

**Does New Urbanist/Neo Traditional Designs Deliver On  
Promises to Affect Modal Choice and Reduce Vehicle Miles  
Traveled**

Jessica McCann

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Approved By:

Jesse J. Richardson Jr., Committee Chair

John M. Levy, Committee Member

Thomas W. Sanchez, Committee Member

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# **Do New Urbanist/Neo Traditional Designs Affect Modal Choice and Reduce Vehicle Miles Traveled**

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## **Abstract**

This paper investigates Neo-Traditional Design's ability to reduce vehicle miles traveled (VMT) and effect modal choice by examining the aspects of the design, mixed-use, density, and accessibility. This examination uses three case studies to gain a clearer picture of mixed-use, density, and accessibility's interaction with modal choice and VMT. The three case studies test the hypothesis of Neo-Traditional Design's ability to reduce VMT and change modal choice. Case study #1 tests the hypotheses from the perspective of mixing uses. Case study #2 tests the hypothesis from the perspective of density's effect on VMT and modal choice. Case study #3 studies accessibility's effect on VMT and changes in modal choice. These case studies represent a variety of localities in terms of age, size, and location. The conclusions indicate mixed uses (case study #1), density (case study #2), and accessibility (case study #3) reduce VMT and change modal choice. Comparing case studies that employ different methodologies, while arriving at similar conclusions, strengthens the legitimacy of the findings in particular and the concept of neo-traditional urban design in general. The similarity of the conclusions in all three case studies suggests that NTD will influence modal choice and reduce vehicle miles traveled. Neo-traditional designs appear to deliver on promises to reduce VMT and change modal choice by mixing uses, creating densities, and increasing accessibility to the urban form. Newer NTD communities will achieve the same results only if the level of mixed use, density, and accessibility rises to that found in the cases studied.

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## **Thesis Statement:**

Does New Urbanist/Neo Traditional Design affect modal choice and reduce vehicle miles traveled?

## **Chapter 1: Introduction**

Since ancient times, humans have been affected by their dwellings, the environment surrounding those dwellings, and ultimately by their response to both. Before the advent of the automobile, the urban form was more compact in order to accommodate walking as a means of transportation. In time, automobile and home ownership trends changed the landscape to include suburban developments. Urban design and transportation planning reflected this change. In some areas the breakneck rate of development far out paced the planners' ability to deal efficiently with the resulting congestion and environmental degradation. The problems caused by such development heightened public awareness to the relationship between the urban form and the individual's quality of life and gave rise to Neo-Traditional Design.

Neo Traditional Design (NTD) is a design type for the layout of localities. The theory harkens back to the development patterns of early New England cities. This design type combines the elements of mixed land uses, connectivity of grid street patterns and greenways, a variety of housing styles and types, human (versus auto) designed spaces, a variety of transportation options (modal choice), dense residential and commercial areas, high environmental quality to promote sustainability, and an accessible

urban form. These elements acting and interacting together achieve NTD's over-arching goal to increase the quality of residential life (Duany, 2000).

This paper seeks to ascertain the effectiveness of Neo Traditional Design (NTD) in achieving some of these goals by using the indicators of reduced vehicle miles traveled (VMT) and increased modal choice. Reduced VMT provides an appropriate indicator because it determines the decrease in car use. An increase in modal choice proves appropriate because it addresses the availability of non-car use transportation. Increased walking, biking, transit, and the reduction of car use speak to the central theory of NTD.

To measure the reduction of VMT and the increase in modal choice, this paper uses the NTD elements of increased mixed land use, density, and accessibility as measurement tools. These three elements are interrelated. The practice of mixed land use allows for integration of commercial businesses and residential areas ( McCormack et.al., 2001). Density refers to the number of houses, people, or commercial establishments per square acre (Greenwald and Boarnet, 2002). Accessibility refers to the proximity and density of goods and services available to residents via transportation networks ( Ewing et.al., 1994). These elements empirically address VMT and modal choice in NTD localities. Locations that increase mixed use and density achieve increased accessibility. Density, mixed use, and accessibility rarely exist separately in NTD localities desiring design transportation benefits. These elements taken together measure the greatest amount of change in VMT and modal choice.

The remaining portions of this paper describe in detail the relationship between Neo-Traditional Design and VMT, modal choice, mixed use, density, and accessibility. The three case studies presented illuminate respectively the effect of mixed use, density

and accessibility on VMT and modal choice. Lastly, the conclusion of this paper discusses the impact of Neo-Traditional Design on the change in VMT and modal choice through mixed use, density, and accessibility.

## **Chapter 2: NTD and Transportation**

### ***2.1 Introduction***

This chapter discusses how NTD addresses change in modal choice and reduction in VMT by mixing land use, creating density, and providing accessibility. Mixing uses, creating density, and providing accessibility, although treated separately in this paper, overlap in practice. This overlap occurs because modal choice and VMT are intrinsically interwoven. Common sense implies simultaneous actors. Studies take into consideration this fact. Density and mixed use interact in NTD communities, addressing transportation issues in a similar way.

Density, mixed-use, and accessibility all affect modal choice. Various transportation methods like walking, biking, and mass transit must be available and convenient (accessible) in order for residents to utilize these alternatives (Steiner, 1994 and Ewing, 1997). In addition, multi-modal travel options help increase the quality of life for both work and non-work travelers (Handy, 1996). For example, aging or handicapped residents have access to transit when they are unable to drive. The inclusion of biking and walking amenities ensures increased health benefits.

NTD reduces vehicles miles traveled through mixed-use and density by bringing trip origins and destinations closer together (Friedman, Gordon, and Peers, 1994). A variety of commercial establishments and housing types at trip destinations reduce VMT

because residents meet daily needs without traveling long distances (Schimek, 1996). For example, if residents live closer to commercial establishments, where they can satisfy their entire daily needs, they reduce their vehicle miles traveled. Reducing VMT by changing from automobile use to alternative modal choices, in theory, frees residents from time spent commuting to greater time in pursuit of other pleasures. This effect enhances quality of life.

## ***2.2 Modal Choice***

Modal choice includes utilizing walking, biking, and transit use. A significant determinant of the effectiveness of NTD revolves around providing alternatives to mandatory automobile use for daily living. (Frank and Privo, 1994, Steiner, 1994). For the work-traveler, having a combination of walking, biking, and mass transit options can change modal choice (Steiner, 1994). Areas that include accessibility, or make it easier for residents to utilize multimodal non work-travel, also affect a change in modal choice (Handy, 1996). Non work-travel actually comprises a significant portion of daily travel. As such, consideration of the non-work traveler needs proves important. If it is safe, convenient, and cost effective for people to utilize a bike path, walking trail, or transit option, they will do so, thereby reducing VMT (Handy, 1996).

Walking proves integral to the NTD school of thought because increased walking speaks to a higher quality of life (Friedman, Gordon, and Peers, 1994, Steiner, 1994, Handy, 1996). An urban form that facilitates walking fosters a sense of community and general well-being (quality of life) (Steiner, 1994, Handy, 1996). NTD neighborhoods attract many people because of the recreational and work walking amenities provided within this design. Mixing uses and creating density, as well as increasing accessibility

to amenities, facilitate more walking (Steiner, 1994, Handy, 1996). The urban designer must take the needs of both recreational and work walkers into consideration in order to reduce VMT and influence modal choice. These needs include safe, short distances with a variety of commercial establishments at the trip origins and destinations, and the availability of walking paths (Greenwald and Boarnet, 2001). Clearly the urban form plays a large part in the walking habits of people (McCormack and Rutherford, 2001). NTD seems to include all the factors that encourage walking (Handy, 1996).

Along with walking, NTD incorporates biking as a modal choice. NTD connects streets and includes bike lanes as a safe mode of travel. These elements promote biking as a work and non-work modal choice and provide for such amenities as bike paths and walkways to dense residential locations.

High transit use, as a modal choice, depends on a high density combination of dwellings (origins) and commercial institutions (destinations) per square mile for efficiency and cost effectiveness. Researchers in the Netherlands, after studying the metropolitan area of Randstad for four years, found the emergence of sub-city centers formed a complex polycentric urban area (Matt and Harts, 2001). Devolving city centers make it difficult for efficient future transit operation. This difficulty arises from prohibitive building costs of rail lines to dispersed locations (Matt and Harts, 2001).

The creation of density through urban infill serves to counteract the developing trend of dispersed sub-cities. The density of destinations and origins enable public transit as a modal option. Landforms typified by dispersed sub-cities fail to present a good environment for the use of public transit, either in terms of economic or environmental resources (Matt and Harts, 2001).

### ***2.3 Vehicle Miles Traveled***

The urban form significantly affects vehicle miles traveled or vehicle hours traveled (Ewing, et.al, 2001, Miller and Ibrahim, 1998, McCormack and Rutherford, 2001). Urban design influences the interrelationship between transportation and destination (Konhiem and Ketcham, 2000). A neighborhood's design may decrease VMT and reduce overall traffic by providing a variety of transportation options (Ewing and Cerverto, 2002, Konhiem and Ketcham, 2000).

However, the urban form may not be solely responsible for reduced VMT and increased modal choice. The relationship between travel behavior depends somewhat on socioeconomic characteristics such as income, ethnicity, age, children, housing type, and length of homeownership (Ewing and Cerverto, 2002, Konhiem and Ketcham 2000).

Location, across all lifestyles, influences choices as a determinate of transportation lifestyle (Ewing, Dumbaugh, and Brown, 2001, Miller and Ibrahim, 1998). A less compact land use pattern, typical in the modern design, requires more residents to travel greater distances in order to meet their daily needs. The potential offered by NTD to change the locations of residential daily needs can reduce VMT (Ewing, Dumbaugh, and Brown, 2001, Miller and Ibrahim, 1998). The proximity of residential areas to commercial areas determines the amount of vehicle miles traveled by locality residents (Sun, Wilmot, and Kasturi, 1998). These results provide the building blocks toward a comprehensive understanding of how people choose and interact with their locations.

In general, car ownership in a more densely populated urban area carries with it greater expense than in less populated areas. High density areas, rather than low density areas, bear a greater variety of expenses pertaining to automobile ownerships. Some

localities levy annual auto taxes. Additionally, fees are charged at daily parking facilities, car storage facilities, not to mention the ubiquitous parking meter. These factors, as well as higher insurance rates, can create prohibitively expensive car ownership (Dunphy and Fisher, 1996) Density, mixed-land use, and the economic hardship of car ownership significantly reduces car use (Schimek, 1996).

## ***2.4 Density***

### **2.4.1 Density and the Ease of Travel for Multi Modal Users**

Generally, residents in NTD localities, as compared to residents of non-NTD localities, make fewer and shorter trips (Sun, Wilmont, and Kasturi, 1998). Clustering of employment centers and residential housing around transit stops significantly decreases the number of trips made by cars, and increases the number of walking, biking, and especially, transit trips in most cases (Steiner, 1994). Transit becomes an efficient and viable mode of transportation in localities with coordinated governance (Lindquist 1998, Konhien and Ketchen, 2000).

The ease of transportation, due to the increased density offered by the NTD urban form, establishes the public's interest in transit (Ewing and Cerverto, 2002). More people select transit, biking, and walking as opposed to the automobile if the locality creates easy access to foot and bike paths, or to public transit (Friedman, Gordon, and Peers, 1994, Steiner, 1994, Handy, 1996)

The public gravitates toward areas where more daily needs can be satisfied in one central area. This density and accessibility of a locality positively affects trip length, and frequency (Steiner, 1994, Friedman, Gordon, and Peers, 1994). Big box stores that offer

‘one stop shopping’ provide a current example of this concept. One reason for the popularity of big box stores rests on the fact that they offer a variety of commercial needs in a compact area, a form of density. However, the dearth of alternatives forces residents to drive longer distances to use these facilities. NTD communities with their compact clustering of residential and commercial areas offer an alternative to this pattern.

Because NTD creates greater density at both origins and destinations, transportation options, such as transit ridership and walking trips, increase (McCormack et.al. 2001). Conversely, as density decreases, single occupancy vehicle use increases (Frank and Pivo, 1994, Ewing and Cerverto, 2002, Konhiem and Ketcham 2000). An inverse relationship exists between mixed uses and the use of the single occupancy vehicle. Mixed uses actually reduce the number of single occupancy vehicles used and the frequency of that use (Frank and Pivo, 1994). International areas such as Ranstad, Netherlands show similar relationships: as density increases automobile dependency decreases (Matt and Harts, 2001, Steiner, 1994).

## ***2.5 Mixed Use***

Mixing residential and commercial land uses decreases all aspects of car travel. It reduces VMT and increases walking, biking and transit use (McCormick, Rutherford, and Wilkins, 2001, Handy, 1996, Friedman, Gordon, and Peers, 1994). The number of trips, their frequency( how often), trip length, and overall vehicles hours of travel decrease due to mixing land uses and combining trip destinations (Ewing, Haliyer and Page, 1994). As accessibility to an area increases because of mixed use, the amount of time residents spends in their cars decreases (Ewing, Haliyer and Page, 1994).

Mixing land uses reduces automobile dependence by making goods and services readily available in one central area. Ideally, in neo-traditional neighborhoods obtaining daily needs requires less distance to travel (McCormack and Rutherford, 2001, Ewing 1997). NTD localities with mixed use can reduce kilometers traveled (McCormack and Rutherford, 2001). These results seem to confirm the idea that density, a mix of land uses, and accessible business localities all reduce single occupancy travel (Ewing, Haliyer and Page, 1994, Friedman, et.al., 1994, McCormack and Rutherford, 2001, Ewing 1997).

## ***2.6 Accessibility***

Accessibility includes residential and destination accessibility. Residential accessibility refers to the concentration of commercial and recreational activities placed within close proximity to residential dwellings. Destination accessibility refers to “the distribution of activities around each other” (Ewing, et.al., 1994). This concept speaks to the ease by which residents can accomplish daily tasks. Accessibility encompasses, and is achieved by, density and mixed land use (McCormack and Rutherford, 2001, Ewing 1997). Plans that incorporate mixing land uses and increasing density by clustering developments attempt to improve accessibility. This type of land planning locates everything the resident may need within walking distance or a short car trip (Ewing, 1997). Neo Traditional Design elements improve accessibility and, thus, decrease time spent in cars (Ewing, Haliyur, and Page, 1994). Densities of residential and commercial development create easy access (accessibility) for residents and thus reduce the miles traveled.

## **Chapter 3: Case Studies**

### ***3.1 Introduction***

This chapter evaluates three case studies. This paper highlights these three studies because each study investigates vehicle miles traveled and modal choice, but employ different methodologies, data, and data analysis. Each case study represents a variety of localities differing in age and size. The case studies conclude that mixing uses (case study #1), density (case study #2), and accessibility (case study #3) are factors that reduce VMT and change modal choice.

### ***3.2 Case Study # 1 – Mixing Land Uses***

Edward McCormack, G. Scott Rutherford, and Martina G. Wilkinson, "Travel Impacts of Mixed Land Use Neighborhoods in Seattle, Washington," *Transportation Research Record; Journal of the Transportation Research Board*, No. 1780, 2001, National Academy Press, Washington, D.C., Paper No. 01-2588, pp. 24-32.

Theoretically, mixing land uses reduces automobile dependence since it makes goods and services readily available. This study investigates that concept with an examination of three different "neo-traditional" neighborhoods and the travel habits of their residents as compared to the surrounding counties, which have a landform with non-compact segregated land uses. Researchers examined recreational and non-recreational biking, walking, public transportation, and automobile travel modes in the two-day logs. The results of this examination confirm that "... residents of the mixed land use study neighborhoods in Seattle traveled 28 percent fewer kilometers than residents in adjacent areas and up to 120 percent fewer kilometers than residents in suburban areas."

(McCormack et.al, 2001). This empirical study explores the transportation effects of NTD neighborhoods to determine if, “mixing land uses can reduce automobile dependency because it makes goods and services available with walking, biking, or short driving distances”(McCormack et.al.).

### **3.2.1 Methodology of Study**

The researchers chose the six communities located in the King County area to study. The study investigates three neighborhoods that exhibit many NTD characteristics and three areas that exhibit no NTD characteristics. The characteristics present in each NTD locality represent a variety of land uses (residential, commercial, and recreational), rectilinear grid street patterns, transit service, and pedestrian orientation. The researchers chose the neighborhoods of Queen Anne, Wallingford, and Kirkland because each exhibited certain NTD characteristics.

Queen Anne, an older traditional neighborhood, represents a locality that incorporates the greatest amount of NTD elements of all neighborhoods studied. Queen Anne’s design indicates that the locality predates World War II. The Queen Anne area encompasses .7 square miles. The locality includes grid-patterned streets and a variety of dwelling styles and types. In addition, Queen Anne includes a dense commercial area housing grocery stores, banks, office facilities, and retail establishments. This commercial area centers on a commonly used main street. On-street parking for automobiles and heavily used sidewalks for pedestrians characterizes Queen Anne.

The researchers chose Wallingford as the next locality with NTD elements. While comparatively newer and larger than Queen Anne, Wallingford incorporates a mix of land uses. Wallingford extends to slightly more than 1 square mile in size. Like

Queen Anne, the Wallingford locality developed within the city of Seattle. This locality consists of parks, residences and numerous retail and commercial facilities. Wallingford uses the traditional grid pattern, actively used sidewalks, as well as on-street parking.

Kirkland, the final locality surveyed in the travel diary and demographic survey, measures slightly greater than 6 square miles and represents the largest of the NTD neighborhoods. While not as dense nor having as much mixed-use as Queen Anne and Wallingford, Kirkland still exhibits NTD elements. It contains a mix of land uses exemplified by a variety of housing types and styles and a definable and varied commercial retail area. Although with a less compact center than found in the other two neighborhoods, the commercial center remains pedestrian friendly. The area includes on-street parking as well as parking lots. The road patterns combine a mix of curvilinear streets and the traditional grid pattern. This locality exhibits a pattern of transition between NTD and modern styles.

Queen Anne, Wallingford, and Kirkland are NTD neighborhoods in King County. In order to compare the above NTD neighborhoods with non-NTD localities, the researchers divided the remaining county into three zones. Post World War II development determined the three remaining zones; North Seattle, the Inner (located within the growth boundary but outside the city proper), and the Outer (includes the remaining area outside the growth boundary of King county). Post WW II development consists of segregated, non-compact land use typified by developments such as Levittown, NY and referred to in this paper as *modern design*.

While certainly automobile-dependent and dense, North Seattle, of the three zones, represents the least automobile-dependent area. North Seattle exhibits the typical

modern design with segregated zoning which disallows mixed use. The inner zone represents a suburban area characterized by dispersed, segregated, contemporary zoning. The outer ring contains rural characteristics as well as newer suburban developments and contains the unincorporated area of King County.

The researchers used a travel diary and demographic survey of NTD neighborhoods and compared the results of the travel diaries against the same travel diary collected by the Puget Sound Regional Council (PSRC) from the surrounding areas. The researchers used surveys as well as census data to measure mixed use. Table 1 depicts the summary of household characteristics of the areas

<b>Table 1 Summary of Household Characteristics</b>						
	Average Household size	Average Number of Employees/ Household	Average Number of Vehicles/ Household	Median Age of Persons over 15	% Household Income over \$35,000	Gross Density - Households per Acre
Queen Anne	2.2	1.4	1.7	39	67%	7.6
Wallingford	2.1	1.3	1.6	37	56%	7.2
North Seattle	1.9	1.2	1.8	37	41%	5.4
Kirkland	2	1	1.9	47	61%	3.1
Inner	2.5	1.4	2.1	35	56%	1.2
Outer	2.7	1.4	2.2	37	55%	0.2
Urbanized King Co.	2.5	1.3	2.1	37	51%	2

Source: McCormack et.al., 2001

Table 1 shows that the smallest household size comes from North Seattle, while the largest exists in the Outer zone. The range of employed household members ranged from 1 in Kirkland to 1.4 in Queen Anne, Inner, and Outer zones. The Inner zone and Kirkland contains the youngest and oldest populations 35, 47 respectively. The highest percentage of income over \$35,000 comes from Queen Anne with 67%, while North Seattle had the lowest percentage over \$35,000, 41%.

### **3.2.2 Data**

Two data sets constitute this study. The information from Kirkland, Queen Anne, and Wallingford represented the first data set, collected in November of 1992. The first data set mirrored the Puget Sound Regional Council's two-day countywide travel diary collected in 1989. The researchers called the residents in each of the three NTD study neighborhoods by a random-dialing phone survey during which they administered a demographic survey. Of all the potential respondents called, over the age of 15, forty three percent agreed to track their trips for two days. Of the respondents who agreed to keep a travel diary of every trip, seventy six percent returned completed diaries. The diary required the respondent to describe every trip taken over that period. The number of respondents totaled 1,620 and the number of trips taken by those respondents equaled 15,600.

The second set of data, obtained from the PSRC's Transportation Panel Survey, gathered travel diary data and a demographic survey between September and November 1989. The comparative analysis uses this data set for base line data. The PSRC data includes 663 households taking 12,000 trips.

### **3.2.3 Data Analysis**

The data allowed for the comparison of travel characteristics (frequency and distance). The diaries included data on destination location, reason for the trip, and modal choice. If the respondent drove, the researchers collected further information on whether the respondent was the driver, a relative of the driver's, or a non-family member passenger. The respondents logged trips of more than 5 minutes in duration.

Questions on the demographic survey dealt with duration of residency, interest in traffic issues and access to public transportation. Additional questions related to gender, age, occupation, travel habits, car pool habits, salary, and number of household occupants. The travel diary required respondents to detail their daily traveling, including car and walking trips. Table 2 shows the results of the miles traveled by location. Residents of the NTD neighborhoods traveled fewer times than the residents of the surrounding zones. The striking difference between Queen Anne (18 miles) and the Outer zone (38 miles) exemplifies the difference.

<b>Table 2 Average daily Personal Travel by Household Location</b>	
	Miles
Queen Anne	18
Wallingford	19
North Seattle	23
Kirkland	27
Inner	30
Outer	38

The NTD mixed land use neighborhoods of Queen Anne, Wallingford, and Kirkland, make up approximately 300 households in each locality totaling approximately 900 households. By comparison, North Seattle, while covering twice the land area of the NTD neighborhoods, has 176, or about half the number of households and exhibits almost no

mixed-use characteristics. The Inner- zone developed between the 1940's and the 1960's, contains 163 households. The Outer ring, the last zone analyzed for comparison, lies farthest away from Seattle. It contains newer subdivisions, as well as rural and non-incorporated areas. The Outer ring contains 248 households. The two identical survey instruments collected demographic data and the transportation characteristics data to allow a comparison of the different zones and the mixed-use neighborhoods.

This discussion on capture rates speaks to the reliability and validity of this study and consequently the results pertaining to mixed-use. Capture rates refer to the amount of measurable business obtained by any central business district (CBD) (McCormack). The

argument that NTD neighborhoods exist closer to already established commercial centers and therefore the location and not the design, reduces VMT caused these researchers to study the capture rates of Seattle's Central Business District (CBD). Estimating the capture rates of the CBD for all the study areas allowed the researchers to avoid potential errors relating to the (CBD) close proximity to the three NTD neighborhoods. For example, the Seattle CBD captured 31 percent of work travel in Queen Anne and 25 percent of Wallingford's work travel. The North Seattle zone captured 31 percent. The equality of the capture rates suggests a low probability that CBD proximity created error. The CBD attracts relatively few work trips from the inner and the outer rings, 13 percent and 7 percent respectively, because work destinations remain centralized within those zones.

The researchers analyzed the locations of households in relation to distance from commercial streets. The researchers used the 'commercial street' for the distance analysis. The 'commercial street' consisted of high concentrations of commercial establishments. The researchers geographically coded these commercial streets and the households in the study area for accuracy. The analysis counted five different distances from these commercial streets as seen in table 4. The commercial streets less than .1 miles away from residential areas consistently captured more shop by walking than any of the other four distances. For accuracy, only the trips that ended (or began) within a census block, which included the mixed-use community, counted for the study.

### 3.2.4 Modal Choice

The belief that commercial centers, with a variety of mixed uses closer to residences, capture more walking trips provides an essential element of the NTD's. The researchers for this case study compared residents at different distances from the selected commercial streets to understand their walking habits as seen in table 3. McCormack et.al. found that the greater the distance between a commercial street and the respondent's dwelling, the less likely walking would occur.

Wallingford as well as Queen Anne exhibited this trait. These neighborhoods incorporated the most NTD elements. Table 3 shows that fifty to seventy-nine percent of

<b>Table 3 Total Shopping Trips by Walking, Related to Household Distance from Commercial Streets</b>					
	< 0.1 miles	0.1- 0.2 miles	0.2 - 0.3 miles	0.3-0.4 miles	> 0.4 miles
Queen Anne	79%	40%	27%	26%	18%
Wallingford	55%	49%	42%	21%	20%
Kirkland	20%	22%	12%	11%	10%

the respondents in those neighborhoods walked to commercial centers that were .1 miles away. Table 3 also shows twenty-seven percent of

the respondents chose walking when the distance to commercial centers exceeded .2 miles. Even when the data included walking trips with recreational destinations, the respondents still engaged in significantly fewer walking trips if the distance exceeded .2 miles.

In Kirkland, the transitional neighborhood, the smaller sample size as well as the low number of walking trips makes any patterns less obvious. In the traditional neighborhoods, walking captured twenty percent of the trips under .1 miles (see table 3), while the rest of King's county only captured about three percent of the walking trips under .1 miles. In Queen Anne, walking trips made up seventy-nine percent of all trips

under .1 miles reported by respondents. Researchers also found personal recreation, not shopping, contributed the most common reason for walking. The Inner and Outer rings respondents reported fewer trips because those zones require automobile use and share the same commercial centers outside a .1-mile distance.

According to the travel diary data, Wallingford and Queen Anne used transit less than the inner and outer zones. Table 4 shows the average total daily travel distances by

<b>Table 4 Average total daily travel distance (miles) by mode</b>		
	Transit	Auto
Queen Anne and Wallingford	6	17
North Seattle	10	23
Kirkland	12	26
Inner and Outer	20	34

mode. The residents of Queen Anne and Wallingford rode six miles by transit, while North Seattle and Kirkland inhabitants rode ten – twelve miles by transit. Driving remains the most utilized mode of transportation in the Inner

and Outer rings. Transit, even though not a significant transportation option in the Inner and Outer zones, did see greater use than any other locality studied due the segregated and diffused urban landform.

### 3.2.5 Vehicle Miles Traveled

For this study, average daily travel distance indicates transportation activity. Table 4 shows the modal choice and miles traveled by location. The numbers reflected by the auto category indicate VMT. The table shows lower transit miles in Queen Anne and Wallingford, possibly because of the attractiveness of walking as a modal option. The overall travel pattern in the non-NTD zones shows higher automobile use and lower transit utilization. The mixed-use areas all display a lower number of VMT followed by North Seattle, Kirkland, Inner ring and finally the Outer ring.

Table 5 shows the travel characteristics by location in minutes, miles, speed, and number of trips. Respondents in Queen Anne, Inner, and Outer zones traveled about the same number of minutes a day. However, Queen Anne respondents traveled a little over

eighteen miles whereas

respondents in the

Outer zone travel just

under forty miles a

day. Respondents in

the Outer zone make

Table 5 Travel Characteristics by Location for All Modes				
	Average Daily Travel Minutes	Average Daily Travel Miles	Average Travel Speed (mph)	Average No. of Daily Trips
Queen Anne	92	18.2	11.9	5.9
Wallingford	91	16.9	11.1	5
North Seattle	86	22.4	15.6	5
Kirkland	90	27.1	18.1	5.2
Inner	90	30.3	20.2	5.1
Outer	93	38.5	24.8	4.9

fewer trips, but those trips were faster and longer in terms of time and distance.

Respondents in Queen Anne and Wallingford actually took more trips than respondents in other locations. However, slower and longer trips in terms of time, but not in terms of distance, characterized the types of trips made by respondents in Wallingford and Queen Anne neighborhoods.

The robust sample size adequately provides significant statistical analysis. The study avoids complex quantitative analyses. Instead, percentages, averages, medians, and gross numbers formed the comparisons. All comparisons in measurement and scale applied to each locality in exactly the same manner. Therefore the likelihood of measurement scale errors is negligible.

### 3.2.6 Results in Action

The data shows mixed-use neighborhoods exhibited fewer miles traveled regardless of modal choice. The data also confirm the concept that mixed-use urban forms could reduce overall travel miles. The distance between commercial

establishments and recreational options on the one hand, and the location of households on the other, appears directly related to the method people use to travel. Respondents utilize amenities closer to home more often than those long distances away. The availability of multi-modal options reduced car travel by 28 percent in North Seattle and 78 percent on the outer suburbs. “Neighborhood characteristics can be associated with travel differences” (McCormack et.al., 2000)

### 3.2.7 Remaining Question

An interesting observation pertains to the demographic information related to traveling distance. Table 6 shows the miles traveled by either males or females. Table 6 shows the income levels of the travelers and the household categories as well.

	Sex		Household Income		Household Category			
	Male	Female	<\$35K	≥\$35K	With Children	One Adult	2 or More Adults	Senior (+65)
Queen Anne	18.7	16.8	14.9	18.7	18.8	17.8	17.3	15.9
Wallingford	16.8	16.2	15.3	17	17	18.8	15.8	14.6
North Seattle	23.5	20.7	20.3	24.3	26	19.3	22.5	16.3
Kirkland	28.1	25.9	22.4	29.3	29.1	25.3	29.8	21.5
Inner	31.4	28.7	27.6	32.3	32	32.2	29.9	21.5
Outer	39.1	36.3	36.7	37.4	39.6	33.4	37	53.2

Females consistently travel fewer miles than do males. Those individual respondents with incomes under \$35,000 also traveled fewer miles. Table 6 also indicates children influence travel. The elderly consistently traveled less than those with children with the single exception of those seniors residing in the Outer ring. Table 6 indicates a broader, more holistic view of the potential causes of higher VMT.

Demographics play a primary determinant role in travel behavior. It remains to be seen whether demographics or design influence NTD's ability to affect VMT and modal choice

Overall, although subject to errors in data collection and analysis, the researchers handled the data in a way that avoided sample bias as well as small sample errors by comparing similar socioeconomic areas and aggregating data. Additionally, in their basic construction of the study, the researchers assumed an underlying relationship between travel habits and land use. Because of this assumption the question remains, *can travel habits be associated with land use?* Additionally, whether changed travel patterns can actually reduce urban congestion on a regional scale remains unclear.

### ***3.3 Case Study # 2 - Density***

Michael J. Greenwald and Marlon G. Boarnet, "Built Environment as Determinate of Walking Behavior; Analyzing Non-work Pedestrian Travel in Portland, Oregon" , *Transportation Research Record; Journal of the Transportation Research Board*, No. 1780, 2001, National Academy Press, Washington, D.C., Paper No. 01-2792, pp. 33-42

This study seeks to determine the benefits of pedestrian non-work travel in Neo-Traditional, New Urbanist, traditional, and cluster developments. Further, the study investigates the benefits density offers residents of NTD communities, both in work-related travel and in the non-work quality of life. The study revealed non-work walking increased when distance to destinations decreased because of greater density.

### 3.3.1 Methodology of Study

A data set previously collected by these same researchers analyzed pedestrian non-work travel by two different methods called model 1 and model 2. Model 1 upholds the old adage ‘time is money’ by suggesting that an urban form that restricts travel increases the direct cost to the resident in terms of time. Model 2 refines model 1 by discussing price as a function of distance and speed. In essence, the closer the destination and the faster the access by pedestrians, the less time and money will cost an individual. Creating density reduces the time spent traveling and, according to this model, saves the resident money. The cost of travel represents the opportunity cost to individual. Time holds value and the time spent getting from point ‘a’ to point ‘b’ could be time used earning money. The researchers propose that these two models provide the basis for comparison from a single population.

Using Crane’s model formula, the researchers determined the demand for walking trips. The formula is:

$$N = f(p,y:S)$$

Where:

N= the number of non-work walking trips taken by an individual

P= the time cost (or price) of a non-work walking trip. Represents both money and time costs (opportunity cost)

Y = individual income

S = A vector of socio-demographic shift (Or taste) variable.

All respondents to the survey resided in the same area and, as such, the price of fuel and other such regional differences do not factor into the equations. The equation

links an individual's value of time with their income level. Model 1 expresses non-work trips as a commodity because time holds value for individuals.

In order to include land use in the model, the researchers used a vector analysis. Greenwald and Boarnet linked the land use to the model this way, "Perhaps the difference in time costs of non-work trips can be completely explained by differences in land use patterns. In other words, land use might affect non-work pedestrian travel frequencies by directly affecting the price, for example, the time cost, of travel."(Greenwald and Boarnet, 2001). If a mode of travel is expensive (in terms of time and money), naturally other less expensive models of travel eventually turn out to be more attractive.

#### *Model One*

$$P = f(L)$$

Substituting L for P in the equation, the researchers say, gives:

$$N=f(L,y,S)$$

*L = This variable represents **density** as a casual factor in the total cost of travel. L is the vector of land use or urban design characteristic.*

This formula assumes that land use and urban design are causal factors in the time cost of travel. In other words, the urban form, density, determines how much time you will spend traveling.

#### *Model Two*

$$N= f(p,y,L,S)$$

Greenwald and Boarnet further separated the time cost (or price) of a non-work walking trip into two parts: trip speed and trip length. Theoretically, this separation

allows the data to be more applicable because traffic speed and travel distance represent tangible things for designers to deal with. This information can be applied to techniques already used by designers such as traffic calming measures, mixed land uses, creating density, and a grid street pattern which allow traffic to disperse through an area.

Replacing the cost (p) with the variable for non-work trip distance (m) and non-work trip speed (t) the formula then becomes:  $N = f(m,t,y,L,S)$ . This formula represents a complicated way to investigate the concept that density affects non-work walking habits.

### **3.3.2 Data**

Greenwald and Boarnet based this study on the data gathered from The Portland Travel Diary for 1994. The data consist of a two-day travel diary collected from a three county area. The information collected consisted of demographic data, trip speed and distance, and the type and nature of the trips. These factors complete the regression model.

### **3.3.3 Data Analysis**

Identical land use variables and the socioeconomic variables in both studies allow for accurate comparison of the data. The Pedestrian Environmental Factor (PEF) consists of a composite score of the ease of street walking, sidewalk continuity, street connectivity, and topography. 1,000 Friends of Oregon originally derived the composite score reflecting the urban form's effect on pedestrians. The derivation of the composite score included 4 criteria: "ease of street crossing, sidewalk continuity, street connectivity, and topography." "...each category was scored on a scale from 1 to 4 (with 4 being the best ranking), so each transportation analysis zone had a maximum possible score of 16

and a minimum possible score of 4” (Greenwald and Boarnet, 2001). The higher the score the greater pedestrian accommodation.

Table 7 lists the variables the researchers collected. The variables under regional land use and neighborhood level land use in table 7 show the way the models incorporated density.

<b>Table 7 Variable Names and Definitions</b>	
<b>Dependant Variables</b>	<b>Explanation</b>
NWTRIPS	Number of non-work walking trips per person over two day travel diary period
<b>Socio-Demographic Variables</b>	
AGE	Age of individual respondent
CARSPRD	Number of cars per licensed driver in household
GENDER	Gender of individual (1=Female, 0=Male)
INCOME	Household income
INCOMESQ	Household income squared
KIDS	Number of children under the age of 16 per household
NUMEMPLY	Number of employed workers per household
RACE	Ethnicity of individual respondents (1 = white, 0 = non-white)
<b>Neighborhood Level Land Use Variables</b>	
PCTGRID	Percentage of area in 1/4 mile buffer zone by grid format
PEFScore	Pedestrian Environmental Factor score for zone of home location
POPDEDENBG	Population density per square mile in 1990 block group
RET94DEN	Density of retail employment within 1 mile of home locations in 1994
<b>Regional Land Use Variables</b>	
ZIPPOPDEN	Population density per square mile for ZIP code in 1990
ZIPRETDEN	Density of retail jobs per square mile in ZIP code in 1992
<b>Trip Cost Variables</b>	
MDWLKDST	Median trip distance per individual
MDWALKSPD	Median trip speed per individual
WORKDAY	Variable for whether or not diary covered at least one workday (1 = yes, 0 = no)
<b>Instrumental Variables</b>	
PCINCBG	Per capita income in census block group in 1990
PCTBLKBG	Percent of Black person living in census black group in 1990
PCTBLKZP	Percent of Black person living in ZIP cope in 1990
PCTCLGBG	Percent of persons in census block group with at least an undergraduate degree in 1990
PCTCLGZP	Percent of Hispanic persons living in census tract in 1990
PCTHSPZP	Percent of Hispanic persons living in ZIP code in 1990
PCTNUHBG	Percent of housing units in block group classified as located in rural environments but not classified as farms in 1990
PCTNUHZP	Percent of housing units in ZIP code classified as located in rural environments but not classified as farms in 1990
PCTUHBG	Percent of housing unites in block group classified as located in urbanized environments in 1990
PCTUHZP	Percent of housing units in ZIP code classified as located in urbanized environments in 1990

Regional land use variables include population density per square mile and density of retail jobs per square mile. Neighborhood land use variables include percentage of area in ¼ mile buffer zone by grid street patterns, pedestrian Environmental Factor score, population density, and density of retail employment. Greenwald and Boarnet tested density by using GIS to create some of the land use variables. The PCTGRID utilized the buffering tool to create the percentages of street grid patterns within a ¼-mile of home.

Two similar geographic levels of data analyzed in this study consisted of Census Block Group and the Transportation Analysis Zone data. The underlying study area coincided with these geographic data areas. Greenwald and Boarnet thought analyzing the data on a scale similar to neo-traditional design provides greater accuracy and usefulness of the data. Greenwald and Boarnet analyze the data using an ordered probit regression to model for non-work trip frequencies. The assumption that an underlying relationship exists between the variables of land use and urban form, defines the meaning of an ordered probit regression. The first analysis consisted of socioeconomic data showing any urban form effects on non-work walking.

<b>Table 8 Ordered Probit Models for Non-Work walking trips, Census Block Group Level</b>								
Variable	Socio-demographic		Socio-demographics and Land Use + PetGrid		Socio-demographics and Land Use - PetGrid		Socio-demographics, Land Use, and Trip Costs	
	Coefficient	Z	Coefficient	Z	Coefficient	Z	Coefficient	Z
Age	-0.005159	-2.47						
Kids	0.089725	2.631	0.1070024	2.149	0.1443604	4.074	0.1391419	3.917
Work day or non work day					-0.289129	-2.154	-0.297134	-2.207
Cars per licensed driver per household	-0.178713	-2.313						
Number of employed workers per household	-0.017481	-2.988			-0.147597	-2.49	-0.151022	-2.546
Population Density per square mile in 1990 census block group					0.0000282	2.985	0.0000291	3.061

Note: shown are the only factors significant at the 5 % level or greater.

Greenwald and Boarnet, using different combinations of variables in the ordered probit models, isolated significant factors in non-work walking trips. Table 8 shows the coefficients and Z-scores for variable listed in table 7. This table also shows significant variables as determined by the ordered probit regression model. Population density was a significant positive factor in non-work walking, as were children within a household. The variables of age of residence, workday, number of drivers, and number of employees all show to be significant within the different models. These variables, out of many others, prove significant in non-work walking.

The model used four combinations of variables (see table 8). The researchers base the first model on socio-demographic data. A second model adds land use variables including the percent of grid street patterns located within a ¼-mile area of the home.

The third model analyzes the socio-demographic variables and the land use variable, with the exception of the quarter mile buffer. Finally, the last model analyzes the variables of socio-demographics, land use, and trip cost.

### **3.3.4 Modal Choice**

The two models, which include land use variables (see table 8), show important relationships between density and modal choice. Population density, among other variables, plays a significant role in modal choice. Density positively affects the number of non-work walking trips when the model incorporates the cost of trips (see table 8). “The *block group density* becomes an even stronger determinant of walking behavior” in this model, as seen in table 8 (Greenwald and Boarnet 2001).

Greenwald and Boarnet found that the number of cars available to a household emerged as a significant factor in analyzing land use variables. Extrapolating from this model, if the number of cars effect non-work walking, more cars mean less non-work walking by the household. The increasing density tends to result in fewer cars owned by residents.

In the land use model that excludes the variable for the grid street pattern, the number of employed people per household becomes significant, as does the population density within the study area. Children remain a significant factor in this model as well although the researchers do not address the reasons for this. In this model the workday (or non-workday) emerges as a significant variable.

### 3.3.5 Vehicle Miles Traveled

The land use variables, such as the grid street patterns located within a quarter mile of respondents, the population density, the retail density, and the Pedestrian Environmental Factor score, speak to the reduction of car use “...[L]and use variables, as a set, are significant in determining probabilities of non-work walking travel.”

(Greenwald and Boarnet, 2001) These variables also address populations and commercial density and its effect on travel behavior because goods and services are closer to the origin of a trip. Greenwald and Boarnet separated the land use variables on the base model and analyzed them individually. Within the models, different combinations of land use variables all show that density affects walking behavior. Table 9 gives the most interesting examples. A negative Z score indicates that a variable exerts

Variable	Pop Density		Retail Density		% Grid Area		PEF Score	
	Coefficient	Z	Coefficient	Z	Coefficient	Z	Coefficient	Z
Age			-0.004136	-1.967			-0.004778	-2.276
Kids	0.1303174	3.7535	0.131388	3.732			0.1099993	3.188
Work day or non work day	-0.271757	-2.029	-0.27039	-2.019				
# of employed workers/ household	-0.157738	-2.681	-0.140397	-2.379	-0.155673	-2.139	-0.1733771	-2.959
Pop. Den. / sq. mile in 1990 census block group	0.0000417	5.776						
Retail Density			0.0002235	4.831				
% Grid Area					0.6452183	2.212		
PEF Score							0.0500604	3.876

Note: shown are the only factors significant at the 5 % level or greater.

a negative influence on non-work walking. For example, considering the variable ‘work day or non-workday’ the negative Z score of -2.029 indicates the degree to which the workday influences non-work walking. The ‘work day or non work day’ as well as the ‘number of workers per household’ negatively affects the number of non-work walking trips. Retail density scores the highest positive z score, meaning it has the greatest positive influence on the number of non-work walking trips.

### **3.3.6 Results in Action**

“Density does affect decision making related to walking” (Greenwald and Boarnet, 2001). The finding that population and retail density positively affect non-work walking in a significant manner supports NTD’s theory contending that density encourages walking. The land use variables, when taken together, positively affect non-work walking. This finding suggests density affects the walking habits of residents. Distance most significantly affected the trip cost model. Shorter distances promoted an increase in the number of walking trips. Goods and services located closer to residences increase non-work walking.

### **3.3.7 Remaining Question**

First, the applicability of the results of this study remains dubious when transferred to a larger regional context. The researchers utilized the census block group as a basis for analysis. As such, the finding fails to apply beyond that level. While density clearly reduces VMT and affects modal choice in the census block group, the application of this study’s findings on a regional level remains unproven. Secondly, the NTD school of thought contends that a street grid pattern promotes walking in a neighborhood. This

case study disputes that assumption since the variable that addresses the percent of grid pattern within ¼ - mile area proves insignificant (see table 9). Therefore, the question remains whether or not the grid pattern really does promote walking .

### ***3.4 Case Study # 3 - Accessibility***

Reid Ewing, Padma Haliyur, and G. William Page, "Getting Around a Traditional City, a Suburban Planned Unit Development, and Everything in Between," *Transportation Research Record; Journal of the Transportation Research Board*, No. 1466, 1994, National Academy Press, Washington, D.C., pp. 53 - 62

This study attempts to determine the influence land use exerts on household travel patterns. The researchers held constant the factors of household income, size, and location (Ewing et.al. 1994). In addressing this question, elements such as trip frequency, modal choice, trip chaining, trip length, and overall vehicle hours of travel help to indicate the accessibility of an area.

Ewing et.al., analyze six communities in Palm Beach County Florida. These selected communities exhibit “a diversity of development within an urban form often characterized as sprawl” (Ewing, et al, 1994). The researchers’ analyze the communities to determine if any significant statistical differences existed. The localities investigated in this study range from traditional neighborhoods to neighborhoods lacking traditional characteristics.

The study found that as accessibility to an area increased, the amount of time residents spent in their cars decreased. The causal factors that increase accessibility include increased density and a mix of land uses. Accessibility refers to two types, residential and destination accessibility. Residential accessibility refers to the

distribution of activities around the place of residence” (Ewing, et.al., 1994). Destination accessibility refers to the “the distribution of activates around each other” (Ewing, et.al., 1994). The results confirm the NTD idea that density, a mix of land uses, and central localities all reduce single occupancy car use.

### **3.4.1 Methodology of Study**

The other case studies reviewed in this paper investigate areas that are representative of NTD landforms. The methodology of this case study investigates the characteristics of “sprawling” communities rather than the characteristics of NTD communities.

The communities in Palm Beach Florida represent a progression of urban development ranging from neighborhoods with some NTD characteristics to neighborhoods lacking any NTD characteristics. West Palm Beach represents a traditional neighborhood with a variety of housing types from single-family dwellings to multi-family dwellings. In addition, West Palm Beach contains a relatively compact grid pattern street design. The presence of some corner stores in residential areas represents minimal elements of mixed use found in this community. The buildings sit closer to the sidewalk and parking usually accessed by way of alleys making parking lots invisible from the street. A widely used transit system and a defined central business district also identify this community as having NTD characteristics. West Palm Beach represents the densest and most accessible of the six communities.

East Boca, built in the 1920’s, represents Florida’s first master planned community. The downtown invites walkability and pedestrian interaction. The modified street pattern combines a NTD grid pattern with a dispersed grid pattern. The landscape

elements include historic neighborhoods, public recreational facilities, small shopping area, school, and sidewalks that connect destinations. Florida Atlantic University acts as the area employment center. This locality ranks second to West Palm Beach in accessibility and density.

West Boca exists as a planned suburb of a nearby Planned Unit Development (PUD). Although planned, West Boca's street pattern disconnects the location from the surrounding area and prevents free movement of cars and people through the locality. The network of collector and arterial roads provides adequate movement, but the lack of through traffic and connectivity in the street pattern disqualifies West Boca's street pattern as a traditional or neo-traditional neighborhood. West Boca contains many golf courses, public parks, and recreation facilities. West Boca services the same employment center as East Boca. The dispersed urban form fails to typify either traditional or NTD communities.

Wellington exists as a planned unit development built in the 1970's. Unlike West Palm Beach, Wellington's street pattern consists of curvilinear streets, with cul-de-sacs and loop roads. The walled residential areas contain a single common entrance and exit from the community. The little-used sidewalks lack useful destinations like commercial areas or other destinations of interest. Wellington also consists of a varied housing type. Like many PUD's built in the 1970's, Wellington attempts to meet most of the residents needs with a school, grocery, medical offices, and recreational areas. However, residents of Wellington rely on automobile use for work travel since no other transportation options exist. The dispersed landform and disconnected street patterns prevent the feasibility of other modal options.

Jupiter and Tequesta, mirror strip cities, straddle two large thoroughfares. These localities lack pedestrian elements, parks, and recreation facilities. The present scale designed for automobiles inhibits pedestrian use. In addition, these twin cities contain limited schools, limited local services, and limited employment availability. The street pattern consists of curvilinear streets with cul-de-sacs and some small areas of grid pattern streets. Juniper and Tequesta rank least dense among the localities in the study, with the exception of West Boca, and lack the neo-traditional design idea of mixing uses. Ewing points out that the mixed-use consists of residential areas abutting the commercial/light industrial areas.

Juniper Farms lacks any elements of a traditionally designed neighborhood. This development contains large lots with single-family homes, a school, park, small shopping center, and no employment center or business district. Completely auto-dependent, residents must access one of two large highways in order to work, shop, or recreate. Juniper Farms “typifies sprawl” (Ewing et.al., 1994). The dispersed land uses and street pattern orient Jupiter Farms to the car and prevent it from being accessible to residents outside the development.

Table 10 gives the characteristics of the study locations. In all the categories

listed in table 10,

<b>Table 10 Characteristics of Palm Beach Communities</b>						
	East Boca	West Boca	West Palm Beach	Wellington	Tequesta & Juniper	Juniper Farms
Residential Density (dwelling/ land acre)	3.51	2.63	3.76	0.76	2	0.12
Employment Density (jobs/land acre)	2.58	0.46	6.65	0.24	1.27	0.01
Jobs-Housing Ratio (jobs/dwelling)	0.82	0.17	1.77	0.32	0.64	0.1
% Multifamily Dwellings	37	49	43	21	0.33	2
Accessibility Index for Work Trips	0.49	0.22	1	0.14	0.31	0.21
Accessibility Index for Non-home-Based Trips	0.72	0.43	1	0.27	0.4	0.08

West Palm

Beach exhibits

the most NTD

characteristics

and includes the

most amounts of

jobs per

household. Table

10 shows the

accessibility indices, amounts of mixed use, and densities for the communities. The number of activities around either the residence or trip destinations constitutes the accessibility index. The accessibility index also takes into account the amount of mixed land use and density for an area for its final number. A higher index number indicates greater area accessibility. West Palm Beach ranks as the most accessible area while Juniper farms scores lowest in accessibility among the location. With the exception of the accessibility index in table 10, these land use elements appear uncomplicated. These findings support NTD theories that density and a mix of uses make an area accessible to the residents.

### 3.4.2 Data

Palm Beach, Florida conducted a travel survey of the records of 16,000 residential respondents. The study seeks to find any statistical differences in the respondents' data

concerning, trip frequency, mode choice, trip chaining, trip length, and over all vehicle hours of travel.

To ensure that income and household size remained constant, Ewing et.al., removed unsuitable respondents (those who did not report on income or automobile ownership) from the study, without any discernable difference in household size or income. This procedure reduced the sample size.

### **3.4.3 Data Analysis**

Although standard practice of conventional travel modeling classifies trips as single separate events, this study aggregates trips into tours. This re-classification seeks to preserve the original trip intent. The conventional model classifies trips as either home-based or non-home based. Most studies aggregate non home-based trips conducted within a home-based trip as part of the home-based trip. The classification of trips in this manner obscures the main purpose for the trip by detailing all the various stops along the way. For example, under the previous classification, a trip that began at home to go to work, interrupted by a stop to buy a newspaper, breaks up into two trips losing the intent of the first trip. The previous classification obscured the work purpose of the trip. Under the new model, the trip constitutes a tour with the intent of going to work. Thus, the origins and destinations of both trips remain accurate.

### **3.4.4 Modal Choice**

Interestingly, this study separates car-pooling from automobile travel. Car-pooling meets the different needs of people. Table 13 shows the importance of car-pooling. Therefore, a variety (mixed use) of clustered (density) destinations remains

important. Ewing et.al., suggest that creating interrelated localities close to each other promotes car-pooling. Creating destination efficiency could reduce VMT or hours traveled.

	Drive alone	Car Pool w/Family	Car Pool w/Others	Walk/Bike	Transit
Work	82%	8%	8%	1%	1%
Recreation	37%	37%	20%	6%	0%
All Purpose	55%	30%	11%	3%	1%
Shopping	54%	36%	8%	2%	0%

Table 11 shows Palm Beach County favors driving alone as major modal choice. It also

shows the variables of driving alone, walking/biking, transit usage, and car-pooling with or without family members. Driving alone and car-pooling makes up a majority of the modal choices. Because of the inaccessibility of the urban form, walking, biking, and transit usage hold diminished significance as major forms of transportation.

Tables 12 and 13 speak to the accessibility of the urban form. Palm Beach County residents depend on the automobile. That dependency, combined with high numbers of trips and trip tours, indicates an inaccessible urban form. Trip chaining or tours, result from residents attempting to make efficient use of time. High numbers of trips and tours, combined with long distances, typify the studied communities. Table 12 refers to work related trips and table 13 refers to non-work related trips. In both tables, trip tours reduce the overall trips from work (table 12) or non-work locations (table 13). The more inaccessible an area, the less mixed use and

	Number of Tours	Number of Trips
Stop 1	<b>915</b>	<b>1830</b>
Stop 2	319	957
Stop 3	257	1028
Stop 4 (or more stops)	<b>417</b>	<b>2913</b>

density exist at its destination/origin. This lack of NTD characteristics results in more

<b>Table 13 Non-Work Related Trip Chaining in Palm Beach</b>		
	Number of Tours	Number of Trips
Stop 1	<b>2196</b>	<b>4392</b>
Stop 2	621	1833
Stop 3	339	1356
Stop 4 (or more stops)	272	1684

VMT. Table 12 demonstrates that first and last stops, in both trip tours as well as individual trips, constitute the highest numbers associated with these stops. “Almost half of all work trips are linked to side trips for other purposes” (Ewing, et.al., 1994). Linking trips, or trip chaining,

combined with high VMT, indicates diffusion of goods and services. This diffusion forces more trip tours and more trips. The high numbers of work and non-work trips and trip tours reveal an inaccessible urban form.

Calculating the modes separately for the different communities shows an automobile-

<b>Table 14 Mode Split in Different Communities</b>						
	West Boca	East Boca	Wellington	Juniper Farms	Tequesta & Jupiter	West Palm Beach
Drive Alone	58%	64%	49%	56%	58%	50%
Carpool w/Family	27%	20%	33%	31%	34%	32%
Carpool w/Others	13%	12%	15%	13%	8%	14%
Walk/Bike	2%	4%	3%	0%	0%	2%
Transit	0%	0%	0%	0%	0%	2%

dependent area. Table 14 shows that driving alone and carpooling make up 96% - 98% of the modal choices of the residents in these

communities. Table 14 shows the modal choice trends for the entire Palm Beach area.

Table 15 displays similar results. Driving alone remains the dominant form of transportation followed by car-pooling. Table 14 reveals Juniper Farms, Tequesta & Juniper as completely car dependent. Table 14 also shows almost zero percent of the population chose to walk, bike, or utilize transit due to the non-availability of those modal options.

### 3.4.5 Vehicle Miles Traveled

Ewing et.al., derived VMT by multiplying vehicle *hours* traveled by the average occupant per vehicle (2.5 occupants and 3.0 occupants for carpools). For this study, the researchers held little confidence in the VMT derivation because it lacked an aspect of time and speed in the formula. Because of the unavailability of time and speed

Table 15 Average Travel Times (min) in Different Communities						
	West Boca	East Boca	Wellington	Juniper Farms	Tequesta & Jupiter	West Palm Beach
Work	27	17	34	27	22	15
Shopping	15	13	9	16	15	14
Recreation	11	17	11	12	25	13
Total	53	47	54	55	62	42

information to make an accurate assessment for VMT, the researchers used vehicle hours traveled (VHT) instead.

Although this study cannot accurately address VHT, time spent in travel adequately substitutes for VMT in this measurement. The greatest differences in the six communities existed in the measurement of VHT. Table 15 shows the results of this difference. The studied communities exhibiting non-NTD landform elements spent between 42 and 62 minutes (VHT) accomplishing daily tasks.

### 3.4.6 Results in Action

The inaccessibility of most of the communities studied discourages residents to make any modal switch. Residents of these areas possess few real modal options and only car use adequately fits the communities' urban forms. Walking, biking, and transit lack viability as transportation options because the design of the locations makes automobile use more convenient. The design of Wellington, West Boca, and Tequesta/ Juniper, as well as Juniper Farms, cause long work commuting times because of the dispersed patterns of land development. West Boca, Wellington, and Tequesta/ Juniper manage to

capture the highest percentage of recreational and shopping trips of their residents. Residents of Juniper Farms need to go elsewhere. Long commutes increase the automobile trip tours. The high incidence of trip chaining, coupled with the long commuting time, indicates a lack of accessibility in the urban form.

### **3.4.7 Remaining Question**

The small sample size could lead to sampling variability. However, an f-test to test for significant differences found sample size acceptable. Infill reduces automobile dependence and for localities like Juniper/Tequesta affects the transportation pattern. With its commercial strip, the potential exists for a centralized business district, as seen in both East and West Boca. West Palm Beach stands out as the best example of NTD in the area. Accessibility, linked to density in this study, reduces time spent in automobiles in all the localities. In West Palm Beach, the mix of uses, densities, and central business location, over all, seem to decrease the automobile travel.

## **Chapter 4: Summary, Conclusions, and Recommendations**

This chapter evaluates the methodologies and summarizes the findings of the three case studies previously presented. Comparing case studies that employed different methodologies, while arriving at similar conclusions, strengthens the legitimacy of the findings in particular and the concept of neo-traditional urban design in its entirety.

### ***4.1 Case study Summary: Comparison Case Studies***

Significant similarities characterize these studies. Each investigated specific places which had implemented statewide growth management strategies and policies and

did so within the same general timeframe. Two studies combined qualitative and quantitative approaches in their methodologies. The studies all used a census block group scale for the unit of analysis. Finally, all the case studies test general assumptions about the NTD development. The similarity of the conclusions in all three case studies suggests that NTD will influence modal choice and reduce vehicle miles traveled.

#### **4.1.1 Methodology of Studies**

The McCormack study (#1), using a meta-analysis, compares three NUT/NTD communities with the surrounding areas to determine if mixed-use neighborhoods could change the modal choice from automobile to walking, biking, or utilizing transit. The Greenwald study (#2) applies a two model qualitative methodology that investigated density which land use variables affected pedestrian non-work travel. The Ewing study (#3) uses a hybrid of quasi-qualitative/quantitative meta-analysis methodology to investigate whether or not location accessibility affects mode choice (household travel). Ewing et.al.sought to determine whether or not the six non-NTD communities induced residents to switch modal choices.

The McCormack study (#1) compared six communities. Three communities contain NTD characteristics and three communities lack these characteristics. The Greenwald study (#2) sets out to compare quantitatively existing data sets with two statistical models. The complexity of the Greenwald study left the study open to error in the methodology. The scale of the measurement, created on a census block group level, prohibits extrapolation beyond that level. The reason for this lies in the different information acquired and required for a census block group level study as opposed to a regional- wide study. The localities exist within the same jurisdictional boundaries. The

Ewing study (#3) utilized a meta-analysis, defined as “a systematic technique utilized by researchers to analyze a set of existing studies. It is conducted to draw general conclusions from several empirical studies” (O’Sullivan and Russell, 1999). As such, the conclusions fall within the scope of that outline. The study arrangement, six localities lacking in most or all NTD elements, showed associations between higher numbers of trip tours and modern urban designs or “sprawl” (Ewing, et.al. 1994). Each study used neighborhood level data in their investigations. However, potential errors in bias or sample error exist due to the method used in selecting the study communities.

#### 4.1.2 Data

The studies in this paper obtained data from 2-day travel diaries conducted by large professional organizations. This method of obtaining data contains inherent bias errors. Individual errors involving the administration of the instrument, the accuracy of recording, and the manner in which the data was entered into a database all provide an opportunity for theoretical error. All three case studies obtain data sets from much larger studies and as such, contain a low probability of sampling errors. Table 16 summarizes

**Table 16 Data Sources for Case Studies**

Study	Data Source
McCormack (#1)	PSRC's and McCormack's 2-day travel diaries
Greenwald (#2)	City of Portland travel diary
Ewing (#3)	City of Palm Beach travel survey

the data sources for the case studies. In case study #1 and #3, the researchers obtained data from outside sources

while case study #2 obtained data from their own previously conducted study. All the data consisted of travel diaries completed by resident/respondents. While an efficient way to obtain data, the accuracy of these travel diaries remains suspect.

### **4.1.3 Data Analysis**

The three studies analyze the data in differing ways. The McCormack study uses a simple statistical analysis. The Ewing study, although a bit more involved, remains a simple analysis. The Greenwald study uses the most complex data analysis scheme of the three case studies with F-Scores, Z-Tests, and coefficients. All tests appear appropriate for the methodology, sample size, and any perceived errors.

### **4.1.4 Modal Choice and VMT**

The studies uses the same type of data. The data from these studies provide a clearer understanding of land use factors and the effect those factors have on modal choice and/or VMT. The McCormack study (#1) focuses on how the mix of land uses changes and encourages a shift from driving to walking, biking, or transit as a modal choice. By focusing the study on mixing land uses, McCormack et.al., demonstrates that incorporating the commercial and residential areas together increase walking in neighborhoods with the NTD element of mixed-use. The Greenwald study (#2) finds that density significantly and positively affects non-work walking trips. Density and mixed land uses bring trip destinations and origins closer together. They create a concentration of people and places at origins and destinations. These two (#1 & #2) case studies agree that density and mixed land uses remain factors in changing the modal choice from automobile dependency to other forms of transportation. Decreased automobile dependence results in the reduction of the vehicle miles traveled suggesting a relationship between modal choice and VMT. By using typical American localities, Ewing finds that a lack in modal choice does increase travel time. By not incorporating NTD, these areas continue to adversely affect automobile commutes and provide few alternative options.

#### **4.1.5 Results in Action**

All the studies conclude that land use elements influence modal choice and VMT. McCormack (#1) finds that independence from automobile travel caused by mixing land uses resulted in lower VMT and a change in modal choice. The Greenwald (#2) study finds that density affects the decision to walk, thus changing modal choice as well as reducing VMT. Finally, the Ewing study (#3) finds that the total lack of NTD elements increased the time spent in cars and dictated automobile use. Present studies use the neighborhood as the unit of analysis. How these urban forms affect the larger region remains unclear.

#### **4.2 Conclusions**

Questions persist as to the actual factors leading to high VMT and car use. Case study #1 brings up the question of whether or not land use legitimately interacts with urban form. Perhaps the need for selection and variety, and not the urban form, compels consumers to drive. Small, pedestrian- friendly designs may not offer the selection consumers are accustomed to having in large retail stores. Perhaps the wave of the future might combine NTD characteristics with larger retail stores to offer the variety and selection consumers crave. Practicality and the pocketbook caused the large retail department stores to flourish. Perhaps this same practicality and frugality might encourage an eclectic mix of uses, density, and accessibility.

Consider a Wal-Mart. Wal-Mart already takes the place of “downtown”. One may obtain groceries, fill prescriptions, see an optician, purchase clothing, tools, recreational equipment, electronics, movies, and bathroom towels. Consider that same ‘big box’ store with the parking lot completely re-landscaped into a peaceful residential

park. Imagine tasteful signage, underground parking, and beautiful residential units built above. Imagine a movie theatre and several restaurants within walking distance of this complex and continuous transit availability.

Case study 2 raises issues of regional acceptance and effectiveness of NTD elements. On a neighborhood level, NTD clearly works, but the question of whether or not increased density on a regional scale reduces VMT and change modal choice remains unanswered. Is more density region-wide an effective transportation solution without regional organization? In addition, the grid street pattern element of NTD disputed in case study 2, suggests connectivity does not rely on a single street pattern.

This paper chooses not include any of the newer developments advertised as Neo-Traditionally designed communities. These developments lack reliable data over time. The physical existence of Neo-Traditional design communities remains relatively new and requires more time for scholarly examination. These communities, such as Celebration, Seaside, and Aragon in Florida still remain in the advertisement stage of development. Although exciting to see the physical development of NTD communities, it remains to be seen whether the amount or degree of mixed use, density, and transit options will provide for fewer vehicle miles traveled and an effective change in modal choice.

Table 17 Result of the Three Case Studies		
	Reduces Vehicle Miles Traveled	Effects a Change in Mode Choice
Increased Mixed Use	McCormack (#1) and Greenwald (2)	McCormack (#1) and Greenwald (2)
More Density (residential, commercial and in population)	McCormack (#1) and Greenwald (2)	McCormack (#1) and Greenwald (2)
Increased Accessibility	Ewing (#3)	Ewing (#3)

No single study encapsulates the many details, facets, and elements of NTD. Human interaction with the urban form presents a complex web of needs

and meeting those needs.

This paper focuses on the connection of NTD characteristics, increased modal choice and reduced VMT and three elements density, mixed uses, and accessibility, to modal choice and VMT. Table 17 shows the coverage of topics by this paper.

McCormack (#1) and Greenwald (#2) find the increasing the mix of uses and density, change modal choice changed and reduce VMT. Ewing (#3) finds that creating an area with mixed use and density increases accessibility to the residents. These characteristics translate to an increase in modal choice and reduction of VMT. The three case studies, with their different methodologies, data, and data analysis, all find that VMT and modal choice influenced by density, mixed-uses, and accessibility. Continuing to implement these design practices on a neighborhood level, will answer the questions about modal choice and high VMT faced by many localities. This paper recommends looking at the regional context of NTD for future research.

Density, mixed uses, and increased accessibility reduce VMT and affect a change in modal choice. Each of the case studies empirically proves that density, mixed use and accessibility increase modal choice and reduced VMT. This paper focuses on the

connection between the NTD elements of density, mixed uses, and accessibility and the transportation indicators of increased modal choice and reduced VMT. The three case studies, with their different methodologies, data, and data analysis, all find that neo-traditional designs reduce VMT and effect a change in modal choice.

The strength in the diversity of research past, present, and future, will continue to provide a greater understanding of our relationship to the urban form. Continuing to look at problems and bodies of thought from different perspectives will prove or disprove the validity of those thoughts. This paper offers one more building block toward that validity in an effort to change our landscape for the better.

### ***4.3 Recommendations***

The conclusion provides two recommendations. The first recommendation concerns the overlapping nature of this information. The information does not lend itself to segregation for study. Modal choice naturally affects VMT. These indicators occur simultaneously and should be studied and implemented in that manner. Density and mixed use interact in NTD communities in a similar way. Which comes first and/or exerts the greatest influence on VMT or modal choice remains difficult to determine. Within NTD communities mixed use generally accompanies density.

Currently, the better-known communities developed and marketed as NTD's lack sufficient NTD elements in significant concentrations to gain the transportation benefits described in this paper. Marketed NTD communities can only realize the same transportation benefits if they incorporate similar levels of mixed use, density, and accessibility as found in the cases studied. Less density, mixed use, and accessibility results in more VMT and fewer modal options.

The second recommendation regards the standardization of NTD elements within communities marketed as NTD's. Not all NTD communities are created equal. Currently, developers market differing levels of mixed use, density, and accessibility under an undifferentiated banner of NTD. Researchers and professionals should provide the public with a standardization and quantification of NTD's elements and impacts. For example, the American Planning Association (APA) might guarantee potential homeowners a certain level of mixed uses, densities, and accessibility by creating an environmentally appropriate rating system. An APA Platinum rating would ensure, for example, a 90% compliance with standardized levels of mixed use, density, and accessibility. A Gold rated NTD certifies a lower level of density, mixed use and accessibility. Silver and bronze rated developments certify successively lower standardized amounts of density, mixed use, and accessibility. Platinum, gold, silver, and bronze certification carries with it marketable assurances to the homebuyer of a certain level of transportation benefits.

Neo-Traditional designs reduce VMT and change modal choice. Professional planning organizations need to take the next step to quantify and standardize the design. The organizations could help answer questions such as, how much density, mixed-use, and improved accessibility will produce a certain amount of VMT reduction and modal choice options? Marketed NTD developments that do not meet basic NTD design guidelines should push professionals and researchers to quantify and standardize this design. Marketed designs that do not meet basic NTD requirements will not reduce VMT nor change modal choice. The Federal Trade Commission, governing truth in advertising, has yet to look into the deception in the advertising and marketing of NTD's.

Like any scientific experiment, one must reproduce the experiment exactly in order to get exactly the same results. If marketed NTD developments do not include the same amount of mixed use, densities, and accessibility, they will not obtain the same reduction in VMT or change in modal choice. It remains dubious whether marketed NTD developments with superficial smatterings of mixed-uses, quarter acre densities, and no viable multi-modal transportation are actually exhibiting NTD characteristics at all. With no governing body to approve the usage of the Neo-Traditional design label, developers and marketing directors appropriate the label with no physical substance behind it. In order for residents to receive the appreciable benefits of this design type, NTD must be more than a label.

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## Curriculum Vitae

Jessica H. McCann

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12700 Foxridge Lane, Apt L, Blacksburg Virginia, 24060

(540) 951-0691

jemccann@vt.edu

### EDUCATION

#### **Master of Urban and Regional Planning**

Virginia Polytechnic Institute, May 2003

- APA Member

#### **Bachelor of Science, Forestry**

University of New Hampshire, May 1997

- Citizen Scholarship recipient
- Forestry Honor Society

### PROFESSIONAL EXPERIENCE

#### **HNTB**

**Charlotte, NC**

**5/02-8/02**

#### **Planning Analyst and Researcher**

Participated in indirect and cumulative impact assessments for North Carolina Department of Transportation highway bypass projects. Investigated potential for induced land development attributable to roadway projects. Assessed potential effects on water quality watersheds and endangered species.

- ArcGIS development suitability analysis.
- Demographic analysis
- Regulatory constraints on development research

#### **Conservation International**

**Washington, D.C.**

**9/99-10/99 and 3/00-7/01**

#### **Field Data Collection Assistant**

Assisted in the gathering of ground & aerial survey data in Ghana, Africa, one of the world's biodiversity "hot-spots" with the Conservation International Aerial Survey Program.

- GIS, video and photographic equipment setup for daily flights
- Recorded imagery of 50,000 acres of threatened rain forest for future protection
- Analyzed image data in ArcView, Erdas Imagine, and Adobe Photoshop
- Assisted in research and development of various imaging systems
- Assisted in advanced field data collection training for Elephant Biology & Management program team.

#### **National Tree Trust**

**Washington, D.C.**

**12/98 - 02/00**

#### **Assistant Program Director**

Implemented the America's Treeways and Community Tree Planting Programs for the 12 Southeastern states

- Liaison between southeast region Tree Planting partners, volunteer groups, and forest industry nurseries
- Administered, reviewed, and approved over 450 grant applications for Southeast program partners
- Facilitated grant years 1998, 1999 and 2000 budget and technical logistics for shipment of tree seedlings
- Represented NTT at national and statewide forestry conferences and tree planting events
- Visited with 63 program partners for unification of communities around tree plantings
- Developed standardized annual reporting procedures for seedling survival rates and distribution logistics
- Media relations with television, newspaper, and radio interviews on behalf of the National Tree Trust

#### **REFERENCES**

Dr. John Levy, Professor, Virginia Polytechnic Institute: 540-231-7509

Jesse J. Richardson Jr., Assistant Professor, Virginia Polytechnic Institute Phone: 540-231-7508

Donal R. Simpson, FAIA, AICP, ASLA, Director, HNTB Charlotte Phone: 704-372-8020