ACCESSING TRANSIT IN THE TOWER ROAD TRIANGLE: AN EVALUATION OF THE BUILT ENVIRONMENT AND BUS STOP ACCESSIBILITY

By

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Dedicated to my beloved grandparents: Konstantyn, Maria, Lydia, and Jose.

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TABLE OF CONTENTS

page

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

BMI: Body Mass Index

CDC: Center for Disease Control and Prevention

FHWA: Federal Highway Administration

FTA: Federal Transit Administration

FDOT: Florida Department of Transportation

NMT: Non-Motorized Transportation

RTS: Regional Transit System

TDP: Transit Development Plan

VMT: Vehicle Miles Traveled

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The Tower Road Triangle [the Triangle] is located outside the Gainesville city limits in Alachua County. The City of Gainesville Regional Transit System (RTS) serves this area with three routes, including route 23, route 75, and route 76. The area is primarily served by route 75.

The Triangle is a transit hostile environment that has irregular street patterns, characterized by disconnected development, and poor connectivity that contribute to poor transit accessibility and mobility. The disconnected development and poorly integrated street system, and lack of direct paths to transit has lengthen the distance to bus stops and created a demand for a network of informal pathways.

The area's lacks non-motorized transportation infrastructure which only further exacerbates the lack of Americans with Disability Act (ADA) compliance at bus stops and makes accessing transit unsafe or impossible for some. The informal path network, however, has been identified to be used by all persons, including women with strollers, wheelchair persons, and bicyclists. Non-motorized transportation infrastructure and

accessing transit has been identified as a proponent for physical activity that may also have the capacity to improve quality of life.

High crime rates, lack of pedestrian infrastructure, and accessibility in the built environment that restricts mobility both among transit operators and transit users are believed to be adversely impacting transit access, mobility, efficiency, and productivity, as well as physical activity and quality of life.

CHAPTER 1
INTRODUCTION

Public Transportation, Physical Activity, and Quality of Life

In the 1800s people's main source of transportation was by foot. By the 1900s people depended largely on walking and public transit, however, development patterns soon began to change and people started locating their residences further from the city center. Suburbanization and decentralization of the city was enabled by the automobile and interstate system, reducing the dependence on walking and public transit, and influencing urban form (O'Sullivan 2009). After World War II, the traditional neighborhood development was abandoned, and the conventional suburban neighborhood with segregated land-use, supported by exclusionary zoning practices (e.g., single use zoning) and economics, was widely implemented. Consequently sprawling development produced challenges to transit that led to its decline. Most notably among the decline of transit ridership were the distinct declines among socioeconomic classes, including the affluent and middle class transit users (Giuliano, 2005). As the affluent and middle classes were no longer dependent on public transit, the major market generators for transit become apparent.

The public transit industry has two major markets: (1) the major activity center market, often composed of discretionary users, and (2) the transit dependents market, consisting of those "who are unable or unwilling to drive, or who do not have access to a private vehicle" (Giuliano, 2005, 63). Historically, public transit subsidies have been allocated based on two objectives: "(a) to provide a basic level of mobility for all persons, but especially the transportation disadvantaged, and (b) to provide an effective substitute for the private car [discretionary users] to reduce automobile travel and its

associated externalities, including traffic congestions, air pollution, and urban sprawl" (Giuliano, 2005, 63).

The rise of the automobile and subsequent auto-orient development that led to the decline of public transit marked a period in time in which a significant proportion of disadvantaged person had a public service and their mobility absolutely deteriorate, leaving those individuals worse off than they were before (Rosenbloom, 1977). "Access to desired destinations is less today than it was for people in like circumstances fifty or one hundred years ago" (Rosenbloom, 1977, p. 30). Ircha and Gallagher (1985) suggest that automobile ownership may be considered a basic need today. Tait (1979) clearly demonstrates this social equity issue, "without a car, people cannot get what they require to pursue a career, develop their personalities or lead fulfilling lives. If mobility[1] is defined as 'access to opportunities,' the partially auto-induced, spatial separation of jobs, health care, shopping and recreation in cities means that those without cars may be denied benefits available to car owners"(Tait, 1979, np; as cited in Ircha & Gallagher, 1985, 2).

When speaking of equity, a central component to policy innovations is the "hold harmless" concept, which refers to the idea that "if programs are undertaken to benefit some portions of society or even 'society as a whole,' they should be carried out in a way that avoids leaving any individuals significantly worse off than they were before" (Rosenbloom, 1977, p. 32). The relative perceptions of increased mobility allowed by the innovation of the automobile may be counterintuitive to the absolute mobility of all

[1] This concept of mobility is currently more closely related to accessibility or access to desired opportunities (goods, services, activities and destinations), while mobility is a subset of accessibility that refers to the movement of people or goods (Victoria Policy Institute, 2010).

persons when considering transportation equity. Rosenbloom (1997, p. 30) illustrates the position of modern equity campaigns attempting to improve conditions for the disadvantaged that were never available while introducing the equity in transit access paradox in the following statements:

> Most campaigns for improved equity in modern America focus on alleged failures to improve the relative positions of disadvantaged groups rapidly enough. It is extremely rare to come across a situation in which the circumstances of a significant proportion of the disadvantaged have deteriorated absolutely over a sustained period of time.

The deterioration of the transit system's ability to continue serving those who need it most has produced disproportional burdens on those populations. When discussing the impacts of the highway finance system and car ownership, low income groups are less likely to own cars and the cars they do own are more likely to be older models that are less gas efficient (Rosenbloom, 1977). As a result, these groups are more likely to drive less (Rosenbloom, 1977). Thus, "they tend to contribute less in absolute terms to highway trust fund coffers than higher income households" (Rosenbloom, 1977, p. 31), and "contribute more in relative terms" (Rosenbloom, 1977, p. 31), which indicate inequities in the transportation system.

Much of the transit equity discussion refers to "fee for service, equality in service distribution, and service distribution according to need" (Rosenbloom, 1977, p. 31), while federal law identifies the need to provide service for the transportation disadvantaged within the urbanized area. According to Florida statutes 427.011,

> Transportation disadvantaged means those persons who because of physical or mental disability, income status, or age are unable to transport themselves or to purchase transportation and are, therefore, dependent upon others to obtain access to health care, employment, education, shopping, social activities, or other life-sustaining activities, or children who are handicapped or high-risk or at-risk as defined in s. 411.202.

When speaking of social equity and transport policy, Montang (2011, np) suggest that the following groups are excluded from society due to transportation, and, thus the transportation disadvantaged include:

> Households that do not own an automobile (sometimes called zero-vehicle households);
>
> People who do not have a driver's license;
>
> People with significant physical or mental disabilities;
>
> Low-income households;
>
> People who are unemployed or underemployed;
>
> People on social assistance and other programs to help disadvantaged groups;
>
> People too young to drive, or being elderly (i.e., over 70 years of age);
>
> Recent immigrants from developing countries, who tend to face language barriers, social isolation, poverty, unemployment, and low rates of vehicle ownership and drivers' licensing.

Meanwhile, the American Disability Act (ADA) requires particular design requirements for accessibility, including vehicle requirements and specific bus stop infrastructure design guidelines for new bus stops. Although the ADA guidelines are very specific according to dimensions and materials, they vaguely require a "reasonable" path to bus stops. It is widely recognized that many transit users are pedestrians first (Besser & Dannenberg, 2005, Edwards, 2008, Morency, Trepanier & Demers, 2011, Lachapelle & Noland, 2012); they are required to walk to bus stop locations. Despite the literature citing that direct and accessible paths to transit are an important, influencing factor for transit use and ridership (Lachapelle & Noland 2012; FDOT, 2008; FTA, 1996; FHWA, 2004) much of the transit equity literature rarely, if ever, speak of equitable access to transit stops in terms of safe pathways—arguably an

essential component to transit—as well as bus stop infrastructure. In fact, when installing a new bus stop, it does not make much sense to install a concrete waiting and landing pad to meet ADA guidelines if it is inaccessible to the ADA certified—no sidewalk or safe path with curb-cuts to enable access to paths.

Why is transit access important? The presence and accessibility of transit contribute to physical activity and the welfare, or quality of life, of transit users. Walking to transit, considering a transit stop is a destination form that brings persons to desired locations, has been associated with achieving minimum physical activity recommendations (Rodriguez, 2009; Besser & Dannenberg, 2005), and has been described as an unexpected source of physical activity (Morency, Trépanier & Demers, 2011). These findings are especially significant because the Center for Disease Control and Prevention (CDC) American Guidelines for Physical Activity recommend minimum 150 minutes of moderate-intensity physical activity; men and women's average walking speeds achieve the minimum pace to obtain moderate-intensity physical activity levels (CDC, 2010, np). Public transit users are also less likely to be obese than those non-public transit commuters (Rodriguez, 2009), and walk more than automobile users (Besser & Dannenberg, 2005). Thus, examining the built environment for accessibility to public transit, relating to the conditions and features in the environment that promote or discourage transit use, and opportunities for physical activity may provide information related to physical activity and potentially reduce medical expenditures related to physical inactivity and obesity, while increasing quality of life.

The rise in physical inactivity and increases in rates of obesity may be partially attributed to development patterns that render walking to destinations infeasible and

decrease access to transit. The deterioration of reliance on active transportation to get to destinations in daily life has led to rises in physical inactivity levels and increased health risks. The U.S. Department of Health Services reports that over 68 percent of U.S. adults are overweight or obese (Body Mass Index [BMI]≥25), while 33.8 percent of all adults are obese (BMI>30), and 5.7 percent are extremely obese (BMI>40). These obesity statistics are important because sustained levels of physical inactivity and obesity have been linked to ailments such as type 2 diabetes, coronary heart disease, high LDL cholesterol, hypertension, osteoarthritis, and some forms of cancers. According to the CDC, the 1998 U.S. medical expenditures attributed to overweight and obesity were as high as $78.5 billion, and in 2002 total medical expenditures increased to $92.6 billion, while government programs Medicare and Medicaid paid for approximately half of these costs.

This is important because zoning and development practices, especially neighborhood design and location, that deter active transportation (e.g., lack of pedestrian infrastructure and low land use mix) may also decrease transit access and physical activity, especially among at risk groups (e.g., colored people, low socioeconomic status, and the disabled). Frumkin (2002, p. 211) identifies that “people of color are more likely to be overweight and more likely to lead sedentary lifestyles”, while minority groups and people of low socioeconomic status are disproportionately affected by pedestrian facilities, leading to higher risk of injury and fatalities (Frumkin, 2002). In a study of two Canadian metropolitan areas, Ircha and Gallagher (1985) found that transit service significantly drops with increased distance from the city center. Subsequently, zoning and development patterns that reinforce sprawl and single-use

zoning with a lack of pedestrian infrastructure creates a reliance on automobiles; reduces transit access, opportunities for physical activity; and consequently contributes to the rise in obesity related disease incidence and prevalence, and increasing healthcare expenditures.

Thus, implementing prevention measures such as built environment modifications to increase connectivity and transit friendly environments that may reduce the risk of obesity and obesity related diseases, while increasing opportunities for physical activity and improving quality of life, is important to consider due to the implementation of the Affordable Care Act. The Affordable Care Act will be extending Medicaid coverage to all people under the age of 65 that meet eligibility requirements. Medicaid eligibility used to be restricted mainly to children, families with children, pregnant women, and a certain group of seniors and disabled person that met qualifications. This change allows for government programs to be extended for a much wider range of people that may increase government spending on obesity related disease believed to be preventable by physical activity and diet. Diet and nutrition are not discussed in this study.

Research Agenda

This Master's thesis is a case study that evaluates the impact of the built environment on transit access, including infrastructure, connectivity, and access for all. This study observes access to transit through the built environment, opportunities for physical activity, and variables, including the prevalence of social conditions such as crime, that influence access to transit and physical activity. This case study analyzes the transition of current zoning to future land use for activity oriented land uses and whether densities are planned to increase or remain as is, and section 9, Goals, Objectives and Initiatives, of the Gainesville Regional Transit System Transportation

Development Plan (TDP). Furthermore, it evaluates bus stop facilities based on the criteria of the RTS Bus Stop Improvement Plan, an internal document referenced in the TDP.

The purpose of the study is to identify conditions presented in the built environment that influence transit access, including bus stop infrastructure and type classification compliance, as well as drivers' ability to maneuver the through the built environment and walkability. This study evaluates the street connectivity of the built environment, including bike and pedestrian infrastructure, as it pertains to pedestrian access to transit stops and transits ability to drive direct paths to transit stops, bus stop infrastructure (ADA compliance, and safety, accessibility, and efficiency), and overall access to transit and how subsequent access may influence physical activity. The study observes the availability of infrastructure for the following modes of transportation: walking, biking, and transit. Existing transit access and existing bus stop facilities; current neighborhood infrastructure along transit stop segments (e.g., sidewalks, curbs, curb cuts, and lighting); and the ability to safely and directly access bus stops are also analyzed. This study assumes that once a person has accessed transit, they will be able to reach desired locations, and addresses transit service frequency. An objective of this study is to identify neighborhood barriers to accessing bus stop facilities, such as physical obstacles (e.g., fences, infrastructure issues restricting disabled persons access), the potential for fear of crime and violence attributed to high incidence and sustained prevalence of crime demonstrated by crime maps, lack of street connectivity, and traffic safety issues that may impact transit use and influence transportation behaviors. The researcher evaluates transit accessibility on the basis of existing bus

stop infrastructure and amenities (e.g., bike racks, benches, landing pads, waiting pads, curb cuts, shelter), and connectivity of the built environment.

The following research question is the focus of this study: How does the built environment and conditions in the built environment influence transit access in the Tower Road Triangle? More specifically, how does crime, walkability of the built environment, ADA compliance at bus stops, and transit driver's ability to maneuver through neighborhoods influence transit access within the study area. The following questions are proposed to support the focal research question: Does the built environment support transit use and ridership for all persons (ADA compliance)? Are there any bus stops within the boundaries of the study area that meet the threshold for amenities, but do not have amenities? How many bus stops meet the essential bus stop infrastructure for their respective type classification based on boardings? This study also assumes that when the most vulnerable persons (e.g., ADA certified persons, children, elderly, women with strollers) are accommodated in infrastructure design, and there are destinations to walk to (e.g., transit stops) that the presence of the appropriate infrastructure will likely lead to use, and increase ADA certified person's ability to use fixed route services.

CHAPTER 2
LITERATURE REVIEW

Introduction

Land use and development policies, the structural economic trends[2], and exclusionary zoning practices do not support transit accessibility but reinforce sprawl and automobile dependence (Giuliano, 2005). In 1850, the typical American city had "all destinations within walking distance for the average able-bodied adult" (Rosenbloom, 1977, p. 30). By 1900, as population growth occurred and development extended metropolitan area boundaries, all destinations were accessible by public transit and/or pedestrian movement (Rosenbloom, 1977). The decline in transit demand began in the 1930s with the decentralization of the city and wide-spread dispersion of development, the point in time when transit began to lose middle- and higher- income passengers to the mobility and convenience of the personal vehicle (Giuliano, 2005). Thus, it is the low-income people who are more heavily dependent on transit and represent an increasing proportional share of users (Giuliano, 2005; Besser & Dannenberg, 2005).

As previously suggested, the built environment—land use, neighborhood design, and the transportation system— influence transit access and physical activity, both of which also impact quality of life. Research has suggested that the availability of pedestrian infrastructure, the presence of parks, living in close proximity to destinations (e.g., shops, retail, restaurants, recreation), and having safe direct routes influence active transportation, physical activity levels (Handy, 2009, McCann, 2005, Sallis et al., 2009) and transit access (Lachapelle & Noland, 2012; FDOT, 2008; FTA, 2012b; FTA, 1996; FHWA, 2004). Conversely, a lack of pedestrian infrastructure, a lack of mixed

[2] Economic trends are not a focus of this study and will not be analyzed.

land-uses, dead-end streets, perceptions of safety and crime, and automobile traffic may influence physical inactivity, risk of obesity, and limit access to transit, while also supporting automobile dependence.

This chapter is organized by first addressing access to transit in the built environment and the respective components of the built environment, land use, urban design and the transportation system; followed by how crime in the built environment may influence transit access by influencing people's willingness to walk and be active outside due to perceptions of fear and safety, prevalence of crime in public housing, and methods of crime prevention.

The Built Environment

The built environment is a combination of land-use, urban design, and the transportation system (Handy et al., 2002). Land-use generally refers to the type of activity permitted in a location, and the distribution and density of those activities (e.g., residential, commercial, industrial) (Handy et al., 2002); zoning prescribes what land uses are allowed in a given area. Urban design is primarily concerned with the appearance and arrangement of physical elements, and their function in space (Handy et al. 2002). The transportation system refers to the physical infrastructure (e.g., roads, sidewalks, bike lanes) and the level of service of the various modes (Handy et al., 2002). All of these components of the built environment contribute to human activity and social behavior. The purpose of this section is to illustrate the evolution of the built environment components and how it has affected transit access and human activity.

Land Use

It is important to understand that policies have shaped the way we structure our built environment and have profound impacts on transportation choices. In 1926, the

Zoning Enabling Act, based on land- use impacts on health, safety, and welfare, was put into effect as proper exercise of police power by cities. Zoning ordinances were meant to protect residents from land-use actions that may produce unfavorable conditions that challenged the health, safety, and welfare of neighborhoods. However, Frank and Engelke (2001) attributes that "modern exclusionary zoning practices, requiring greater travel distances between where we live, work, and play, may be counter to the original health intent imbedded within the Zoning Enabling Act" (Frank & Engelke, 2001, p. 203). Separating land uses produced a greater demand for mobility in order to safely access desired locations. Yet, low densities and the separation of land uses created sprawling development patterns that are not transit supportive. Subsequently, those who rely on transit for mobility are disproportionately burdened by substantially decreasing their ability to access transit to get to desired locations essential to their health and welfare. Thus, exclusionary zoning practices that promote segregated land uses and encourage sprawling low density development patterns that decrease transit access and make it unsafe to use active transportation to get to destinations may be counter to the intentions and origins of the Zoning Enabling Act.

Historically, Pre-World War II cities were designed to be compact and to accommodate multiple modes of transportation. In this time period, active transportation, utilizing human power, accounted for most trips traveled. Frank et al. (2004) states that, "transportation was a primary source of physical activity" pre-World War II (p. 146). However, as the city produced unhealthy living conditions and zoning laws required the separation of land uses, planners began planning neighborhoods differently, locating these neighborhoods further away from the city center. Ultimately,

zoning policies and the land development process endorsed altering the urban fabric of the built environment impacting the appearance, design and function of public spaces, and has had negative influences on transit access. How may these issues be prevented in the future? The FTA (2012a, p. 1) states that early considerations for bus transit are important matters in the land development and planning processes; the following strategies facilitate early participation:

> solid support by local government officials, a strong land development planning process, and good coordination and communication with local planning and/or government staff.

Urban Design

"Choice of mode for accessing transit service presents a situation akin to choice of mode for short distance local area travel, and is very sensitive to urban form " (TRB, 2012b, p. 16-166). In the last ten years, researchers have accumulated data that suggest the built environment and community characteristics such as "proximity of recreation facilities; street design; housing density; and accommodation for safe pedestrian, bicycle, and wheelchair use play a significant role in promoting or discouraging physical activity" (Dannenberg et al., 2003; Frank & Engelke, 2001; Kahn, Ramsey, Brownson, et al., 2002); these characteristics exemplify some of the situations akin to the choice to use active transportation for local area travel that TRB(2012b) describes. Such built environment and neighborhood designs also greatly impacts a person's ability, especially persons with disabilities, to access transit, engage in physical activity, and socially integrate into their community (Dannenberg et al., 2003, World Health Organization [WHO], nd).

Land use and urban design—the appearance and arrangement of physical elements, as well as the functionality of public space (Handy et al., 2002)—influence the

design of transportation networks. “A good integrated street network is a basic requirement for an efficient transit system (FTA, 2006, p. 40). Subsequently, street connectivity may be an indicator of how well streets and paths are integrated within a neighborhood and into the overall network, and how a good integrated street network influences transit accessibility and mobility, physical activity, and quality of life. This is an important concept to consider when thinking about access control (to be discussed further in Chapter 2 in the section with the same name) and barriers to accessing transit since the walking alongside the road network provides a guaranteed path to accessing transit (non-motorized transportation is to be discussed further in the Transportation System section of Chapter 2). For example, the FTA (2012b) states:

> Paved sidewalks are constructed alongside motorized vehicle travel ways with the intent of providing a safe, attractive environment for walking, separated from motor vehicles. ADA [Americans with Disabilities Act] provisions such as avoidance of sidewalk obstructions and abrupt changes in cross-slope facilitate their use by the mobility disadvantaged and the general public. While sidewalks are found to the side of almost all streets in high-density urban sectors, they are not always consistently found in lower-density city and suburban areas. Where low-density residential area sidewalks are lacking, walking along low-volume, low-speed residential streets may serve as a generally inferior but workable substitute, as does use of paved shoulders in suburban and rural situations (p. 16-4).

Therefore, the urban design of neighborhoods, such as traditional neighborhood design or conventional suburban neighborhood design, influence transportation mode choice, and may promote or discourage transit access, physical activity, and quality of life.

Traditional neighborhood design

Traditional neighborhood design was abandoned after WWII, however regained interest with the New Urbanist Movement in the 1980’s. Traditional neighborhood designs are associated with transit-oriented development, which accommodates the needs of transit and the pedestrian. Traditional neighborhoods “tended to have

narrower, tree-lined streets, houses with porches and balconies rather than garages, and small lots that allowed houses to relate to the street" (Berman 1996, p. 352). The design of these neighborhoods were done so on a human scale that permitted a safe pedestrian environment that encourage social interaction and the characteristic gridiron design provided more efficient transportation. Cervero (1996) reports that a study in the San Francisco Bay Area in 1980 found that residents of traditional neighborhoods were more likely to walk to use transit for trips than auto-oriented suburban neighborhoods. The rediscovery of the benefits that traditional neighborhoods had to offer spurred a movement towards recapturing traditional neighborhood development and retrofitting and developing suburbs in ways to embrace such principles, thus giving birth to forms of development such as New Urbanism and neo-traditional design.

New Urbanism and neo-traditional neighborhood developments are largely characterized by narrow, gridiron pattern streets lined with sidewalks and trees with alleyways providing rear access to home garages, and central core. Such design offers greater transportation connectivity with proximity to a central core district fashioned for commercial uses and offices. This mixed use design permits walkability and encourages physical activity, while rectilinear street layouts provide capacities to reduce automobile congestion, increase the level-of-service of roads and reduce vehicle miles travel—a result of a more direct routing (Berman, 1996; Cervero, 1996). In addition, neo-traditional development has "shallow" setbacks, on-street and rear building parking, open public spaces, higher residential densities, and accommodates all income levels. These additional qualities may help create a sense of community, tradition and place-making; decreases criminal incentives with improved natural surveillance and eyes-on-

the street that create safer social places; increases opportunity for physical activity and promotes a higher quality of life; while it “maximizes street frontage that could be sold” (Berman, 1996, p. 351) and provides “the most streets and shortest trip lengths” (Berman, 1996, p. 351). The benefits of narrower streets with on-street parking may promote a safer pedestrian environment that encourages reduced speeds while parked cars provide a buffer for pedestrians from traffic (Berman, 1996), increasing perceptions of safety. Meanwhile, on street parking also “reduces surface parking” (Berman, 1996, p. 351) , which gives the unattractive appearance of a sea of parking, and may increase the pedestrians aesthetic environment, while improving safety as previously mentioned. The following excerpt from Dannenberg et al.(2003) demonstrates the ideology that New Urbanism and traditional neighborhood design may support:

> Communities that have user-friendly transportation systems and are compact and walkable are more accessible for persons with disabilities, allowing them to participate more fully in the community by working, shopping, and living within the integrated setting. Persons who use wheelchairs and other mobility devices generally benefit whenever a community is made more walkable, as long as appropriate accommodations (such as curb cuts) are included in such community improvements (p. 1504).

Meanwhile, “elderly persons without disabilities may [also] receive similar benefits in improved quality of life from community designs that aid persons with disabilities” (Dannenberg et al., 2003, p. 1504).By planning on the human scale and providing pedestrian and transit infrastructure that accommodate people of all abilities, while consciously implementing mechanisms to improve safety for the pedestrian and transit user, traditional and New Urbanism design may provide safer environments for the pedestrian and increases access to transit than conventional suburban neighborhoods.

Conventional suburban neighborhood

In contrast to traditional neighborhood design, conventional suburban neighborhoods located outside of the city are typically transit hostile environments with disconnected development patterns that tend to convenience automobiles, instead of the pedestrian and transit. Typically the functionality of the suburban home appears to be designed for the convenience of the automobile with the drive-way and the garage as focal points. These neighborhoods typically have lower densities with segregated land-uses, and are characterized by a hierarchy of curvilinear roads with limited connectivity (e.g., cul-de-sacs) for access control, poor access to transit service, and a shortage of sidewalks (Frank, 2000).

The FTA (2006) illustrates how irregular street patterns resulting in a disconnected street network characteristic of suburban areas influence transportation as compared to traditional grid-like street patterns:

> In a suburban network with numerous dead-end streets and few continuous arterials, all trips are routed onto the arterials, loading them with high traffic volumes and rendering travel highly circuitous. In contrast, a traditional grid is composed of many continuous through-streets, each of which can be used for travel, thereby dispersing traffic and resulting in shorter travel routes (p. 40).

However not all suburban neighborhoods are designed with the conventional suburban characteristics as previously described, some suburban neighborhoods have been designed on traditional grid-like networks with varying land use densities. A study analyzing transit accessibility among suburban neighborhoods with varying land use densities and street patterns found that the suburban neighborhoods with grid-like street patterns and a higher-density mix of residential and commercial land uses had 19-25% greater transit accessibility than the suburban neighborhoods analyzed with irregular

street patterns and lower-density land use (Hsiao et al., 1997). This study measured pedestrian transit accessibility using the percentage of the population that was within 0.25 miles of transit stops following the centerline of the road network; but what about suburban neighborhoods with irregular street patterns and high residential densities? Research suggests that “density not well integrated into the urban fabric—such as apartments in the middle of auto-oriented suburban sprawl—will not offer a full measure of beneficial effects on VMT, transit use, or walking and bicycling for transportation” (FTA, 2012b, p. 16-162-3).

The following characteristics of conventional suburban neighborhoods may indicate that these neighborhoods were not designed with the specific intention to create functional activity- oriented public spaces at the pedestrian scale: low density land use mix and single-use zoning limiting proximity to destinations; irregular street patterns, curvilinear roads, dead-ends and cul-de-sacs limiting connectivity of the transportation system and increasing distance to access desired locations; lack of pedestrian infrastructure; and poor transit access and mobility. Subsequently, conventional suburban neighborhoods are associated with auto-oriented development; low walkability, poor connectivity and limited proximity to destinations; and poor transit access.

The Transportation System

“Urban transportation technology determines urban form” (O’Sullivan, 2009, p. 299); “the automobile freed workers from their dependence on walking and streetcars, causing suburbanization and lower residential density” (O’Sullivan, 2009, p. 300) We have previously discussed how zoning supporting single land uses and low residential densities have contributed to sprawling urban forms, and the design of neighborhoods

that convenience the automobile while simultaneously limiting transit access. Now we will discuss the role the automobile and highway played in the decentralization of the city and the associated repercussions of transportation investments that have adversely affected transit access. This discussion of the transportation system includes impacts of the built environment and the subsequent impacts on transit access, physical activity and quality of life

The automobile

Many planners and social scientist heralded the freeway and the automobile as the solution to the overcrowded and unsanitary conditions of the urban environment (Fotsch, 2007). The mass development of suburban communities on the outskirts of the city and into the countryside boasted increased health benefits due to a quieter, private life devoid of the noise, congestion and air pollution externalities of the city. "For much of the 20th century in the United States, however, particularly during the great expansion of metropolitan areas into the suburbs after World War II, pedestrian and bicycle facilities received significantly less attention than was desirable" (FTA, 2012b, p. 16-1). Instead, much attention was given to developing the motorized transportation system. The automobile and the freeway allowed for the decentralization of the city by providing increased mobility, which only proved to highlight the inefficiencies of public transits, as well as its inability to compete (Fotsch, 2007). Widespread car ownership beginning in the 1920s (Frumkin, 2002) subsequently contributed to the decline of public transit ridership in cities across America (to be discussed under "Public Transit") (Fotsch, 2007).

The rise in popularity of the automobile occurred for a number of reasons. For example, GM's option to finance a vehicle made purchasing an automobile easier

(Fotsch, 2007), increased income, land use practices favoring automobiles, public investment in highway infrastructure (Frank, 2000), developing housing outside the city center, and the relatively low price of gasoline (Pratt, Macera, Sallis, ODonnel, & Frank, 2004, p. 141) all contributed to the growth and dependence of the automobile. These examples also illustrate some of the factors that contributed to the decline of transit.

The rapid growth in automobile ownership and attention focused on advancing motorized travel has had an adverse impact on roadways level of service, and pedestrian and bicycle safety. As previously mentioned, less attention was given to pedestrian and bicycle facilities, while more attention was given to maintaining and further developing the motorists' transportation network, such as widening roadways (Frank, 2001). While efforts went toward improving roadways and increasing roadway efficiency and safety, vehicle safety policies that established safety standards for new cars to enhance vehicle safety and reduce vehicle fatalities were adopted and implicated. However, the Vehicle Safety Act negatively influenced driving behavior and fatalities among pedestrians and bicycles (O'Sullivan, 2009). However, the attention directed toward advancing motorized travel has had negative implications on transit.

In order to decrease roadway congestion and increase the level of service of roads, engineers and construction crews began widening the roadways under the planning process' authorization. Widening roads, however, can often "reduce the space allocated to non-motorists, reduce streetscape amenities, and increase hazards associated with higher vehicle speeds" (Frank, 2001, 204). This may suggest that pedestrians and transit access are negatively impacted by roadway widening; a lack of sufficient space allocated to pedestrian infrastructure results in reduced streetscape

amenities (e.g., sidewalks and transit amenities)that impact both the pedestrian and transit user's ability to safely walk along the roadway and access transit. Meanwhile, higher vehicle speeds enabled by widening roadways and reinforced by vehicle safety mechanisms (e.g., seat belts, air bags) also increase safety risks for bicyclists and pedestrians. O'Sullivan (2009) reports that the Vehicle Safety Act of 1996 was predicted to significantly decrease death rates among car occupants, however death rates only decreased a relatively small amount while death rates among pedestrians and bicyclists increased. Consequently, roadway widening reduces transit access while also creating more opportunities for unsafe conditions for the pedestrian, bicyclist, and transit user; and demonstrates another example of how investments in transportation infrastructure can discourage physical activity (Frank & Engelke, 2001).

In the advent of shifts in transportation priorities focus on highway infrastructure, the movement of people and business from the city center to cheaper, more spacious land in the suburbs further creates a dependency on the automobile (Frank, 2004). The location theory explains the relationship between accessibility of transportation infrastructure and land-use patterns determined by economic conditions (O'Sullivan, 2009; Frank, 2004). Meanwhile, the bid-rent model determines the ability to pay based on land-use patterns and the spatial relation to the city center (O'Sullivan, 2009; Frank, Andresen & Schmid, 2004). When applying location theory and the bid-rent model to physical activity in relation to the distance from the city center, where there is a healthy combination of mixed land use, the further a resident is located from the city center the prevalence of mixed land use decreases, which is associated with less physical activity and increases the probability of being obese. Another study suggests that there is a

direct relationship between sprawl and rising obesity rates in America (Vandegrift & Yoked, 2003).

Although land use and economics are not a direct focus in this study it is important to mention their influence on transit access and physical activity. In addition to neighborhood design, economics also poses considerable influences on land use and development, which in turn affects the mode of transportation people choose. Three distinct economic factors that influence the preferred mode of travel and affects the overall levels of physical activity in are:

> (1) regional and local transportation investment decisions determining which types of investments are made at the corridor or community level, (2) location choice decisions made by governmental institutions, developers, and resulting end users including home buyers, employers, employees, and shop owners, (3) individual travel choice decisions that result from the marginal cost and convenience of walking or biking versus other modes of transportation to the individual traveler for each individual trip or activity (Frank, Andresen & Schmid, 2004, p. 146).

In other words, the economics behind land-use and development patterns influence our preferred mode of transportation by defining what kind of transportation infrastructure is available, the location and "arrangement of activities," and the perceived efficiency of travel choice (Frank & Engelke, 2001, p. 210). Collectively, land-use patterns and transportation infrastructure are components of the built environment that impact the walkability index of neighborhoods (to be discussed within the Crime and Walkability section).

Today, the preferred mode of travel is by motorized transportation, and is supported economically by transportation investment, land development, and location decisions that cater to the accessibility of motorized transportation and promote sedentary forms of travel (Frank, Andresen & Schmid, 2004). A study suggests that

when vehicular travel is supported, while simultaneously restricting other modes that time spent driving increases and time spent walking decreases (Frank, Andersen & Schmid, 2004). In fact, the 2001 Atlanta Household Travel Survey reported that of the 17,000 respondents surveyed only 10% reported walking in any form (Frank, Andresen & Schmid, 2004). It is also important to note that the Atlanta region has little variation in urban form, many neighborhoods support automobile usage exhibiting low levels of walkability, and low densities. Additionally, Frank, Andersen, and Schmid (2004) states that the "more time spent traveling also equates with less leisure time for recreational forms of physical activity," attributing a lack of time as a personal barrier to exercise. Subsequently, the increase in the amount time devoted to motorized transportation is associated with many economic costs due to traffic congestion and time and energy losses (Frank, Andersen & Schmid, 2004). Meanwhile, further suggestion that an inverse relationship between time spent driving and time spent walking are reinforced as Frank, Andersen, and Schmid (2004) states that "each additional 30 minutes in a car is associated with a 3% increase in the odds of being obese, while each additional kilometer walked per day is associated with a 4.8% reduction in these odds."

Public transit access

Giuliano (2005) suggests that transit investment policies aims are focused on discretionary riders—riders that have a choice to use transit or drive instead— to reduce environmental externalities, rather than investments to improve mobility for transit dependent riders, but what about improving conditions for transit dependent riders in terms of transit accessibility in the built environment? .As previously mentioned, significantly less attention was given to pedestrian and bicycle facilities post World War II, resulting in a lack of pedestrian and bicycle infrastructure in sprawling suburban

areas described as auto-oriented development. However, “pedestrian and bicycle facilities form essential elements of the overall transportation system, whether utilized for walking or bicycling as the primary form of travel, or as the means of accessing other transportation modes” (FTA,2012b, p. 16-1). The FTA (2012b, p. 16-3) summarizes the following findings in the literature describing the objectives of Non-Motorized Transportation (NMT):

- Support for trips too short to be effectively served by motorized transportation.
- Reduction of vehicular trips and parking demand through
  - diversion of short- and intermediate-distance auto trips to non-motorized travel.
  - reduction in chauffeuring of unlicensed youth and elders.
  - enhancement of public transportation through access improvement.
  - diversion of automotive transit access trips to non-motorized access modes.
- Achievement of associated local and global environmental and security benefits through
  - pollutant and carbon emissions reduction.
  - conservation of oil and other energy resources.
- Provision of economic benefits through transportation and health care cost savings.
- Enhancement of mobility and safety, with attendant improvements in equity, for
  - unlicensed youth and elderly persons.
  - physically or mentally challenged individuals who cannot drive.
  - low income persons who cannot readily afford an automobile.
  - other persons without access to an automobile, temporarily or long term.

– all members of society regardless of auto ownership, income status, or age.

• Enhancement of quality of life through

– making available a broader array of viable and attractive transportation choices.

– improving conditions for pedestrians and cyclists of all types and circumstances.

– providing expanded, enjoyable recreation and exercise opportunities.

– expanding opportunities for chance social and community interaction.

– supporting more livable, vibrant, healthy, and sustainable communities.

Not only does pedestrian and bicycle infrastructure and facilities facilitate safe transit access and reduce environmental externalities, but they also help reduce traffic congestion through reduced VMT and costs associated with roadway use, while promoting quality of life and health benefits that translate into transportation and health care cost savings for all members of society regardless of age, income, and disability.

Distance has been cited as the biggest barrier to accessing transit, however, “the impact of the walking environment on acceptable walking distance is not well known” (FTA, 2006, p. 45). The FTA (2012b, p. 16-128) identifies that:

> After distance, the four most prevalent reasons given by survey respondents for not walking to transit stations were “inadequate sidewalks, weather, not dressed appropriately, and dangerous traffic intersections” (Wilbur Smith and Associates et al., 1996a). Another study cites “danger from auto traffic, no sidewalks, and inadequate lighting” as the chief reasons for not walking by potential walkers (Replogle and Parcells, 1992).

Providing infrastructure that enables more direct paths and “shortening pedestrian access distances to transit through introduction of good pedestrian linkages should logically increase walk-transit trip making” (FTA, 2012b, p. 16-134) and may also increase ridership (FTA, 2012b). Furthermore, good pedestrian linkages that comply

with Americans with Disability Act (ADA) guidelines may increase ridership among all members of society; the FTA (2012b) summarizes the economic incentive to increase transit accessibility for all members of society:

> Construction of suitable bus stop provisions combined with critical links of sidewalk have been shown in specific cases to be quite cost effective when they allow access to conventional transit service by people with disabilities who otherwise would require expensive-to-provide and often time-constraining Americans with Disabilities Act (ADA) door-to-door paratransit service.

The FTA (2012b, p. 16-19) reports that research on the "effect of ADA-compliant pedestrian and multi-use facilities (or lack thereof) on the travel and mobility of people with disabilities," is an area deficient in research coverage; areas deficient in ADA compliant research also include research or data with regard to presence or lack of sidewalks and their impact on "trip-making or exercise by people with disabilities" (FTA, 2012b, p. 16-19). Despite the lack of research, the FTA (2012b, p. 16-19) recognizes the "importance of having facilities which people with disabilities can readily use to get from one place to another is fairly self-evident;" and report benefits to include (FTA, 2012b, p. 16-19):

- enhanced mobility with attendant social and economic benefits
- a better life for the affected persons, and
- reduction in need for special social services such as costly door-to-door paratransit.

Overall, good pedestrian linkages as previously discussed and a well-integrated street network may increase transit accessibility and ridership among all persons, increase opportunities for physical activity, and improve quality of life.

A well-integrated street network with good connectivity is not only important for walk-trip efficiency and transit use "given the desirability of being able to walk directly to

the nearest bus stop" (FTA, 2012b, p. 16-172), but for transit mobility and regional transit success. Among other factors such as density, transit mobility between adjacent areas and regional mobility influences the ability for transit to service areas, and access to transit, which ultimately impact regional accessibility (FTA, 2012b). Regional transit success depends upon whether or not the pedestrian environment in each neighborhood permits access to infrastructure (Frank & Engelke, 2001) in order to facilitate transit access; while poor regional accessibility contributes to auto-dependency. Subsequently, connectivity of street networks within and between neighborhoods, and the availability of pedestrian infrastructure and bicycling paths within each neighborhood may be important accessibility factors that play into the regional success of transit.

In addition to connectivity, density is also a contributing factor, whereas the market area for transit is defined by the density of potential riders around bus stops or transit stations within approximately 10 minutes walking distance (Frank & Engelke, 2001; O'Sullivan, 2009), or between a quarter to half mile walking distance (FTA, 2012b). Relatively recently, more attention has been given to the integration of bicycles and transit as a means to increase the market area for transit. The introduction of bike racks to buses, however, has the capacity to widen the transit service area far beyond walking standards and increases access to transit, as well as contributing to physical activity (Frank, 2004; Pucher & Buehler, 2009; FTA, 2005). "Access to transit and facilitation of transit trips are important roles for pedestrian and bicycle facilities" (FTA, 2012b, p. 16-6).The FTA (2012b, p. 16-6) states that "physical connections and bicycle storage at

transit stops and stations" are vital elements that influence access to transit. In a synthesis of transit practices for integrating bicycles and transit FTA (2005) found that,

> Agencies felt that their bicycle services could increase transit ridership by
>
> • Extending the range that customers can travel to reach transit stops and stations,
>
> • Increasing the flexibility that passengers have to reach destinations at the end of a transit trip,
>
> • Providing "seamless" transportation between bicycle and transit modes, and
>
> • Offering an additional amenity to customers that increases the attractiveness of transit.
>
> Transit agencies also suggested many other reasons for providing bicycle-related services including:
>
> • Increasing the number of multimodal trips made in a community;
>
> • Removing motor vehicles from roads and parking lots so that space can be used by others;
>
> • Enhancing the quality of life in the community by reducing air pollution and automobile traffic congestion;
>
> • Increasing the visibility of bicycling as a viable transportation option;
>
> • Improving the public image of transit to generate allies in the bicycling community who support additional transit funding;
>
> • Contributing to regional commuter assistance programs;
>
> • Providing an alternative for bicyclists so that they can bypass areas that are barriers to bicycling, such as bridges, tunnels, steep hills, roads with traffic, and avoid riding a t night or during adverse weather conditions (see Figure 5); and
>
> • Providing public infrastructure to support active living and prevent health problems related to a lack of physical activity (p. 12-13).

Although bike racks have the capacity to increase transit service area, "the majority of suburban bus transit systems…appear to pay little, if any, attention to bicycle parking

facilities at bus stops" (FHWA, 1992, p. 42). As more public transit systems add bicycle racks to buses and bus stops, bicycle use has the capacity to provide multimodal linkages that allow active transportation and public transit to compete with sedentary forms of travel in terms of cost, time, and convenience (Frank, 2004; Pucher & Buehler, 2009), however transit agencies need to keep in mind that increase in bike rack demand also increases demand for bicycle parking (FHWA, 1992).

The disparities that contribute to poor regional access can most often be attributed to low densities that do not economically support ridership, low proximity to destinations, single-use zoning, a lack of pedestrian and bicycle infrastructure and amenities, and poor connectivity —the built environment. Conversely, higher residential, employment, and mixed land- use densities and good connectivity have the capacities to reduce the need for auto-base travel, improve transportation options, and increase the efficiency of transit(Frank & Engelke, 2001; Frank, 2000; Filion, McSpurren & Appleby 2006).

The FTA (2012b) reports that the physical activity literature cite transit stops as a significant destination for active transportation. Multiple sources have stated that the pedestrian environment and land use practices of the built environment have impacts on physical activity levels (Handy, 2009; Sallis et al., 2009), and transit access. While Frank et al. (2004) found that with increased land use mix the rate of obesity is reduced, transit also operates optimally with greater land-use densities (Filion, McSpurren & Appleby, 2006). Transit use has been associated with achieving the minimum recommended minutes of physical activity (Rodriguez, 2009; Besser &

Dannenberg, 2005), and with each kilometer walked risk of obesity is reduced by 4.8% (Frank, Andresen & Schmid, 2004).

Besser and Dannenberg (2005) conducted a study using the National Household Travel Survey (NHTS) to ascertain minutes walked to and from transit on any given day through bivariate and multivariate analyses stratified by age, education, race/ethnicity, household income, transit type, population density, and car ownership; descriptive statistics were calculated for the full NHTS sample (n=105,942) and transit users sample. The full data set had 32.2% of households complete an interview, while 91.4% of individuals in those households completed an interview; Besser and Dannenberg (2005) required that 50% of adults in each household complete an interview in order to be included in the study. After exclusions—children under 18 years old, and modes used other than or in addition to walking to commute to transit—the final sample size for transit users was 3,312 individuals.

The results found that 3.1% of adults from the NHTS sample commuted to transit by foot on their assigned travel day; overall transit users had a mean walking time of 24.3 minutes with a median of 19 minutes walked(Besser & Dannenberg, 2005). Besser and Dannenberg (2005) found that overall 29.2% of transit users walk 30 minutes or more when commuting to transit. The purpose for most transit trips were to commute to work followed by shopping (Besser & Dannenberg, 2005).

Significant differences were observed when the data was stratified by household income, age, and household car ownership. In the Besser and Dannenberg (2005) study, households with less than $15,000 income had significantly more transit users compared to other income groups in the sample, the highest mean minutes (29) walked

to and from transit, and the highest proportion (40.7%) of individuals walk 30 minute or more to and from transit. Individuals between the age of 18 and 29 also had significantly more transit users among the transit sample; while race/ethnicities other than white were more likely to use transit (Besser & Dannenberg, 2005). The mean minutes walked for individuals that were not primary drivers (23 minutes) and those who reported living in a household without a car (28.1 minutes) had significantly higher means than those identified as primary drivers (Besser & Dannenberg, 2005).

Meanwhile, Edwards (2008) found that "an additional 8.3 min of daily walking could save $4800, $5500, or $6600 in present value per person depending on the intensity, and about 80% of the savings is public money" (p. 18). The differences in cost saving values depend on the intensity of walking, varying from slow, moderate, and fast. These calculations were tabulated according to net energy expenditures by walking pace and quantified using Quality Adjusted Life Years (QALY). Edwards' (2008) calculations are based on projections that obesity generates an extra $32,200 per person in health costs.

Transit Access, the Built Environment and Crime

Transit access contributes to health and quality of life not only by providing access to desired locations, but by accumulating minutes of physical activity walking to and from bus stops. As previously mentioned, studies have found that low income persons and person under the age of 30 use transit at high rates, accumulating minutes of physical activity, and that persons without a car are more likely to walk greater than 30 minutes to or from transit (Besser and Dannenberg, 2005). Walking 8.3 minutes daily has been demonstrated by Edwards (2008) to translate into significant savings in obesity related medical expenditure. Obesity is attributed to overconsumption of calories

and a lack of physical activity resulting in an energy imbalance and the storage of fat (CDC, Overweight and obesity: Causes and consequences [webpage], 2011). The FTA (2012a) reports:

> Many communities are encouraging pedestrian transportation to improve public health and safety, reduce the public costs of private automobile travel, improve personal mobility, and create other economic benefits. Communities that have been most successful at providing pedestrian transportation options recognize that a safe and usable pedestrian environment requires more than meeting minimum standards. High-quality pedestrian environments are places where pedestrians are anticipated, encouraged, and will congregate (p.1).

This is important because "streets are the largest single source of public space in urban areas" (FTA, 2006, p. 40) where people of all ages congregate as pedestrians and bicyclists (or skateboarder, rollerblader, etc.) for leisure, recreation, and transportation; thus, "planners must balance the street's transport role with its role as land use" (FTA, 2006, p. 40) to create attractive and safe environments. Furthermore, the FTA (2012a) states:

> The creation of safe pedestrian environments often occurs at the intersection of various fields. Many of the practices in this report benefited from cooperation and collaboration among agencies and departments including transportation, planning, public works, and parks and recreation departments, design studios, law enforcement, emergency response, and transit agencies (p. 545).

Planning walkable neighborhoods with adequate transit access that promote activity and natural surveillance (to be discussed) of the built environment may be examples of prevention tactics to reduce risk of obesity, while improving quality of life in the neighborhood.

Inability to balance the role of the street, land use, and urban design may contribute to the features in the physical environment of neighborhoods that are associated with crime rates and fear of crime (Dannenberg et al., 2003). Subsequently,

researchers are exploring the relationship between the built environment influence on communities, how the design of neighborhoods may predispose an individual to be more, or less, physical activity within their neighborhood (Sallis et al., 2009); how crime influences outdoor activity (Bennet et al., 2007) and tactics to reduce crime through crime prevention through environmental design (CPTED).

Research has suggested that crime influence the walkability of a neighborhood by affecting perceptions of safety which impact people's willingness to walk to destinations, especially at certain times of the day (Bennet et al, 2007). This is especially significant to consider in areas with public housing, since it is likely populations residing in public housing are also transit dependent populations. Therefore, through good collaboration and cooperation with local agencies and planning for activity using crime prevention through environmental design (CPTED) tactics in these neighborhoods may increase perceptions of safety, decrease risk of crime, increase people's willingness to walk to destinations, and increase transit access. Additionally, the "implementation of CPTED recommendations may have consequences on the health of a community beyond crime prevention, such as improvements in physical activity, mental health, and social capital" (Dannenberg et al., 2003, p. 1504).

Walkability and Crime Impacts on Physical Activity

California WALKS, funded by the California Department of Public Health, states that "walkability refers to how safe, friendly and accessible walking is in a neighborhood or community," and represents an "essential element for healthy communities" (California WALKS, 2011). Many factors influence walkability, such as the "availability of continuous, level sidewalks and pathways, safe, accessible crossings, lighting, vehicle speed, number of lanes and street width," along with elements that influence

"real and perceived safety from crime, gang activity and aggressive dogs, graffiti, maintenance of trees and greenery, and safe access to desired destinations," among other factors (California WALKS, 2011).

While walkability indexes often evaluate the physical design of the built environment based on connectivity and proximity, perceptions of safety and crime may also have an effect on the true walkability of a neighborhood or community. Living in neighborhoods with high rates of physical disorder (e.g., graffiti, abandoned buildings, litter) and social disorder (e.g., crime, loitering, drunkenness, drug use) contribute to increased levels of stress and perceptions of fear (Loukaitou-Sideris, 2004), which may deter physical activity because people who are fearful of street crime are also likely to reduce their participations in outdoor activities (Loukatiou-Sideris, 2004; Ross, 1993; Ross & Mirowski, 2001; Klinenberg, 2002).

Time of Day and Perceptions of Crime and Safety Influence Walking

Despite walkability, the time of day, whether it is light or dark out, and perceptions of crime and safety may influence walking behavior. In 2007, Bennet et al. conducted a study examining perceptions of safety and physical activity, objectively measured (pedometer) and included self-efficacy measures, among 12 public housing sites in metropolitan Boston. Bennet et al. (2007) assert that the time of day, whether it was daytime or nighttime, may impact perceptions of safety and steps walked per day among public housing residents. When asked about their perceptions of safety at night, only 37% of respondents reported feeling safe, while over 80% of respondents reported feeling safe during the day (Bennet et al., 2007).

Men were more likely to report feeling safe than women regardless of time of day, however (Bennet et al., 2007). Women that reported feeling unsafe in their

neighborhood had fewer steps per day at night compared to those who reported their neighborhood was safe (Bennet et al., 2007). No associations existed between nighttime safety perceptions and steps per day for men, however, “men who reported feeling a little unsafe or unsafe were significantly less likely to have high physical activity self-efficacy” (Bennet et al., 2007, 1602) compared to those who reported feeling safe at night (Bennet et al., 2007). The results found that “feeling unsafe in one’s neighborhood was associated with decreased confidence in one’s ability to be physically active” (Bennet et al., 2007, 1603).

Although Bennet et al., 2007 report conducting this study in metropolitan Boston and regard urban areas as highly walkable, no evidence exists that an assessment of the built environment was conducted to confirm high walkability levels among the 12 urban housing communities. The study also did not discuss the built environment conditions that may influence crime (e.g., little or no illumination, abandoned buildings, vandalism, low activity, low natural surveillance) and safety perceptions overall. However, the results do indicate that perceptions of fear of crime and safety in public housing impact walking, especially among women at night, and contribute to decreased confidence in one’s ability to be physically active.

Public Housing and Crime

As previously discussed, people living in public housing may have a fear of crime and safety that impacts their willingness to walk to destinations; however characteristics of public housing have yet to be discussed. Public housing, such as affordable housing for low income persons and subsidized housing by the federal government, is utilized by “a disproportionate number of racial/ethnic minorities” (Bennet et al., 2007, p. 1600). Public housing is often located in areas with existing high crime rates that also tend to

be low-income areas (Srivastava, 2006). In a study conducted in Dallas, Texas low-income neighborhoods that offered affordable house were areas characterized by "higher concentration of minority population with low income and low education status," and, "were also more susceptible to criminal activities at the census tract level" (Srivastava, 2006). The study found no conclusive evidence that affordable housing in a neighborhood increases crime levels (including property crime), which may suggest that low-income neighborhoods generally may harbor increased level of crimes and pose questions regarding safety that have previously been mentioned as a barrier to physical activity. It may also be likely that populations that qualify for Medicaid and Medicare may also be eligible candidates for affordable housing. With the evidence aforementioned, one may assert that low-income neighborhoods would be a population that may benefit most from incorporating principles of crime prevention through environmental design (CPTED) into the planning and design of neighborhoods for a number of reasons.

Crime Prevention Through Environmental Design

Public housing, as previously discussed, has high rates of crime, which may influence resident's willingness to walk to destinations and restrict outdoor activity. Fear of crime may also impact transit access, especially at hours of the day that lack sunlight. However, planning for activity in low-income neighborhoods utilizing CPTED principles-surveillance and access control - may have the potential to reduce the risk of crime and ensure a sense of safety within the neighborhood that may help facilitate physical activity (Office of the Deputy Prime Minister [ODPM], 2004) and further enable transit access during all hours of the day.

Providing activity designed spaces and planning for activity in a neighborhood is important for the quality of life and safety of residents. As aforementioned, the availability of parks and recreation facilities has been associated with increased use and quality of life. ODPM (2004), identifies that "providing activities for young people, such as 'hang outs'/youth shelters, youth centers, sports pitches, helps to provide a focus for and can prevent criminal behavior" (p. 38). However, it is important that activities provided do "not to attract excessive numbers to any one location" (ODPM, 2004, p. 38) because "concentrations of groups such as young people may be more likely to offend, or be targeted as victims" (ODPM, 2004, p. 38). Thus, we discuss principles and mechanisms of surveillance and access control that contribute to planning for activity as tactics to reduce risk of crime, and increase transit access and perceptions of safety.

Surveillance

Surveillance refers to the theory that places are safer if they are visually observed because the opportunity to be seen committing a crime or the ability for another person to witness a crime and take action acts as a deterrent (ODPM, 2004). Activity outdoors serves as a mechanism of surveillance to deter crime by providing eyes on the street while going about daily routines such as walking for utilitarian or recreational purposes (ODPM, 2004). Keep in mind that a well- designed neighborhood offering the right mix of uses in the area has the potential to "almost always lead to more surveillance, more of the time" (ODPM, 2004, p. 36). Design recommendations to enhance surveillance from residential buildings are to consider reducing setbacks of building placements between residences and sidewalk/street to enable eyes on the street, and implementing glazing requirements and door position so that windows and doors face the street (the more windows the better).

Another component of surveillance within a neighborhood that should be considered is illumination. Neighborhoods should have good lighting along paths and open spaces to reduce the number of potential hiding places along primary routes so that people have the ability to be aware of their surroundings and increasing legitimate activity after dark (ODPM, 2004). The type of lighting needs to be taken into careful consideration to ensure appropriate lighting that does not pose burdens such as glare or compromise privacy of residents (ODPM, 2004). An important note to consider with illumination is that areas that are not intended for nighttime activity and do not provide access to destinations with night time use, or may be identified as a vulnerable space that are relatively isolated at night may suffer more from a lack of proper illumination and encourage criminal activity (ODPM, 2004). By deciding not to illuminate an area, lighting choice and placement becomes a form of access control discouraging activity and passage through an area.

Access control

Access control involves the access and movement to and between "places with well-defined routes, spaces and entrances that provide for convenient movement without compromising security" (ODPM, 2004, p. 16). Typically, a well-designed neighborhood has "direct routes that lead to where people want to go by whatever means, including on foot, by cycle or public transport," (ODPM, 2004, p. 16) and plans in order to accommodate for the elderly and disabled (ODPM, 2004). Routes that are particularly identified as vulnerable routes that may be isolated, and do not appear on a primary route, should be removed in order to reduce the opportunity of crime or should not be illuminated at night to discourage use (ODPM, 2004).

Frank et al. (2004), reports that unlike automobile transportation, the level-of-service of pedestrian infrastructure is perceived to increase with the greater number of users observed walking. The “quality and intensity of streets and sidewalks can determine the number of people using them,” (ODPM, 2004, p. 18) which emphasizes the importance of functionality and quality of design also brings into consideration location and surveillance of paths that limit potential hiding spaces, increases visibility, and accommodates multiple users (e.g., wide sidewalks to enable individuals to walk side by side) (ODPM, 2004). It is important to note that keeping all forms of transportation clustered together, but separated by use, helps create primary routes and links shared spaces that enables surveillance and contributes to safe transportation networks (ODPM, 2004). Access control can also refer to restricting or discouraging vehicular use, which can be done by strategies such as directing traffic through one way streets, and using speed control tactics such as reducing lane width and narrowing streets, or installing traffic calming devices (e.g., speed bumps, traffic circles, roundabouts, etc.) (ODPM, 2004). The access control elements mentioned above uses CPTED theory to increase walkability and promote safe transportation practices that enhance surveillance.

Summary

The literature finds that lower density land use mix and single use zoning, poor urban design that limits connectivity of street networks, and the lack of non-motorized transportation facilities and infrastructure highlights the inefficiency of transit, and impacts transit access overall. Residential density not well integrated into the urban fabric of an urbanized area with lower density land use mix, low connectivity and a poorly integrated street network lacking pedestrian infrastructure may limit the success

of transit, reducing transit accessibility and mobility. For example, apartments located in auto-oriented suburban areas with irregular street patterns that create disconnected development with dead-end streets decreases regional accessibility, increases distance to transit stops, decreases population transit accessibility, and increases the distance buses need to travel to serve the area. Keep in mind that distance to transit stops is identified as one of the biggest indicators of transit accessibility. Thus, urban design and features in the built environment that increase walking distances to transit stops decreases transit accessibility.

Although not much is known about the walking environments impact on accessing transit, including the lack of research related to ADA compliant infrastructure and accessibility, it is recognized that good pedestrian linkages that are ADA compliant and shorten distances to transit stops by creating more direct paths would logically increase ridership and transit accessibility. In addition to direct, ADA compliant pedestrian paths, bicycle facilities and storage are also vital to transit accessibility. Non-motorized transportation utilized to access transit, and the ability to access transit has the capacity to improve quality of life and provide health benefits; transit stops are one of the most significant destinations for active transportation. Walking or biking to transit also helps transit users accumulate minutes of physical activity, which may produce health benefits such as decreased risk of obesity and obesity related disease.

Not only does the built environment and features in the built environment influence transit access but it also influences crime, and crime may influence transit access. Crime in the built environment may impact transit access as the literature finds that people restrict their activity outside when there is a high prevalence of street crime, and

perceptions of fear and safety may decrease outdoor physical activity, such as walking, especially among women. The prevalence and fear of crime and safety that limits low income person's ability to safely access transit may impact the people most dependent on transit disproportionately; low income persons also disproportionately lack access to safe pedestrian facilities. Subsequently, low income, transit dependent populations may have decreased transit accessibility and limited opportunity to access desired locations essential to their health and welfare when compared to discretionary riders that are able to afford their own personal vehicle.

CHAPTER 3
METHODOLOGY

This research is a cross-sectional case study of the Tower Road Triangle (the Triangle), located southwest of Gainesville, that uses three methods of data collection: (1) observation and evaluation of bus stop infrastructure and the conditions adjacent to bus stops in the neighborhood using a methodology developed by the Florida Department of Transportation and guidelines developed by RTS, (2) evaluates conditions of the built environment that influence transit access and physical activity (such as urban form, connectivity, and crime), 3)and, review of the land development regulations of the neighborhood and the Transportation Development Plan (TDP).This case study evaluates the impact the built environments' has on transit access. It analyzes the impacts that bus stop infrastructure and connectivity of the built environment has on transit access. The study also analyzes zoning and future land use influence on transit access, physical activity opportunities, and quality of life. Future transit plans and goals, objectives, and initiatives in the Transit Development Plan (TDP) are analyzed for best methods to ensure transit access.

Transit Access Methods of Analysis

Several methodologies were used to evaluate the built environment and transit access. These methods utilized available public data, observation, personal communication and literature.

Transit Service

Thirty minute frequency or better was used as the standard for good bus service, while frequencies between 31 minutes and 60 minutes were considered fair, and more than 60 minutes were considered poor.

Transit Users

Automatic passenger counter (APC) technology used to identify 2012 ridership, provided by RTS, was used to identify the number of transit users in the Triangle and boardings at each bus stop. Ridership for 2012 averaged ridership data for spring, summer, and fall to identify transit users. The APC equipment was identified to have an approximate 10% margin of error that resulted in possible under-reported passenger counts. Ridership at bus stops was used to identify the bus stop type classification (local, local primary, super stop, primary super stop), which identified essential, beneficial, and optional amenities.

Bus Stop Evaluations

Available photos of existing bus stops (see Appendix B) were used to evaluate current conditions of bus stop infrastructure in the Triangle according to bus stop type compliance, and safety, accessibility and efficiency critical factors.

Bus stop type compliance and Americans with Disability Act (ADA) compliance

Bus stop type classifications use ridership boardings to indicate their respective type classifications, and evaluate compliance with essential amenities based on stop type. Table 3-1 shows the type classifications, description, and essential amenities. Bus stops are also evaluated on minimum ADA compliance consisting of 5’x8’ landing pad connected to the back of the curb, if applicable. Landing pad should have a cross slope no greater than 2% with a connection to the sidewalk; if there’s a curb sidewalks require curbcuts (illustrated in Figure 3-1).

Critical factor rankings

Each bus stop attribute is evaluated using criteria according to safety, accessibility, and efficiency, and was rated on a scale that consisted of good, fair, and

poor. The following tables break down the conditions of what constitutes each rating by critical factor: safety, table 3-2; accessibility, table 3-3; efficiency, table 3-4.

ADA certified passengers' presence

Addresses of ADA certified passengers were geocoded and mapped in GIS. To identify presence of ADA certified passengers within 0.5 mile and 0.25 mile radii of bus stops, ArcGIS software was used to create 0.5 mile and 0.25 mile buffers; however, this is an assumption based on straight line distance to bus stops and should not be misinterpreted for actual path distance from bus stops. Percentage of Alachua County ADA certified persons residing in the Triangle were also calculated.

The Built Environment and Transit Access

ArcGIS, Google Streetview, the Prevention Pathways Grant Application, field observation, personal communication, and crime statistics were used to evaluate conditions in the built environment that may impact transit access, such as urban form, connectivity of the transportation system, crime, and zoning and future land uses.

Urban form

ArcGIS and Google Streetview were used to identify transit friendly or transit hostile urban forms based on Florida Department of Transit (2008).

Connectivity of the transportation system

The Prevention Pathways Grant Application, Google Streetview, and field observations were used to evaluate connectivity, and identify demand for connectivity.

Crime

Observations, personal communication, and crime statistics were used to identify conditions that may indicate perceptions of crime and safety and may influence transit access, physical activity, and quality of life.

Zoning and Future land uses

Current zoning and plans for future land uses in the Triangle were analyzed to indicate plans for changes in densities and land uses in the built environment, long term implications on transit service, and potential impacts on physical activity and quality of life.

The Transit Development Plan (TDP)

Section 9, Goals, Objectives, and Initiatives, of the TDP was analyzed for best methods to increase transit access.

Table 3-1. RTS Bus Stop Classification Description and Amenities

Stop Type	Name	Description	Amenities		
			Essential	Beneficial	Optional
I	Local Stop	Less Than 15 Boardings per Day, Low-Density Residential Land Use	Transit Sign, ADA Compliance	Stop Lighting	Bench, Bicycle Storage, Kiosk
II	Primary Local Stop	16 to 35 Boardings per Day, Mixed Land Use, Higher Intensity of use than Local Stops	Transit Sign, ADA Compliance, Bench, Trash Receptacle, Stop Lighting	Bicycle Storage, Kiosk, Leaning Rail, Back Door Landing Pad	Bus Shelter, System Map
III	Super Stop	36 to 80 Boardings per Day, High-Density Mixed-use Land Use, Located near neighborhood focal points, community centers, parks and schools	Transit Sign, ADA Compliance, Bench, Trash Receptacle, Stop Lighting, Bus Shelter, Kiosk, Landscaping	Bicycle Storage, System Map, Leaning Rail, Back Door Landing Pad, Bus Bays	Emergency Telephone, Retail Kiosk
IV	Primary Super Stop	More than 80 Boardings per Day, High-Density Mixed-use Land Use, Major Trip Generators	Transit Sign, ADA Compliance, Bench, Trash Receptacle, Stop Lighting, Bus Shelter, Kiosk, Landscaping, Back Door Landing Pad, Bicycle Storage, Bus Bays	System Map, Leaning Rail, Newspaper Stand, Emergency Telephone	Retail Kiosk

Table 3-2. Critical Factors

Variable	Criteria	Description	Good	Fair	Poor
Safety	Natural Surveillance	Visibility from buildings Illumination Activity/Number of combined transportation modes (road, bike lane, sidewalk)	All Present	Some present	Only one or none present
	Access Control	Any type of measure used to identify exit and entrance of bus stop	All Present	Some present	Only one or none present
	Territorial Reinforcement	Pavement treatment Landscaping Amenities (excluding sign)	All Present	Some present	Only one or none present
	Maintenance	Presence of physical disorder (e.g., trash, graffiti, conditions of amenities)	All Present	Some present	Only one or none present
Accessibility	Landing Pad	5' x 8' firm, stable surface landing pad connected to backside of curb	All Present	Some present	Only one or none present
	Type F curb and gutter	See BSIP	All Present	Some present	Only one or none present
	Sidewalk/Path	5' wide accessible pathway that provides connectivity between stops and adjacent uses	All Present	Some present	Only one or none present
	Cross Slope	less than 2 % cross slope	All Present	Some present	Only one or none present
	ADA compliant	Landing pad connected to sidewalk/path	All Present	Some present	Only one or none present
	Bus Stop Visibility	No visual obstructions that block views to and from bus stops (transit user perspective)	All Present	Some present	Only one or none present
Efficiency	Location and Placement	Nearside (poor), Farside (good) Intersection (good), midblock (poor)	All Present	Some present	Only one or none present
	Landscaping (Visibility)	Landscaping permits bus driver to see bus stop and transit users	All Present	Some present	Only one or none present
	Access for all (ADA compliant)	Minimum landing pad that connects to curb (if applicable) with connecting sidewalk/path	All Present	Some present	Only one or none present
	Highly visible (bus stop)	Bus driver and transit users able to see each other	All Present	Some present	Only one or none present

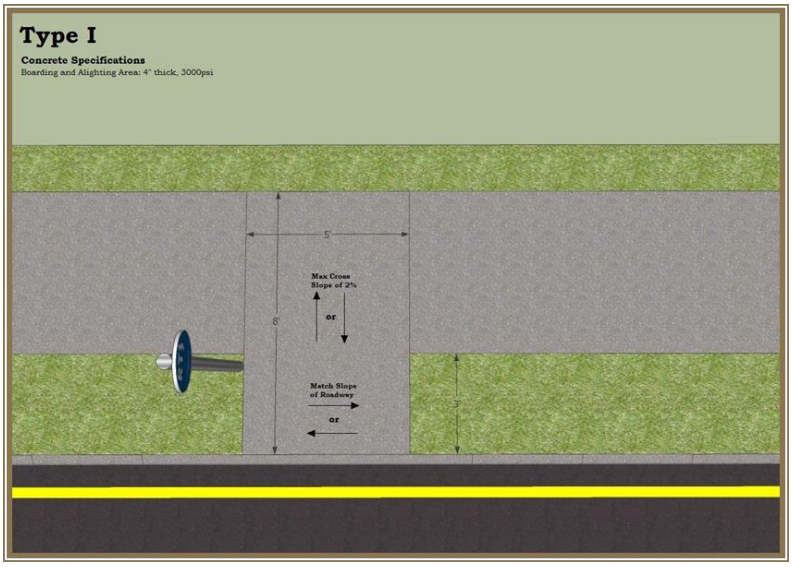


Figure 3-1. Type 1 Bus Stop Minimum ADA Compliance

CHAPTER 4
FINDINGS

The background findings and analysis in this case study rely on the literature review, ArcGIS, Google Street View and aerial images, observation, and available public data. The available public data used in this analysis come from the following sources: 2010 Census, RTS, MV Paratransit Services, Alachua County Sherriff, the Prevention Pathways Grant Application, and Southwest Advocacy Group. Personal communication with persons knowledgeable of the area is also used to identify conditions of the study area that may influence transit access.

This study evaluates the impact of the built environment on fixed-route transit access, including zoning and future land uses; built environment connectivity, bus stop infrastructure and Americans with Disability Act (ADA) compliance. Zoning and future land use maps are used to identify plans indicating potential changes in residential density and speculates the impact on transit, as well as identifying recreational land uses. This analysis is used to demonstrate the impact of land uses on transit access, crime and safety, physical activity, and quality of life. The built environment connectivity is evaluated for pedestrian and transit access, and identifies barriers to accessibility, including those associated with bus stop infrastructure and ADA compliance. Bus stop infrastructure is evaluated based on ridership indicating essential amenities, critical factors (safety, accessibility, and efficiency) and ADA compliance. The critical factors used to evaluate safety, accessibility, and efficiency is based on a scale of good, fair, and poor. Bicycle parking at bus stops are also identified.

The literature identifies that inappropriate use of access control may contribute to risk of crime rather than deter it. This study also identifies the influence of inappropriate

use of access control (e.g., fences) has on creating opportunities for crime that may influence transit access. The case study analysis also speculates the impact of crime incidence and prevalence has on transit access, including the influence that perceptions of safety and crimes has on night time transit access and physical activity based on literature.

In order to identify plans for service improvements in the Triangle and best methods for improving accessibility, the City of Gainesville RTS Transportation Development Plan is reviewed and identifies portions of Section 9, Goals, Objectives, and Initiatives that may have the biggest impact on improving transit access.

Background

Study Area

The study area, the Triangle, is in unincorporated Alachua County located southwest of the Gainesville city limits (illustrated in figure 4-1). The Triangle is bordered by I-75, SW 24th Ave (SW 20th Ave), Tower Road (NW 75th St), and W Newberry Road (SR 26). The Triangle is served by three routes: Route 23, 75, and 76 (illustrated in figure 4-2).

Study Population

A dynamic population primarily composed of renters, the Triangle has a high concentration of low socioeconomic status with a median household income of $35,000. Most subdivisions are identified as public housing, affordable housing and housing assistance units; there are reported to be 636 verified funding assistance units designated for families. According to the University of Florida Shimberg Housing Center (2013) the following are the tenant characteristics of populations living in funding assistance units in the Tower Road Triangle:

- 55% of households are extremely low-income
- 63% are very low income

The Triangle is mostly comprised of minorities (63%) with 46% black, 11% Hispanic, 2% Asian, and 3% identified as other. More than half the study population are females (55%), and 52% of households are families. Based on 2010 Census Data at the Census Tract level, the average median age of the area is 25.8 years old, 3% of the population is seniors, 62% are under 30, and 29 % are under the age of 18. According to data provided by MV Paratransit Services, approximately 2% of the population is qualified for Paratransit Services due to a form of disability that influences the ability to safely access fixed-route transit service.

According to the 2011 American Community Survey, greater than 10% of households in the Tower Road Triangle do not own personal vehicles for transportation; while approximately 53% of households own a single vehicle. Lack of access to personal vehicles and low household incomes may restrict resident's mobility and limit their access to employment, healthy food, and education, among others destinations and events important to quality of life. Subsequently, the Tower Road Triangle represents a population that may be referred to as a transit dependent market, many of whom may qualify as transportation disadvantaged.

Transit Access

Public transit is a social service that allows user to access desired locations during daily life. For transit captive markets, such as the Triangle, transit services allows residents to increase their mobility to access desired locations that are essential to their quality of life, such as employment, medical appointments, grocery shopping, education, recreation and social activity. Therefore, bus stops are considered a destination that

permits access to desired locations. Bus stop infrastructure and conditions of the built environment, however, have the ability to improve or reduce transit access and impact overall transit service.

Transit Service in the Triangle

Route 75 is the only route that serves the majority of the Tower Road Triangle. Route 76 serves the southern-most boundary of the Triangle with service to Haile Plantation, while route 23 serves the northern-most boundary with service to Santa Fe College—an approximate two mile distance between the routes. Routes 23 and 76 services do not enter the study area, but travel along the boundaries of the Triangle. Both routes 23 and 76 are concluded to have limited catchment area, as bicycle parking is not available. Due to weekday frequencies between 30-60 minutes, routes 75, 76, and 23 these services receive a fair service rating. There is no transit service to the Triangle on Sundays, and only route 75 provides 105 minute frequency service on Saturdays, which is considered poor service.

Bus Stop Evaluations

In order to accurately evaluate transit access, evaluations of bus stop infrastructure were conducted to ensure that bus stops in the Triangle adequately accommodate essential amenities for the number of users accessing transit (See Appendix B for bus stop photos). The evaluations also include whether bus stop infrastructure provides ADA accessibility, and identifies bus stops accessed most by wheelchairs, indicating where bus stop infrastructure should be prioritized to increase accessibility. Furthermore, bus stop safety, accessibility, and efficiency were evaluated on scale of good, fair, and poor; safety, accessibility, and efficiency are identified by RTS as critical factors for accessing transit (See Appendix C).

Bus stop type compliance

Bus stops that have less than 15 passenger boardings per day, which are also classified as Type 1, require the following essential amenities: transit sign and ADA Compliance. Thirty-one bus stops classified as Type 1, and only one was ADA compliant. In order to meet ADA compliance and Type I classification for essential amenities, thirty bus stops would need ADA compliant landing pads; currently three are non-compliant. Fifteen bus stops need sidewalks and thirty need connections between landing pads and sidewalks, of those, one need an additional curbcut.

Bus stops with 16 to 35 passenger boardings per day are classified as Type 2 bus stops and require the following essential amenities: transit Sign, ADA Compliance, bench, trash can, and stop lighting. Ten bus stops are classified as Type 2, and only two are ADA compliant. Of the remaining bus stops eight need ADA compliant landing pads; five need sidewalks; 8 need connections between sidewalks and landing pads; eight need ADA compliant benches, six of which have non-compliant benches; and four need lighting, 6 bus stops currently depend on street lighting.

Bus stops with 36 to 80 passenger boardings per day are classified as Type 3 bus stops and require the following essential amenities: transit sign, ADA Compliance, bench, trash can*, stop lighting, waiting pad, shelter. Two bus stops are classified as type 3, and none are ADA compliant. These bus stops need two ADA compliant landing pads, both need sidewalks with connections to landing pads, both sidewalks have curbs and need curbcuts, both need ADA compliant benches, although they do have two non-compliant benches, and one of which needs lighting, while the other has street lighting.

ADA compliance

Of the 45 bus stops in the area, 22 are lacking sidewalks and only three bus stops are ADA compliant; 40 bus stops need connections between sidewalks and landing pads upon construction of the previously mentioned number of sidewalks Fences act as barriers limiting direct access to bus stops and require transit users to follow the road network, however, this study did not calculate real distance traveled to bus stops for transit users due to data limitations.

When looking at the amenities available at bus stops, 25 bus stops have benches available, but only four of these benches are ADA compliant. Only six bus stops had landing pad, while only three are ADA compliant. The bus stops that had waiting pads also had three shelters and only three of the stops are ADA compliant. Of the three shelters available at bus stops, only two are ADA compliant. Seventeen bus stops reported street lighting, while no bus stop had lighting specifically designed for the bus stop. None of the bus stops had bicycle parking.

ADA certified passengers and wheelchair access on fixed-routes

. ADA certified passenger are people that have physical or cognitive impairments that make them unable to use fully accessible fixed-route services without aid; individuals who need assistance of a wheelchair lift or other boarding device; have a disability with a “specific impairment-related condition which prevents such an individual from traveling to a boarding location or from a disembarking location on such a system” (RTS, 2012, 3-4). Based on data provided by MV Paratransit Services, 5% of ADA certified passengers residing in Alachua County live in the Triangle; quarter mile buffers around bus stops indicate that residents in the Triangle are within a quarter mile straight line distance from bus stops

Although paratransit service is not being evaluated, it is important to identify the gap in service for persons that utilize paratransit services due to inability to access fixed-route services. MV provides paratransit service for ADA certified individuals, and has limited Saturday service. In addition to limited weekend service, paratransit services trip priorities for patrons outside the city limits, like those in the study area, are capped at the first three priorities; ADA certified passenger residing with the city limits generally receive trip priority over those residing in the County. The trip priorities are as follows:

1. Vital Care-Medical
2. Other Medical
3. Employment
4. Pharmacy and Grocery Shopping
5. Education
6. Social Service Agencies
7. Shopping
8. Recreation

These limitations in mobility require heavier reliance on fixed-route service access or access to an automobile for trips to the pharmacy and grocery stores, education, social services, shopping, and recreation; and may lead to an isolated group of people.

Among the bus stops within the Triangle four bus stops were identified as among the top twenty-five wheelchair accessed stops (illustrated in Figure 4-4). The two bus stops that place in the top ten wheelchair accessed stops (illustrated in Figure 4-5) are classified as type 3 bus stops. Neither of these bus stops is ADA compliant, and is lacking sidewalks, curbcuts, ADA compliant landing pads and benches, waiting pads,

shelters, and specific stop lighting. None of the bus stops in the Triangle that place in the top twenty-five wheelchair accessed bus stops are ADA compliant, lacking in basic minimum ADA compliance (e.g., 5'x8' landing pad, sidewalk).

Safety, accessibility, and efficiency critical factor bus stop ratings

When analyzing bus stops for the safety critical factor, 32 bus stops ranked poor, 11 ranked fair, and 1 ranked good. Among the Accessibility critical factor, 37 bus stops ranked poor, 4 ranked fair, and 3 ranked good. When analyzing for the efficiency critical factor, 14 ranked poor, 30 ranked fair, and none were found to be ranked good, this finding may be mostly attributed to lack of ADA compliance.

The Built Environment

The urban design of the built environment impacts transit access through the appearance, arrangement, and function of physical elements in space, and connectivity of the transportation system. For example, the arrangements of dwellings on lots may be arranged around cul-de-sacs with fences providing access control functions. Although access control is an intended function in urban design and is used as a mechanism for crime prevention through environmental design, it creates limited routes available to maneuver through the built environment and may contribute to adverse impacts, such as bottleneck traffic congestion (requiring traffic to enter and exit at one or limited points), decrease connectivity important for walkability, and inappropriate use of access control and poor urban design can increase opportunities for crime. Thus, urban design that utilizes access control, decreases connectivity of the transportation system, and may increase opportunities for crime in areas with poor surveillance and little activity. Zoning and future land use also influences transit as prescribed land uses,

activities permitted, and densities may be important to consider for long term access to transit and the ability to get to desired locations.

Urban design and access control

The urban design of the Triangle resembles a transit hostile environment (illustrated in Figure 4-6 and Figure 4-7) that requires out-of-direction travel. The neighborhood design most closely resembles a conventional suburban neighborhood, and has curvilinear streets with dead-ends or looping streets, and limited neighborhood access points concerning both vehicle access and pedestrian/bicycle movement. Fences used for access control mark the boundaries of each subdivision subsequently creating limited official pedestrian and bicycle paths between neighborhoods.

Connectivity of the transportation system

The Triangle road network lacks connectivity (illustrated in Figure 4-6) between neighborhoods, and utilizes fencing as previously mentioned, to regulate pedestrian, bicycle, and motorized transportation access between neighborhoods. The lack of connectivity among the modes has several implications on transit access, the built environment and crime.

The primary barrier identified based on bus driver's ability to move through the built environment in the Triangle is attributed to the lack of connectivity, despite existing roadway infrastructure through private property, between Linton Oaks and Holly Height bus stops. The lack of connectivity between Holy Heights and Linton Oaks requires the route 75 buses to travel a long distance to bus stops in close proximity.

According to data provided by RTS, route 75 (see figure 4-8) spends approximately 25 minutes in out-direction-travel spent traveling each way inside Linton Oaks on inbound and outbound cycles. Currently, traveling from Tower Road route 75

enters Linton Oaks off of SW 24th and travels to the northwest boundary of the development, past a grocery market adjacent to a fence that discontinues the street, and loops back to SW 24th to head back towards Tower Road, which takes about 25 minutes. The fence that discontinues SW 8th Avenue lines the boundary of the Hidden Oaks Mobile Home Park owned by a single land owner. After leaving Linton Oaks, the bus heads west on SW 24th, turns north on Tower Road, and travels up to 8th Ave to pick up passenger at the bus stops on the other side of the discontinued street. After picking up passengers in Holly Heights the bus loops back to Tower Road to continue the route north towards Oaks Mall. The route follows similar path inbound and outbound.

Not only do the bus driver's lack mobility and direct paths between Linton Oaks and Holly Heights, but pedestrians and bicyclists lack access as well. Figures 4-9 through 4-15 illustrate informal pathways used to travel between neighborhoods. These informal pathways are identified as routes utilized by pedestrians, including wheelchair bound persons and mothers with strollers, and bicyclist.

The presence of informal pathways, as illustrated in Figure 4-9, provides the evidence that people residing in the Triangle need better connectivity. This may also suggest that if pathways were formalized that they will be used, and with appropriate design (e.g., sidewalks with curbs and curbcuts) and proper lighting residents may be better able to access transit stops and increase ridership throughout the day. Figures 4-10 and 4-11 demonstrate that wheelchair bound person and mothers with strollers need better access to bus stops and safe pathways to travel. Another potential advantage of formalizing pathways and providing appropriate lighting would be the potential to

increase physical activity during all hours of the day, while also increasing natural surveillance as street activity increases. Formalizing pathways utilizing proper design that promotes surveillance and activity may also decrease opportunities of situational crime in neighborhoods, and reduce opportunities of crime along isolated informal paths by eliminating the need for informal pathways.

Crime in the built environment

The Tower Road Triangle has unusually high rates of crime that may influence access to transit and decrease physical activity outside due to the perceptions of fear related to crime and safety. Figures 4-16, 4-17, 4-18 illustrate that the Triangle, also referred to as the MIKE Zone by the Sherriff, has a high incidence and sustained prevalence of crime. Not only does the area have a high incidence and sustained prevalence of crime, but the crimes committed are violent crimes (identified in Figure 4-17) and identified as major cases (illustrated in Figure 4-19), which demonstrate that there may be a real perception of fear of crime and safety. As illustrated in Figure 4-19, Gordon Manor, Hidden Oaks Mobile Home Park, and Linton Oaks have had violent cases that involve weapons, such as homicide, person shot, and armed-robbery. Despite high rates of crime, the neighborhoods with some of the most crime (illustrated in Figure 4-18), such as Linton Oaks and Gordon Manor (now Holly Heights), are also neighborhoods that have bus stops with the most ridership and are the most frequently accessed bus stops by wheelchairs. Crimes are not recorded by time of day, and ridership does not take into account the time of day, nor does it reflect the sex of the transit user. Although the most frequented bus stops also have high crime rates in the area, time of day, night or day time, may influence when people access transit, especially among sex.

Inappropriate use of access control may also contribute to opportunities of crime. Figures 4-21 through 4-24 illustrate the conditions of the SW 8th Avenue dead end in Linton Oaks, and identify physical disorders that indicate public consumption of alcohol. Observations in Majestic Oaks near informal pathways, where recurrent damage to fences and identification of drug use (e.g., presence of needles, “dime bags”, and “crack lighters”) may indicate inappropriate use of access control. Several informal pathways have been observed to lead to destruction of fences (illustrated in Figure 4-15), and subsequently trespassing violations (illustrated in Figure 4-14).

Zoning and future land use

Compared to current zoning maps (illustrated in Figures 4-25 and 4-27), future land use maps demonstrate that plans for the Triangle indicate increases in residential densities in the future (illustrated in Figures 4-26 and 4-28), which may suggest that demand for service may increase, while potential transit users increase as density increases; residential densities support transit. No recreational land uses are planned for the area, and no additional activity oriented land uses are planned.

The Transportation Development Plan (TDP)

Meanwhile, Section 9 of the TDP has goals, objectives and initiatives that align with a more equitable and balanced transportation service that meets the needs of the Gainesville urbanized area. The TDP (2009) pledges to “expand and maintain transportation infrastructure to enhance transportation choices and improve capacity for future transit expansions and improvements” including, enhancing bus stops, encouraging multimodal practices (e.g., bicycle and pedestrian needs), and preserving existing transit infrastructure, while enhancing mobility for ADA passengers. The TDP also has a goal to “improve the quality of life in our neighborhoods for the benefit of all

residents and enhance community appearance", which includes enhancing RTS amenities (e.g., bicycle racks, landing pads) and "pursuing funding for improvements of new and existing bus stops." The most promising of the goals may be the goal with objectives, and initiatives that are associated with coordinating public transportation with planning efforts by promoting transit improvements during the development review process and increasing coordination with other planning agencies.

Summary

The Triangle is consistent with transit hostile urban design requiring out-of-direction travel reducing productivity and efficiency of transit service, and has poor connectivity for transit, pedestrians, and bicyclists, which reduces the ease to access transit. The study area has limited pedestrian and bicycle infrastructure and bus stops lack ADA compliance, despite high wheelchair usage at select bus stops and relatively high ADA certified populations residing in the area. The lack of infrastructure and ADA compliance provides unsafe options to access bus stops and reduces the efficiency of route service by having inadequate loading and unloading areas at bus stops. Bus stop infrastructure is inconsistent with essential amenities for their respective type classifications prescribed by ridership boardings at bus stops, which negatively influences safety, accessibility, and efficiency of transit access. The majority of bus stops have poor safety attributes (32), poor accessibility (37), and fair efficiency (30) ratings. Meanwhile, transit service in the Triangle has long trip cycles, fair weekday service frequency (between 30-60 minutes), and limited transit service on weekends (e.g., 105 minute frequency for route 75 Saturdays, no Sunday service, and route 23 and 76 do not run on weekends).

The study area has a high incidence and prevalence of crime that may influence access to transit during hours of darkness, which may also influence physical activity within the neighborhood. Additionally, fences used for access control may be contributing to crime rather than deterring it. Fences create a demand for connectivity resulting in unsafe informal pathways, which are used to access transit stops, and also create isolated areas that increase opportunities for situational crime, public alcohol consumption and drug use.

The zoning and future land use maps indicate plans to increase residential densities, but do not indicate plans to increase activity oriented land uses in an area that is transit captive. Zoning indicates that currently there is a lack of access to recreational areas to be physically activity, and has limited destinations in close proximity to walk other than bus stops. These factors may contribute to physical inactivity and development of sedentary lifestyles; reduce access to desired locations (e.g., work, grocery store), especially on Sundays; and may contribute to a lower level of quality of life for the study area overall. Meanwhile, the best opportunities to increase transit access identified in the TDP may be to coordinate with other planning agencies to ensure that transit access is accounted for in all plans (current and future), pursue funding opportunities for bus stop improvements, strategic placement of bicycle parking, and enhancing mobility for ADA certified passengers.

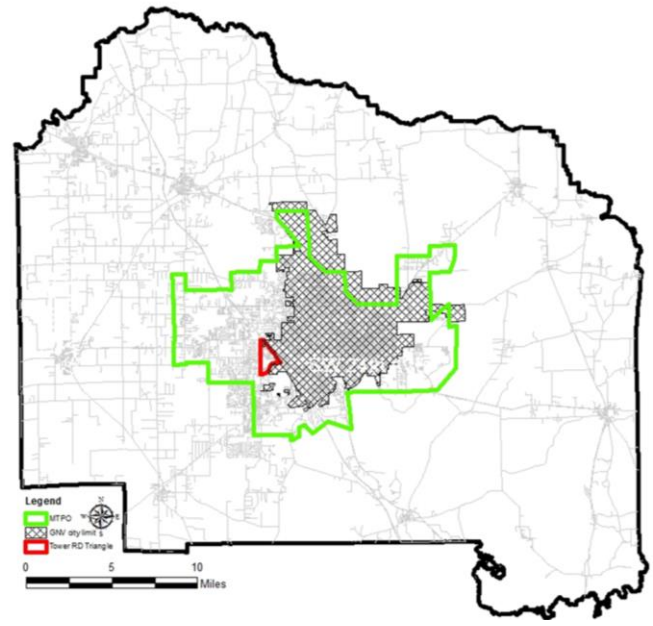


Figure 4-1. Context map of the Tower Road Triangle

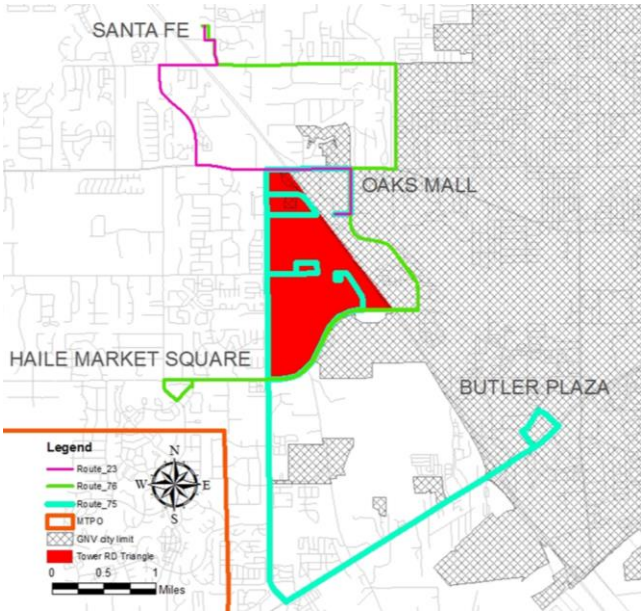


Figure 4-2. Transit map of routes serving the study area and their destinations

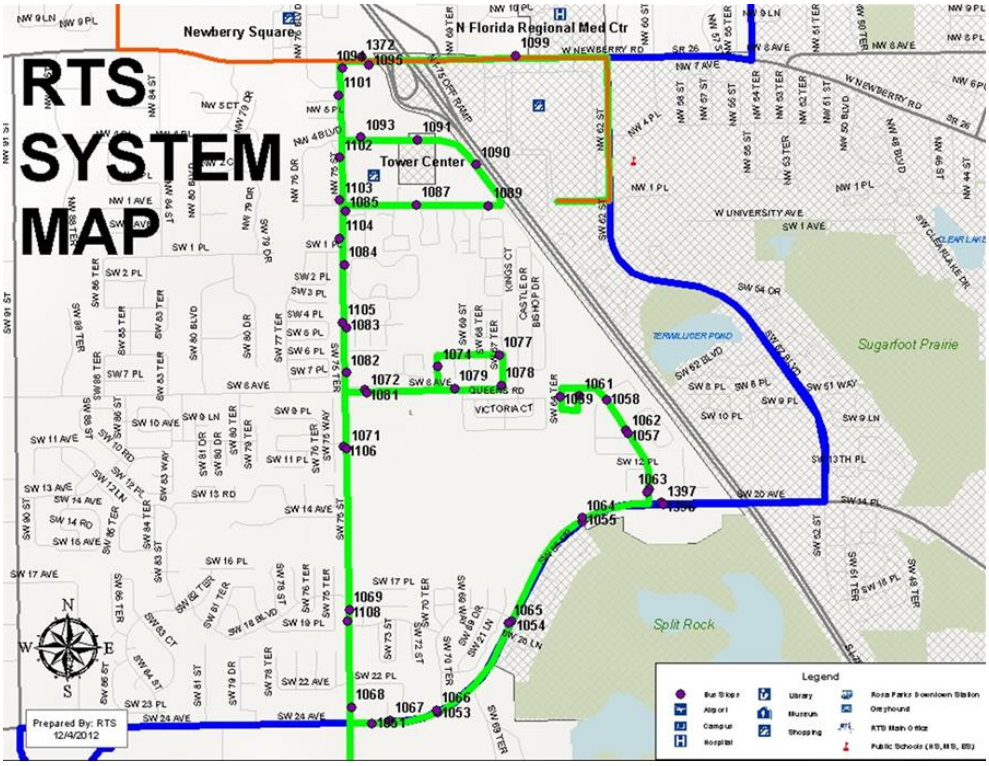


Figure 4-3. RTS Routes 23 (orange), 75 (green), and 76 (blue)

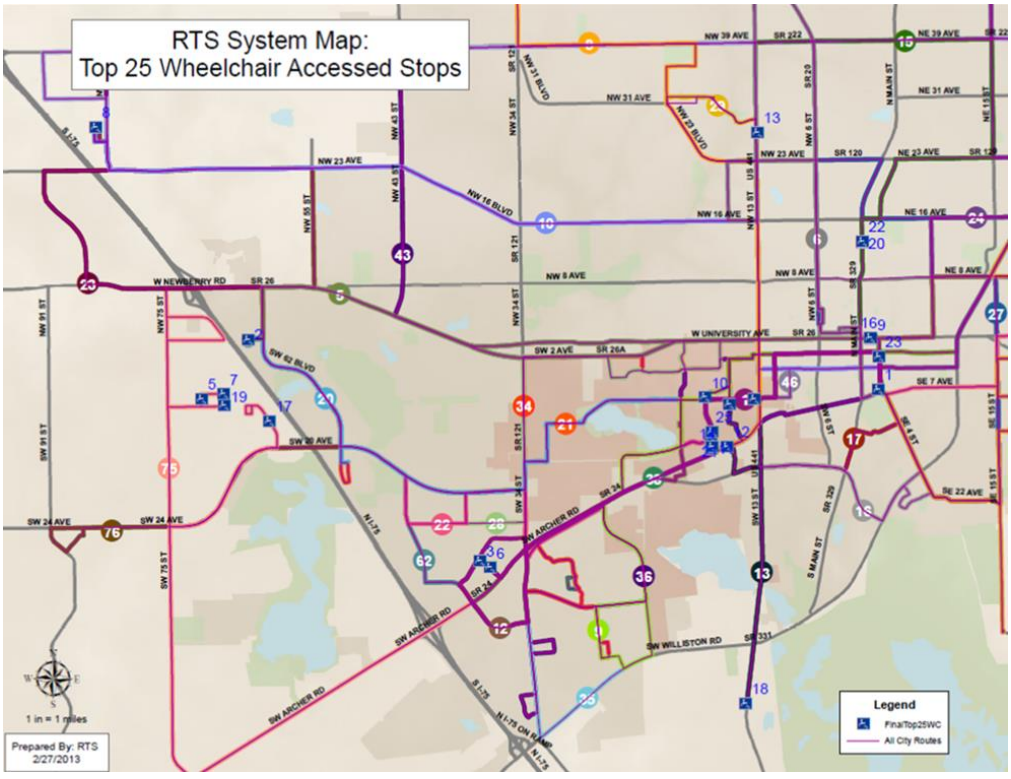


Figure 4-4. Top twenty-five wheelchair accessed bus stops (RTS, Fall 2012)

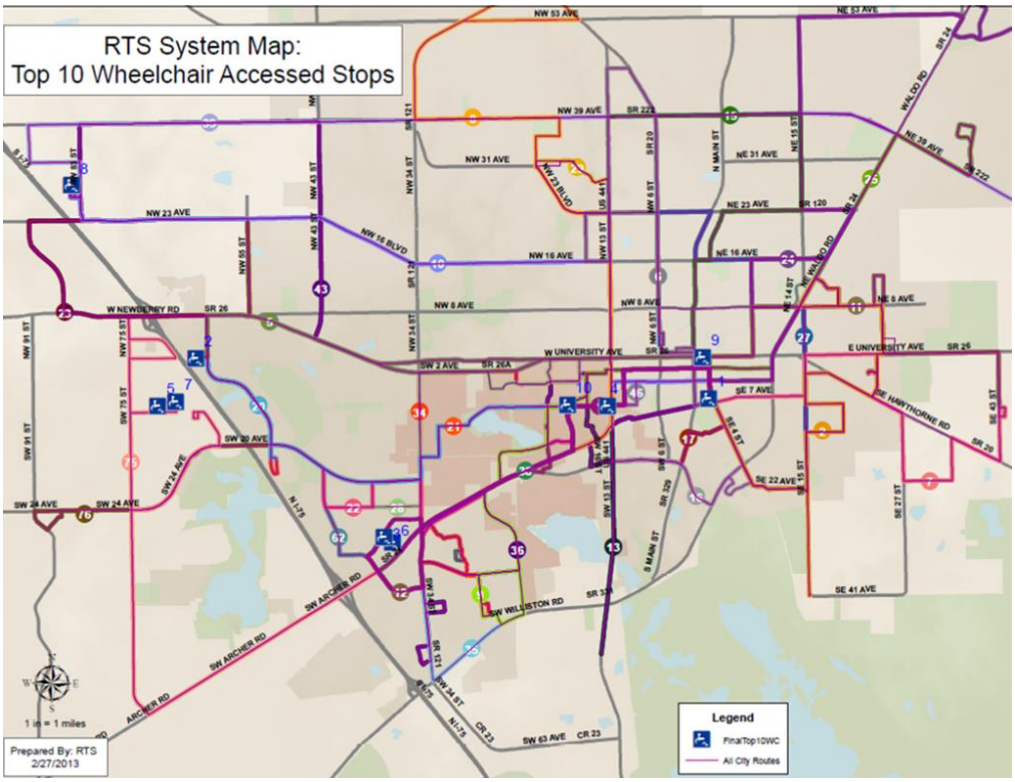


Figure 4-5. Top ten wheelchair accessed bus stops (RTS, Fall 2012)

Figure 4-6. Tower Road Triangle Transit Hostile Urban Design

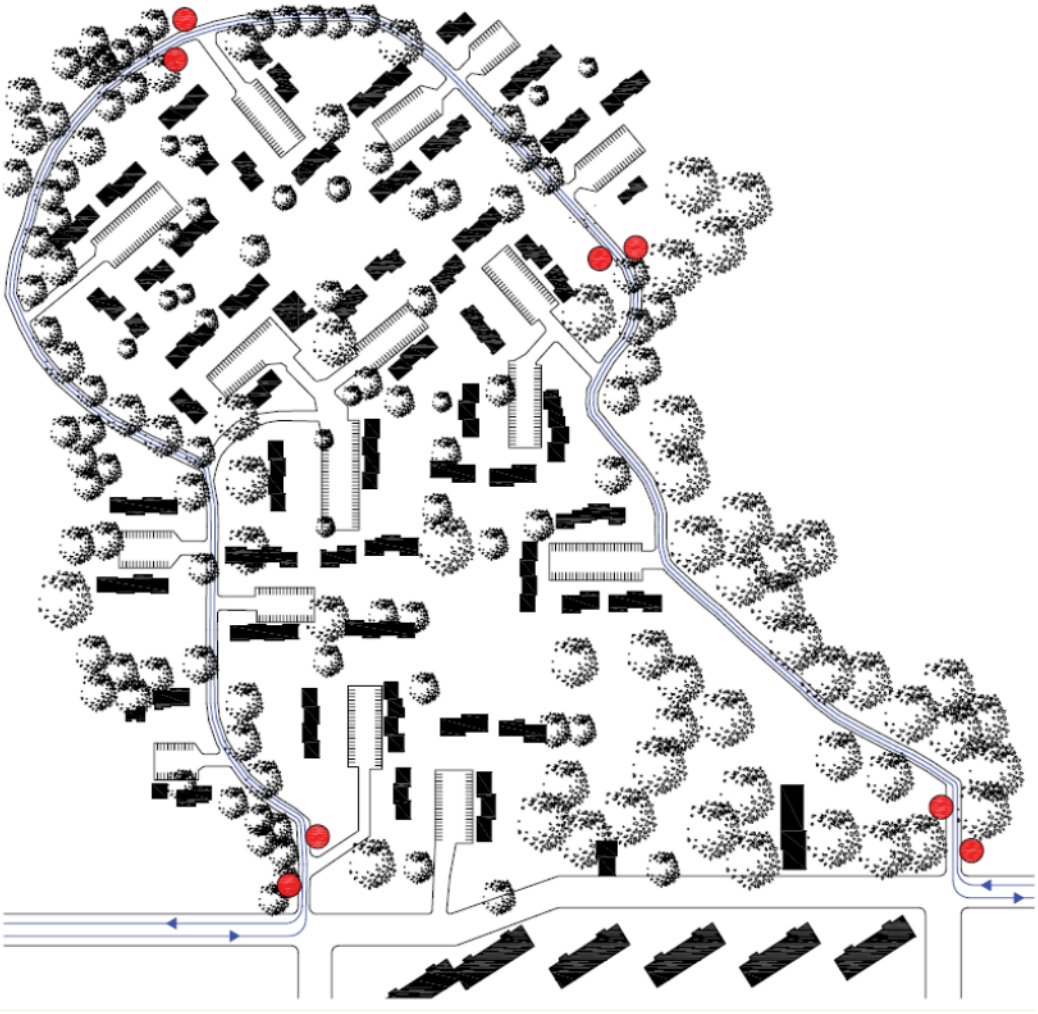


Figure 4-7. Multi-family residential transit hostile urban design (Florida Department of Transportation [FDOT], 2008)

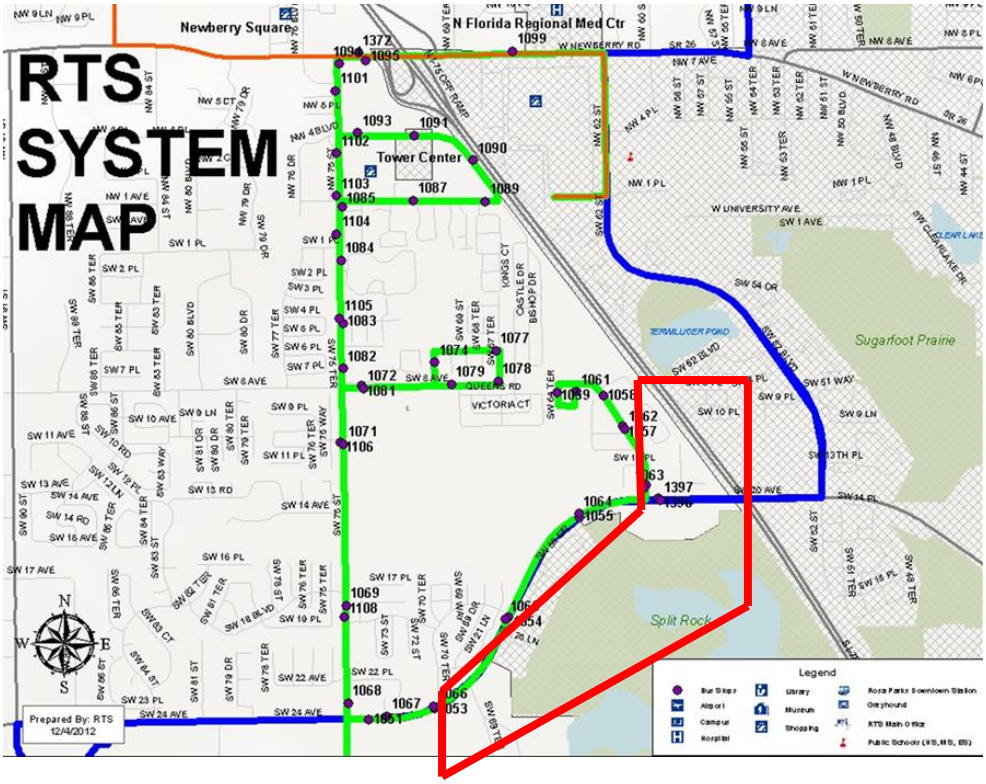


Figure 4-8. Red outline identifies Route 75 out-of-direction travel

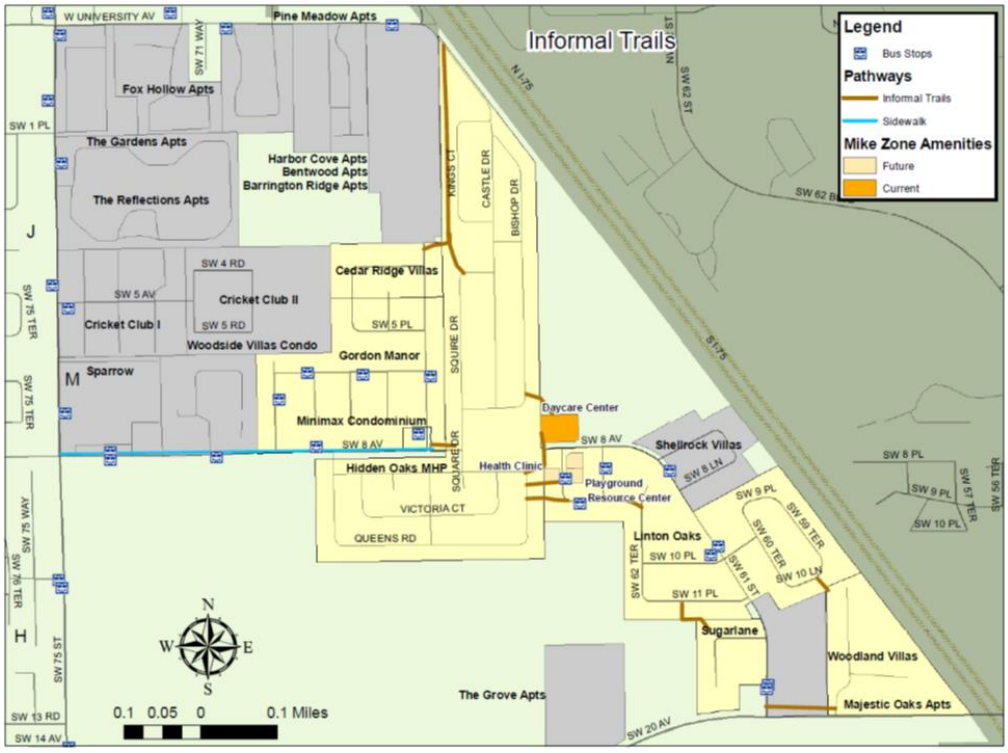


Figure 4-9. Informal Trails (Prevention Pathways Grant Application, 2011)

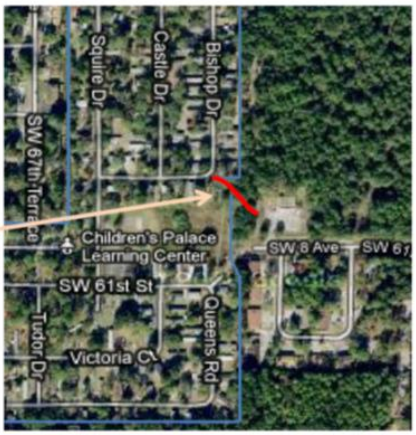
Disabled male and his female companion use this path to access the #75 RTS bus in Linton Oaks on SW 64th Terrace. They explained that this is where you catch this bus to go to Archer Rd. The stop located at the entrance to this mobile home park will take you to the Oaks Mall and will be a much longer trip to Archer Rd.

Photo of mangled fencing at this junction. The resident near this junction stated that a Hidden Oaks resident pulled down the fence with a lawn mower after it was repaired.

Documented 3/4/11

Figure 4-10. Image of wheelchair bound person utlizing SW 8th Ave informal trail to access transit (Prevention Pathways Grant Application, 2011)

This path connects the two halves of the mobile home community and runs along a fence separating Hidden Oaks From Linton Oaks. The area to the west of this path is ambiguous space and collects a lot of litter.



Analyst Katie Fields walked with a mother of 3 "the long way" (shown left) from the path to her home on Queens Rd because she felt the 1HOHO path was too dangerous with a stroller and small children because of the rocks sticking out of the ground. The path she had been using had been blocked the day before. Like the disabled man, she uses these paths to access the RTS #75 bus to take her son to a Tower Road elementary school.

Documented 3/4/11

Figure 4-11. Informal Paths advantage and disadvantages (Prevention Pathways Grant Application, 2011)

Figure 4-12. Bicyclist uses informal path adjacent to Linton Oaks SW 8th Avenue dead end (Google Streetview, 2013)

Figure 4-13. Linton Oaks SW 8th Avenue informal path entrance (Amanda Douglas, 2013)

Figure 4-14. Linton Oaks SW 8th Avenue informal path and private property sign (Amanda Douglas, 2013)

Figure 4-15. Linton Oaks SW 8th Avenue informal path leading to damaged fence and trespassing (Amanda Douglas, 2013)

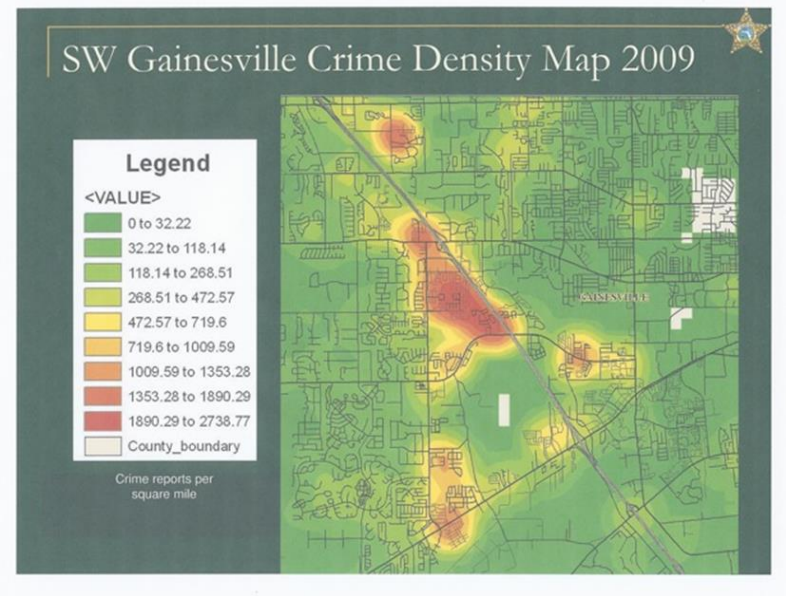


Figure 4-16. 2009 Crime Density Map (Alachua County Sherriff, 2009)

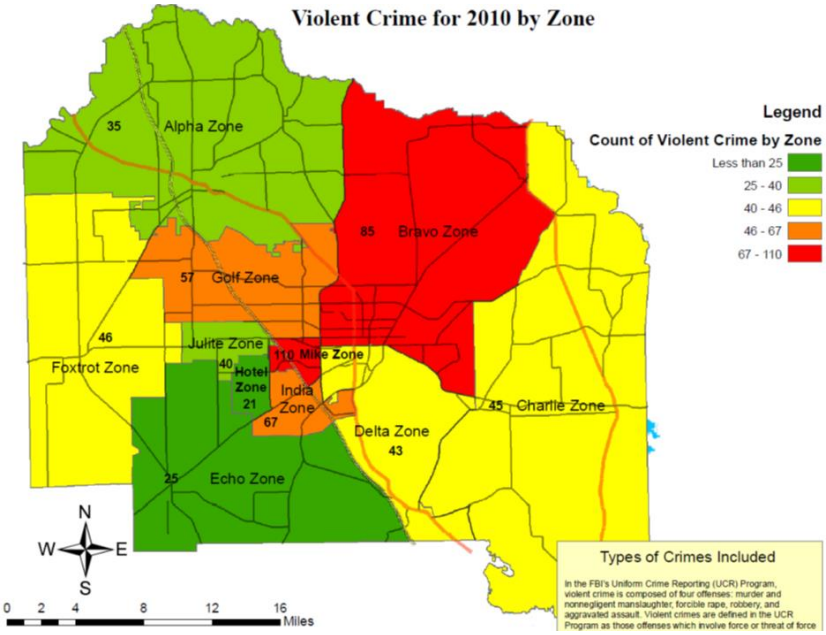


Figure 4-17. Violent crime for 2010 by zone (Prevention Pathways Grant Application, 2011)

Figure 4-18. MIKE zone neighborhood crime reports (Prevention Pathways Grant Application, 2011)

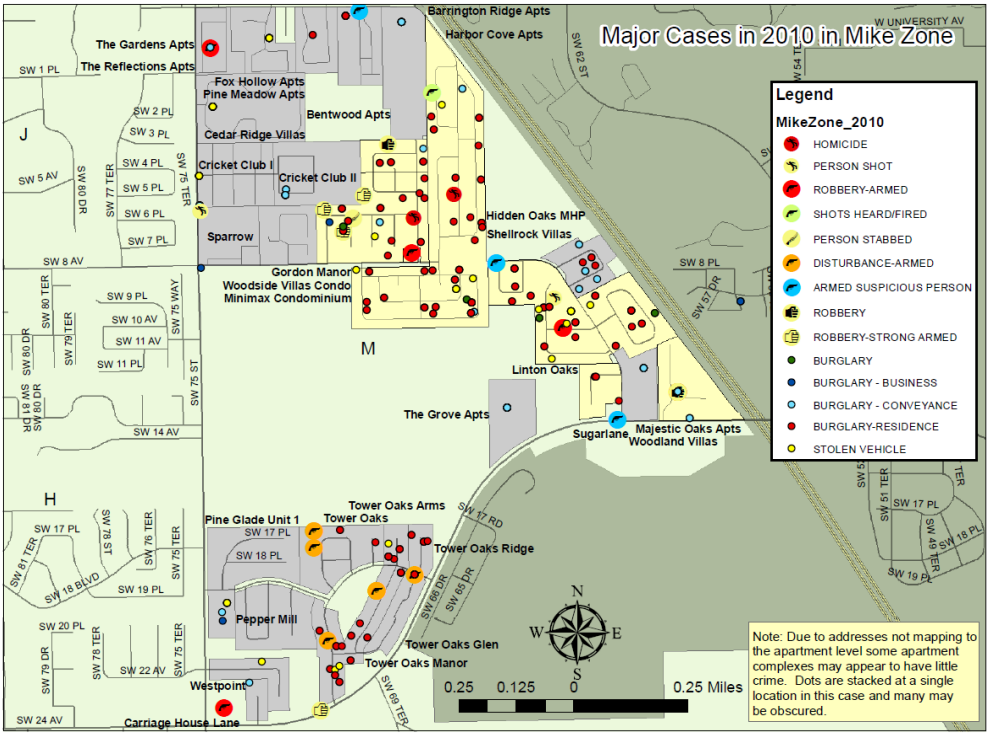


Figure 4-19. 2010 Major Crime Cases in the Triangle reports (Prevention Pathways Grant Application, 2011)

Figure 4-20. Aerial Image of Linton Oaks discontinued SW 8th Ave (Google Streetview)

Figure 4-21. Image of Linton Oaks discontinued SW 8th Avenue (Amanda Douglas, 2013)

Figure 4-22. Image of Linton Oaks SW 8th Ave dead end (Amanda Douglas, 2013)

Figure 4-23. Linton Oaks SW 8th Avenue dead end physical disorder (Amanda Douglas, 2013)

Figure 4-24. Linton Oaks SW 8th Avenue dead end physical disorder (Amanda Douglas, 2013)

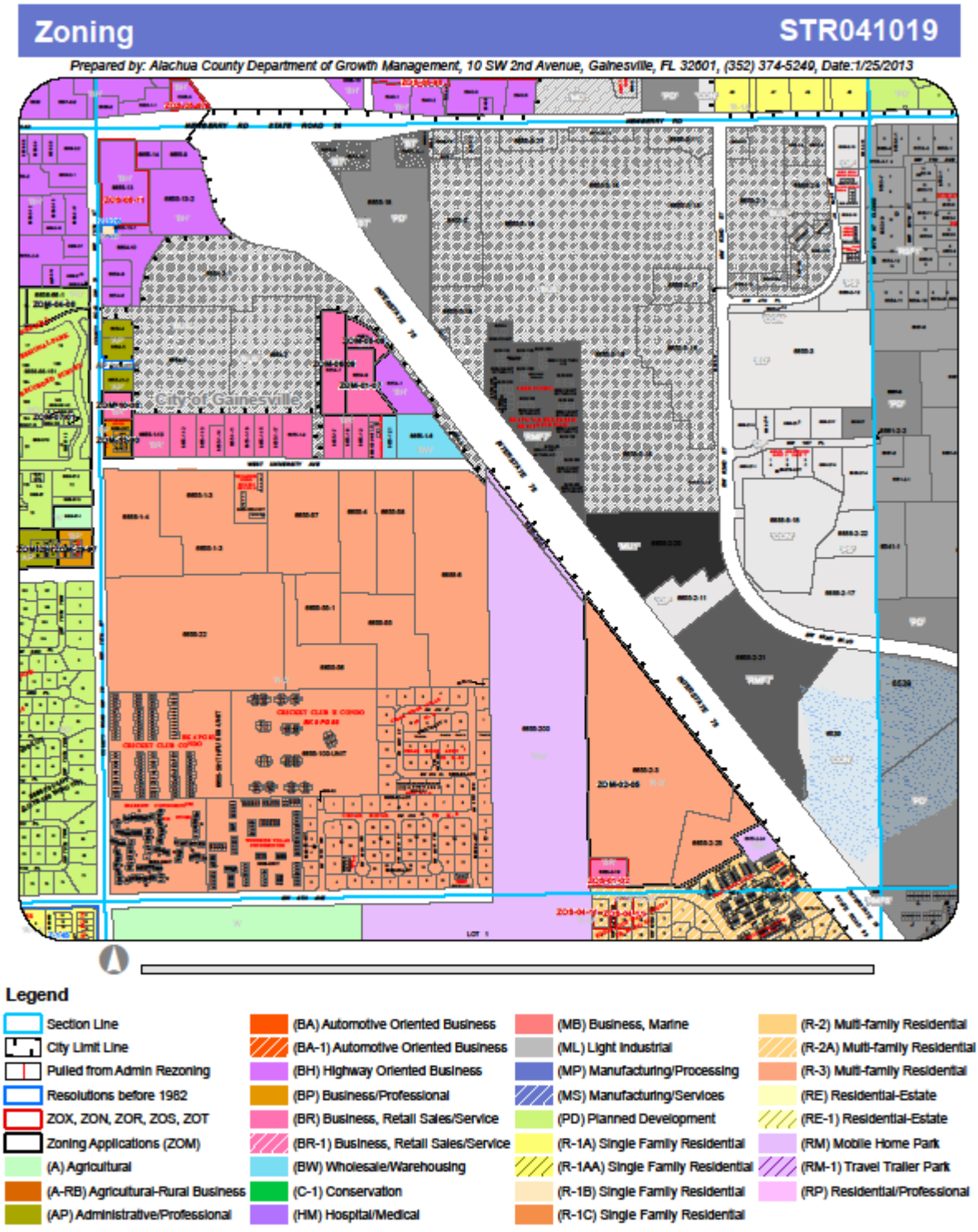


Figure 4-25. Zoning map illustrating current land uses

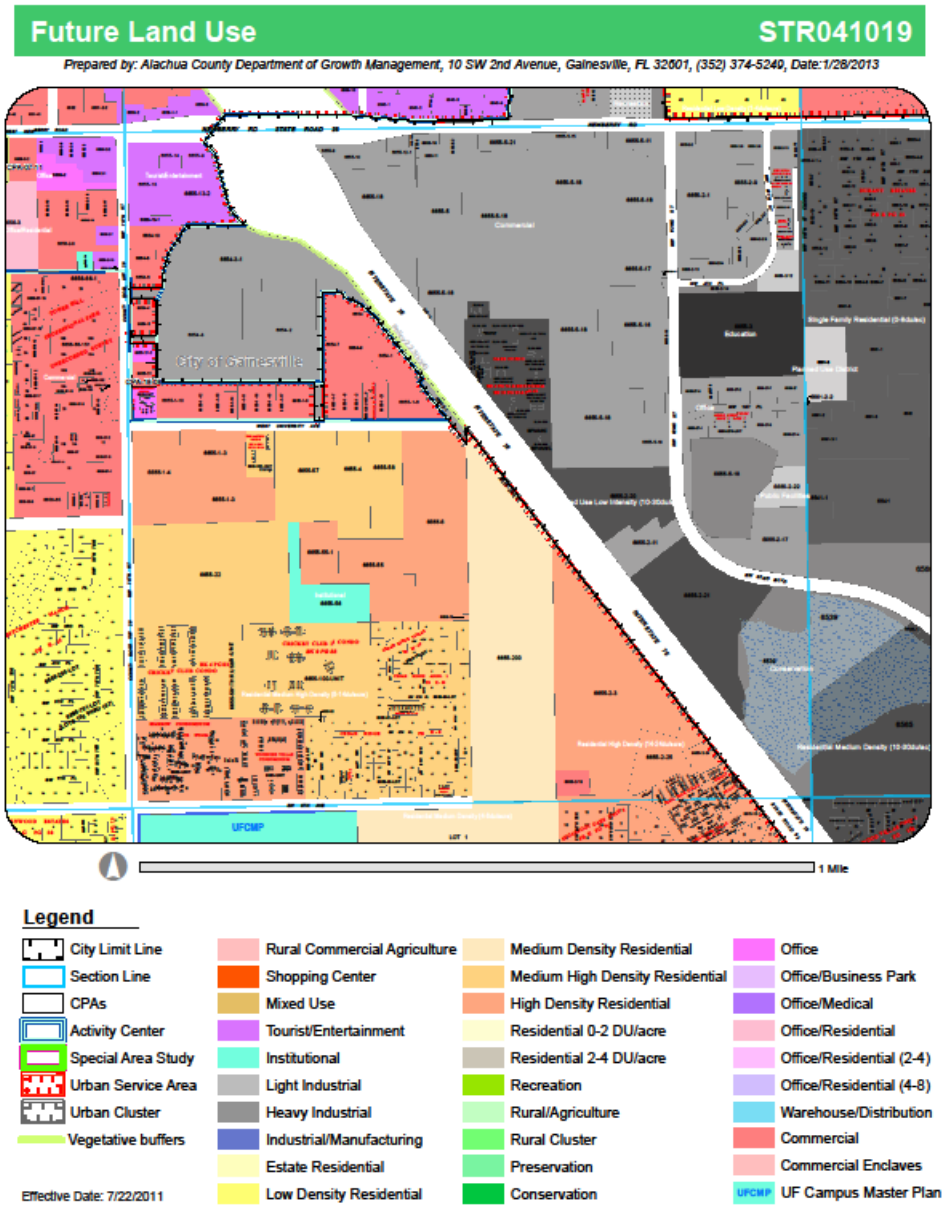


Figure 4-26. Future land use map illustrating planned land uses

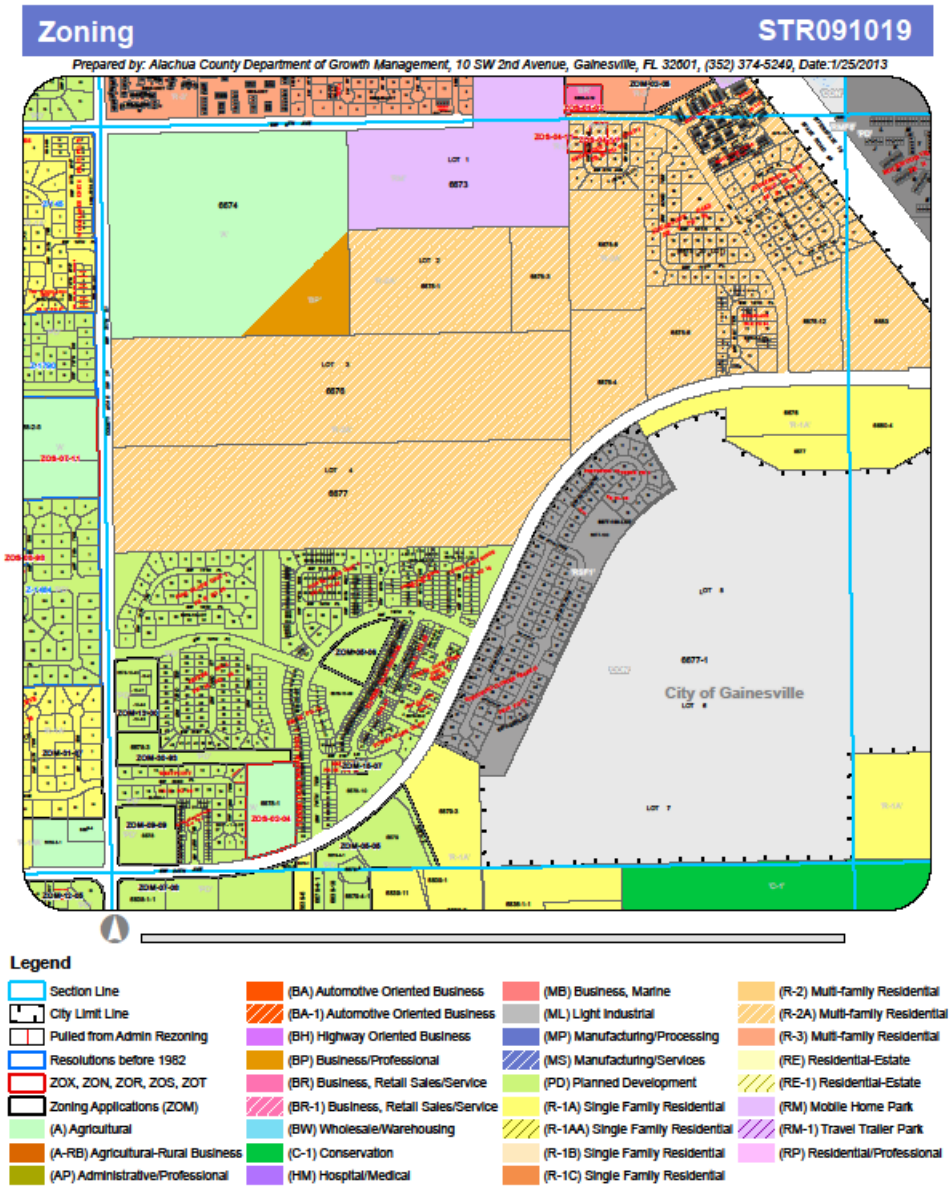


Figure 4-27. Zoning map illustrating current land uses

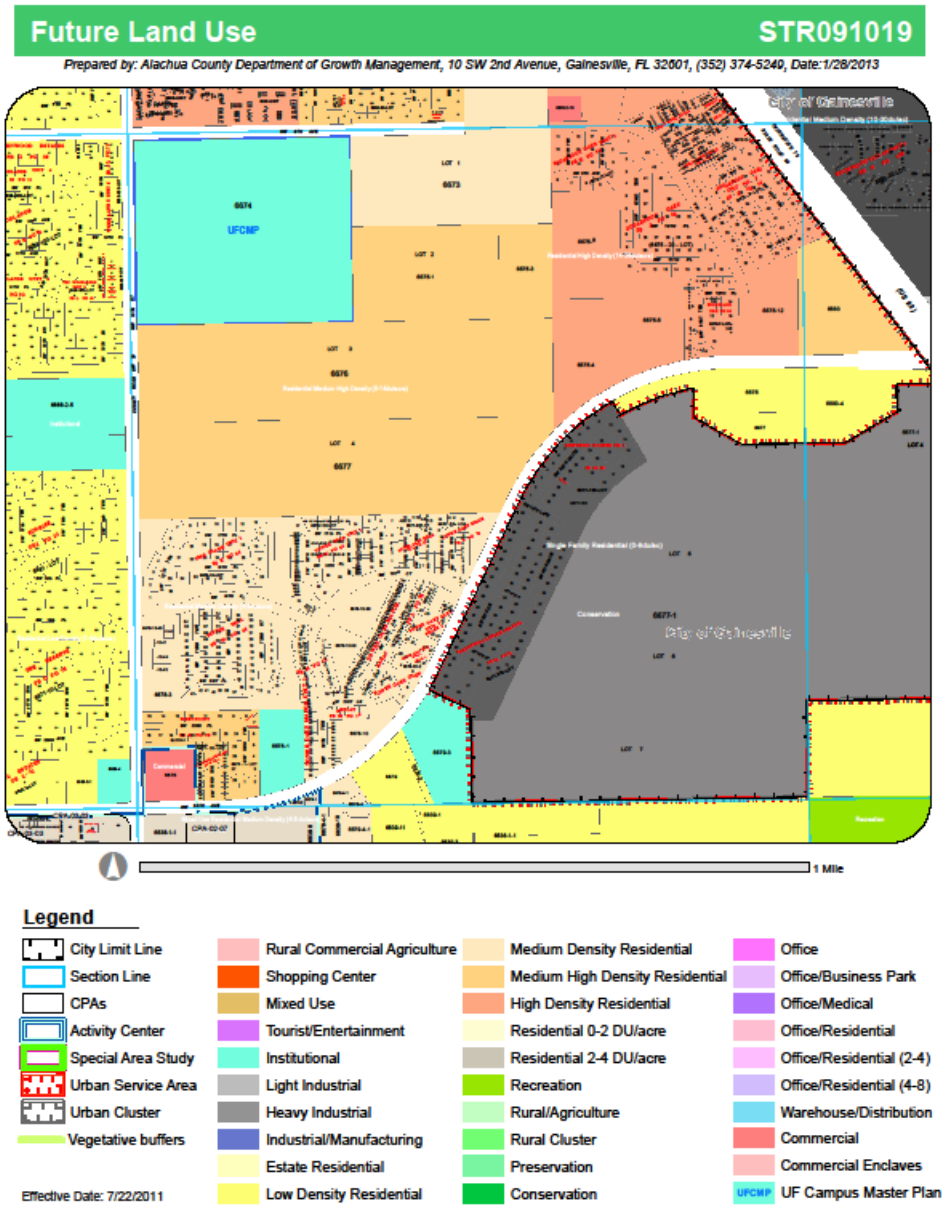


Figure 4-28. Future land use map illustrating planned land uses

CHAPTER 5
DISCUSSION

The Triangle, located in unincorporated Alachua County, is an area that has a low rate of automobile ownership and a high concentration of low income households that are using transit at high rates. Yet, fixed-route transit is not convenient and the stops are not adequately accessible, especially to those with disabilities. This has significant implications because public transit is a social service that provides access to desired opportunities, including goods, services, activities, and destinations. Zoned primarily residential with no public parks, little to no employment opportunities and limited destinations to walk to other than bus stops, the Triangle has limited direct access to desired locations. Although transit may not be able to provide direct access to desired locations in a single trip, transit stops are considered destinations because they increase resident's accessibility to desired locations (e.g., employment, education, and grocery shopping) essential to health and quality of life. Bus stops may be one of few destinations to walk daily within the Triangle. Subsequently, having safe, adequate access to transit is important for one's livelihood; however, the Triangle lacks essential transportation infrastructure with the connectivity that enables access for all, and has high rates of crime that may influence transit access, physical activity, and quality of life.

Transit Access and Americans with Disability Act (ADA) Accessibility

The urban form of the built environment limits bus driver's ability to drive direct paths for optimal transit access, while lack of ADA accessibility reduces the number of people that are able to access transit. The built environment in the Triangle is transit-hostile requiring out-of-direction travel and lacks essential infrastructure for transit

access, which decrease transit accessibility and mobility. Subsequently, transit spends almost a quarter of its round trip cycle back tracking.

Meanwhile, bus stop infrastructure in the Triangle lacks ADA compliance for 42 of 45 bus stops, which is mostly attributed to inadequate loading and unloading areas (lack of ADA compliant landing pads),and a lack of sidewalks and curb ramps at intersections leading to bus stops. The overall lack of infrastructure combined with a lack of ADA compliant existing infrastructure reduces transit accessibility. Subsequently, transit is both less efficient and less productive.

The lack of accessibility may suggest that the transit system has not fulfilled its potential to adequately serve the area. This may be especially significant on the account that the relatively large population of ADA certified passengers that reside in the Triangle may be lacking accessibility to fixed-route services due to the lack of essential infrastructure. Despite the area having four bus stops rank in the top twenty-five wheelchair accessed bus stops during the Fall of 2012, none of the bus stops have ADA compliant infrastructure. Inadequate infrastructure for loading and unloading areas at these bus stops may be decreasing the overall efficiency of route 75, while creating safety concerns. Additionally, the lack of built environment connectivity adds 25 minutes of backtracking through Linton Oaks, which increases the route trip cycle time and decreases mobility, efficiency, and productivity. Combined, the Triangle's transit hostile built environment and inadequate ADA infrastructure decreases the accessibility, mobility, efficiency, and productivity of route 75.

A Need for Greater Connectivity in the Built Environment to Access Transit

The Triangle area lacks in functional formal pathways that allow easy access to transit stops, which has contributed to the development of an informal path network.

The presence of an informal pathway network alone identifies a need for greater connectivity and only highlights the imperfections of the built environment in the Triangle. Persons in wheelchairs and pedestrians have been identified using informal paths to access transit, as well as bicyclists. If the built environment were modified to improve connectivity and provide formal pathways then, based on the apparent demand, it is likely the paths will be used. With greater connectivity, safe, accessible pathways, and reasonable (e.g., 0.25 miles) proximity to bus stops, ridership may increase as accessibility for all users increase as well. As ridership increases, the number of people walking to transit may also increase. Subsequently, more people may be engaging in physical activity and improving their quality of life.

Crime and CPTED

Another consequence of a poorly designed built environment with lack of connectivity, infrastructure, and low proximity to activity oriented destinations is increasing risk of crime. With inappropriate use of access control, residents resort to informal pathways to get to desired locations, which demand an initial form of property damage (vandalism), habitual trespassing, and requires passage through less visible areas lacking in lighting and natural surveillance that make them less safe options for transportation. Also, inappropriate placement of fencing not only increases distances to transit stops, but contributes to the creation of enclaves that are less visible and may harbor crime, such as public alcohol consumption, drug use, and possible drug dealing, and create greater opportunities for situational crime, such as assault and robbery.

Implementing policies and design that encourage planning for activity and facilitate surveillance, access control, ownership, management and maintenance in low-income neighborhoods have the ability to reduce the risk of crime and improve perceptions of

safety. Low-income neighborhoods have been identified as a population that is particularly at risk for crime and the unintended consequences of crime—fear to be active outdoors. Individuals that are fearful to go outside and be active outdoors are less likely to be attaining the recommended minutes of minimum physical activity (the CDC recommends 150 minutes per week) and have lower self-efficacy (Bennet et al., 2007).

Research identifies that the time of day, daytime or nighttime, and perceptions of safety and crime also has an influence on walking, especially among women (Bennet et al., 2007). The decreases in physical activity due to perceptions of crime and safety may be contributing to the increasing rates of obesity, and may also be increasing the risk of obesity and obesity related diseases within the study area. This is significant because as mentioned previously Medicaid and Medicare have covered approximately half of the obesity related medical expenditures, which means that the federal government and states are paying a large proportion of medical expenditures for a condition that can be prevented. If incorporating CPTED principles into the built environment have positive results in reducing risk of crime and increase perceptions of safety in low-income neighborhoods then medical expenditures related to physical inactivity may also reduce, thus reducing the margin of disparities in public health.

At the end of the day, planning neighborhoods to be walkable with good and activity-oriented may increase physical activity and social cohesion, decrease risk of crime, and reduce medical expenditures related to obesity and physical inactivity. The best way of ensuring walkable design, ADA compliance, and improve transit access in the future may be through coordinating transit accommodations into the development

review process, and have active coordination among city and county agencies to ensure plans are compliant with current and future transit needs.

This prevention tactic, planning for walkability and access to transit, is important especially because the Affordable Care Act is extending Medicaid eligibility to persons under age 65 in the future; a government program that used to restrict eligibility to children, families, pregnant women, and qualified disabled persons and seniors. What this means is that Medicaid, a government program, will be providing healthcare coverage to a large group of people not previously eligible. As a result, government programs will likely be responsible for payment of increasing figures of medical expenditures related to obesity and physical inactivity as healthcare coverage is extended to growing group of eligible people.

Recommendations

A well-integrated street network and good pedestrian linkages are important elements that contribute to transit accessibility and mobility. Modification to the built environment would not only greatly increase accessibility to transit and transit mobility, but also the efficiency of route 75. Route 75 efficiency, if passage through 8th Avenue from Linton Oaks to Holly Heights were permitted, would improve as cycle time decreases, number of trips increases, frequency increases, and, as a result, productivity increases. If 8th Avenue were accessible, route 75 could decrease its round trip cycle from 105 minutes and run on a 90 minute cycle or 80 minute cycle. On a 90 minute cycle with three buses, the route's frequency would be increased to every 30 minutes, the amount trips within the same service span would increase (9), and ridership may increase. On an 80 minute cycle with three buses, the route frequency would be increased to every 27 minutes, round trips would increase, and ridership may also

increase. Increases in ridership may suggest new transit users and more frequent transit users, both of which may increase time spent walking to transit. Route 76 may also be realigned to serve the 8th Avenue area with access from Tower Road and SW 24th Avenue, since bus stops along 8th Avenue in Holly Heights and Linton Oaks have high ridership.

Increasing pedestrian infrastructure available within neighborhoods, eliminating physical barriers to direct walking paths, and providing good pedestrian linkages may increase ridership and physical activity by providing safe places to walk. This is especially significant for those who are ADA certified and do not currently access fixed-route transit due to a lack of safe access. Adding proper illumination along routes frequently walked to bus stops may increase natural surveillance and may also increase perceptions of safety. Increased perceptions of safety, regardless of time of day, may translate to more minutes spent walking, improved quality of life, and could potentially reduce medical expenditures related to obesity.

Increasing amenities at bus stops that currently meet the threshold for amenities, and making bus stops ADA compliant may increase ridership and improve the transit experience. Bus stops with a lot of wheelchair activity should be prioritized, as well as type 3 bus stops. Strategic placement of bicycle parking (bike racks) at bus stops along routes, especially routes 23 and 76, may increase ridership by increasing the catchment area, and provide residents greater mobility and opportunity to access desired locations.

In addition to meeting type classification amenity thresholds and improving ADA compliance to increase accessibility, bicycle access is another important issue to address with transit. Transit agencies are integrating bicycles and transit as means to

increase accessibility, mobility, catchment area, and provide multimodal linkages. Bicycle racks on buses have enabled the bicyclist to carry their bicycle with them providing fluid transport to and from destinations. Although RTS buses are equipped with bicycle racks, the Triangle area does not have any bicycle parking available at bus stops. Increasing bicycle parking available at bus stops facilitates transit use, as bicycle racks on buses are sometimes filled to capacity and patrons are unable to bring their bicycle with them. Enabling the bicyclist to use transit also contributes to improving quality of life, increasing opportunities for physical activity, and decreasing automobile congestion and air pollution. This study recommends strategic placement of bicycle parking at bus stops to increase the catchment area and potential ridership, increase mobility and multimodal linkages, and enable secondary impacts previously mentioned related to traffic congestion, quality of life and increased opportunities for physical activity.

If future land uses permit activity oriented design, it may be possible to decrease the rates of crime by providing more natural surveillance and community cohesion. Another tactic is collaboration and cooperation with law enforcement; establishing the sheriff's presence in the area to facilitate regular policing of the grounds for criminal activity. Since the study area lacks recreational spaces and there are no future plans for recreation, the sheriff's department can also take a more active role with the adolescents in the study area by being mentors and coaches. For example, the sheriff's department could create an intramural league for low income adolescents and transport them to playing fields for games and practices. This tactic teaches adolescents

teamwork, creates a relationship with the local sheriffs, and provides a means for achieving physical activity and subsequent health benefits.

This research recommends that a full health impact assessment of this community may be beneficial to accurately portray the extent of the health impacts in the area that are influenced by conditions of and within the built environment, such as crime, walkability, and poor proximity to destinations. Obesity incidence and prevalence should be identified, as well as obesity related diseases. A questionnaire, like the one in Appendix A, is recommended to be administered. Also, accelerometer or pedometer equipment, as well as GPS equipment, is recommended to be used in order to capture objectively measured data on bouts and intensity walked, or steps walked, and to link the accelerometer or pedometer data to GPS, so the researcher may see where participants are walking. This full HIA will require incentives for participation.

Limitations

Ridership may be under-reported. Ridership was calculated using weekday boardings only. Although weekend ridership and service was not analyzed, the Tower Road Triangle is the only area in the Greater Gainesville area served by RTS that does not receive any transit service on Sundays; impact of the lack of Sunday service on Tower Road Triangle residents is an area to be further researched.

Data for specific curb type at bus stops was inconsistent, thus compliance with specific curb type was not included in the ADA compliance calculations. Data related to presence of a curb and curbcuts were, instead, used to determine whether sidewalks permitted wheelchair access; ADA compliant bus stops require a type F curb at bus stops.

This research lacked data for obesity prevalence and incidence within the study area, as well as minutes spent walking to and from transit and paths traveled to access transit. There was also a lack of data related to physical activity, such as if people feel safe walking in their neighborhood, if temporal issues (day or night time) influence physical activity, and if people stay indoors at night because of fear of crime or lack of activity oriented land uses. Data related to perceptions of safety walking on informal pathways, and whether perceptions of safety changed during light and dark hours were not collected and represent another area of research to be conducted. Prevalence and incidence of crime along informal paths are another area to be further researched.

CHAPTER 6
CONCLUSION

This research adds to the literature regarding Americans with Disability Act (ADA) compliant infrastructure, and contributes to understanding barriers in the walking environment and how people cope with such hostile walking environments. The Tower Road Triangle is deficient in ADA compliant infrastructure and non-motorized transportation facilities necessary for persons with disabilities to safely access transit. Bus stops that are not ADA compliant but have high use may be increasing dwelling times and decreasing the efficiency of the service; however, the transit hostile built environment and features in the built environment may have greater impacts on access to transit and the overall success of services.

Irregular street patterns, dead-ends, fences, and physical obstructions in the built environment have increased distances to transit stops and decreased transit mobility. The lack of ability to walk direct paths to transit has created a hostile walking environment that has resulted in the creation of informal paths that requires the destruction of private property to access, mostly attributable to the repeated destruction of fences that are re-repaired. The lack of non-motorized transportation infrastructure combined with a poorly integrated street network and a lack of connectivity between adjacent developments are responsible for decreasing transit accessibility and creating a transit hostile environment.

Walking is the oldest form of transportation. Yet, pedestrian infrastructure and non-motorized transportation decidedly received less attention than desirable when the Tower Road Triangle was developed. In most cases, a transit user begins their trip as a pedestrian, and while bicyclists are beginning to grow among users, these vital non-

motorized transportation facilities and supporting amenities are not well integrated into the urban design of the study area, nor are present pedestrian facilities well integrated into transit stops. Consequently, a network of informal paths that we can infer are used in high volumes due to the sheer presence and state of the paths, traversed to the point that grass no longer grows along the path and the presence of excessive trash, have developed and represent a need for greater connectivity, pedestrian infrastructure, and direct paths to destinations. The informal networks are accessed by all populations, some of whom have reported using these paths to access transit, including: women with strollers, families, bicyclists, youth, and disabled persons. The demand for pedestrian infrastructure with good linkages and direct paths to transit is obvious. These demands identify a desire for greater connectivity and proximity, and demonstrate the fundamental concepts of walkability.

Non-motorized transportation facilities that provide direct paths to destinations and transit stops that accommodate the needs of the most vulnerable users, such as person in wheelchairs, women with strollers, the elderly, and children, will likely increase access for all people, facilitate use, and increase transit ridership. ADA compliant design of pedestrian infrastructure and transit stops create circumstances that ensure that a greater number of people can safely access destinations within proximity utilizing non-motorized transportation facilities, and translating into health benefits such as improving quality of life, and accumulating minutes of physical activity. Increased ADA accessibility may also have the capacity to reduce the need for costly paratransit, or door-to-door services, by increasing access to fixed-route services. If plans for pedestrian facilities are designed to provide ADA compliant pedestrian linkages that

connect adjacent developments, increase connectivity and shorten proximity to destinations, then it is likely to result in a more transit -friendly and accessible environment. Walkability logically increases transit accessibility, but it may also be an indicator of transit mobility, efficiency and productivity reflecting the ability to travel direct paths through the built environment without out-of-direction travel.

Transit success depends on the pedestrian's ability and willingness to maneuver through the built environment to access transit, where infrastructure, connectivity and proximity to stops have been cited as contributing factors for transit accessibility, as well as transit mobility. Transit mobility refers to the bus driver's ability to maneuver through the built environment, between destinations, in the most direct path. Transit mobility requires a well-integrated street network for greater connectivity to reduce time wasted in out-of-direction travel, and reduce loading and congestion on arterials. Thus, a well-integrated street network that permits higher transit mobility increases accessibility and allows transit to serve a greater number of people and provide a more efficient, productive service.

If a neighborhood is walkable it is also likely that the built environment permits multiple modes of transportation along the same route, which may provide for a safer route. For example, a road used by transit and automobiles may also allocate space for bicycle facilities and accommodate streetscape facilities such as ADA compliant pedestrian infrastructure and transit amenities. Roads that incorporate non-motorized infrastructure into plans with the intention of creating facilities that accommodate a number of modes and users not only provides greater transportation options and greater access to transportation, but increases safety, and decreasing risk of crime

through natural surveillance permitted by activity-oriented design. By providing multiple modes of transportation along a route and good connectivity, one may increase opportunities to safely access desired locations through a more direct path; proximity to locations is also a contributing factor.

Thus, it is to no surprise that the built environment influences access to desired locations, transit use, transportation efficiency, crime, safety, physical activity, and the welfare of residents. Coordinating plans and collaborating with city and county agencies and creating partnerships with non-profit organizations and grass root organizations may help facilitate planning transit friendly neighborhoods and healthier communities that suit the long term needs of population. Planning the built environment for access for all and with health prevention in mind may be one of the best ways to improve the quality of life in neighborhoods, while also reducing medical expenditures related to physical inactivity and obesity related diseases in the long term.

APPENDIX A
QUESTIONNAIRE

Access to transit and healthy foods: health impact assessment survey

Please, take five to ten minutes to complete this survey about access to transit and the walkability of your neighborhood. What you have to say is important to us. Thank you for your participation!

- Fill out the questions as accurate as you can. Remember, there are no right or wrong answers.
- Your responses will be kept strictly confidential.
- Please try not to skip any questions.

For Researcher Use Only
Date survey received: _____
Date survey entered (A): _____
Date survey entered (J): _____

1 Where do you live? (Circle one)

HARBOR COVE	HIDDEN OAKS	PINE MEADOW	HOLLY HEIGHTS
LINTON OAKS	MAJESTIC OAKS	TOWER OAKS	OTHER: _____

2 Place(s) of Employment (Location) _____

_____

_____

3 What is your employment status? (Circle all that apply)

PART-TIME	FULL-TIME	DO NOT WORK	LOOKING FOR A JOB
(up to 20 hours/wk)	**(40 or more hours/wk)**		

4 What hours do you usually work and on which days of the week? We want to get an idea when you work and when you would need the bus in order to get to work.

What hours do you usually work?	Days of the Week (Check all that apply)						
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
For example, 7 AM- 3 PM.	√		√		√		
1							
2							
3							

5 Do you have a valid RTS ADA card? (Circle one): YES NO NOT SURE

a. **If yes to question 5, do you use city route bus service? (Circle one):** YES NO

b. **If yes to question 5, do you use Paratransit (MV) services? (Circle one):** YES NO

A. Getting to Where You Need to Go: We want to get a sense of how you get place to place most often, whether you walk, bike, drive, or take the bus, and any combination of the ways to get place to place.

How do you get around?	*DAYS PER WEEK*						
1 WALK	1	2	3	4	5	6	7
2 BIKE	1	2	3	4	5	6	7
3 BUS + WALK	1	2	3	4	5	6	7
4 BUS + BIKE	1	2	3	4	5	6	7
5 BUS + WALK + BIKE	1	2	3	4	5	6	7
6 BUS + CAR	1	2	3	4	5	6	7
7 CAR (AS THE DRIVER)	1	2	3	4	5	6	7
8 CAR (AS THE PASSENGER)	1	2	3	4	5	6	7

☐ **Check box if you DO NOT RIDE THE BUS.**

If checked, do you have access to a car on most days, meaning 4 or more days? YES NO

B. Where do you go most often? We want to figure out which routes you use most to get to places or if you do not ride the bust how you get to where you need to go.

Where do you most often travel to? (Examples: Health Department, Oaks Mall, Butler Plaza, Haile Plantation, Publix)	*Which bus routes do you use to get there? (If you do not use the bus, how do you get there: walk, bike, drive?)*
1	
2	
3	
4	
5	

C. Walking Distance to Destinations: We want to figure out how far you are walking if the bus or a car is not available to use

How long does it take to walk to … □ Check here if do not walk (Skip to E)	**1-5 min**	**6-10 min**	**11-20 min**	**21-30 min**	**31+ min**	**Don't know**
1 Nearest Bus Stop I use						
2 Work (check here if do not work □)						
3 Supermarket						
4 Public Park						
5 Bike/Walking/Hiking trails, paths						
6 Basketball court						
7 Other playing fields/courts						
8 Recreation center/Exercise facility						
9 Mall/Shopping center						
10 School						
11 Health Care						
12 Swimming pool						
Other:_____						

D. RTS Bus Service: We want to get an idea how you feel about bus service and conditions in your neighborhood that may impact bus use and experience**.**

	How much do you agree with the following statements? (Check one box per statement)	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	The bus runs when I need it to.					
2	The bus does not come to my neighborhood often enough.					
3	A fence blocks the path to the nearest bus stop from my home.					
4	I feel safe waiting at my bus stop in my neighborhood.					
5	I feel safe walking to the bus stop I use in my neighborhood.					
6	I am happy with the bus service available to me in my neighborhood.					
7	The bus goes where I need it to go.					
8	It is easy to catch the bus in my neighborhood.					
9	It is easy to take the bus to where I need to go.					
10	I have or know some who has been a victim of a crime or violent act at a bus stop in my neighborhood.					
11	I use a computer to check RTS bus route information.					

12. Do you have a smart phone? YES NO

If yes, do you use the RTS Transloc app to check when the bus is coming? YES NO

GOOD WORK! KEEP GOING, YOU ARE ALMOST FINISHED!!!! ☺

E. In My Neighborhood: We want to get an idea of how safe you feel in your neighborhood.

	How much do you agree with the following statements? (Check one box per statement)	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	I have places to exercise in my neighborhood.					
2	I enjoy walking around my neighborhood.					
3	There are sidewalks on most streets in my neighborhood					
4	The streets have good lighting at night in my neighborhood					
5	I walk alone at night in my neighborhood					
6	I walk with others at night in my neighborhood					
7	The traffic makes it difficult or unpleasant to walk in neighborhood					
8	Walkers and bikers can be easily seen by people inside their homes in my neighborhood					
9	There is a high crime rate in my neighborhood					
10	I have been a victim of a crime or violent act in my neighborhood					
11	I know someone who has been a victim of a crime or violent act in my neighborhood					
12	I am afraid of being harmed by a stranger in my neighborhood					
13	I am afraid of being harmed by a known "bad" person (adult or child) in my neighborhood					
14	I usually stay inside my home after dark					
15	I feel safe walking at night in my neighborhood					
16	I have to walk in the street to get around in my neighborhood					
17	There is nothing to do in my neighborhood after dark					

J. Demographics (For statistical purposes only)

1 How do you identify yourself? (Circle all that apply.)

RESIDENT RTS USER STUDENT OTHER: _____

2 Race (Circle one):

WHITE BLACK ASIAN AMERICAN INDIAN MULTI-RACIAL OTHER: _____

3 Are you Hispanic or Latino (Circle one): YES NO

4 Sex (Circle one): FEMALE MALE

5 Education (Circle one): LESS THAN HIGH SCHOOL SOME HIGH SCHOOL

HIGH SCHOOL GRADUATE SOME COLLEGE COLLEGE DEGREE

GRADUATE DEGREE

6 Do you own or rent your current home? (Circle one): OWN RENT NEITHER

K. ADDITIONAL COMMENTS: _____

_____

_____

_____

_____

_____

APPENDIX B
BUS STOP INVENTORY PHOTOS


1074
1077
STOP
1078
1079


1081
1082
SPEED LIMIT
40
1083
1084
LANE
ENDS
1085
RTS
1087
1089
1090


1091
1093
1094
Tampa
1101
1102
1103
1104


1105
1108
1396
26
1372
1397

APPENDIX C
BUS STOP CRITICAL FACTOR RATINGS

Safety:

Stop ID	Natural Surveillance	Access Control	Territorial Reinforcement	Maintenance	Average	Overall Rating
1051	2	1	1	3	1.75	Poor
1053	2	1	1	3	1.75	Poor
1054	2	1	1	3	1.75	Poor
1055	2	1	1	3	1.75	Poor
1056	1	1	1	3	1.5	Poor
1057	2	1	1	3	1.75	Poor
1058	1	1	2	3	1.75	Poor
1059	2	1	1	3	1.75	Poor
1061	2	1	1	3	1.75	Poor
1062	2	1	1	3	1.75	Poor
1063	1	1	1	3	1.5	Poor
1064	2	1	1	3	1.75	Poor
1066	2	1	1	3	1.75	Poor
1067	2	1	1	3	1.75	Poor
1068	1	1	1	3	1.5	Poor
1069	1	1	1	3	1.5	Poor
1071	1	1	1	3	1.5	Poor
1072	1	1	1	3	1.5	Poor
1074	2	1	2	3	2	Fair
1077	1	1	1	3	1.5	Poor
1078	1	1	1	3	1.5	Poor
1079	1	1	1	3	1.5	Poor
1081	1	1	1	3	1.5	Poor
1082	3	1	1	3	2	Fair
1083	1	1	3	3	2	Fair
1084	2	1	2	3	2	Fair
1085	2	2	2	3	2.25	Fair
1087	2	2	3	2	2.25	Fair
1089	2	2	3	3	2.5	Fair
1090	1	2	1	3	1.75	Poor
1091	1	1	2	3	1.75	Poor
1093	2	1	2	3	2	Fair
1094	2	1	1	3	1.75	Poor
1095	2	1	1	3	1.75	Poor
1101	2	1	1	3	1.75	Poor

1102	2	1	1	3	1.75	Poor
1103	3	1	1	3	2	Fair
1104	3	3	3	3	3	Good
1105	2	2	1	3	2	Fair
1106	1	1	2	3	1.75	Poor
1108	2	1	1	3	1.75	Poor
1372	3	1	1	3	2	Fair
1396	2	1	1	3	1.75	Poor
1397	1	1	1	3	1.5	Poor

Accessibility:

Stop ID	Landing pad	Sidewalk	ADA Compliant	Visibility	Average	Overall Rating
1101	1	3	2	3	2.25	Fair
1102	2	3	2	3	2.5	Fair
1103	2	3	2	3	2.5	Fair
1104	2	3	1	2	2	Fair
1087	3	3	3	3	3	Good
1089	3	3	3	3	3	Good
1094	3	3	3	3	3	Good
1051	1	2	1	3	1.75	Poor
1053	1	2	1	3	1.75	Poor
1054	1	2	1	3	1.75	Poor
1055	1	2	1	3	1.75	Poor
1056	1	1	1	3	1.5	Poor
1057	1	1	1	2	1.25	Poor
1058	1	1	1	3	1.5	Poor
1059	1	1	1	3	1.5	Poor
1061	1	1	1	2	1.25	Poor
1062	1	1	1	3	1.5	Poor
1063	1	1	1	3	1.5	Poor
1064	1	1	1	3	1.5	Poor
1066	1	1	1	3	1.5	Poor
1067	1	1	1	3	1.5	Poor
1068	1	2	1	3	1.75	Poor
1069	1	1	1	3	1.5	Poor
1071	1	1	1	3	1.5	Poor
1072	1	1	1	3	1.5	Poor
1074	1	1	1	3	1.5	Poor
1077	1	1	1	3	1.5	Poor
1078	1	1	1	3	1.5	Poor
1079	1	2	1	3	1.75	Poor

1081	1	2	1	3	1.75	Poor
1082	1	2	1	3	1.75	Poor
1083	1	2	1	3	1.75	Poor
1084	1	2	1	3	1.75	Poor
1085	1	2	1	2	1.5	Poor
1090	1	1	1	3	1.5	Poor
1091	1	1	1	3	1.5	Poor
1093	1	1	1	3	1.5	Poor
1095	1	2	1	3	1.75	Poor
1105	1	2	1	3	1.75	Poor
1106	1	2	1	3	1.75	Poor
1108	1	2	1	3	1.75	Poor
1372	1	2	1	3	1.75	Poor
1396	1	1	1	3	1.5	Poor
1397	1	1	1	3	1.5	Poor

Efficiency:

Stop ID	Location/placement	Landscape	ADA Compliant	High Visibility	Average	Rating
1051	2	3	1	2	2	Fair
1053	2	3	1	2	2	Fair
1054	2	3	1	2	2	Fair
1055	2	3	1	2	2	Fair
1056	3	3	1	2	2.25	Fair
1057	3	3	1	2	2.25	Fair
1058	1	3	1	3	2	Fair
1059	2	3	1	2	2	Fair
1063	3	3	1	3	2.5	Fair
1066	3	3	1	3	2.5	Fair
1068	2	3	1	3	2.25	Fair
1069	2	3	1	2	2	Fair
1072	3	3	1	2	2.25	Fair
1079	2	3	1	2	2	Fair
1081	2	3	1	2	2	Fair
1082	2	3	1	2	2	Fair
1087	1	3	3	3	2.5	Fair
1089	1	3	3	2	2.25	Fair
1090	2	3	1	2	2	Fair
1094	1	3	3	2	2.25	Fair
1095	2	3	1	2	2	Fair
1101	1	3	2	3	2.25	Fair
1102	3	3	2	3	2.75	Fair
1103	1	3	2	3	2.25	Fair

1104	1	3	1	3	2	Fair
1105	1	3	1	3	2	Fair
1106	3	3	1	3	2.5	Fair
1108	2	3	1	3	2.25	Fair
1372	3	3	1	2	2.25	Fair
1397	3	3	1	3	2.5	Fair
1061	2	2	1	2	1.75	Poor
1062	1	3	1	2	1.75	Poor
1064	1	3	1	2	1.75	Poor
1067	1	3	1	2	1.75	Poor
1071	1	3	1	2	1.75	Poor
1074	1	3	1	2	1.75	Poor
1077	1	3	1	2	1.75	Poor
1078	1	3	1	2	1.75	Poor
1083	1	3	1	2	1.75	Poor
1084	1	3	1	2	1.75	Poor
1085	1	2	1	1	1.25	Poor
1091	1	3	1	2	1.75	Poor
1093	1	3	1	2	1.75	Poor
1396	1	3	1	2	1.75	Poor

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BIOGRAPHICAL SKETCH

Josette N. Severyn was born and raised in Florida. She attended the University of Connecticut for her undergraduate studies, where she double majored in psychology and sociology. During her post-undergraduate studies she was a research assistant at the San Diego State University Research Foundation with Dr. James Sallis. She worked on two National Institutes of Health (NIH) funded studies, the Teen Environment And Neighborhood study and the Neighborhood Impact on Kids study. The skills she developed with these studies led her to work for Urban Design for Health on yet another NIH funded with Stanford University, while at the University of Florida. Also while at University of Florida, she worked on the Regional Cooperation in Transportation study and the Health Impact Assessment in Florida study.