BARRIERS AND FACILITATORS OF WALKABILITY:
ANALYSIS OF STREET NETWORKS AND URBAN DESIGN CHARACTERISTICS AROUND CENTRAL FLORIDA ELEMENTARY SCHOOLS

By

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To my wonderful family and close friends, for all their love and support

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Walkability is an important concept in planning. The term is built around the concept of providing healthy communities, reducing dependency on automobiles and improving health consciousness in both adults and children. However the growing rate of childhood obesity is taking precedence in many cities. Based on factors including connectivity, densities, amenities, and socio-economics, this research focuses on elementary school sites through the influence of urban design characteristics and street networks within Central Florida. Analyzing the selected school sites and deciphering what are the specific barriers and facilitators that surround them, helps produce design standards and methods that can help implement pedestrianism for every type of city infrastructure or planned development. Using geospatial data and actual surveyed data helps locate sites with high rates for walkability. After exploring the elements within both sets of data, developing a list of important urban design characteristics is meant to only provide successful means and methods of pedestrianism. Additional qualities such as distance, safety, and socio-economics also play a role in the rates of walkability of

elementary schoolchildren. Combining all the variables provides a mix of aesthetic and descriptive data used towards determining the successful models.

Preliminary findings suggest that a half-mile pedestrian network offers a realistic distance for a child to commute to school but one-mile networks are provided as a feasible travel distance as well. The urban design characteristics listed as facilitators take place within all types of developments, but the number of barriers is what determines the hindrance of walkability. Dependent upon the context surrounding the school, high rates of walkability is capable based on high residential density, low number of intersections and updated pedestrian infrastructure for children to utilize. Street grids and land use variety can provide towards walkability as well. There is also dependency on the timeframe a school was built and how is connects within the context of the surrounding environment. Socio-economics and school planning plays a larger role in determining walkability within each site analysis. Overall, these findings can suggest the important configurations of a community, emphasizing all aspects within a safe and sustainable environment.

CHAPTER 1
INTRODUCTION

Background Information

The United States is one of the most car-dependent countries in the world. Along with that, the Surgeon General recommends 30 minutes of moderate-intensity physical activity most days of the week in order to maintain good health. As for the future, energy and fossil fuel costs continue to rise, making travel cost inflated and environmentally the automobile makes up for about 25 percent of carbon dioxide emissions throughout the world. All of these elements combined are heavy concerns throughout the world. The growing importance of human health as well as environmental and economic sustainability has motivated many people to find alternative means of transportation besides the automobile and the growing popularity of providing pedestrian routes has multiple cost-free benefits. In data from 17 countries published by The National Geographic Society in 2009, they conducted a comparison study between transportation statistics between all the countries. Within the United States alone, only 5 percent of the population uses public transportation daily, only 7 percent use public transportation at least once a week and 61 percent of people have never used public transportation. In comparison internationally, 25 percent of respondents reported using public transportation daily and 41 percent reported using it at least once a week. This is a huge difference of people, especially if we consider the fact that the United States makes up less than 5 percent if the overall world population. Based off just trends given, the United States is not familiar with anything outside of personal vehicles and daily commutes. Obviously that is not a good trend to continue with.

The planning of street networks and connectivity throughout a city helps define how a city continues to expand and grow. Maneuvering streets and alleyways to become more accessible and pedestrian friendly can be a challenge if not established from the infancy of the development, but it can be done as long as multiple of the important elements within the city's infrastructure cohort the idea. Most stabilized cities, especially the ones established pre-1800, have more successful methods of circulation through many different nodes and paths that allow all its residents the ability to travel from one point to another without barriers. With remarkable consistency, cities grew no larger than someone on foot could cross in an hour. However after The Industrial Revolution occurred, the harnessing of steam power meant that people and goods could travel faster than was ever dreamed possible and that city streets, once perfectly capable of handling both foot and wagon traffic, became so crowded that movement was nearly impossible (Soderstrom, 2008). Presently cities are coping with population and residential growth challenges, the push for environmental regulations and conservation as well as economic instabilities. Most of those factors have taken precedence in many development patterns and unfortunately, in order to revitalize and maintain downtowns and city centers, necessary monetary and resident backing needs to be available.

In determining how viable a city can potentially become, people rely on factors including accessibility, building densities, options in transportation, land use categorization, amenities and safety. How cities allow these different factors to reciprocate and organize can transform and help implement a strong sense of pedestrianism within an urban center or city core. Currently this kind of living situation is becoming popular trend considering now 6 out of 10 of Americans say they would prefer to live in walkable neighborhoods, in both cities and suburbs, if they could (Florida, 2010). Children walking to school are a whole other responsibility and challenge for any type of pedestrian oriented neighborhood. The generalized notion of children being able to walk to school seems to be a gradually outdated theory. Safety and accessibility have bigger roles for parents to determine whether they allow their child to walk to and from school. There are many positives and negatives people can list, but the idea is that if a development is pedestrian friendly and safe enough for a younger child, then adults might be more inclined to walk with their children, as well as to and from their own work and residential establishment. Physical activity and accessibility to a city doesn’t just provide improved health benefits, but it also provides its residents with a sense of place and responsibility to its surroundings.

Pertaining to children being able to walk to and from school, childhood obesity has become a growing issue not only in the United States, but also internationally. Understanding physical activity behaviors among children and adolescents reveals that there are a multitude of factors that can influence physical activity behaviors among children and adolescents such as sex differences (male or female), parental overweight status, previous physical activity and perceived activity competence to name a few (Bejleri, 2010 from Sallis, 2000). Additionally, some children lack physical activity because of parental perceptions concerning safety of their environment (Beljeri, 2010 from Valentine and McKendrick, 1997). Providing an environment where not only the parent feels safe, but that they trust their child can commute whether by themselves or with other students can change the whole dynamic of a neighborhood or community, carrying along all the other beneficial aspects of having the opportunity for physical activity. Along with that, people must take into account the rising population growth and with that, rising public school enrollment. Addressing the issues now allow for smarter growth and a healthy growing population to go along with it.

Objectives

> Walkability is more than an attractive amenity- it's a magnet for attracting and retaining the highly innovative businesses and highly skilled people that drive economic growth, raising housing values and generating higher incomes (Richard Florida, 2010).

Conducting a study that provides cities, neighborhoods and their residents with the directional strengths and weaknesses surrounding the area of schools can help improve walkability. Specifying the factors included as types of barriers and facilitators of walkability[1] and using them in comparison to the characteristics of the two networks can potentially change the way children travel to and from school. Defining which factors can be determined as barriers and facilitators can help outline what constitutes an automobile network from a pedestrian network. Analyzing the number of students and residential units within the attendance zones and each catchment area forms different ratios between the general street grid straight line distance (automobile network), the adjusted grid plus additional pedestrian options (pedestrian network), and then finally the actual number of children who walk to and from school. Finally the characteristics of urban design help differentiate the ability to walk to school versus actually walking to school, also defined by the barriers and facilitators.

[1] Walkability or the term walkable (used throughout this document) refers to an area or built environment where a person can travel on foot or even on bicycle from one location to another location without creating a harmful, unsafe or inconvenient situation for him or herself.

Pedestrianism[2] is an important topic for future development of health, safety and land procurement reasons, along with many others that is defined later. It is important to establish the context and the variable being affected, which in this case is schoolchildren, before properly focusing on any sort basis of analysis and conclusion. As for the context, the data used in this study was generated purely from 31 randomly selected elementary schools between the four counties of Hillsborough, Orange, Seminole and Pasco within the state of Florida from a concurrent research project at the University of Florida as part of the Safe Routes to Schools charter. Each of the surveyed elementary schools focus on the actual survey and geospatial data within half-mile and one-mile of each point based on technical analysis and then furthermore by specific urban design characteristics to determine the advantages and disadvantages of each. As for the variable of schoolchildren, the study focuses only on elementary school children that are within kindergarten and 5th grade. Between the University of Florida Geoplan Center and the Center for Health and the Built Environment, the study is a more specific analysis of walkability to and from schools in relation to several elements of urban form, specifically the built environment. The overall goal of this analysis is to define those characteristics of urban design in relation to mainly the pedestrian oriented network in order to setup a formula that can potentially help establish how walkability can be successful and potentially unsuccessful. A comparison and contrast between the evidence in both scenarios is then conducted.

This document contains five chapters in total. The next four chapters contain a literature review, methodology, results and finally a detailed discussion of the research.

[2] Pedestrianism is the design for pedestrian dimensions and distances through compact form, layout, and streetscape characteristics (Nelessen, 1994).

Chapter 2 examines the research available regarding health in the built environment, walkability and urban design characteristics. Chapter 3 provides an overview of materials and data used within the study. Chapter 4 presents the results and findings of the study. Then Chapter 5 further discusses the conclusions and interpolate any further analysis that can determine a formula for walkability.

CHAPTER 2
LITERATURE REVIEW

This chapter focuses on the important aspects within the focus of school siting and walkability. Further implications promoting walkable school communities include topics such as health, land development trends, pedestrian patterns and complexities, and urban design characteristics. The literature begins to dissect the main benefits and growing health trends of walkability, including how a healthy community can be developed and how children health tendencies are dependent upon their environment. From there the focus explains the historical aspects and regulations of Florida’s land use development trends, concentrating on growth management and public school facilities siting procedure. Next, defining walkability including how it can be measured and the complexities of children walking patterns. The last section describes the barriers and facilitators towards walkability using the characteristics of urban design and includes the two important aspects of street connectivity and residential density. This section provides justification and foundation for my research study.

Health in the Built Environment

The positive health benefits of walking or any sort of physical activity have been well established for a long period of time. The Center for Disease Control has stated that though physical inactivity has been shown to be a leading cause in mortality, less than 50 percent of the adult population engages in the recommended levels of physical activity. Along with that, childhood obesity has become a growing concern within the United States. As of recently, 33.6 percent of children and adolescents are considered obese or at risk for becoming obese, which is three times the rate of obesity in children and adolescents for decades ago (Wang, 2006). Childhood obesity has been attributed to a number of factors related to diet, physical activity, and changes in children's daily activities. The concepts of providing outdoor activities and the means of easily walking or biking to multiple locations within a minimal distance from each other, can provide people subconsciously with alternative ways of getting the physical activity needed to maintain a healthy lifestyle.

Most recently the concept of cities and developments providing externalities that promote physical activity has started to become popular. Urban environments are far from homogeneous, and neighborhood-level measures of the built environment have been associated with levels of walking (Lovasi et al., 2009) and obesity (Papas et al., 2007). The dimension of built neighborhood environment measures remains a debate in public health research. Many public health studies have focused on the traditional risk factor approach, which examines the independent effects of specific neighborhood characteristics related to physical activities (Yan, 2009). The built environment design provides cues and opportunities for physical activity, and perceptions of the neighborhood environment play a large role in shaping physical activity behaviors. Some research has shown positive associations of moderate physical activity levels with both objective and perceived accessibility of destinations such as shops, stores, and interesting places within walking distance. In addition, perceptions of certain neighborhood features (e.g., well-lit streets, biking or walking trails, pedestrian safety, traffic volume and speed, disorder, and crime) are associated with physical activity (Yan et al., 2010).

Understanding the correlates of physical activity is a prerequisite for developing evidence-based interventions; increasing numbers of studies are identifying physical environment attributes as correlates of physical activity behaviors (Gebel, 2009). Factors in the built environment such as street connectivity and residential density are two main physical attributes of a community that have an impact on physical activity. However, walking in most areas has become a lost mode of transportation. In early versions of traffic modeling software, pedestrians were not included as a default, and even today, modeling software tends to treat them not as actual actors, but as a mere “statistical distribution,” or as implicit “vehicular delay” (Vanderbilt, 2012). Pedestrians are a burden to certain forms of development because they offer a challenge for developers to accommodate for.

Childhood Obesity and Physical Inactivity: Childhood obesity is a growing issue not only in the United States, but also internationally. Adding to the constant population growth and rising public school enrollment numbers, this is a topic that could be changed by healthy community involvement and planning. The multiple factors that can influence physical activity behaviors among children and adolescents include sex differences (male or female), parental overweight status, previous physical activity and perceived activity competence (Bejleri, 2010), and mostly parental perceptions concerning safety for the child’s environment. Children and adolescents are spending a lot more time inside their homes than before, mostly including more time in front of televisions and video games. Along with that, there is the constant concern for safety within communities for children especially concerning elementary-aged students. Changing physical regiment and daily routine could possibly be the largest challenge towards improving a student’s health and life choices. If a community safely allowed for a child to simply just walk or bike to school, even if that was the minimal change in daily routine, it could provide the necessary physical activity needed to maintain a healthy lifestyle.

There is a connection between the built environment and physical activity with children. Many public health studies have focused on the traditional risk factor approach, which examines the independent effects of specific neighborhood characteristics related to physical activities. However, from an urban planning perspective, specific aspects of the built environment, such as land use mix and density, occur concurrently in neighborhoods (Yan et al., 2010). In many cases, children are deprived of the opportunities to engage in physical activity due to a growing separation between residential dwellings and commercial, civic, and institutional services (e.g., school facilities), inadequate provision of community places for children to commune (e.g., parks, ball-fields, and other (natural) recreational destinations), and the lack of necessary infrastructural elements like sidewalks, bicycle lanes, and other pedestrian pathways that support recreational and travel opportunities (Day, 2009). Provisions towards a city having to provide these types of spaces and infrastructural improvements are important to the health of all its residents.

Land Use Development in Florida

What are the major concerns today with planning and development? First there is urban sprawl, next there is the issue of water conservation, and then later air pollution in relation to car use and lack of alternative methods of transportation. In the state of Florida alone, the population is set to double by the year 2060 to over 35 million people. The automobile-dependency trend throughout the United States has caused for many different areas of low density and sprawl to occur outside major nodes and cities, including multiple small and large school neighborhood developments. Recently it has come to the attention to the public that there is a higher need for innovative and strategic planning for our future, otherwise natural resources will continue to be threatened and the quality of life could possibly diminish. This is where we acknowledge the fact that besides all the rules and regulations that are already in place from the state, there is a need for implemented guidelines for community development with a heavy emphasis on the physical environment, connectivity and density, including modern social and economic sensibilities. Focusing on the discussion of school siting and development, similar guidelines and regulations that provides students with the proper means to safely travel to school is important to strategic planning for the future.

Transportation development has taken a huge leap in importance in the last few decades with the recent complications and stipulations towards natural resources and pollution. The main discussion would be toward providing alternative methods of transportation. If the trend for the personal automobile cannot be decelerated, then the focused on making sure traffic density is dissipated and not continually overwhelming (less traffic lights possibly). A few best practices would be “Design the street network with multiple connections and relatively direct routes”, “Provide networks for pedestrians and bicyclists as good as the network for motorists” and “Incorporate transit-oriented design features.” Contemporary planning in Florida has allowed networks of developments with their curves and dead ends to go around or stop short of valuable natural areas. (Ewing, 1996) With the heavy integration of good land use practices, transportation can provide the ample amount of reserve space for environmental sustainability.

Aside from transportation development, residential development is also another huge contention within the concept of school planning. Functionalities including affordability, diversity, measured density, and location are the main topics of discussion. The integration of affordable single-family housing with moderate-income housing could make a bigger impact for a community than someone might expect. These sorts of housing opportunities are dependent upon the community and its residents. However if you integrate a better land use development and better transportation circulation, any combination might work in helping tighten the housing density the United States deals with when discussing urban and suburban sprawl. By combining some commercial land use within housing areas one might create a better walkable community.

Siting of Public School Facilities

Combat growth is a growing problem related to school siting trends in recent years. The idea of trying to reduce sprawl has actually promoted families to move to the suburbs so their children can attend newer and generally develop tense socio-economic segregations between the newer traditional neighborhood developments within these newer suburbs and the older established urban schools. Comparing the concept of economics, specifically distinguishing how much income the child's guardian annually accumulates, as well as the likelihood as to whether or not a child ultimately walks or bikes to school provides its own challenges. The suburbanization trend could be partly promoted by some of the newer public school siting trends there has been within the United States. One way of controlling enrollment and capacity within schools, which was developed by district school boards, was by School Attendance Zones (SAZs). These are specifically geographic boundaries that provide schools with a maximum zoning radius as to where the students must reside in order to attend the school. They were established based a series of factors, including safe and efficient student transportation and travel (Table 2-1). The SAZs vary in size and shape across the school district depending upon the density of children in the residential neighborhood surrounding each school.

There are also other incentives for school siting adjacent to or within neighborhoods. When it comes to basic infrastructure, when school development happens near already established roads, water and utilities, the cost effectiveness is much lower. Also if the development is within a generally walkable community, transportation costs are estimated to be lower as well. However these types of school locations usually pull people away from city centers and take away from promoting schools within those established areas. It is also common to have a disconnect between local and state governments with jurisdictional school districts on decisions related to siting, building, ad renovating schools. Those decisions are driven by competition with neighboring districts and demographic shifts. The responses that are taking shape as part of movements focusing on smart growth, sustainability, livability, or healthy communities, all call for both a shift in the way we think about school siting and a change in the strategies we use (Miles, 2011). The focus of school siting should be based on providing a continually updated educational system with safe and infrastructural-sound school facilities. There should also be a focus in creating schools that are integrated within the community, providing healthy and safe conditions for students to get to and from their homes.

Growth Management in Florida

The multiple regulations in place today help with controlling unplanned growth as well as reallocate the initial blame, whether it’s bad regulations, population increase or developers. The timeframe of when the school was built plays the main role in assessing its initial development. Segmenting the different growth management legislation eras are defined as follows: schools sited before 1950 (historically these schools were sited within residential districts), schools sited between 1950 and 1985 (the period prior to the enactment of the 1985 Growth Management Act), schools sited between 1986 and 1995 (the period prioer to the State requiring school districts to share development information with local governments), and schools sited after 1996 (the period in which the requirements for school siting have become increasingly stringent) are all compared. Using these time periods to compare the indicators of the pedestrian environment offers insight into the evolution of urban form around elementary schools and the implications of urban form for the potential of children to walk to school (Bejleri, Steiner, Provost, Fischman, & Arafat, 2008).

Defining Walkability

In data from 17 countries published by The National Geographic Society in 2009, only five percent of Americans surveyed used public transportation daily, and only seven percent reported taking public transportation at least once a week. Sixty-one percent of Americans reported that they never use public transportation. Internationally, 25 percent of respondents reported using public transportation daily, and 41 percent reported using it at least once a week (Benfield, 2011). Also there is evidence that when the 1960 Census collected and published information regarding Journey to Work the original numbers began with 13 percent taking transit, 10 percent walked and 7 percent worked at home (think farmers) (Pisarski, 2011). Since then, mainly with the growing trend of the private vehicle within the last 50 years, the public transit and walk modes have declined. Obviously there are many choices of transportation today, but these are becoming an increasing privilege considering the abundance of economic and environmental means it now requires to operate an automobile. Not only that, but there are so many technological distractions currently that walking and even driving are both slow declines and instead people are at home in front of their computers. Walking and biking are both alternative means of transportation that do not require any cost fluctuations and do not cause any environmental contingencies. In addition, the American Heart Association also claims that studies are showing that for every hour of walking, life expectancy may increase by two hours. The benefits of creating a safe pedestrian-friendly environment have proven to be not only cost effective, but a healthy stimulation for its residents.

There are many different websites and resources that provide insight towards the promotion of walkable neighborhoods. One great resource is Walkscore.com, which is an online group that rates walkable neighborhoods, providing detailed data on walkability for 2,500 cities and 6,000 neighborhoods across the United States. This one important measuring tool that helps determine the relation between cities centers, people, mixed income, parks and public spaces, pedestrian design, schools and workplace, and complete streets (taken from www.walkscore.com). Richard Florida, a social and economic theorist, has done extensive analysis involving Walk Score and was able to relate walkability with key economic and demographic characteristics in the U.S., which helped define “significant associations” (2011). He was able to produce relationships that proved that walkable metros had higher levels of highly educated people, higher wages, higher housing values, more high-tech companies, greater levels of innovation, and more artistic associates. These outcomes show pedestrianism playing an ecological and financial importance overall.

The concept of moving back to the city and out of the suburbs has been slowly becoming a popular concept in recent years, considering the economic and environmental challenges our society is experiencing. Trending numbers shows that people are ing to pay more to live closer in proximity to work and social activities. Along with that, because of the current price of gasoline and pressure to reduce consumption of natural resources, people are looking for alternative options that do not depend on an automobile or any additional expenses. This option also includes concerns with school children and academic placement. Some parents and guardians are willing to relocate so their child can attend a better ranking school. These concerns are basis for further research on walkable communities and its long-term benefits. Residents in many cities are requesting options or moving closer to these alternatives, mostly discussing options of transit. Even the popularity of retrofitting car-oriented developments into more pedestrian-friendly, mixed-use communities are becoming continually popular throughout the United States. These being only a few concepts pertaining to economic aspects of walkability, furthermore people can make the assumption that the change in economy and demography promotes the relationship of walkability.

The physical attributes apart of walkability include all of those measuring tools, but it is also dependent upon physical building and spaces and how they adapt over time to reflect new social and economic needs without exact references to any historical period.

Providing incentive for people to move closer to places they frequent on regular occasion is an important thing to the consumer. Families want good schools and safe neighborhoods for their children. Young professionals generally want to live nearby where they work and in close proximity to social activities (restaurants, bars, etc.). Each individual provides a different challenge to meet, but with the proper density in place and a good model to develop by, cities can successfully provide all these things and more.

Measuring Walkability

Physical proximity is one of the main factors of walkability. There are two groups of measures of pedestrian travel in the context of the physical environment: general walkability and origin-destination walkability (Bejleri et al., 2011). Literature shows that on average, an acceptable distance for pedestrian and transit-friendly travel can be distinguished by a 5- to (maximum) 10-minute walk, which is approximately one-quarter to one-half of a mile (Bejleri et al., 2010 from Ewing, 2000). The further a child lived away from the school, the least likely he/she was able or even allowed to walk or bike to school. General aspects of walkability include specific numbers of intersections and block length and size. For example, smaller block sizes or shorter block lengths indicate better connectivity or greater potential for movement through space (Bejleri et al., 2011 from Dill, 2004). In relation to the origin-destination walkability, measurements focusing on the straight-line distance between the origin and destination along the walkable network are one concept and the measurements related to residential density is another. Concentrations of residential dwellings in proximity to desired locations provide an indication of the potential for individuals to travel between home and a destination.

Providing the part of the data that are viable towards calculating walkability must first focus on what it is people are walking to. In a publication in The Atlantic, Richard Florida digested how certain cities rank higher than others on websites like

Walkscore.com. Their data states that walkable metros had higher levels of highly educated people that had higher incomes and higher housing values, more high-tech companies, and greater levels of innovation (Florida, 2011). This is only primarily discussing what specifics correlate with pedestrians being primarily adults. Calculating children walking specifically to school must not only take into account sometimes the lifestyle of the parents, but also car ownership, work timeframe, aspect of older siblings, health of the child and parent and any specific urban design detail that could derail the accessibility of a walkable route to the school location.

Complexities of Children Walking Patterns

In 1969, 40.7 percent of children walked or biked to school compared to only 12.9 percent in 2001, a 68 percent decline, according to analyses of the National Personal Transportation Survey (McDonald, 2007a). Certain barriers, such as age, sex, and distance, generalize breaking down the physical and mental capacity of allowing a child to walk or bicycle to school. Children under the age of six, unless they have older siblings or guardians to escort them, might be typically generalized as being too young. Children between the age of seven and nine have a more broadened sense of direction and safety and by the age of ten, most parents might trust their child to walk to school by themselves, obviously dependent on the built environment from their home to school. According to the National Highway Traffic Safe Administration (NHTSA) children, even in the same grade, vary in their readiness to handle traffic situations, such as choosing a safe time to cross a street. In general, children are not ready to cross a street alone until age 10 (http://www.saferoutesinfo.org/program-tools/what-age-can-children-walk-school-themselves).

If schools are located in automobile-dominated neighborhoods, a child's opportunity to walk to school is diminished. Alternatively, children can walk or bicycle to schools located near residences with a high level of connectivity (Bejleri et al., 2008). There have been many different studies done in relation to students walking to school associated with community design as well as child and parent barriers. In a "walkable community," students attend walkable schools that are centrally sited in a walkably designed community that featured narrow streets leading to the school, no cul-de-sacs, road-separated walking paths, and an adjacent community recreation center. Town homes and single-family detached dwellings were clustered on relatively small lots, so that all students lived within a mile of the school. In the "mixed community," children attended the walkable school but lived just outside the boundary of the walkable community; 75% lived within a mile of the school. This community featured standard suburban design- many cul-de-sacs and larger lots. In the "less walkable community," students lived in a neighborhood near the two other groups but in an area with larger lots so that only 35% lived within a mile of school (Napier, 2010).

Urban Design Characteristics

Defining what qualities make a city a successful pedestrian-influenced urban core, focusing on urban design characteristics, help outline this research topic. The specific list of important variables includes aspects of not only walkability, but also urban design and land use. Urban design elements include architecture, land use categorization, usage of public space, traffic solutions, quality of sidewalks, and street level activities as some of the variables that determine the type of livable community people live in. Land use mainly divides the separation between commercial, residential, and mixed use (or multi-family), amongst a few others. The main theory is that each particular aspect defined of urban design and land use can manipulate the outcome for pedestrianism to be a popular transportation option. Combining these urban design and land use elements, there are design principles outlined to help plan for a unified community. Nelessen's book (1994) focuses on a few principles starting with designing for the human scale. The human scale is the relationship between the dimensions of the human body and the proportion of the spaces, which people use. This is important in order to make sure the elements mentioned are proportional for pedestrians and facilitate human interaction while enhancing the human experience. Additionally, within the design principles there must be a focus on pedestrianism, open spaces, community focus, streetscapes, and maintenance to name a few.

Ewing and Handy's (2009) article discussing the measures of urban design qualities that relate to walkability mentions that because of the importance of walking becoming a bigger issue day by day, even with the Center for Disease Control and Prevention (CDC), measuring tools like walking audit instruments have become widely used across the U.S. by researchers, local governments, and community groups. Active living research has found that even though it is important to try and focus on more than just the physical features, those physical features influence the quality of the walking environment both directly and indirectly through the perceptions and sensitivities of individuals. Along with that, Forsyth and Southworth (2008) discuss in their article how high-speed traffic broke up the pedestrian networks of the U.S. and how streets that lost their intimate scale and transparency just became a mere service road, separate from the public. In relating both articles, an observer can then start to believe that the perception of safety related to the speed of cars might influence someone's decision to walk within the vicinity. Obviously there are more elements that affect a person's decision other than just the perception of safety. However the perception of walkability alone can include other aspects, for example: proximity, fluidity, safety, and social scale. It comes down to personal needs per each individual to have in order to feel comfortable and make it a viable option amongst others, dependent on what options are available and feasible.

Factors include total number of automobiles, energy and rising restraints of natural resources (available fossil fuels and gas prices), aesthetics and current building infrastructure, zoning and regulations, human health, history and weather patterns are either permanent (non-changing) or differential variables that play important roles in defining barriers and facilitators within the study. Some factors weigh more heavily amongst the others, but the commonalty between all the sites is the specifics needed to define an outcome. Common barriers that may reduce walkability between home and school could include hazardous walking conditions like inadequate sidewalks, high speed and volume of traffic, fences or walls, and the absence of crossing guards to facilitate the safe crossing of the street (Bejleri et al., 2011 from Dellinger and Staunton, 2002). In contract, facilitators that can enhance opportunities for walking could include trails and other informal pathways, rear entrances to school grounds and the employment of crossing guards at hazardous street intersections (Bejleri et al., 2011). Both are important

Two main characteristics focused upon in urban form are explored in this study: *Street Connectivity* and *Residential Density*. Street Connectivity is analyzed using three indicators: (1) Street Density, (2) Intersection Density, and (3) Pedestrian Route

Directness (PRD). Residential Density is also analyzed using three indicators. The first two are strict measures of residential density including (1) Gross Residential Density and (2) Net Residential Density (Bejleri, et al., 2008). The third measure (3) Effective Walking Area (EWA), is used to make assumptions on potential walkability based on the percentage of residential parcels that are found along the street network. Both of these main characteristics are represented in not only the two types of adjusted and unadjusted network sheds, but also within the analysis of urban design dimensions.

Furthermore, by collecting the multiple parts of the data within the study and then creating an outline for an urban design analysis based on Matthew Carmona's dimensions of urban design, specific questions about the site and its surroundings are focused upon in full detail. Focusing on the dimensions such as morphological, perceptual, social and visual, this separation is for the purpose of clarity in exposition and analysis only. Overlapping and interrelated, these dimensions are the 'everyday matter' of urban design (Carmona et al., 2003). Creating an overall complexion for pedestrianism, considering both the technical systems and the detailed design complexities, completes an overall design aesthetic and overlay that promotes and continues to change with time.

Street Connectivity

Because streets accommodate most forms of travel, their importance serves as a central focus in understanding patterns of walkability (Bejleri, et al., 2010). Historically cities have developed using different patterns and trends. At the beginning, based on early European city development plans, the older United States cities were laid in a gridiron pattern, but over time with the development of automobile and other technologies started to bring about irregular forms of roadways some made up of cul-de-sacs and dead ends. The circuitous nature of lopping roadways of automobile thoroughfares, focused on making residential streets safer for the pedestrian. Conventional street designs have had adverse effects resulting in reduced connectivity, an increase in vehicle miles traveled, increased traffic conditions, and a host of other public nuisances and health-related issues (Bejleri, et al., 2010 from Frumkin et al., 2004). Theorists and planners such as Clarence Perry and Clarence Stein both publicized the importance of street hierarchy and pedestrian-friendly neighborhoods. Both men were some of the early promoters of a community development built around a school, which unfortunately took on many different forms by developers as subdivisions and presumably safer informal road linkages.

Street connectivity can be used to create social interactions and spaces throughout different areas of a city. Segments of streets can be designed to accommodate pedestrian use and outdoor dining at midday as well as large public gatherings at other times. Along with that, sidewalks connected to these streets are social spaces. They require great care to maintain their vitality as something more than pedestrian conduits (Crankshaw, 2009). There are also measurements for street connectivity that helps promote ideal block lengths and sizes, levels of density and standards for pedestrian’s route directness. Table 2-2 summarizes the most common measurements utilized in the urban planning field as proxies for street connectivity and ranges of values associated with high connectivity (Bejleri et al., 2008). The connection between the built environment and the physical activity of children and adults is prevalent.

Residential Density

Density is often defined using population, employment, or floor-area ratio. In this case, residential density statistics, using housing unit counts, indicate the maximum number of students who potentially live within pedestrian sheds around the selected elementary schools (Bejleri et al., 2008). This data provides a generality for how many potential students live within the SAZ attending the school and where the majority of the neighborhoods lie directionally towards the school location. However, it must also be taken into account that not every household has a child and some might have multiple, but the general idea is to identify the direction and path a student potentially takes from within a neighborhood cluster to the school. Obviously this concept can be different in other types of urban or rural developments. In other cases, a more urban development might have residential land use mixed with other types of commercial and mixed land uses within smaller block sizes or a more rural development could otherwise be vastly spread out to include larger block sizes. All types of residential densities are important to the potentiality of walkability.

Higher residential densities as part of a pedestrian-friendly environment may lead to an increase in walking as a person's primary transportation mode. As a result, individual physical activity levels may increase (Bejleri et al., 2008).

Table 2-1. Criteria for establishing school attendance zones

Priority	Determinants
1	School Capacity
2	Convenience of access to schools
3	Safe and efficient student transportation and travel
4	Effective and appropriate instructional programs
5	Socio-economic diversity in school enrollments
6	Financial and administrative efficiency
Source: Florida Statutes 1001.4141	41 (2), F.s.; 1001.42(4); 751.01-.05, F.S.

Table 2-2. Summary of common street connectivity measures

Measure	Description	Ideal Values
Block Length	Blocks are the land area carved out by the street network. It is presumed that shorter the block, the greater amount of connectivity	300 to 600 feet (Dill, 2004)
Block Size	Measured by the length and the width, blocks that are smaller in total size presumably infer better connectivity	Fort Collins, Colorado requires block sizes to be between 7 and 12 acres (Steiner, et al., 2006)
Street Density	The total linear miles (or kilometers) of streets per unit of area (usually in square miles of kilometers)	Not identified
Intersection Density	The number of intersections per unit of area (usually in square miles or kilometers). It is presumed that higher density equates to higher connectivity	Over 78 intersections per square mile (Frank, et al., 2005)
Pedestrian Route Directness (PRD)	The ratio of network distance to straight-line distance for two selected points. Numbers closer to one may represent better connectivity	Values between 1.2 and 1.5 have been recommended as acceptable standards (Dill, 2004)
Residential Density	The total number of dwelling units (or parcels) per unit of area (usually in square miles or kilometers)	Schools located in neighborhoods containing 5 dwelling units per acre (City of Raleigh, NC, 2008)

Source: Bejleri, et al., 2011.

CHAPTER 3
METHODOLOGY

This chapter describes the specific data and the method that were used to analyze the walkability (including both pedestrians and bicyclist) of children in each surveyed school in Central Florida. Parts of this methodology was generated from a research project at the University of Florida as part of the School Siting and Children's Travel study developed by Drs. Ruth Steiner and Ilir Bejleri, funded in part by the Robert Wood Johnson Foundation (Steiner, et al., 2008; Bejleri, et al., 2008). The concept originated from The Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) legislation calls for the establishment of a Safe Routes to School program in each state that was funded for the five fiscal years from 2005 through 2009.

The research examined the data within school attendance zones, related to patterns of children commute (walking, biking, and motorized) to selected elementary schools located in and around central Florida. The main research components include: (1) the study area and school siting analysis; (2) analysis of the potential walkability for children to and from elementary school sites based on the geospatial data collected and examined; (3) analysis of the actual children walking and biking to school based on the in-school survey data; (4) full comparison and analysis of both potential and actual commuting totals to and from the schools focusing on the schools with high rates of walking; and (5) analysis of specific urban design aspects that provide the accessibility to the successful case studies.

Establishing the Study Area

Naturally any parent or guardian might question letting a young child, averaging between the age of 5 and 11 years old, walk more than two miles to and from school. Aside from that, literature also shows that on average an acceptable distance for pedestrian and transit-friendly travel can be distinguished by a 5- to (maximum) 10-min walk, which is approximately one-quarter to one-half of a mile (Ewing, 2000). However, as stated before, the State of Florida established a two-mile buffer around each school point where school bus transportation is not provided unless there are special circumstances. Taking into account the state regulation and using a geographic information system (GIS) to attain, manage, analyze, and display geographically referenced data, this study focuses on the specific designs within the half-mile maximum pedestrian-friendly network and the one-mile network within Florida's Pasco, Seminole, Orange and Hillsborough Counties.

The surveyed schools and any addition data collected within each county were taken around the specific points of all the 31 surveyed schools, becoming the main focus of the study area. All the surveyed schools were randomly selected within the four counties, but only 26 of the 31 surveyed schools are represented by name within this study based on privacy regulations. These school districts were chosen because they have large populations (>400,000 in 2006), high rates of enrollment (>30,000 in 2005-2006 with >20 percent student enrollment growth from 2000 to 2005), and contain at least 30 elementary schools representing a range of time periods in which schools were constructed (Bejleri, Steiner, Fischman, & Schmucker, 2010). Each school represents a different time period for development, whether historical (constructed before 1950), pre-growth management (constructed between 1950 and 1985), pre-school coordination (constructed between 1986 and 1995), or post-school coordination (constructed after 1995). These specific datasets are helpful in explaining population growth and growth management aspects that helped shape the development and policy regulation once the analysis of the built environment characteristics take formation.

Within the data, the study first focuses on the specific school site and the School Attendance Zones (SAZs). All the SAZs vary in size and shape dependent upon student and residential density, which furthermore determine the "pedestrian" (adjusted) and the "automobile" (unadjusted) network sheds, the two important measures used for breaking down the geospatial data. GIS data layers assembled for this study include high resolution aerial photographs, school attendance zone boundaries, school point locations, roadway network (including the specific number of intersections and hazardous walking conditions), property parcels, census data (specifically focused on income and vehicle ownership), crash frequencies and de-identified[1] student residential locations (generalized by actual residential density in the Figures).

Development of Variables to Measure Walkability

From the selection of all 31 surveyed schools, there are multiples elements of data as established in determining the study area. The multiple items of information within this study are all based on the potential walkability versus the actual or realized surveyed total. When focusing on the two types of network analysis (or catchment areas) within the geospatial data, there is an adjusted and an unadjusted dataset that translates to the assumable pedestrian and automobile networks as the first analysis of the study. Secondly, there is also the availability of the survey data that can provide

[1] De-identified data refer to a data set in which sensitive information has been removed to protect the identity of students (Bejleri, et al., 2010).

actual numbers and percentages of the different methods of transportation amongst the students that attend each school, later used in comparison to the probable data that is within the GIS data.

Development of Adjusted and Unadjusted Network Sheds

The research amongst these four counties and each school attendance zone begins based on analysis of trends in street network connectivity and residential density near its zoned school. These variables are measured by determining the number of residences that have reasonable walking and bicycling access to school or have incomplete commuting paths that would not hinder the student otherwise within both zonal areas of half-mile and one-mile. Using GIS network analysis and previous studies, a pedestrian and bicycle connected “catchment area” was determined as well as an automobile area. The catchment area is a polygon that encapsulates all the parts of the network that are fully connected, otherwise referred to as sheds.

As part of earlier research analysis, pedestrian sheds of half-mile (10 minute walk) and one-mile (20 minute walk) were first generated around each school based on (a) straight-line distance, (b) roadway network distance and (c) pedestrian network distance adjusted for barriers such as major roads, and lack of sidewalks and facilitators such as pedestrian paths, crossing guards and rear entrances to school. The pedestrian sheds are compared based on two measures: (1) pedestrian route directness (PRD) – an index that measures urban form permeability and connectivity and (2) the student count in each shed – a measure that indicates how effectively the pedestrian shed captures potential students along these networks.

An additional zone also analyzed in earlier studies, represented as the pedestrian network shed, was created using the street network around each school. Both the pedestrian shed and the pedestrian network shed extended beyond the boundaries of the SAZs and were adjusted to reflect the area contained within the school attendance zone (Bejleri, Steiner, Provost, Fischman, & Arafat, 2008). 3-1 shows visually how these pedestrian network sheds were created. Furthermore, the adjusted and unadjusted networks sheds refer to the modifications made for the school attendance zones in relation to barriers and facilitators. Figure 3-2 shows the generation of pedestrian sheds from the original potential walkability diagram to the potential walkability adjusted for barriers and facilitators. The final catchment areas (pedestrian sheds) were created using ArcGIS Network Analyst extension. The difference between the two sets of final catchments network sheds used in this study is that virtually no adjustments were made for pedestrian walkability and hazardous walking conditions, separating the “automobile” (unadjusted) from the “pedestrian” (adjusted) networks. The adjusted walkability network was developed based on zone-specific indicators within each zone. These factors included: availability and design of a continuous, predictable, and safe sidewalks and bike paths, and barriers to the safe movement of pedestrians and bicyclists (e.g., major arterials, ditches and swales, difficult street crossings).

Actual Walkability Survey Data

The data that provides the actual student counts and the potential data are from two different forms of research collections. Surveyed teacher-administered in-school data was previously collected over a three-day period between 2007 and 2008 from each school helping to identify the specific number of students that not only have the ability to walk or bike to school, but actually use it as a daily means of commute in comparison to the other forms of motorized transportation. The geospatial data previously discussed as the “pedestrian” or adjusted network has been taken from data previously collected and analyzed, as well as from the Florida Geographic Data Library (FGDL). This data included generalized locations of where students live for the purpose of zoning, quantifying the total number of students that accessibly live within both half-mile and one-mile connected networks. The overlapping of both data provides both the actual and potential student numbers that can provide percentage used to range each school on levels of walkability, furthermore increasingly focusing on the specific schools that can provide methods for walkable development.

One difference between both sets of data is that the survey data is unable to specifically locate whether the student being surveyed lives within the one-mile network boundary. Even though the survey data is separate from the geospatial data and does not provide a specific description of how far each child lives from the school, it still provides a good understanding which school has the better chance of walkability just based on the previous research based on walking commute times and children's walking trends. Charting out the numbers from each day and combining the walkers with the bicyclists in comparison to the daily school population can provide a specific walkable percentage for each day, regardless of the specific location and travel route of the student.

Barriers and Facilitators: Urban Design Variables

There are many urban design factors that can affect walkability. This part of the method is primarily focused on urban design variables around each school and within the half-mile or one-mile area in order to define what makes it different from the other school sites based on rates of walkability. The focus was placed on a select number of school sites within the half-mile and one-mile network that have the highest rate of potential walkability as well as a high percentage rate of actual pedestrians. Measures were developed for the size, placement and layout of the adjusted catchment areas.

As for the specific barriers and facilitators of walkability, the main focus was to determine the specific aspects that define the surrounding urban form and creating the opportunity for pedestrians. Within each shed measures were developed for number of students, the average pedestrian route directness (PRD), and number of housing units. Major roads, speed limits, personal safety aspects (streetlights, crossing guards, etc) and the lack of sidewalks act as the main barriers. Facilitators considered included pedestrian paths, crossing guards, siblings, and the specific number of access points and entrances to schools. Some of these variables can be both barriers and facilitators, which include time management, motivation, environment, and school-related aspects.

Summary

The multiple sets of data within this study were developed to measure urban design characteristics that promote walkability. Focusing between the half-mile and one-mile pedestrian and automobile catchment areas as well as the potential numbers stemmed from the pedestrian catchment and comparing them to the actual student numbers within the surveyed data provided the basis for the actual school sites necessary to understand the role of barriers and facilitators of children travel to school.

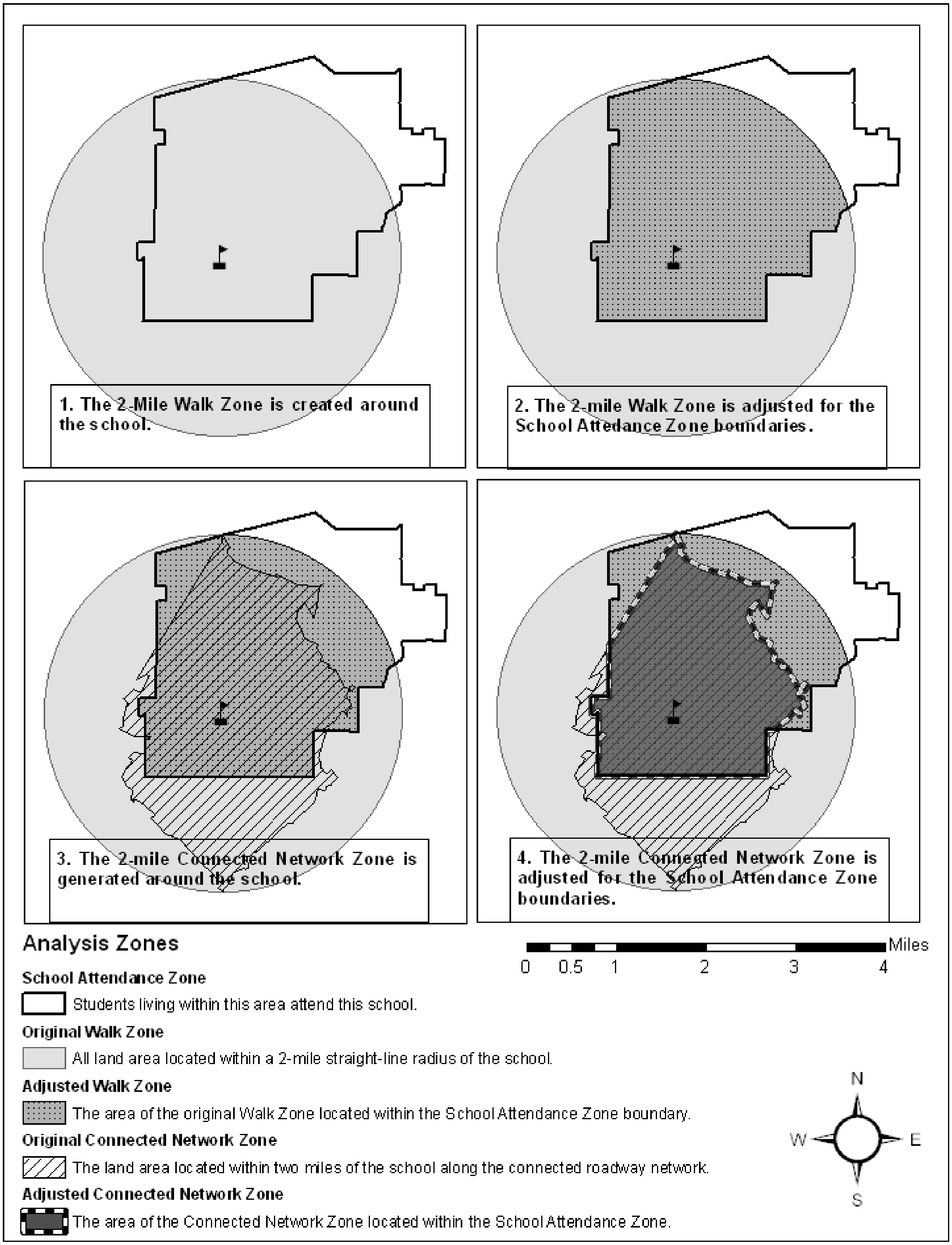


Figure 3-1. Creation of analysis zones (pedestrian sheds) (Steiner, et al., 2008)

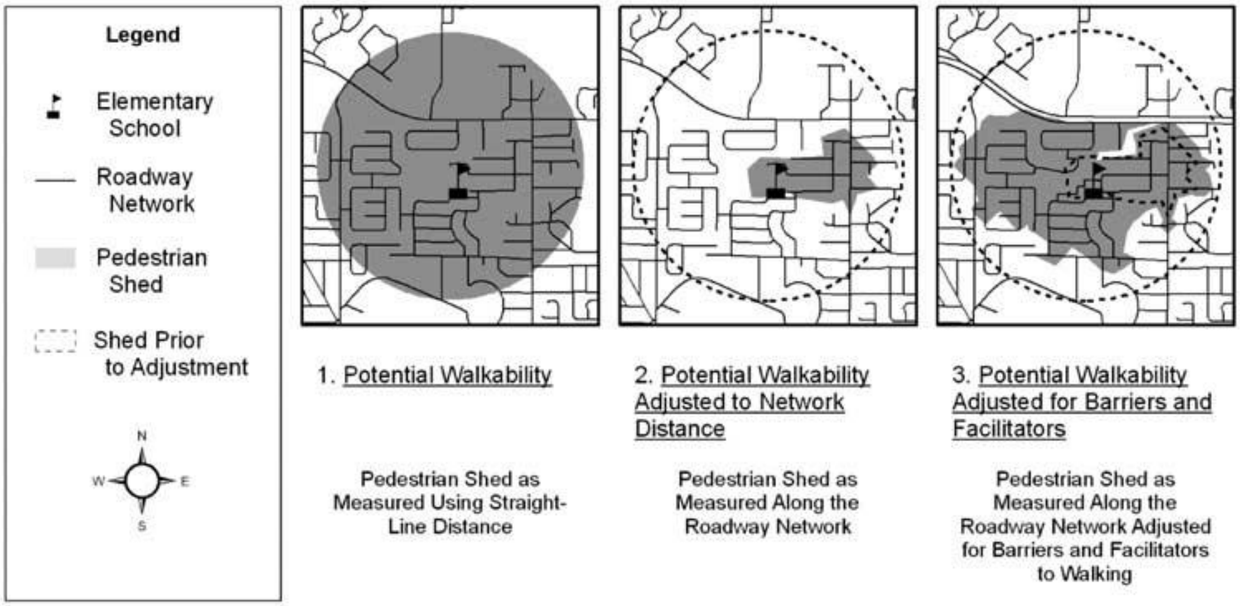


Figure 3-2. Generation of pedestrian sheds (Bejleri, et al., 2011)

CHAPTER 4
RESULTS

In this Chapter, the results are provided in four separate sections. The first section provides the overall results of the study area and school siting analysis. The second section presents a comparison analysis of selected elementary schools within Hillsborough, Orange, Pasco and Seminole counties of the adjusted and unadjusted catchment areas including a comparison using the survey data. The third section breaks down the specific urban design characteristics of at least one specific school site per county that showed high rates of walkability. The last section provides a summary of the overall outcome.

Overview of Study Area

The four counties in this study represent a significant portion of the total population and total student enrollment for the State of Florida (Figure 4-1). The 26 specifics schools (31 total within complete data) within the four central Florida counties of Hillsborough, Orange, Pasco and Seminole, represented a large sample of schools built during different time periods, as well as a large and continually growing study region within the state of Florida. According to Florida's Economic and Demographic Research correlating with Census data in 2011, Hillsborough and Orange County make up two of the top five most populous counties in the state and population growth is level or continuing to increase. Orange County gained the most population in the state between 2000 and 2010. Between 2000 and 2010 Census, the data concluded that all four counties saw anywhere between a 13 to 25 percent (average of 20 percent) increase in overall population along with an increase in total number family households an average of 13 percent (Figure 4-2). Most importantly, the total elementary student enrollment of all four counties equals about 19 percent of the State of Florida's overall elementary student total. A feasible and sustainable design formula for development and urban design not only helps project smart growth, but also provides healthy communities and less dependency for automobiles for future residents.

Results of Walkability Comparison Analysis

All the selected school sites within the study, although random, had many different qualities that gave further insight into the different types of elements that variably change walkability possibilities. Providing a comparison analysis between all the data generated and collected is intended to provide practitioners with a technique to measure, at the aggregate level, factors in the spatial environment adjacent to schools that may facilitate a child's ability to walk or bicycle to school (Bejleri, et al., 2008). Within both analyses of the adjusted and unadjusted datasets as well as the actual survey data versus the potential geospatial data, each is comparison is separated within each county and each individual school is shown with a map.

Hillsborough County

Hillsborough County, the largest county in the study by size and second largest by population, is made up of 1,229,226 people within 132,935 are enrolled elementary school students. Within the county, the study focused on thirteen specific elementary schools in total (twelve only represented openly in this paper) amongst the 133 public elementary schools within the whole county (Figure 4-3). Hillsborough- especially the city of Tampa- has a traditional grid street pattern and historic neighborhoods schools, comprising one of the oldest inventories of schools in the state. Other parts of the county have suburban patterns and schools sited from the 1960s to the 1990s, while still other areas contain schools built recently under more innovative school planning efforts. Hillsborough was a pilot community for coordinated school planning, and since 1997, the county and the school board have maintained an interlocal agreement to facilitate information sharing between the two entities (Steiner, 2009).

Analysis #1: Adjusted and unadjusted network sheds

The adjusted and unadjusted network sheds or catchment areas of the schools within Hillsborough County all have different variances of size and location based from the location of schools and students. Looking at the maps of schools like Forest Hills Elementary (Figure 4-7), Gibsonton Elementary (Figure 4-8), Lake Magdalene (Figure 4-9), Mendenhall Elementary (Figure 4-10), Robles Elementary (Figure 4-13), and Tampa Bay Boulevard Elementary (Figure 4-14) all show regimented half-mile and one-mile boundary lines as well as a closely relatable adjusted and unadjusted network sheds. These schools have a more formal level of residential development around the school, with less roadway and pedestrian restrictions in comparison to the other schools. Large green spaces and bodies of water can usually be the reason for a broken grid pattern like with Pride Elementary (Figure 4-11) and Turner Elementary (Figure 4-15). The erratic boundary lines of all the network connections definitely play a deterrent in potential walkability within a community.

Amongst both the adjusted and unadjusted catchment areas, the maps also show the different densities of residential parcels, most of them that house the students that attend the school within the attendance zone. Just by looking at the map of Doby Elementary (Figure 4-5) one might be able to realize that the elementary school is built amongst a densely residential neighborhood, which provides reason for the high rate of walkability later discussed. Riverview Elementary (Figure 4-12) is also surrounded by a large amount of residential properties. Rural development also provides a different level of density and settlement patterns as seen at Bryan Elementary (Figure 4-4), Doby Elementary (Figure 4-5) and Dover Elementary (Figure 4-6). Property and parcel sizes surrounding Dover provides a lesser amount of nearby residents to the school and the large number of green space (whether agricultural or ecological protected land) surrounding Bryan and Doby Elementary determine nonexistent pathways for pedestrians.

Analysis #2: Actual survey data versus potential geospatial data

After taking into account all the potential walkability within the adjusted and unadjusted catchment areas, the study focuses on the potential pedestrian network correlated to the teacher-administered, in-school survey data previously mentioned in this study. Using both the mapping data and the actual collected data helps provide a more concrete establishment of what is a successfully walkable school development. Also like previously discussed, walkability to an elementary school can entail more specific details needed for a safe development for a child, however for this part of the results the study focuses purely on the surface analysis of the potential geospatial data and the actual survey numbers.

Even though the difference between both sets of data is that the survey data is unable to specifically locate whether the student surveyed lives within the one-mile network boundary, past research concludes that acceptable walking distance lies mostly within a half-mile radius but because of Florida’s regulation of not providing busing within a two-mile distance, that proves to be the ultimate boundary. Since this study does focus on younger elementary students, a twenty-minute commute of a one-mile maximum was used. The surveyed Hillsborough County elementary schools showed a range in student count amongst the potential and actual walkability numbers. The elementary schools such as Robles and Tampa Bay Boulevard showed high potential for young pedestrians, however Robles was the only of the two that showed a high rate of walkability. Bryan, Riverview and Turner Elementary Schools showed an overall low potential and realized walkability totals and all three schools are closely located to a major roadway. The potential numbers always provided a substantially higher number in comparison to the actual survey total except for schools like Bryan, Dover and Riverview Elementary mostly because of the larger parcels sizes and close location of major roads acting as immediate boundaries. After closely comparing the two sets of data, study shows that both Doby and Robles Elementary Schools presented high rates of walkability not only potentially but mostly in actual surveyed numbers. The two schools are used in the urban design analysis later on within this chapter.

Orange County

Orange County, the second largest county by size and largest by population, is made up of 1,145,956 people within 120,313 are enrolled elementary school students. Within the county, the study focused on eleven specific elementary schools in total (seven only represented openly in this paper) amongst the 120 public elementary schools within the whole county (Figure 4-16). Although it may be more urban at its core than Hillsborough, Pasco, and Seminole counties, sprawl is characteristic of Orange County, due to unbridled growth influenced by the construction of I-4 and the Florida Turnpike. Whereas Orlando exhibits a traditional grid street pattern and historic neighborhood schools, many schools built beyond the city limits are typically in the midst of the curvilinear street patterns and cul-de-sacs of suburbia (Steiner, 2009).

Analysis #1: Adjusted and unadjusted network sheds

The adjusted and unadjusted network sheds, or catchment areas, in Orange County project a full range of different types of school developments. Taking into account the few schools that the study was unable to mention for privacy, the seven out of eleven schools all show different variations of schools within the county except for any that were historically built. Focusing on street networks, every school location was located within a mile from a major highway. Naturally that provides the adjusted or pedestrian network with a boundary. The placement of the major highways and roadways within Orange County play a role in the size and shape of the network shed or catchment area. Both Maxey (Figure 4-19) and Riverdale (Figure 4-21) Elementary Schools are shaped primarily by the location of the school and the major roadway within close proximity, considered possibly as a “string” development. The area of Riverdale Elementary is also the largest within the selected schools. John Young (Figure 4-17) and Pineloch Elementary (Figure 4-20) both have outer western boundaries by major highways while Lovell (Figure 4-18) and Shenandoah Elementary (Figure 4-22) have major roadways splitting both network and visibly not affected the size and boundary lines of both. From that the study might suggests later on that both Lovell and Shenandoah might have certain qualities that provide a connected roadway system for cars, but also that the development must have quality pedestrian linkages.

The residential density within the surveyed Orange County elementary schools visually seems to be either integrated with other land uses or part of a primarily residential community like John Young, Riverdale, Shenandoah and Stone Lakes (Figure 4-23) Elementary Schools. Surrounding Lovell, Maxey and Pineloch Elementary Schools the maps show that the surrounding development is more diverse amongst its types of land uses available, including some commercial and ecological (green space) parcels. All eleven presented and private maps within Orange County were also built post-1950. This detail could later provide some further analysis on the specific characteristics each school provides going against what literature usually says providing that schools built before 1950 and before growth management and school coordination policies generally were surrounded by higher density. Aside from the two “string” catchment areas, all the represented Orange County schools show a reasonable amount of density surrounding each school that most likely include details that motivates and allows children to walk to school.

Analysis #2: Actual survey data versus potential geospatial data

Orange County provides comparatively high numbers for potential child commuters and actual (or realized) commuters compared to most other schools throughout the entire study. Aside from Maxey, Pineloch and Riverdale Elementary Schools all had an average of between 52 and 170 children walking or biking to school within the three-day survey collection data. Along with that, John Young, Lovell, Shenandoah and three of the four privatized schools have the potential of at least 200 students walking or biking to school. Some of these schools actually can provide the numbers within the survey data that goes to prove that whatever design aesthetics the development focused on, helped provide people with the comfort of having their child walk to school. The school with the lowest total margin between potential data and actual (or realized) data proves to be the successful one. For a school like Shenandoah, having the potential of 214 students accessibility to walk to school and then provide that on average 123 actually do participate is considered successful school development. Along with that, Lovell also has an extremely high rate of walkability and those two sites are later used in the urban design analysis to pinpoint what possible quality provides students with those options more often than others.

Pasco County

Pasco County is made up of 464,697 people within 44,717 are enrolled elementary school students. Within the county, the study focused on 3 specific elementary schools (Figure 4-24) amongst the 46 other elementary schools. Pasco County is directly adjacent to and north of Hillsborough County. Interstate 75 (I-75) runs along the west coast of Florida connecting the two counties, and in recent years Pasco has become a suburban haven for workers commuting to Tampa using I-75. During the time of the survey in 2007, Pasco was ranked the fiftieth fastest-growing county in the country by the U.S. Census Bureau, based on population growth from 2000 to 2006 (Steiner, 2009).

Analysis #1: Adjusted and unadjusted network sheds

All three elementary schools surveyed within Pasco County represent the three main shapes or types of catchment areas we have previously discussed. First, Chasco Elementary (Figure 4-25) is what was referred to earlier to as a “string” network layout, correlating to one or several major roads lying within a close proximity to the school location. Richey Elementary (Figure 4-26) is made up of well thought-out development scheme around regimented roadways and residential neighborhoods. Providing that the school was built in 1958, pre-growth management phase along with the location help explain the design. Lastly, Seven Springs Elementary (Figure 4-27) primarily focuses on one side of the school because of a major highway to the east of the location creating a heavy boundary and limits the pedestrian shed. In relation to the similar adjusted and unadjusted network sheds, these types of developments are not uncommon, especially during the time period before school coordination. All three of the surveyed schools in Pasco County display different forms and coordination elements of school siting.

Analysis #2: Actual survey data versus potential geospatial data

Pasco County's three separate surveyed schools not only show diversity in the adjusted and unadjusted data analysis but also in the surveyed numbers collected. Chasco Elementary provides no potential number for walkability and only one person on average took it upon himself or herself to walk to school. Just by looking at the map of Chasco Elementary, one begins to see how Ridge Road (US Highway 56) is acting mainly as a boundary line, separating both the school location from all the large northern residential development. This presents the question as to what physically makes this school inaccessible and how it fits within the landscape and surrounding areas. However, Richey and Seven Springs Elementary School present not only high numbers for potential walkers in relation to the total number of students enrolled, but also presents above average actual number taken from the survey. Comparatively Richey and Seven Springs Elementary have fewer limitations when it comes to their adjusted or pedestrian network shed, especially making Richey Elementary the prime focus within this county in the urban design analysis later within this chapter.

Seminole County

Seminole County is made up of 422,718 people within 44,649 are enrolled elementary school students. Within the county, the study focused on 4 specific elementary schools in total, amongst the 37 total public elementary schools within the county (Figure 4-24). Seminole County is located directly north of Orange County. Seminole County's population is nearly 89 percent of the population size of Pasco County, contained in less than half of Pasco's land area. While large parts of suburban

Pasco County are rural in nature, very little land in Seminole County is undeveloped (Steiner, 2009).

Analysis #1: Adjusted and unadjusted network sheds

The four elementary schools within Seminole County used in this study all closely border the northern portion of Orange County and all four also connected to a major roadway within the county. From previous studies, historically street density and development within Seminole was very minimal before 1950. Most development, including all four of the elementary schools in this study, was started post-1950 before growth management took place. Also just assuming the population of Orange County continues to grow, that will only give Seminole County the opportunity to possibly to also grow along to meet supply and demand for residents especially bordering the county.

All four elementary schools project a similar layout and context of each site. All are located within a heavily residential neighborhood and only provide minimal, if at all any, variation in land uses. From just purely looking at the maps, Bear Lake (Figure 4-28), Longwood (Figure 4-30) and Sterling Park (Figure 4-31) Elementary Schools are all schools primarily within a large residential community located off one major roadway. Carillon Elementary (Figure 4-29) is different only because the roadway provides the outline, similar to the “sting” network layout previously discussed at other school locations. In comparing the adjusted and the unadjusted catchment areas, one will notice that mostly all of them provide similar areas for both but one interesting detail is that the adjusted or pedestrian catchment areas sometimes actually cover more area then the unadjusted or automobile catchment. That would conclude that there is less limitations for students within the half-mile and one-mile radius of all the schools then there is for automobile transportation. The urban design site analysis provides further insight into why Seminole County projects that sort of outcome.

Analysis #2: Actual survey data versus potential geospatial data

In the comparison between the actual survey data and the potential numbers projected geospatially, all four of the elementary schools within the county showed an even sample of both numbers. All four averaged between 11 and 21 percent walkability in the survey numbers and the potential numbers of Bear Lake, Carillon and Longwood were not less than 248 within the one-mile pedestrian catchment area. Sterling Park Elementary shows lower number but in comparison to the total number of students that attend the school and the area it covers, it is comparatively successful amongst all the elementary schools within the study. The higher numbers all stem from the fact that all these locations, like previously discussed, are surrounded by heavily residential parcels. The schools act as part of the community within the area and were more than likely built to accommodate any future resident planning on living within the area. Even though all the schools used in this study showed interesting numbers, Longwood Elementary shows the lowest margin between the actual and potential numbers and the highest percentage of students commuting by walking and biking over the three-day survey. Longwood is the focused site within Seminole County during the urban design analysis.

Urban Design Analysis: Qualitative Results

All the selected school sites within the study, although random, had many different qualities that gave further insight into the different types of characteristics a person might not initially notice within a walkable community. Based on *Public Places Urban Spaces* dimensions of urban design (Carmona, 2003), there are different levels of analysis one should acknowledge. First there is the morphological dimension that outlines the urban space including the figure ground, size of blocks, grid type and permeability. Secondly, a perceptual dimension establishes the sense of place within an area, defining paths, edges, districts, nodes and possibly even landmarks. Next an analysis must particularly pay attention to the visual aspects of the defined area. Aesthetic and physical features such as sidewalk widths, street width, traffic volumes, building heights, canopies, and patterns are some examples that a person might notice first. Breaking down the specific qualities of urban design such as sense of enclosure, sense of place, human scale, and linkage could be a descriptive analysis that could be done amongst each school that generated a high rate of walkability. Furthermore, when talking about children walking to school, additional analysis needs to focus on individual variables such as sense of safety and comfort. Each site has an overall walkability that is characterized by its physical efforts, but the potential to walk in comparison to the actuality of walking changes based on the walking behavior of the surrounding areas and the logistics that are prevalent within the attendance zone.

The particular elementary schools selected represented the highest rates of walkability based on the survey data, dividing the total walkers and bikers in the total number surveyed and not the total enrolled. Some of the poor numbers resulted from outside forces that even walkability characteristics would not be able to change. Analyzing all the survey data numbers (Figures 4-32 and Figure 4-33), the particular sites selected are credibly walkable with percentages off walkers and bikers over 20 percent of the total each day. Within Hillsborough County, Doby (Figure 4-34) and Robles (Figure 4-36) Elementary Schools were selected. Within Orange County, Lovell (Figure 4-38) and Shenandoah (Figure 4-40) Elementary Schools were selected. Lastly, within Pasco County was Richey Elementary (Figure 4-42) and within Seminole County was Longwood Elementary (Figure 4-44).

School Site #1: Doby Elementary

- Number of potential pedestrians: 59 within Half-Mile / 177 within One-Mile
- Number of actual pedestrians/bicyclists: 107
- Average rate of walkability in survey: 26%
- Average number of students surveyed: 415.3
- Total enrolled: 390

Initially reviewing the site, the study establishes that Doby Elementary was built in 2005 making it the newest developed school within the surveyed schools in Hillsborough County (Figure 4-35 for full chart of analysis). Along with that, based on the location of the school and residential density surrounding it, the study concluded that it is built within a more rural area of the county with the focus of becoming a traditional neighborhood development. Examining Doby Elementary's morphological dimension takes that assumption about the development and examines the space and street pattern. Establishing that the layout is mostly a traditional neighborhood development, the density is present showing condense building pattern with 1,288 individual residential units only within a one-mile pedestrian catchment area. The noticeable factor of it's laddered street system provides that almost each road end point or residential cul-de-sac becomes only a place to go rather than a place that might also be passed through on the way to somewhere else (Carmona, et al., 2003). This might be an important concept to the idea of walkability, in which the layout protects the arterial roads from being congested with outside commuters. The structure of the grid is misaligned from the shaping of the residential or urban blocks to the variation in street widths.

The surroundings perceptual dimension defines the sense of place and establishes different elements it physically includes. Looking particularly at the paths, there is a noticeable scale and concentration of the roads. As for edges, Interstate-75 acts as a major eastern edge for the development. As for design for an elementary school, there always must be certain change in texture, form or space to distinguish the presents of school children. In Figure 4-36 image A, the large crosswalk separates the development from the neighborhood and plays as a key linkage to the site (or node), especially considering the low number of intersections (27 with the Half-Mile and 44 within the One-Mile).

The social dimension of Doby Elementary and its surroundings fit the concept of neighborhood unit elements that fit the compact and interconnected development. Aside from providing no variation in land uses and accessibility is limited to people who live outside the attendance zone, all elements help towards creating a safe environment for pedestrians and bicyclist. Visual aspects, such as street lighting, prove that the high rates for walkability were attainable as long as the community is aware of the importance of safety and security as well. Also examining the fact that the one-mile pedestrian network shed only has one bicycle or pedestrian crash recorded shows the low chance of hazardous conditions within the given boundary. Establishing the denseness and safeness of the surrounding area around Doby Elementary gives precedence for why the rate of walkability is high.

Visual analysis of Doby Elementary includes physical attributes include visible bicycle lanes, large gated area and racks for bicycles on school property, low speed limits at all times, newer sidewalks and visible crosswalks, street lighting, open area/new development, and only two-lane roads surrounding the school site. Aesthetically within the whole attendance zone and focusing on the network of streets and how the development functions, this particular area of Hillsborough County is recognized with a sense of pattern and order, as well as naturalness to the sites topography. The bottom left images on Figure 4-33 outlines the positive and negative space forming the current bold informal layout.

Finally in discussing the socio-economic aspects of the area surrounding Doby Elementary, one might already predict that the development houses relatively more families who do not live below the poverty line, but in actuality make the higher incomes. In 2010, based on Federal Poverty Guidelines and Census Bureau Data, the poverty line for one person under 65 was US$11,344 and US$22,133 for a family. Pertaining to the socio-economic analysis of Doby Elementary, the Census data concludes that 4.6 percent of the people within the one-mile pedestrian network shed live below the individual poverty line, which in this case is based on whoever makes less than US$14,000, and in addition to that percentage of people, 11.2 percent of the people make below US$29,000. In addition to those numbers, about 2.4 percent of the Census block population does not own a car.

School Site #2: Robles Elementary

- Number of potential pedestrians: 155 within Half-Mile / 342 within One-Mile
- Number of actual pedestrians/bicyclists: 154
- Average rate of walkability in survey: 24%
- Average number of students surveyed: 657.7
- Total enrolled: 729

Robles Elementary was built in 1959, before the initiation of Growth Management practices with Hillsborough County (Figure 4-37 for full chart of analysis). Along with that, one might acknowledge from the maps that the surrounding land uses are primarily residential with variation of land uses to the east of the site beyond the one-mile pedestrian network shed. The site's morphological dimension displays a mostly traditional figure ground with a variety of block sizes. The grid is somewhat both symmetrical and deformed since the site is not only dealing with major roadways as boundaries, but also the Hillsborough River. The densely developed area around the school site, including the 2,013 residential units within the One-Mile Catchment, helps to promote permeability for both pedestrians and automobiles.

The sense of place near Robles Elementary includes a variety of paths, edges and levels of topography. Between the 47 intersections within the Half-Mile and the 130 intersections in the One-Mile sheds, it has double the amount of intersections acting as breaks between blocks as well as possible traffic inclusions in conflict with pedestrians than at Doby Elementary. Aside from E Sligh Avenue that acts as the main access road in front of the school, which is also reduced to a two-lane road at the intersection of N 56th Street, the site only has arterial roadways that border the One-Mile Catchment boundary. One of those major edges is the six-line N 56th Street along the further eastern point of the One-Mile network shed, E Hannah Ave at the southern edge and N 40th Street to the west. The Hillsborough River also acts as a major boundary to the west of the school site.

The configuration and content of Robles is a large determinate for type of safety and security elements surround the area. The heavy density and major roadways within close proximity of the elementary school adds for an extra challenge for pedestrians and bicyclists. Considering the 12 pedestrian and bicycle crashes that occurred within the

Half-mile and the 28 within the One-Mile, the school still shows higher numbers of walkability than Doby Elementary. The significance comes from the heavy integration of other land uses and also other nearby schools. Also Figure 4-34 shows that the majority of the crashes happen along the major roadways and away from the locations where the majority of students live, which lies directly to the north and south of the school.

Visual aspects of Robles include what seems to be a cul-de-sac development, visible crosswalks and signs around the school, as well as sidewalks. The historical aspects of the school are prevalent in the size and condition of the sidewalks surrounding the school as well as the mix of both single-family and multi-family housing directly across from the site. There also seems to be only one visual entrance to the school for pedestrians with no visible bike lock location and no visible speed limit signs within close proximity.

Lastly, the socio-economic analysis of Robles Elementary within the Census data concludes that 40.6 percent of the people within the one-mile pedestrian network shed live below the individual poverty line, which in this case is based on whoever makes less than US$14,000, and in addition to that percentage of people, 16.8 percent of the people make below US$29,000. That data concludes that 57.4 percent, more than half of the people living within the one-mile catchment areas surround Robles Elementary make less than US$29,000 annually. In addition to those numbers, about 7 percent of the Census block population does not own a car. As literature has previously stated, lower income neighborhoods are more than likely to walk or bike to school within a two-mile radius than in comparison to a child within a family who lives above the poverty line. Considering both schools are within Hillsborough County, one of the main comparisons between Doby Elementary and Robles Elementary is the difference in socio-economics, providing that even safety, scale and sense of place do not change effect the walkability numbers.

School Site #3: Lovell Elementary

- Number of potential pedestrians: 51 within Half-Mile / 294 within One-Mile
- Number of actual pedestrians/bicyclists: 122
- Average rate of walkability in survey: 34%
- Average number of students surveyed: 357
- Total enrolled: 722

Lovell Elementary School was built in 1960 before Growth Management was established in Orange County, like many of the other surveyed school sites with the four counties (Figure 4-39 for full chart of analysis). The traditional building layout shows a variety of block and parcels sizes. The permeability of the school site is associated with the location of the two major roadways surrounding it, Semoran Boulevard and Orange Blossom Trail. Those two major roadways provide fluidity through the gridded street system. The majority of the space between those two major roads holds a dense 139 residential units within the Half-Mile Catchment and 501 residential units within the One-Mile, housing the majority of the 122 commuting students.

Orange Blossom Trail and Semoran Boulevard both act as an edge and boundary of both half-mile and one-mile catchment areas, creating a viable mix of land uses around the school site including the high density of residential units. The number of intersections between these boundaries is small in comparison of the other school sites with only 13 within the Half-Mile and 61 within the One-Mile Catchment. This provides the idea that the block sizes where the majority of the students reside are larger within the area south of the school site and north of Orange Blossom Trail. This still does not determine the location of the various pedestrian and bicyclist crashes. The majority of 10 crashes within the Half-Mile and the 24 within the One-Mile take places along the major roadways but the locations also exist near the school. The high potential for walkability versus the actual surveyed number shows a large differential even though there was a high count of children living within the One-Mile Catchment.

Visual aspects of Lovell Elementary include the fact that the school site is between two major roads creating a specific type of node. Visible sidewalks, crosswalks and speed limits signs help direct potential pedestrians, but the presence of no street lights provide that walkability around the area is only for hours of the daylight.

Pertaining to the socio-economic analysis of Lovell Elementary, the Census data concludes that 15 percent of the people within the one-mile pedestrian network shed live below the individual poverty line, which in this case is based on whoever makes less than US$14,000, and in addition to that percentage of people, 33.6 percent of the people make below US$29,000. That data concludes that 48.6 percent, about half of the people living within the one-mile catchment areas surround Lovell Elementary make less than US$29,000 annually. In addition to those numbers, about 7.2 percent of the Census block population does not own a car. This site could be closely relatable to Robles Elementary in Hillsborough County.

School Site #4: Shenandoah Elementary

- Number of potential pedestrians: 52 within Half-Mile / 214 within One-Mile
- Number of actual pedestrians/bicyclists: 123
- Average rate of walkability in survey: 21%
- Average number of students surveyed: 587.3
- Total enrolled: 659

Also similarly to the previous Lovell Elementary site, Shenandoah Elementary was built before Growth Management implementation in 1969 (Figure 4-41 for full chart of analysis). Given the majority of the sites we have focused on were built around the same timeframe 40+ years ago, land development, roadways and regulations have changed a lot since then. However in most cases, the development happens within a close proximity of the school. Primarily single-family housing surrounds Shenandoah Elementary, similar to Doby and Robles Elementary Schools previously discussed. Traditional neighborhood development with a laddered street grid, providing a course set of connections reducing permeability. The high density is represented in the 353 residential units within the Half-mile Catchment and the 1,439 residential units within the One-Mile. The student density locations are spread almost evenly across the whole development, providing the reason why 123 students, over half of the potential number of students within a One-Mile Catchment, actually commute to school by walking or biking to school every day.

Establishing a sense of place within a central location of a large development primarily made up of residential units is dependent upon the feeling of the neighborhood itself. Shenandoah Elementary borders between heavy residential units outlining the natural landscape as well as major roadways that not only divides the pedestrian network, but also acts as an edge. Hoffner Avenue and Gatlin Avenue are displayed as the north and south edges to the development and Conway Road connects the two roadways with the actual school site. Within the catchment areas there is relatively the same number of intersections as its fellow Orange County school, Lovell Elementary, with 24 within the Half-Mile and 90 within the One-Mile. This could give explanation for why the potential and actual pedestrian numbers are so close between the two schools. Also the four-lane Conway in front of the elementary school challenges the school location within the concept of linkage, access and safety. However the separate entrance and road built in 2007, around the time of the survey, offsets traffic from the entrance of Conway Road and makes the school more of its own distinct destination. That element could explain why there are lesser pedestrian and bike crashes (8 within the Half-mile and 12 within the One-Mile) purely from that road construction. The map (Figure 4-36) displays that the majority of those crashes happen along Conway Road, so with reduced numbers of automobile commuters using the previously single entrance helps allow Shenandoah Elementary to be the safer school within the two Orange County schools focused on.

Visual aspects of Shenandoah Elementary include the renovation concluded between March of 2007 and November of 2007 from aerial images that not only improved the school itself, but also provided a separate backside road and entrance to the school in order to avoid the major four-lane roadway located right to the west of the school site.

Pertaining to the socio-economic analysis of Lovell Elementary, the Census data concludes that 5.2 percent of the people within the one-mile pedestrian network shed live below the individual poverty line, which in this case is based on whoever makes less than US$14,000, and in addition to that percentage of people, 18.6 percent of the people make below US$29,000. That data concludes that 23.8 percent of the people living within the one-mile catchment areas surround Shenandoah Elementary make less than US$29,000 annually. In addition to those numbers, about 3.4 percent of the Census block population does not own a car.

School Site #5: Richey Elementary

- Number of potential pedestrians: 86 within Half-Mile & 215 within One-Mile
- Number of actual pedestrians/bicyclists: 96
- Average rate of walkability in survey: 21%
- Average number of students surveyed: 458.7
- Total enrolled: 645

An earlier built elementary school in Pasco County, Richey was built in 1958. Located alongside of US Highway 19, this school site shows a more various level of density surrounding its location (Figure 4-43 for full chart of analysis). Containing 668 individual residential units within the Half-Mile catchment and largely 1529 units within the One-Mile, the numbers can then explain the heavy density. As a more modern urban space environment, the surrounding area displays mostly small sized block with a finely meshed grid allowing the space to have more continuity. The permeability of the gridded space within Richey's attendance zone allows primary movement of both pedestrians and automobile.

Defining the site and establishing the perceptual dimension of Richey Elementary starts with the major defining edges that contain the development. Both major roadways of US-19 and Congress Street set eastern and western perimeter to the school and its surrounding development. The gridded network of streets formulates concentrated and well-used pathways. The gridded street system, intertwining 90 intersections within the Half-Mile and 199 within the One-Mile, is a much larger area than most of the other analyzed school sites aside from Robles Elementary in Hillsborough County, its neighborhood county. Considering the large amount of intersections, the small block sizes and visibility help contain the amount of pedestrian and bicycle crashes down to 7 within the Half-Mile and 25 within the One-Mile. The placement and environment of the school could be an added characteristics because not only does the school border several civic buildings but also a police department.

Visually Richey Elementary and its surrounding area provide more accommodations for pedestrians including crosswalks, sidewalks and active speed limit signs that notify drivers if they are speeding by the school. Also the level of safety is prevalent with a closely located police department and recreational center.

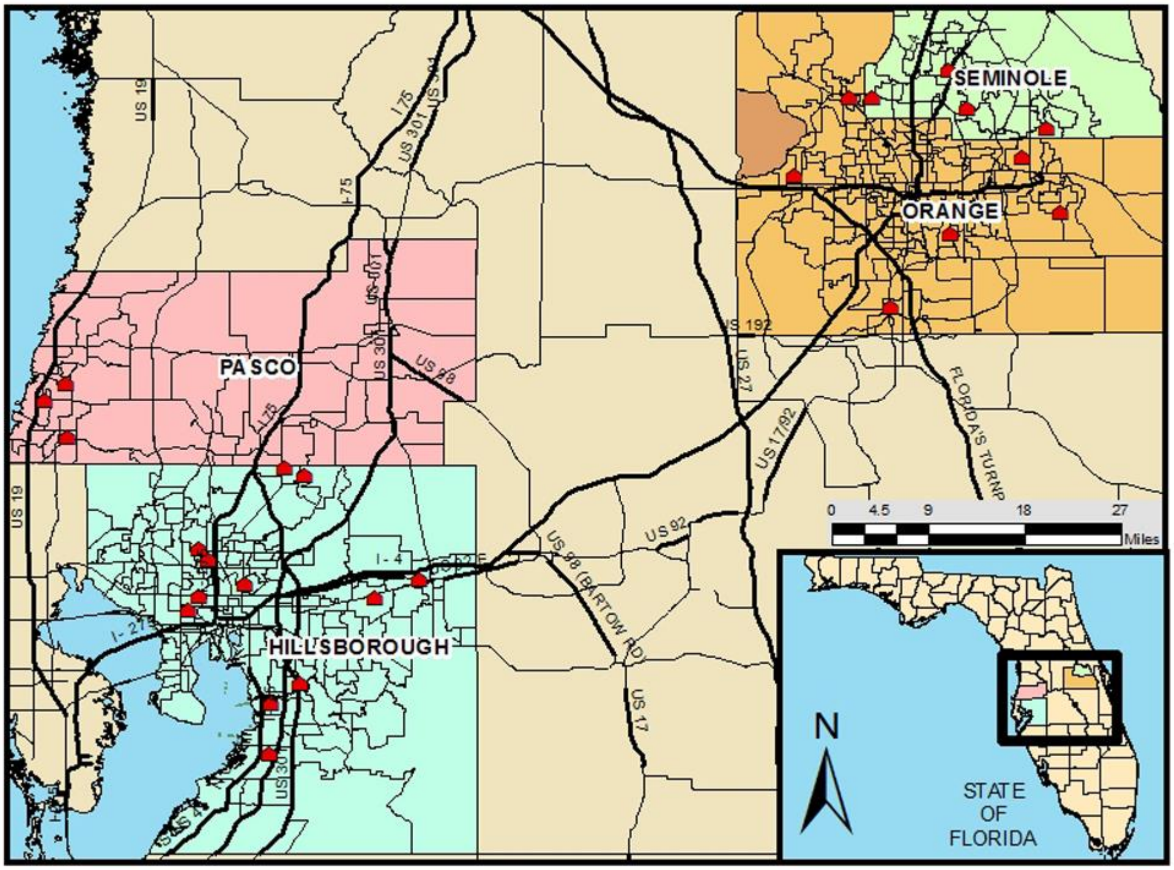
Pertaining to the socio-economic analysis of Richey Elementary, the Census data concludes that 18.4 percent of the people within the one-mile pedestrian network shed live below the individual poverty line, which in this case is based on whoever makes less than US$14,000, and in addition to that percentage of people, 44.7 percent of the people make below US$29,000. That data concludes that 63.1 percent of the people living within the one-mile catchment areas surround Richey Elementary make less than US$29,000 annually. In addition to those numbers, about 8.9 percent of the Census block population does not own a car. This is concluded to be the lowest income level school within the study.

School Site # 6: Longwood Elementary

- Number of potential pedestrians: 113 within Half-Mile / 248 within One-Mile
- Number of actual pedestrians/bicyclists: 83
- Average rate of walkability in survey: 25%
- Average number of students surveyed: 341.3
- Total enrolled: 703

Built in 1959, Longwood Elementary is one of many schools within Seminole County that were built before Florida Growth Management Act (Figure 4-45 for full chart of analysis). The traditional development made up of primarily small blocks and parcels provides a fine grid useful in accommodating continuity within and around the area. Similar to some of the other elementary schools, Longwood has about 443 residential units within the Half-Mile and 1,132 within the One-Mile pedestrian network shed explaining the high potential number for walkers or bicyclists. In relation to the type of density the site contains, looking at the number of intersections versus the number of pedestrian and bicycle crashes helps explain the level of safety and access the school has to offer. Longwood within the Half-Mile was recorded with 3 crashes while within the One-Mile there were only 5. Relative comparing all the six schools used in this urban design analysis, Longwood and Dobles are the two schools with the fewer amounts of crashes. Both share a few more similarities aside from the more precise boundary line of Longwood in addition to the lakes that surround the area, breaking up the repetitive and rhythmic pattern of the residential units. Also there is a much larger comparison of intersections within the developments with Longwood having 45 within the Half-Mile and 118 within the One-Mile, providing the concept that within a traditional neighborhood, the multiple numbers of intersections might not be too much of a deterrent for walkers.

Pertaining to the socio-economic analysis of Longwood Elementary, the Census data concludes that 4.6 percent of the people within the one-mile pedestrian network shed live below the individual poverty line, which in this case is based on whoever makes less than US$14,000, and in addition to that percentage of people, 20.9 percent of the people make below US$29,000. That data concludes that 25.5 percent of the people living within the one-mile catchment areas surround Longwood Elementary make less than US$29,000 annually. In addition to those numbers, about 5.4 percent of the Census block population does not own a car.



SURVEYED COUNTIES

COUNTY	AREA (SQ MI)
HILLSBOROUGH	1,266 (1,051 LAND)
ORANGE	1,004 (907 LAND)
PASCO	868 (745 LAND)
SEMINOLE	345 (308 LAND)

2010 DATA				
COUNTY	POPULATION	DENSITY	# OF HOUSEHOLDS	# OF FAMILIES
HILLSBOROUGH	1,229,226	1,170 PPL/SQ MI	463,425	296,335
ORANGE	1,145,956	1,263 PPL/SQ MI	408,605	266,454
PASCO	464,697	624 PPL/SQ MI	184,270	122,488
SEMINOLE	422,718	1,372 PPL/SQ MI	150,443	101,734

2000 DATA				
COUNTY	POPULATION	DENSITY	# OF HOUSEHOLDS	# OF FAMILIES
HILLSBOROUGH	998,948	951 PPL/SQ MI	391,357	255,164
ORANGE	896,344	988 PPL/SQ MI	336,286	220,267
PASCO	344,765	463 PPL/SQ MI	147,566	99,016
SEMINOLE	365,196	1,185 PPL/SQ MI	139,572	97,281

Figure 4-1. Layout and background of complete study area

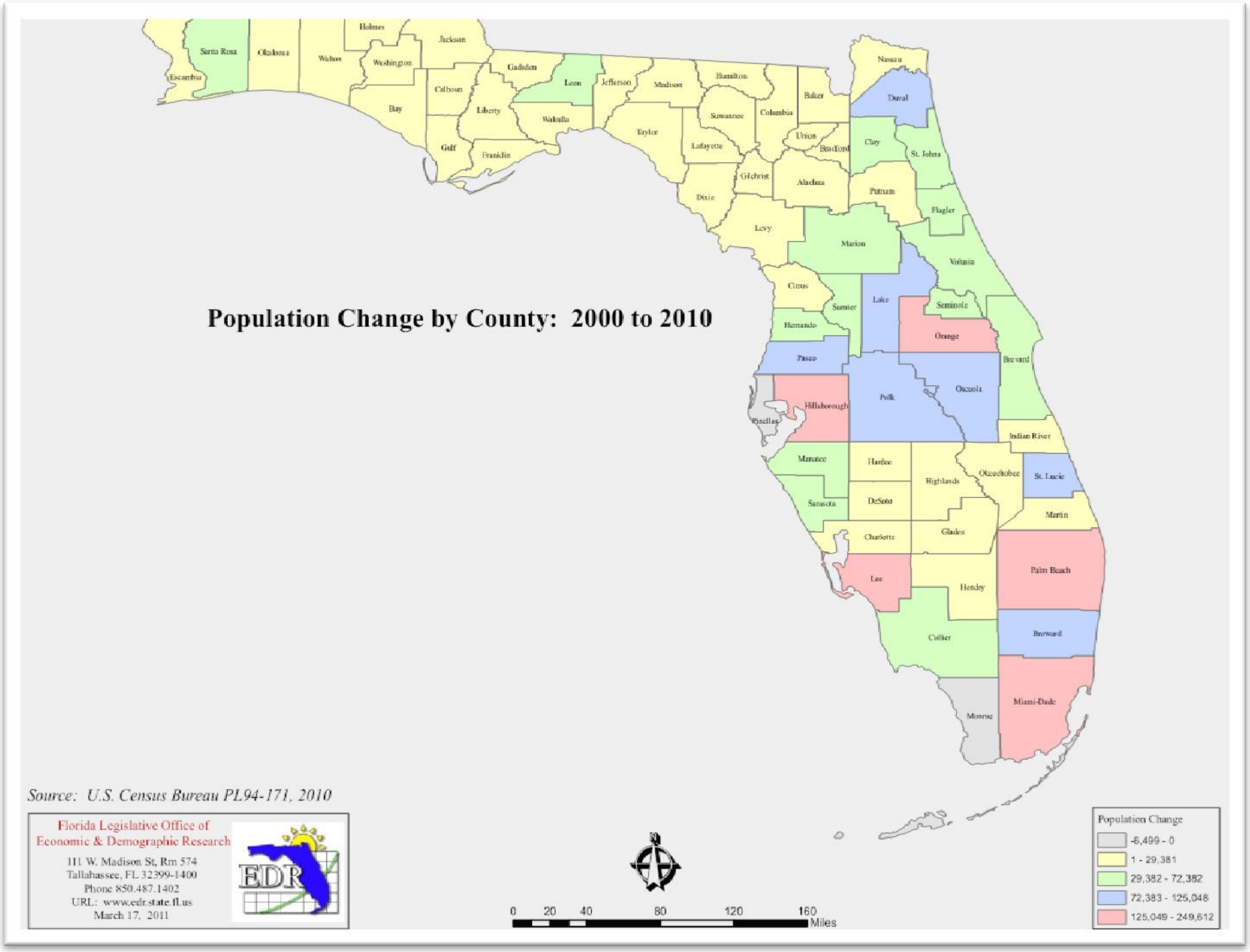
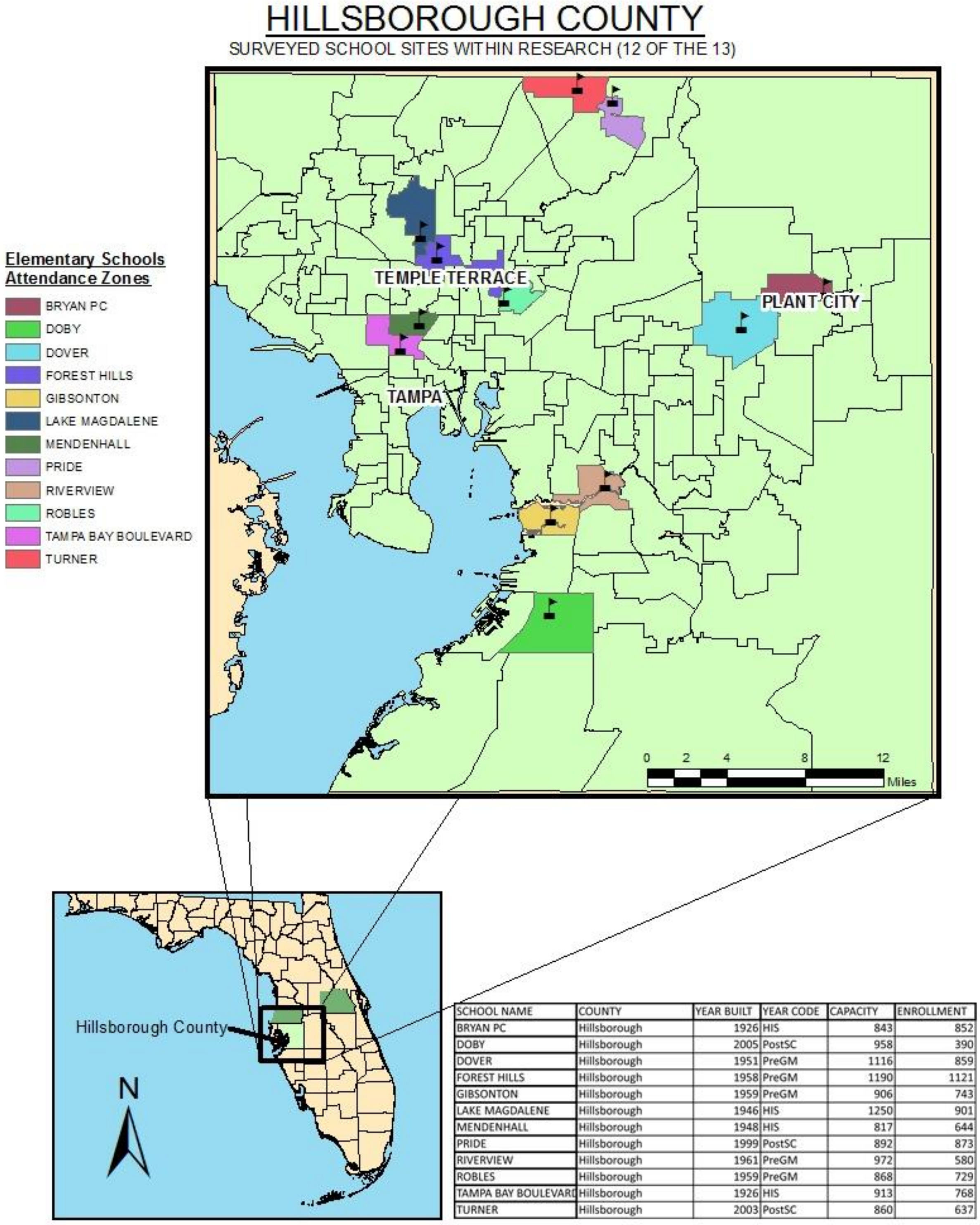


Figure 4-2. Map from U.S. Census Bureau showing population change by County: 2000 to 2010



SCHOOL NAME	COUNTY	YEAR BUILT	YEAR CODE	CAPACITY	ENROLLMENT
BRYAN PC	Hillsborough	1926	HIS	843	852
DOBY	Hillsborough	2005	PostSC	958	390
DOVER	Hillsborough	1951	PreGM	1116	859
FOREST HILLS	Hillsborough	1958	PreGM	1190	1121
GIBSONTON	Hillsborough	1959	PreGM	906	743
LAKE MAGDALENE	Hillsborough	1946	HIS	1250	901
MENDENHALL	Hillsborough	1948	HIS	817	644
PRIDE	Hillsborough	1999	PostSC	892	873
RIVERVIEW	Hillsborough	1961	PreGM	972	580
ROBLES	Hillsborough	1959	PreGM	868	729
TAMPA BAY BOULEVARD	Hillsborough	1926	HIS	913	768
TURNER	Hillsborough	2003	PostSC	860	637

Figure 4-3. Map of school attendance zones in Hillsborough County

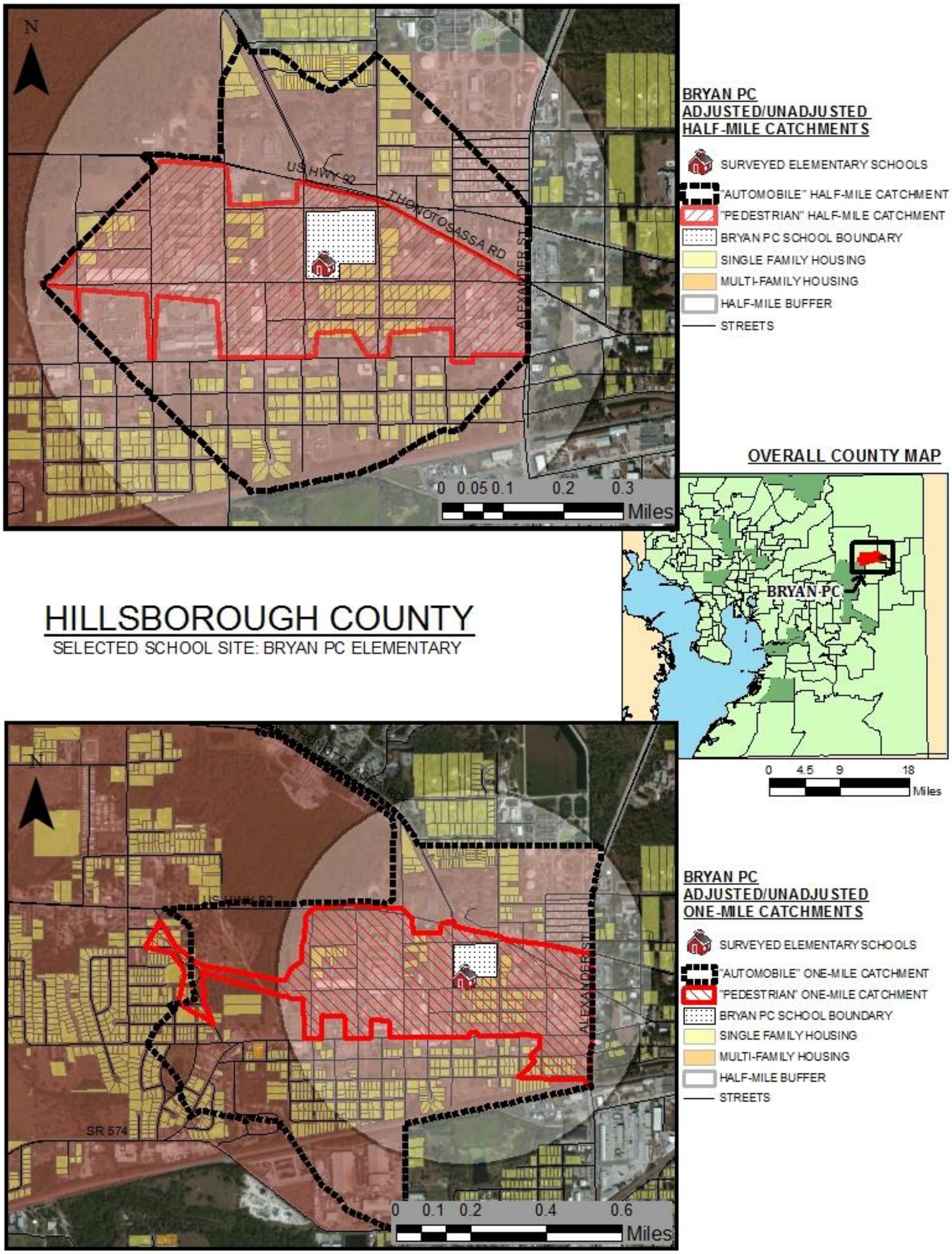


Figure 4-4. Map of Bryan Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Hillsborough County

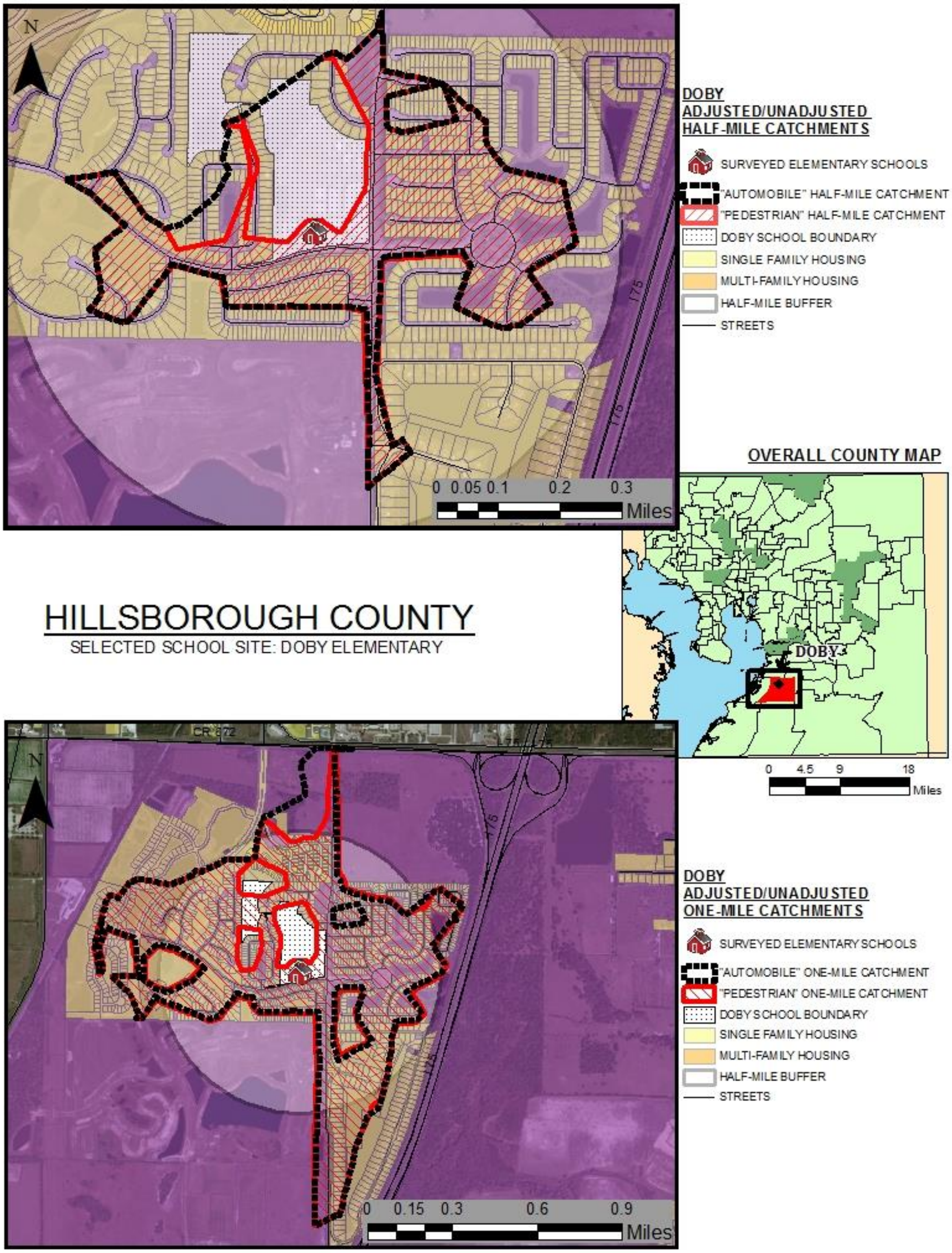


Figure 4-5. Map of Doby Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Hillsborough County

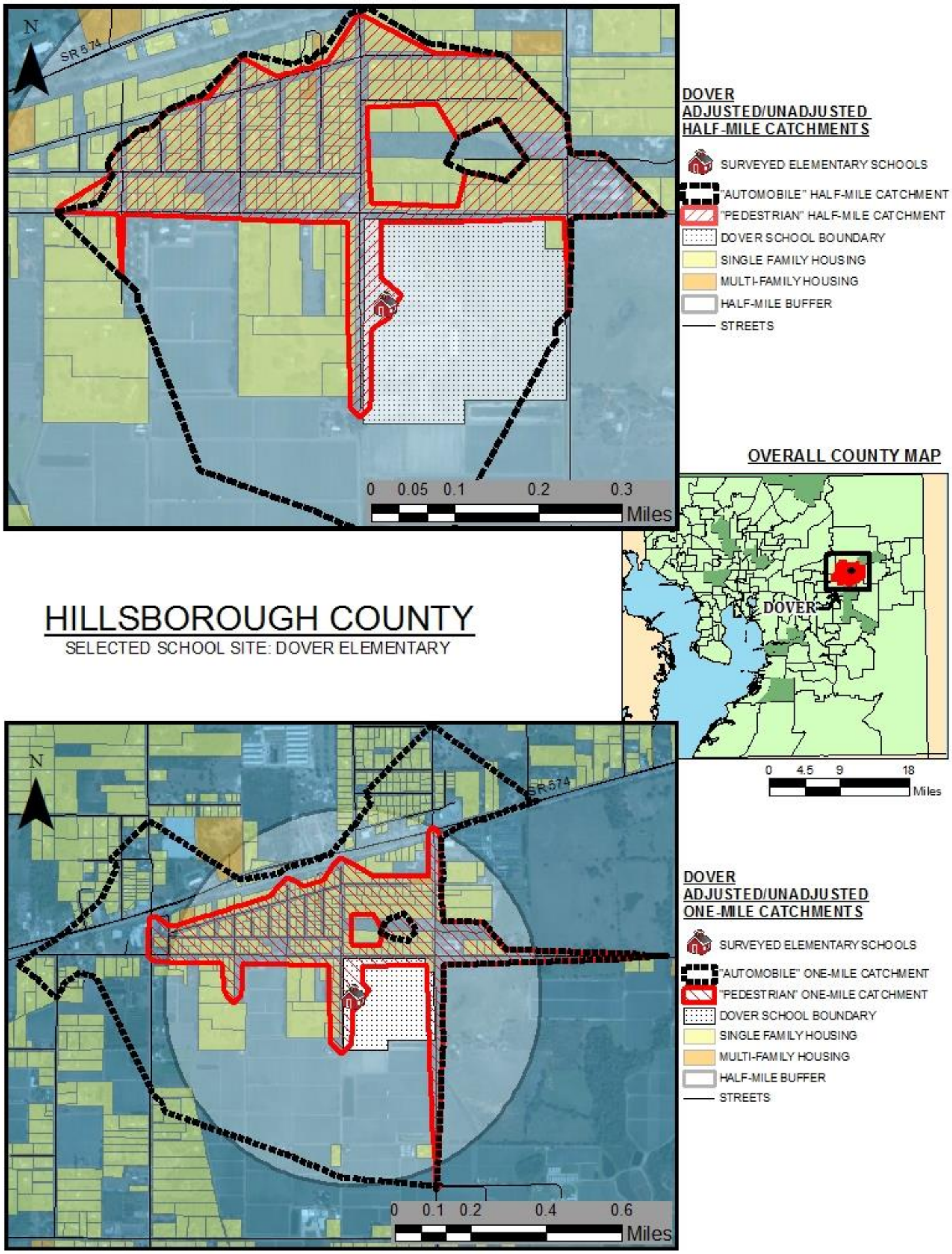


Figure 4-6. Map of Dover Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Hillsborough County

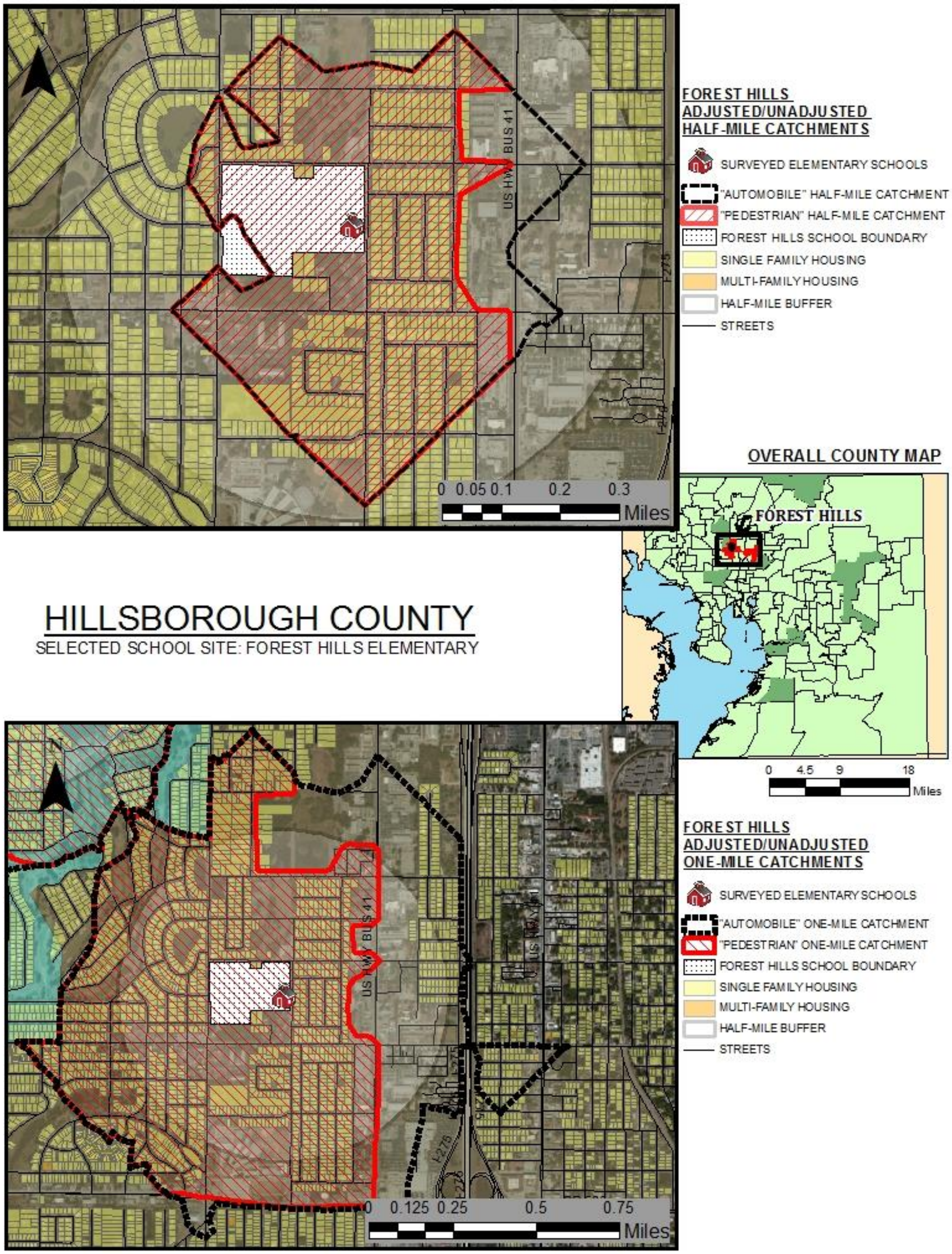


Figure 4-7. Map of Forest Hills Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Hillsborough County

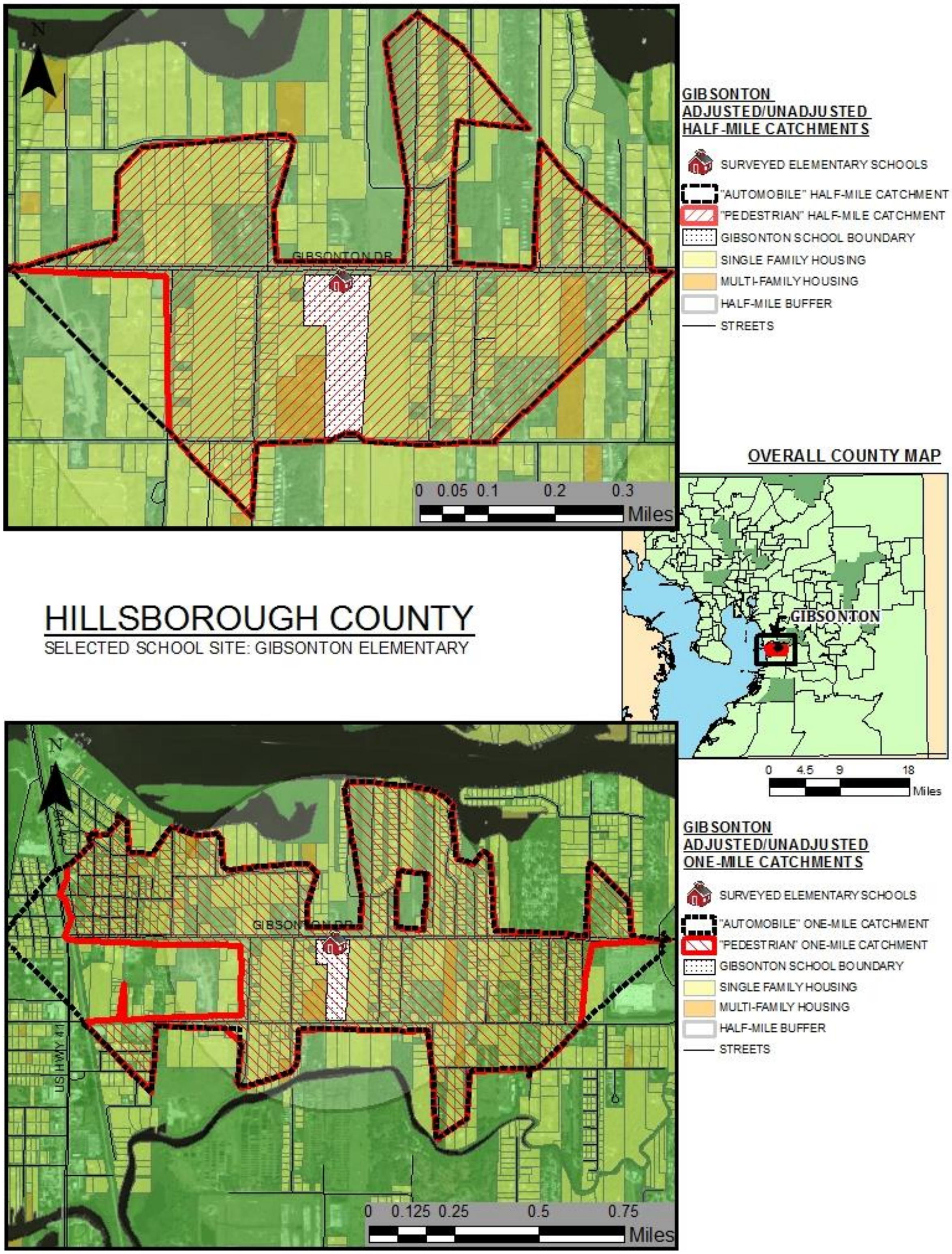


Figure 4-8. Map of Gibsonton Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Hillsborough County

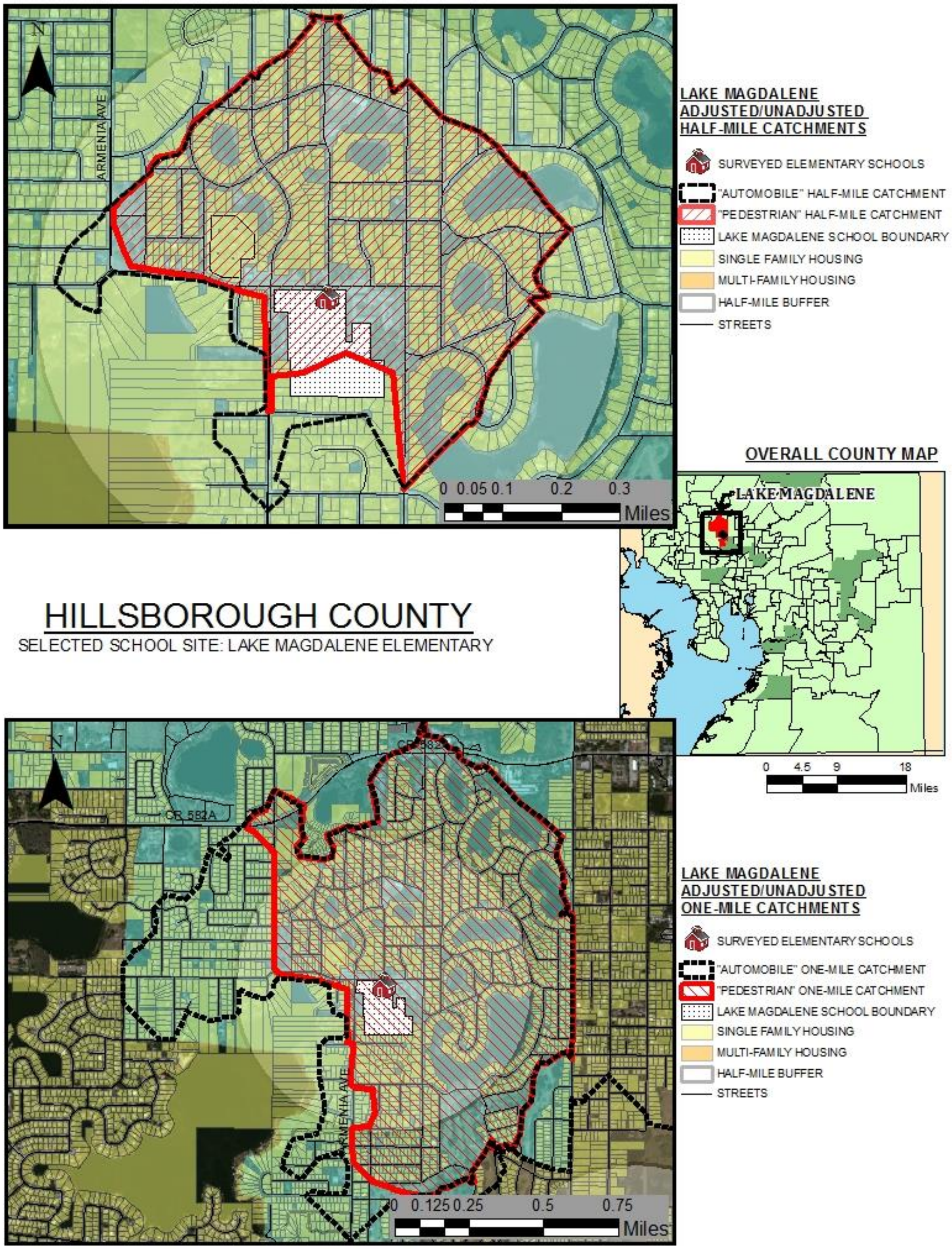


Figure 4-9. Map of Lake Magdalene Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Hillsborough County

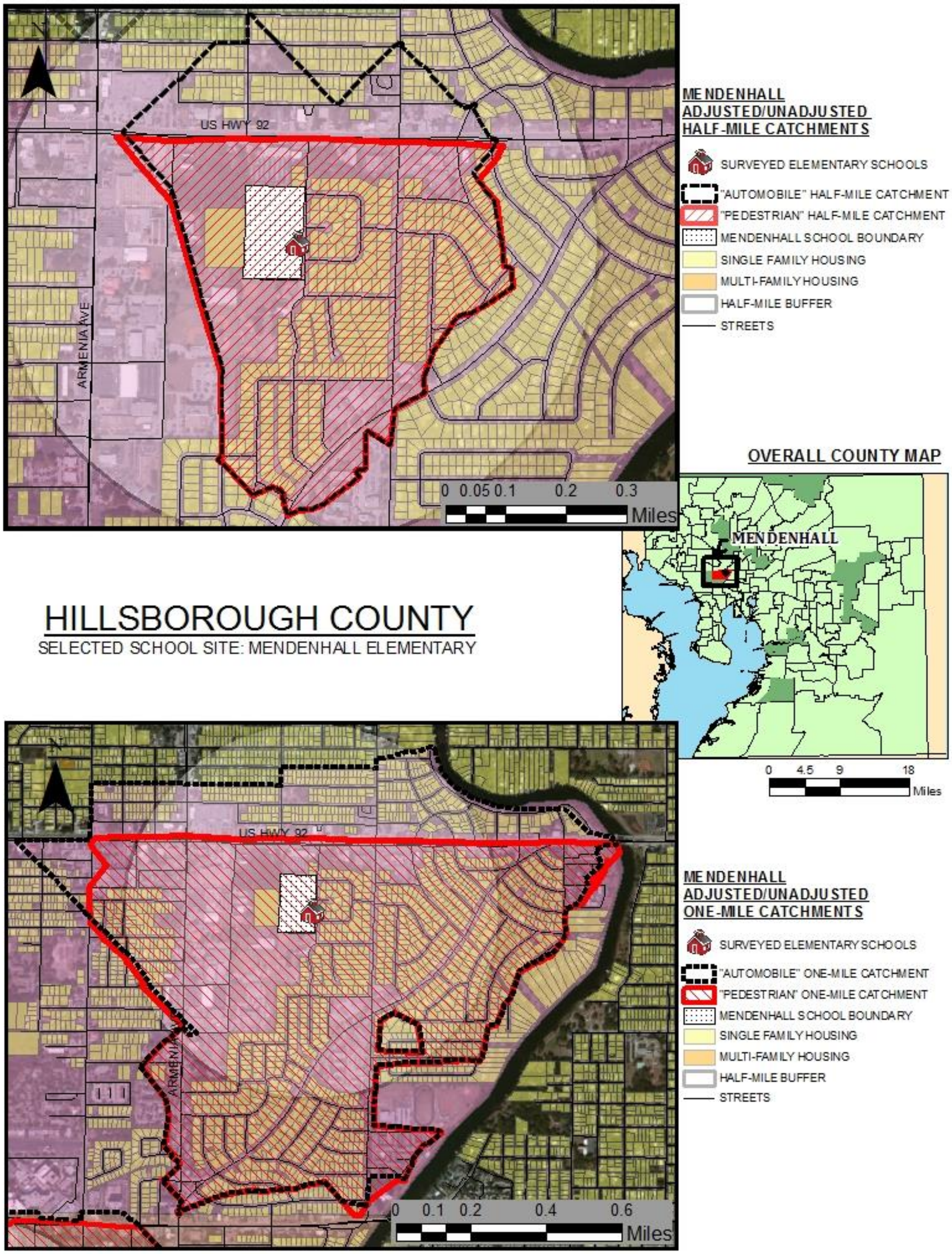


Figure 4-10. Map of Mendenhall Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Hillsborough County

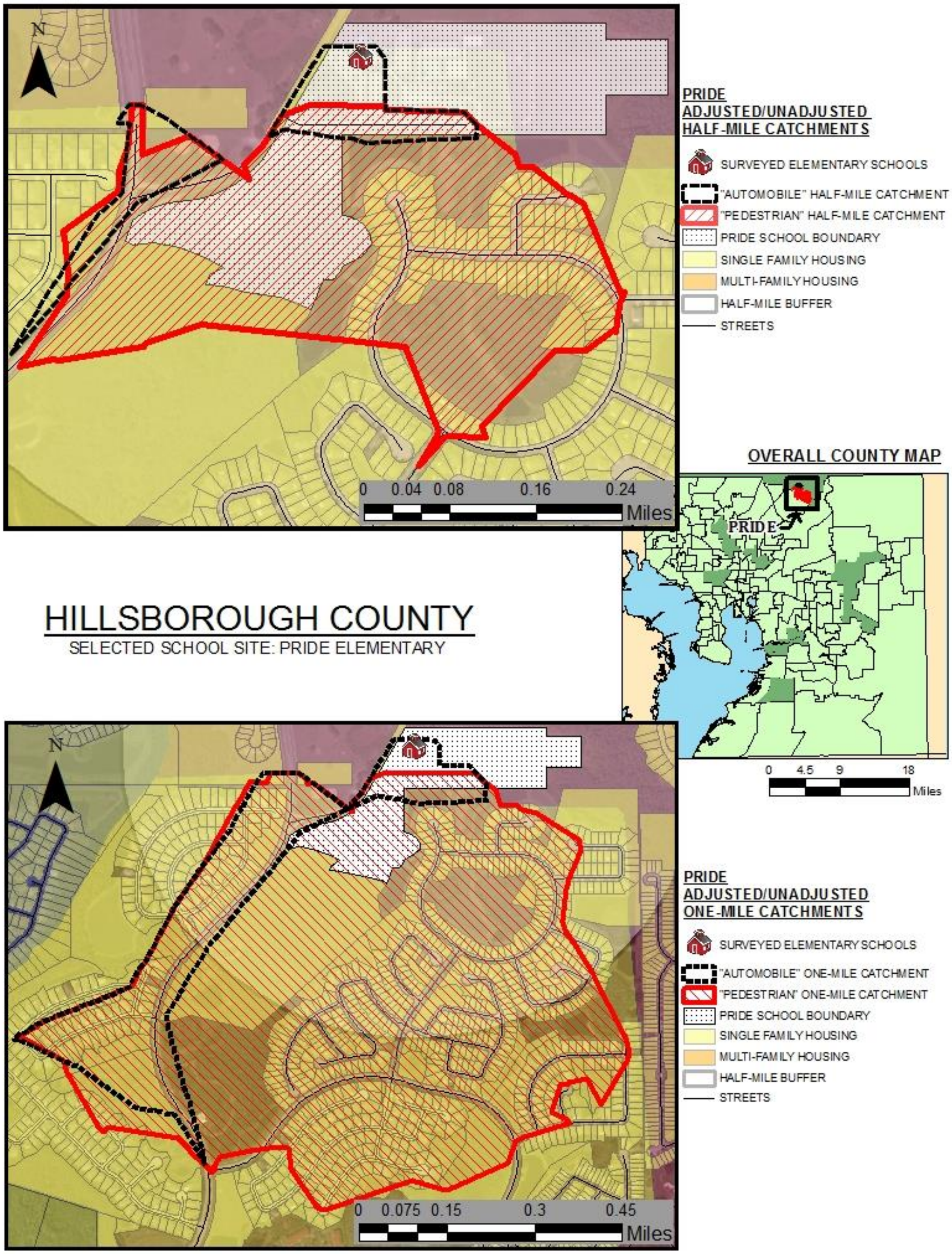


Figure 4-11. Map of Pride Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Hillsborough County

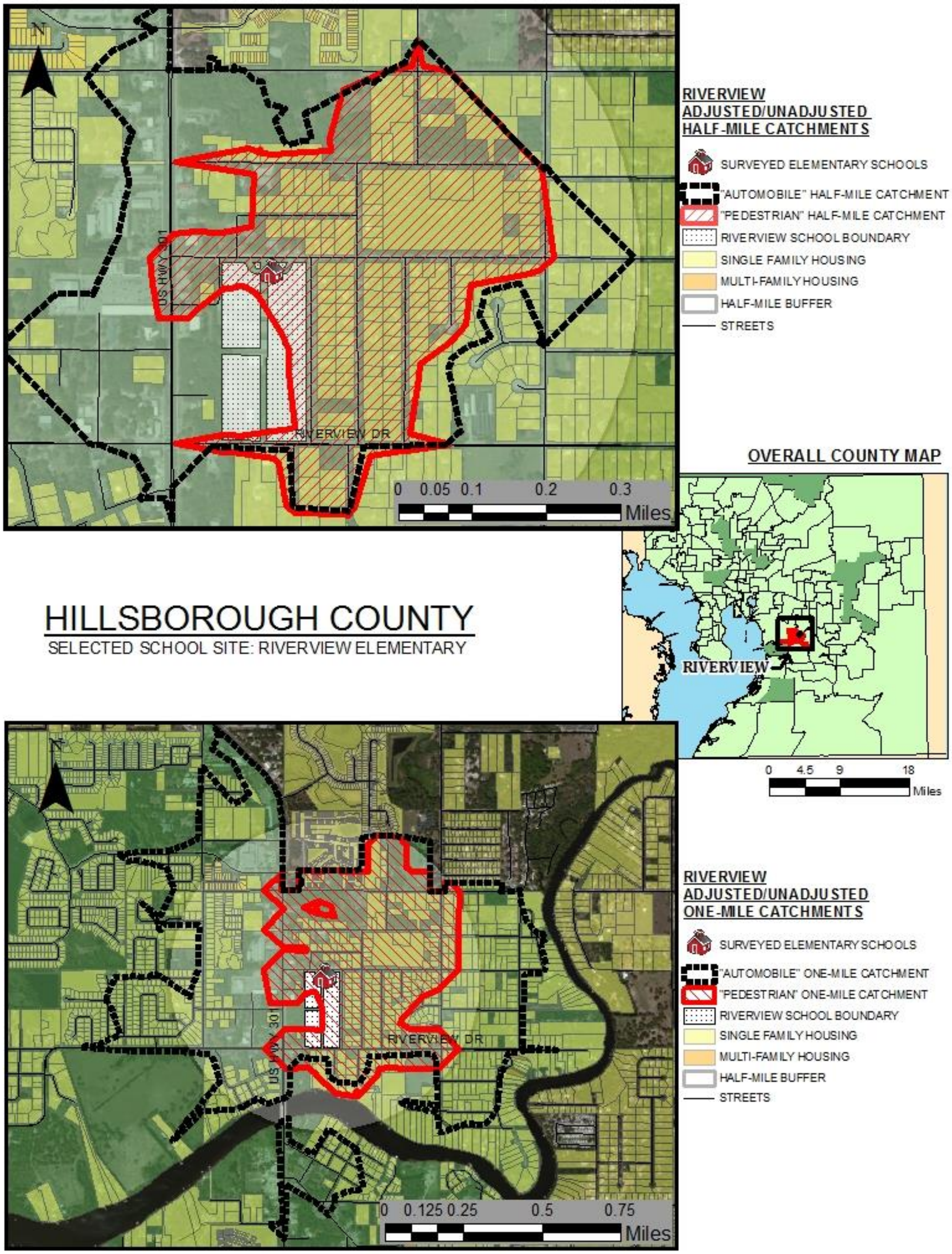


Figure 4-12. Map of Riverview Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Hillsborough County

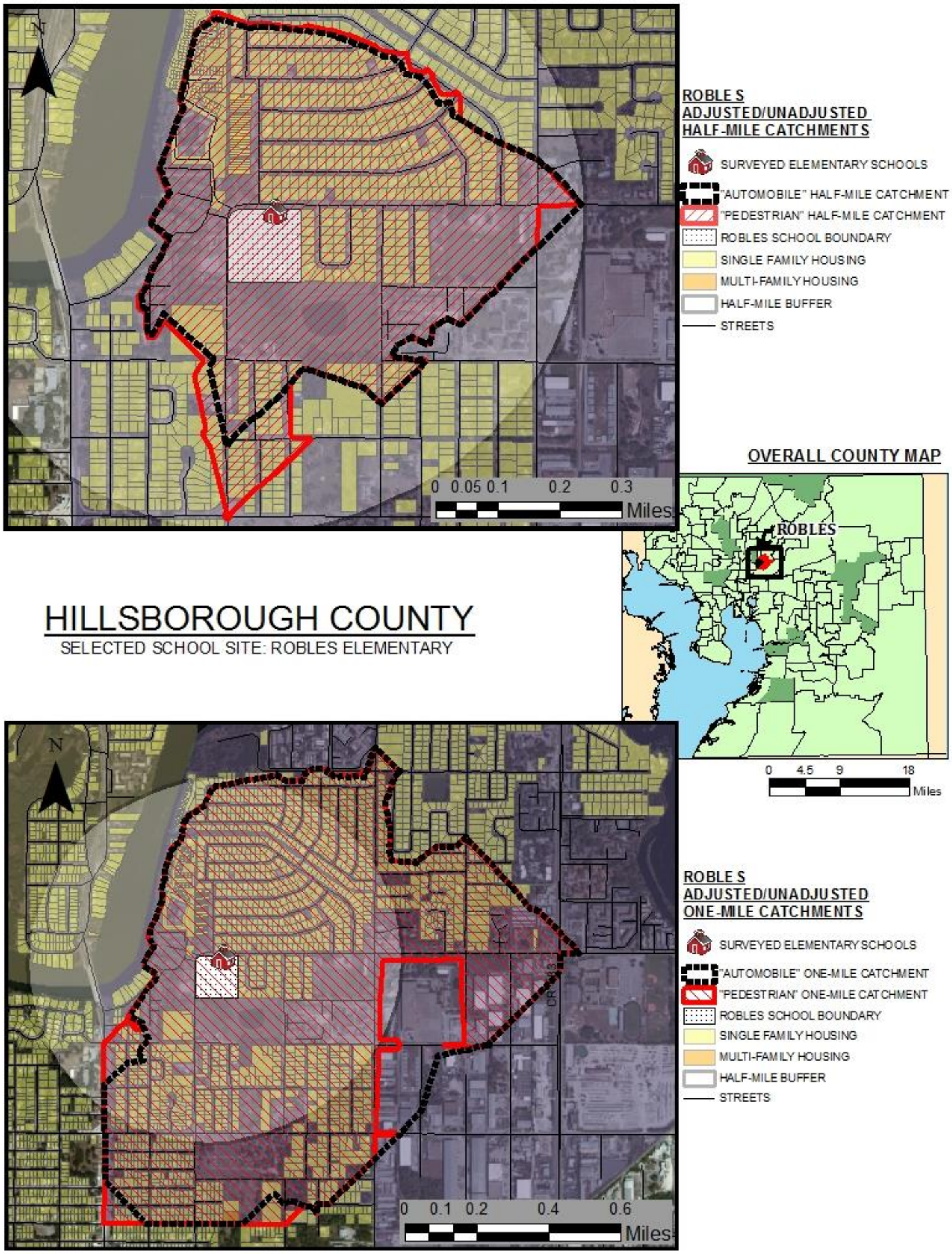


Figure 4-13. Map of Robles Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Hillsborough County

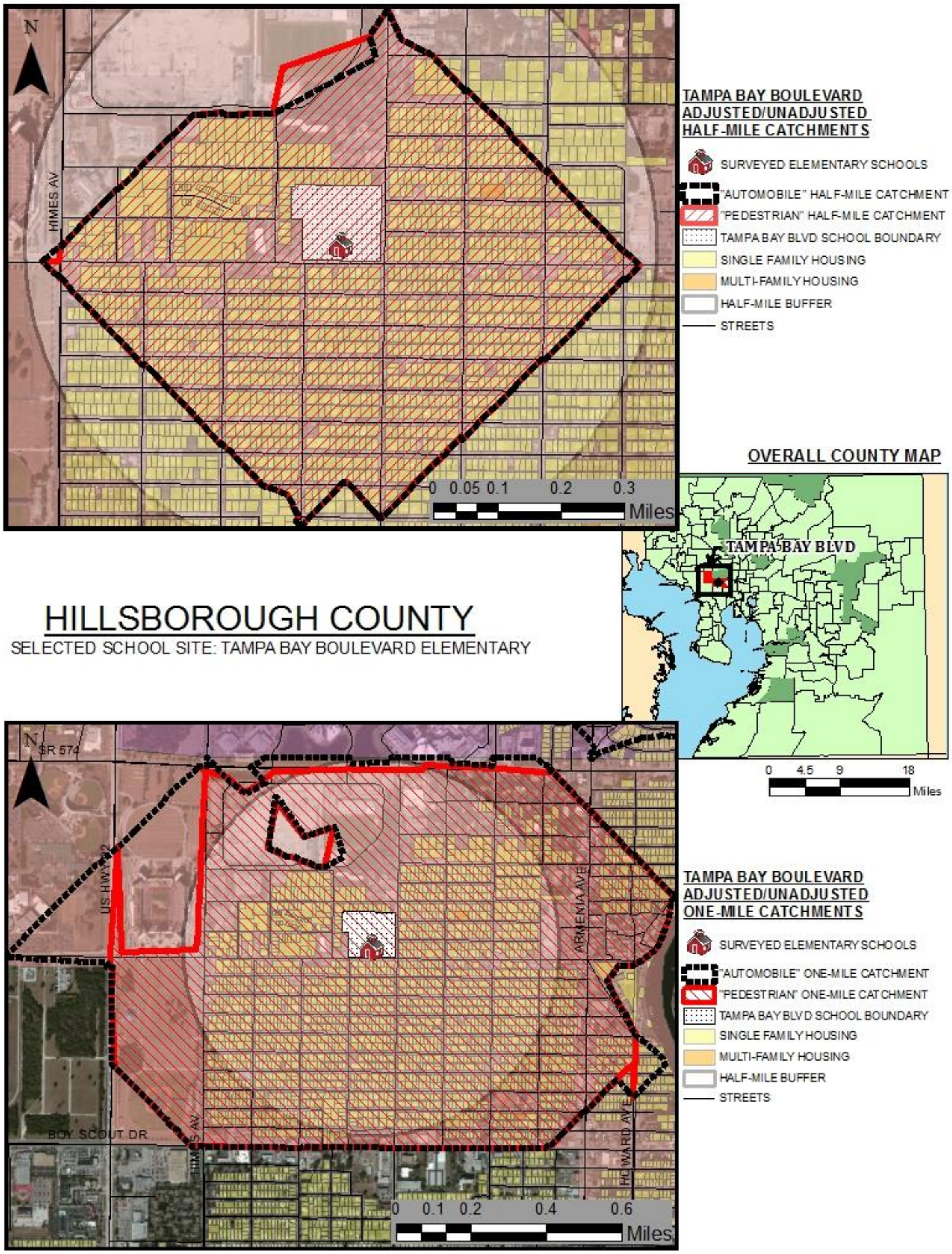


Figure 4-14. Map of Tampa Bay Boulevard Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Hillsborough County

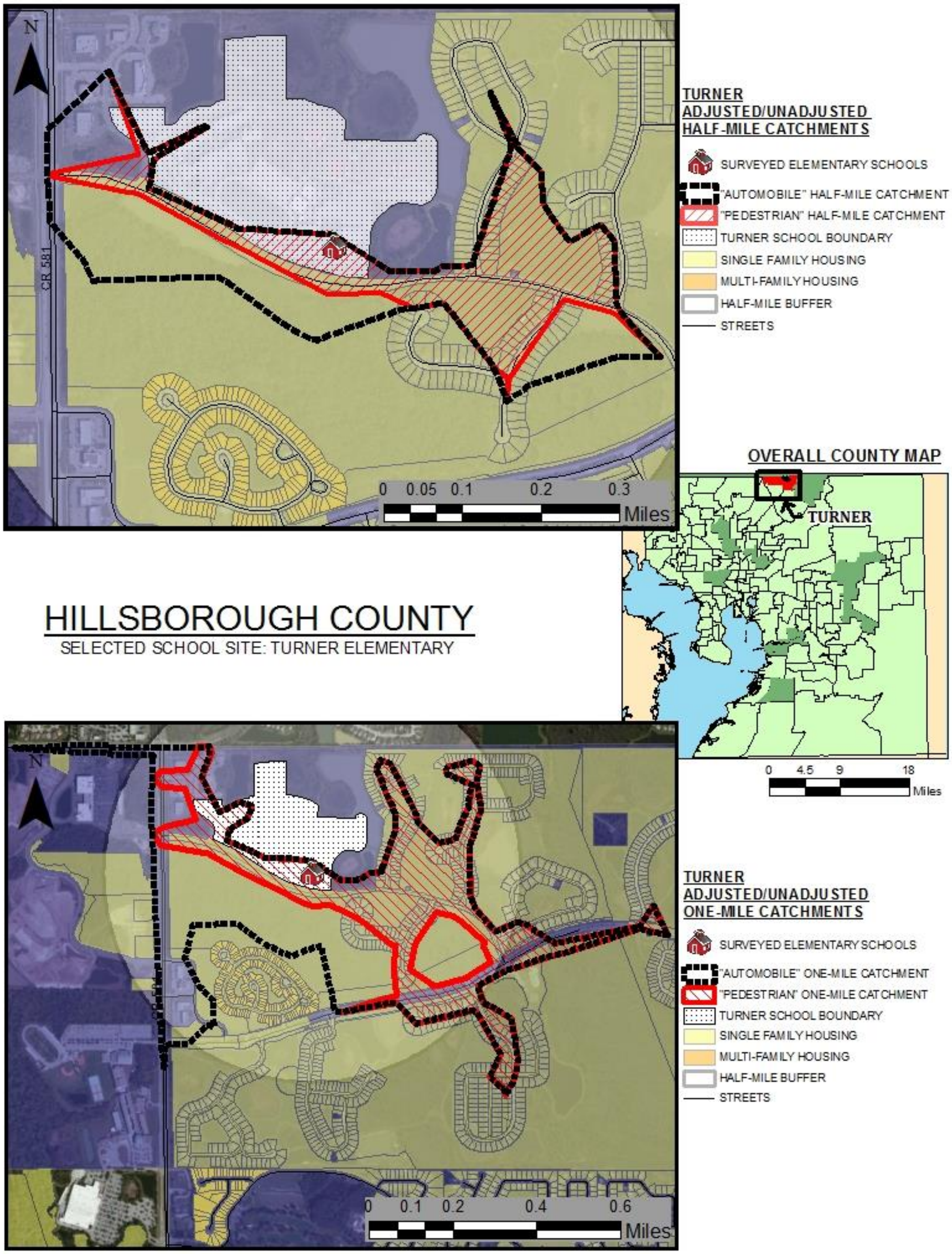
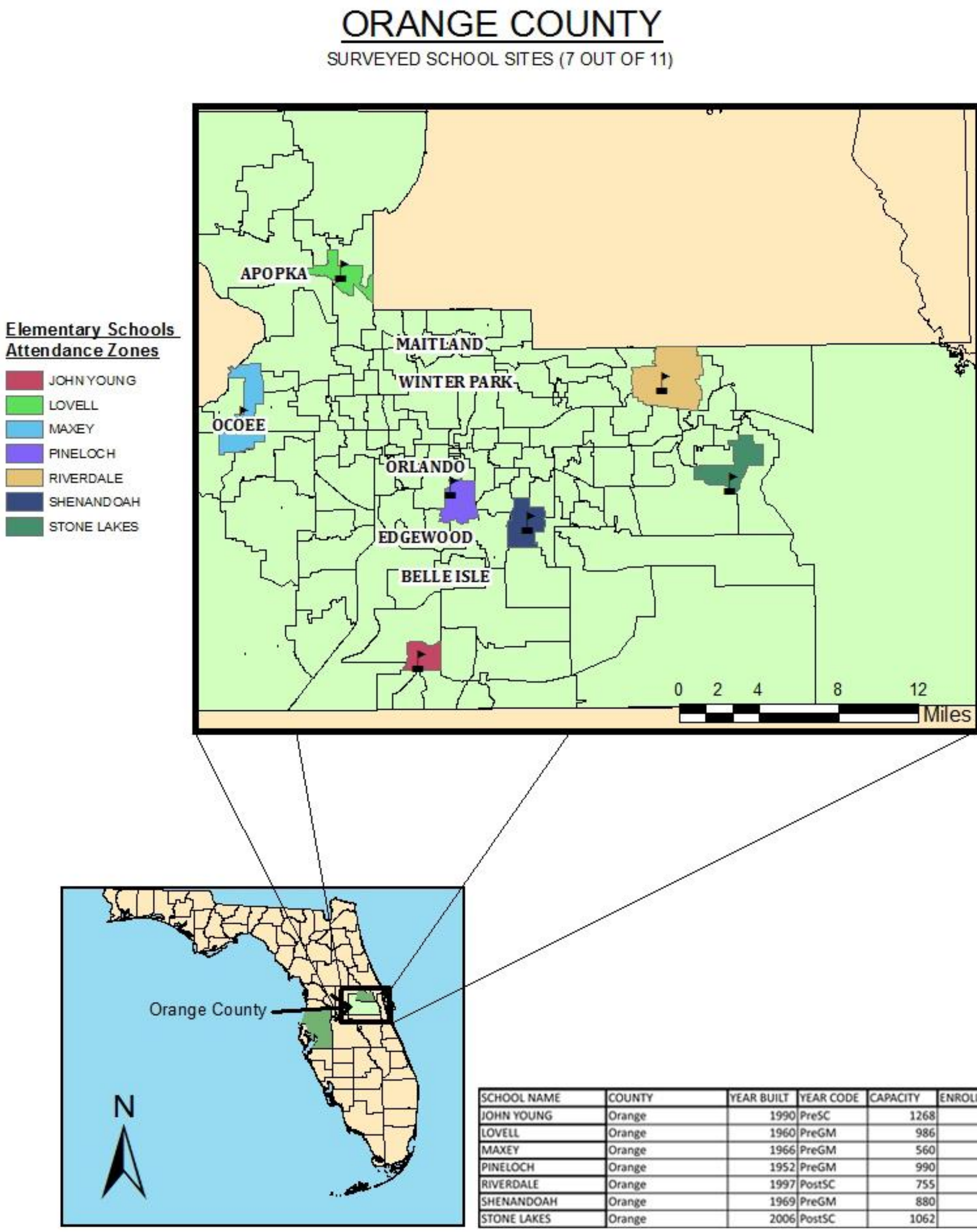


Figure 4-15. Map of Turner Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Hillsborough County



SCHOOL NAME	COUNTY	YEAR BUILT	YEAR CODE	CAPACITY	ENROLLMENT
JOHN YOUNG	Orange	1990	PreSC	1268	977
LOVELL	Orange	1960	PreGM	986	722
MAXEY	Orange	1966	PreGM	560	273
PINELOCH	Orange	1952	PreGM	990	667
RIVERDALE	Orange	1997	PostSC	755	782
SHENANDOAH	Orange	1969	PreGM	880	659
STONE LAKES	Orange	2006	PostSC	1062	1052

Figure 4-16. Map of school attendance zones of Orange County

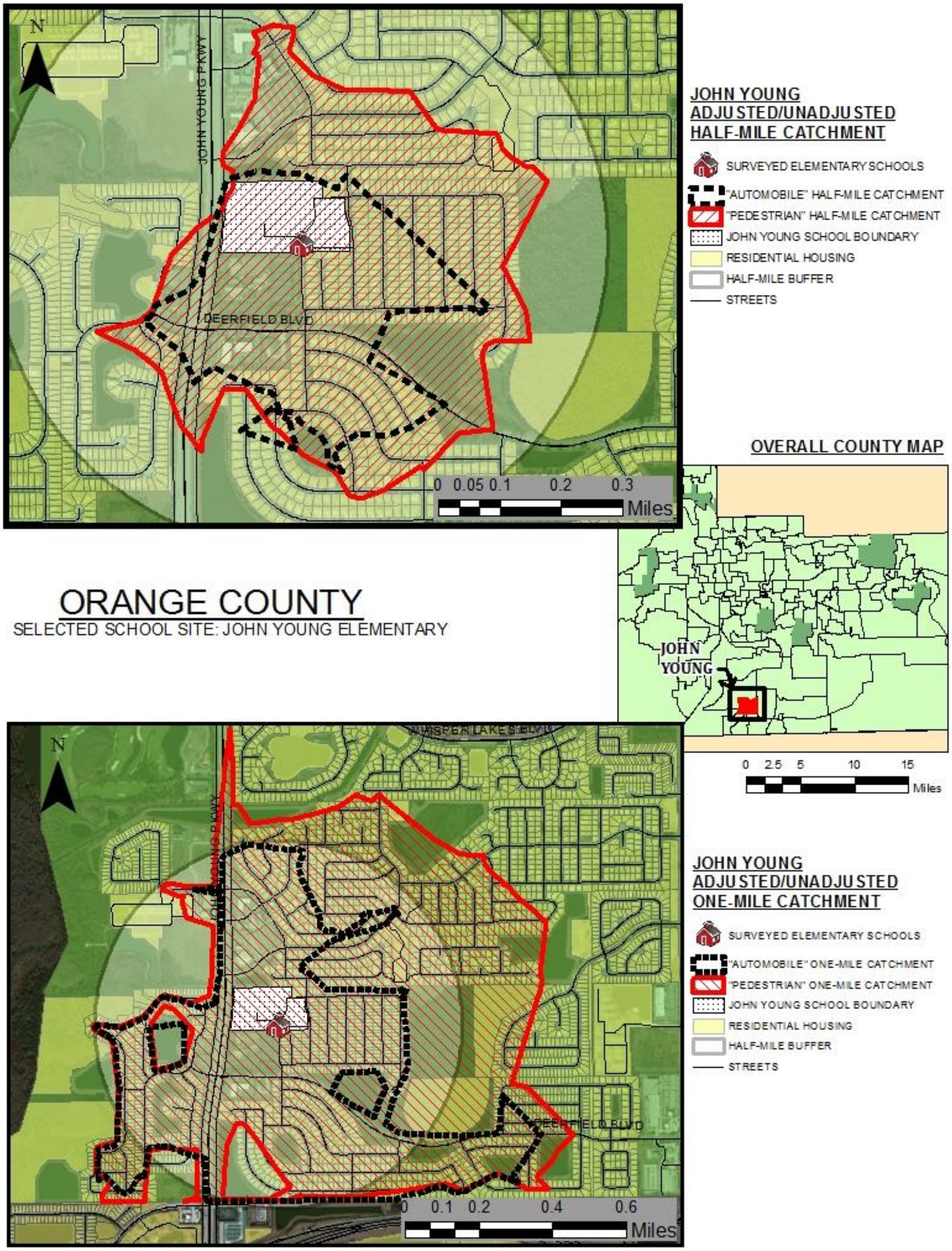


Figure 4-17. Map of John Young Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Orange County

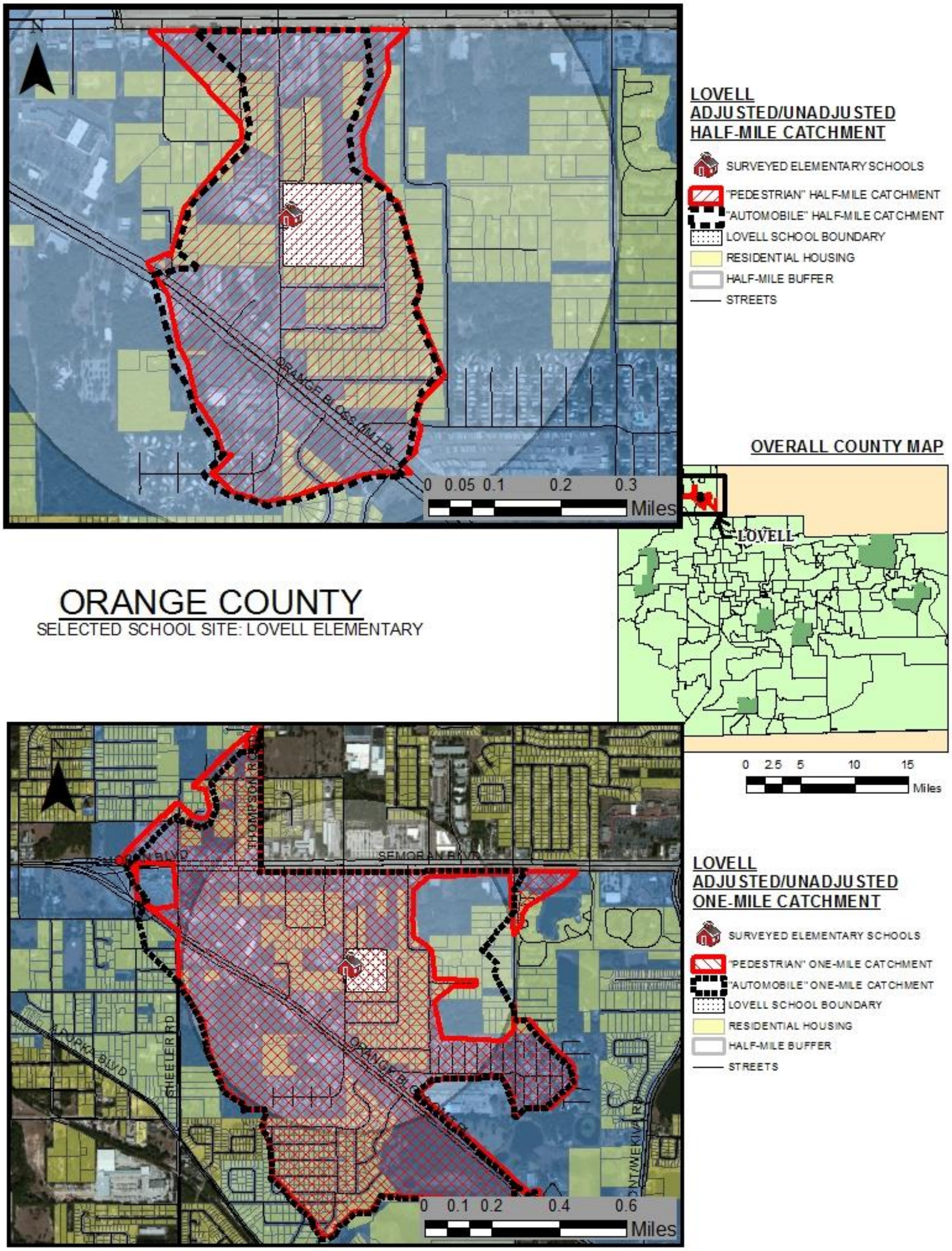


Figure 4-18. Map of Lovell Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Orange County

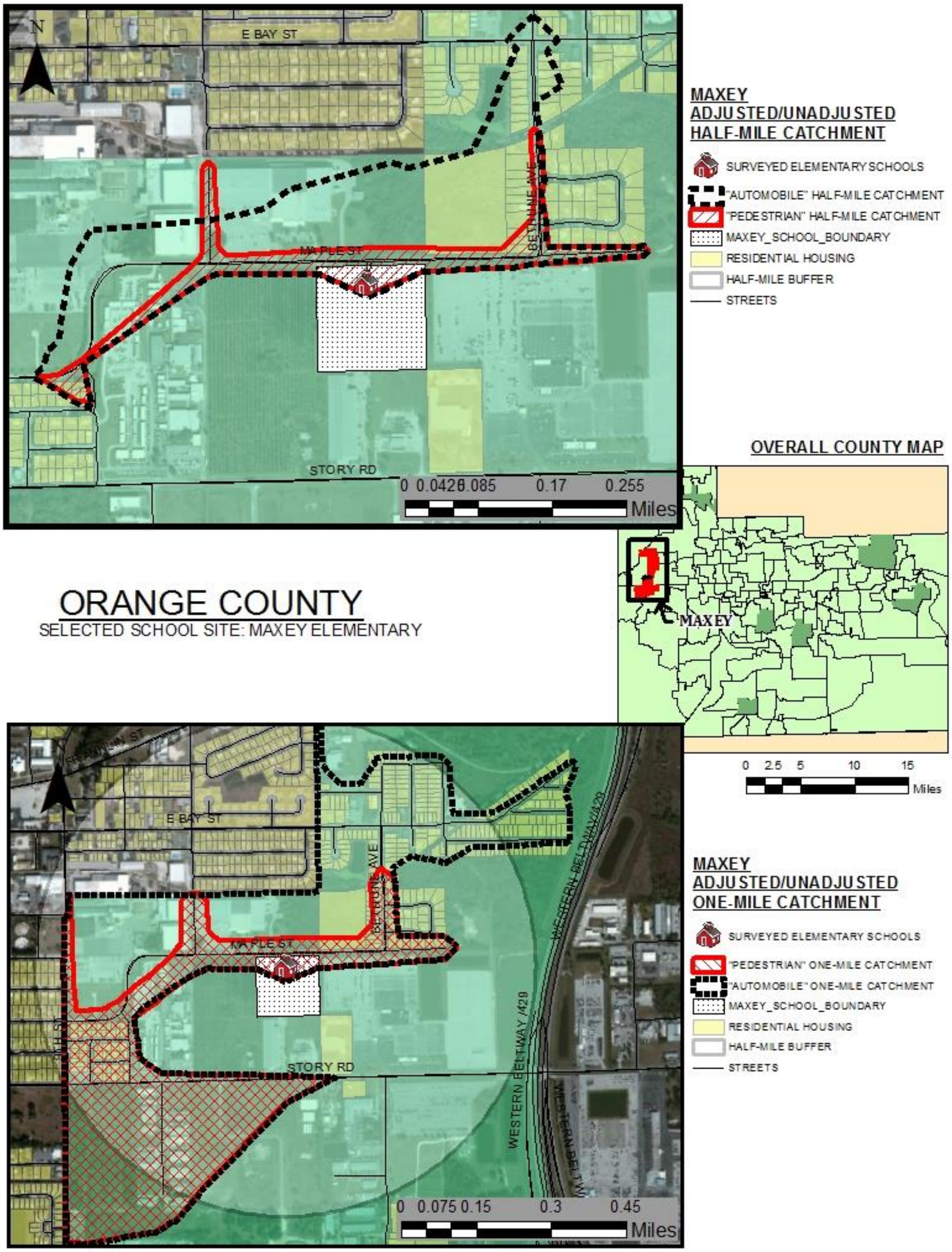


Figure 4-19. Map of Maxey Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Orange County

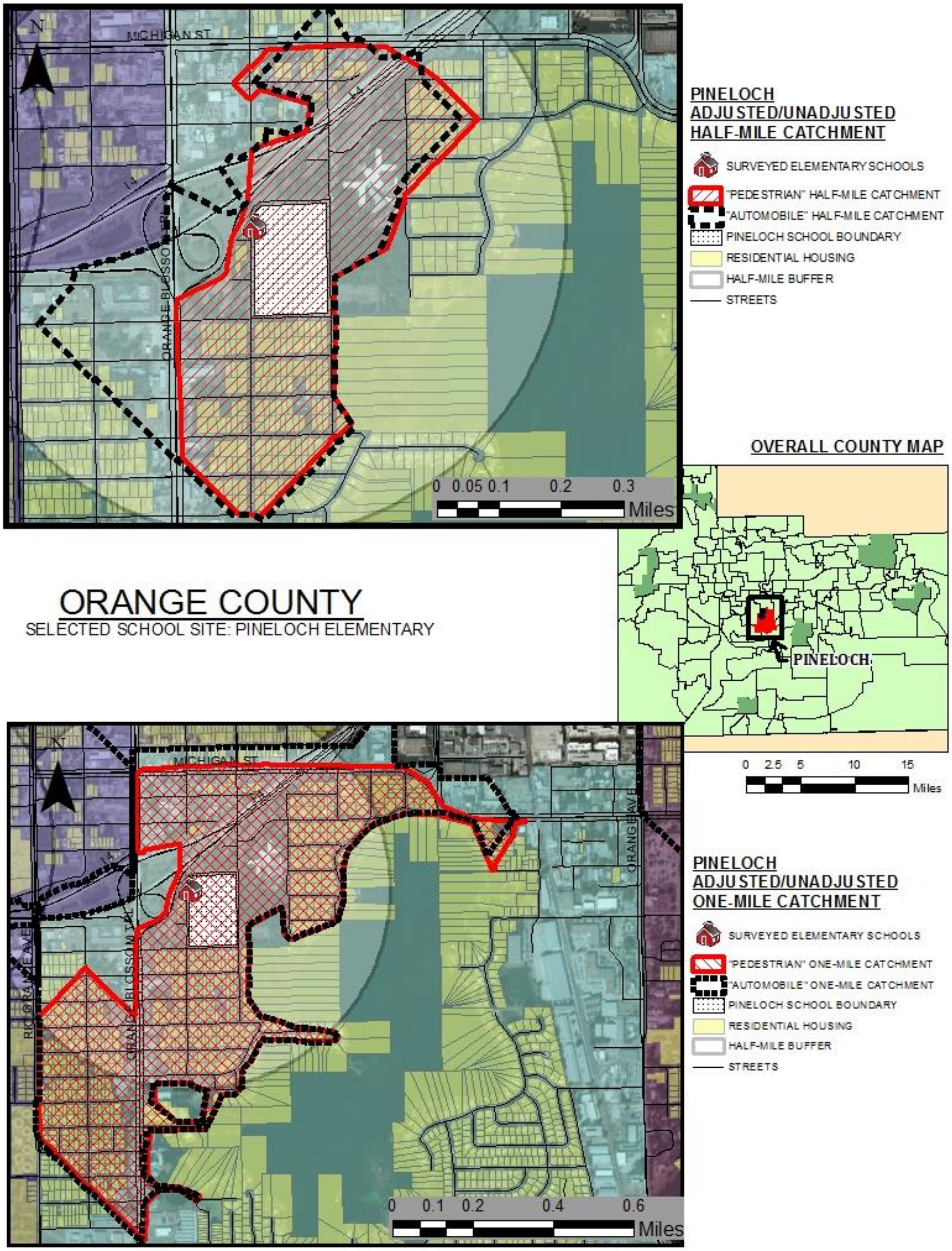


Figure 4-20. Map of Pineloch Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Orange County

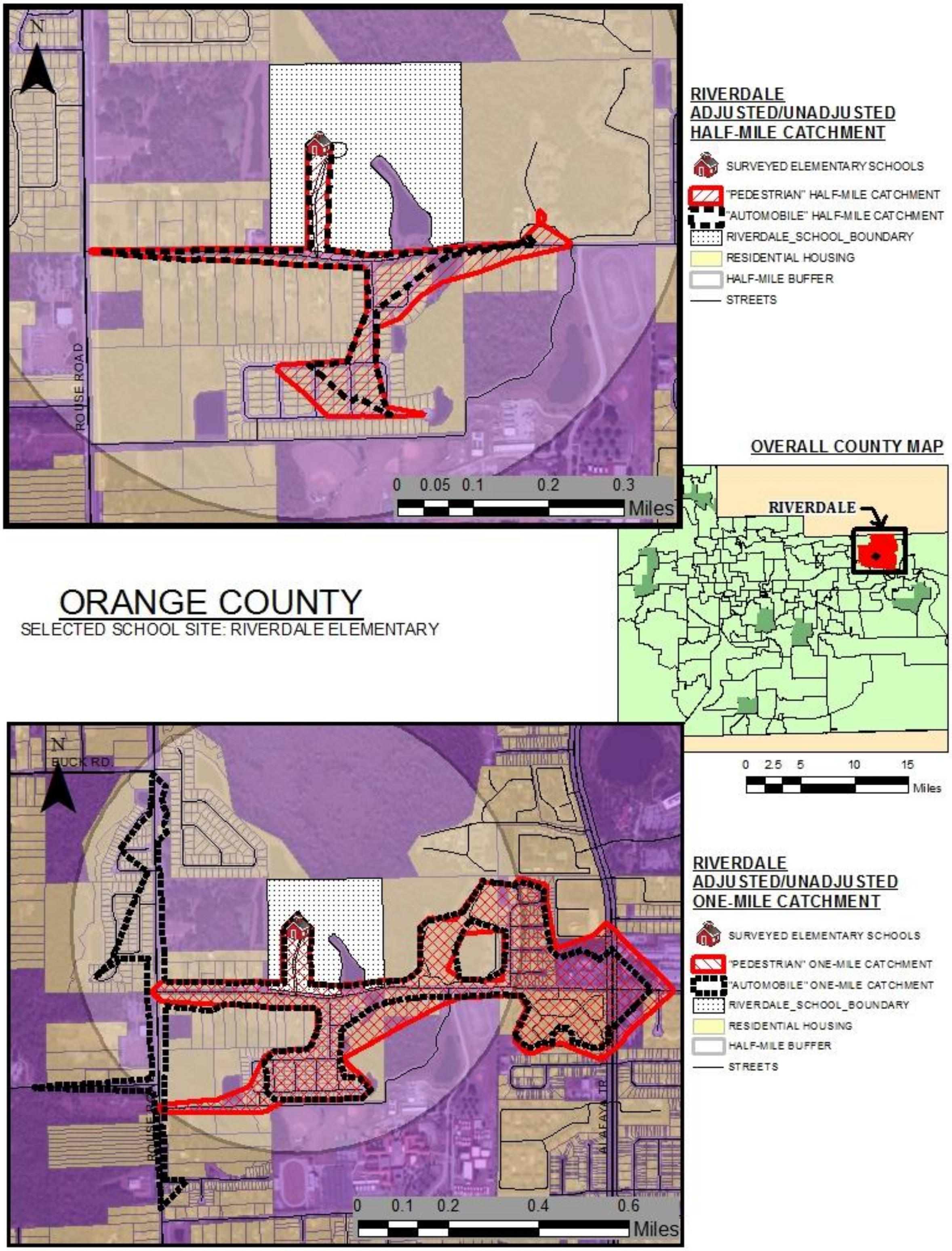


Figure 4-21. Map of Riverdale Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Orange County

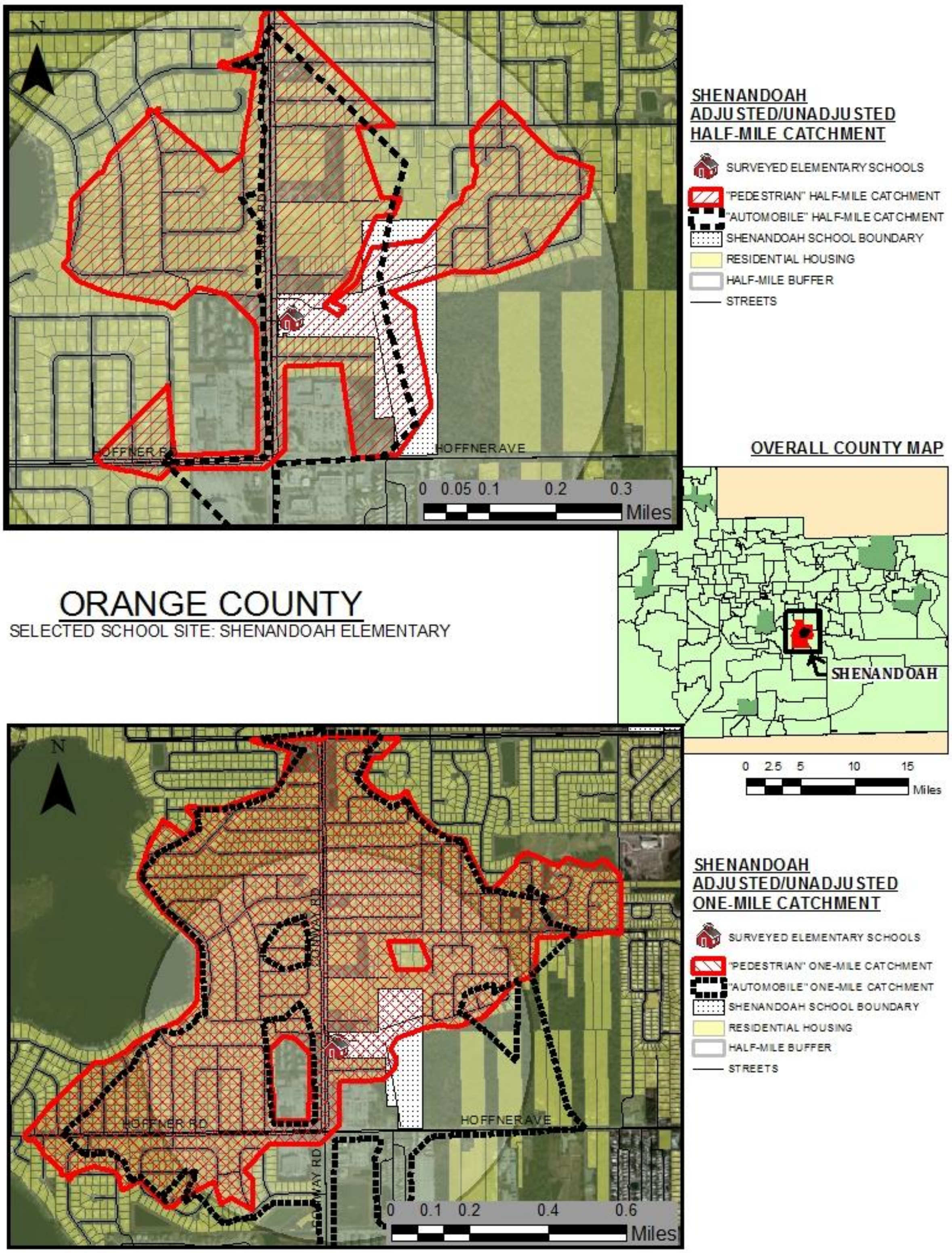


Figure 4-22. Map of Shenandoah Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Orange County

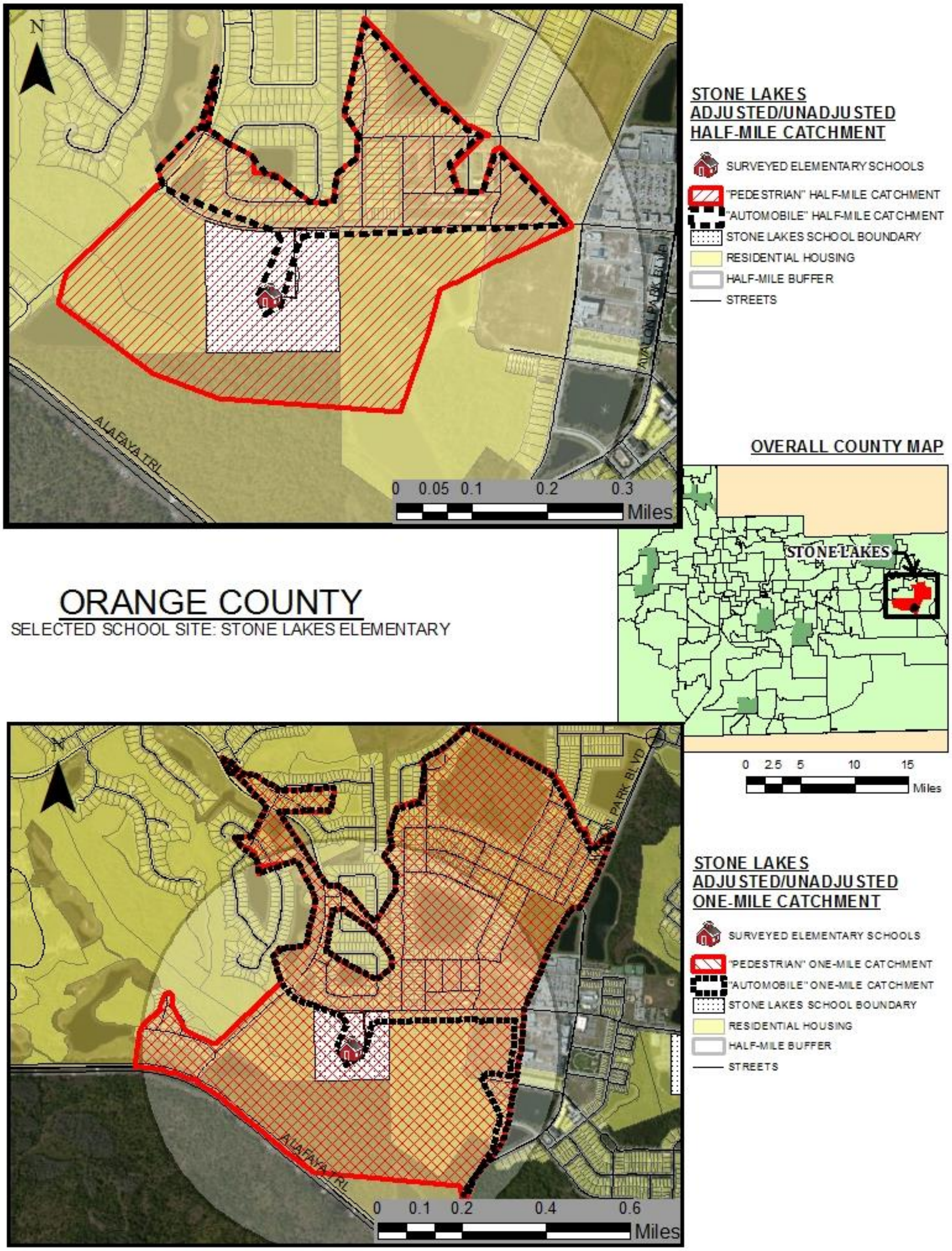
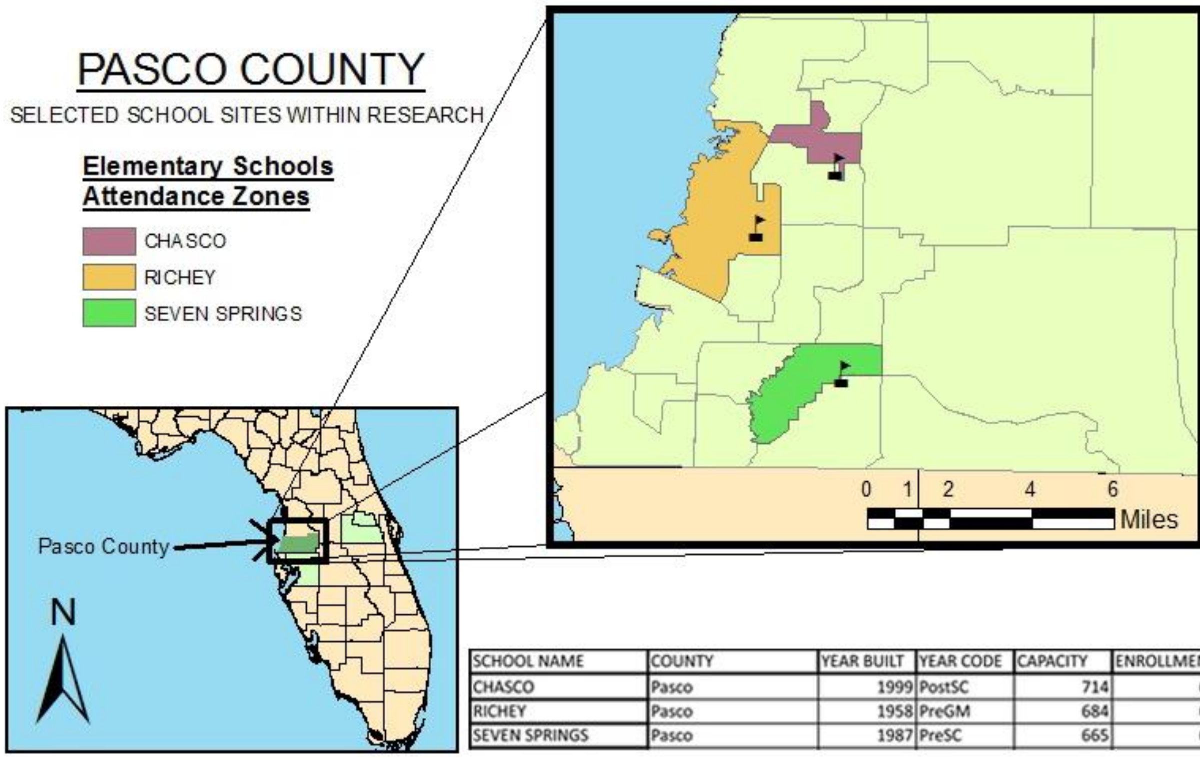


Figure 4-23. Map of Stone Lakes Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Orange County

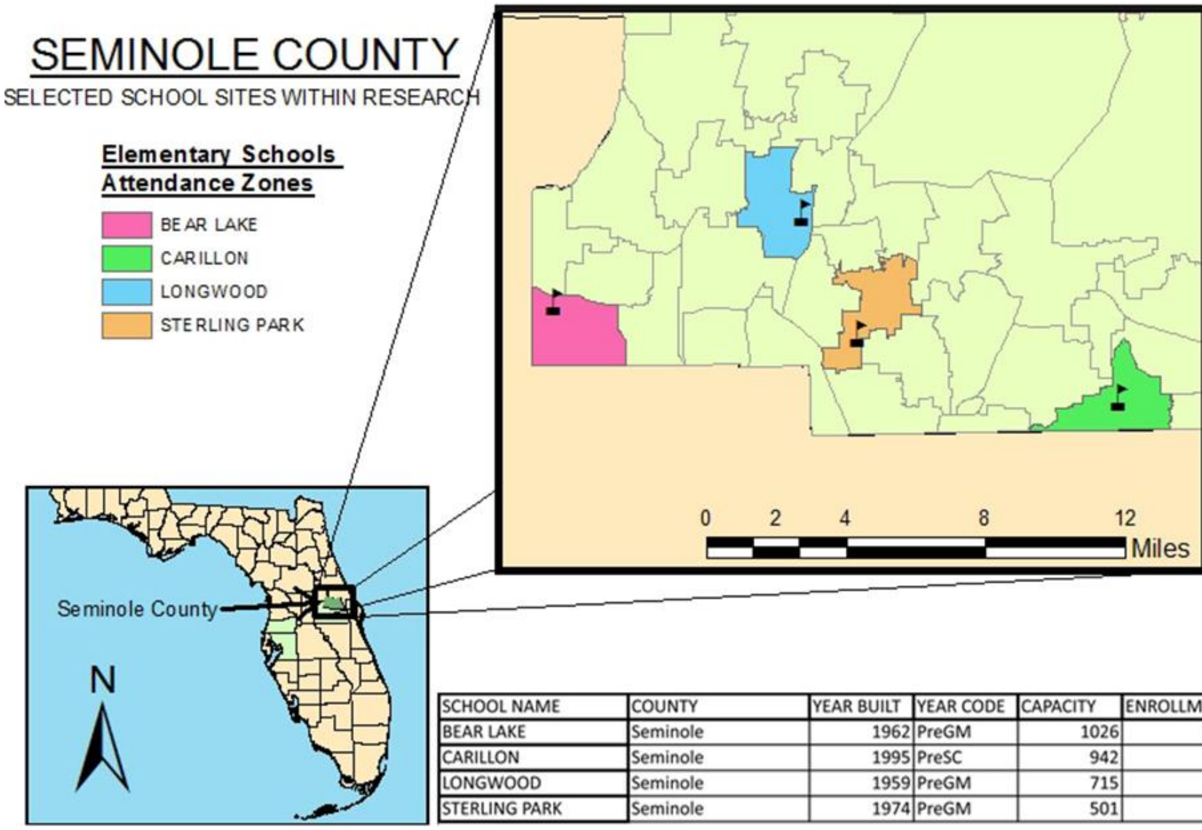
Figure 4-24. Map of school attendance zones of (A) Pasco County and (B) Seminole County

A



SCHOOL NAME	COUNTY	YEAR BUILT	YEAR CODE	CAPACITY	ENROLLMENT
CHASCO	Pasco	1999	PostSC	714	650
RICHEY	Pasco	1958	PreGM	684	645
SEVEN SPRINGS	Pasco	1987	PreSC	665	698

B



SCHOOL NAME	COUNTY	YEAR BUILT	YEAR CODE	CAPACITY	ENROLLMENT
BEAR LAKE	Seminole	1962	PreGM	1026	1140
CARILLON	Seminole	1995	PreSC	942	887
LONGWOOD	Seminole	1959	PreGM	715	703
STERLING PARK	Seminole	1974	PreGM	501	665

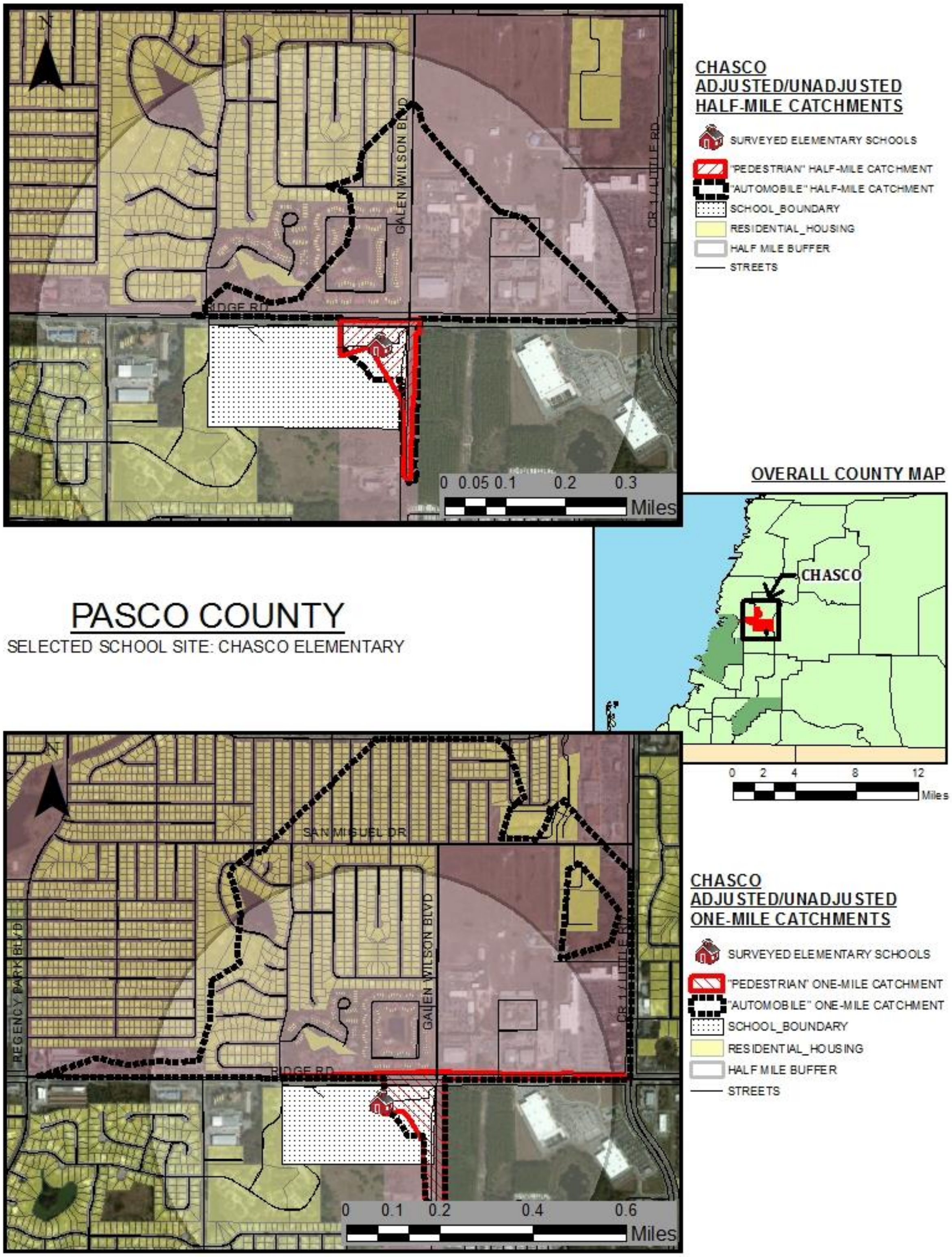


Figure 4-25. Map of Chasco Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Pasco County

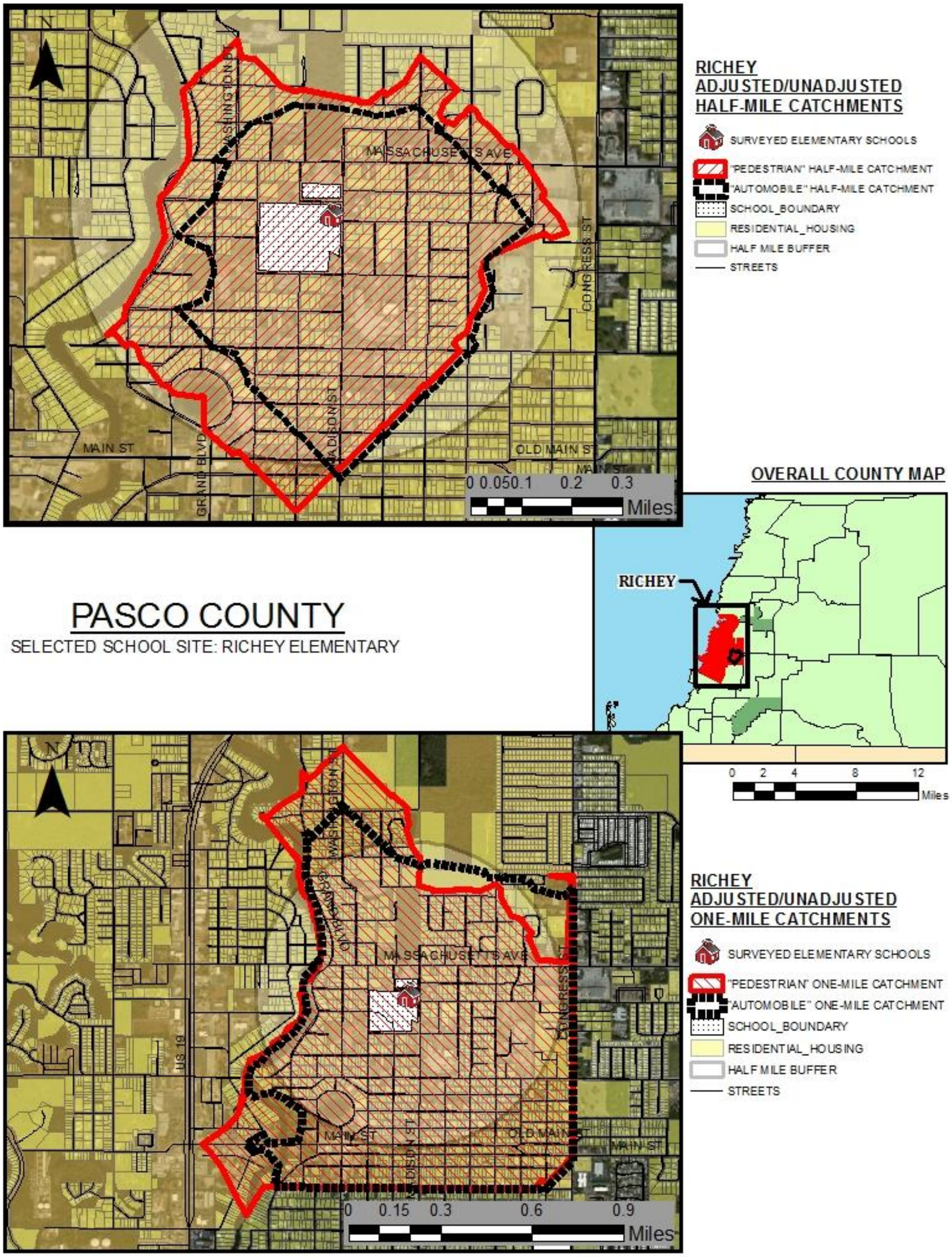


Figure 4-26. Map of Richey Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Pasco County

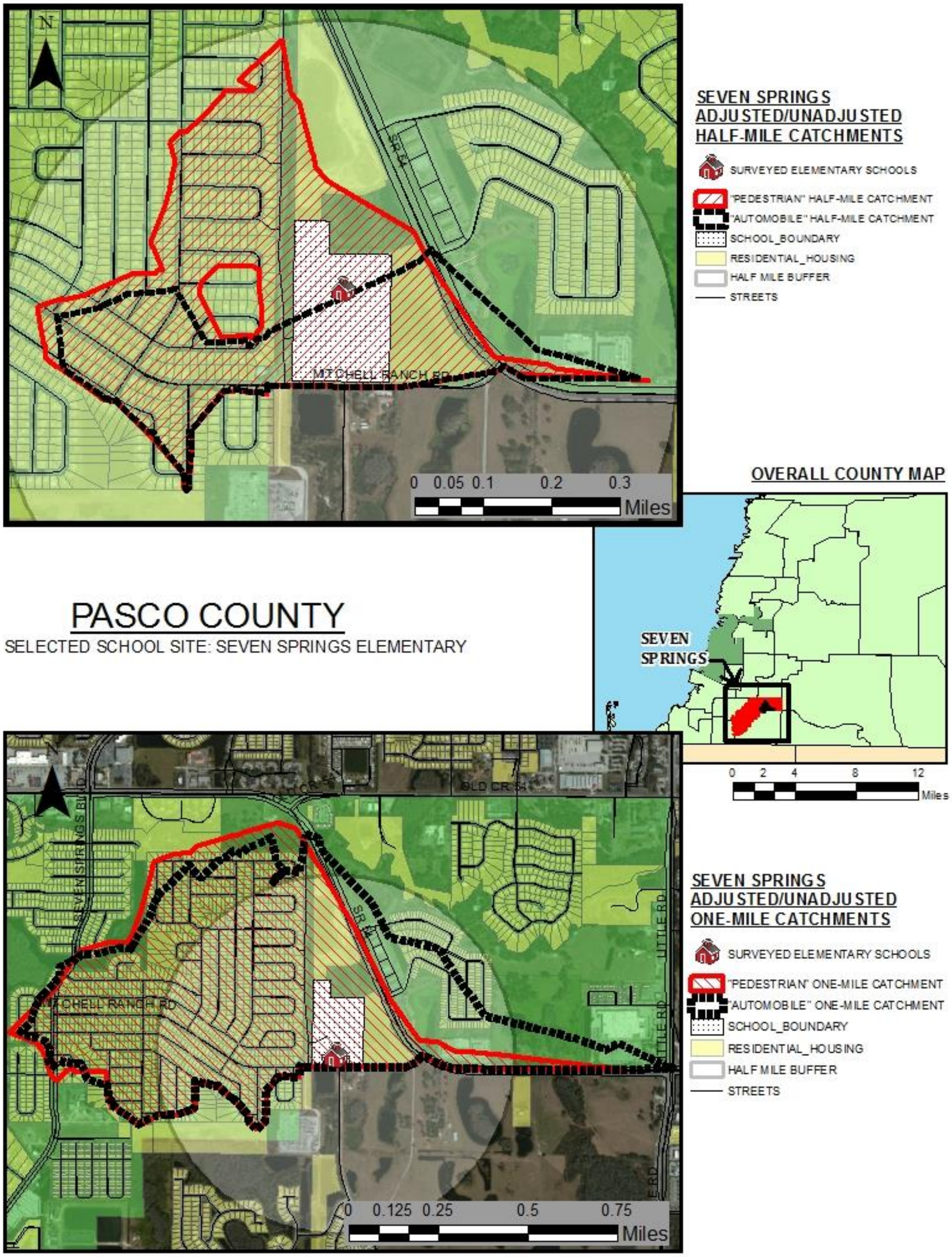


Figure 4-27. Map of Seven Springs Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Pasco County

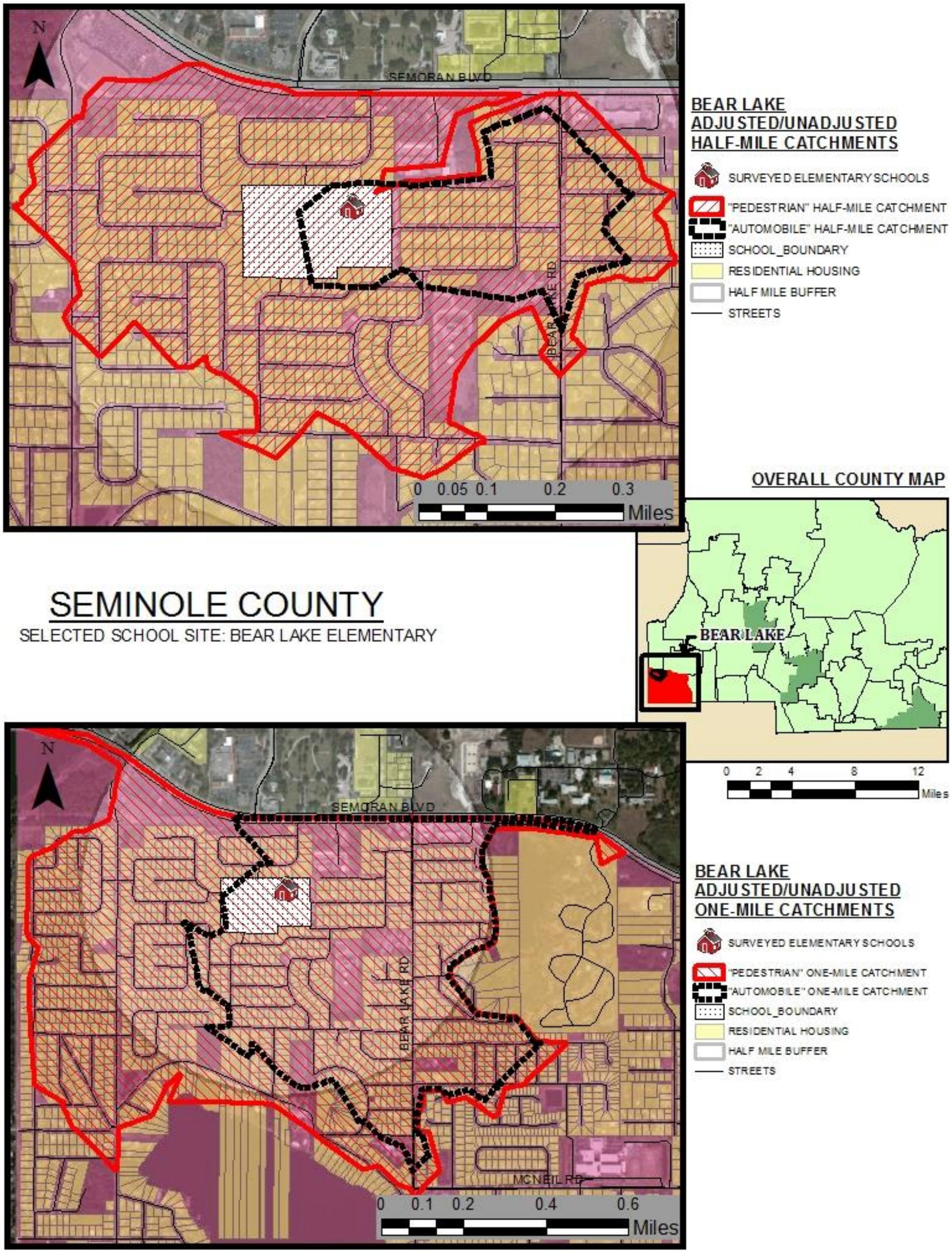


Figure 4-28. Map of Bear Lake Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Seminole County

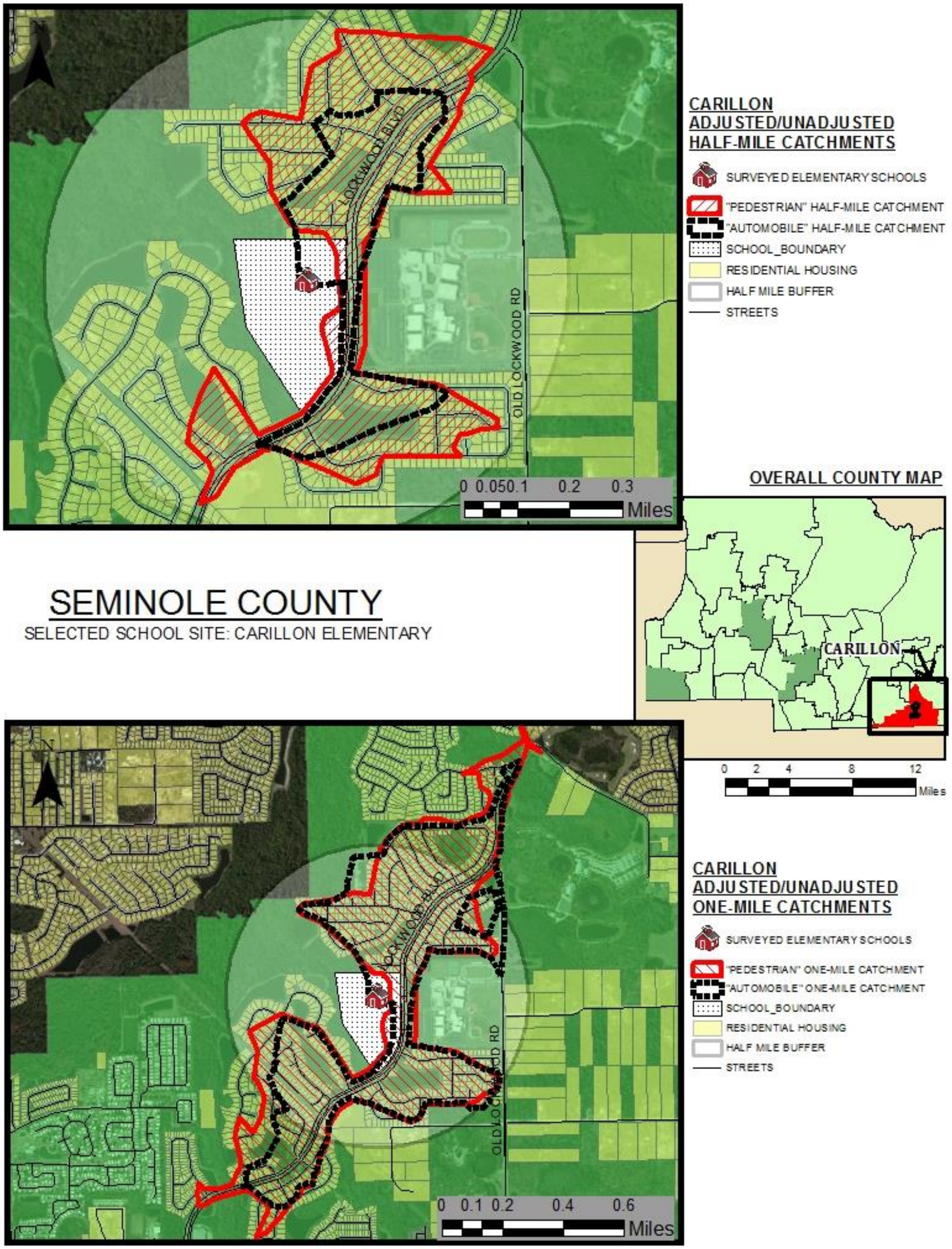


Figure 4-29. Map of Carillon Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Seminole County

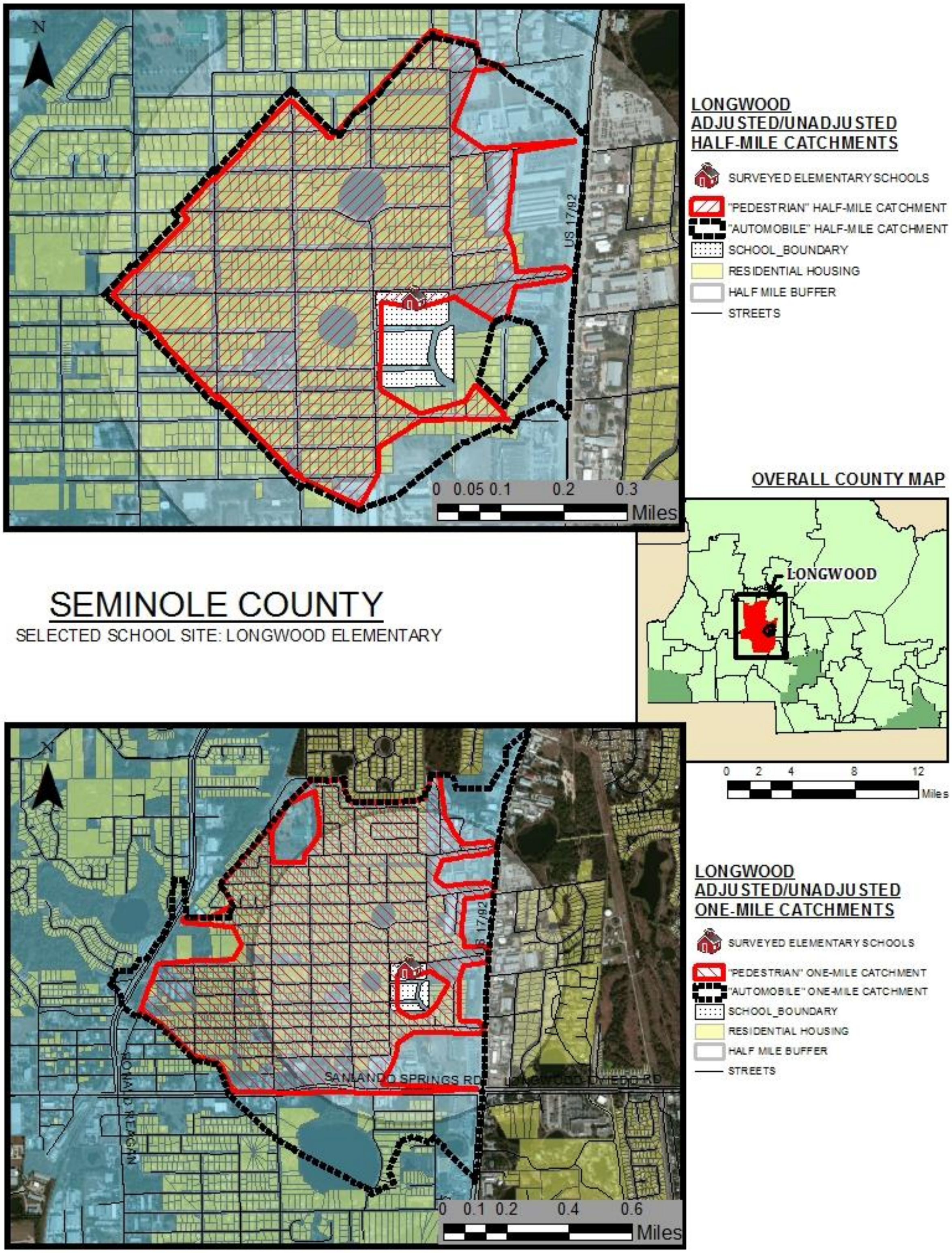


Figure 4-30. Map of Longwood Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Seminole County

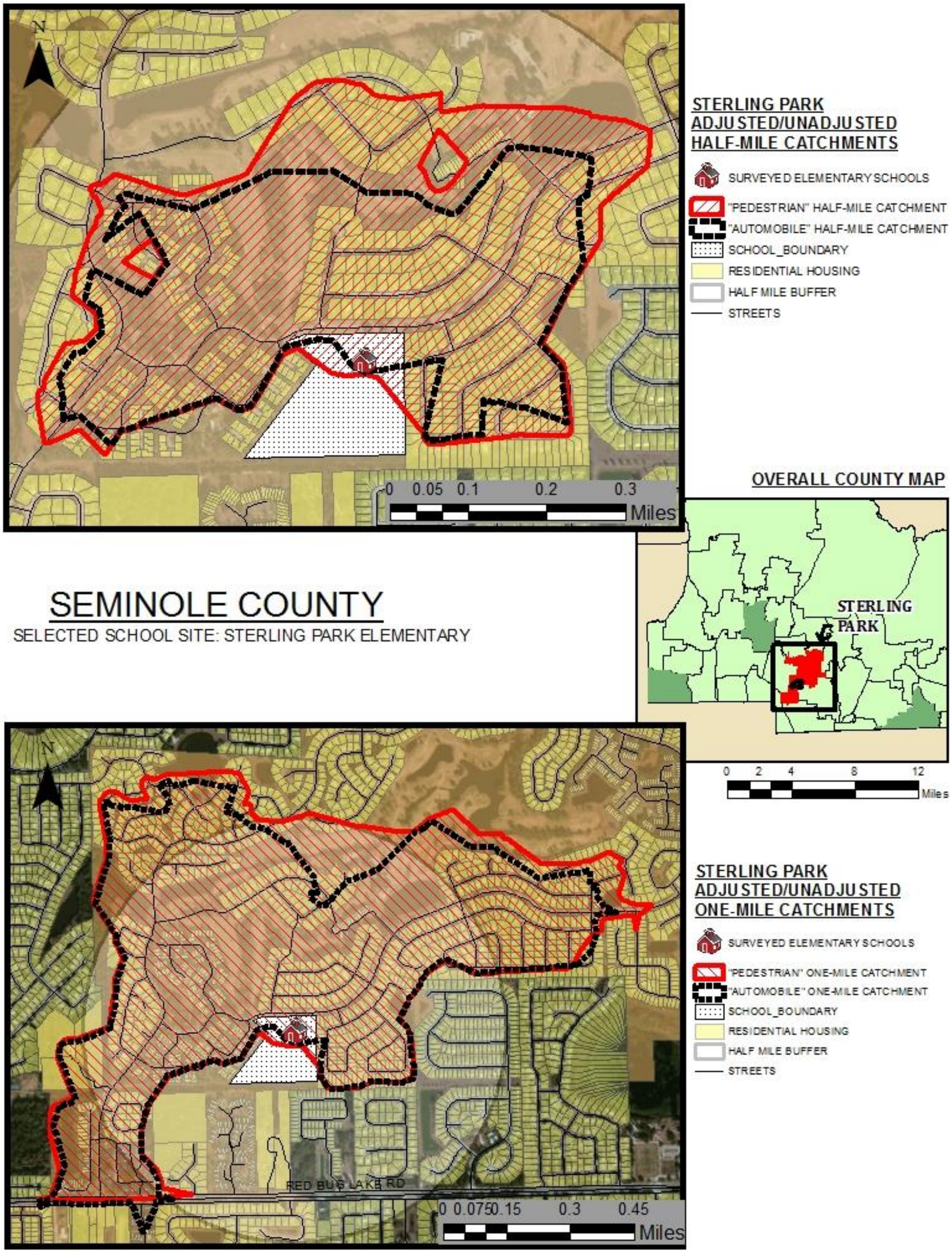


Figure 4-31. Map of Sterling Park Elementary half-mile and one-mile adjusted/unadjusted catchments areas in Seminole County

Figure 4-32. Chart of survey data collected (A) Day 1 (B) Day 2 and (C) Day 3

A

DAY 1					
SCHOOL NAME	WALK/BIKE	CAR	BUS	TOTAL	% WALKABILITY
BRYAN PC	20	287	409	716	3%
DOBY	106	214	89	410	26%
DOVER	57	252	360	670	9%
FOREST HILLS	49	536	422	1008	5%
GIBSONTON	83	321	191	589	14%
LAKE MAGDALENE	20	585	173	778	3%
MENDENHALL	38	333	145	518	7%
NELSON	0	223	243	468	0%
PRIDE	42	444	226	712	6%
RIVERVIEW	19	336	72	428	4%
ROBLES	146	432	89	589	25%
TAMPA BAY BOULEVARD	33	418	231	689	5%
TURNER	30	340	130	505	6%
JOHN YOUNG	154	733	25	912	17%
LOVELL	125	167	61	356	35%
MAXEY	17	171	92	281	6%
PINELOCH	84	348	149	618	14%
RIVERDALE	26	335	246	608	4%
SHENADOAH	117	437	26	585	20%
STONE LAKES	94	473	410	979	10%
CHASCO	1	236	244	482	0%
RICHEY	103	218	135	458	22%
SEVEN SPRINGS	62	371	102	536	12%
BEAR LAKE	103	416	256	778	13%
CARILLON	89	458	78	629	14%
LONGWOOD	96	263	176	453	21%
STERLING PARK	61	358	139	559	11%

B

DAY 2					
SCHOOL NAME	WALK/BIKE	CAR	BUS	TOTAL	% WALKABILITY
BRYAN PC	16	286	408	710	2%
DOBY	106	219	93	419	25%
DOVER	52	237	372	661	8%
FOREST HILLS	55	545	418	1018	5%
GIBSONTON	76	314	188	578	13%
LAKE MAGDALENE	27	594	162	784	3%
MENDENHALL	40	344	146	536	7%
NELSON	0	226	248	476	0%
PRIDE	36	441	228	705	5%
RIVERVIEW	22	299	77	340	6%
ROBLES	159	445	85	693	23%
TAMPA BAY BOULEVARD	36	405	220	558	6%
TURNER	28	345	133	506	6%
JOHN YOUNG	143	747	23	913	16%
LOVELL	122	176	71	358	34%
MAXEY	21	164	95	281	7%
PINELOCH	85	347	156	632	13%
RIVERDALE	28	345	245	619	5%
SHENADOAH	125	431	22	583	21%
STONE LAKES	117	459	402	980	12%
CHASCO	0	240	249	490	0%
RICHEY	96	229	136	463	21%
SEVEN SPRINGS	66	367	103	537	12%
BEAR LAKE	105	427	258	793	13%
CARILLON	87	448	78	616	14%
LONGWOOD	66	240	147	231	29%
STERLING PARK	61	373	131	566	11%

C

DAY 3					
SCHOOL NAME	WALK/BIKE	CAR	BUS	TOTAL	% WALKABILITY
BRYAN PC	16	289	403	714	2%
DOBY	108	215	93	417	26%
DOVER	54	249	375	678	8%
FOREST HILLS	41	536	380	956	4%
GIBSONTON	73	312	184	489	15%
LAKE MAGDALENE	22	592	163	778	3%
MENDENHALL	36	342	157	538	7%
NELSON	0	237	235	474	0%
PRIDE	41	431	218	582	7%
RIVERVIEW	20	313	76	351	6%
ROBLES	158	438	90	691	23%
TAMPA BAY BOULEVARD	33	392	214	436	8%
TURNER	29	349	137	515	6%
JOHN YOUNG	141	745	23	909	16%
LOVELL	116	182	57	357	32%
MAXEY	18	160	96	275	7%
PINELOCH	79	358	144	613	13%
RIVERDALE	24	352	239	616	4%
SHENADOAH	128	425	26	594	22%
STONE LAKES	102	472	389	843	12%
CHASCO	1	240	250	492	0%
RICHEY	90	225	139	455	20%
SEVEN SPRINGS	68	353	105	527	13%
BEAR LAKE	98	431	255	789	12%
CARILLON	80	456	82	622	13%
LONGWOOD	86	248	155	340	25%
STERLING PARK	59	377	131	568	10%

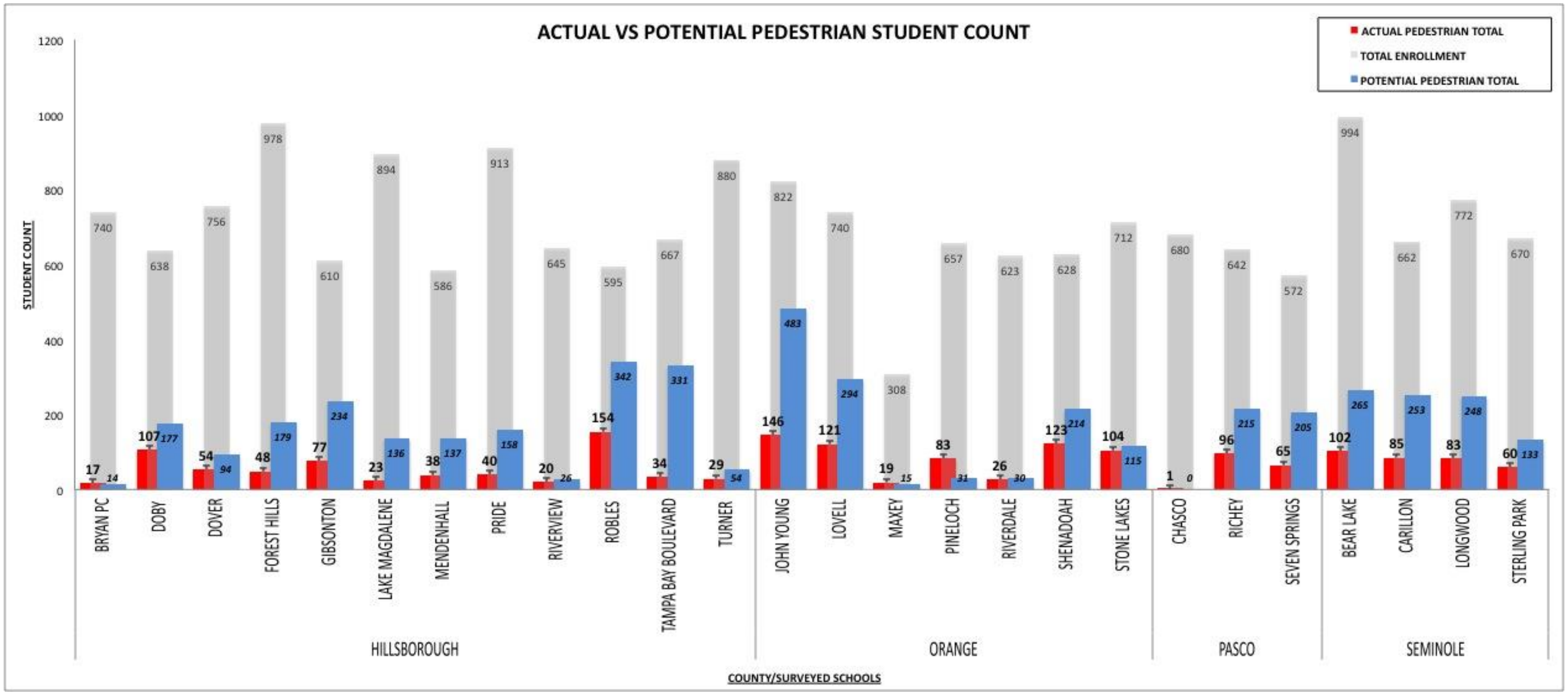
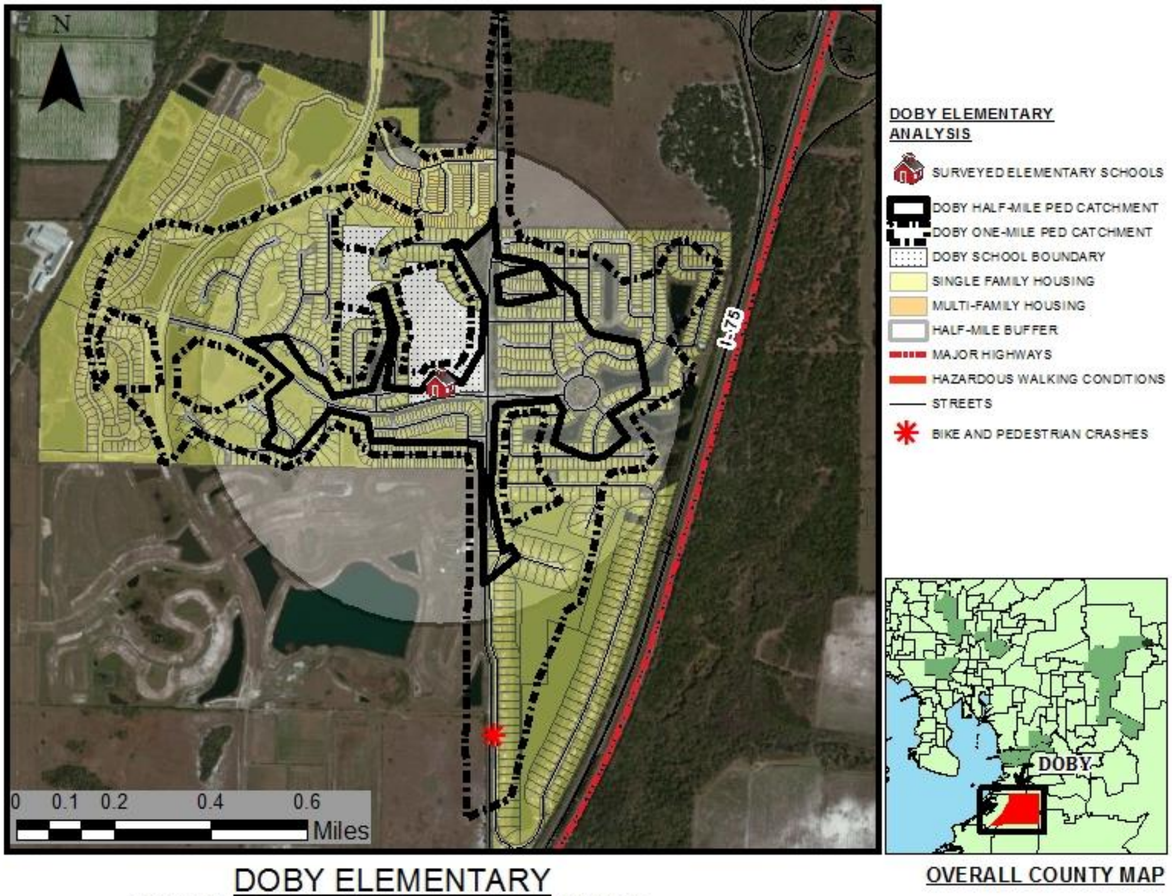


Figure 4-33. Graph of actual versus potential pedestrian student count



DOBY ELEMENTARY

SELECTED SCHOOL SITE: URBAN DESIGN ANALYSIS

OF INTERSECTIONS WITHIN HALF-MILE: 27
OF INTERSECTIONS WITHIN ONE-MILE: 44

OF RESIDENTIAL UNITS: 1288 (ONE-MILE)

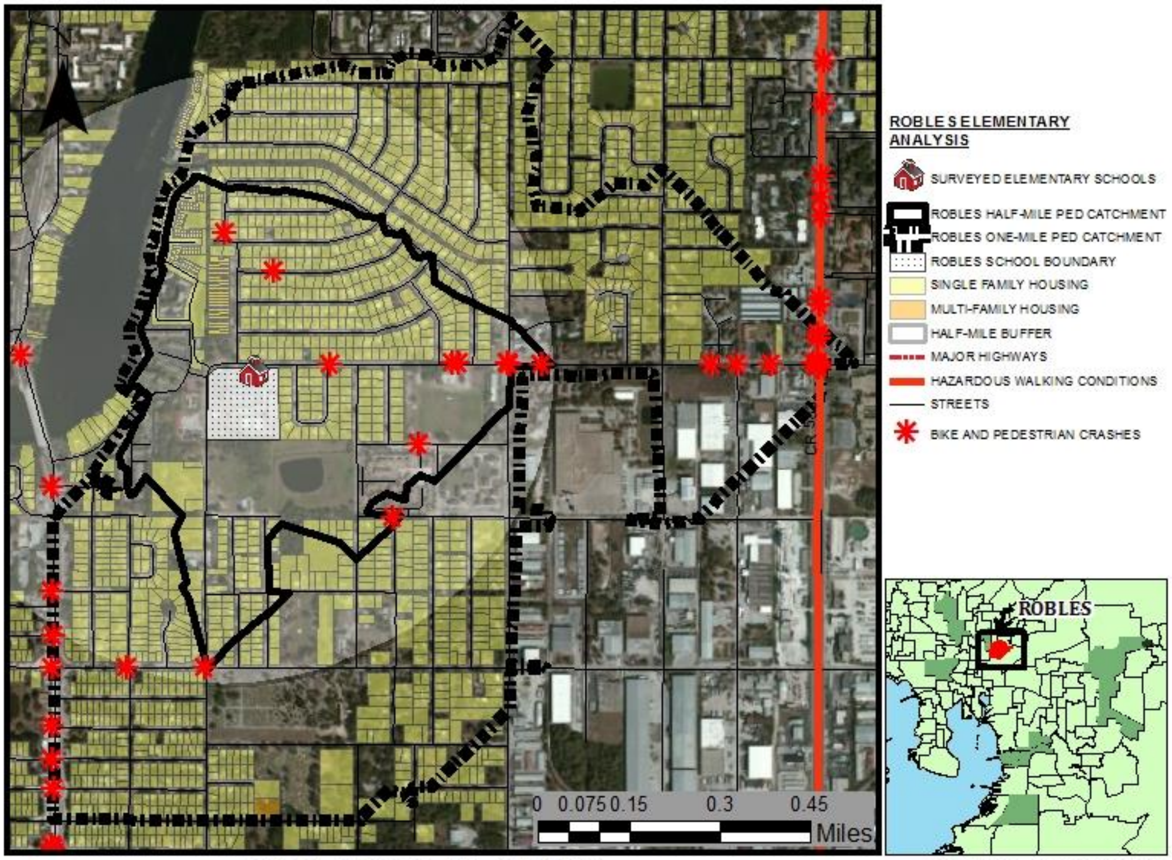
OF STUDENTS WITHIN HALF-MILE: 59 (POTENTIAL)
OF STUDENTS WITHIN ONE-MILE: 177 (POTENTIAL)
OF STUDENTS THAT WALK/BIKE: 107 (ACTUAL)

OF BIKE/PEDESTRIAN CRASHES WITHIN ONE-MILE: 1

Figure 4-34. Map of Doby Elementary in Hillsborough County for urban design analysis

SITE #1: DOBY ELEMENTARY (HILLSBOROUGH COUNTY)	YEAR BUILT	2005		
	YEAR CODE	POST SC		
	CAPACITY	958		
	ENROLLMENT	638		
	AVERAGE # OF STUDENTS SURVEYED	415.3 (65%)		
	# OF RESIDENTIAL UNITS WITHIN ONE-MILE	1,288		
	PEDESTRIANS	POTENTIAL (HALF-MILE)	59	
		POTENTIAL (ONE-MILE)	177	
		ACTUAL SURVEYED	107	
		AVERAGE RATE OF SURVEYED WALKABILITY	26%	
	INTERSECTIONS	WITHIN HALF-MILE	27	
		WITHIN ONE-MILE	44	
	# OF PED/BIKE CRASHES	WITHIN HALF-MILE	0	
		WITHIN ONE-MILE	1	
	INCOME	% < US$14,000 ANNUALLY	4.6%	
		% < US$29,000 ANNUALLY	15.8%	
		% DO NOT OWN A CAR	2.4%	
	MORPHOLOGICAL	URBAN SPACE	TRADITIONAL	
		SIZE OF BLOCKS	SMALL	
		PERMEABILITY	COARSE	
		GRID	DEFORMED LADDERED	
		PRIMARY MOVEMENT	BOTH AUTO/PED	
	PERCEPTUAL	PATHS	REG USE-PROX	
		EDGES	ENCLOSURE: I-75	
		DISTRICTS	UNCERTAIN BOUNDARY	
		NODES	N/A	
		LANDMARKS	N/A	
	SOCIAL	TYPE OF NEIGHBORHOOD	TRADITIONAL COMPACT	
		SAFETY & SECURITY	CONTROLLED	
		ACTIVITY	ALL RESIDENTIAL	
		ACCESSIBILITY/EXCLUSION	EXCLUSION-SPACES HARD TO FIND	
	VISUAL	STREETS & SQUARES	FORMAL	
		POS & NEG SPACE	MOSTLY POSITIVE/VERY DENSE	
		PATTERNS	RHYTHMIC	
		AESTHETIC PREFERENCES	NATURALNESS?	NO-BUILT ELEMENTS DOMINATE
			UPKEEP/CIVILITIES?	YES
			OPENNESS/DEFINED?	DEFINED

Figure 4-35. Chart of Doby Elementary characteristics (including analysis of Carmona's dimensions of urban design of the site)



ROBLES ELEMENTARY

SELECTED SCHOOL SITE: URBAN DESIGN ANALYSIS

OVERALL COUNTY MAP

OF INTERSECTIONS WITHIN HALF-MILE: 47
OF INTERSECTIONS WITHIN ONE-MILE: 130

OF RESIDENTIAL UNITS: 2013 (ONE-MILE)

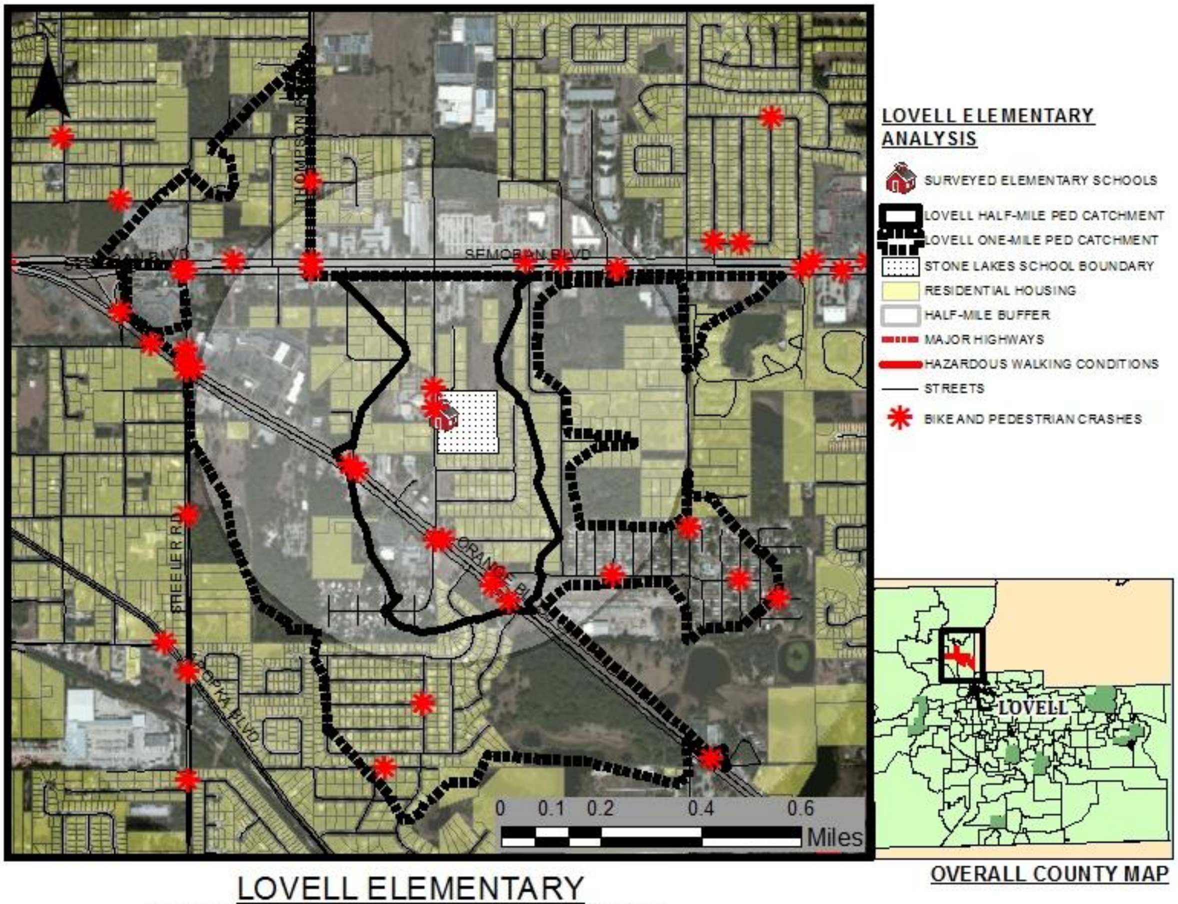
OF STUDENTS WITHIN HALF-MILE: 155 (POTENTIAL)
OF STUDENTS WITHIN ONE-MILE: 342 (POTENTIAL)
OF STUDENTS THAT WALK/BIKE: 154 (ACTUAL)

OF BIKE/PEDESTRIAN CRASHES WITHIN HALF-MILE: 12
OF BIKE/PEDESTRIAN CRASHES WITHIN ONE-MILE: 28

Figure 4-36. Map of Robles Elementary in Hillsborough County for urban design analysis

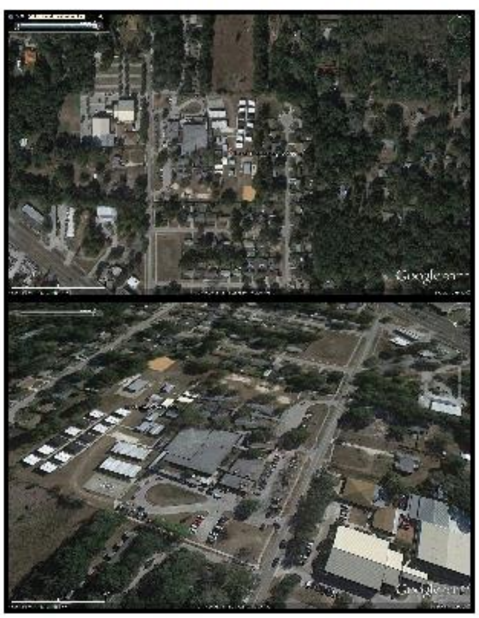
SITE #2: ROBLES ELEMENTARY (HILLSBOROUGH COUNTY)	YEAR BUILT	1959		
	YEAR CODE	PRE GM		
	CAPACITY	868		
	ENROLLMENT	729		
	AVERAGE # OF STUDENTS SURVEYED	657.7 (90%)		
	# OF RESIDENTIAL UNITS WITHIN ONE-MILE	2,013		
	PEDESTRIANS	POTENTIAL (HALF-MILE)	155	
		POTENTIAL (ONE-MILE)	342	
		ACTUAL SURVEYED	154	
		AVERAGE RATE OF SURVEYED WALKABILITY	24%	
	INTERSECTIONS	WITHIN HALF-MILE	47	
		WITHIN ONE-MILE	130	
	# OF PED/BIKE CRASHES	WITHIN HALF-MILE	12	
		WITHIN ONE-MILE	24	
	INCOME	% < US$14,000 ANNUALLY	40.6%	
		% < US$29,000 ANNUALLY	57.4%	
		% DO NOT OWN A CAR	7.0%	
	MORPHOLOGICAL	URBAN SPACE	TRADITIONAL	
		SIZE OF BLOCKS	MOSTLY SMALL BUT MIXED	
		PERMEABILITY	BOTH (RESIDENTIAL MOSTLY COARSE)	
		GRID	DEFORMED - LADDERED	
		PRIMARY MOVEMENT	BOTH - AUTO/PED	
	PERCEPTUAL	PATHS	REG USE - PROX	
		EDGES	ENCLOSURE: 56TH ST/40TH ST/HILLS RIVER	
		DISTRICTS	PRECISE BOUNDARY	
		NODES	N/A	
		LANDMARKS	HILLBOROUGH RIVER	
	SOCIAL	TYPE OF NEIGHBORHOOD	URBAN/TRADITIONAL	
		SAFETY & SECURITY	CONTROLLED/UNCONTROLLED	
		ACTIVITY	MULTI	
		ACCESSIBILITY/EXCLUSION	VISIBLE/ACCESSIBLE	
	VISUAL	STREETS & SQUARES	FORMAL	
		POS & NEG SPACE	MOSTLY POSITIVE/DENSE	
		PATTERNS	SPORADIC/NON-RHYTHMIC	
		AESTHETIC PREFERENCES	NATURALNESS?	NO-BUILT ELEMENTS DOMINATE
			UPKEEP/CIVILITIES?	BOTH YES/NO
			OPENNESS/DEFINED?	OPENNESS

Figure 4-37. Chart of Robles Elementary characteristics (including analysis of Carmona's dimensions of urban design of the site)



LOVELL ELEMENTARY

SELECTED SCHOOL SITE: URBAN DESIGN ANALYSIS



OF INTERSECTIONS WITHIN HALF-MILE: 13
OF INTERSECTIONS WITHIN ONE-MILE: 61

OF RESIDENTIAL UNITS: 139 (HALF-MILE)/501 (ONE-MILE)

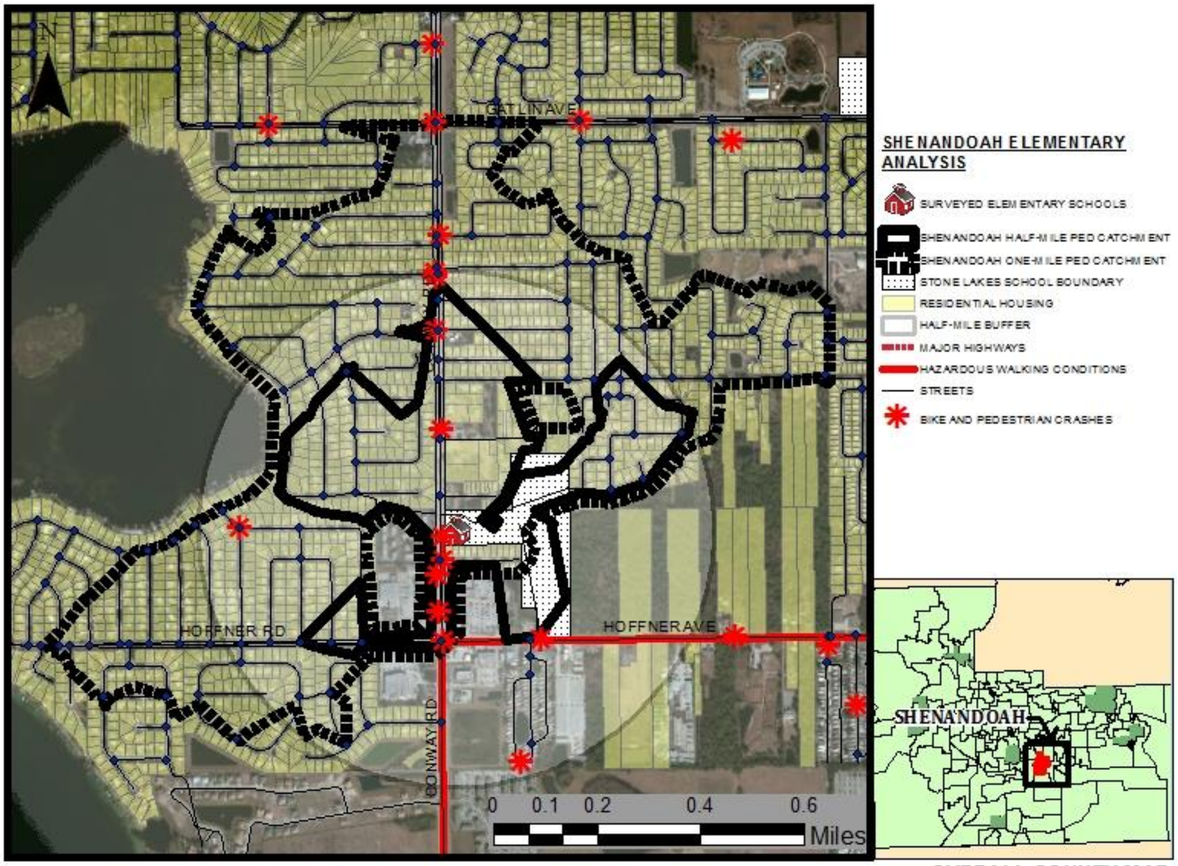
OF STUDENTS WITHIN HALF-MILE: 51 (POTENTIAL)
OF STUDENTS WITHIN ONE-MILE: 294 (POTENTIAL)
OF STUDENTS THAT WALK/BIKE: 122 (ACTUAL)

OF BIKE/PEDESTRIAN CRASHES WITHIN HALF-MILE: 10
OF BIKE/PEDESTRIAN CRASHES WITHIN ONE-MILE: 24

Figure 4-38. Map of Lovell Elementary in Orange County for urban design analysis

SITE #3: LOVELL ELEMENTARY (ORANGE COUNTY)	YEAR BUILT	1960		
	YEAR CODE	PRE GM		
	CAPACITY	986		
	ENROLLMENT	722		
	AVERAGE # OF STUDENTS SURVEYED	357 (49%)		
	# OF RESIDENTIAL UNITS WITHIN ONE-MILE	501		
	PEDESTRIANS	POTENTIAL (HALF-MILE)	51	
		POTENTIAL (ONE-MILE)	294	
		ACTUAL SURVEYED	122	
		AVERAGE RATE OF SURVEYED WALKABILITY	34%	
	INTERSECTIONS	WITHIN HALF-MILE	13	
		WITHIN ONE-MILE	61	
	# OF PED/BIKE CRASHES	WITHIN HALF-MILE	10	
		WITHIN ONE-MILE	24	
	INCOME	% < US$14,000 ANNUALLY	15.0%	
		% < US$29,000 ANNUALLY	48.6%	
		% DO NOT OWN A CAR	7.2%	
	MORPHOLOGICAL	URBAN SPACE	MODERN	
		SIZE OF BLOCKS	MAJORITY MED	
		PERMEABILITY	BOTH (RESIDENTIAL MOSTLY COARSE)	
		GRID	GRIDDED STREET SYSTEM	
		PRIMARY MOVEMENT	BOTH AUTO/PED	
	PERCEPTUAL	PATHS	PROXIMITY	
		EDGES	ENCLOSURE: SEMORAN BLVD; SEAM: ORANGE BLOSSOM	
		DISTRICTS	PRECISE BOUNDARY	
		NODES	N/A	
		LANDMARKS	N/A	
	SOCIAL	TYPE OF NEIGHBORHOOD	URBAN	
		SAFETY & SECURITY	CONTROLLED/UNCONTROLLED	
		ACTIVITY	MULTI	
		ACCESSIBILITY/EXCLUSION	VISIBLE/ACCESSIBLE	
	VISUAL	STREETS & SQUARES	INFORMAL	
		POS & NEG SPACE	EQUAL USE BUT DENSE SURROUNDING CATCHMENT	
		PATTERNS	SPORADIC/NON-RHYTHMIC	
		AESTHETIC PREFERENCES	NATURALNESS?	NO-BUILT ELEMENTS AND ROADS DOM
			UPKEEP/CIVILITIES?	NO
			OPENNESS/DEFINED?	OPENNESS

Figure 4-39. Chart of Lovell Elementary characteristics (including analysis of Carmona’s dimensions of urban design of the site)



OVERALL COUNTY MAP

SHENANDOAH ELEMENTARY

SELECTED SCHOOL SITE: URBAN DESIGN ANALYSIS

OF INTERSECTIONS WITHIN HALF-MILE: 24
OF INTERSECTIONS WITHIN ONE-MILE: 90

OF RESIDENTIAL UNITS: 353 (HALF-MILE)/1439 (ONE-MILE)

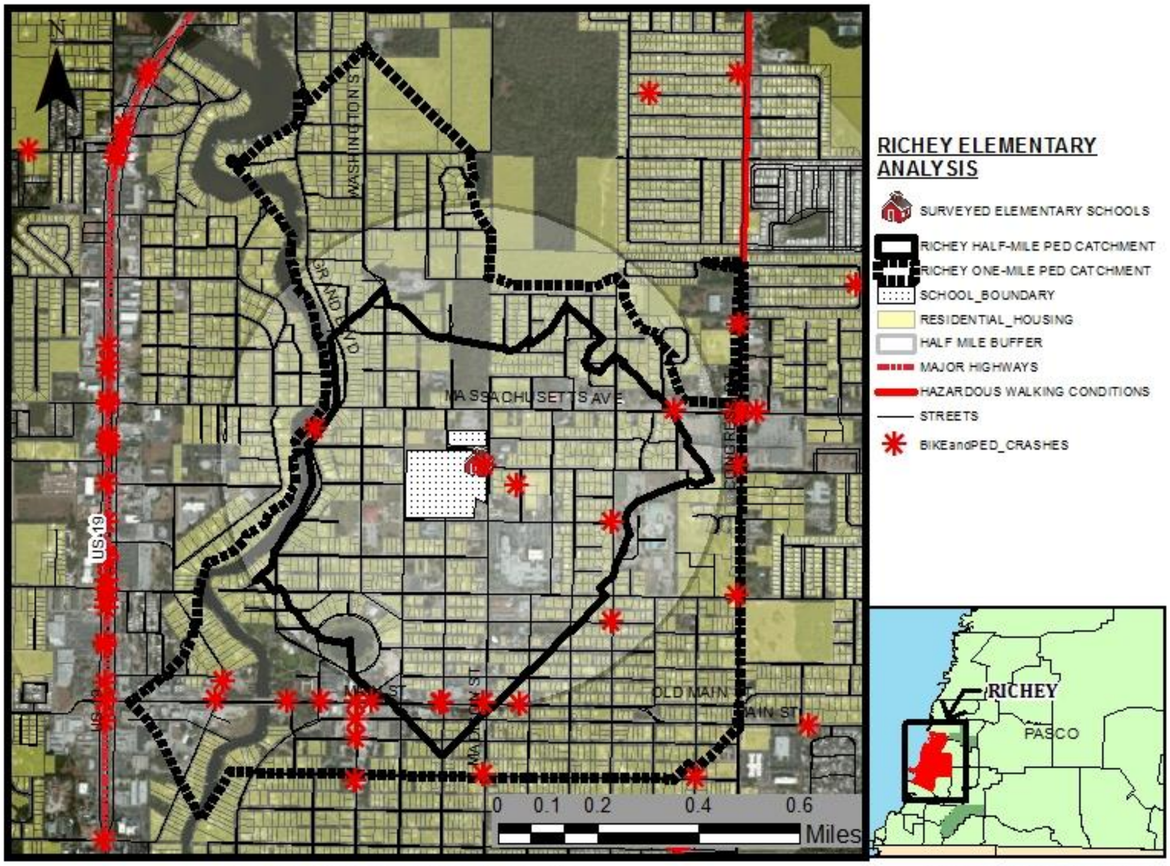
OF STUDENTS WITHIN HALF-MILE: 52 (POTENTIAL)
OF STUDENTS WITHIN ONE-MILE: 214 (POTENTIAL)
OF STUDENTS THAT WALK/BIKE: 123 (ACTUAL)

OF BIKE/PEDESTRIAN CRASHES WITHIN HALF-MILE: 8
OF BIKE/PEDESTRIAN CRASHES WITHIN ONE-MILE: 12

Figure 4-40. Map of Shenandoah Elementary in Orange County for urban design analysis

SITE #4: SHENANDOAH ELEMENTARY (ORANGE COUNTY)	YEAR BUILT	1969		
	YEAR CODE	PRE GM		
	CAPACITY	880		
	ENROLLMENT	659		
	AVERAGE # OF STUDENTS SURVEYED	587.3 (89%)		
	# OF RESIDENTIAL UNITS WITHIN ONE-MILE	1,439		
	PEDESTRIANS	POTENTIAL (HALF-MILE)	52	
		POTENTIAL (ONE-MILE)	214	
		ACTUAL SURVEYED	123	
		AVERAGE RATE OF SURVEYED WALKABILITY	21%	
	INTERSECTIONS	WITHIN HALF-MILE	24	
		WITHIN ONE-MILE	90	
	# OF PED/BIKE CRASHES	WITHIN HALF-MILE	8	
		WITHIN ONE-MILE	12	
	INCOME	% < US$14,000 ANNUALLY	5.2%	
		% < US$29,000 ANNUALLY	23.8%	
		% DO NOT OWN A CAR	3.4%	
	MORPHOLOGICAL	URBAN SPACE	TRADITIONAL	
		SIZE OF BLOCKS	SMALL	
		PERMEABILITY	COARSE	
		GRID	DEFORMED LADDERED	
		PRIMARY MOVEMENT	BOTH AUTO/PED	
	PERCEPTUAL	PATHS	REG USE/CONCENTRATED	
		EDGES	CONWAY RD ACTS AS A SEAM/ GATLIN&HOFFNER ARE ENCLOSURES	
		DISTRICTS	UNCERTAIN BOUNDARY	
		NODES	SCHOOL SITE	
		LANDMARKS	N/A	
	SOCIAL	TYPE OF NEIGHBORHOOD	URBAN/TRADITIONAL	
		SAFETY & SECURITY	CONTROLLED/UNCONTROLLED	
		ACTIVITY	MOSTLY RESIDENTIAL ASIDE FROM BIG BOX STORES	
		ACCESSIBILITY/EXCLUSION	EXCLUSION- SPACES HARD TO FIND	
	VISUAL	STREETS & SQUARES	INFORMAL	
		POS & NEG SPACE	MOSTLY POSITIVE/VERY DENSE	
		PATTERNS	SPORADIC/NON-RHYTHMIC	
		AESTHETIC PREFERENCES	NATURALNESS?	NO- BUILT ELEMENTS AND ROADS DOMINATE
			UPKEEP/CIVILITIES?	BOTH YES/NO
			OPENNESS/DEFINED?	OPENNESS

Figure 4-41. Chart of Shenandoah Elementary characteristics (including analysis of Carmona's dimensions of urban design of the site)



RICHEY ELEMENTARY

SELECTED SCHOOL SITE: URBAN DESIGN ANALYSIS

OF INTERSECTIONS WITHIN HALF-MILE: 90
OF INTERSECTIONS WITHIN ONE-MILE: 199

OF RESIDENTIAL UNITS: 668 (HALF-MILE)/1529 (ONE-MILE)

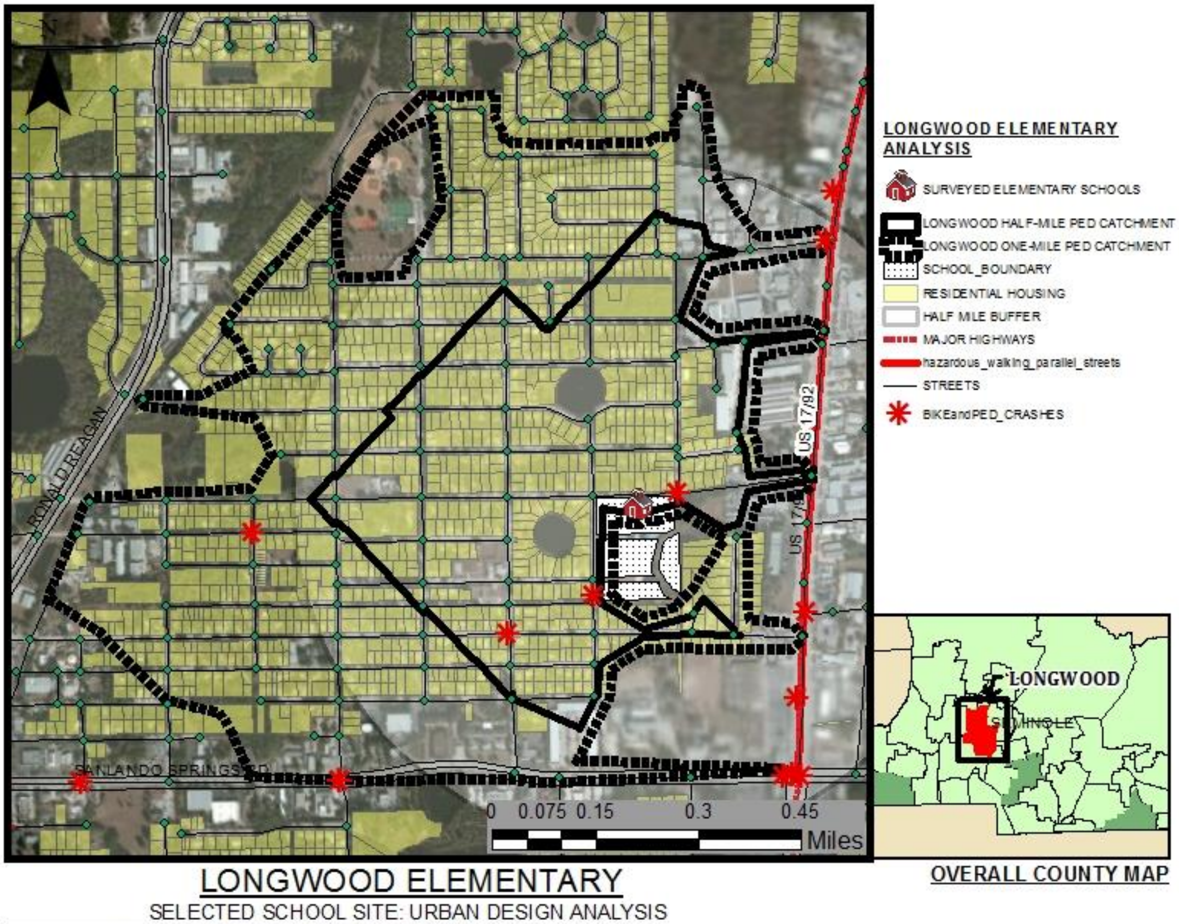
OF STUDENTS WITHIN HALF-MILE: 86 (POTENTIAL)
OF STUDENTS WITHIN ONE-MILE: 215 (POTENTIAL)
OF STUDENTS THAT WALK/BIKE: 96 (ACTUAL)

OF BIKE/PEDESTRIAN CRASHES WITHIN HALF-MILE: 7
OF BIKE/PEDESTRIAN CRASHES WITHIN ONE-MILE: 25

Figure 4-42. Map of Richey Elementary in Pasco County for urban design analysis

SITE #5: RICHEY ELEMENTARY (PASCO COUNTY)	YEAR BUILT	1958		
	YEAR CODE	PRE GM		
	CAPACITY	684		
	ENROLLMENT	645		
	AVERAGE # OF STUDENTS SURVEYED	458.7 (71%)		
	# OF RESIDENTIAL UNITS WITHIN ONE-MILE	1,529		
	PEDESTRIANS	POTENTIAL (HALF-MILE)	86	
		POTENTIAL (ONE-MILE)	215	
		ACTUAL SURVEYED	96	
		AVERAGE RATE OF SURVEYED WALKABILITY	21%	
	INTERSECTIONS	WITHIN HALF-MILE	90	
		WITHIN ONE-MILE	199	
	# OF PED/BIKE CRASHES	WITHIN HALF-MILE	7	
		WITHIN ONE-MILE	25	
	INCOME	% < US$14,000 ANNUALLY	18.4%	
		% < US$29,000 ANNUALLY	63.1%	
		% DO NOT OWN A CAR	8.9%	
	MORPHOLOGICAL	URBAN SPACE	MODERN	
		SIZE OF BLOCKS	MOSTLY SMALL	
		PERMEABILITY	FINE- CONTINUITY	
		GRID	GRIDDED STREET SYSTEM	
		PRIMARY MOVEMENT	BOTH AUTO/PED	
	PERCEPTUAL	PATHS	REG USE/CONCENTRATED	
		EDGES	ENCLOSURES: US19 & CONGRESS ST	
		DISTRICTS	PRECISE BOUNDARY	
		NODES	SCHOOL SITE	
		LANDMARKS	N/A	
	SOCIAL	TYPE OF NEIGHBORHOOD	URBAN/TRADITIONAL	
		SAFETY & SECURITY	CONTROLLED (INCLUDING NEARBY POLICE DEPT)	
		ACTIVITY	MULTI	
		ACCESSIBILITY/EXCLUSION	VISIBLE/ACCESSIBLE	
	VISUAL	STREETS & SQUARES	INFORMAL	
		POS & NEG SPACE	MOSTLY POSITIVE/DENSE	
		PATTERNS	SPORADIC/NON-RHYTHMIC/SENSITIVE TO HIGHWAYS	
		AESTHETIC PREFERENCES	NATURALNESS?	SOMEWHAT
			UPKEEP/CIVILITIES?	BOTH YES/NO
			OPENNESS/DEFINED?	DEFINED

Figure 4-43. Chart of Richey Elementary characteristics (including analysis of Carmona's dimensions of urban design of the site)



OF INTERSECTIONS WITHIN HALF-MILE: 45
OF INTERSECTIONS WITHIN ONE-MILE: 118

OF RESIDENTIAL UNITS: 443 (HALF-MILE)/1132 (ONE-MILE)

OF STUDENTS WITHIN HALF-MILE: 113 (POTENTIAL)
OF STUDENTS WITHIN ONE-MILE: 248 (POTENTIAL)
OF STUDENTS THAT WALK/BIKE: 83 (ACTUAL)

OF BIKE/PEDESTRIAN CRASHES WITHIN HALF-MILE: 3
OF BIKE/PEDESTRIAN CRASHES WITHIN ONE-MILE: 5

Figure 4-44. Map of Longwood Elementary in Seminole County for urban design analysis

SITE #6: LONGWOOD ELEMENTARY (SEMINOLE COUNTY)	YEAR BUILT	1959		
	YEAR CODE	PRE GM		
	CAPACITY	715		
	ENROLLMENT	703		
	AVERAGE # OF STUDENTS SURVEYED	341.3 (49%)		
	# OF RESIDENTIAL UNITS WITHIN ONE-MILE	1,132		
	PEDESTRIANS	POTENTIAL (HALF-MILE)	113	
		POTENTIAL (ONE-MILE)	248	
		ACTUAL SURVEYED	83	
		AVERAGE RATE OF SURVEYED WALKABILITY	25%	
	INTERSECTIONS	WITHIN HALF-MILE	45	
		WITHIN ONE-MILE	118	
	# OF PED/BIKE CRASHES	WITHIN HALF-MILE	3	
		WITHIN ONE-MILE	5	
	INCOME	% < US$14,000 ANNUALLY	4.6%	
		% < US$29,000 ANNUALLY	25.5%	
		% DO NOT OWN A CAR	5.4%	
	MORPHOLOGICAL	URBAN SPACE	TRADITIONAL	
		SIZE OF BLOCKS	SMALL	
		PERMEABILITY	FINE- CONTINUITY	
		GRID	GRIDDED STREET SYSTEM	
		PRIMARY MOVEMENT	BOTH AUTO/PED	
	PERCEPTUAL	PATHS	PROXIMITY	
		EDGES	ENCLOSURES: US17/92, SR434 & RONALD REAGAN BLVD	
		DISTRICTS	PRECISE BOUNDARY	
		NODES	N/A	
		LANDMARKS	LAKES	
	SOCIAL	TYPE OF NEIGHBORHOOD	TRADITIONAL COMPACT	
		SAFETY & SECURITY	CONTROLLED	
		ACTIVITY	MOSTLY RESIDENTIAL	
		ACCESSIBILITY/EXCLUSION	VISIBLE/ACCESSIBLE	
	VISUAL	STREETS & SQUARES	INFORMAL	
		POS & NEG SPACE	MOSTLY POSITIVE/VERY DENSE	
		PATTERNS	RHYTHMIC	
		AESTHETIC PREFERENCES	NATURALNESS?	NO- BUILT ELEMENTS DOMINATE
			UPKEEP/CIVILITIES?	NO
			OPENNESS/DEFINED?	DEFINED

Figure 4-45. Chart of Doby Elementary characteristics (including analysis of Carmona's dimensions of urban design of the site)

Figure 4-46. Series of visual factors used in promoting walkability at the surveyed elementary schools. A) Displays a crosswalk at Doby Elementary, B) displays the road width and crosswalk at Robles Elementary, C) shows a speed limit sign at Lovell Elementary, D) displays the multiple uses of signage at the major intersection in front of Shenandoah Elementary, E) displays the multiple uses of signage including the active speed limit sign at Richey Elementary and F) shows signage and roadway displays of school zone at Longwood Elementary. All photos were taken from Google Earth.

CHAPTER 5
DISCUSSION AND CONCLUSION

This study analytically identifies several different urban design characteristics as well as logistics of development that are important towards encouraging walkability amongst young children. Within the methods, establishing the study area and thereafter providing a comparison data analysis between the geospatial and survey data and then following it with the result of the urban design analysis, helped provide these results. When discussing the complexities of how children walk to school in relation to their built environment, there are a lot of different variables taken into account that normally might not be considered if strictly discussing adults. In this case, the main focus was centered upon visual characteristics and somewhat then deciphered generalities from socio-economic and historical details. Focusing on the network sheds, that represented data such as straight-line distance, block length or size, and connectivity within both half-mile and one-mile distances provided a good basis for the study, but the addition of the urban design analysis gave physicality to these sites and provided further explanation for the high rates of walkability.

One of the main important parts of the study was the comparison between the data within the Half-Mile and the One-Mile. Whether it was density, population, land use or even restricted natural boundaries or edges, all was taken into account in the final results of the walkability urban design analysis. Going back to the methodology, the adjusted (pedestrian) and unadjusted (automobile) network sheds essentially played a small role, considering the variation in size and location was very similar. However with the analysis of the both distance projections, providing information beyond the actual site of the school and the close-by neighborhoods, helped give a broader range of barriers and facilitators within traditional or urban developments. The urban design characteristics were more of a measure for daily conditions and obstacles pedestrians face. Not only does a pedestrian consider the distance and amount of time it takes to get from one point to another, they also must consider the variables that enable or hinder them from getting there along the way (placement of sidewalks, major roads/highways, placement of crossing guards or crosswalks, etc.).

Based on the findings from this study and the supportive literature, it is assumed that there is a higher probability for walkability where schools are surrounded by traditional neighborhood style developments, as seen at Doby Elementary in Hillsborough County. However, with some examples of more urban development with heavy usage of a gridded street networks and visible pedestrian aides can also produce high rates of walkability, regardless of social and economic status like Robles Elementary in Hillsborough County and Lovell Elementary in Orange County. First analyzing the GIS data surrounding all 26 elementary school sites, there was an immediate focus on the size of the pedestrian network sheds (or catchment areas), the actual placement of these school sites within the SAZs, street and residential densities and then the overall scale of these elements. Some examples include whether the size of the SAZ is similarly the size of the pedestrian network sheds, which can predict higher potential for walkability. Along with that, major roads can restrict connectivity and reduce walkability and higher densities of residential units within the SAZ prove to have higher potential for walkability. Visually, the type of grid and pattern within these networks start to formulate a hypothesis for the rate of walkability the site might produce. Furthermore, since residential density and street connectivity play huge roles in determining the design composition, schools with more restrictive elements were going to be affected and the accessibility hindrance would adversely show within the survey data.

Focusing on the actual survey data provided the type of concrete evidence needed to show the successful walkable school sites. Averaging together all the individual student's transport choices within the three-day study and then dividing them by the total number of students that were actually surveyed, not the total number of students enrolled, provided the percentage rates of walkability for each school. Even though the total number of students surveyed differentiated between the total students enrolled, if the site provided a certain amount of consistency relatable to other successful school sites, it would be set to assume that the rate of walkability would closely translate for the total amount of students.

Deciding to focus on just the successful sites and not the unsuccessful ones was intentional to provide the set of characteristics that are only encouraging towards walkability. Being aware that some of these noted characteristics could also be potential barriers does not hinder the fact that, even with some of the different combinations of positive and negative characteristics within each school boundary, there is still the ability for children to walk to school and live within an active community. The justification for this study is to promote healthy living amongst children and decipher positive and safe elements for parents to allow the option.

Different types of activities surrounding schools provide sustainable and healthy neighborhoods. Evidence shows that the location of the school in the SAZ, the presence of higher density housing immediately around the school, the street network (size of the catchment), and the size of the SAZ are all positive facilitators, but there needs to be a more detailed focus that in the end can formulate a list of characteristics that promote accessibility to those students who can potentially and in reality can participate in walking or biking to school. Using the dimensional breakdown of urban design allowed a proper outline towards formulating the characteristics needed for a walkable community. Configurations of blocks and street networks as well as residential density can make up some of the main important aspects. Also school-siting ordinances, concurrency, planning policies and anything relevant to the counties in school siting could be a determinant.

Limitations of this Study

This study focused on many different types of data and urban design characteristics primarily focusing on factors such as distance, safety and socio-economic that was justified by the survey data taken. Aside from the analysis of the actual pedestrian numbers being use as the main source of dissevering the successful school sites from the unsuccessful, the geospatial data was a perfect addition to the analysis in order to use the generalization of the density and socio-economic factors to further give incentive towards a successful walkable community. However the data and survey data might not correlate in the correct years. For example, Census data was taken from the most recent (2012) shape file from FGDL whilst the actual survey data was collected back in 2007 and the early part of 2008. Also the occurrences of the pedestrian and bicycle crashes were reported and used in the study from 2006 to 2010. Even though this data might have varied if they were reported all within the same timeframe, the data is still able to show the conflicts and challenges within each school attendance zone (SAZ) affecting the walkability. The point of this information is to show a generality of the kind of surrounding economic status as well as the additional hazardous condition points, usually involving major roadways or limited visibility roads.

As for the survey data, the study only focusing on the actual students that took part in the survey and not the total enrolled at the school. Some students could have not participated in the survey (specific reasons not stated whether student was absent, etc) so that may make the data slightly off. It appears that the students were geocoded from a list of registered students. Ideally each student surveyed at a particular school should be included somewhere in those points. Unfortunately there is no way to tell which of those points took the survey. Ideally the total number of students in the GIS layer assigned to a school should not exceed the number of students who took the survey for that particular school.

Additionally, the survey data does not indicate which children walk to school, especially if want to specifically look at ages or number of children within the same household who have the opportunity to walk together. We simply know the number of children that walk to a specific school. Thus, for example, you could have a child who lives very close that is driven to school and one that lives further from the school that walks. On the other hand, the literature strongly supports the idea that distance is the strongest predictor of the decision to walk. So while you can’t predict with any certainty which children walked and which did not collectively you can look at the ratio between the number of walkers and the potential for children to walk.

Opportunities for Future Research

The relationship between income and the overall rate of walkability has many different complexities. A comparison study between the student density and income density could be an interesting analysis especially since there has already been some evidence within this study that rates of income does not always provide basis for whether a child walks or bikes to school. This is also dependent upon the site development the school is surrounded by, whether a traditional neighborhood development or a more urban central location. It would also be interesting to analyze income related to probability of walking to school. Generally literature suggests that only children who are from income families only walk or bike to school. This study slightly suggests in one of the selected schools that income does not play a role in suggesting how children get to school.

Along with that, after dissevering the type of development the school site is located around, an interesting analysis would be student walkability rates towards other types of land uses (i.e. recreational centers, malls, playgrounds, etc.), taking into account variables such as safety, income, age and parental employment. Most of the school sites densely showed residential units as the primary surrounding land use, but some provided variation within the one-mile network sheds. Developing a connection between health statistics within surrounding land uses, suggesting that with changes and additions to businesses, parks and community sites there could be a variation in health amongst the residents living within network sheds.

Lastly, developing a design standard based on a concept like LEED (Leadership in Energy and Environmental Design) within the U.S. Green Building Council could potentially provide incentive for municipalities, designers, developers and contractors to initiate and produce sustainable environments for schools. Certain state and local level agencies within the United States already provide incentives, including cost reductions, expedited permitting, tax credit and density bonuses, for projects that correlate with sustainable building standards. It is important for future development to provide these types of promotional aspects so that there is an elimination of any future restrictive planning. This concept can be the foremost important type of promotion towards the development of healthy building standards and communities.

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BIOGRAPHICAL SKETCH

Angela Lynn Coullias is the daughter of Michael Coullias and Lynn McNulty, received her Master of Arts in urban and regional planning at the University of Florida in 2013. Before attending graduate school, she attained a Bachelor of Design majoring in architecture also at the University of Florida in 2007. During her undergraduate years, she had the opportunity to study abroad at the Vicenza Institute of Architecture in the fall of 2006 where she immediately became interested in European city infrastructure, urban design and walkability. After graduating with her bachelor degree and before deciding to attend graduate school, she had the opportunity to work with an international engineering consulting firm as an architectural intern and designer. She had the opportunity to gain experience within the professional world of architecture, design and project consulting, while also exploring sustainable design. During her time in graduate school, her studies focused on urban design, land use planning and GIS within the realm of health and the built environment. Angela hopes that her future career will continue to focus on smart growth, revitalization planning and healthy communities pertaining to urban design in to help society and future generations continue to acknowledge the importance of these aspects towards the longevity of city infrastructures and sustainability.