SUBURBAN WALKABILITY: UNDERSTANDING THE ROLE OF URBAN DESIGN AND RESIDENTIAL PREFERENCES

by

Jacqueline Kinney
B.Sc., University of Victoria, 2000

RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF URBAN STUDIES

in the
Urban Studies Program
Faculty of Arts and Social Sciences

© Jacqueline Kinney 2012

SIMON FRASER UNIVERSITY
Spring 2012

All rights reserved. However, in accordance with the Copyright Act of Canada, this work may be reproduced, without authorization, under the conditions for “Fair Dealing.” Therefore, limited reproduction of this work for the purposes of private study, research, criticism, review and news reporting is likely to be in accordance with the law, particularly if cited appropriately.
Approval

Name: Jacqueline Kinney
Degree: Master of Urban Studies
Title of Thesis: Suburban Walkability: Understanding the Role of Urban Design and Residential Preferences

Examining Committee:

Chair: Matt Hern
Lecturer, Urban Studies

________________________
Anthony Perl
Senior Supervisor
Director, Urban Studies
Professor, Urban Studies and Political Science

________________________
Michael von Hausen
Supervisor
Adjunct Professor, Urban Studies
President, MVH Urban Planning and Design Inc.

________________________
Ryan Allen
External Examiner
Assistant Professor, Faculty of Health Sciences

Date Defended/Approved: 3 January 2012
Partial Copyright Licence

The author, whose copyright is declared on the title page of this work, has granted to Simon Fraser University the right to lend this thesis, project or extended essay to users of the Simon Fraser University Library, and to make partial or single copies only for such users or in response to a request from the library of any other university, or other educational institution, on its own behalf or for one of its users.

The author has further granted permission to Simon Fraser University to keep or make a digital copy for use in its circulating collection (currently available to the public at the “Institutional Repository” link of the SFU Library website (www.lib.sfu.ca) at http://summit.sfu.ca and, without changing the content, to translate the thesis/project or extended essays, if technically possible, to any medium or format for the purpose of preservation of the digital work.

The author has further agreed that permission for multiple copying of this work for scholarly purposes may be granted by either the author or the Dean of Graduate Studies.

It is understood that copying or publication of this work for financial gain shall not be allowed without the author’s written permission.

Permission for public performance, or limited permission for private scholarly use, of any multimedia materials forming part of this work, may have been granted by the author. This information may be found on the separately catalogued multimedia material and in the signed Partial Copyright Licence.

While licensing SFU to permit the above uses, the author retains copyright in the thesis, project or extended essays, including the right to change the work for subsequent purposes, including editing and publishing the work in whole or in part, and licensing other parties, as the author may desire.

The original Partial Copyright Licence attesting to these terms, and signed by this author, may be found in the original bound copy of this work, retained in the Simon Fraser University Archive.

Simon Fraser University Library
Burnaby, British Columbia, Canada

revised Fall 2011
STATEMENT OF ETHICS APPROVAL

The author, whose name appears on the title page of this work, has obtained, for the research described in this work, either:

(a) Human research ethics approval from the Simon Fraser University Office of Research Ethics,

or

(b) Advance approval of the animal care protocol from the University Animal Care Committee of Simon Fraser University;

or has conducted the research

(c) as a co-investigator, collaborator or research assistant in a research project approved in advance,

or

(d) as a member of a course approved in advance for minimal risk human research, by the Office of Research Ethics.

A copy of the approval letter has been filed at the Theses Office of the University Library at the time of submission of this thesis or project.

The original application for approval and letter of approval are filed with the relevant offices. Inquiries may be directed to those authorities.

Simon Fraser University Library
Simon Fraser University
Burnaby, BC, Canada

Last update: Spring 2010
Abstract

Neighbourhood design can play a role in facilitating walking within the neighbourhood. Elements in the built environment that are believed to play a role in walking include density, land use mix, connectivity, and urban design.

This capstone project measures and compares walking frequencies, the number of observed pedestrians as well as self reported walking trips, in two suburban neighbourhoods. The neighbourhoods differ in many aspects of their built form: one neighbourhood is a neo-traditional design (NTD) while the comparison community is conventional suburban design (CSD). Neighbourhood perceptions, residential preferences, and travel attitudes were assessed.

Higher observed and self-reported walking frequency can be found in the NTD neighbourhood. Walking frequency is higher among all NTD residents, not only those that prefer urban form features related to walking. The results indicate that the built environment does play a role in utilitarian walking within the neighbourhood.

Keywords: urban design, neo-traditional design, conventional suburban design; walking within the neighbourhood for non-work purposes; residential self selection; Behavioural Model of the Environment; Garrison Crossing, Chilliwack, British Columbia
Dedication

for Theo and Adeline – you inspire me to do better.
Acknowledgements

Firstly, I would like to express my gratitude to my family and friends for the unconditional support and encouragement that got me to this point. To Pat & Gordy, for countless hours of the highest quality child minding a mother could dream of. To my mom and dad, Angela & Purvis, for imbuing confidence as well as financial and logistical support. I could not have done this without you! A special thanks to my husband Steven for unwavering support through the ups and downs, making me laugh through the tears, and for telling me that you are proud: I love you.

I would also like to thank Anthony Perl for his guidance and patience through this marathon: it has been an enjoyable and rewarding experience. Thank you to Michael von Hausen for inspiring me through his passion and enthusiasm for great urban design. Thank you to my supervisory committee, including Ryan Allen and Matt Hern for your thoughtful questions, insight and support. I would be remiss to overlook the time and contributions of Terri Evans and my fellow Urban Studies students.

This research project would not have been possible without the interest and contributions of many: Randy Fasan, Janice Seymour, and staff at Canada Lands; Chad Hampson, Gillian Villeneuve, Peter Li, and Rod Sanderson at the City of Chilliwack; and residents of Garrison Crossing and Promontory Heights. Thank you!
# Table of Contents

Approval........................................................................................................................................... ii
Abstract................................................................................................................................................ iii
Dedication................................................................................................................................................ iv
Acknowledgements........................................................................................................................... v
Table of Contents ............................................................................................................................... vi
List of Figures ......................................................................................................................................... viii
List of Tables .......................................................................................................................................... x

1: Introduction ........................................................................................................................................ 1

1.1 Historical Overview......................................................................................................................... 5
1.2 Case Study Design ............................................................................................................................ 7
1.3 Research Purpose and Significance ................................................................................................. 9

2: Background ......................................................................................................................................... 11

2.1 Theories of Travel Behaviour ......................................................................................................... 12
2.2 The Behavioural Model of the Environment .................................................................................. 13
  2.2.1 Origin and Destination .............................................................................................................. 15
  2.2.2 Route .................................................................................................................................. 17
  2.2.3 Area ................................................................................................................................... 25
2.3 Correlation not Causality: The Issue of Residential Self-selection .............................................. 27

3: The Case Study Neighbourhoods .................................................................................................... 31

3.1 Land Use Mix ................................................................................................................................. 33
3.2 Street Pattern and Connectivity ..................................................................................................... 36
3.3 Dwelling Units within walking distance ....................................................................................... 40
3.4 Urban Design Qualities ................................................................................................................. 42
3.5 Density ........................................................................................................................................ 50

4: Findings ............................................................................................................................................. 52

4.1 Pedestrian Count ............................................................................................................................ 52
  4.1.1 Observations in the CSD ........................................................................................................ 53
  4.1.2 Observations in the NTD ........................................................................................................ 55
4.2 Survey .......................................................................................................................................... 58
  4.2.1 Survey Respondents ............................................................................................................. 59
  4.2.2 Survey Outcomes .................................................................................................................. 60
5: Conclusions .................................................................................................................................79
Reference List .................................................................................................................................85
Appendix: Qualitative Definitions of Urban Design Qualities .................................................95
## List of Figures

| Figure 1-1 | High density: carriage house in Garrison Crossing (NTD) .................................................. 1 |
| Figure 1-2 | High density: Multi-family housing in Garrison Crossing (NTD) .............................................. 2 |
| Figure 1-3 | Accommodation for the pedestrian in Garrison Crossing (NTD) ................................................. 2 |
| Figure 1-4 | Low density housing and wide streets in Promontory Heights (CSD) ......................................... 3 |
| Figure 1-5 | Automobile oriented shopping centre in Promontory Heights (CSD) ........................................... 4 |
| Figure 2-1 | Behavioural Model of the Environment: Three Components of Origin and Destination, Route and Area .................................................. 15 |
| Figure 2-2 | High Connectivity Street Pattern .................................................................................................. 20 |
| Figure 2-3 | Low Connectivity Street Pattern .................................................................................................. 21 |
| Figure 2-4 | High friction street ....................................................................................................................... 22 |
| Figure 2-5 | Low friction street ........................................................................................................................ 22 |
| Figure 2-6 | Curb bulge and choker to narrow street for pedestrians and slow traffic .................................... 23 |
| Figure 2-7 | Roundabout ..................................................................................................................................... 24 |
| Figure 2-8 | Behavioural Model of the Environment: Conceptual Structure and Example Variables ........................................................................ 27 |
| Figure 3-1 | Locations of case study neighbourhoods ......................................................................................... 33 |
| Figure 3-2 | Locations of destinations within each neighbourhood .................................................................. 36 |
| Figure 3-3 | Overall street pattern in NTD ........................................................................................................ 37 |
| Figure 3-4 | Seven meter wide boulevard in NTD .............................................................................................. 38 |
| Figure 3-5 | Parking pocket on six meter wide road in NTD ............................................................................. 38 |
| Figure 3-6 | Overall street pattern in CSD ........................................................................................................ 39 |
| Figure 3-7 | Eleven metre wide road in CSD ...................................................................................................... 40 |
| Figure 3-8 | NTD: Dwelling within walking distance ......................................................................................... 41 |
| Figure 3-9 | CSD: Dwelling units within walking distance ................................................................................ 42 |
| Figure 3-10 | Urban Design Qualities (UDQ) Score ............................................................................................... 43 |
| Figure 3-11 | Example of a small courtyard in NTD ........................................................................................... 44 |
| Figure 3-12 | Outdoor eating area in NTD .......................................................................................................... 44 |
| Figure 3-13 | Pitched rooflines, balconies and awning in NTD .......................................................................... 45 |
| Figure 3-14 | Imageability: Pitched rooflines in NTD ......................................................................................... 45 |
| Figure 3-15 | Awning in NTD ............................................................................................................................. 46 |
| Figure 3-16 | Commercial area in CSD .............................................................................................................. 47 |
List of Tables

Table 1-1  Comparison of neighbourhoods used in cited literature and case study neighbourhoods.................................................................9
Table 3-1  Summary of 2006 Canada Census data for case study neighbourhoods ..........................................................32
Table 3-2  Comparison of built environment elements in case study neighbourhoods ..........................................................32
Table 3-3  Vancouver Walkability Index (VWI) ......................................................................................................34
Table 3-4  Land Use Inventory .........................................................................................................................35
Table 3-6  Percentage of four way intersections ..........................................................................................40
Table 3-7  Neighbourhood and study area densities ......................................................................................51
Table 4-1  Sample versus Population Characteristics ..................................................................................60
Table 4-2  Walking frequency results ........................................................................................................61
Table 4-3  Neighbourhood perceptions ........................................................................................................63
Table 4-4  Residential preferences .................................................................................................................70
Table 4-5  Travel attitudes ..........................................................................................................................76
1: Introduction

This capstone project will analyse and compare walking frequencies, the number of observed pedestrians as well as self-reported walking trips, in two suburban neighbourhoods. The neighbourhoods differ in many aspects of their built form. One neighbourhood is a neo-traditional community while the comparison community is a conventional suburban neighbourhood. Neo-traditional design (NTD) offers an alternative to conventional suburban design (CSD) (Duany, Plater-Zyberk, & Speck, 2000; CMHC, 2010). Compared to CSD, NTD is characterised by “somewhat higher densities, mixed uses, provision of public transit, accommodation of the pedestrian and bicyclist, and a more interconnected pattern of streets” (Figure 1-1, Figure 1-2 and Figure 1-3) (Southworth & Ben-Joseph, 2003 page 105). For illustrations of a connected street pattern refer to Figure 2-2 on page 20 and Figure 3-3 on page 37.

Figure 1-1  High density: carriage house in Garrison Crossing (NTD)
Figure 1-2  High density: Multi-family housing in Garrison Crossing (NTD)

© J. Kinney.

Figure 1-3  Accommodation for the pedestrian in Garrison Crossing (NTD)

© J. Kinney.
NTD uses historical precedents in its approach and takes inspiration from the classic small town (Duany, Plater-Zyberk, & Speck, 2000; CMHC, 2010). NTD, along with ‘traditional neighbourhood development’ (TND), ‘transit –oriented development’ (TOD), and ‘pedestrian pocket’ are ideas that fall under the term New Urbanism (Carmona et al., 2003). New Urbanism appeared in the USA in the latter part of the 1980s and early 1990s, where the central idea was to design neighbourhoods that were “explicitly related to transport connections” (Carmona et al., 2003: 10). NTD has been described as “walkable, [having] a clear civic structure, a mix of uses and housing types, and harmonious design of its buildings and spaces” (Southworth & Ben-Joseph, 2003, page 105).

CSD, primarily developed from the 1970s onward, is typified by: low density, single family, detached houses; wide, curved streets and cul de sacs; and automobile oriented shopping centres (Figure 1-4 and Figure 1-5) (Moudon, 1992; Duany, Plater-Zyberk, & Speck, 2000). For illustrations of street patterns typical of CSD refer to Figure 2-3 on page 21 and Figure 3-6 on page 39.

Figure 1-4  Low density housing and wide streets in Promontory Heights (CSD)
This capstone project will aim to answer the following research questions:

1. Do residents in Garrison Crossing, an NTD neighbourhood, that has urban form features such as higher density, mixed use, and pedestrian oriented street design, make more walking trips within their neighbourhood than residents in Promontory Heights, a CSD neighbourhood?
   - Hypothesis: Measures of pedestrian frequency, that is the number of observed pedestrians and the number of self reported walking trips, will be higher in an NTD neighbourhood than in a CSD neighbourhood (Cao et al., 2009b).

2. Does residential self selection into a neighbourhood that has urban form features such as density, mixed use, and pedestrian oriented street design play a role in pedestrian frequency (Cao et al., 2009b)?
   - Hypothesis: Measures of pedestrian frequency will be higher among residents who prefer urban form features such as density, mixed use, and pedestrian oriented street design and prefer active modes of transportation than those that prefer single use, automobile oriented neighbourhood and prefer transportation by automobile.
This research can contribute to further understanding which attributes of the built environment are associated with walking. It can also highlight neighbourhoods where people are choosing to walk and identify barriers that may be discouraging walking. It will seek to understand why people choose the type of neighbourhood they live in, their attitudes about transportation, and how urban form plays a role in transportation choices. When residents are able to walk within their neighbourhood to destinations that can meet daily needs, for groceries, services, and socialization, rather than travelling in a car, positive contributions to personal health and wellbeing as well as reductions in greenhouse gas emissions can be achieved. (Condon, 2010; Tolley, 2009; Frank et al., 2009).

1.1 Historical Overview

In North America, the automobile has become the mode of transportation that has shaped the city (Newman & Kenworthy, 1999). Post World War II, widespread use of private automobiles initiated a dramatic change in travel patterns and urban development (Vuchic, 1999). With the demise of streetcars, walking and transit use declined and the use of the automobile “became not so much a choice but a necessity” (Newman & Kenworthy, 1999 page 31).

Increased time spent in automobiles is having significant effects on the health and wellbeing of Canadians and British Columbians in terms of sedentary lifestyles and climate change. Obesity rates and other chronic diseases are dramatically increasing (Frank et al., 2009). Cities are contributing up to eighty percent of greenhouse gas production as a result of how buildings are constructed and arranged, what is inside of them, and how people move between them (Condon, 2010). The development of healthy and sustainable communities in British Columbia, where walking is a feasible option, is of vital importance.

The end of World War II is a defining point in time when the form of cities began to change dramatically (Condon, 2010; Southworth & Ben-Joseph, 2005; Duany, Plater-Zyberk, & Speck, 2000). In Canada, the population moved outward from the central city and urban residential densities dropped from 6,803 persons per square mile in 1960 to 4,000 persons per square mile in 2006 (Demographia, 2006). This rate of decentralization was most pronounced between 1941 and 1961 and again between 1966 and 1971, during the time of major highway construction in metropolitan Canada.
(Edmonston, Goldberg, & Mercer, 1985). Where middle-class and working-class families had lived in higher density, walkable, and transit-served neighbourhoods with commercial areas concentrated on streetcar corridors, they moved to lower density and car-dependant suburbs (Condon, 2010). This new suburban landscape had limited public transit services yet inexpensive fuel for private automobiles allowed workers to live farther from where they worked (Condon, 2010). Shopping centres and office parks followed this move to the suburbs (Duany, Plater-Zyberk, & Speck, 2000). Shopping centres and offices were built along high speed collector roads, away from residential areas and where they could be easily accessed by vehicles (Figure 1-5 on page 4). This separation of land uses in the suburban landscape changed the relationship between home, shopping, services, and work (Condon, 2010). Where workers would walk or take transit to work, and stop along the way at conveniently located commercial areas, the growing distance between these locations required the use of an automobile. The design of public streets also changed: growing wider to accommodate more vehicles and often without sidewalks (Condon, 2010; CMHC, 2010).

Land at the peripheries of cities was generally less expensive and developers found more profit in building residential developments even further away from the metropolitan centre (Condon, 2010). This effect trickled down to homebuyers and the further out from the city centre they were willing to travel, the less expensive a single family home (Gurin, 2003). The growing number of personal automobiles and government subsidies for infrastructure for automobiles, water, sewer, and utilities has created a bias for a low density and sprawling style of development (Duany, Plater-Zyberk, & Speck, 2000). The affordability of a new single family home as well as the privacy, space and “the promise (though not necessarily the reality) of greater quiet, cleanliness, and safety” of these new suburbs increased their appeal (Gurin, 2003: 7).

All of these factors worked in conjunction to alter transportation mode choice, from walking and transit, requiring walking from home and work to transit stops, to the automobile.

This change in the urban fabric has had many consequences: people live further apart from their neighbours; houses, shops, and workplaces that were once mixed are now segregated; and trips once made on foot or by transit are made by automobiles (Condon, 2010). The urban planning practices that led to these changes in the urban form have contributed to people’s decisions to drive rather than to walk (Tomalty &
Haider, 2009). The proportion of Canadian adults that travelled everywhere by car rose from 68% in 1992 to 74% in 2005 while the proportion of Canadians who made at least one trip by bicycle or on foot declined from 26% in 1992 to 19% in 2005 (Turcotte, 2008). In low density neighbourhoods, more than 80% of residents made at least one trip by car per day while less than half of the people living in very high density neighbourhoods did so (Turcotte, 2008). In Canada, the number of vehicles per capita has been steadily increasing since the 1950s (Schimek, 1996). The number of cars in Metro Vancouver increased by 40% between 1991 and 2006 while the population increased by only 32% in the same period (Translink, 2007). Only 12% of all trips made to the store, work, or school are done by walking or cycling in Canada compared to 46% in the Netherlands and 41% in Denmark (Tomalty & Haider, 2009). Despite this relatively low number, eight out of ten respondents in a survey of 1500 adults across Canada stated they would like to walk more than they already do (Tomalty & Haider, 2009).

1.2 Case Study Design

A case study methodology will be used to examine the differences in walking frequency. Two neighbourhoods, both in Chilliwack, British Columbia, Canada, will be used to control for differences in location within the greater region of the Fraser Valley Regional District (FVRD) and Metro Vancouver, school quality, transit and other public services. The neighbourhoods will embody key differences based on NTD and CSD: density, land use mix, and street pattern (Khattak, 2005; Dill, 2004; Cao et al., 2009).

The NTD neighbourhood, Garrison Crossing, an award winning1 army base redevelopment, began construction in the mid 2000s. As such, it is a retrofit of an existing community. As Canadian Forces Base (CFB) Chilliwack, the community was a “thriving military community, with over 2,500 personnel and their families living or working at the Base” (GCNP, 2003: 6). CFB Chilliwack closed in 1998 and the Cheam Recreation Centre came under Young Men’s Christian Association (YMCA) management and the remaining 388 residential units were leased to military and non-military personnel (GCNP, 2003). The rich military history and existing built form of the community informed the redevelopment.

---

1 Garrison Crossing was awarded Best Master Planned Development in 2008 by the Urban Development Institute, a national non-profit association of the Canadian development industry.
The neighbourhood features smaller lot sizes compared to conventional suburban development, commercial space within a five minute walk of all residences, a variety of residential options and amenities for pedestrians (Table 3-1 on page 32 and Table 3-4 on page 35) (M. von Hausen (personal communication March 27, 2008); GCNP, 2003). The retail area at Garrison Crossing includes a grocery store, restaurants, a coffee shop, a liquor store, a tanning salon and a dental clinic (Canada Lands Company, 2010). A recreation centre is a central feature of the neighbourhood (Canada Lands Company, 2010). The central boulevard, designed for pedestrians and cyclists, as well as vehicles, connects residential areas, commercial areas, and local recreational trails. An objective in the Garrison Crossing Neighbourhood Plan (GCNP) is to develop an interconnected sidewalk and path network to encourage walking, biking and the use of transit (GCNP, 2003). The GCNP also outlines the use of pedestrian lighting, street furniture as well as extensive tree retention to create a comfortable and safe walking environment. Roadways within the NTD are narrow: 6 and 7 metres wide compared to 8.5 and 11 metres in the CSD neighbourhood (Sanderson, 2011; GCNP, 2003). The residential density in the NTD is one and a half times higher compared to the CSD, 6.99 and 4.58 residences per acre, respectively (Table 1-1). This is aided by designating 75% of housing units as multifamily housing and 25% as single family housing, as well as facilitated by the construction of secondary suites, coach houses, townhouses and condominiums (M. von Hausen (personal communication March 27, 2008); GCNP, 2003).

A nearby neighbourhood, Promontory Heights, will be used as a comparison and as an example of CSD. Residential development began in the CSD in the late 1980s. The CSD neighbourhood has a more conventional suburban street network with a curvilinear pattern, limited land use mix and lower density (Table 3-1 on page 32 and Table 3-4 on page 35). Median incomes are comparable in both case study neighbourhoods, according to the 2006 Canadian Census, $73,185 in the CSD and $63,017 in the NTD (Table 1-1 compares the NTD and CSD neighbourhoods with respect to built form and also offers a comparison of these neighbourhoods to neo-traditional, traditional, and conventional suburban neighbourhoods used in other research).
### Table 1-1: Comparison of neighbourhoods used in cited literature and case study neighbourhoods

<table>
<thead>
<tr>
<th>Study</th>
<th>Net residential density(^a)</th>
<th>Street pattern</th>
<th>Land use mix</th>
</tr>
</thead>
</table>
| Khattak, 2005 | NTD 2.15  
CSD 1.59 | • NTD high street connectivity and accessibility  
• CSD curvilinear with cul de sacs | • NTD >200,000 sq ft commercial space  
• CSD 0 sq ft of commercial space |
| Cao et al., 2006 | TND\(^b\) 13.3  
CSD 3.5 | • TND Rectilinear grid  
• CSD curvilinear with cul de sac | • TND residential and commercial uses  
• CSD only residential |
| Dill, 2004 | • NTD single family and multi-family homes  
• CSD single family homes | No data | • NTD >150,000 sq ft of commercial space  
• CSD 0 sq ft of commercial space |
| NTD\(^c\)  
(Garrison Crossing) | 6.99 | Modified grid | • Land use mix index 0.176  
• Retail floor area 0.1147 |
| CSD \(\text{(Promontory Heights)}\) | 4.58 | Curvilinear with cul de sacs | • Land use mix index 0.071  
• Retail floor area 0.0000 |

\(^a\) Number of residential units per acre of designated residential land area.  
\(^b\) This study compared traditional neighbourhood development (TND) to CSD  
\(^c\) Data for Garrison Crossing and Promontory come from Larry Frank’s Walkability Index using data from 2005 except for street pattern designation. Street pattern designation was assessed by an evaluation of road network maps.

### 1.3 Research Purpose and Significance

Garrison Crossing was chosen as a study site as I believe it is important to understand the potential and limitations for walking within a neo-traditional design neighbourhood in a suburban setting. Other research is also striving to understand the possibilities and constraints of neighbourhood design on transportation choice (Christian et al., 2011; Cao et al., 2009b; Dill, 2006; Rodriguez et al., 2006; Khattak & Rodriguez, 2005). Over the last ten to fifteen years, urban design principles associated with neo-traditional design have increasingly influenced planning and development, with over forty two communities being planned and developed in Canada (Grant & Bohdanow, 2008). Many municipal plans in Canada are also adopting elements of neo-traditional design (Grant & Bohdanow, 2008; CHMC, 2010). Due to the growing popularity of these types
of developments, I believe there is a need to examine how these neighbourhoods are performing with respect to intended objectives, specifically those related to walking.

Traditional neighbourhoods, those built prior to the Second World War, have been used in research as a proxy for neo-traditional neighbourhoods (Handy, 1996a; Nasar, 2003). With more and more neo-traditional neighbourhoods being built it is becoming more feasible and necessary to evaluate their success (Dill, 2006). Despite Garrison Crossing being a new development, other research does exists on “young” neo-traditional neighbourhoods (Lund, 2003; Khattak & Rodriguez, 2005; Dill, 2006; Dill, 2004). As the development matures it could be studied again to get a sense of how the evolving built environment and transportation choices change over time (Khattak & Rodriguez, 2005).

This research is focussing on active transportation, specifically utilitarian walking within the neighbourhood. Studies have shown that there is potential to increase the amount of walking for transportation as over 90% of trips made are by automobile and 27% of those trips are less than 1.6 kilometres, a distance that most people can walk in under fifteen minutes (Lee & Moudon, 2003). Other research echoes this sentiment stating that the majority of walking occurs in neighbourhood streets and outdoor public spaces (Giles-Corti & Donovan, 2002; Troped et al., 2001; Brownson et al., 2001; Powell et al., 2003).
2: Background

The benefits of walking are numerous and widely documented. Walking is promoted as an inexpensive and effective way to limit the increasing burden of sedentary lifestyles and overweight-related health problems (Frank et al., 2009; Kayser, 2005). Engaging in a regular regimen of walking reduces the risk of premature mortality in general and in particular coronary heart disease, hypertension, colon cancer, and diabetes mellitus and plays a positive role in the health of muscles, bones, and joints (USDHHS, 1996). Walking in the outdoors can lead to positive mental health outcomes such as increasing self esteem and improving mood, as well as building social bonds (Barton & Pretty, 2010).

People who live in neighbourhoods with a mix of shops and businesses within an easy walking distance have a 35% lower risk of obesity (Frank et al., 2004). On average, people in highly walkable neighbourhoods take one or two more walking trips per week than those living in places with poor walkability (Saelens et al., 2003). An American study found that people living in compact, higher density counties walk more, weigh less, are less likely to be obese or have hypertension than people living in more sprawling counties (Ewing et al., 2003; Sturm & Cohen, 2004). Among middle-aged men, walking or bicycling to work was associated with lower weight and less weight gain, whether or not the men engaged in more vigorous forms of exercise (Wagner et al., 2001).

“Walkability is the foundation for the sustainable city: without it, meaningful resource conservation will not be possible” (Southworth, 2005 page 248). Walking, unlike vehicular travel, has a low environmental impact and conserves energy without noise and air pollution (Newman & Kenworthy, 1999). Walking is a good substitute for high emission short distance trips, those of one to three kilometre distance (Tolley, 2009).

It is clear that walking has many benefits. But the question remains: why are people not walking and continuing to choose to drive? Researchers have been investigating the link between the built environment and walking behaviour in an effort to
ameliorate the negative effects of greenhouse gases, urban sprawl and sedentary lifestyles. A significant body of research has recently emerged that has shown a consistent association between the way communities are designed and the amount of walking that residents of those communities engage in (Sallis et al., 2004; Saelens & Handy, 2008; Frank et al., 2009). The efforts of researchers from two different fields have contributed to this work: transportation planning and public health. The health field has primarily examined psychological and social variables that may be associated with walking behaviour (Sallis & Owen, 1999), while the transportation field has focused on defining variables associated with the built environment that appear to influence the behaviour of whole communities (Ewing & Cervero, 2001; Handy et al., 2002).

2.1 Theories of Travel Behaviour

The theoretical framework that is often used to explain the relationship between the built environment and motorized travel behaviour is the discrete choice theory (McFadden, 1976; Ben-Akiva & Lerman, 1985). This theory states that the probability of an individual making a particular choice out of a set of choices is contingent upon the utility of that choice relative to the utilities of other available choices (Ben-Akiva & Lerman, 1985). With respect to travel behaviour, the theory suggests that an individual makes a logical decision regarding what mode of transportation to take depending on the utility, or relative attractiveness, of that choice relative to other modes (Ben-Akiva & Lerman, 1985). The utility of the choices may be based on monetary costs, such as the cost of fuel, transit fares, or tolls or in terms of time and convenience. The discrete choice model assumes that choices made by individuals can be predicted based on a limited set of quantifiable factors and that people are essentially rational decision-makers who seek to make choices that maximize their utility (FHA, 1999). With respect to neo-traditional planning and design, the discrete choice model suggests that is not the density in these neighbourhoods that impacts travel behaviour, but rather, the set of choices related to density that influences travel behaviour (Handy, 1996b). This theory can also be applied to residential choice: an individual’s choice to locate in a neighbourhood would be based on the overall utility relative to other neighbourhoods, such as proximity to work, parks and other amenities, and median housing prices (Joh, 2009).
Joh (2009) argues that there are factors that influence travel behaviour that cannot be explained by the discrete choice theory alone: specifically, the factors related to the impact of neighbourhood design and the built environment on walking behaviour. In the discrete choice theory, travel demand is assumed to be a derived demand (Ben-Akiva & Lerman, 1985). This means that travel is based on the need to reach destinations as efficiently as possible and not for the sake of travel itself (Joh, 2009). While this theory can readily be applied to driving trips, its application to walking trips is arguable when motivations for walking are considered (Joh, 2009; Cervero, 2002). Motivation for walking can come from an individual’s choice to walk based on the experience of walking not necessarily because it is the most efficient choice (Joh, 2009). Past studies, based on this theory have inadequately specified the influences on transportation mode choice, ignoring the potential effects of densities, land use mixtures, and urban designs in and around trip origins and destinations (Moudon & Lee, 2003; Cervero, 2002).

With gaining interest in promoting walking behaviours from the public health field, studies began to look at how psychological and social variables are associated with the decision to walk (Sallis et al., 2004). Researchers began to better understand and incorporate more factors that influence the decision to walk into their models (Moudon & Lee, 2003; Cervero, 2002; Handy & Clifton, 2001). Researchers began to look more closely at social cognitive behaviour theory that suggests behaviour is influenced by individual factors in combination with the social and physical environment (Bandura, 1986). The types of environments that affect behaviour may be physical (weather or climate, the built environment) social (social supports, norms, beliefs, and attitudes) as well as objective (actual) or subjective (perceived) (Sallis et al., 2006). The environment can be a particularly strong behavioural determinant for behaviours that are directly shaped through environmental constraints and supports, such as walking (Owen et al., 2004; Bandura, 1986).

2.2 The Behavioural Model of the Environment

The Behavioural Model of the Environment (BME) has been proposed as a theoretical framework and conceptual model that can be used to better understand and link the various characteristics of the individual and the environment on active transportation (Frank et al., 2009; Sallis et al., 2006 Moudon & Lee, 2003). The BME is
a multidisciplinary framework that connects physical activity from the health perspective to the transportation perspective as well as the importance of the physical environment in supporting active transportation through the urban design and planning professions (Lee & Moudon, 2004).

The general thesis of the BME is that the environment restricts the range of behaviours by “promoting and sometimes demanding certain actions and by discouraging or prohibiting other behaviours” (Sallis et al., 1998: 380). The BME implies that variables relating to the environment and policy, in addition to intrapersonal and interpersonal variables, can help explain active transportation behaviour. The BME does not claim that it is only environmental variables that influence behaviour (Sallis et al., 1998).

The basis of this model rests on the concept of an interactive relationship between human behaviour and human environments (Moudon & Lee, 2003). What makes this model unique is that it places emphasis on the environmental variables that influence behaviour and its specific purpose is to identify those variables that facilitate or place constraints upon the potential to engage in active transportation (Moudon & Lee, 2003). These variables are: 1) inter and intrapersonal 2) environmental and 3) trip characteristics (Moudon & Lee, 2003).

Interpersonal factors relate to an individual’s “internal response to being in a physical environment, such as perceived comfort, attractiveness, [and] safety” (Moudon & Lee, 2003: 22) and can be influenced by psychological and biological variables, such as age, gender and ethnicity. Interpersonal factors include the type and intensity of human uses in the physical environment. This can be measured by volumes of pedestrians and safety issues as a result of conflict between pedestrians and automobiles (Moudon & Lee, 2004). Environmental factors that play a role in walking include street network connectivity, density and land use mix (Frank et al., 2009). Together these variables affect how close destinations are to each other and how easy it is to get to those destinations (Frank et al., 2009). Trip characteristics are defined by the purpose and length of the trip (Moudon & Lee, 2003). All of these determinants interact when an individual makes the decision to walk (Moudon & Lee, 2003) and will be explained in more detail as they relate to specific components of the BME.

When the BME is applied to walking behaviour, three components of the environment emerge as critical factors that are used by an individual when they decide
to walk: 1) origins and destinations; 2) route characteristics; and 3) area characteristics (Figure 2-1).

Figure 2-1  Behavioural Model of the Environment: Three Components of Origin and Destination, Route and Area

2.2.1  Origin and Destination

Any walking trip starts and ends at certain points: origins and destinations. The types and locations of origins and destinations play a role in an individual's decision to walk by defining a trip purpose and can be recorded as locations where people walk to

Frank et al., 2009 (p. 38); used with permission.
(Lee & Moudon, 2004). When understanding utilitarian walking within the
eighbourhood the origin is home and a destination could be a retail area, a community
centre or a place to meet others to socialize. Where there are “appropriate local
destinations there is an increased chance that people will walk” (Pikora et al., 2003 page
1696).

Condon (2010) describes new suburban developments as sometimes being
equipped with walking trails but lacking compelling destinations for regular walking.
Condon (2010) goes on to suggest that a compelling destination for an average person
might be a convenience store, where a person can purchase basic goods such as bread,
milk, eggs, and newspapers among other items. Further, if a convenience store is
located next to other services, hair stylist, bank, café, accountants, dentists, and a local
grocery store, it will be much more likely for walking to become a daily part of life for
nearby residents (Condon, 2010).

Land use mix refers to the number of different types of land uses in a given area.
Mixing land uses increases the diversity of destinations in an area as well as reducing
the distance required to travel to these destinations. In order to create an environment
that can facilitate walking within the neighbourhood an appropriate and complementary
mix of land uses is required (Krizek, 2003; Lynch, 1960). Jane Jacobs argued that fine-
grain mixing of diverse uses creates vibrant and successful neighbourhoods (Jacobs,
1961). The balance and complementary relationship of the land uses is an important
consideration for increasing walking. Jane Jacobs differentiates between primary uses
and secondary uses. Primary uses “bring people to a specific place because they are
anchorages” (Jacobs, 1961:161). Secondary uses are those that develop in response to
the primary uses (Jacobs, 1961). There is no prescription for an effective mix of land
uses to promote walkability. The balance is intricate and complex in successful urban
areas.

Proponents of mixed use argue it many benefits, including: an active urban
environment at all hours to optimise the use of infrastructure; a wider range of housing
options; increased affordability by mixed housing types; reduced dependence on cars by
placing housing closer to commercial and civic uses; increasing pedestrian and transit

---
2The evolving nature of e-commerce is argued to have implications on transportation patterns by
reducing shopping trips and commuting. The impact of e-commerce on neighbourhood land
use mix will depend on consumers’ response to technology (Rotem-Mindali & Salomon, 2007).
use and reducing vehicle use and ownership by enabling people to live closer to work, shopping, and recreation (Grant, 2002).

Land use mix can be measured by inspection, that is, by simply documenting the presence or absence of specific land use types (Krizek, 2003). Frank et al., (2009) measure land use mix by “the evenness of square footage distribution across residential, commercial, entertainment, and office development within a neighbourhood buffer” (Frank et al., 2009: 56) for use in a walkability index. A higher value in this measure indicates a more even distribution of land between the land use types.

Current research has shown that residents that report walking for more than an hour a week, living in highly walkable neighbourhoods were up to twice as likely to walk for transport as residents of less walkable neighbourhoods (Christian et al., 2011). A walkability index including ‘Residential’, ‘Retail’, ‘Office’, ‘Health, welfare and community’, and ‘Entertainment, culture and recreation’ land uses were found to be most strongly associated with walking for transportation (Christian et al., 2011). Higher levels of walking, over 150 minutes a week, were not as strongly associated with these land use types (Christian et al., 2011). Land uses such as ‘Public open space, sporting infrastructure, primary and rural’ did not show an increase in walking for transport, although did show a stronger relationship with recreational walking (Christian et al., 2011). This research shows that the specific land use diversity and those land uses that are included in the walkability index studies plays a role in the amount and type of walking that is recorded. This research also shows increasing diversity in land use does not equate to increasing the amount of walking. Land use mix can play a role in facilitating walking only to a certain level. In reviews of the literature, the concept of mixed use is well documented as being one of the components of a neighbourhood that can lead to increased walking by conveniently locating destinations (Badland & Schofield, 2005; Heath et al., 2006; Saelens et al., 2003 Giles-Corti & Donovan, 2002; Handy & Clifton, 2001).

2.2.2 Route

This second component of the behavioural model defines the characteristics of the route taken for walking trips: the route between origins and destinations. These include physical environment aspects, such as distance between an origin and a destination and the width, connectivity, design, and character of a road or pathway.
Route characteristics can have inter and intrapersonal aspects, such as the number of cars, bicycles, or people on the roadway, the quality of the route, or the safety, comfort, experience, and perceptive experience of pedestrians. Therefore, route qualities are measured objectively (route distance) as well as subjectively, as the user's perception of the route (Lee & Moudon, 2004). In other words, the quality of the route is unique to the individual experiencing the route and how they perceive it: “Is it far?; Is it safe?; Is it noisy? It is a combination of these characteristics, both objective and subjective, that affect an individual’s decision to walk and for how long they are willing to walk for.

Pikora et al. (2003) indicate three features that can influence the characteristics of a route: functional, safety, and aesthetic features. Functional features relate to the “physical attributes of the street and path that reflect the fundamental structural aspects of the local environment” (Pikora et al., 2003: 1696). These features include specific attributes of the path, the width of the street, and the connectivity of the street network.

Connectivity is the primary purpose of any transportation network; it links locations that people want to travel between (Dill, 2004). Increased network connectivity can reduce travel distance and increase route options (Dill, 2004). This allows for more direct travel between destinations, making it more conducive to walking (Frank et al., 2009; Condon, 2010). High levels of connectivity can be found in North American neighbourhoods built prior to 1950 with relatively high numbers of intersections (Figure 2-2) (Condon, 2010). This gridiron street system creates an interconnected system that makes all trips as short as possible and allows pedestrians to move through the system with limited barriers and inconveniences (Condon, 2010). As such, no homes are completely cut off from passing traffic but more linear feet of street per standard lot are required compared to conventional suburban road networks with cul de sacs (Condon, 2010). Post-World War II suburban cul de sac systems, those generally associated with CSD, with predominantly dead end streets, offer limited paths from origins to destinations (Figure 2-3) (Condon, 2010). This dendritic system has a main trunk, or freeway, with feeder suburban arterial streets or minor highways attached. The feeder arterial streets give access to collector streets that connect to residential streets that end in cul de sacs. The system is popular as they can shift traffic away from homes lucky enough to be at the end of a cul de sac, allow cars to flow easily through a well designed system, as well as using less linear feet of street per standard lot, which is appealing to developers. Discontinuous streets with loops and cul-de-sacs are thought to provide
safety by limiting through traffic, sociability and efficiency (CMHC, 2002). Yet in this system the majority of trips are made longer than they would be if the system was interconnected (Condon, 2010). Pedestrian connectivity is a measure of 1) the directness of a route and 2) the route distance for the pedestrian for each home-destination trip (Randall, 2001). “Appropriate local destinations” (Pikora et al., 2003: 1696) need to be within a five-minute walk if individuals are going to choose walking rather than driving (Condon, 2010). Condon (2010) goes on to suggest that the “five minute rule is meaningless if there is no place to walk to” (Condon, 2010: 68). This relates back to the first component of the BME: the importance of local destinations.

Street connectivity, defined as “the directness and availability of alternative routes from one point to another within a street network” (TRB, 2005: 104) has been found to be consistently associated with walking within the neighbourhood (Soltani et al., 2006; Rodriguez et al., 2006). Recent empirical research has found sufficient evidence to conclude that accessibility based on distance to destinations is associated with more walking (Handy, 2005; Humpel, 2002; Lee & Moudon, 2004; McCormack et al., 2008; McMillan, 2007; Pikora et al., 2006; Dill, 2006; Soltani et al., 2006; Rodriguez et al., 2006).
Figure 2-2  High Connectivity Street Pattern

Frank et al., 2009 (p. 34); used with permission.
Safety features reflect the need for, real or perceived, safe environments in order for people to walk along a route. Streets that are wider are more dangerous to pedestrians than narrower ones (Swift, 1998). Prior to 1940 the majority of residential streets in Canada were less than twenty-eight feet wide (8.5 meters), as measured from curb to curb and allowed car parking on both sides of the street creating a buffer between cars and pedestrians (Southworth & Ben-Joseph, 2003). These traditional streets have a high level of side friction\(^3\) as a result of the narrow space for travel: two cars approaching each other must slow dramatically to pass each other (Figure 2-4) (Condon, 2010).

\(^3\) The term side friction was first used in 1936 in a paper for the Highway Research Board (Barnett, Haile, and Moyer, 1936). Originally the term was used in the highway context but over time the concept was also applied to residential street (Condon, 2010)
In comparison, and as a result of a perception that this condition was unsafe, street standards in the 1950s increased road width by six feet, to thirty-four feet (10.4 meters) (Condon, 2010). This width allowed for the free flow of traffic, without the need to slow down. (Figure 2-5). Residential streets widths are widening and it is not uncommon for suburban residential streets to be forty feet wide (Condon, 2010).
Criteria have been formulated for safety from traffic and street crime including crossing times, placement and length of cross walks, traffic speeds, pedestrian and traffic control signing and signals, sidewalk width, sidewalk condition, path surveillance, and night lighting (Southworth, 2005). Traffic calming techniques to make streets more inviting for pedestrians by slowing traffic down, include chokers, speed humps, narrowed streets, rough paving, traffic diverters, roundabouts, and landscaping (Figure 2-6 and Figure 2-7). Attributes related to safety were found by four reviews to be correlates of walking (Cunningham & Michael, 2004; Humpel, 2002; Lee & Vernez-Moudon, 2004; Owen et al., 2004).

Figure 2-6  Curb bulge and choker to narrow street for pedestrians and slow traffic
Aesthetic urban design qualities are acknowledged by transportation planners and urban designers to be important factors for affecting pedestrian behaviour (Southworth, 2005; Ewing et al., 2006). Southworth (2005) writes:

“[a] safe, continuous path network in a monotonous physical setting will not invite pedestrians. The path network must engage the interest of the user. Many aspects of the path context can contribute to a positive walking experience: visual interest of the built environment, design of the street as a whole, transparency of fronting structures, visible activity, street trees and other landscape elements, lighting and views” (page 251).

Susan Handy states that, “the pedestrian sees, hears, smells, and feels much of the surrounding environment, [therefore] urban form is likely to play a greater role in the choice to walk” (Handy, 1996b: 135).

Successful approaches to the design of walkable streets vary by culture, place and city size from small 17th century lanes, broad tree canopied boulevards, to treeless, arcaded streets in Italy where the architecture, streetscape and street life provide interest and engage the pedestrian (Southworth, 2005). Nevertheless, a few attributes are likely to contribute to the quality of a path in most urban and suburban settings: scale of street space, presence of street trees and other landscape elements, views, visible activity and transparency, scale and coherence of built form (Southworth, 2005). These
are the elements that engage the pedestrian’s interest along the route (Southworth, 2005).

The urban design literature outlines aspects of design that might work to encourage or discourage walking, features relating to a house or building design and those that relate to the street. Urban design that creates a link between the private space of buildings and the public space of the street encourage more street activity and make for a more interesting environment (Handy, 2005).

A study that examined urban walkability by comparing neighbourhoods that varied in quality of the path network found that the neighbourhood characterized by tree lined, small scaled streets with small shops, cafes and services, among other features, had the most walkers (Lamont, 2001). The neighbourhood with the least amount of walkers had wide streets, fast traffic, large buildings with little transparency, minimal landscaping and street furniture, and few pedestrian crossings (Lamont, 2001). Several reviews of the literature found sufficient evidence to conclude that aesthetic qualities are associated with walking (Cunningham & Michael, 2004; Handy, 2005; Heath et al., 2006; Lee & Vernez Moudon, 2004; Humpel, 2002; McCormack et al., 2004; McMillan, 2007).

It is recognized that measures of aesthetics are especially variable across the studies included (Saelens & Handy, 2008). This may be a reflection of the challenge associated with quantifying abstract and subjective qualities of the built environment (Handy, 2005). Route characteristics require two different methods: self-reporting for perceptive measures and environmental audits for objective measures (Hoehner et al., 2005).

2.2.3 Area

The third component of the behavioural model refers to the characteristics of the area or neighbourhood in which the pedestrian trip takes place. These include physical aspects of the environment such as density and land use mix. The overall pattern of the street network affects the actual or potential volumes of pedestrians and route choices. Inter and intrapersonal aspects of the area component include perceptions of the neighbourhood quality such as safety, friendliness, and enjoyable scenery (Lee & Moudon, 2004).
Area characteristics are strongly associated with density and intensity of development (Frank et al., 2009). Density is a measure of urban form that conveys objective information about how compact the built form is in a particular area. Higher densities can increase the number of potential destinations within an area, lessening distance between origins and destinations and reducing travel distances that can increase the likelihood of walking (Frank et al., 2009; Condon, 2010). With density, more people can generate the demand for more services, leading to more destinations to walk to. But density alone cannot create an enticing environment for walking. The relationship between the concentration of people and an increasingly interesting and walkable environment is not linear (Jacobs, 1961). High density combined with overcrowding, or too many people in a dwelling for the number of rooms available, can create unfavourable conditions for urban life (Jacobs, 1961). Jane Jacobs describes ideal city dwelling densities “as a matter of performance” (Jacobs, 1961: 208). Ideal densities are dependant upon place and can vary within a neighbourhood. The purpose of density is to aid, encourage, and promote diversity for housing, jobs and services and to reduce travel distances between them. Density can be measured in terms of population, residential, employment, or building square footage over a unit of area. Three reviews of empirical studies point to density as an important correlate of walking (Badland & Schofield, 2005; Handy, 2005; Saelens et al., 2003; Saelens et al., 2008).

The three components of the BME, origins and destinations, routes, and areas, are not mutually exclusive of each other: many variables address more than one component of the BME (Figure 2-8) (Lee & Moudon, 2004). For example, measures of accessibility to destinations have a place in both the origins and destinations as well as the routes components. The components of the BME are also interdependent. Lee and Moudon (2004) state that all three components of the behavioural model of the environment must be considered to comprehensively measure the effect of the built environment on walking. For example, sidewalks can support utilitarian walking only if they link a trip origin to a destination. Further, the sidewalk can support a substantial number of pedestrians only if they link origins and destinations that have a substantial number of people around them. In other words, it is the synergy of these elements that create the potential for walking within the neighbourhood. The BME outlines the three areas of the built environment that need to be analyzed in order to understand how a neighbourhood can create the potential for walking.
2.3 Correlation not Causality: The Issue of Residential Self-selection

Empirical studies, as described above, have shown that there is a correlation between the built environment and walking behaviour: residents of walkable neighbourhoods walk more than residents of nonwalkable neighbourhoods (Sallis et al., 2004; Saelens & Handy, 2008; Frank et al., 2009). Yet the results are not conclusive. Correlation between the built environment and walking behaviour does not mean that a change in the built environment will lead to a change in walking behaviour. While most of these studies confirm only the association between the built environment and travel...
behaviour, they have not yet established the predominant underlying causal link (Cao et al., 2009b). Specifically, researchers are examining the role of residential self-selection. Residential self-selection has been defined as “the tendency of people to choose locations based on their travel abilities, needs and preferences” (Litman, 2005: 6).

Researchers are asking: does the built environment influence travel behaviour or do preferences for land use patterns and travel options affect residential choice? (Cao et al., 2009b). In other words, those preferring walking may choose to live in walkable neighbourhoods and thus walk more than those that prefer driving and therefore choose more automobile oriented neighbourhoods. The intrapersonal component of the BME refers to individuals “internal response to being in a physical environment, such as perceived comfort, attractiveness, safety” (Moudon & Lee, 2003: 22). Preferences for a particular style of built form and transportation mode will play a role in how an individual will respond to being in and behave in a particular physical environment.

The theory of residential self-selection suggests that residents have predispositions towards particular modes of travel and styles of the built environment. Research has shown that residents who prefer walking may consciously chose to live in a neighbourhood that possesses the built environment features that are conducive to walking (Handy & Clifton, 2001). This theory suggests that the observed differences in walking behaviour that are found in research may be more strongly related to residential choice than travel choice.

If residential self-selection does play a role in pedestrian behaviour there would be limits to the ability to use the built environment to change travel behaviour. If there is a greater share of individuals that prefer low density and automobile oriented neighbourhoods, efforts to build neotraditional neighbourhoods with goals to increase walking could be ineffective. Planning has an important role to play in creating neighbourhoods that can facilitate walking, but it is important to realize the limits of policy to develop neo-traditional neighbourhoods for the purpose of increasing walking. Despite this, some studies have shown that there is an insufficient supply of walkable neighbourhoods (Boarnet & Crane, 2001; Levine & Inam, 2004). Levine and Inam (2004) argue that the predominance of CSD style developments in North America is not an indication of market demand. The authors suggest that it is more accurately a reflection of current planning standards and would be remedied by policy reform at the municipal planning level (Levine & Inam, 2004). A national survey in the United States
found that, among developers, there is a perception of “considerable market interest in alternative development forms” (Levine & Inam, 2004: 409).

If residential self-selection plays a dominant role in transportation decision-making, other areas of public policy will be required to facilitate and encourage more active forms of transportation. Education and health promotion policy that can teach the benefits and values of walking will be important. Enforcement and safety education policies to promote pedestrian safety may also be able to encourage more individuals to take up walking. Policy that encourages a multi-disciplinary approach among policy makers, academics, and practitioners in transportation, planning and health can break down barriers that exist between these fields (Southworth, 2005). Academic policies that encourage multi-disciplinary approaches, where partnerships can be fostered, can assist in developing broadly educated planning professionals.

Studies that have investigated the role of self-selection on travel demand have shown varied results. Kitamura et al. (1997) and Bagley & Mokhtarian (2002) found that the variation in travel demand is explained more by attitudinal factors and lifestyle variables than residential location characteristics. Cao et al. (2006) examined the influence of the built environment on pedestrian behaviour, controlling for residential preferences and confirmed the influence of self selection, although it did not account for all the variation in pedestrian behaviour: the built environment does influence individual’s travel choices. Frank et al. found that study participants preferring and selecting neighbourhoods with greater walkability walked more, for both recreational and utilitarian walking, and even more so when located in neighbourhoods where the built environment variables are those that are more conducive to walking.

More recent research from Cao et al. (2009b) shows that mixed use, walking infrastructure, and aesthetic quality are associated with individual’s travel decisions, especially non-motorized travel frequency. These associations were found to be present even after accounting for the influences of residential preferences and travel attitudes. Although the study does not confirm causality between the built environment and travel behaviour, it strongly suggests that the built environment itself influences individual’s travel behaviour.

Schwanen & Mokhtarian (2003) compared trip frequency, commute mode choice (2005a), and mode-specific distances travelled (2005b) among mismatched suburban and urban residents (those whose preferences for a more or less dense/diverse
neighbourhood did not match the one they currently lived in) to matched residents (those whose preferences matched the neighbourhood they currently lived in). The study found that while suburban residents’ travel behaviour was similar whether they were matched or mismatched, mismatched urban residents’ behaviour fell between that of matched urban and matched suburban residents. That is, they were more auto-oriented than the former but less so than the latter.

These findings suggest that suburban environments inhibit urban-style travel behaviour to a greater extent than urban environments inhibit suburban-style travel behaviour. The lack of choice that the conventional suburban built environment imposes on residents’ plays out significantly in transportation mode choice. The suburban environment is not designed for the pedestrian; it is designed for the automobile. Road and transportation engineering professions play a dominate role in residential development; both in the past and in current conventional planning (Southworth & Ben-Joseph, 2003). When the transportation planning profession can shift the focus from the needs of the automobile to a more equitable balance with the needs of the pedestrian, advances in encouraging walkability will be achieved.

Researchers recognize the importance of residential self selection yet conclude that the “results suggest that if cities use land use policies to offer options to drive less and use transit and non-motorized modes more, many residents will tend to do so” (Cao et al., 2009: 548). Walkable neighbourhoods can be built specifically for those residents that prefer and choose to walk. These neighbourhoods can also be built to assist in developing a culture of walking that may encourage non-walkers to change their behaviours (Tolley, 2009; Canada Walks, 2009).
3: The Case Study Neighbourhoods

Using data from the 2006 Canadian Census, The City of Chilliwack, and The Metro Vancouver Walkability Index (VWI), the two case study neighbourhoods Garrison Crossing (NTD) and Promontory Heights (CSD) can be seen to vary in specific dimensions related to neighbourhood type and urban form: density, layout of the street network, and design of commercial centres (Table 3-1 on page 32, Table 3-2 on page 32 and Table 3-3 on page 34). The corresponding case study neighbourhoods have a similar location within the urban context (Figure 3-1) and comparable demographic characteristics (Table 3-1).
### Table 3-1 Summary of 2006 Canada Census data for case study neighbourhoods

<table>
<thead>
<tr>
<th></th>
<th>NTD</th>
<th>CSD</th>
<th>Chilliwack</th>
<th>BC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population density per square kilometre</td>
<td>1618.3</td>
<td>118.6</td>
<td>66.8</td>
<td>4.4</td>
</tr>
<tr>
<td>Land area (square kilometer)</td>
<td>5.13</td>
<td>58.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median age of the population</td>
<td>35.5</td>
<td>35</td>
<td>40</td>
<td>40.8</td>
</tr>
<tr>
<td>Percent of the population aged 15 years and older</td>
<td>75.8%</td>
<td>73.6%</td>
<td>80</td>
<td>83.5</td>
</tr>
<tr>
<td>Percent of households with children</td>
<td>35.46%</td>
<td>44.30%</td>
<td>27.61%</td>
<td>26.32%</td>
</tr>
<tr>
<td>Median income in 2005 – All census families ($)</td>
<td>$63,017</td>
<td>$73,185</td>
<td>$58,068</td>
<td>$62,346</td>
</tr>
<tr>
<td>Percent of the population with a University certificate, degree, or diploma</td>
<td>13.67%</td>
<td>8.76%</td>
<td>8.83%</td>
<td>19.27%</td>
</tr>
<tr>
<td>Percent of the population visible minority</td>
<td>5.19%</td>
<td>5.72%</td>
<td>4.17%</td>
<td>24.76%</td>
</tr>
<tr>
<td>Percent low income after tax</td>
<td>6.9%</td>
<td>6.6%</td>
<td>9.0%</td>
<td>13.1%</td>
</tr>
</tbody>
</table>

### Table 3-2 Comparison of built environment elements in case study neighbourhoods

<table>
<thead>
<tr>
<th></th>
<th>NTD</th>
<th>CSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total dwelling units (2009)</td>
<td>1,111</td>
<td>2,274</td>
</tr>
<tr>
<td>Commercial space (square metres)</td>
<td>7,542</td>
<td>885</td>
</tr>
<tr>
<td>Office space (square metres)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Land area</td>
<td>61.5 ha</td>
<td>306.6 ha</td>
</tr>
<tr>
<td>Build out</td>
<td>Approximately 80%</td>
<td>Nearly complete</td>
</tr>
</tbody>
</table>
3.1 Land Use Mix

Both neighbourhoods are mostly single family residential with some multifamily residential (Table 3-4). The NTD has a greater mix of housing choices with 44.1% single family and 65.9% multi-family. The NTD also has secondary suites and carriage houses associated with the majority of houses, increasing housing diversity further (GCNP, 2003). The CSD has more land dedicated to single-family residential development with 78.7% designated single family and 22.3% multifamily (Table 3-4).

According to the Metro Vancouver Walkability Index (VWI), the NTD has a slightly more even mix of land uses compared to the CSD (Table 3-3), 0.176 and 0.048, respectively. This value, placed within a range from 0 to 1, represents the evenness of square footage distribution across residential, commercial, entertainment, and office development within a neighbourhood (Frank et al., 2010). A higher value indicates a more even distribution of land between the land use types.
Field observations of the type of commercial services available in the neighbourhoods show that the two neighbourhoods have similar offerings. Coffee shops, casual dining and fast food outlets are available in both neighbourhoods. Both neighbourhoods have grocery stores located in the commercial area, albeit the store in the NTD is a full service grocery store and the store in the CSD is considerably smaller. Both neighbourhoods offered a range of personal services. Table 3-4 outlines the type of commercial outlets available in each neighbourhood for each land use type included in the VWI. Also included in the table are other land use types that are not included in the VWI but argued to play a role in walkability (Saelens et al., 2003a; Southworth, 2005). Figure 3-2 shows the locations of local destinations in each neighbourhoods.
<table>
<thead>
<tr>
<th>Land use types</th>
<th>NTD</th>
<th>CSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Family Residential</td>
<td>44.1%(^a)</td>
<td>74.1%(^b)</td>
</tr>
<tr>
<td>Multifamily residential</td>
<td>65.9%(^a)</td>
<td>25.9%(^b)</td>
</tr>
<tr>
<td>Entertainment (including entertainment, restaurants, and fast food outlets)</td>
<td>Sandwich shop</td>
<td>Coffee shop</td>
</tr>
<tr>
<td></td>
<td>Coffee shop</td>
<td>Sushi</td>
</tr>
<tr>
<td></td>
<td>Sushi</td>
<td>Pizza</td>
</tr>
<tr>
<td></td>
<td>Bistro</td>
<td>Movie rental</td>
</tr>
<tr>
<td>Retail (including small and large neighbourhood retail; large retail; grocery and convenience stores; and excluding super large retail)</td>
<td>Grocery store</td>
<td>Grocery store</td>
</tr>
<tr>
<td></td>
<td>Liquor store</td>
<td>Dollar store</td>
</tr>
<tr>
<td></td>
<td>Running equipment shop</td>
<td>Hair salon</td>
</tr>
<tr>
<td></td>
<td>Tanning salon</td>
<td>Tanning salon</td>
</tr>
<tr>
<td></td>
<td>Hair salon</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dollar store</td>
<td></td>
</tr>
<tr>
<td>Office and office building</td>
<td>Dentist</td>
<td>Interior design</td>
</tr>
<tr>
<td>Not included in VWI</td>
<td>Recreation Centre</td>
<td>Day Care</td>
</tr>
</tbody>
</table>

\(^a\) Data source: J. Seymour (personal communication, January 13, 2012).

\(^b\) Data source: City of Chilliwack (2009)
3.2 Street Pattern and Connectivity

The overall street pattern within the NTD is one of curvilinear streets with loops and a singular cul de sac (Figure 3-3). The neighbourhood also has areas that could be classified as warped parallel, which is more closely related to the gridiron pattern (CMHC, 2002). NTD neighbourhoods are adopting street patterns related to the grid pattern to create clearer and more direct pedestrian routes (CMHC, 2002).
The main boulevard in the NTD is seven meters wide and all others are six meters wide (Figure 3-4 and Figure 3-5) (Sanderson, 2011). Both these road widths offer one continuous travel lane in each direction. Periodic parking pockets are available (Figure 3-5).
The overall street pattern within the CSD contains curvilinear streets with loops and numerous cul de sacs (Figure 3-6). The CSD also has areas classified as ‘loops and lollipops’ and ‘loops on a stick’ (CMHC, 2002).
The CSD also contains several gated townhouse complexes with private roads and no trespassing signs. Roads in the CSD are 8.5 meters and 11 meters wide. The 8.5 meter wide roads offer one continuous travel lane in each direction and one continuous parking lane against the curb on one side (Sanderson, 2011). The 11 metre wide roads offer one continuous travel lane in each direction and two continuous parking lanes, one against each curb (Sanderson, 2011) (Figure 3-7).
Street connectivity is measured as the percentage of four way intersections to total intersections (Boarnet & Sarimento 1998; Cervero & Kockelman 1997; Berrigan et al., 2010). The NTD has 45% four way intersections and the CSD has 20% (Table 3-5).

### Table 3-5 Percentage of four way intersections

<table>
<thead>
<tr>
<th></th>
<th>NTD</th>
<th>CSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four way intersections/Total Intersections</td>
<td>9/20</td>
<td>14/71</td>
</tr>
<tr>
<td>Percentage of four way intersections</td>
<td>45%</td>
<td>20%</td>
</tr>
</tbody>
</table>

### 3.3 Dwelling Units within walking distance

Virtually all residences in the NTD are within a reasonable walking distance of 800 metres of the local commercial centre (Figure 3-8). In the CSD, about two-thirds of the residences are within 800 metres of the local commercial centre, and the remaining residences are outside of this “reasonable walking distance” threshold (Figure 3-9).
Figure 3-8  NTD: Dwelling within walking distance

The City of Chilliwack; used with permission
3.4 Urban Design Qualities

As a complement to the urban form measures, more subtle urban design characteristics are examined to further understand the role of the built environment on walking. These urban design characteristics are examined at the highest level of resolution, at the street segment or block face. These characteristics have been assessed in this field of study through observational and often subjective measures (Ewing et al., 2006; Rundle et al., 2007; Purciel et al., 2009). Practitioners and scholars in urban design have described the qualities that make the built environment “comfortable, memorable, interesting, or appealing, and may thereby encourage walking” (Purciel et al., 2009: 457). These qualities are imageability, enclosure, human scale, transparency, and complexity (Ewing et al., 2006).

These urban design qualities were assessed using a measurement tool developed by researchers through the Active Living Research Project (Ewing et al., 2006). The tool is designed to be used by researchers to study the relationships between urban design qualities and walkability. The operational definitions link objectively measured physical features of the environment to ratings of urban design...
qualities (Ewing et al., 2006). Operational definitions and measurement protocols have been developed for these five perceptual qualities of urban design related to walkability: imageability, visual enclosure, human scale, transparency, and complexity. See Appendix 1 for definitions and examples of these urban design qualities. The operational definitions of the urban design qualities intend to “capture the essence of each quality and can be measured with a degree of reliability across raters” (Ewing et al., 2006: S225).

Two sections surrounding the commercial area of each neighbourhood were tested using the Urban Design Qualities Tool. Figure 3-10 shows the average score for each urban design quality as well as the total Urban Design Quality (UDQ) score for each neighbourhood.

**Figure 3-10 Urban Design Qualities (UDQ) Score**

<table>
<thead>
<tr>
<th>Quality</th>
<th>NTD</th>
<th>CSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imageability</td>
<td>8.59</td>
<td>6.42</td>
</tr>
<tr>
<td>Enclosure</td>
<td>1.89</td>
<td>1.34</td>
</tr>
<tr>
<td>Human Scale</td>
<td>3.04</td>
<td>2.31</td>
</tr>
<tr>
<td>Transparency</td>
<td>3.73</td>
<td>1.71</td>
</tr>
<tr>
<td>Complexity</td>
<td>5.39</td>
<td>4.95</td>
</tr>
<tr>
<td>UDQ Score</td>
<td>22.63</td>
<td>16.42</td>
</tr>
</tbody>
</table>

Imageability is the “quality of a place that makes it distinct, recognizable and memorable” (Ewing et al., 2006: S226). Imageable places may have “distinctive buildings or landscape features as well as a coherent or "legible" organization” (Purciel et al., 2009: 457). The imageability score for the NTD is 8.59 and for the CSD, 6.42 (Figure 3-10). The condominium and commercial area of the NTD was designed and built with small courtyards (Figure 3-11), areas for outdoor dining, and with clear signage on the buildings to identify them (Figure 3-12 and Figure 3-13).
Figure 3-11 Example of a small courtyard in NTD

© J. Kinney.

Figure 3-12 Outdoor eating area in NTD

© J. Kinney.

The proximity to the cenotaph and views of the mountains assists in making the area unique, distinct and memorable. The architecture of the buildings includes pitched rooflines, balconies, and awnings (Figure 3-13, Figure 3-14 and Figure 3-15). These features add interest to buildings, increasing the imageability score whereas simple rectangular shaped buildings do not (Ewing et al., 2006). There were numerous people
observed, walking through the area and sitting in the outdoor dining areas or on benches increasing the imageability score (Figure 3-11 and Figure 3-12).

**Figure 3-13 Pitched rooflines, balconies and awning in NTD**

![Image of pitched rooflines, balconies and awning in NTD](image)

© J. Kinney.

**Figure 3-14 Imageability: Pitched rooflines in NTD**

![Image of imageability: Pitched rooflines in NTD](image)

© J. Kinney.
The design of the commercial area in the CSD was in the style of a strip with a narrow sidewalk between the parking area and the shops (Figure 3-16). There was a small courtyard and the café had a table and chairs outside. The architectural style had some interesting detail but also included rectangular buildings that lower the imageability score (Figure 3-16). Few people were observed in and around the commercial area. The mountains surrounding the neighbourhood assisted in making the place distinct and memorable (Figure 3-17).
Enclosure is the “extent to which an exterior space is visually bounded by buildings, fences, trees, and other vertical elements, so that it has a room like quality (Purciel et al., 2009: 457). A street wall, or a continuous row of buildings with minimal setback (distance between the sidewalk and the building line) contributes to a feeling of enclosure (Purciel et al., 2009). The sense of enclosure was limited for both
neighbourhoods, with scores of 1.89 and 1.34 for the NTD and the CSD, respectively (Figure 3-10 on page 43). There were long sightlines in multiple directions. The commercial high street in the NTD was unique as it had a continuous street wall that gave the area a room like quality (Figure 3-18).

Figure 3-18 Commercial high street in NTD

Human scale “concerns whether the size and texture of physical elements matches the size and proportion of humans” (Purciel et al., 2009: 457). It has been conceptualized as a matter of building height and street width (Alexander et al., 1977). Windows, building exteriors, and street furniture may have a role in the perception of scale (Purciel et al., 2009). The human scale scores were 3.04 for the NTD and 2.31 for the CSD (Figure 3-10 on page 43). Numerous and well placed planters and street furniture as well as windows at street level in the NTD contributed to its higher score.
(Figure 3-19) while these components were limited in the CSD commercial area (Figure 3-16).

Figure 3-19 Street furniture and planters in NTD

![Street furniture and planters in NTD](image)

© J. Kinney.

Transparency reflects the abilities of passersby to perceive human activity beyond the sidewalk or building line (Curran, 1983; Jacobs, 1961). Windows and open fences create a sense of transparency, while a solid wall does the opposite (Purciel et al., 2009). Transparency scores for the NTD and the CSD were 3.73 and 1.71, respectively (Figure 3-10 on page 43). The NTD’s higher score was aided by the proportion of windows at street level (Figure 3-15 on page 46 and Figure 3-19 on page 49) and by the presence of active uses, such as shops and restaurants (Figure 3-12 on page 44 and Figure 3-13 on page 45). In the CSD, the parking lot fronting the commercial area limited the transparency score (Figure 3-16 on page 47).

Complexity refers to “visual richness: a complex place stimulates the senses with a variety of colours, architectural styles, buildings, and activities” (Purciel et al., 2009: 457). Complexity scores are 5.39 for the NTD and 4.95 for the CSD (Figure 3-10 on page 43). The number of buildings, building colours, outdoor dining, public art and number of pedestrians all contributed to the higher score for the NTD (Figure 3-13 on page 45, Figure 3-14 on page 45, and Figure 3-15 on page 46). The overall Urban Design Qualities scores for the case study neighbourhoods are 22.63 for the NTD and 16.42 for the CSD (Figure 3-10 on page 43).
3.5 Density

Density, which plays a major role in urban form, is considerably higher in the NTD (1618.3 people per square kilometre) than in the CSD (118.6 people/square km) (Figure 3-20). Residential density, or the number of residential units per acre designated for residential use, is also higher in the NTD (6.99 compared to 4.58) (Figure 3-21)\textsuperscript{4}.

Figure 3-20 Gross population density

\textsuperscript{4} Residential density data comes from the Vancouver Walkability Index. The 2006 Canadian Census offers the most current density measures for the case study neighbourhoods. More current data (2009) from the City of Chilliwack can not be limited to the study areas in question.
In summary, the NTD is more compact and has more housing diversity than the CSD. The two neighbourhoods hold similar non-residential land uses and offer similar commercial services. The NTD has a more connected street pattern with less cul de sacs and more four way intersections. Almost all residents of the NTD are within a reasonable walking distance to the commercial area of the neighbourhood while about two thirds of the residents of the CSD are within a reasonable walking distance. The CSD is a larger neighbourhood, and this reflects the smaller proportion of residents that live within the reasonable walking distance. The population is considerably higher in the NTD (2006 Canada Census, 6908 in CSD and 8294 in NTD) and therefore allows for a greater number of people to be within reasonable walking distance.
4: Findings

4.1 Pedestrian Count

The pedestrian count took place over the course of two days in mid-May, 2011. Two locations within each neighbourhood were selected, one in the commercial area and one at a major intersection within the residential area of the neighbourhoods (Figure 4-1).

Figure 4-1 Pedestrian Count Locations

© 2011 Google.
4.1.1 Observations in the CSD

The pedestrian count in the CSD took place on Wednesday May 11, 2011. The weather conditions were overcast with light rain at times\textsuperscript{5}. Pedestrian count location A, at Tesky Road east of Promontory Road, counted pedestrians entering and exiting or passing by the commercial area (Figure 4-3).

\textsuperscript{5} The weather conditions at the time of the count may have affected the results. Fewer pedestrians may have been observed in the CSD due to poor weather.
Pedestrians ranged from an estimated 2 per hour (11:00 and 14:00) to 20 per hour (15:00) (Figure 4-2). During the course of the count 30 of the 79 observed pedestrians were walking with a dog. Between 9:00 and 12:00, two pedestrians exited the commercial area carrying shopping bags. One woman walked past the area wearing business clothes and carrying a briefcase. A woman with two young children walked into the commercial area and went into the day care facility. A few youths walked by heading towards a bus stop further down Tesky Road. In the afternoon hours of the count, dog walkers were observed as well as youths walking past the commercial area and entering the local grocery store.

Pedestrian Count location B in the CSD was located at the intersection of Lutz Road and Sylvain Road, on the east side (Figure 4-4).
Pedestrians ranged from an estimated zero per hour (9:00) to 54 per hour (14:00). Dog walkers accounted for 32 of the 152 total pedestrians counted during the course of the day. Some pedestrians were wearing casual exercise style clothing. Children walking to school were also observed. In the afternoon, the majority of pedestrians counted were children, again, likely walking home from school. The intensification of pedestrians at 14:00 were school children and youths getting off the school bus and public transit.

4.1.2 Observations in the NTD

The pedestrian count in the NTD took place on Thursday May 12, 2011. The weather conditions were partly cloudy. Pedestrian count location A was at the end of Market Way, at the west pedestrian and vehicle entrance to Garrison Village, the commercial area of the NTD (Figure 4-5 and Figure 4-6).

Pedestrians ranged from an estimated 12 per hour (14:00) to 36 per hour (15:00 and 16:00) (Figure 4-2 on page 53). Seventy-four of the 228 pedestrians counted over the course of the day were walking dogs. One man in business clothes, carrying a briefcase and an umbrella was observed leaving an apartment building in the commercial area at 8:00. Pedestrians were observed carrying grocery bags. Women pushing babies and children in strollers were also observed.
Figure 4-5  NTD pedestrian count location A: Southwest end of Market Way

![Image of Market Way location A](image1)

Canada Lands Company; used with permission

Figure 4-6  NTD pedestrian count location A: Northwest end of Market Way

![Image of Market Way location B](image2)

Canada Lands Company; used with permission.

Pedestrian count location B in the NTD was at the intersection of Tamihi Way and Garrison Boulevard on the northwest corner (Figure 4-7).
Pedestrians ranged from an estimated 22 per hour (10:00) to 70 per hour (16:00) (Figure 4-2 on page 53). Of the 332 pedestrians counted over the course of the day, 57 were walking dogs. The observations of pedestrians were similar to the other pedestrian count locations: people walking dogs, families with small children, and children and youths presumably going to school in the morning and coming home in the afternoon.

The pedestrian count shows that pedestrian frequency in the NTD was greater than in the CSD for all but a one-hour time segment during the course of the pedestrian count (Figure 4-2 on page 53). This exception was observed at CSD pedestrian count location B, in the residential area for the hour between 14:00 and 15:00, when there were 54 pedestrians counted, mostly children and youths getting off public transit and school buses. The composition of pedestrians were similar in both neighbourhoods: people walking dogs, families with small children, and children and youth travelling to school and home.

A steady flow of pedestrians was observed in NTD location A over the course of the morning, dipping in the early afternoon hours before peaking in the later afternoon. Pedestrian traffic was highest at NTD location B (Figure 4-8). Early morning and late afternoon saw the highest numbers of pedestrians, although pedestrian traffic did remain steady throughout the day. This location, being a major intersection within the
residential part of the neighbourhood, gives a good indication that some residents choose to walk within their neighbourhood and to amenities nearby.

The fewest number of pedestrians were observed at CSD location A (Figure 4-8). The number of pedestrians peaked at this location in the late afternoon. Steady automobile traffic observed around this neighbourhood commercial area indicates that it is a destination for residents: they just are not walking there. CSD location B is an important location for school aged children as they walk between home and school either on foot or using transit for a portion of the journey. Pedestrians were observed to be most frequent early in the morning and late in the afternoon.

Figure 4-8  Total number of estimated pedestrians

4.2 Survey

A survey was conducted among residents of the two study neighbourhoods in order to assess neighbourhood perceptions, residential preferences, attitudes about travel, as well as self-reported walking frequency. The survey was carried out on-line.

On May 10, 2011 one thousand survey invitations were delivered to the case study neighbourhoods, five hundred to each. Due to time constraints, survey invitations were delivered to every house within several small areas of the neighbourhoods. This
allowed for efficient door to door delivery but also strived to achieve a wide representation within the neighbourhood. By June 15, 2011 sixty-five residents had completed the survey (forty-two from the NTD neighbourhood and twenty-three from the CSD neighbourhood), equivalent to a 6.5% return rate. The response rate for a survey administered to the general population is typically 10 to 40% (Sommer & Sommer, 1997). In mid-July a second attempt to recruit participants was made. Two hundred and fifty reminder cards, one hundred and twenty five to each neighbourhood, were delivered. Direct contact with residents was made through door knocking and a brief explanation of the research project and survey. A cumulative response rate of 13.6% was achieved, with a total of one hundred and thirty-six completed surveys, seventy from the NTD (14% response rate) and sixty-six from the CSD (13.2% response rate) (Table 4-1).

4.2.1 Survey Respondents

A comparison of sample characteristics to population characteristics (based on the 2006 Canadian Census) shows that the survey respondents tend to be older on average than residents of their neighbourhood as a whole (Table 4-1). Households with children have similar representation in the NTD sample compared to the population of the NTD neighbourhood (33% and 35% respectively) and are slightly overrepresented in the sample from the CSD compared to the population of CSD neighbourhood (52% and 44%). The population median income falls within the mean income range gathered from the survey. Despite a low response rate, the sample characteristics are a fair representation of the population for both case neighbourhoods.
Table 4-1  Sample versus Population Characteristics

<table>
<thead>
<tr>
<th>Sample characteristics</th>
<th>NTD</th>
<th>CSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of respondents</td>
<td>70</td>
<td>66</td>
</tr>
<tr>
<td>Response rate</td>
<td>14%</td>
<td>13.2%</td>
</tr>
<tr>
<td>Percent female</td>
<td>54%</td>
<td>45%</td>
</tr>
<tr>
<td>Median age</td>
<td>49 years</td>
<td>45.5 years</td>
</tr>
<tr>
<td>Average household size</td>
<td>2.7</td>
<td>3.1</td>
</tr>
<tr>
<td>Percent of households with children</td>
<td>33%</td>
<td>52%</td>
</tr>
<tr>
<td>Mean income range</td>
<td>$60,000 to $80,000</td>
<td>$60,000 to $80,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Population characteristics</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (2006)</td>
<td>8294</td>
<td>6908</td>
</tr>
<tr>
<td>Median age</td>
<td>35.5 years</td>
<td>35 years</td>
</tr>
<tr>
<td>Average household size</td>
<td>2.7</td>
<td>3.0</td>
</tr>
<tr>
<td>Percent of households with children</td>
<td>35%</td>
<td>44%</td>
</tr>
<tr>
<td>Median income</td>
<td>$63,017</td>
<td>$73,185</td>
</tr>
</tbody>
</table>

### 4.2.2 Survey Outcomes

The data collected from the survey was used to explore behavioural and attitudinal differences among residents of the case study neighbourhoods as well as self reported walking frequency. The survey is based on an existing survey (Handy et al., 2004; Cao et al., 2009b). The survey was created to examine the differences between travel behaviour in traditional neighbourhoods and conventional suburban neighbourhoods as well as to control for residential self-selection. Surveys have been used to examine the relationship between neighbourhood level built environment and non-motorized travel behaviour (Handy & Clifton, 2001; Kitamura et al., 1997; Handy et al., 2005; Handy et al., 2006; Cao et al., 2005; Cao et al., 2006).

#### 4.2.2.1 Walking Frequency

The frequency of home-based walking trips to specific non-work destinations in a typical month with good weather were self reported by respondents to the survey. The destinations are: church and civic buildings, service provider, restaurant and coffee,
store, a place to exercise, and out of the house without a particular destination. The frequency was reported on a six-point ordinal scale from “Never” to “Two or more times per week”. An indicator of overall trip frequency was calculated by summing the individual frequency measure (0 to 5) across the six types of destinations (Cao et al., 2009b). Therefore, the overall frequency indicator ranges from 0 to 30. Figure 4-9 presents the means of this indicator by neighbourhood along with the 95% confidence intervals. The mean walking trip frequency is higher in the NTD neighbourhood (13.01) than in the CSD neighbourhood (7.71). A significance test with a t-value of 1.97 indicates that the means are significantly different at the 0.05 level ($p \leq 0.05$).

**Figure 4-9  Mean home based walking trip frequency by neighbourhood**

![Bar chart showing mean walking trip frequency by neighbourhood](image)

<table>
<thead>
<tr>
<th>Neighbourhood</th>
<th>Walking frequency</th>
<th>Standard deviation</th>
<th>Lower 95% confidence interval</th>
<th>Upper 95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>NTD</td>
<td>13.01</td>
<td>5.66</td>
<td>11.73</td>
<td>14.29</td>
</tr>
<tr>
<td>CSD</td>
<td>7.71</td>
<td>5.16</td>
<td>6.39</td>
<td>9.03</td>
</tr>
</tbody>
</table>

Eighty-three percent of respondents from the NTD neighbourhood reported walking within their neighbourhood at least once a week compared to 64% of those from the CSD (Figure 4-10). Fifty-two percent of NTD respondents report utilitarian walking
within their neighbourhood compared to 13% of respondents from the CSD (Figure 4-10). Further, while “a place to exercise” and "out of the house with no particular destination in mind" were frequent destinations for both the NTD and CSD neighbourhoods, more respondents from the NTD walked to destinations such as church and civic buildings, service providers, stores, and restaurants and coffee shops (Figure 4-10).

Figure 4-10 Percentage of respondents who walk to specific destinations

---

4.2.2.2 Neighbourhood perceptions

Survey respondents were asked to indicate how true 34 characteristics are for their neighbourhood, on a four-point scale from “not at all true” (1) to “entirely true” (4). Scores above 1 reflect some degree of truth for that characteristic (Handy et al., 2004). The characteristics of the neighbourhoods, as perceived by survey respondents, reflect the differences in NTD and CSD that relate to walking (Cao et al., 2009b; Handy et al., 2004). The characteristics are grouped into six factors related to walkability: accessibility, physical activity options, attractiveness, safety, socializing, outdoor spaciousness (Cao et al., 2009b)
### Table 4-3 Neighbourhood perceptions

<table>
<thead>
<tr>
<th></th>
<th>NTD</th>
<th>CSD</th>
<th>difference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accessibility</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shopping areas within walking distance</td>
<td>3.77</td>
<td>2.53</td>
<td>1.24</td>
</tr>
<tr>
<td>Other amenities such as a pool or community centre</td>
<td>3.99</td>
<td>2.14</td>
<td>1.85</td>
</tr>
<tr>
<td>Easy access to regional shopping centre</td>
<td>3.41</td>
<td>2.83</td>
<td>0.58</td>
</tr>
<tr>
<td>Easy access to highway</td>
<td>3.34</td>
<td>3.38</td>
<td>-0.04</td>
</tr>
<tr>
<td>Good public transit service</td>
<td>2.94</td>
<td>2.73</td>
<td>0.22</td>
</tr>
<tr>
<td>Easy access to downtown</td>
<td>2.32</td>
<td>2.45</td>
<td>-0.13</td>
</tr>
<tr>
<td><strong>Physical activity options</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parks and open space nearby</td>
<td>3.78</td>
<td>3.20</td>
<td>0.58</td>
</tr>
<tr>
<td>Sidewalks throughout neighbourhood</td>
<td>3.86</td>
<td>3.61</td>
<td>0.25</td>
</tr>
<tr>
<td>Good bicycle routes beyond neighbourhood</td>
<td>3.25</td>
<td>2.73</td>
<td>0.52</td>
</tr>
<tr>
<td>Good public transit service</td>
<td>2.32</td>
<td>2.45</td>
<td>-0.13</td>
</tr>
<tr>
<td><strong>Attractiveness</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attractive appearance of neighbourhood</td>
<td>3.90</td>
<td>3.56</td>
<td>0.34</td>
</tr>
<tr>
<td>High level of upkeep in neighbourhood</td>
<td>3.53</td>
<td>3.38</td>
<td>0.15</td>
</tr>
<tr>
<td>Variety in housing styles</td>
<td>3.86</td>
<td>3.12</td>
<td>0.73</td>
</tr>
<tr>
<td>Big street trees</td>
<td>3.73</td>
<td>2.25</td>
<td>1.38</td>
</tr>
<tr>
<td><strong>Safety</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safe neighbourhood for walking</td>
<td>3.81</td>
<td>3.50</td>
<td>0.31</td>
</tr>
<tr>
<td>Low crime rate within neighbourhood</td>
<td>3.40</td>
<td>3.09</td>
<td>0.31</td>
</tr>
<tr>
<td>Quiet neighbourhood</td>
<td>3.53</td>
<td>3.15</td>
<td>0.38</td>
</tr>
<tr>
<td>Safe neighbourhood for kids to play outdoors</td>
<td>3.64</td>
<td>3.30</td>
<td>0.33</td>
</tr>
<tr>
<td>Low level of traffic on neighbourhood streets</td>
<td>3.23</td>
<td>2.88</td>
<td>0.05</td>
</tr>
<tr>
<td>Good street lighting</td>
<td>3.59</td>
<td>3.47</td>
<td>0.12</td>
</tr>
<tr>
<td><strong>Socializing</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lots of people out and about within the neighbourhood</td>
<td>3.58</td>
<td>3.21</td>
<td>0.37</td>
</tr>
<tr>
<td>Lots of interaction among neighbours</td>
<td>3.16</td>
<td>2.88</td>
<td>0.28</td>
</tr>
<tr>
<td>Diverse neighbours in terms of ethnicity, race and age</td>
<td>3.00</td>
<td>2.92</td>
<td>0.08</td>
</tr>
<tr>
<td>Economic level of neighbours similar to my level</td>
<td>3.07</td>
<td>3.14</td>
<td>-0.06</td>
</tr>
<tr>
<td><strong>Outdoor spaciousness</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lots of off street parking (garages or driveways)</td>
<td>2.70</td>
<td>3.41</td>
<td>-0.71</td>
</tr>
<tr>
<td>Big street trees</td>
<td>3.73</td>
<td>2.25</td>
<td>1.38</td>
</tr>
<tr>
<td>Large backyards</td>
<td>2.04</td>
<td>2.70</td>
<td>-0.65</td>
</tr>
<tr>
<td>Large front yards</td>
<td>2.03</td>
<td>2.56</td>
<td>-0.53</td>
</tr>
</tbody>
</table>

If the difference between the average score for each characteristic is greater than 1, it is perceived differently between neighbourhood types (Handy et al., 2004). There are some notable characteristics that respondents from the NTD neighbourhood
perceive as true, to a higher degree than residents of the CSD neighbourhood. These characteristics relate to accessibility (shopping areas within walking distance, amenities nearby) as well as attractiveness and outdoor spaciousness (big street trees) (Table 4-3). Focussing on the higher scores for characteristics related to accessibility, this may indicate that respondents from the NTD perceive more opportunities for walking than their CSD counterparts.

The impact of the mature trees in the NTD neighbourhood is significant. An objective stated in the NTD Neighbourhood Plan is:

“[T]o retain and enhance the tree cover in [the NTD] and keep the green character in the redevelopment of the site. Tree protection measures will be undertaken during construction, with road and building construction carefully considering the existing trees” (GCNP, 2003: 16).

Despite the higher population and residential density in the neighbourhood, it is an interesting finding that the mature trees impart a sense of outdoor spaciousness (Figure 4-11, Figure 4-12, and Figure 4-13). The trees, in combination with public space, in the form of neighbourhood parks and greenspace, may be contributing to this sense of outdoor space in this particular case study NTD. This finding may reveal that sense of space, generally affiliated with CSD, can be created in a higher density setting when specific qualities exist, such as mature trees. A greater sense of outdoor spaciousness and the aesthetics contributions of mature trees are important elements that can enhance the pedestrian experience by adding visual interest (Southworth, 2005).
Figure 4-11 Mature trees in NTD

© J. Kinney.

Figure 4-12 Mature trees in NTD

© J. Kinney.
These characteristics that the NTD respondents found to be more true in their neighbourhood are significant physical features that are easily observed, unique and notable in their neighbourhood: amenities such as a pool or community centre (Figure 4-14), shopping within walking distance (Figure 4-15), and big street trees (Figure 4-16).
Figure 4-14 Community centre and pool in NTD

Canada Lands Company; used with permission.

Figure 4-15 Local shopping in NTD

Canada Lands Company; used with permission.
The respondents from the CSD did not perceive any characteristics to be more apparent than their NTD counterparts. As such, the remainder of the average scores did not differ significantly between residents of the NTD neighbourhood and the CSD neighbourhood. When the scores were reduced into six factors: accessibility, physical activity options, safety, socializing, attractiveness, and outdoor spaciousness, the average factor scores for NTD and CSD are comparable (Figure 4-17) (Cao et al., 2009b). Residents of the NTD neighbourhood gave higher scores on average for accessibility. As suggested earlier, this difference may reveal that the residents of the NTD neighbourhood perceive more opportunities for walking than the CSD residents. The prominence of the commercial area, as a result of the mixed use zoning in the NTD, is providing an opportunity for residents to walk for shopping and services as it is in close proximity and along accessible routes from the residential areas.

The differences between the average scores for the other factors were not significantly different. Despite this, they yield interesting results including several characteristics that may influence travel behaviour (Handy et al., 2004). Respondents from both neighbourhoods perceive their neighbourhoods to have options for physical activity (Table 4-3) that is, that there is a perception of infrastructure in their neighbourhood that can facilitate walking. These characteristics are related to
opportunities for walking and biking, although they are more related to recreational walking rather than walking for transportation (Handy et al., 2004). Also, respondents from both neighbourhoods find their respective neighbourhoods to be safe, also an important condition for facilitating walking. Overall, the similarity between neighbourhood perceptions could mean that the respondents from both neighbourhoods generally see their neighbourhoods in similar ways. It could also mean that the nuances in urban design at the neighbourhood level are difficult to define (Handy et al., 2004).

**Figure 4-17 Neighbourhood Perceptions**

![Neighbourhood Perceptions Graph](image)

### 4.2.2.3 Residential Preferences

Preferences for residential characteristics can provide an indication of the degree to which respondents prefer a neighbourhood that offers greater opportunities for walking. Respondents were asked to indicate the relative importance, on a four-point scale from “not at all important” to “extremely important” for each of the 34 neighbourhood characteristics, under the context of looking for a new place to live. An average score of 2.5 represents a neutral position (Handy et al., 2004). This is intended to generate a better understanding of residential preferences.
Table 4-4  Residential preferences

<table>
<thead>
<tr>
<th></th>
<th>NTD</th>
<th>CSD</th>
<th>difference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accessibility</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shopping areas within walking</td>
<td>3.52</td>
<td>2.85</td>
<td>0.67</td>
</tr>
<tr>
<td>Other amenities such as a pool</td>
<td>3.36</td>
<td>2.72</td>
<td>0.64</td>
</tr>
<tr>
<td>or community centre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easy access to regional</td>
<td>3.10</td>
<td>2.91</td>
<td>0.19</td>
</tr>
<tr>
<td>shopping centre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easy access to highway</td>
<td>3.04</td>
<td>3.25</td>
<td>-0.21</td>
</tr>
<tr>
<td>Good public transit service</td>
<td>3.04</td>
<td>2.79</td>
<td>0.25</td>
</tr>
<tr>
<td>Easy access to downtown</td>
<td>2.81</td>
<td>2.58</td>
<td>0.23</td>
</tr>
<tr>
<td><strong>Physical activity options</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parks and open space nearby</td>
<td>3.69</td>
<td>3.52</td>
<td>0.17</td>
</tr>
<tr>
<td>Sidewalks throughout</td>
<td>3.63</td>
<td>3.38</td>
<td>0.25</td>
</tr>
<tr>
<td>neighbourhood</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good bicycle routes beyond</td>
<td>3.20</td>
<td>2.82</td>
<td>0.38</td>
</tr>
<tr>
<td>neighbourhood</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good public transit service</td>
<td>3.04</td>
<td>2.79</td>
<td>0.25</td>
</tr>
<tr>
<td><strong>Attractiveness</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attractive appearance of</td>
<td>3.76</td>
<td>3.68</td>
<td>0.08</td>
</tr>
<tr>
<td>neighbourhood</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High level of upkeep in</td>
<td>3.61</td>
<td>3.64</td>
<td>-0.03</td>
</tr>
<tr>
<td>neighbourhood</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variety in housing styles</td>
<td>3.36</td>
<td>3.05</td>
<td>0.31</td>
</tr>
<tr>
<td>Big street trees</td>
<td>3.17</td>
<td>2.88</td>
<td>0.29</td>
</tr>
<tr>
<td><strong>Safety</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safe neighbourhood for walking</td>
<td>3.89</td>
<td>3.85</td>
<td>0.04</td>
</tr>
<tr>
<td>Low crime rate within</td>
<td>3.84</td>
<td>3.89</td>
<td>-0.05</td>
</tr>
<tr>
<td>neighbourhood</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quiet neighbourhood</td>
<td>3.67</td>
<td>3.71</td>
<td>-0.04</td>
</tr>
<tr>
<td>Safe neighbourhood for kids to</td>
<td>3.64</td>
<td>3.61</td>
<td>0.03</td>
</tr>
<tr>
<td>play outdoors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low level of traffic on</td>
<td>3.60</td>
<td>3.55</td>
<td>0.05</td>
</tr>
<tr>
<td>neighbourhood streets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good street lighting</td>
<td>3.60</td>
<td>3.47</td>
<td>0.13</td>
</tr>
<tr>
<td><strong>Socializing</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lots of people out and about</td>
<td>3.23</td>
<td>3.08</td>
<td>0.15</td>
</tr>
<tr>
<td>within the neighbourhood</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lots of interaction among</td>
<td>3.16</td>
<td>3.02</td>
<td>0.14</td>
</tr>
<tr>
<td>neighbours</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diverse neighbours in terms of</td>
<td>2.91</td>
<td>2.61</td>
<td>0.30</td>
</tr>
<tr>
<td>ethnicity, race and age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic level of neighbours</td>
<td>2.84</td>
<td>2.86</td>
<td>-0.02</td>
</tr>
<tr>
<td>similar to my level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Outdoor spaciousness</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lots of off street parking</td>
<td>3.20</td>
<td>3.39</td>
<td>-0.19</td>
</tr>
<tr>
<td>(garages or driveways)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Big street trees</td>
<td>3.17</td>
<td>2.88</td>
<td>0.29</td>
</tr>
<tr>
<td>Large backyards</td>
<td>2.80</td>
<td>3.03</td>
<td>-0.23</td>
</tr>
<tr>
<td>Large front yards</td>
<td>2.53</td>
<td>2.65</td>
<td>-0.12</td>
</tr>
</tbody>
</table>

Preferences for residential characteristics were similar between the two case study neighbourhoods: the difference between mean scores for each characteristic was never greater than 1 (Table 4-4) (Handy et al., 2004). This indicates that respondents from both neighbourhood styles generally prefer the same types of characteristics. What
can be seen by this data is the relative importance of these characteristics: the closer the average score is to 4 it is seen to be more strongly valued by the respondents.

Characteristics related to safety were given high scores among respondents from both neighbourhoods. This can be seen as an indication that given the opportunity to walk within their neighbourhood, many residents of either neighbourhood would walk. This does not specify whether the walking would be recreational or for transportation. Some characteristics relating to physical activity options are also preferred, such as sidewalks and parks and open space. This is also an interesting finding that reveals that an interest in walking within the neighbourhood exists among respondents from both neighbourhoods. Once again, this may be more oriented towards recreational walking as opposed to walking for transportation.

With respect to accessibility, being within walking distance to shopping was the most highly preferred characteristics relating to accessibility along with being near other amenities. Despite the difference between average scores being less than 1, these two characteristics are the two most strongly preferred by the respondents from the NTD compared to the CSD. The implications of this finding are interesting: residential self-selection may be playing a role in the relationship between built form and walking within these case study neighbourhoods. These results may indicate that the NTD residents have chosen this neighbourhood because of a preference for walking and accessibility.

This finding could also indicate that now that these residents have experienced living in an accessible neighbourhood, these characteristics have become ones that they do value. This finding begs the question, does the preference for walking come first or can the built environment encourage this preference over time? Attitudes may influence behaviour. On the contrary, the built environment may indirectly influence behaviour by affecting attitudes, which over time affect behaviour (Cao et al., 2009b). This indicates that the relationship between the built environment and travel behaviour may be bi-directional (Figure 4-18) (Handy et al., 2004). That is, living in a neighbourhood that offers the opportunity for walking may increase the preference for walking, over time.
As seen in Figure 4-19, when the characteristics are reduced into factors, the similarities of residential preferences between the NTD and CSD can be observed.
Among survey respondents that have a stronger preference for accessibility, walking frequency was higher among NTD respondents (Figure 4-20). The same was found for survey respondents with a stronger preference for physical activity options (Figure 4-21). In fact, among all survey respondents, whether there was a weak or strong preference for these factors, mean walking frequency was higher among respondents from the NTD.

These results do not indicate that residential self-selection is at work in these case study neighbourhoods as a cause of higher walking frequency. In other words, walking frequency is higher among NTD respondents whether or not they prefer urban form features that facilitate walking within the neighbourhood. This does not mean that residential self-selection may not be a cause of the higher walking frequency in the NTD but further investigation would be required to gain a better understanding of the role of residential self-selection in these case study neighbourhoods.
4.2.2.4 Travel attitudes

To measure attitudes about travel, the survey asked respondents whether they agreed or disagreed with thirty-two statements on a five-point scale from “strongly disagree” (1) to “strongly agree” (5). A score of 3 represents a neutral position, neither agree or disagree (Handy et al., 2004). These statements were reduced into six factors:
pro bike/walk, pro-transit, pro-travel, travel minimizing, car dependent, and safety of car (Cao et al., 2009b). These results show some important differences and similarities between the two neighbourhoods (Table 4-5).
### Table 4-5  Travel attitudes

<table>
<thead>
<tr>
<th></th>
<th>NTD</th>
<th>CSD</th>
<th>difference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pro bike/walk</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking can sometimes be easier for me than driving</td>
<td>3.64</td>
<td>2.59</td>
<td>1.04</td>
</tr>
<tr>
<td>I like riding my bike</td>
<td>3.43</td>
<td>2.88</td>
<td>0.56</td>
</tr>
<tr>
<td>I prefer to walk rather than drive whenever possible</td>
<td>3.80</td>
<td>3.09</td>
<td>0.71</td>
</tr>
<tr>
<td>I prefer to bike rather than drive whenever possible</td>
<td>2.94</td>
<td>2.45</td>
<td>0.50</td>
</tr>
<tr>
<td>I like walking</td>
<td>4.46</td>
<td>4.27</td>
<td>0.18</td>
</tr>
<tr>
<td>Biking can sometimes be easier for me than driving</td>
<td>2.81</td>
<td>2.05</td>
<td>0.76</td>
</tr>
<tr>
<td><strong>Pro transit</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking can sometimes be easier for me than driving</td>
<td>3.64</td>
<td>2.59</td>
<td>1.04</td>
</tr>
<tr>
<td>I prefer to take transit rather than drive whenever possible</td>
<td>2.21</td>
<td>1.74</td>
<td>0.47</td>
</tr>
<tr>
<td>I like taking transit</td>
<td>2.36</td>
<td>1.95</td>
<td>0.41</td>
</tr>
<tr>
<td>Travelling by car is safer overall than riding a bike</td>
<td>3.44</td>
<td>3.58</td>
<td>-0.13</td>
</tr>
<tr>
<td>Public transit can sometimes be easier for me than driving</td>
<td>1.81</td>
<td>1.97</td>
<td>-0.16</td>
</tr>
<tr>
<td>I like walking</td>
<td>4.46</td>
<td>4.27</td>
<td>0.18</td>
</tr>
<tr>
<td><strong>Pro travel</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Travel time is generally wasted time (-) *</td>
<td>3.22</td>
<td>2.85</td>
<td>0.37</td>
</tr>
<tr>
<td>I use my trip to/from work productively</td>
<td>3.04</td>
<td>3.16</td>
<td>-0.11</td>
</tr>
<tr>
<td>I like driving</td>
<td>3.49</td>
<td>3.64</td>
<td>-0.15</td>
</tr>
<tr>
<td>The only good thing about travelling is arriving at your destination (-)</td>
<td>2.61</td>
<td>2.70</td>
<td>-0.08</td>
</tr>
<tr>
<td>The trip to/from work is a useful transition between home/work</td>
<td>3.03</td>
<td>3.38</td>
<td>-0.35</td>
</tr>
<tr>
<td><strong>Travel minimizing</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I try to limit my driving to improve air quality</td>
<td>3.34</td>
<td>2.92</td>
<td>0.42</td>
</tr>
<tr>
<td>I prefer to organize my errands so that I make as few stops as possible</td>
<td>4.41</td>
<td>4.47</td>
<td>-0.06</td>
</tr>
<tr>
<td>The price of gasoline affects the choices I make about my daily travel</td>
<td>3.61</td>
<td>3.61</td>
<td>0.01</td>
</tr>
<tr>
<td>Fuel efficiency is an important factor for me in choosing a vehicle</td>
<td>4.14</td>
<td>4.20</td>
<td>-0.05</td>
</tr>
<tr>
<td>I often use the phone or Internet to avoid having to travel somewhere</td>
<td>3.86</td>
<td>3.97</td>
<td>-0.11</td>
</tr>
<tr>
<td>Vehicles should be taxed on the basis of the amount of pollution they</td>
<td>3.56</td>
<td>2.74</td>
<td>0.81</td>
</tr>
<tr>
<td>When I need to buy something, I usually prefer to get it at the closest</td>
<td>3.59</td>
<td>3.56</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Safety of the car</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Travelling by car is safer overall than walking</td>
<td>2.23</td>
<td>2.38</td>
<td>-0.15</td>
</tr>
<tr>
<td>Travelling by car is safer overall than riding a bicycle</td>
<td>3.44</td>
<td>3.58</td>
<td>-0.13</td>
</tr>
<tr>
<td>Travelling by car is safer overall than taking transit</td>
<td>2.62</td>
<td>2.79</td>
<td>-0.16</td>
</tr>
<tr>
<td>The region needs to build more highways to reduce traffic congestion</td>
<td>2.70</td>
<td>3.29</td>
<td>-0.59</td>
</tr>
<tr>
<td>The price of gasoline affects the choices I make about daily travel</td>
<td>3.61</td>
<td>3.61</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Car dependent</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I need a car to do many of the things I like to do</td>
<td>3.81</td>
<td>4.58</td>
<td>-0.76</td>
</tr>
<tr>
<td>Travelling by car is safer overall than riding a bicycle</td>
<td>3.44</td>
<td>3.58</td>
<td>-0.13</td>
</tr>
<tr>
<td>Getting to work without a car is a hassle</td>
<td>3.58</td>
<td>4.25</td>
<td>-0.67</td>
</tr>
<tr>
<td>We could manage pretty well with one fewer car than we have (or no</td>
<td>2.89</td>
<td>2.03</td>
<td>0.86</td>
</tr>
<tr>
<td>I like driving</td>
<td>3.49</td>
<td>3.64</td>
<td>-0.15</td>
</tr>
</tbody>
</table>

* The negative sign (-) indicates an inverse relationship between the characteristics and the factor.
The greatest difference in travel attitudes between respondents from each neighbourhood was found for the statement, “walking can sometimes be easier for me than driving” with the NTD on average agreeing more (Table 4-5). This finding indicates that the urban form of the NTD does in fact make walking within the neighbourhood a practical travel mode choice. Respondents from the NTD also like riding a bike, prefer to walk or bike rather than drive whenever possible, and agree more often than their CSD counterparts that biking can sometimes be easier than driving. Generally the results show that respondents from the NTD are more pro walk/bike than respondents from the CSD (Figure 4-22). Interestingly, respondents from both neighbourhoods strongly agree, by scoring highly with the statement, “I like to walk”. This indicates that if the built environment conditions are conducive to walking, there is the potential for more individuals to walk.

The relatively low scores for the pro transit factor indicate that for respondents from both neighbourhoods, public transit may be a barrier to walking more for part of a journey (Figure 4-22). Attitudes are similar for both neighbourhoods for the pro travel factor: agreement with the statements is fairly neutral (Figure 4-22). Respondents from the NTD agree more strongly with some statements relating to travel minimizing: limiting driving to improve air quality and taxation for vehicles based on production of pollution (Table 4-5). Interestingly, respondents from the CSD agree similarly with respect to organization of errands, how the price of gasoline affects choices for daily travel, fuel efficiency, and preferring the closest store for making purchases. This could be an indication that if given the choice to live in a neighbourhood where access to shopping and services was closer, more individuals from the CSD may be interested.

Agreement for statements regarding safety of the car were similar and fairly neutral for respondents from both neighbourhoods (Table 4-5). With respect to car dependency, respondents from both neighbourhoods agree that they need a car to do many of the things they like to do, but the average score was higher for respondents from the CSD (Figure 4-22). Likewise, the score was higher for respondents from the CSD requiring a car for work. Respondents from the NTD agreed more strongly with the statement regarding needing one less car or no cars.
Figure 4-22 Travel Attitudes
5: Conclusions

Several issues limit the analytical outcomes of this capstone project. Firstly, despite attaining more than the minimum acceptable number of completed surveys, it must be acknowledged that a significant response bias may exist due to a low response rate. The results may not be a fair indication of the perceptions, preferences and attitudes of residents from the case study neighbourhoods. The results of the survey cannot be generalized to other neighbourhoods or regions: the results are only specific to the case study neighbourhoods under study at this time. This type of study would need to be replicated, with a response rate equal to or higher than 25% (Handy et al., 2004), in other neighbourhoods and among differing socio-economic groups to generate a broader understanding of the influence of neighbourhood design on walking. The self-reported nature of walking frequency as reported by survey respondents must be acknowledged. Survey respondents may have perceived or incorrectly remembered, or deliberately misreported the frequency of walking within their neighbourhood.

Despite these limitations, the results of this capstone project provide some encouragement that built form and urban design can influence walking within the neighbourhood in a suburban setting. The objective analysis of the built environment of the two case study neighbourhood established that the NTD neighbourhood has many urban form elements that can facilitate walking within the neighbourhood. The more connected grid like street pattern and variety of commercial services within a reasonable walking distance enhance walkability. These elements, inherent to NTD design, also include higher density and thoughtful urban design, and are clearly exhibited in the NTD case study neighbourhood. The CSD lacks important built form features to facilitate walking. The features that are limiting opportunities for walking within the neighbourhood include lower density, a less connected street pattern, and urban design better suited for automobiles than pedestrians, including the design of the commercial area and wide roads (Table 3-2, Figure 2-3, Figure 1-5, Figure 2-5).

The most basic goal of this capstone project was to examine the differences in walking frequency for residents of two different styles of neighbourhood. The first
hypothesis is: residents of the NTD make more walking trips within their neighbourhood than residents of the CSD. Both observed and self reported data support the hypothesis. The survey results show that walking frequency in the NTD is significantly higher than in the CSD (Figure 4-9 and Table 4-2 on page 61). This shows a correlation between the built environment and walking behaviour at the neighbourhood level.

To move beyond correlation and to come to a more complete understanding of the cause of the higher walking frequency, a closer look at residential preferences and travel attitudes is necessary. This is the self-selection issue: individuals who prefer to walk may choose to live in neighbourhoods conducive to walking. In other words, the characteristics of the built environment does not cause them to walk more, rather it is their desire to walk that causes them to select a neighbourhood with those characteristics. This is the reverse of the presumed causality (Handy et al., 2004). The theory of residential self-selection suggests that the observed associations between travel behaviour and neighbourhood characteristics are partly explained by the self-selection of residents with certain attitudes into certain kinds of neighbourhoods. This is why it is important to consider the role of residential preferences in studying the link between neighbourhood design and travel behaviour.

The second goal of this study was to explore this issue of self-selection: do residents that prefer urban form features such as density, mixed use, and pedestrian oriented street design have a higher walking frequency? The results of this study could not support this hypothesis. The research shows that walking frequency is higher among all NTD residents, not only the ones that prefer urban form features related to walkability. In other words, respondents in the NTD walk more than their CSD counterparts whether or not they prefer the features in their neighbourhood that encourage the opportunity for walking. This finding reveals that the built environment itself, in the case study NTD, may encourage more walking. This finding is supported by the survey results that show that the respondents from the NTD find that “walking can sometimes be easier for me than driving” (Table 4-5 on page 76).

The results from this study indicate that the relationship between the built environment and travel behaviour may be bi-directional (Figure 4-18 on page 72) (Handy et al., 2004). That is, living in a neighbourhood that offers the opportunity for walking may increase the preference for walking, over time (Table 4-4 on page 70 and Table 4-5 on page 76). Respondents from the NTD more strongly prefer characteristics of the built
environment associated with accessibility than their CSD counterparts, specifically the features that are unique to the NTD: shopping with walking distance and amenities nearby. In this case, respondents from the NTD have become accustomed to the urban form features that enable them to easily walk in their neighbourhood for shopping, services, recreational and community activities (Figure 4-14 and Figure 4-15 on page 67). For an individual who prefers walking and lives in a neighbourhood that is conducive to walking, the built environment may enable the walking behaviour and reinforce this preference (Handy et al., 2006). For an individual that does not enjoy walking, living in a neighbourhood conducive to walking may promote walking behaviour and facilitate a higher walking frequency over time (Handy et al., 2006).

The results of this study echo results of prior research that shows that neighbourhood design plays less of a role in recreational walking as opposed to utilitarian walking (Saelens et al., 2003; Rodriguez et al., 2006). The survey found that respondents from both case study neighbourhoods walk within their neighbourhood for recreation, yet more respondents from the NTD walked to destinations within their neighbourhood (Figure 4-10 on page 62). That is, neighbourhood design appears to more strongly influence walking to a specific location, rather than walking for exercise. Results from this study show that while walking is of interest to respondents from both neighbourhoods (Table 4-5 on page 76) and occurs in both neighbourhoods, utilitarian walking to specific locations occurs more frequently in the NTD (Figure 4-10 on page 62). Findings from this study support other research that confirms that residential neighbourhood type is a good predictor for walking trips (Handy et al, 2005; Handy et al., 2006; Cao et al., 2009). The urban form features that are thought to facilitate walking such as density, connected street network and pedestrian oriented design and that are found in the case study NTD appear to facilitate a higher walking frequency despite interest in among respondents from both case study neighbourhoods.

This research shows that residential self selection may play a role in walking behaviour but that the built environment in the NTD appears to facilitate more walking within the neighbourhood for transportation purposes. Residents of the NTD do place a higher value on accessibility (Table 4-4 on page 70) and are slightly more interested in minimizing travel but respondents from the CSD do exhibit an interest travelling less (Table 4-5 on page 76).
When it comes to preferences in the built environment and neighbourhood style, respondents from both neighbourhoods prefer many of the same characteristics relating to safety and attractiveness that can be found in neighbourhoods built in the traditional and neo-traditional style (Table 4-4 on page 70). Interestingly, respondents from the CSD were similarly and notably interested in the opportunity to walk to shopping and services. This demonstrates, as discussed above, that respondents from both neighbourhoods enjoy and are interested in walking but respondents from the NTD find it easier to walk in their neighbourhood. In addition, respondents from the NTD claim to be less dependent on an automobile (Table 4-5 on page 76).

The results from this capstone project can support the idea that individuals generally like walking and want to walk more (Tolley, 2009) and that if neighbourhoods are built with more amenities within walking distance, connected streets, and interesting and engaging urban design, more people may choose to live in this style of neighbourhood and may choose to walk within their neighbourhood for transportation purposes. There is similar interest in walking exhibited in both case study neighbourhoods, but less walking is observed and reported in the CSD neighbourhood. This indicates that there is potential in building more walkable neighbourhoods, in the style of the NTD, to give more choice to residents: more residents may choose neighbourhoods where they can walk.

Future research can build upon the results of this capstone project. As the case study NTD neighbourhood under examination matures, future studies of the influence of urban form on walking may be pursued. Research must allow for the possibility that choices about travel modes and choices regarding the built environment, as well as the attitudes about them, may change over time. In order to establish causation with respect to the role of the built environment on travel mode choice, research is exploring this question through longitudinal studies that track individual residential choices, travel behaviour and attitudes over time (Giles-Corti et al., 2008). Research that examines unique populations, such as children and the elderly, will be important to create neighbourhoods that can support the needs of residents through all stages of life. Evaluation of neighbourhoods undergoing retrofit it will be important to understand the efficacy of ideas, concepts, and techniques.

Walkable suburban neighbourhoods, that provide viable transportation alternatives, are one part of the solution to the sustainability challenges that lie before
city planners, developers, and urban designers. Policy makers and planners must now incorporate the concepts that make neighbourhoods walkable into all new developments, not only the ones that are built under the premise of New Urbanism or neo-traditional design. In suburban areas, the retrofit of existing conventionally designed neighbourhoods and shopping malls offers opportunity to enhance walkability. Intensity of land use and zoning for higher population densities close to arterial roads and transit hubs, in conjunction with greater land use mix, would create more complete neighbourhoods and suburban city centres. As demonstrated in the case study NTD, public services such as community centres and libraries present opportunities for public investments that can strategically shape redevelopment. Opportunity for improving walking routes is possible with the current wide suburban roads, with dedicated room for multiple transport modes.

The arguable crux to the development of walkable suburban neighbourhoods is the offer of good jobs that are located near homes and along transit routes. Adjacent to the NTD case study neighbourhood, further land use diversity and employment opportunities exist. The Canada Education Park, which includes The University of the Fraser Valley, The Justice Institute of British Columbia, Royal Canadian Mounted Police (RCMP) Training Academy, and space planned for research and education related industries, will provide many employment opportunities within walking distance. Predominant opinions about the potential of noise and pollution associated with manufacturing and industrial jobs are limiting opportunities for more land use mixing. Many current manufacturing and industrial industries in Canada could exist in closer proximity to residential areas than current standards allow (Condon, 2010). There are other innovative development projects in British Columbia that are embracing the concept of industry co-existing with a residential neighbourhood (von Hausen et al., 2003). Another paradigm shift that is required in order to allow for more integration between home and employment relates to existing standards for space allotments for warehousing and distribution. Current development practices that build sprawling single story buildings and surplus parking are contributing to land consumption and commuting times. Controls on the amount of suburban land available for development could steer reinvestment back into existing suburban areas (Condon, 2010).

Complete communities would enable people to walk, cycle, or use transit to meet many of their day-to-day needs. In turn, these communities can play a role in mitigating
climate change, reduce dependence on fossil fuels, and help people live more active and healthy lives.
Reference List


Handy, S. (2010). Email communication.


Sanderson, R. (2011). Email communication with Rod Sanderson, Manager of Transportation & Drainage, City of Chilliwack.


Tolley, R. (2009). Walking Around the World: Innovation and Inspiration for Designing, Engineering and Planning in our Cities. Presentation at Simon Fraser University, Vancouver BC.


Appendix:

Qualitative Definitions of Urban Design Qualities

Imageability

Imageability is the quality of a place that makes it distinct, recognizable, and memorable. A place has high imageability when specific physical elements and their arrangement capture attention, evoke feelings, and create a lasting impression.

Figure 5-1  Example of imageability

© J. Kinney.

Enclosure

Enclosure refers to the degree to which streets and other public places are visually defined by buildings, walls, trees, and other elements. Spaces where the height of vertical elements is proportionally related to the width if the space between them have a room-like quality.
Figure 5-2  Example of enclosure

Human scale

Human scale refers to the size, texture, and articulation of physical elements that match the size and proportions of humans and equally important, correspond to the speed at which humans walk. Building details, pavement texture, street trees, and street furniture are all physical elements contributing to human scale.
Figure 5-3  Example of human scale

© J. Kinney.

**Transparency**

Transparency refers to the degree to which people can see or perceive what lies beyond the edge of a street or other public space and, more specifically, the degree to which people can see or perceive human activity beyond the edge of a street or other public space. Physical elements that influence transparency include walls, windows, doors, fences, landscaping, and openings into midblock spaces.
Complexity

Complexity refers to the visual richness of a place. The complexity of a place depends on the variety of the physical environment, specifically the numbers and kinds of buildings, architectural diversity and ornamentation, landscape elements, street furniture, signage, and human activity.

© J. Kinney.
Definitions taken from: