit Database

With the demographic shifts caused by Hurricane Katrina, the overwhelming majority (67%) of the population living in poverty in the New Orleans region now resides in suburban areas where transit service is generally worse than the central city or non-existent (Plyer & Ortiz, 2012). This shift in the distribution of the transit-dependent population, coupled with service cuts made by RTA and JeT, has likely caused the transit mode share for the metro area to remain low since Katrina. So while creating high quality transit service in the suburbs can attract choice riders, it can also re-attract transit-dependent riders who are likely relying on other modes like carpooling, walking, and bicycling in areas with low levels of transit service.

As Table 3.3.1 below shows, transit service in the suburbs is well below that of the central city. While virtually all block groups in the central city have access to transit within 0.75 miles of their population centroid, only half of suburban block groups have such access. Suburban areas also suffer from substantially less frequent service and access to jobs via transit when transit service is provided (Tomer, Kneebone, Puentes, & Berube, 2011).

Table 3.5 Transit Service Accessibility Metrics, New Orleans

	Residential Coverage	Service Frequency (Minutes)	Jobs Accessible by Transit
Metro	65.3%	10.8	36.1%
City	98.7%	8.8	45.3%
Suburbs	50.3%	15.4	28.0%
Source: Tomer, Kneebone, Puentes, & Berube, 2011			

Despite employment decentralization and an increasing presence of low-income workers in suburban areas of the region, transit service in metro New Orleans has actually become more CBD-oriented. In 2004, transit service in metro New Orleans was best characterized as multi-destination oriented, with approximately 50% of its transit routes exclusively serving areas outside the Central Business District (Brown & Thompson, 2008b). Post-Katrina, many cross-town routes were eliminated or consolidated. This was especially true of routes in areas with the lowest return rates, areas that were predominately suburban like New Orleans East, Gentilly, and the Lower 9th Ward (Braden-Perry, 2012). As of 2012, the transit system is much more radial, with less than 29% of its transit routes exclusively serving areas outside of the CBD.

Land Use and Transportation in Veterans Boulevard Corridor

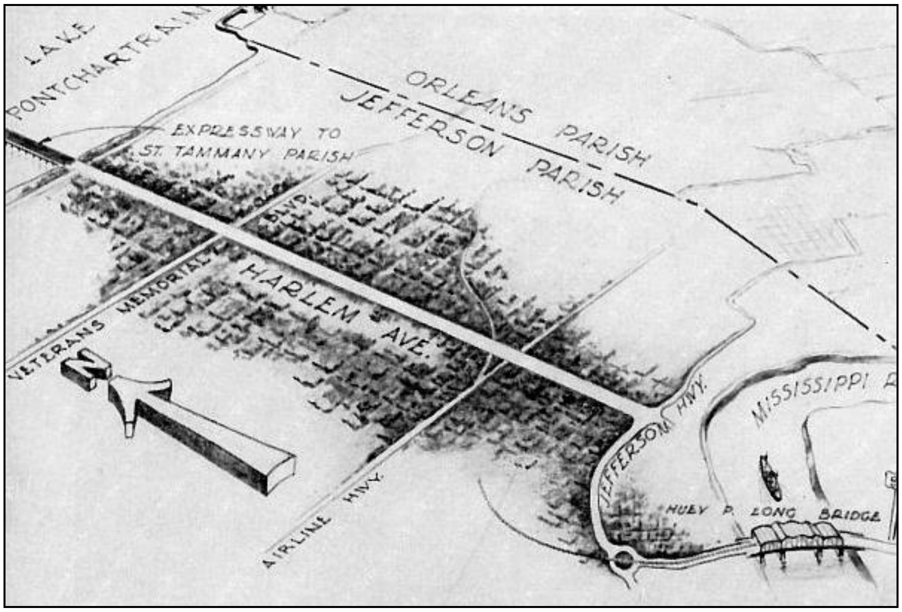
Historical Development

As is characteristic of Edge Cities, the Veterans Boulevard corridor was mostly undeveloped hinterland prior to World War II. In fact, the majority of the corridor and surrounding area was swampland until a local invention in 1913, the Wood Screw Pump, made widespread drainage feasible in low-lying areas around New Orleans (Campanella, R., 2008). Still, it was not until the post-WWII highway building boom that the area began to see substantial development. Just as streetcar lines had concentrated growth in specific corridors of earlier suburbs, highways would do the same in later suburbs.

Prior to WWII, urban development on the east bank of Jefferson Parish was confined to a few corridors: Metairie Road, Jefferson Highway, and Airline Highway. There was also some development along

Harlem Avenue (Causeway Boulevard) which served as a north-south connection between the latter two corridors (Campanella, C., 2008).

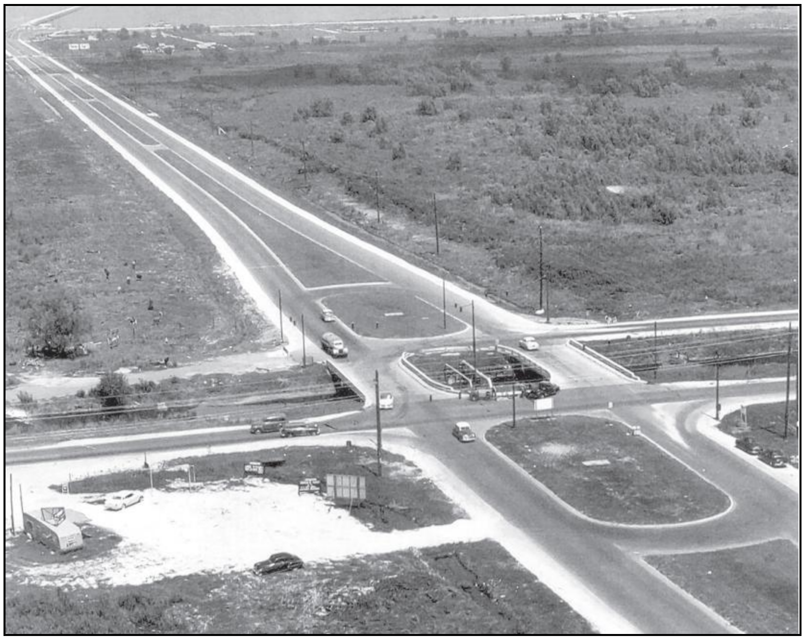
Figure 3.15 1954 Plan for Harlem Avenue (Causeway Boulevard) Improvements



Source: Campanella, C., 2008

In 1954, plans were completed to expand and improve Harlem Avenue and construct what would eventually become the Causeway Bridge at its terminus near Lake Pontchartrain, connecting Jefferson Parish and New Orleans to the North Shore. In the same year, construction of the six-lane, divided Veterans Highway (Boulevard) began, opening up large swaths of former backswamp and agricultural land to commerce. By the end of the decade, these highway projects were complete and new single-family housing developments began to settle this new frontier landscape (Campanella, C., 2008). Most of these new residents were middle-class white families fleeing Orleans Parish after the implementation of desegregation, especially of public schools (Greater New Orleans Community Data Center, 2007). This suburban “white flight” was enabled by lending practices of the Federal Housing Administration (FHA) and Department of Veterans Affairs (VA) which incentivized loans for new construction, single-family housing over loans for multi-family housing or renovation of existing housing (Lamer, 2010).

Figure 3.16 Intersection of Causeway Boulevard and Veterans Boulevard, 1957



Source:The Times-Picayune, 2012

The 1960's would see more road building with the construction of Interstate 10 through the heart of Metairie, better connecting the Veterans Boulevard corridor to New Orleans and beyond. This decade also saw considerable retail and service industry development. Many of the institutions developed in this period would drive the overall economic development of the area and remain to this day.

Lakeside Mall opened in 1960 at the intersection of Causeway Boulevard and Veterans Boulevard, pictured above. Later that decade, a second mall, Clearview Mall, opened further down Veterans Boulevard at the intersection of Clearview Parkway (Campanella, C., 2008). East Jefferson General Hospital also broke ground on Clearview Parkway in the 1960's, lakeside of Veterans Boulevard (East Jefferson General Hospital, 2012). Practically since inception, Veterans Boulevard has been a commercial corridor. The 1970's would build upon this foundation, bringing more diverse development in the form of an entertainment district and office towers.

Figure 3.17 Emerging Metairie CBD, 1970's

Source: Campanella, C., 2008

In the 1970's the development of Fat City, a mixed-use entertainment district adjacent to Lakeside Mall, marked a turning point in the brief history of the Veterans Boulevard corridor, from bedroom community to job-rich suburb. The district was created incrementally by local developers and entrepreneurs who opened various nightclubs, lounges, and restaurants. Apartments in the style of townhouses were built on the periphery, said to be catered to young singles (Campanella, C., 2008). A central destination was beginning to emerge, fostering greater densities and the ascendance of an Edge City.

After Fat City was developed, the New Orleans economy began to experience rapid growth attributable to the Oil Boom of the late 1970's and early 1980's. This period coincided with massive outmigration of residents from New Orleans to Jefferson Parish, where land was more plentiful and cheap and taxes were low (Campanella, R., 2008). During this boom time, New Orleans and Metairie both witnessed a period of great office tower building. In Metairie, most of this building boom occurred along Causeway Boulevard, lakeside of Veterans Boulevard. By the 1980's the area lakeside of the intersection of Veterans Boulevard and Causeway Boulevard had become a major employment center in the region, and a relatively dense and diverse one at that.

Despite its automobile oriented development patterns, the sheer density of commercial development along Veterans Boulevard made the corridor a prime candidate for transit service. Since the 1970's the corridor has been served by buses and has been one of the most popular transit routes in Jefferson Parish. Still, transit service was never heavily utilized in Jefferson Parish and the two original transit

providers, Louisiana Transit Co. Inc. and Westside Transit Lines, struggled to remain fiscally viable in their early years (Atkinson, 1989). That would soon change.

Table 3.6 Annual Ridership, E1 Veterans Bus Route

Year	Ridership
2011	506,835
2010	487,880
2009	505,952
2008	514,564
2007	478,693
2006	527,971
2005	632,421
2004	863,684
Source: Jefferson Transit	

In 1989, transit in Jefferson Parish reached a tipping point. A fiscal crisis caused by decreasing ridership and funding resulted in severe cutbacks and elimination of routes. The Causeway bus route was completely eliminated, preventing many riverside workers and residents from accessing the many jobs and other services provided at the Veterans and Causeway intersection (East Jefferson Bureau, 1989). These sorts of cutbacks were creating a vicious cycle of decreasing ridership and decreasing revenues, making complete dissolution of transit in the parish an imminent possibility. However, to the surprise of many, later that year parish voters approved a ballot creating the first dedicated funding source for transit in the parish. The ballot created a 2-mill property tax to support conventional transit service and a 1-mill property tax to support its paratransit service (Hyman, 1999).

Over time, transit service in Jefferson Parish grew to become very fiscally self-supporting, achieving farebox recovery rates upwards of 55% in the late 1990's. However, by the turn of the century, ridership in Jefferson Parish was shrinking despite a national trend of increasing ridership. Local planners blamed this downward trend on the increasing decentralization of jobs in the region and the inability of transit service to effectively adapt (Scallan, 2002).

This downward trend would only be exacerbated in coming years with the devastation wrought by Hurricane Katrina and the 2008 economic recession. Levee breaches and high winds during Hurricane Katrina caused extensive damage to houses, businesses, and infrastructure in the area. Aside from the damage to transit infrastructure, demographic and economic trends did not bode well. From 2000 to 2010, the population of Metairie decreased by 5% (Plyer & Ortiz, 2011). During this same time period commercial development activity along Veterans Boulevard decreased and land values stagnated or decreased (Maloney, 2009).

Hurricane Katrina caused Jefferson Transit, the new consolidated transit agency, to spend most of its funding reserves on infrastructure repairs and ongoing operations and maintenance costs during a time when ridership and fare revenues dropped precipitously. Federal funding eased the burden, but the Jefferson Transit that emerged post-Katrina was substantially smaller. In 2007 service hours, fleet size, and staffing were all approximately 50% of their pre-Katrina levels (swLEADER, Inc., 2007). In the years following Katrina, some routes were eliminated completely, weekend or Sunday service was cut for many, and frequencies decreased on virtually all routes as fewer buses were in operation. As Table 3.5 shows, transit ridership on the E1 – Veterans bus route dropped significantly post-Katrina and is facing a slow recovery to reach its pre-Katrina ridership, despite incremental improvements.

Current Conditions

Land use patterns have changed little since before Katrina. Relatively intense commercial uses still predominate on Veterans Boulevard and other primary arterials like Causeway Boulevard, Clearview Parkway, David Drive, and Williams Boulevard. Medium and high density residential land uses are located near these commercial areas, serving as a buffer between low-density, single-family residential uses. Lafreniere Park is the only major public open space along the corridor, but it is rather large and is a regional attraction. See the Appendix for land use maps for Jefferson Parish, The City of Kenner, and The City of New Orleans.

Recent planning efforts are attempting to make the corridor more supportive of transit and walking. The 2007 *Transit Plan for the Greater New Orleans* calls for several nodes in the Veterans Boulevard corridor to be designated "TOD Design Nodes," including the Metairie CBD and the following intersections: Veterans and Clearview, Veterans and David Drive, and Veterans and Oaklawn (Clearview Mall). These nodes were recommended to have zoning and building standards that encourage transit use as the future land use plan for Jefferson Parish envisions these areas to be the densest commercial and residential areas and home to the majority of future job growth. They also represent areas where roadway capacity expansion is limited because of existing development patterns (swLEADER, Inc., 2007).

Efforts are also being made to transform Fat City and the Metairie CBD into more walkable, mixed-use areas through streetscape improvements and economic redevelopment (Jefferson Parish Economic Development Commission, 2009; Burk-Kleinpeter, Inc., 2001). The *Metairie CBD Land Use and Transportation Plan* calls for extensive mixed-use development and many pedestrian, bicycle, and transit improvements in addition to improved street connectivity (Burk-Kleinpeter, Inc., 2001).

Perhaps because of the intensity of commercial uses, strict separation of land uses, and automobile dependence, traffic congestion is a recognized problem on Veterans Boulevard. Of all the major thoroughfares (excluding freeways) in the study area surveyed by Jefferson Parish, Causeway Boulevard and Veterans Boulevard have the highest traffic (Jefferson Parish Traffic Engineering Division, 2012). A congestion index created by the New Orleans Regional Planning Commission (NORPC) in 2010 rated the corridor as a high priority for congestion mitigation (New Orleans Regional Planning Commission, 2010). While traffic along the corridor actually decreased from 2008 to 2010, this is likely a result of the economic recession, which has reduced the number of daily trips Americans are making. Similarly, transit ridership for the E1 – Veterans bus route decreased during this time period, though to a lesser extent.

Table 3.7 NORPC Traffic Counts along Veterans Boulevard, 2008-10

				ADT		
Road	From	To	Parish	2008	2010	Change
Veterans Blvd.	Williams	Power	Jefferson	35,800	33,700	-5.87%
Veterans Blvd.	Power	I-10	Jefferson	37,100	37,800	1.89%
Veterans Blvd.	I-10	Clearview	Jefferson	49,500	48,800	-1.41%
Veterans Blvd.	Clearview	Cleary	Jefferson	55,200	50,700	-8.15%
Veterans Blvd.	Cleary	Causeway	Jefferson	55,900	50,900	-8.94%
Veterans Blvd.	Causeway	Bonnabel	Jefferson	59,000	52,600	-10.85%
Veterans Blvd.	Bonnabel	Parish Line	Jefferson	48,000	37,500	-21.88%
Veterans Blvd.	Parish Line	West End	Orleans	37,186	36,087*	-2.96%
Source: New Orleans Regional Planning Commission, Traffic Counts						
*Note: *Collected in 2011*						

While traffic may have decreased in recent years, this trend may be fleeting as the local economy is rebounding and unless travel behavior changes, automobile traffic will inevitably return to its former level.

Already, Veterans Boulevard is seeing renewed commercial investment, mostly in the form of retail and restaurant establishments. As of late 2012, commercial land values on certain stretches of Veterans Boulevard had reached historic levels, reflecting higher occupancy rates and little available land (Webster, 2012). Transit ridership also appears to be on the rebound.

The Veterans Corridor has decent transit accessibility as it is served by ten transit routes including the E1 – Veterans route. In Jefferson Parish, the Kenner Loop, Clearview, and Causeway bus routes all intersect the Veterans route. At the Cemeteries transfer station in New Orleans, the Veterans route connects with the Metairie Road route and six Regional Transit Authority (RTA) routes serving New Orleans, including the Canal Streetcar. The most popular stops on the Veterans route are Lakeside Mall, Clearview Mall, and the Cemeteries transfer station (Jefferson Transit, 2008).

3.4 Bus Rapid Transit

Bus Rapid Transit (BRT) is an increasingly popular form of rapid transit which combines the quality of rail-based transit with the flexibility of bus-based transit. Much of BRT's recent popularity is attributable to its potential cost-efficiency compared to rail and its relatively similar results. BRT can be as attractive as rail-based transit because of its system-based approach which incorporates many distinct components that collectively improve the speed, reliability, and public perception of bus transit (Currie, 2005).

It is important to note that while BRT has become popular in the United States, is not an entirely new or foreign concept. BRT was first proposed in the *1937 Chicago Plan* and similar plans were made later in Washington, D.C. (1956), St. Louis (1959), and Milwaukee (1971). Also, during the 1960's and 70's many concept plans and technical studies espoused the potential benefits of BRT systems. Admittedly, these plans and studies mostly focused on the segregation aspect of BRT and focused on implementation along new expressways radiating from Central Business Districts. Little attention was given to the service or branding aspects of BRT systems (Levinson, Zimmerman, Clinger, & Rutherford, 2002).

In the 1970's a shift in transit planning occurred amidst rapid urban decentralization and increases in automobile ownership. Many BRT plans were abandoned and the national focus shifted to High Occupancy Vehicle (HOV) lanes and Light Rail Transit (LRT). HOV lanes were seen as more widely applicable and practical in an era of highway capacity expansion and LRT was seen as more attractive than buses. It was not until the late 1990's, following the success of international BRT systems in Curitiba and Ottawa, that BRT received renewed attention in the United States (Levinson, Zimmerman, Clinger, & Rutherford, 2002).

Characteristics

The three most common types of BRT systems are conventional radial routes, extensions of rail rapid-transit lines, and peak-period commuter express options. Regardless of type, all BRT systems should address the following components: running ways; stations; vehicles; branding; service planning; ITS applications; and fare collection (Levinson, et al., 2003).

Running Ways

Running ways are the primary element of BRT systems and should serve major travel markets like Central Business Districts (CBDs), dense commercial corridors, or corridors linking major activity centers. Exclusive, grade-separated right-of-ways are ideal but not necessary for an effective system. If implemented, special running ways (busways, bus lanes, etc.) are most appropriate in areas with high congestion, a considerable bus presence, accommodating street geometry, and political willingness. Their implementation should result in net travel time savings for transit riders that is greater than the net travel time loss for automobile drivers. The primary goal of running ways is to minimize travel time while still providing convenient access to major destinations (Levinson, et al., 2003).

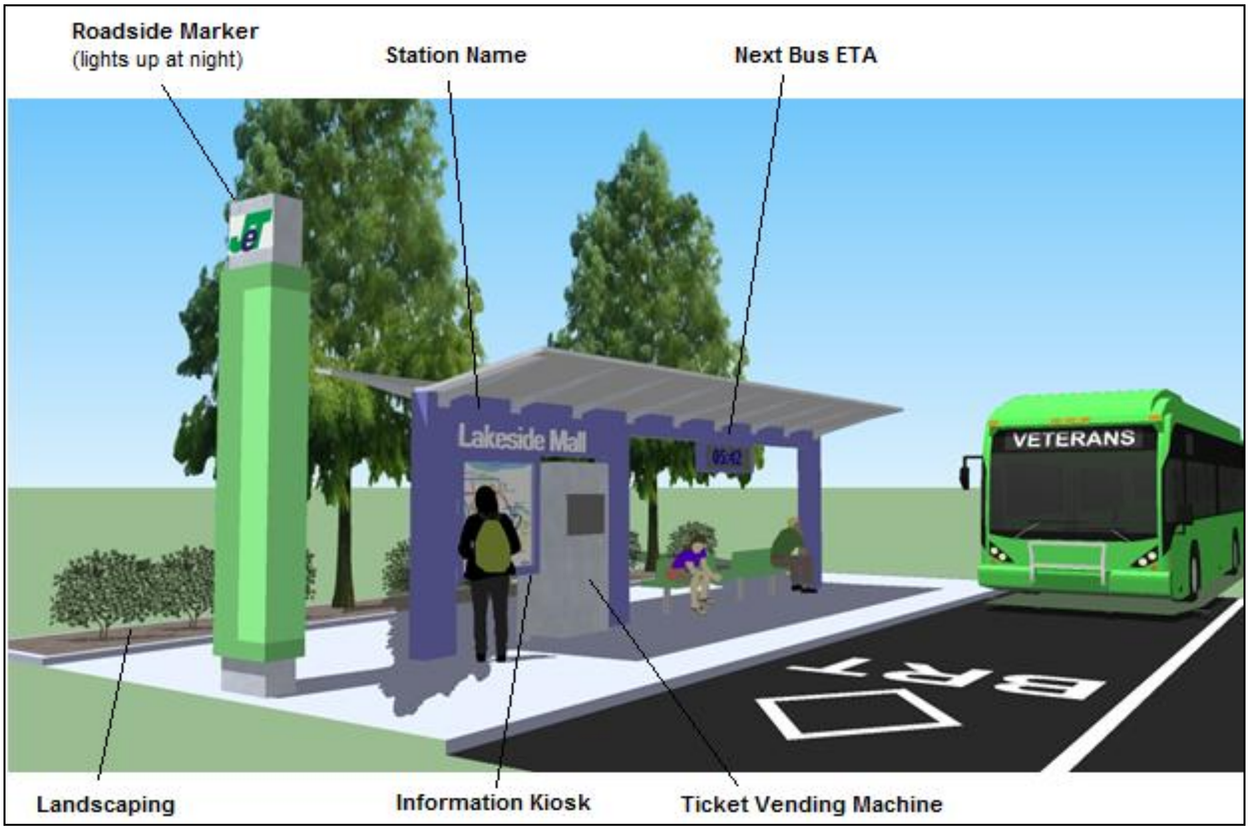
Table 3.8 Running Ways Classified by Extent of Access Control

Class	Access Control	Facility Type
	Uninterrupted Flow	Bus Tunnel
	Full Control of Access	Grade-Separated Busway
I		Reserved Freeway Lanes
II	Partial Control of Access	At-Grade Busway
	Physically Separated Lanes	Arterial Median Busway
III	Within Street Rights-of-Way	Bus Street
	Exclusive Semi-exclusive Lanes	Concurrent and
IV		Contra Flow Bus Lanes
V	Mixed Traffic Operations	
Source: Levinson, et al., 2003		

Stations

Station Area planning should be encouraged at the earliest stages of development so that future land uses can be coordinated with BRT. Obviously, safe and attractive pedestrian and automobile access to stations is important, but context-sensitive design and urban design standards are also important. Implementing urban design standards and land use plans that complement BRT can foster Transit Oriented Development (TOD) which in turn can increase ridership (Levinson, Zimmerman, Clinger, & Rutherford, 2002).

Figure 3.18 Illustrative Rendering of Potential Station Area Improvements



Source: Created by Author

Vehicles

BRT vehicles should have an identity unique from conventional buses in order to convey their higher level of service and convenience. Most systems which operate BRT lines use a separate BRT fleet. Because of the potentially high capacity associated with BRT, many vehicles have more seating capacity, wider doorways, more points of ingress/egress, and more on-board comforts when compared to conventional buses. They also typically emit lower levels of air and noise pollution (Levinson, Zimmerman, Clinger, & Rutherford, 2002).

Branding

The identity and image of a BRT system should be distinctive and consistent in the design of all BRT elements. Special branding and advertising of BRT should convey the service attributes of BRT and provide constant marketing exposure (Levinson, Zimmerman, Clinger, & Rutherford, 2002).

Service Planning

Service should be simple, efficient, and convenient. Headways between buses should be 5-10 minutes during peak hours and 10-12 minutes in off-peak. Travel time should be minimized by increasing stop-spacing and minimizing dwell time. Transfer avoidance should be balanced with simplicity and frequency. Having a few high-frequency routes is generally preferable to many routes with long headways (Levinson, et al., 2003).

The flexibility of buses should be incorporated into the service plan for BRT. In North America, this is most commonly seen in the overlay of an express (limited-stop) route along the BRT route during peak periods. In off-peak periods the express vehicles may retire or serve as local feeder routes for the BRT route. All transfers from local routes to BRT should occur in stations that are well-designed and accommodating (Levinson, Zimmerman, Clinger, & Rutherford, 2002).

ITS Applications

Intelligent Transportation Systems (ITS) applications can reduce travel times through monitoring/controlling bus operations and giving buses priority at signalized intersections. The cost of implementing these applications is relatively low provided a region already has an integrated regional transportation system (Levinson, Zimmerman, Clinger, & Rutherford, 2002).

Fare Collection

The main goal with respect to fare collection is to reduce dwell time associated with passenger boarding/alighting. Ideally, fares would be collected at stations so that multiple-door boarding may occur. Major stations and stops should be prioritized for off-board fare collection. Another alternative is the utilization of multiple points of payment. ITS applications like smart card technology can reduce boarding times as well (Levinson, et al., 2003).

Benefits and Costs

Many of the benefits associated with Bus Rapid Transit (BRT) are similar to other forms of rapid transit. The advantage of BRT lies in its potential flexibility and cost savings compared to these other forms. The benefits of BRT can be broken down into four categories: system benefits, environmental benefits, and community/economic benefits.

System Benefits

The principal system benefit of BRT is increased ridership due to the greater attractiveness created by some combination of BRT characteristics summarized in the previous section. Increasing ridership justifies an investment in rapid transit and reduces congestion and pollution while increasing accessibility and revenues. On average, ridership in existing transit corridors increases 35% after implementing BRT, though there is considerable variation depending on system characteristics (Diaz & Hinebaugh, 2009).

Findings from a survey of recent BRT systems found that the ridership impact of BRT is comparable to Light Rail Transit (LRT). The survey also showed that ridership increases are attributable not just to level of service improvements, but also to the branding and other unique characteristics of BRT systems (Diaz & Hinebaugh, 2009).

BRT systems are also noted for their cost effectiveness because of their lower capital costs compared to other forms of rapid transit, especially rail alternatives. Thus, they are a more cost-effective method of increasing ridership. Empirical evidence has also shown that BRT systems improve the efficiency of corridor operating costs as performance indicators like passengers per revenue hour, subsidy per passenger mile, and subsidy per passenger all improve post-implementation (Diaz & Hinebaugh, 2009).

Environmental Benefits

The system benefits that result in more efficient service provision mean that fewer transit vehicles are operating in a given day, thereby reducing energy consumption and emissions. BRT vehicles also have lower emissions compared to conventional buses as they are typically fueled by alternative energy sources and propulsion systems. Also, by stimulating a mode shift from automobiles to transit, BRT

systems are simultaneously increasing the utilization of a more sustainable mode of transportation and reducing roadway congestion and the ensuing air pollution (Diaz & Hinebaugh, 2009).

Community/Economic Benefits

An obvious benefit of implementing BRT is the improved economic conditions for transit riders afforded by shorter travel times. If a considerable mode shift occurs, automobile traffic congestion can lessen and travel times for automobile and freight vehicles will also decrease, improving the efficiency of the local transportation system and movement of goods (Diaz & Hinebaugh, 2009).

In corridors with poor or non-existent service prior to implementation, BRT can also increase commercial activity and increase access for the labor force to the area. Also, in addition to the short-term job creation involved in implementing a BRT system, BRT systems have also been shown to bring about land use changes and Transit-Oriented Development (TOD), especially if considerable station and streetscape improvements are made (Diaz & Hinebaugh, 2009). For example, in Cleveland and Boston, BRT lines coupled with attractive stations and considerable streetscape improvements have helped to revitalize blighted corridors and attract private development, especially in the case of Cleveland (Breakthrough Technologies Institute, 2008; Litt, 2008). However, given that BRT is a rather recent phenomenon in North America, there is still debate over the land use impacts and potential for redevelopment and TOD.

It is posited that the more similar the design of a BRT system is to rail, the more likely it is to effect land use changes similar to rail rapid transit (Diaz et al., 2004). Still, the largest obstacle to achieving redevelopment and TOD with BRT as opposed to LRT is the perception that BRT lacks the permanence of LRT or other rail-based modes (Kittelson & Associates, Inc., 2007). While surveys of twelve developers in North American cities with BRT systems confirm that the perceived permanence was a very important factor in their decision to invest in a transit corridor, these developers also characterized the permanence of BRT in their city as very high or high (Breakthrough Technologies Institute, 2008). Surveys indicated that this is likely due to the presence of the following elements, which developers indicated impacted the perceived permanence: exclusive running ways and dedicated lanes (high); size and quality of stations (high); streetscape improvements (moderate); and park-and-ride lots (moderate).

Survey results were mixed when asked whether or not their perception of permanence would change if a rail-based system were used instead. Developers also indicated that BRT had a very positive impact on their property, with approximately half indicating that proximity to BRT increased property value by 3-5% compared with similar properties not in proximity to BRT. Regarding TOD, developers indicated proximity to BRT had a positive impact on reducing parking demand, increasing customer traffic, reducing vacancy rates, and enhancing image and appeal to customers.

Seven government agencies responsible for planning for TOD and land use around BRT systems were also surveyed (Breakthrough Technologies Institute, 2008). Results of this survey indicate that these government agencies actively promote and incentivize development in the BRT corridor. The agencies also found that developer interest increased to very high levels after construction.

In reviewing existing literature, only two recent studies were found which used hedonic price regression models to estimate the impact of BRT on land values in the United States. Both of these studies indicate that proximity to BRT stations positively affects residential land values.

The first study focused on the Pittsburgh East Busway and found a strong inverse relationship between distance from a BRT station and residential land values of single-family homes (Perk & Catalá, 2009). The degree to which land values were higher in proximity to BRT stations was found to be large in comparison to similar studies of Light Rail Transit (LRT). This quantitative analysis, along with anecdotal evidence and over $300 million of investment in the Pittsburgh East Busway, supports the authors' hypothesis that BRT increases land values and stimulates development (Perk & Catalá, 2009; Breakthrough Technologies Institute, 2008).

The second study focused on the EmX BRT line in Eugene, Oregon and found mixed results (Hodel & Ickler, 2012). Along the original segment of the EmX line, implemented in 2007, there was a significant, negative relationship between distance from BRT stations and single-family and multi-family residential real estate sales from 2007 to 2012. However, along the EmX Gateway extension, implemented in 2011, no significant relationship between distance from BRT stations and single-family and multi-family residential real estate sales from 2011 to 2012 was found. It was thus concluded that BRT did have a

positive effect on residential land values but that the impact may not be immediate (Hodel & Ickler, 2012).

Costs

The relatively low capital and operating costs associated with BRT systems are a major part of their appeal in an era defined by economic recession and governmental deficit-spending. With levels of service similar to Light Rail Transit (LRT), BRT systems offer a cost-efficient way of improving transit. Because of its lower costs and ability to be implemented quickly, BRT can be used to rapidly expand the coverage of high-quality transit service, such as in Bogota (Deng & Nelson, 2011).

Table 3.4.2 compares the cost of implementing a BRT system to a LRT system. While BRT is cheaper, as more amenities are added to BRT systems, the cost disparity between BRT and LRT decreases. Still, even at high end estimates, the capital cost of implementing BRT is a quarter of LRT.

Table 3.9 Typical Cost Ranges for BRT and LRT Projects

	Cost per Mile (Millions)		
Service Type	Low	High	Annual Operating Costs (Millions)
Bus Rapid Transit	$5	$15	
Light Rail Transit	$30	$50	$27-$29
Source: Cambridge Systematics, Inc., A.G. Samuel Group, Inc., & Sabra, Wang & Associates, Inc. 2008			

There is still debate over whether or not operating costs are cheaper for LRT than BRT. Some reports indicate that the operating costs are more or less the same (Cambridge Systematics, Inc., A.G. Samuel Group, Inc., & Sabra, Wang & Associates, 2008). Others argue that the cost differential is minimal in most scenarios but really depends on the type of service being implemented, frequency, capacity, and other characteristics (Bruun, 2005). A report comparing operating costs of BRT and LRT systems in American cities that operate both systems found that BRT tends to be cheaper, especially when cost is calculated per vehicle revenue hour or revenue mile (U.S. General Accounting Office, 2001). Still, some argue that operating costs are less for LRT than for BRT (Hass-Klau, Crampton, Biereth, & Deutsch, 2003). Research fueling this debate is rather limited and will likely remain so until more BRT and LRT systems are implemented in the United States.

Table 3.4.3 breaks down the cost of BRT systems by element. Depending on the type of running way, this element can be the most expensive or have no cost at all. Most BRT systems utilize at-grade separated running ways for at least portions of their route but costs vary considerably by project. The cost of stations are also highly variable depending on the amenities provided and capacity. Obviously, systems with more stations would be more costly. The cost of buses is more fixed, only varying by capacity (standard-length vs. articulated). Of course, the lifespan of buses warrants additional investment upon vehicle retirement.

Table 3.10 Estimated Capital Costs by Element

Cost Element	Unit	Capital Cost Range	
		Low	High
Running Way	Per lane mile	$0 (Mixed Traffic)	$10,000,000 (At-Grade Separated)
Stations	Per station	$15,000 (Simple Shelter)	$2,000,000 (Enclosed Station)
Vehicles	Per vehicle	$500,000 (Stylized, Standard-Length)	$1,000,000 (Stylized, Articulated)
Source: Diaz & Hinebaugh, 2009			

Negative Externalities

Of course, like most forms of mass transit, BRT can disrupt traffic and produce air and noise pollution. Newer technologies and operating efficiencies associated with BRT can mitigate the latter externalities. In fact, BRT systems can have a net positive impact on air pollution. The impact BRT systems have on local traffic is largely a byproduct of the type of system implemented, local conditions, and roadway geometry. Many adaptations can be made to mitigate potential traffic disruptions (Deng & Nelson, 2011).

Supportive Land Use Densities

Urban Density and Transit Demand

The three urban form variables that transit planners typically analyze are density, diversity and design, collectively known as the three D's. While density obviously refers to the concentration of residents or

employment within a given area, diversity refers to the mix of land uses and design refers to urban design variables like building heights, setbacks, parking ratios, and the pedestrian environment. These three dimensions of the built environment significantly affect an individual's mode choice, number of trips, and distance of trips traveled (Cervero & Kockelman, 1997).

However, density is the primary urban form variable transit planners analyze when predicting future ridership. This is largely because research has shown that the relationship between population and employment density and mode choice is nonlinear, with transit usage increasing as densities increase (Frank & Pivo, 1994; Selskin, Cervero, Zupan, & Howard, 1996). Also, the other two variables are more difficult to quantify and have been shown to correlate positively with density (Ewing, 1994).

Empirical evidence has also shown that higher residential and employment densities are correlated with Vehicle Miles Traveled (VMT) reductions, fewer vehicle trips, lower automobile ownership rates, more pedestrian trips, and higher transit mode shares (Pushkarev & Zupan, 1977; Frank & Pivo, 1994; Seskin, Cervero, Zupan, & Howard, 1996; Newman & Kenworthy, 1999; Ewing & Cervero, 2001). Thus, in the case of transit planning, density remains the most important predictor of work-related individual travel patterns and is the most widely used variable to predict transit ridership (Cervero & Kockelman, 1997).

Measuring Density, Defining Service Areas

There are two types of densities evaluated by transit planners when studying the feasibility of Bus Rapid Transit, residential and employment density. Of these two, residential density is the most commonly utilized measure, but research indicates that employment density may be the more appropriate measure (Frank & Pivo, 1994; Cervero & Guerra, 2011).

Residential density is typically measured in residents per square mile, dwelling units per acre, or floor area ratio. In the case of BRT studies, this measure is almost always presented as dwelling units per acre. Employment density is measured in jobs per acre, commercial square footage, or floor area ratio. While floor area ratio or commercial square footage would be ideal, it is often difficult to obtain or accurately derive this data. Thus, analysis of employment density is typically measured in jobs per acre.

When measuring residential or employment densities, it must be determined whether gross density or net density is most appropriate. In the case of BRT feasibility analysis, gross densities are the standard measure. Gross density means that the total number of units (dwelling units, jobs, etc.) is divided by the total land area. This differs from net density wherein all space not occupied by buildings is subtracted from the total land area. Net density is typically used for site planning for new development while gross density is more suitable for understanding the overall intensity of development and pedestrian environment since it includes all land area (Puget Sound Regional Council, 1999).

BRT feasibility studies measure residential and employment densities in two service area geographies: the station area and corridor. Station area densities are important in land use planning and in planning express BRT service which operates with considerably long stop-spacing to decrease travel time. While stop-spacing on local BRT lines is generally longer than conventional bus service, a corridor service area is typically used for feasibility analysis.

Once the service area geography is determined, the catchment area must be determined. A catchment area represents the area that is within a walkable distance, generally regarded as a 5 minute walk (New Jersey Transit Authority, 1994; Ewing, 1999). The industry standard for traditional transit catchment areas is a radial distance of a quarter mile, but research has shown that larger catchment areas are more appropriate for residential density, especially if high quality transit service exists (Johnson, 2003; Ewing, 1999). Empirical research has also shown the highest correlation between ridership and residential density is a half mile radius while the highest correlation with respect to employment density is a quarter mile buffer (Cervero & Guerra, 2011).

A Review of Density Thresholds for Bus Rapid Transit

Though there is no agreed upon industry standard for density thresholds for Bus Rapid Transit (BRT), standards and guidelines recommended by existing research suggest a relatively narrow range for residential density and a considerably wider range for employment density. Of course, these thresholds vary by service area, with higher thresholds for station areas than for entire corridors. Density thresholds have also changed over time as new research emerged and challenged the accepted wisdom of the time.

Contemporary debate on density thresholds necessary to support specific types of transit can be traced back to the 1977 seminal work of Puschkarev and Zupan, *Public Transportation and Land Policy*. This book essentially established industry standards for corridor density thresholds required for basic service, frequent service, light rail, and heavy rail. Though widely influential in the transit industry, it is important to note a few caveats of this work. Pushkarev and Zupan focused their analysis on the New York region, a region which is a statistical anomaly in terms of density, transit service, and transit patronage in the United States. It was also published over 30 years ago, using data from the 1960's when vehicle ownership was much lower and transit patronage across the country was much higher. For these reasons, contemporary use of their standards has been criticized by some.

Since Puschkarev and Zupan, there has been little prescriptive research on transit-supportive thresholds, much less any as influential or widely applied. Most recent research regarding density thresholds has been performed by consultants for specific clients and regions. Of course, there are a few exceptions.

It is important to note that Pushkarev and Zupan did not mention employment densities per se, but instead focused on the size of CBDs, assuming a radial transit network. In the 1970's, the study of polycentric regions was in the nascent stage and almost all transit service was oriented to the CBD. Beginning in the 1980's transit service began to adapt to employment decentralization and cross-town routes linking major employment centers became more common. Following this trend, the Institute of Transportation Engineers (ITE) sought to build upon Pushkarev and Zupan's research by recommending employment density thresholds necessary to support certain forms and qualities of transit service.

Though innovative, the standards set forth by ITE are extremely high compared to contemporary standards and guidelines. As research began to show that employment density was more attractive to riders and a better predictor of ridership, employment density thresholds gradually declined in subsequent research (Frank & Pivo, 1994). In 1994 the New Jersey Transit Authority, following the enactment of the Clean Air Act (1990) and Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, published *Planning for Transit-Friendly Land Use: A Handbook for New Jersey Communities*. This document is notable because it focuses on the station area and it suggests an employment density threshold much lower than the ITE, especially considering it is just for the station area as opposed to the entire corridor.

In 1999, for the Florida Department of Transportation and American Planning Association, Reid Ewing published *Pedestrian- and Transit-Friendly Design: A Primer for Smart Growth* in which he maintained Pushkarev and Zupan's residential density threshold but added a corridor employment density threshold of 50 employees per acre (Ewing, 1999). Following the growing popularity of BRT in the United States in the late 1990's, most new research began to suggest lower density thresholds for both residential and employment densities. This is likely a result of a growing body of literature that showed BRT could be just as attractive as LRT.

The tables below show gross density threshold guidelines and standards at the corridor and station area level. The most recent research will be the most applicable to this thesis as it accounts for the attractiveness of BRT as a distinct mode, attributable to its many unique characteristics.

Table 3.11 BRT Density Thresholds for Corridors

Source	Service Type	Distance	Population Density (Units/Acre)	Employment Density (Employees/Acre)
Public Transportation and Land Use Policy - Pushkarev and Zupan - 1977	Frequent Local Bus (120 buses per day)	n/a	15	n/a
A Toolbox for Alleviating Traffic Congestion (ITE) - 1989	Frequent Local Bus (10 minute headways)	n/a	15	200-500
Pedestrian- and Transit-Friendly Design: A Primer for Smart Growth - Reid Ewing - 1999	Premium Bus Service	0.25 miles	15	50
Community Design & Transportation: A Manual of Best Practices in Integrating Transportation and Land Use - Valley Transportation Agency - 2003	Bus Rapid Transit	n/a	12	n/a
Lee County Bus Rapid Transit Feasibility Study - Tindale & Oliver Associates Inc. - 2008	Bus Rapid Transit	n/a	6-7	5-6
Southern MD Transportation Needs Assessment - 2008	Bus Rapid Transit (5 minute peak headways)	n/a	9	n/a
Kane County Randall/Orchard Road Corridor Bus Rapid Transit Feasibility Study - Nelson/Nygaard Consulting Associates - 2010	Bus Rapid Transit	n/a	15	20
What Does Transit Supportive Density Look Like? - Fregonese Associates - 2011	Bus Rapid Transit	n/a	12-15	n/a
Note: A 5-minute walk is synonymous with 0.25 miles.				
Sources: Pushkarev & Zupan, 1977; Institute of Transportation Engineers, 1989; Ewing, 1999; Valley Transportation Authority, 2003; Tindale & Oliver Associates Inc., 2008; Cambridge Systematics, Inc., A.G. Samuel Group, Inc., & Sabra, Wang & Associates, Inc., 2008; Nelson\Nygaard Consulting Associates, 2010; Fregonese Associates, 2011				

Table 3.12 BRT Density Thresholds for Station Areas

Source	Service Type	Distance	Population Density (Units/Acre)	Employment Density (Employees/Acre)
Planning for Transit Friendly Land Use - New Jersey Transit Authority - 1994	Rail or Other High Capacity Service	n/a	15-24	150
Creating Transit Station Communities in the Central Puget Sound Region - Puget Sound Regional Council - 1999	Frequent, High Capacity Transit Service	n/a	10-20	25
Transit Oriented Development Design Guideline DRAFT - Florida Department of Transportation - 2009	Suburban BRT/LRT	0.5 miles	20-25	30-40
Downtown Waldorf Vision Plan and Design Guidelines - 2010	Bus Rapid Transit/Light Rail Transit	0.5 miles	15-35	38
Note: A 5-minute walk is synonymous with 0.25 miles.				
Sources: New Jersey Transit Authority, 1994; Florida Department of Transportation, 2009; ERM, EDSA, Inc., & Sabra Wang & Associates Inc., 2010; Puget Sound Regional Council, 1999				

4.0 Discussion of Research Results

4.1 Residential and Employment Densities and BRT Thresholds

RQ1: What are the residential and employment densities along the Veterans Boulevard corridor? According to existing literature, are these densities supportive of Bus Rapid Transit?

Hypothesis: The residential densities barely meet or do not meet the minimum thresholds suggested by existing literature for Bus Rapid Transit but the employment densities exceed such minimum thresholds.

Corridor Densities and Thresholds

Results

Table 4.1 BRT Density Thresholds for Corridors

Source	Service Type	Distance	Population Density (Units/Acre)	Employment Density (Employees/Acre)
Public Transportation and Land Use Policy - Pushkarev and Zupan - 1977	Frequent Local Bus (120 buses per day)	n/a	15	n/a
A Toolbox for Alleviating Traffic Congestion (ITE) - 1989	Frequent Local Bus (10 minute headways)	n/a	15	200-500
Pedestrian- and Transit-Friendly Design: A Primer for Smart Growth - Reid Ewing - 1999	Premium Bus Service	0.25 miles	15	50
Community Design & Transportation: A Manual of Best Practices in Integrating Transportation and Land Use - Valley Transportation Agency - 2003	Bus Rapid Transit	n/a	12	n/a
Lee County Bus Rapid Transit Feasibility Study - Tindale & Oliver Associates Inc. - 2008	Bus Rapid Transit	n/a	6-7	5-6
Southern MD Transportation Needs Assessment - 2008	Bus Rapid Transit (5 minute peak headways)	n/a	9	n/a
Kane County Randall/Orchard Road Corridor Bus Rapid Transit Feasibility Study - Nelson/Nygaard Consulting Associates - 2010	Bus Rapid Transit	n/a	15	20
What Does Transit Supportive Density Look Like? - Fregonese Associates - 2011	Bus Rapid Transit	n/a	12-15	n/a
Note: A 5-minute walk is synonymous with 0.25 miles.				
Sources: Pushkarev & Zupan, 1977; Institute of Transportation Engineers, 1989; Ewing, 1999; Valley Transportation Authority, 2003; Tindale & Oliver Associates Inc., 2008; Cambridge Systematics, Inc., A.G. Samuel Group, Inc., & Sabra, Wang & Associates, Inc., 2008; Nelson\Nygaard Consulting Associates, 2010; Fregonese Associates, 2011				

Table 4.2 Study Area Corridor Densities

Buffer Distance	Residential Density		Employment Density	
	Total Dwelling Units	Dwelling Units/Acre	Total Jobs	Jobs/Acre
Half Mile	25,501.73	4.03	44,389.71	7.01
Quarter Mile	11,345.78	3.64	28,556.14	9.17

Figure 4.1 Half Mile Study Area Residential Densities

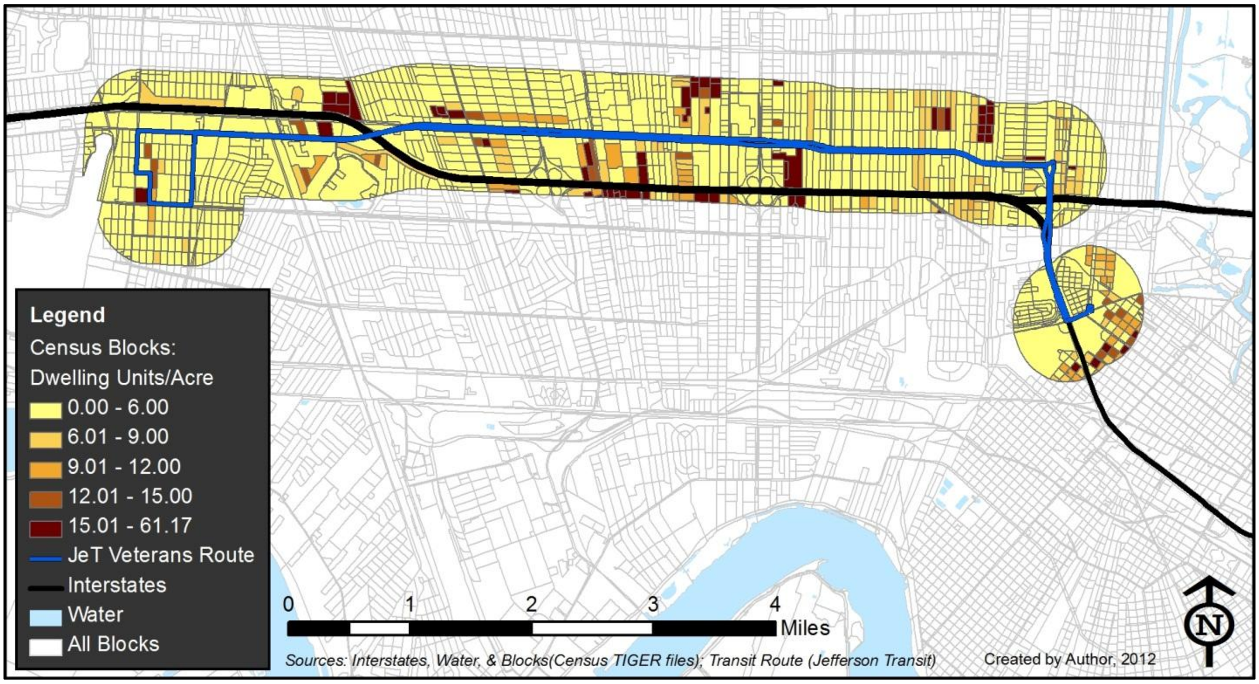


Figure 4.2 Half Mile Study Area Employment Densities

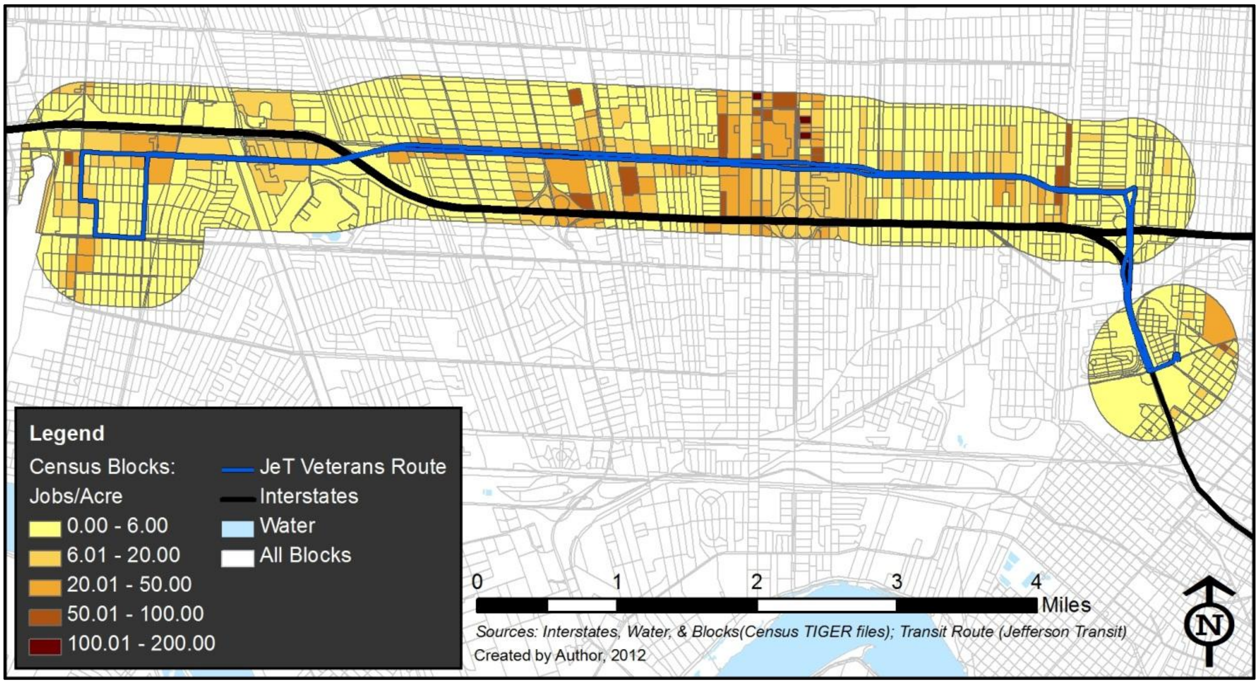


Figure 4.3 Quarter Mile Study Area Residential Densities

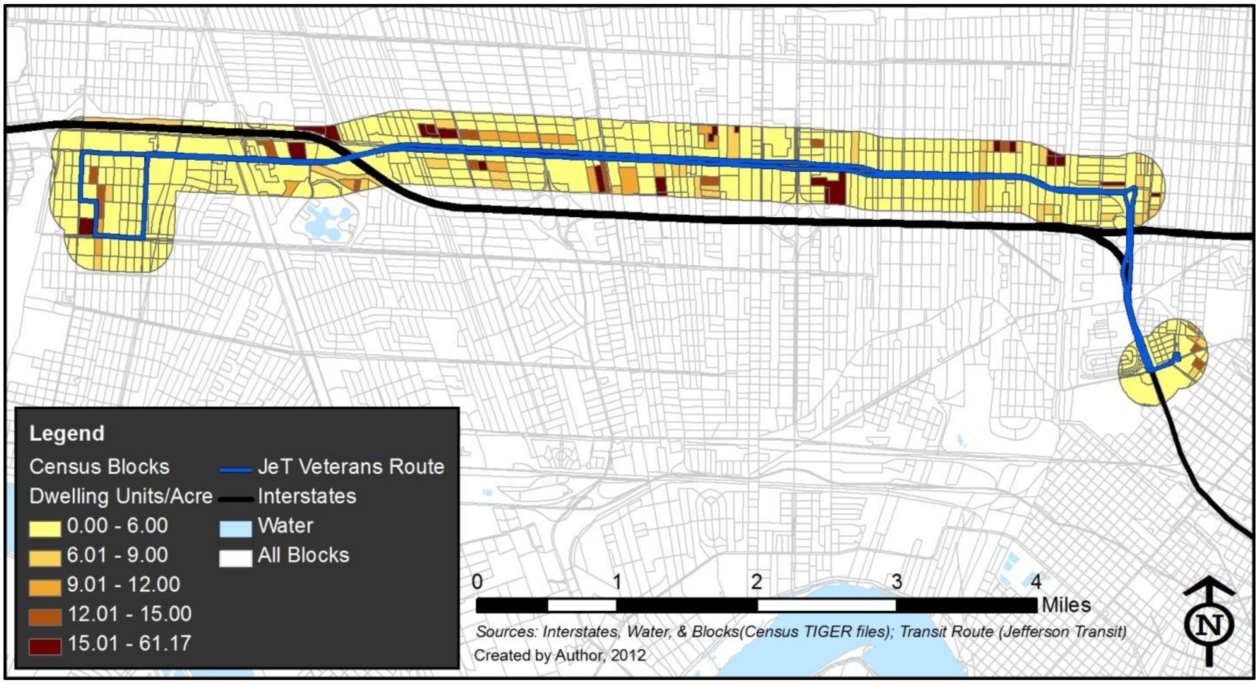
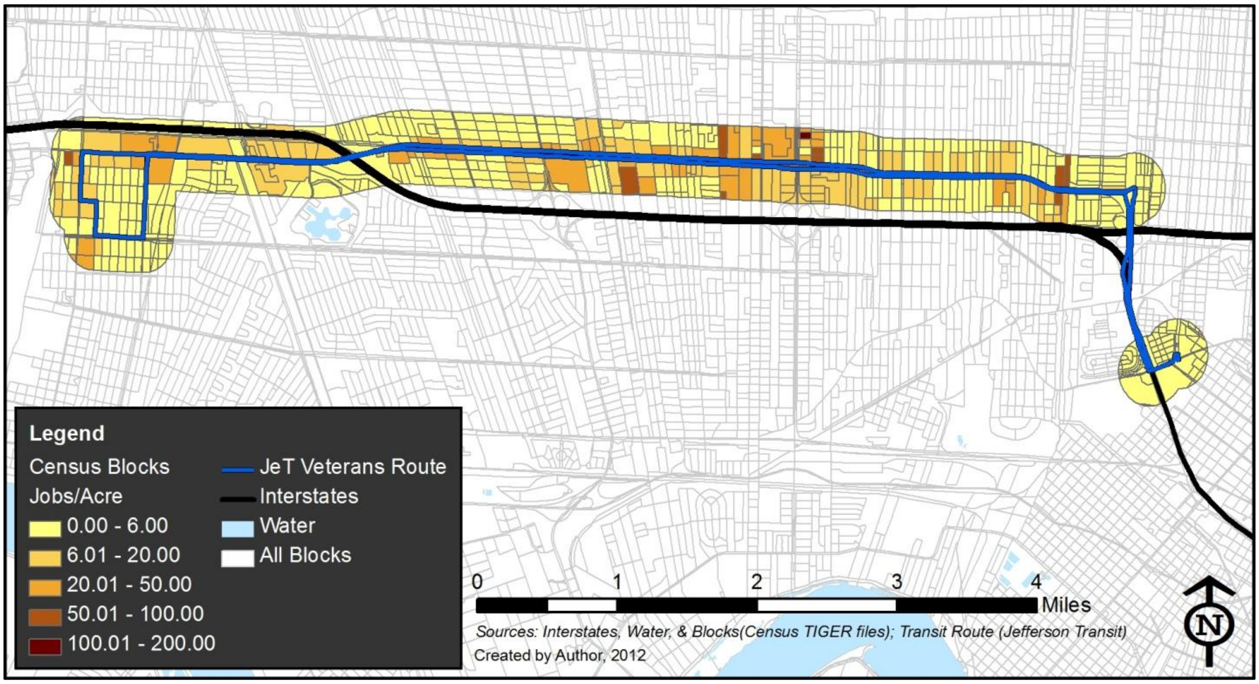


Figure 4.4 Quarter Mile Study Area Employment Densities



Discussion

Existing literature on residential and employment density thresholds for Bus Rapid Transit corridors shows considerable variation. Residential density thresholds, measured in dwelling units per acre, were more uniform than employment densities. While thresholds for residential densities ranged from 6 units per acre to 15 units per acre, most were between 12 to 15 units per acre. Literature on recommended employment densities was much more scarce and variable. Suggested employment densities ranged from 5 jobs per acre to 500 jobs per acre with most thresholds at 50 jobs per acre or less. The evolution of the literature over time suggests that the lower end of the spectrum is more accurate. Older studies and reports tended to overemphasize the number of jobs necessary and were predicated on the notion that rapid transit must be oriented to the Central Business District.

It is important to note that while most of the thresholds were standards or guidelines for identifying areas supportive of BRT, many of them also note that exceptions may be made and the thresholds are mere suggestions. That being said, using both half-mile and quarter-mile buffers, residential densities along the Veterans Boulevard corridor do not meet thresholds suggested for BRT service by existing literature.

Employment densities in the corridor, however, do meet the density threshold suggested for BRT in Lee County, Florida.

At both scales, residential density in the corridor is lower than employment density, illustrating the preponderance of commercial uses in this area. However, residential density is higher using a half-mile buffer, indicating higher residential densities further away from Veterans Boulevard. Conversely, employment density is higher using a quarter-mile buffer. Considered together, this data indicates a rather strict separation of uses with most employment located closer to Veterans Boulevard and most residences located further away from Veterans Boulevard.

The maps showing residential and employment densities by census block show that there is considerable variation in densities within the corridor. There are clusters of residential densities above 12 units per acre but the majority of the corridor is below 6 units per acre. Employment density also varies considerably within the corridor with the highest densities clustered between Causeway Boulevard and Clearview Parkway. There are also smaller high-density employment clusters near Lake Avenue, Roosevelt Boulevard, and Delgado University.

Station Area Densities and Thresholds

Results

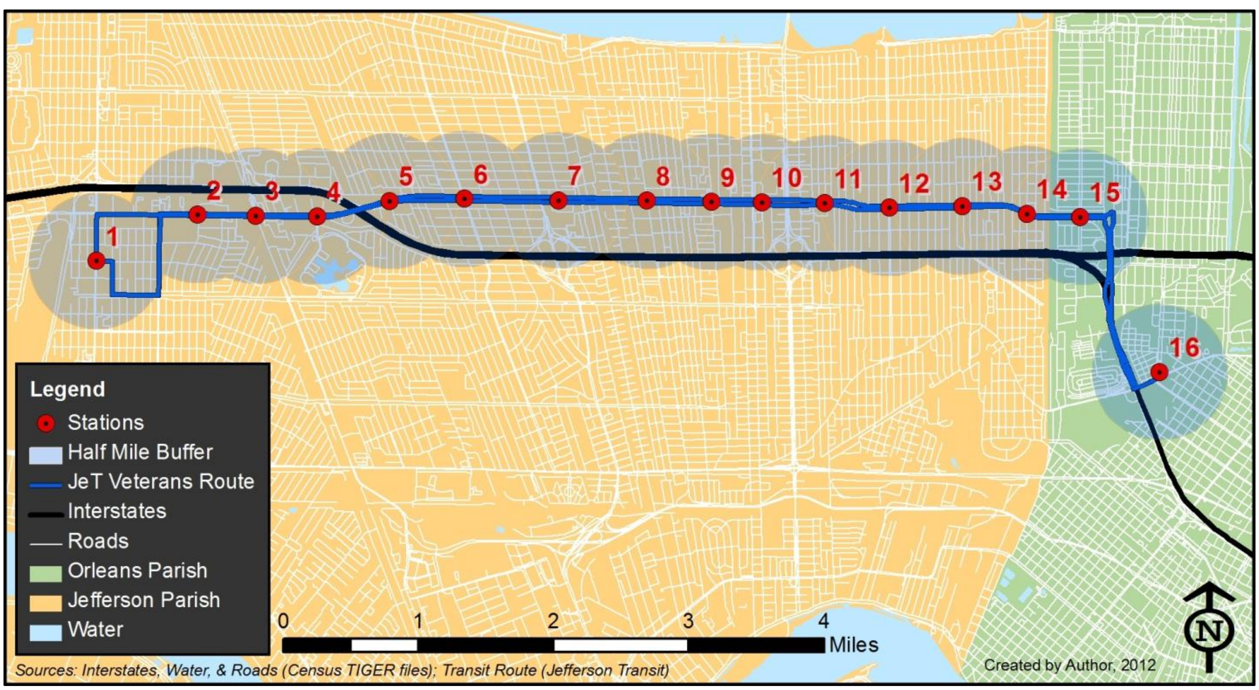
Table 4.3 BRT Density Thresholds for Station Areas

Source	Service Type	Distance	Population Density (Units/Acre)	Employment Density (Employees/Acre)
Planning for Transit Friendly Land Use - New Jersey Transit Authority - 1994	Rail or Other High Capacity Service	n/a	15-24	150
Creating Transit Station Communities in the Central Puget Sound Region - Puget Sound Regional Council - 1999	Frequent, High Capacity Transit Service	n/a	10-20	25
Transit Oriented Development Design Guideline DRAFT - Florida Department of Transportation - 2009	Suburban BRT/LRT	0.5 miles	20-25	30-40
Downtown Waldorf Vision Plan and Design Guidelines - 2010	Bus Rapid Transit/Light Rail Transit	0.5 miles	15-35	38
Note: A 5-minute walk is synonymous with 0.25 miles.				
Sources: New Jersey Transit Authority, 1994; Florida Department of Transportation, 2009; ERM, EDSA, Inc., & Sabra Wang & Associates Inc., 2010; Puget Sound Regional Council, 1999				

Table 4.4 Study Area Station Area Densities

Station #	Station Area	Dwelling Units per Acre	Jobs per Acre
1	Williams and 25th	4	12.7
2	Veterans and Massachusetts Ave	4.7	14.6
3	Veterans and David Dr	6.6	12.4
4	Veterans and Downs Blvd	10.8	12.1
5	Veterans and Roberta St	8.9	5.5
6	Veterans and Transcontinental Dr	8.2	5.6
7	Veterans and N Woodlawn Ave (Clearview Mall)	5.4	17.9
8	Veterans and Cleary Ave	10.1	21.2
9	Veterans and Division St	11.1	36.7
10	Veterans and N Hullen St (Lakeside Mall)	8.5	54.9
11	Veterans and Clifford Dr	9.1	28.9
12	Veterans and Bonnabel Blvd	8.3	7.2
13	Veterans and E William David Pkwy	8.2	8.1
14	Veterans and Carrollton Ave	8.6	12.6
15	Veterans and Fleur De Lis Dr	5.8	7
16	Cemeteries Transfer Station	3.1	3.6

Figure 4.5 Study Area Station Areas



Discussion

Existing literature on residential and employment density thresholds for Bus Rapid Transit station areas was more concise and recent than that of corridors. As with corridors though, station area residential density thresholds were more uniform than those for employment density. Thresholds for residential densities were slightly higher for station areas than for the corridor, ranging from 10 units per acre to 35 units per acre. Suggested employment densities ranged from 25 jobs per acre to 150 jobs per acre with most thresholds at 40 jobs per acre or less. The evolution of the literature over time suggests that the lower end of the spectrum is more accurate. Older studies and reports tended to overemphasize the number of jobs necessary and were predicated on the notion that rapid transit must be oriented to the Central Business District.

It is important to note that while most of the thresholds were standards or guidelines for identifying areas supportive of BRT, many of them also note that exceptions may be made and the thresholds are mere suggestions. That being said, using the standard half-mile station area buffer, only three of the 16 station areas have residential densities that meet the lowest suggested threshold for BRT service. Of these three, the Downs Avenue station area is actually skewed by a dense cluster of apartment buildings north of the interstate which are physically separated from the rest of the station area by both the interstate and canal system. That leaves only two station areas: Cleary Avenue and Division Street. It is worth noting that all stations between Roberta Street and Carrollton Avenue, with the exception of the Clearview Mall station, approach the lowest suggested density threshold of 10 units per acre. It is the ends of the Veterans bus route that have the lowest residential densities.

Station area employment densities vary greatly within the study area. The three station areas around the Metairie CBD are the only ones to meet at least one of the suggested employment density thresholds. The Lakeside Mall station area in particular has extremely high employment densities relative to the other stations, meeting three out of four thresholds. The station areas with relatively low employment densities are Roberta Street, Transcontinental Drive, Bonnabel Boulevard, E William David Parkway, Fleur de Lis Drive, and Cemeteries.

4.2 Latent Demand for Transit Commuting and Existing Rider Trends

RQ2: Is there latent demand in the study area for work-based trips on locally-serving Bus Rapid Transit? Phrased differently, are there many commuters residing and employed in the corridor but considerably fewer utilizing transit? Are those currently commuting by transit best characterized as transit dependent?

- In 2010, how many commuters in the study area both resided and worked within a walkable distance of the Veterans Bus Route? What areas in Orleans and Jefferson parishes have the highest densities of employment for commuters residing within a half mile of the Veterans Bus Route?
- In 2006-2010, how many commuters residing in the study area commuted by transit? Compared to all commuters residing in the study area, are transit commuters disproportionately transit-dependent, or members of low-income or carless households?

Hypothesis: There are considerably more commuters that reside and work within a walkable distance of the Veterans bus route than utilize transit. Those currently using transit are best characterized as transit-dependent.

Latent Demand

Results

Table 4.5 Study Area Resident Commuters Employed in Corridor, 2010

Total Resident Commuters	Employed within 1/4 mile		Employed within 1/2 mile	
19,229	2,107	10.96%	3,184	16.56%
Source: U.S. Census Bureau, Center for Economic Studies, OnTheMap				

Figure 4.6 Resident Commuters Employed within Quarter Mile of Veterans Bus Route, 2010

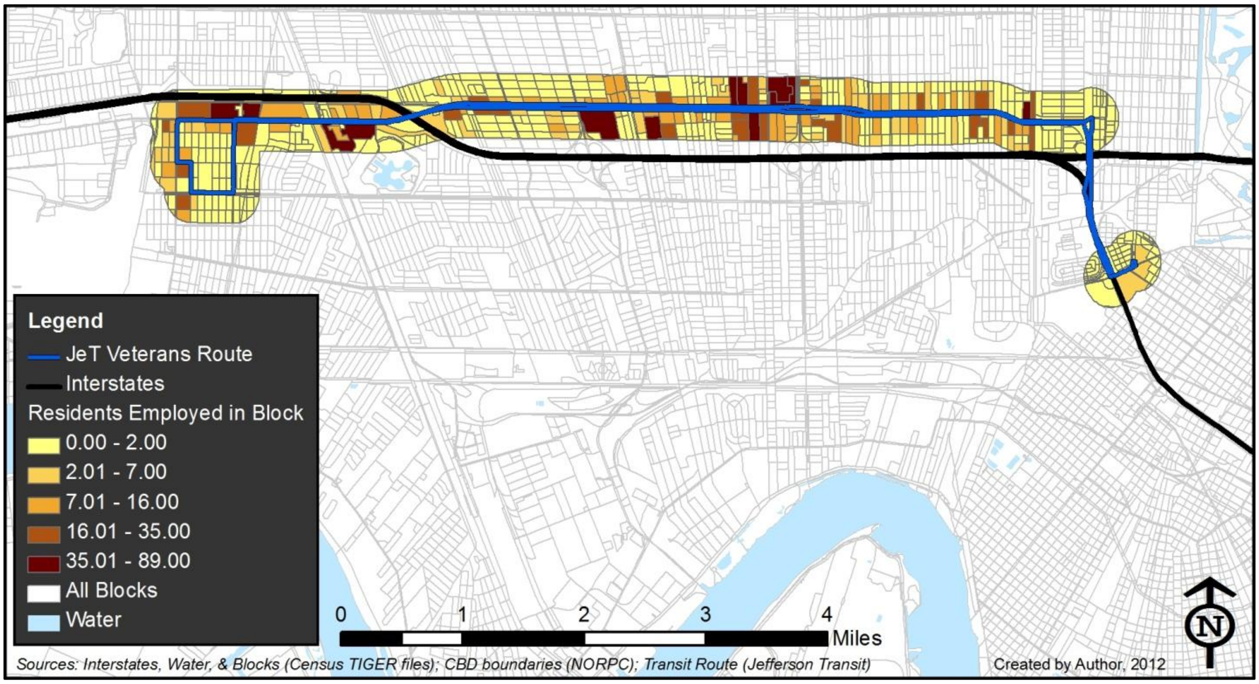


Figure 4.7 Resident Commuters Employed within Half Mile of Veterans Bus Route, 2010

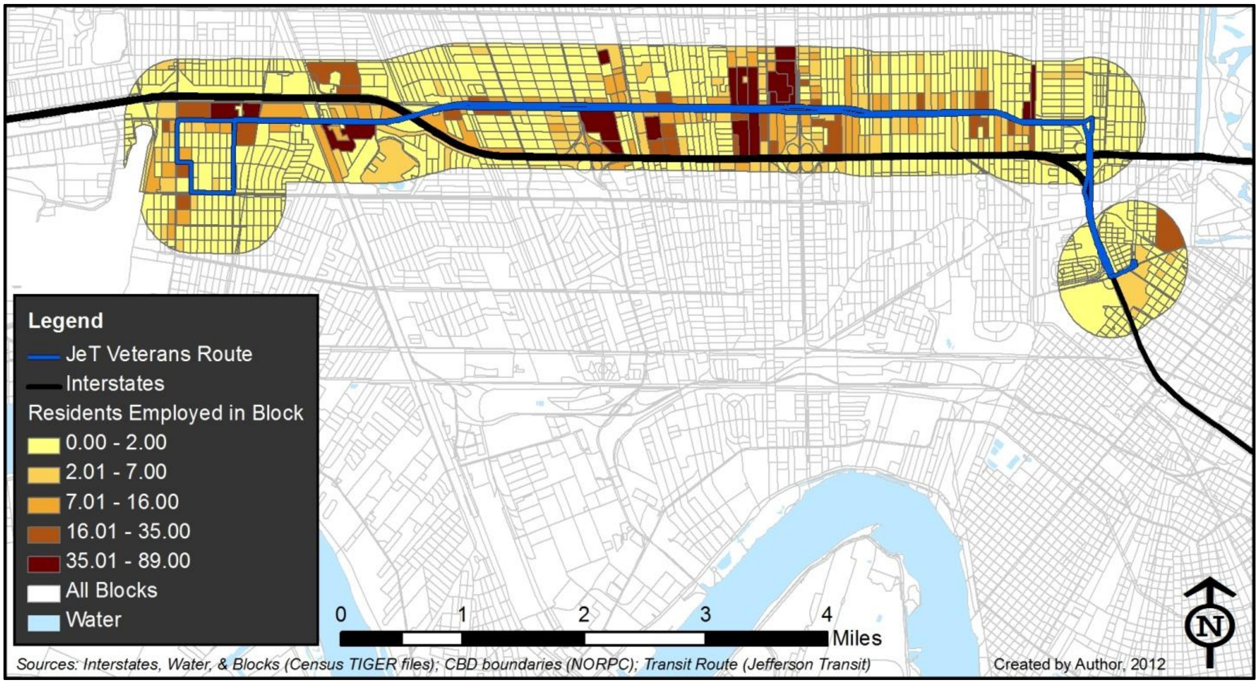
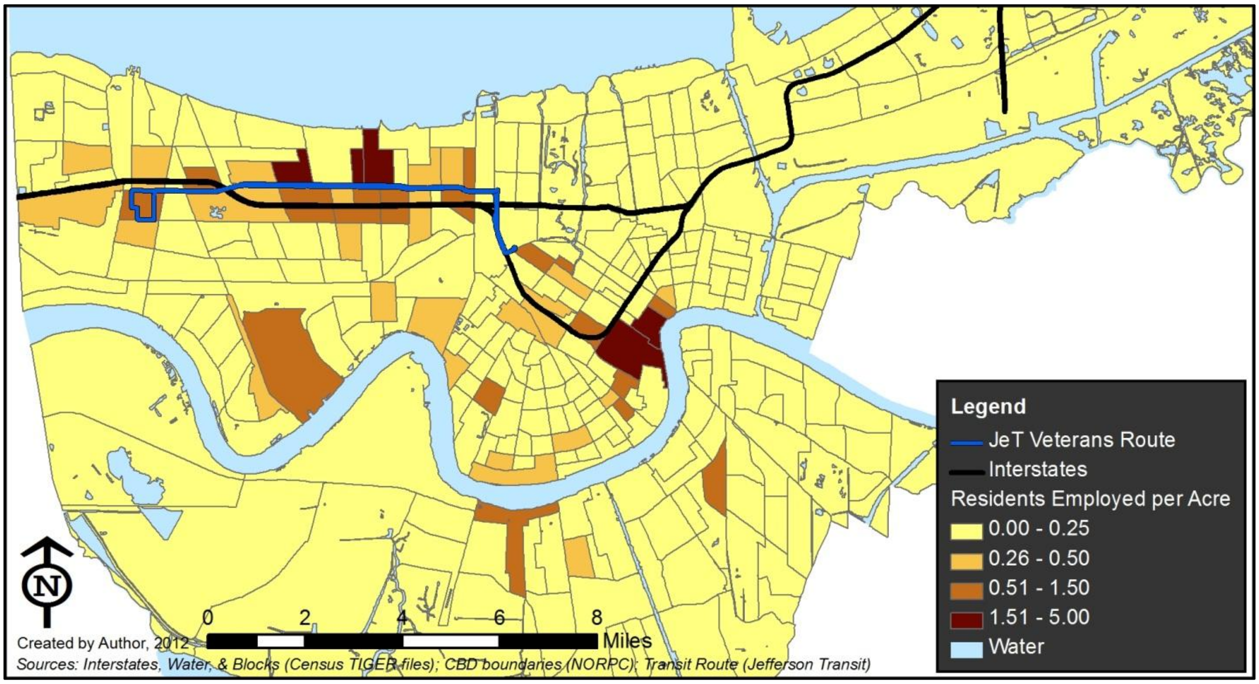


Figure 4.8 Density of Employment Destinations for Study Area Residents, 2010



Discussion

In 2010, of all 19,229 commuters residing within a half mile of the Veterans bus route, 2,107 (11%) were employed within a quarter mile of this route and 3,184 (17%) were employed within a half mile. As the maps above show, most of these commuters employed within the study area are employed within the Metairie CBD or the following clusters: Clearview Parkway; Cleary Avenue; David Drive; Roosevelt Avenue; Lake Avenue; and Martin Behrman Avenue.

The map above illustrates that the highest concentrations of study area commuters' workplaces are in fact along the Veterans Boulevard corridor. Outside of this corridor, areas of high concentration include: the New Orleans CBD; French Quarter; New Orleans Bio-Medical District; Tulane/Loyola Universities; Elmwood; Gretna Boulevard/Westside South Shopping Center; and River Road in Marrero.

Existing Rider Trends

Results

Table 4.6 Commuting Statistics for Study Area, 2006-10

	All Commuters		Transit Commuters		Quotient
	#	%	#	%	
Total Commuters	38,960		931		
All Commuters	38,724		813		
No vehicle available	1,436	3.7%	256	31.5%	8.49
1 vehicle available	11,009	28.4%	308	37.9%	1.33
2 vehicles available	17,271	44.6%	194	23.9%	0.54
3 vehicles or more	9,008	23.3%	55	6.8%	0.29
All Commuters	38,960		931		
Below Poverty Level	2,511	6.4%	156	16.8%	2.6
100-149% of Poverty Level	2,534	6.5%	156	16.8%	2.58
150% or more of Poverty Level	33,915	87.1%	619	66.5%	0.76
All Commuters	38,960		931		
$1 to $9,999 or loss	5,141	13.2%	214	23.0%	1.74
$10,000 to $14,999	3,001	7.7%	126	13.5%	1.76
$15,000 to $24,999	6,641	17.0%	301	32.3%	1.9
$25,000 to $34,999	5,975	15.3%	151	16.2%	1.06
$35,000 to $49,999	7,070	18.1%	52	5.6%	0.31
$50,000 to $64,999	3,990	10.2%	9	1.0%	0.09
$65,000 to $74,999	1,735	4.5%	8	0.9%	0.19
$75,000 or more	5,407	13.9%	70	7.5%	0.54
All Commuters	37,848		931		
under 15 minutes	11,520	30.4%	51	5.5%	0.18
15 to 29 minutes	16,834	44.5%	222	23.8%	0.54
30 to 44 minutes	6,899	18.2%	363	39.0%	2.14
45 to 59 minutes	1,415	3.7%	173	18.6%	4.97
60 minutes or more	1,180	3.1%	122	13.1%	4.2
Sources: U.S. Census Bureau, 2006-10 American Community Survey, Tables B08301, B08141, B08122, B08119, C08134					

Discussion

Only 931 commuters (2.4%) residing in the census tracts containing the study area block groups commute by transit. This means, under the most liberal assumption (i.e. all 931 transit commuters resided exclusively in the block groups that comprise the study area), less than 5% of all study area commuters commuted by transit from 2006 to 2010. In reality, the transit mode share is likely even lower since all transit commuters probably do not live exclusively in the block groups that comprise the study area. Considering that no more than 5% of study area resident workers commuted by transit while approximately 17% of these workers were employed within a walkable distance of the Veterans bus route, there is significant latent demand for transit commuting.

Transit commuters in the census tracts containing the study area are disproportionately transit-dependent compared to all commuters in the study area. They have disproportionately lower incomes, higher rates of poverty, and lower rates of vehicle availability. They also suffer from longer travel times to work than commuters in the census tracts as a whole.

4.3 Ridership Impacts of BRT Service Improvements

RQ3: How much would the E1 – Veterans bus route ridership increase if Bus Rapid Transit (BRT) service improvements were implemented?

Hypothesis: Transit ridership will increase greatly because BRT conditions are a drastic improvement from current, baseline conditions.

Results

Table 4.7 Results of BRT Ridership Scenario Analysis

Variable Modeled	30 min Travel Time (Bus Lane)		20 min Travel Time (Busway)	
	Factor	Product	Factor	Product
Travel Time Elasticity	1.154	563,014	1.4	683,032
+ Frequency Elasticity	1.374	773,581	1.374	938,486
+ BRT Multiplier	1.25	966,976	1.25	1,173,107
Note: Baseline ridership is 487,880				

Discussion

Using the midpoint arc method of demand elasticity modeling, it is determined that implementing service improvements associated with Bus Rapid Transit will approximately double existing ridership in both the bus lane (30 minute travel time) and busway (20 minute travel time) scenarios. Both scenarios assume a reduction in peak-hour headways from 23 minutes to 10 minutes, the minimum frequency considered BRT. Both scenarios also assume a basic package of service upgrades characteristic of BRT (e.g. station area improvements and branding) which attract additional ridership after ridership is adjusted based on demand elasticities for travel time and frequency. The scenarios are only unique in their change in travel time. Following the findings of case studies of existing U.S. BRT systems, the bus lane scenario assumes a reduction of 10 minutes in travel time, or 1 minute per mile while the busway scenario assumes a reduction of 20 minutes in travel time, or 2 minutes per mile (Levinson, et al., 2003).

Bus Lane Scenario

This scenario assumes a reduction of peak-hour, in-vehicle travel time from 40 minutes to 30 minutes. Given these assumptions, a base ridership of 487,880 can be expected to increase to 966,976. This increase of 479,096 represents a 98% increase in ridership.

Busway Scenario

This scenario assumes a reduction of peak-hour, in-vehicle travel time from 40 minutes to 20 minutes. Given these assumptions, a base ridership of 487,880 can be expected to increase to 1,173,108. This increase of 685,228 represents a 140% increase in ridership.

5.0 Conclusion

5.1 Residential and Employment Densities

Despite sustained suburbanization and employment decentralization in the New Orleans region, this study determined that residential and employment densities along the Veterans Boulevard corridor do not meet Bus Rapid Transit density thresholds suggested by the literature review. Residential densities especially fall short while employment densities in a few areas, near the Metairie CBD, meet or exceed the suggested thresholds. Many of the areas with the highest employment densities are designated as "Existing Regional TOD Design Nodes" in the Transit Plan for Greater New Orleans (swLEADER, Inc., 2007).

While the relatively low study area densities may be discouraging for transit advocates, they do not necessarily mean that BRT is unsuitable in the corridor. Most of the density thresholds identified in the literature review are merely guidelines or suggestions, a fact often emphasized.

5.2 Latent Demand for Transit Commuting and Existing Rider Trends

This study found that, in 2010, 17% of workers residing in the study area (census block groups with population centroids within a half mile of the Veterans bus route) were employed in census blocks with centroids within a half mile of the bus route. Furthermore, 11% of these workers were employed in census blocks with centroids within a quarter mile of the bus route.

The study also found that from 2006 to 2010, no more than 5% of workers in the study area commuted by transit. For this study, "latent demand" was defined as the difference between the study area's transit mode share ($\leq$5%) and percentage of study area residents employed within a half mile of the Veterans bus route (17%). Using this definition, there is significant latent demand. The difference of 12% equates with 2,253 potential transit riders. Of course, this is a rather liberal assumption since some of these workers may be employed within walkable distances of their residence, limiting their attractiveness to transit. However, this definition of latent demand is also somewhat conservative because it only measures latent demand for workers residing in the study area. Service improvements along Veterans Boulevard would likely increase the attractiveness of transit to workers residing or employed outside of

the study area. Thus, this assessment of latent demand does not take into account the network benefits of improvements along the Veterans Boulevard corridor.

This study also sought to determine what areas in Jefferson and Orleans parishes employed large concentrations of study area resident workers. GIS analysis indicates that the largest cluster of high concentrations of study area employment destinations was actually along Veterans Boulevard. This follows the national trend of suburb to suburb commuting. Still, the New Orleans CBD and French Quarter cluster also had high concentrations of study area employment destinations. Thus, for many, the suburb to central city commute remains a reality. It is interesting to note that the Veterans bus route connects with the Canal Streetcar. Thus, any improvements in transit service along Veterans Boulevard would also benefit those with origins and/or destinations in the New Orleans CBD/French Quarter area.

The concept of latent demand was explored further by determining if existing transit users in the study area were disproportionately transit-dependent compared to the study area as a whole. It was assumed that a disproportionately transit-dependent ridership base indicates poor service relative to other modes, thus reducing demand for transit. The degree of transit-dependency of existing riders was explored by analyzing demographic and “Journey to Work” characteristics of existing transit workers from the 2006-10 American Community Survey.

This study found that existing transit riders in the study area were in fact disproportionately transit-dependent. They were disproportionately low-income workers, disproportionately living below the poverty level, and had disproportionately lower rates of vehicle availability. They also suffered from disproportionately longer commuters.

5.3 Ridership Impacts of BRT Service Improvements

This study sought to project ridership on the E1 – Veterans bus route if Bus Rapid Transit improvements were implemented. The intent was to explore if BRT service improvements, which represent a drastic improvement for most suburban bus routes, could have a significant impact on regional transit ridership. A direct demand elasticity model was used to predict ridership.

It was hypothesized that service improvements associated with BRT would drastically increase the level of service along the Veterans bus route and thus drastically increase ridership. This was hypothesized because of the sensitivity of the demand elasticity model to large changes in service variables. Essentially, a significant improvement should translate into a high multiplier effect which would not be the case in an area better served by transit.

This study thought it useful to make ridership predictions for two scenarios with different running way treatments and thus two different travel time scenarios. BRT travel time is largely a function of the running ways treatment and thus highly variable amongst BRT systems. Current in-vehicle travel time of the E1 – Veterans bus route during peak hours was found to be 40 minutes. Implementing dedicated bus lanes along the corridor could reduce travel time to 30 minutes while implementing a busway with partially grade-separated right-of-way along the corridor could reduce travel time to 20 minutes. Aside from travel time, the following assumptions were made in predicting potential BRT ridership under both scenarios:

- Implementation of all BRT components illustrated in Table 2.3. This includes: safe, attractive, and accommodating stations with ticketing machines, seating, transit system information, and real-time displays of next bus arrival times; BRT vehicles; stop spacing that is longer than local buses; Transit Signal Priority (TSP), an element of Intelligent Transportation Systems (ITS); and branding of the BRT vehicles and service.
- Change in frequency from 23 minute headways during peak hours to 10 minute headways.

This study found that, under both scenarios, ridership would increase tremendously on the E1 – Veterans bus route. In the bus lane scenario, ridership would nearly double, increasing by 98% from 487,880 to 966,976. In the busway scenario, ridership would increase by 140% to 1,173,108. It is important to note that demand elasticities model short-term changes and that long-term changes may result in even higher increases as the service becomes established.

5.4 Limitations of the Study

Existing literature on residential and employment densities supportive of Bus Rapid Transit, or any specific form of transit for that matter, is very limited. The most comprehensive and commonly cited

literature dates from the 1970’s and does not explicitly discuss employment density, instead emphasizing accessibility to the CBD. Considering the many changes in demographics and land use patterns in the U.S. since its publication, this literature is likely outdated. Despite this fact, it maintains its influence because a more recent study of similar scope has yet to emerge.

The relationship between employment density and transit patronage also limited this study because research on this topic is still rather controversial compared to residential density. This is reflected in the wide range of suggested employment density thresholds compared to residential densities.

The part of this study that analyzed latent demand and existing rider trends was limited by the availability of fine-grain, local data. Because available origin-destination data (LEHD) is work-trip oriented and the only locally available personal travel data (ACS) is also work-trip oriented, this study focused on the work-trip. However, work trips represent only 20% of all personal trips and 60% of all transit trips, making this work-trip orientation a major limitation of the research.

Another limitation of this study is the demand elasticities used to predict potential BRT ridership. The elasticities used in this study are similar to other studies but are limiting because they are based on research in specific regions. Ideally, local or locally calibrated demand elasticities would be used but to the knowledge of this author that data does not exist. Another limitation of using demand elasticities to predict BRT ridership is that it is not known what accounts for the increase in the ridership. Specifically, this method does not address whether increased ridership is a result of mode shift, induced travel, or some other factor.

Another limitation of this research is that the study area was limited to the service area of the existing E1 – Veterans bus route. Analysis of urban densities, commuting patterns, latent demand, and potential BRT ridership did not consider areas or data beyond this service area. The main reason for this is that the direct demand elasticity model used to predict BRT ridership projects change in ridership based on changes in travel conditions on an existing route. It does not allow for consideration of route changes or any potential impacts on ridership these changes may have.

5.5 Suggestions for Future Research

Considering the limitations of this study, there are several areas of research that should be studied further. The most glaring is the relationship between employment density and transit patronage. Existing literature is far from reaching a consensus on the role of employment density in generating transit demand. This is evidenced by the considerable variation in recommended employment density thresholds for Bus Rapid Transit in this study.

Similarly, research on density thresholds supportive of each form of transit should be better explored, especially Bus Rapid Transit. While BRT has been shown to be as attractive as LRT to choice riders, existing literature appears to be divided on this subject. Some suggest BRT density thresholds that are similar to light rail (LRT) while others suggest BRT requires higher densities than LRT.

Regarding employment density, most research on BRT thresholds focus on employment generally and the work trip. However, not all types of employment are equally attractive for non-work trips. For instance, retail employment generates more transit demand than most other types of employment for non-work trips. Using a more refined approach that weights jobs by the overall attractiveness of their industry may be more indicative of the actual transit demand of the corridor. Such an approach would border on travel demand modeling but could be a simple yet valuable tool for estimating transit demand in corridors in preliminary stages of planning. Research that explores the relationship between employment industry mix and transit patronage in corridors throughout a region, controlling for external factors, could be extremely useful.

Though the study area was limited to the service area of the existing E1 – Veterans bus route, future research could explore the urban densities, commuting patterns, latent demand, and potential BRT ridership of different route alignments through the Veterans Boulevard corridor. For example, if the route was modified and extended to connect to the Louis Armstrong New Orleans International Airport (MSY) via Airport Road (bypassing Williams Boulevard) and the New Orleans CBD via Orleans Avenue, it could attract even more riders because of its direct connection to major regional destinations and coverage of more areas with low-income housing. Such a study would be more complex and ridership analysis would

require utilization of either the four-step based model or direct ridership model. However, this type of analysis could explore the network benefits associated with improving regional connectivity.

Another potential area for future research is to compare the costs and benefits of implementing a BRT system along the Veterans Boulevard corridor versus implementing Light Rail Transit (LRT) system. There is considerable debate over both the capital and operating cost differential between BRT and LRT systems, especially when a BRT system requires significant Right-of-Way acquisition and significant investments are made to make station areas attractive and efficient. It stands to reason that if the difference in cost of implementing a BRT or LRT system with similar service characteristics is minimal, a LRT system may have more impacts on land use and more easily foster Transit-Oriented Development.

Studying the land use and economic impacts of existing BRT systems in North America would also be useful future research. Because BRT technologies are rather new and BRT systems are only now beginning to become common in American cities, there is a lack of quantitative research showing the degree to which BRT impacts land values and land use development, particularly Transit-Oriented Development. In reviewing existing literature, only two recent studies were found which used hedonic price regression models to estimate the impact of BRT on land values in the United States, specifically BRT systems in Pittsburgh, PA and Eugene, OR. Results of these studies appear to indicate that BRT increases residential land values near station areas but that these results may take at least a few years to manifest (Perk & Catalá, 2009; Hodel & Ickler, 2012). Similar studies of other U.S. BRT systems and inclusion of commercial land values would strengthen these conclusions. Future research of successful TOD projects along BRT lines would also be useful.

5.6 Implications of the Study

Bus Rapid Transit Density Thresholds and Transit-Oriented Development

The finding that residential and employment densities along the Veterans Boulevard corridor do not meet Bus Rapid Transit (BRT) thresholds suggested by existing literature indicates that relatively dense suburban corridors may need to become even denser in order to support non-CBD oriented BRT. In suburban commercial corridors like Veterans Boulevard, which serve as regional destinations and have

highly segregated land use patterns, encouraging more multi-family residential development will better balance the mix of uses and increase residential densities, which in the case of the Veterans Boulevard corridor are particularly low relative to suggested BRT thresholds. Still, it may not be necessary for these types of corridors to wait for such development before planning or implementing BRT service. Experiences in Cleveland, Pittsburgh, and Ottawa illustrate that significant private development can occur in BRT corridors if conducive land use regulations and incentives are in place and dedicated guideways, attractive station areas, and streetscape improvements are provided.

Despite issues regarding the perceived permanence of BRT, in areas with significant public investment in BRT corridors, developers actually perceive BRT as having a high degree of permanence. In the cases of Pittsburgh and Cleveland, it is the public investment in dedicated guideways, transit stations, and surrounding streetscape improvements which appear to mitigate any perceptions of impermanence. However, as BRT begins to include many of the amenities often associated with Light Rail Transit (LRT), the cost savings of BRT relative to LRT begin to diminish. At this point, given LRT's longer history and reputation, it may become a more attractive technology to induce land use changes, particularly Transit-Oriented Development (TOD).

As with LRT, BRT systems that have successfully attracted private development have utilized land use regulations and incentives to encourage infill development, particularly TOD. In built-out suburban corridors with densities below suggested BRT thresholds, such as Veterans Boulevard, regulatory tools and incentives may be critical in increasing densities and creating pedestrian and transit-friendly environments around station areas and throughout the corridor.

Though zoning regulations along the majority of Veterans Boulevard allow building heights ranging from 45 to 65 feet, parking regulations discourage the proliferation of buildings of these heights because such intense development requires either expansive surface parking lots or structured parking for larger, more intense developments (Jefferson Parish, 2012). Expansive surface parking lots may be cheaper than structured parking but they are a woefully inefficient use of land in areas like Veterans Boulevard where land values are high and still increasing (Webster, 2012). Expansive surface parking lots also discourage pedestrian trips and walkable urbanism. While structured parking can be designed to accommodate

walkable urbanism, the relatively high cost of structured parking may prove unattractive to smaller developers and businesses. Thus, reducing parking minimums would reduce a barrier to development and allow for denser development, either vertically or horizontally. Another reason for reducing parking minimums in a rapid-transit corridor is that it will encourage transit patronage and other modes of transportation like carpooling, walking, and biking. However, in regions that have yet to develop a reliable or frequent regional transit network, it may be necessary to temper parking regulation reform in the short-term. For instance, while parking reforms can be implemented, it may be necessary to construct Park-and-Ride structures at strategic locations so as to simultaneously mitigate parking concerns and encourage transit patronage.

In addition to reforming parking regulations, providing incentives like expedited permitting and density bonuses have accompanied significant private development along BRT systems in Ottawa, Cleveland, and Pittsburgh (Breakthrough Technologies Institute, 2008; Kittelson & Associates, 2007). Incentives that encourage dense, mixed use development may be especially important in areas like Veterans Boulevard where there is not a history of such transit-supportive development and developers may view TOD as risky. Surveys of developers that have invested along BRT systems indicate that expedited permitting is valued highly by developers because time is a major factor in making projects financially viable (Breakthrough Technologies, 2008). Public Private Partnerships are encouraged to expedite permitting and construction of TOD projects (Kittelson & Associates, 2007). Density bonuses allowing greater building heights, floor area ratios, or dwelling units per acre for the provision of affordable housing, elderly housing, streetscape improvements, and ground floor commercial uses are common TOD incentives (MARTA, 2010; Kittelson & Associates, 2007). These sorts of density bonuses could be targeted for major station areas in suburban corridors, such as those identified as “Existing Regional TOD Design Nodes” in the *Transit Plan for the Greater New Orleans Region* (swLEADER, 2007).

Land use along many BRT and LRT corridors are regulated by zoning overlays which enforce additional standards or allow variances to the underlying zoning. These zoning overlays are used to implement TOD design standards (e.g. reduced parking minimums and building orientation to the street) and to provide incentives like density bonuses. The majority of the Veterans Boulevard corridor is actually

already regulated by a zoning overlay, the Commercial Parkway Overlay Zone (CPZ). This overlay is primarily intended to improve the aesthetics of commercial areas along major arterials and connectors in Jefferson Parish by further regulating signage, landscaping, buffering, parking, and setbacks (Jefferson Parish, 2012). However, reworking this existing overlay into a TOD overlay or using it as a basis for a new TOD overlay could be simple and could be applied to other corridors that are currently served by transit and home to designated regional TOD design nodes (e.g. Airline Highway and Clearview Parkway) (Jefferson Parish, 2007; swLEADER, 2007). Ideally, TOD overlays have stricter regulations for parcels within certain distances of station areas (e.g. parking), but they also typically provide density bonuses for these parcels (MARTA, 2010).

Metropolitan Commuting Trends and Regional Transit Service

Because of its relatively high employment densities, proximity to the Louis Armstrong New Orleans International Airport (MSY), and connection with the New Orleans Central Business District (CBD) via Canal Street, the Veterans Boulevard corridor has the potential to become the backbone of a future regional rapid transit system. However, if the corridor is to assume such a role, it would be useful to study the impacts of extending the route to the New Orleans CBD and Louis Armstrong New Orleans International Airport. There is currently no bus route along Orleans Avenue/Basin Street in New Orleans and the facility's low levels of congestion and connection with existing and proposed downtown streetcars could make the route an ideal connection to the New Orleans CBD (RTA, 2012; New Orleans Regional Planning Commission, 2010; RTA, 2011). Regarding the airport, the long-range master plan suggests two alternatives for expansion. One of these alternatives involves relocating the passenger terminal closer to Veterans Boulevard and is endorsed by New Orleans Mayor Mitch Landrieu (Krupa, 2011). If this alternative is ultimately pursued, then integrating a Veterans BRT system should be considered in the planning process. Even if the passenger terminal is not relocated, extension to the airport by way of Airport Road or Williams Boulevard should be studied.

The commuting patterns of workers residing in the Veterans Boulevard corridor indicate that many of these workers are actually employed within close proximity to their residence or in other suburban areas (see Figure 4.8). This is somewhat remarkable given the relative strength of New Orleans' CBD

compared to other U.S. regions (McMillen, 2001; Garreau, 1991; Cutsinger & Galster, 2006; Kneebone, 2009). However, this is consistent with national trends illustrating the predominance of the suburb-to-suburb commute flow (Pisarski, 2006). It is also consistent with research suggesting that multi-destination oriented transit service more closely matches commuters to employment destinations (Brown & Thompson, 2012). Therefore, if decentralized American regions are to provide adequate transit service in suburban areas, transit service must not be primarily oriented to the Central Business District.

Transit service on the east bank of Jefferson Parish is actually already characteristic of a multi-destination approach with its grid-like network of routes and many transfer points. While existing frequencies and travel times may not provide a high level of service, the network design is a good foundation from which to build a regional rapid transit system. If BRT service along the Veterans Boulevard corridor was to become the backbone of such a system, many intersecting routes within the existing network could be converted into feeders. For instance, timetables on intersecting routes like the E8 – Clearview and E5 – Causeway routes could be redesigned to allow for timed transfers with the Veterans BRT system. Over time, service could be incrementally improved so that frequencies are high enough to make timed transfers unnecessary. Eventually feeder service could be introduced to other locations, such as the job-rich Highway 190 corridor on the Northshore by way of the Causeway Bridge. By improving transit service and reliability in other areas, the network effect may begin to materialize, causing transit ridership in the region to increase greatly, especially on the Veterans BRT system.

Finally, the finding that BRT service improvements would result in drastic ridership increases, suggests that transit under-served areas, areas with relatively high densities but relatively poor transit service, can be significant markets to increase regional ridership. Because transit service in these areas is typically poor relative to areas closer to the CBD, ridership is more sensitive to service improvements associated with BRT. Furthermore, because of their relatively high densities, base ridership figures in these areas may already be high despite low levels of service. This was the case with the Veterans Boulevard corridor which has particularly high employment densities and is home to the E1 – Veterans bus route, the highest ridership route in Jefferson Parish.

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7.0 Appendix

Table 7.7.1 Research Question Two Study Area Residential (Origin) Block Groups

FIPS Code	Parish	Tract	Block Group
220710054001	Orleans	54	1
220710055002	Orleans	55	2
220710056032	Orleans	56.03	1
220710056031	Orleans	56.03	2
220710056033	Orleans	56.03	3
220710065001	Orleans	65	1
220710076041	Orleans	76.04	1
220710076052	Orleans	76.05	2
220710076063	Orleans	76.06	3
220510202012	Jefferson	202.01	2
220510202022	Jefferson	202.02	2
220510202034	Jefferson	202.03	1
220510202033	Jefferson	202.03	3
220510202031	Jefferson	202.03	4
220510203031	Jefferson	203.03	1
220510205062	Jefferson	205.06	2
220510211001	Jefferson	211	1
220510211003	Jefferson	211	2
220510211002	Jefferson	211	3
220510212001	Jefferson	212	1
220510212002	Jefferson	212	2
220510213001	Jefferson	213	1
220510213002	Jefferson	213	2
220510215001	Jefferson	215	1
220510215002	Jefferson	215	2
220510216003	Jefferson	216	3
220510217004	Jefferson	217	1
220510217002	Jefferson	217	2
220510217005	Jefferson	217	3
220510217003	Jefferson	217	4
220510217001	Jefferson	217	5
220510218011	Jefferson	218.01	1
220510218012	Jefferson	218.01	2
220510218041	Jefferson	218.04	1

(Table continued on next page)

FIPS Code	Parish	Tract	Block Group
220510219001	Jefferson	219	1
220510221011	Jefferson	221.01	1
220510221021	Jefferson	221.02	1
220510222002	Jefferson	222	1
220510222001	Jefferson	222	2
220510222003	Jefferson	222	3
220510223013	Jefferson	223.01	1
220510223011	Jefferson	223.01	3
220510223021	Jefferson	223.02	1
220510223032	Jefferson	223.03	2
220510224001	Jefferson	224	1
220510225002	Jefferson	225	2

Midpoint Arc Elasticity Method:

$$R_2 = R_1 \left(\frac{(E-1)X_1 - (E+1)X_2}{(E-1)X_2 - (E+1)X_1} \right)$$

Where:

$E = elasticity\ value\ for\ service\ attribute$

$R_1 = base\ ridership$

$R_2 = estimated\ future\ ridership$

$X_1 = base\ value\ of\ serice\ attribute\ (e.g. travel\ time\ minutes)$

$X_2 = future\ value\ of\ serice\ attribute$

Travel Time Equation ($X_2 = 30$)

$$R_2 = 487{,}880 \left(\frac{(-0.5-1)40 - (-0.5+1)30}{(-0.5-1)30 - (-0.5+1)40} \right)$$

$$R_2 = 487{,}880 \left(\frac{(-1.5)40 - (0.5)30}{(-1.5)30 - (0.5)40} \right)$$

$$R_2 = 487{,}880 \left(\frac{-60 - 15}{-45 - 20} \right)$$

$$R_2 = 487{,}880 \left(\frac{-75}{-65} \right)$$

$$R_2 = 487{,}880(1.154)$$

$$R_2 = 563{,}013.52$$

Travel Time Equation ($X_2 = 20$)

$$R_2 = 487{,}880 \left(\frac{(-0.5-1)40 - (-0.5+1)20}{(-0.5-1)20 - (-0.5+1)40} \right)$$

$$R_2 = 487{,}880 \left(\frac{(-1.5)40 - (0.5)20}{(-1.5)20 - (0.5)40} \right)$$

$$R_2 = 487{,}880 \left(\frac{-60 - 10}{-30 - 20} \right)$$

$$R_2 = 487{,}880 \left(\frac{-70}{-50} \right)$$

$$R_2 = 487{,}880(1.4)$$

$$R_2 = 683{,}032$$

Frequency Equation ($X_2 = 10$)

$$R_2 = 563{,}013.52\left(\frac{(-0.4-1)23 - (-0.4+1)10}{(-0.4-1)10 - (-0.4+1)23}\right)$$

$$R_2 = 563{,}013.52\left(\frac{(-1.4)23 - (0.6)10}{(-1.4)10 - (0.6)23}\right)$$

$$R_2 = 563{,}013.52\left(\frac{-32.2 - 6}{-14 - 13.8}\right)$$

$$R_2 = 563{,}013.52\left(\frac{-38.2}{-27.8}\right)$$

$$R_2 = 563{,}013.52(1.374)$$

$$R_2 = 773{,}580.576$$

BRT Multiplier Equation ($X = 1.25$)

$$R_2 = 773{,}580.576(1.25)$$

$$R_2 = 966{,}975.72$$

Frequency Equation ($X_2 = 10$)

$$R_2 = 683{,}032\left(\frac{(-0.4-1)23 - (-0.4+1)10}{(-0.4-1)10 - (-0.4+1)23}\right)$$

$$R_2 = 683{,}032\left(\frac{(-1.4)23 - (0.6)10}{(-1.4)10 - (0.6)23}\right)$$

$$R_2 = 683{,}032\left(\frac{-32.2 - 6}{-14 - 13.8}\right)$$

$$R_2 = 683{,}032\left(\frac{-38.2}{-27.8}\right)$$

$$R_2 = 683{,}032(1.374)$$

$$R_2 = 938{,}485.968$$

BRT Multiplier Equation ($X = 1.25$)

$$R_2 = 938{,}485.968(1.25)$$

$$R_2 = 1{,}173{,}107.46$$

Table 7.2 E1 – Veterans Bus Route Peak Hours Schedule

West to East Direction						East to West Direction					
Williams & 25th	Veterans & Clearview	Veterans & Causeway	Cemeteries	Headway	Travel Time	Cemeteries	Veterans & Causeway	Veterans & Clearview	Williams & 25th	Headway	Travel Time
6:02	6:14	6:23	6:37	-	0:35	6:42	6:55	7:02	7:17	-	0:35
6:22	6:35	6:44	6:58	0:20	0:36	7:03	7:16	7:23	7:39	0:21	0:36
6:42	6:56	7:05	7:19	0:20	0:37	7:24	7:37	7:44	8:02	0:21	0:38
7:02	7:17	7:26	7:40	0:20	0:38	7:45	7:58	8:05	8:24	0:21	0:39
7:23	7:39	7:48	8:02	0:21	0:39	8:07	8:19	8:26	8:46	0:22	0:39
7:45	8:02	8:11	8:25	0:22	0:40	8:30	8:42	8:49	9:09	0:23	0:39
8:07	8:24	8:33	8:47	0:22	0:40	8:52	9:05	9:12	9:32	0:22	0:40
8:29	8:46	8:55	9:09	0:22	0:40	9:14	9:27	9:34	9:54	0:22	0:40
8:51	9:08	9:17	9:31	0:22	0:40	9:36	9:49	9:56	10:16	0:22	0:40
14:49	15:06	15:15	15:31	-	0:42	15:36	15:51	16:00	16:20	-	0:44
15:14	15:31	15:40	15:56	0:25	0:42	16:01	16:16	16:25	16:45	0:25	0:44
15:39	15:56	16:05	16:21	0:25	0:42	16:26	16:41	16:50	17:10	0:25	0:44
16:04	16:21	16:30	16:46	0:25	0:42	16:51	17:06	17:15	17:35	0:25	0:44
16:29	16:46	16:55	17:11	0:25	0:42	17:16	17:31	17:40	18:00	0:25	0:44
16:54	17:11	17:20	17:36	0:25	0:42	17:41	17:56	18:05	18:25	0:25	0:44
17:19	17:36	17:45	18:01	0:25	0:42	18:08	18:23	18:30	18:48	0:27	0:40
17:44	18:01	18:10	18:26	0:25	0:42	18:33	18:48	18:55	19:13	0:25	0:40
DIRECTIONAL AVERAGE:				0:22	0:40	DIRECTIONAL AVERAGE:				0:23	0:40
ROUTE AVERAGE:										0:23	0:40
Source: Jefferson Transit website, Routes and Schedules, Weekday Schedule, retrieved in 2012											

Figure 7.1 Jefferson Parish Existing Land Use Map

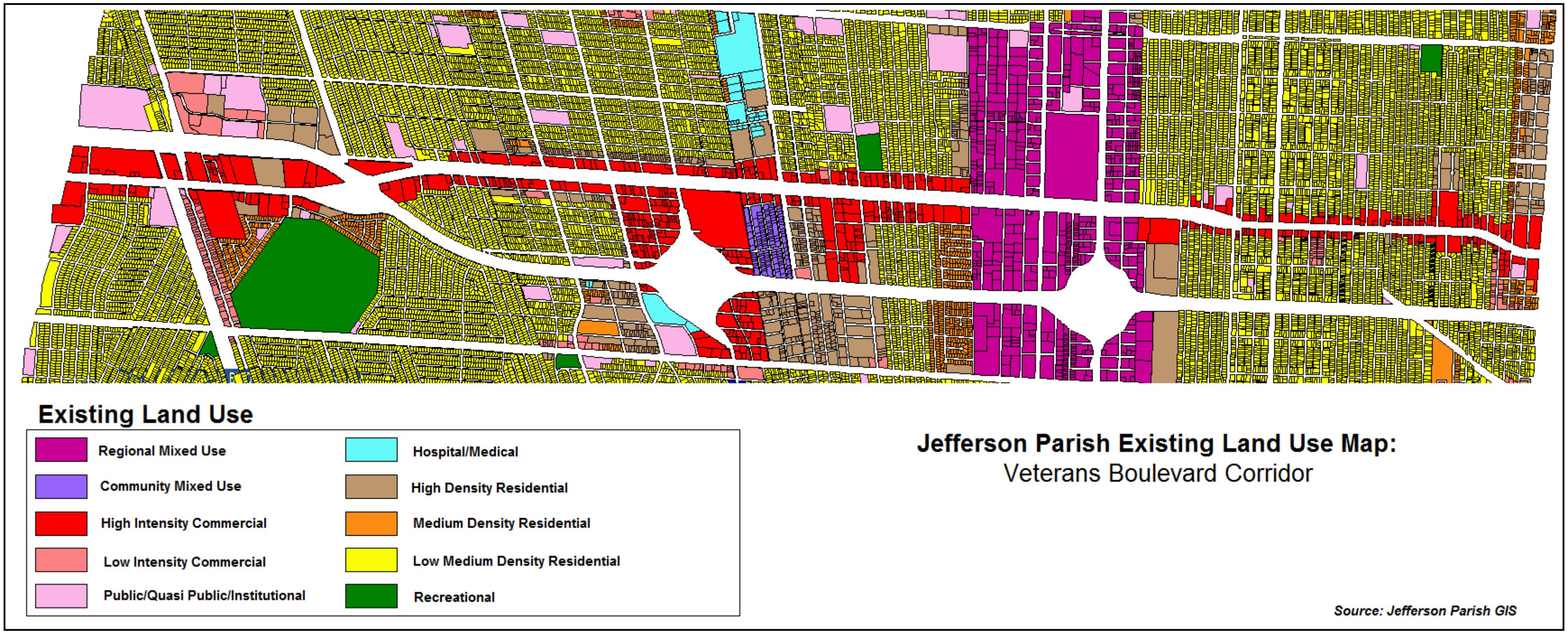


Figure 7.2 Kenner Existing Land Use Map

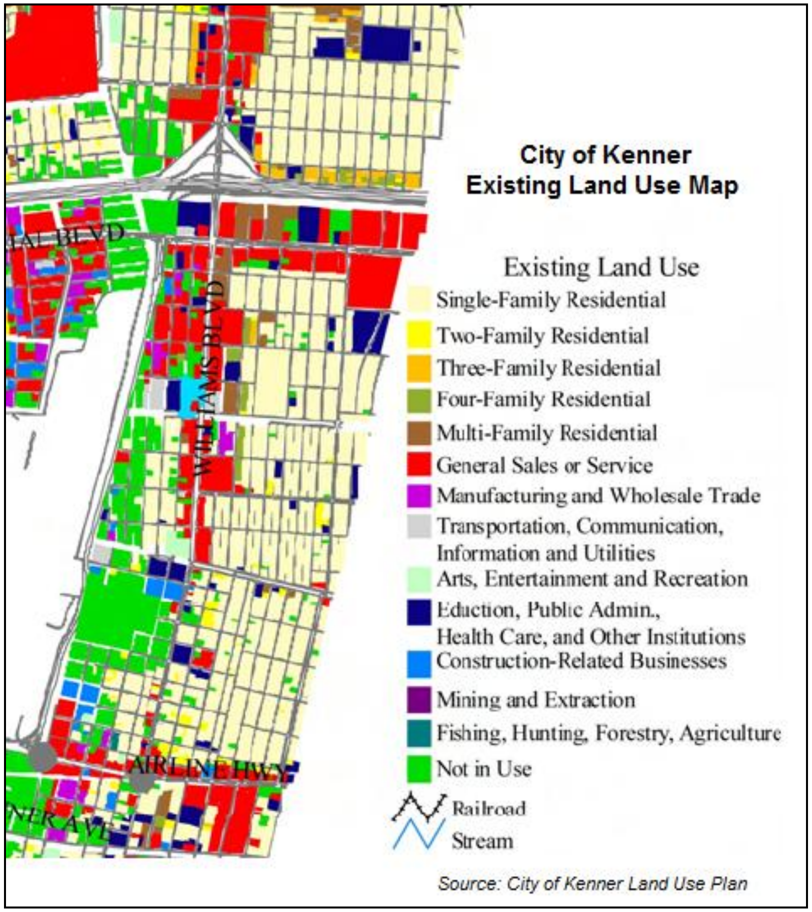


Figure 7.3 New Orleans Future Land Use Map

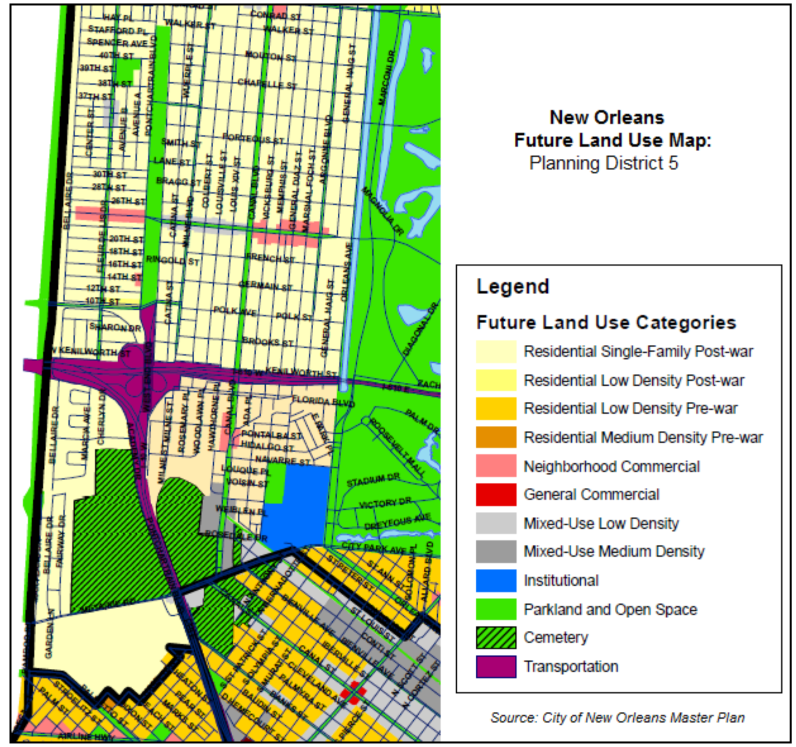
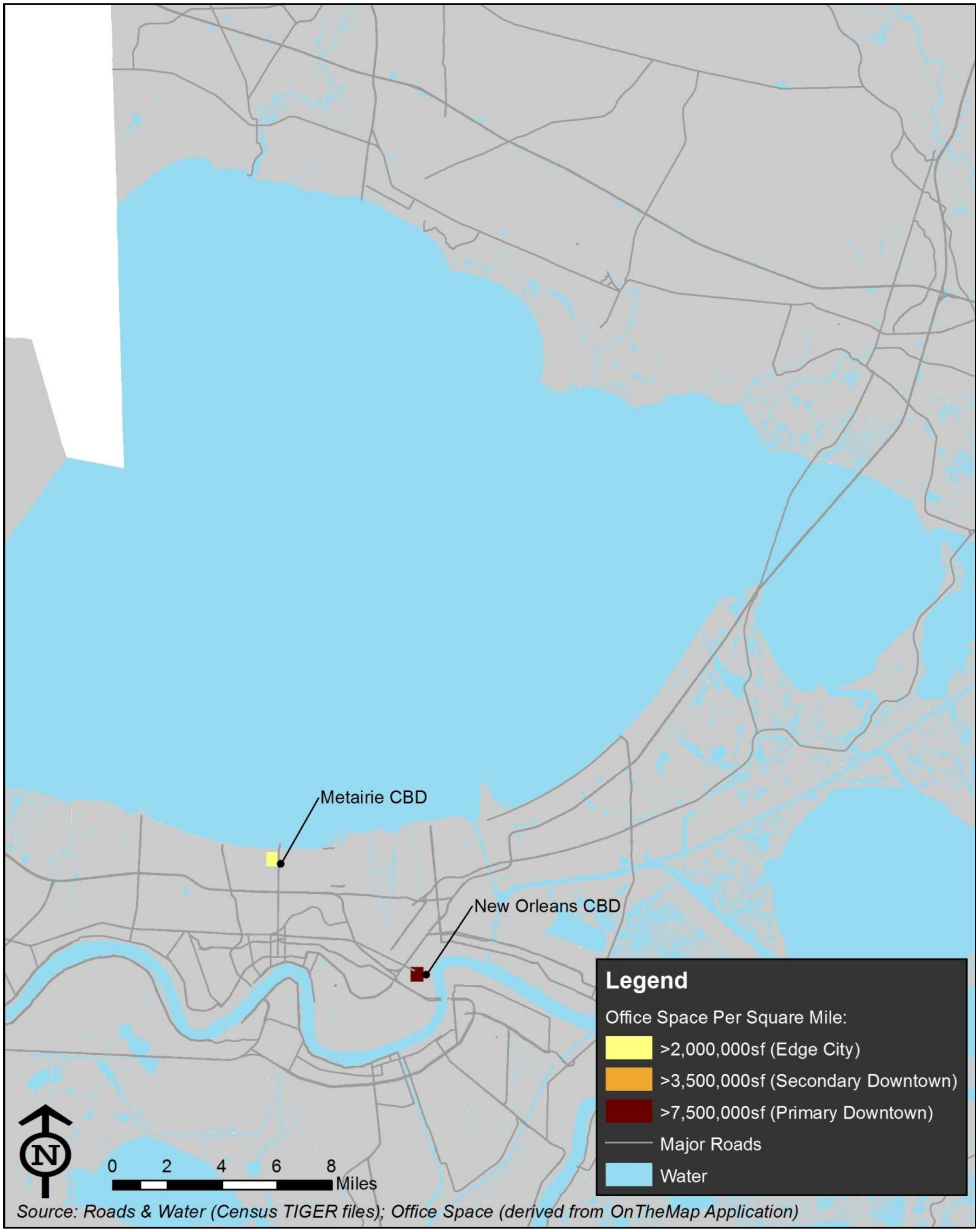


Figure 7.4 Office Space Density in New Orleans Region, 2010



Vita

Taylor Marcantel is originally from Lake Charles, LA but grew up in cities across the American South. He graduated from high school in Gastonia, NC in 2007 and went on to receive a B.A. in Geography from Louisiana State University in 2009. In 2012 he completed the Master's of Urban and Regional Planning program at the University of New Orleans with specializations in Transportation Planning and Land Use & Urban Design.