HOUSING RESEARCH REPORT

Impact of Self-Selection Bias on Travel Behaviour: Follow-Up of Study "Comparison of Canadian New Urbanist and Conventional Suburban Neighbourhoods"

Canada

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IMPACT OF SELF-SELECTION BIAS ON TRAVEL BEHAVIOUR: FOLLOW-UP OF STUDY "COMPARISON OF CANADIAN NEW URBANIST AND CONVENTIONAL SUBURBAN NEIGHBOURHOODS"

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RESEARCH HIGHLIGHT

February 2013

Socio-economic Series 13-002

Comparing Canadian New Urbanist and Conventional Suburban Neighbourhoods (Updated)

BACKGROUND

New urbanism is an urban design movement that emerged in the 1980s as an alternative to the typical post-war suburb. The originators of the concept[1] borrowed design standards from the pre-automobile age aiming to create neighbourhoods with connected and pedestrian-friendly streets, mixed housing types, local commercial services and a higher level of aesthetic and public amenities.

New urbanist design principles are most clearly stated in the 1996 Charter of the New Urbanism. The design elements are intended to influence behaviours, such as travel decisions and attitudes of residents: mixed uses will accommodate "many activities of daily living within walking distance;" mixed housing will "strengthen the personal and civic bonds essential to an authentic community;" better streetscapes and pedestrian networks will "encourage walking and enable neighbours to know each other;" and public amenities will "reinforce community identity."

The literature review revealed several studies comparing behaviours of occupants of new urbanist and older neighbourhoods to conventional suburban ones. The studies tended to focus on single issues, such as travel behaviour, and are based chiefly on American examples. The review identified a clear research gap with regard to Canadian developments and examination of the full range of travel and social behaviours.

This study examines data from Canadian examples of new urbanist development compared to corresponding examples of conventional suburban development to test the hypothesis that new urbanist design features are associated with more sustainable travel behaviour and a higher degree of resident engagement with one another and with their communities.

PURPOSE OF THIS REPORT

The purpose of the study is to gather data from selected new urbanist developments (NUDs) and conventional suburban developments (CSDs) in order to determine whether the NUDs achieved the following objectives to a greater degree than the CSDs.

Design characteristics

- Better access to daily destinations, such as public open space, institutional and commercial/retail destinations
- More pedestrian routes and connectivity
- More housing choice
- Less land per housing unit

[1] American architects Andrés Duany and Elizabeth Plater-Zyberk first developed the concept that was later adopted by the Congress for the New Urbanism, founded in 1993.

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Behaviour and attitudes

- Less car use for weekday urban travel
- More walking and bike use for daily destinations
- Greater use of public transit
- Higher resident satisfaction with neighbourhood design
- More use of public open/green space
- More social interaction with neighbours
- Greater sense of neighbourhood attachment

The study also employs statistical procedures to examine the relationships between the built-form design features and the travel behaviour observed among these different neighbourhood types.

STUDY METHODOLOGY

This study addresses the research questions empirically, by conducting a cross-sectional comparison between four new urbanist developments and four conventional suburban developments in Canada. This was carried out in the following steps:

Literature review: The study began with a review of the literature on the post-occupancy impacts of new urbanist design features. The review covered both the U.S. and Canada and was focused on travel behaviour and social attitudes that may be affected by neighbourhood design features such as density, mix of uses, street patterns and quality of the streetscape.

Scan for NUDs: A scan was conducted in order to identify the most suitable NUDs for inclusion in the study. Besides searching on the Internet and in newspaper archives, key informants in different regions of the country were contacted for leads on promising NUDs. The scan resulted in the identification of 38 distinct projects that had new urbanist features.

Selection of NUDs: Once a potential NUD was identified, contact was made with a local planner in order to gather more detailed information about the development, including its age, size, number of residential units and non-residential land uses. Based on this information, a final selection of four NUDs was made.

Selection of comparable CSDs: Four conventionally designed neighbourhoods were then chosen that would allow for meaningful comparison with the selected NUDs. For each NUD, a nearby CSD was chosen that had a similar location within the urban context, demographics, price ranges, size and age of neighbourhood, as well as similar levels of access to public transit.

Collection of neighbourhood design data: Geographic Information System and satellite sources along with on-site surveys and data from local planners provided detailed information on the physical design characteristics of each neighbourhood. Neighbourhood metrics included the area, number of housing units, non-residential land uses, street widths, setbacks, and so on.

Geocoding of neighbourhood metrics: Much of the data collected on the physical design of the neighbourhood was geocoded for spatial presentation and tabulation.

Household survey: A quantitative survey was conducted among the eight study neighbourhoods in order to assess travel and social behaviours. The questionnaire included a 24-hour trip diary for all household members. The survey was carried out largely through an online questionnaire but was also available in print form or could be filled out with telephone assistance. The survey period was from August 30 to October 30, 2006. A total of 2,043 households completed and returned the survey.

Geocoding of survey results: All spatial elements (home and daily destinations) of the survey responses were geocoded for detailed analysis of travel distances.

Analysis of survey results: The various data sets were analyzed to quantify differences between NUD and CSD neighbourhoods.

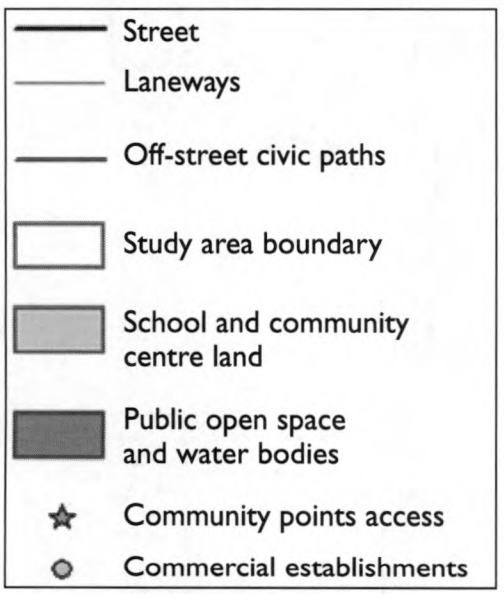
Statistical analysis: Selected results were included in a correlation analysis that explored linkages among urban design variables and travel behaviour. A regression analysis was carried out in order to assess the main factors affecting vehicle use in the eight study neighbourhoods.

THE STUDY NEIGHBOURHOODS

The four NUDs and their CSD counterparts selected for inclusion in the study are shown in table 1.

Table 1 Neighbourhoods selected for inclusion in the study

New Urbanist Developments	Conventional Suburban Developments	City	Urban Context
McKenzie Towne	McKenzie Lake	Calgary	Outer suburbs
Garrison Woods	North Signal Hill	Calgary	Inner suburbs
Cornell	Woodbine North	Markham	Outer suburbs
Bois-Franc	Nouveau Saint-Laurent	Montréal	Inner suburbs



Legend for neighbourhood plans (plans based on construction completed at the time of this study's survey)

MAJOR FINDINGS

Physical design metrics

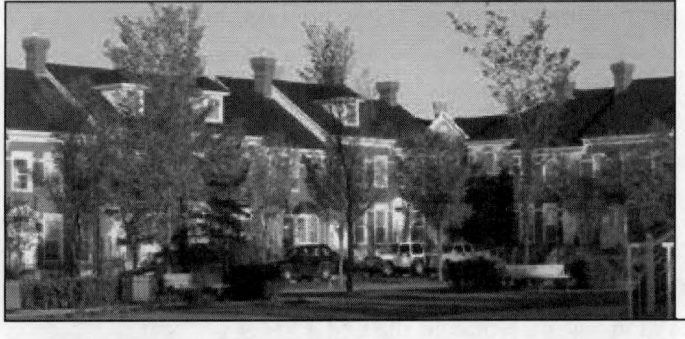
A key characteristic of urban form is housing density. In general, gross residential densities in the NUDs averaged 2,021 dwellings per km^2 (20.2 uph), against 1,163 dwellings per km^2 (11.6 uph) in the CSDs, which indicates that the NUDs were significantly more compact. The NUDs also had a greater mix of housing types; the NUDs had less than half the proportion of single-detached units found in the CSDs and five times the percentage of multi-family units in buildings higher than five storeys.

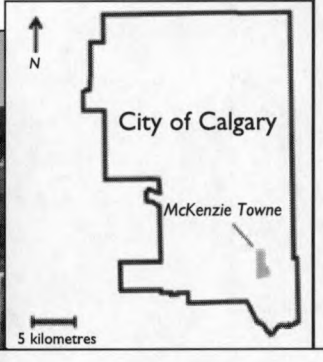
In our study neighbourhoods, we observed almost double the number of stores and services, as well as educational and recreation/entertainment establishments, within 1 km of the neighbourhood centroid in the NUDs than in the CSDs. However, when looking at employment within a 5-km radius of the neighbourhood centroid, we found that the NUDs had 17 per cent fewer jobs than did the CSDs. Again, each CSD was selected to have a location similar to its NUD counterpart with regard to distance to the metropolitan core.

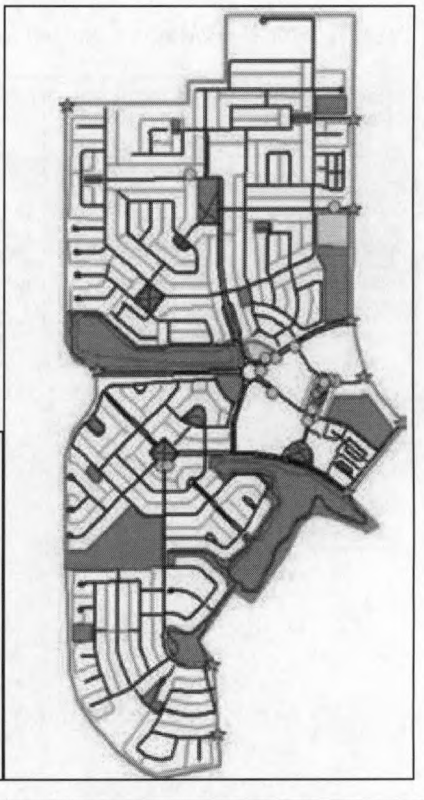
In the four NUDs, we observed slightly more public open and green space than in the CSDs (14.4 per cent of total surface area, versus 13.8 per cent). The street density was about the same in the two types of neighbourhoods but, when lanes were added to the metric, NUDs showed a street density 38 per cent higher than did CSDs. As for off-street civic paths (excluding sidewalks), the NUDs had a higher density than the CSDs (2.3 km versus 1.9 km length/total km^2). Together, the path/street/lane density in the NUDs was 36 per cent higher, on average, than in the CSDs.

McKenzie Towne

- 20 km from Calgary's central business district (CBD)
- Study area is 2.6 km², developed as of 2006: 4,625 homes in study area out of 8,000 at build-out
- 60% single-detached housing, with townhouses, duplexes and apartments; gross density of 17.2 units per hectare (uph)
- Commercial centre on site
- 16% of site is public open space
- 2 schools within 1 km of centre
- 83% of streets have sidewalks on both sides





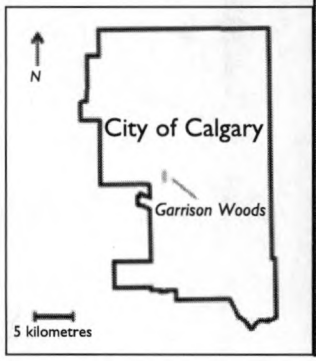


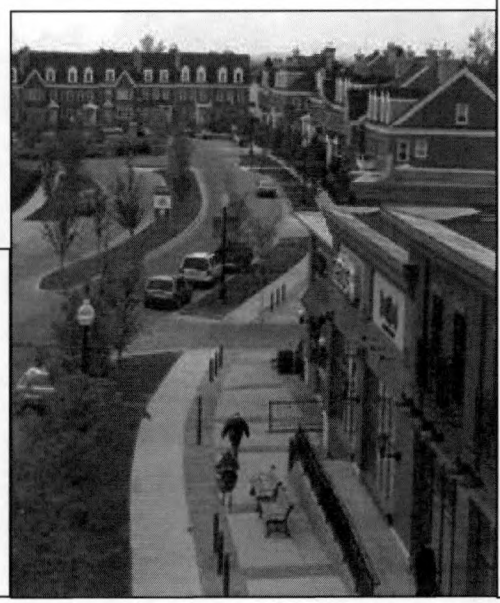
McKenzie Lake

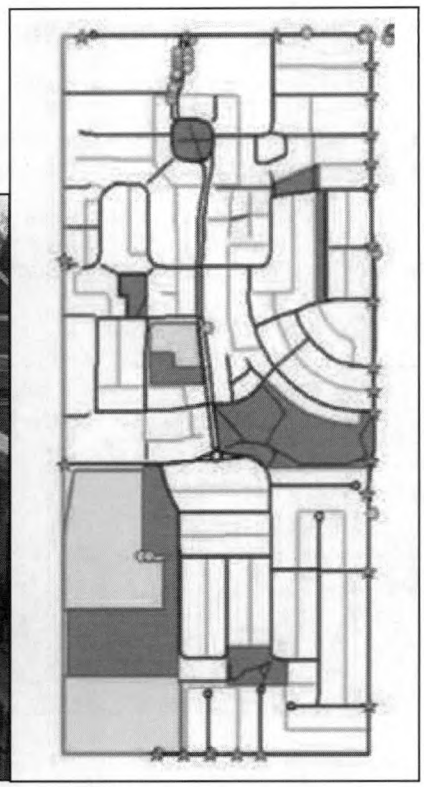
- 20 km from Calgary's CBD
- Study area is 4.2 km², completed by 1999: 4,641 homes
- 90% single-detached housing, with townhouses, duplexes and apartments; gross density of 10.5 uph
- Few commercial uses, 4 schools within 1 km
- 19% of site is public open space
- 40% of streets have sidewalks on both sides

Garrison Woods

- 5 km from Calgary's CBD
- Study area is 0.77 km^2, completed in 2005: 1,535 homes
- Over 30% apartments, 20% townhouses and 15% duplexes; gross density of 20 uph
- 12% is public open space (high quality), the most paths/km^2
- The most non-residential uses within 1 km, 11 schools within 1 km
- 53% of streets have sidewalks on both sides

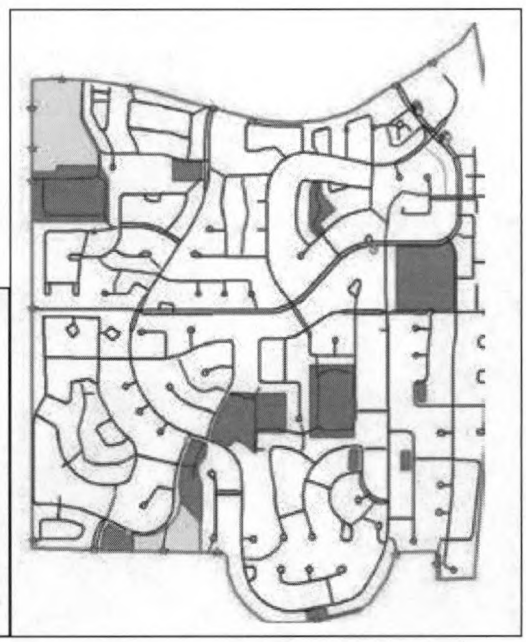






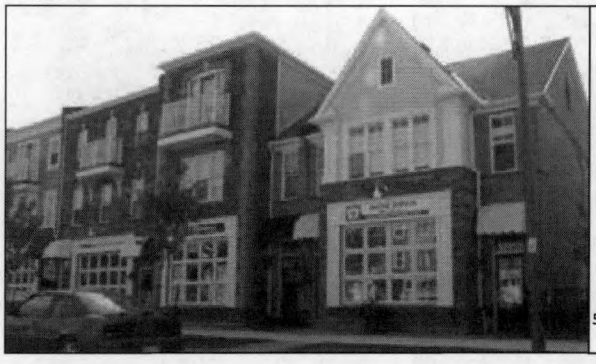
North Signal Hill

- 8 km from Calgary's CBD
- Study area is 2.5 km^2, completed in the 1990s: 3,114 homes
- 70% single-detached housing; gross density of 12.6 uph
- The fewest commercial uses, 1 school within 1 km
- 8% is public open space
- 33% of streets have sidewalks on both sides



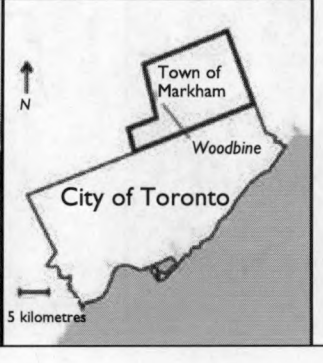
Cornell, Markham

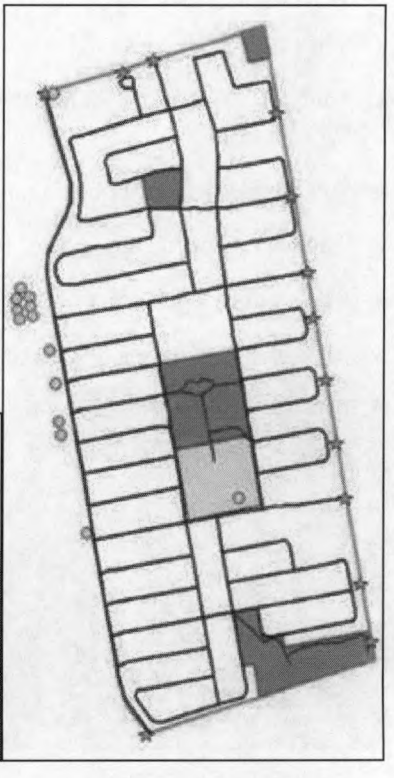
- 30 km from Toronto's CBD
- Study area is 1 km^2, began construction in 1999
- 1,894 homes in study area, 10,000 at build-out
- 36% single-detached housing, 46% townhouses, 17% semi-detached homes and 1% apartment; gross density of 19.6 uph
- Some commercial uses: main street
- 13% is public open space
- 1 school within 1 km
- 93% of streets have sidewalks on both sides



Woodbine North, Markham

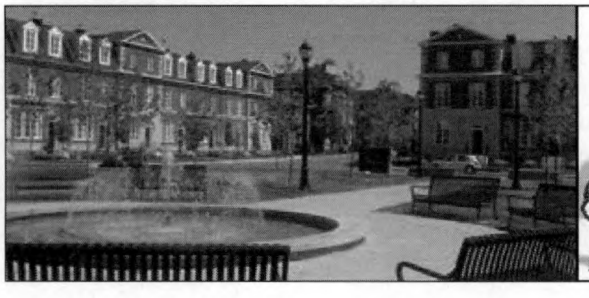
- 28 km from Toronto's CBD
- Study area is 0.75 km^2, completed in 2002: 1,218 homes
- 64% single-detached housing, 15% townhouses and 21% semi-detached homes; gross density of 16.3 uph
- Adjacent to shopping centre, 1 school within 1 km
- 10% is public open space
- 19% of streets have sidewalks on both sides

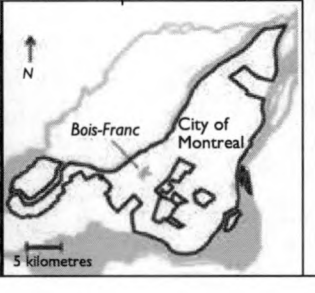




Bois-Franc

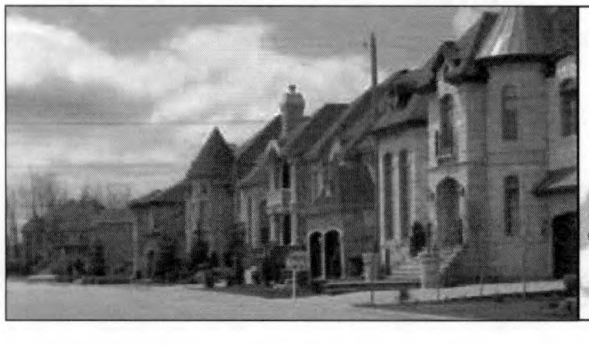
- 11 km from Montréal's CBD
- Study area is 0.9 km², began construction 1993: 2,605 homes at the time of study, 5,300 at build-out
- 43% townhouses, 50% multi-family homes, 7% semi- and single-detached homes; gross density of 30.7 uph
- Small commercial centre
- 13% is public open space (high quality)
- 4 schools within 1 km
- 81% of streets have sidewalks on both sides

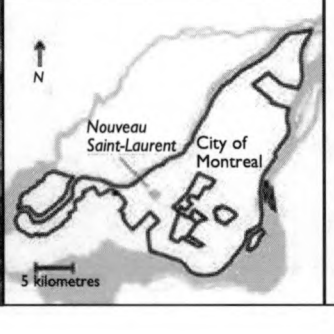


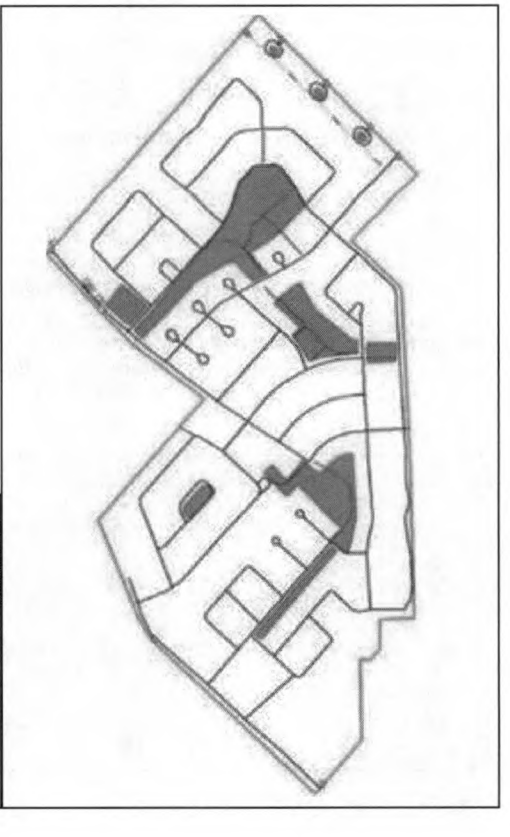


Nouveau Saint-Laurent

- 11 km from Montréal's CBD
- Study area is 0.9 km², with 970 homes in study area, 1,200 at build-out
- 52% single-detached housing, 24% townhouses, 4% semi-detached homes and 20% multiplex dwellings; gross density of 10.5 uph
- Very few commercial uses, no school within 1 km
- 10% is public open space
- 21% of streets have sidewalks on both sides







We found a very high percentage of streets without sidewalks in the CSDs compared to the NUDs (27.5 per cent of street km in CSDs, versus 2.8 per cent in NUDs). Over three quarters of the streets in the NUDs had sidewalks on both sides of the street, compared to only 28.5 per cent in the CSDs. Similarly, the NUDs had significantly smaller setbacks when compared with those observed in the CSDs; 83.7 per cent of streets in the CSDs had setbacks larger than 5.5 metres, compared to only 43.1 per cent of streets in the NUDs. In terms of street widths, on average, the NUDs had about three times more streets that were narrow, at less than 7.6 metres wide, than the CSDs (11.5 per cent, versus 3.9 per cent).

We found that the NUDs offered somewhat better pedestrian connectivity than the CSDs. When we computed the average ratio of the straight-line to network distances between each home and all other homes within each neighbourhood, we found that the NUDs had slightly higher connectivity values (0.78) for the ratio when compared with the CSDs (0.74), for a difference of about 5 per cent.

Some of the physical design metrics are summarized in table 2.

Household survey findings

The findings presented in this section were obtained from the over 2,000 households who completed the survey described above.

Household profiles

The survey revealed that responding households living in the CSDs had more household members (3.3) than those living in the NUDs (2.7). We also observed that households residing in the CSDs were more likely to include children than their counterparts in the NUDs. Not surprisingly then, we observed a significantly larger percentage of students in the CSDs than in the NUDs.

When we focus on adults from the responding households, we observed that adults in the NUDs were younger than their counterparts in the CSDs. We found that older cohorts over the age of 45 constituted 36 per cent of the residents in the CSDs but only 28 per cent in the NUDs. Furthermore, a higher percentage of NUD dwellers were employed than their counterparts in the CSDs. This suggests that the NUDs attracted younger adults, whereas the CSDs attracted older adults with children. Consistent with this interpretation, we found that household incomes were about 8 per cent higher in the CSDs than in the NUDs. The average household income in both types of developments was in excess of $100,000.

As one would expect from the difference in household size between the two types of neighbourhoods, the housing units of responding households in the CSDs were larger in size than those found in the NUDs. For instance, 80 per cent of the housing units in the NUDs had three bedrooms or less, compared with 45 per cent in the CSDs. And since the housing stock in the NUDs was smaller in size, the homes were, on average, cheaper than the homes in the CSDs.

Table 2 Summary of certain physical design metrics

Neighbourhood	Total Area (km^2)	% Single-Detached Houses	Gross Density (uph)	Non-Res. Land Uses Within 1 km*	% Public Green/ Open Space	% Sidewalks Both Sides	% Set-backs >5.5 m	% Streets < 7.6 m Wide	Ped. Connect-ivity	Street/ Lane/Path Density
Bois-Franc	0.85	3	30.7	24	12.7	80.7	35.5	24.8	0.76	15.7
Nouv. St-Laurent	0.92	52	10.5	12	9.6	21.2	97.1	1.5	0.71	15.3
Cornell	0.97	36	19.6	22	12.8	93.1	32.4	2.1	0.82	25.9
Woodbine North	0.75	64	16.3	46	8.9	19.4	76.5	0	0.80	18.7
Garrison Woods	0.77	28	19.9	132	12.2	52.8	73.8	4.9	0.79	23.8
North Signal Hill	2.46	72	12.6	49	8.2	33.1	82.5	10.4	0.70	15.4
McKenzie Towne	2.69	59	17.2	45	16.2	83.2	31.0	13.9	0.74	21.8
McKenzie Lake	4.42	91	10.5	16	18.6	40.2	78.8	3.5	0.76	16.8
NUD avg.	**1.32**	**31**	**20.2**	**55.8**	**14.4**	**77.4**	**43.1**	**11.5**	**0.78**	**21.8**
CSD avg.	**2.14**	**70**	**11.6**	**30.8**	**13.8**	**28.5**	**83.7**	**3.9**	**0.74**	**16.0**

* includes commercial and institutional land uses

Almost 38 per cent of the housing units of the responding households in the CSDs were under $450,000, compared to 68 per cent in the NUDs.

There were no significant differences in housing tenure between the two types of developments. In both the NUDs and CSDs, 96 per cent of responding households owned their dwellings.

Perceptions of the neighbourhood

The survey revealed that, in comparison with their CSD counterparts, nearly double (60 per cent, versus 34 per cent) the respondents in the NUDs reported being very satisfied with the physical design of the streets, landscaping and façades in their neighbourhoods. Similarly, double the respondents in the NUDs found the streetscapes very pleasant for walking, compared to the households in the CSDs (85 per cent, versus 44 per cent). Similarly, the design of the streetscapes was considered to be very safe for walking and biking by 51 per cent more respondents living in NUDs than those residing in CSDs (55 per cent, versus 37 per cent). These perceptions may help to explain the other survey results that suggested that 70 per cent of households in NUDs, compared with just 47 per cent of households in CSDs, found it very convenient to either walk or bike to parks.

Furthermore, 52 per cent of NUD respondents reported visiting public open or green spaces several times a week, compared to only 40 per cent of the respondents in the CSDs, even though our neighbourhood metrics showed that NUDs had only slightly more public green and open space than the CSDs and that the CSDs had more children per household.

Table 3 Summary of certain survey results: Household profiles

Household Variable	NUD Avg.	CSD Avg.
Household size (# persons)	2.7	3.3
Household members over 9 yrs. (# persons)	2.2	2.7
Household income ($)	110,000	119,000
House price ($)	411,000	495,000
House size (# bedrooms)	2.9	3.6

There also appears to be a difference between the two types of developments in terms of respondents' appreciation of the architectural quality of their respective neighbourhoods. A large percentage (29 per cent) of respondents from NUDs cited the architectural quality of homes and other buildings in the neighbourhood as the number one factor in choosing the neighbourhood. In comparison, only 6 per cent of respondents from the CSDs cited this as the primary reason to locate in the neighbourhood. The quality of their own dwelling unit was cited by 22 per cent of respondents from the CSDs as the primary reason to locate in that particular neighbourhood, compared to only 13 per cent of respondents from the NUDs.

Respondents from NUDs reported being more attached to their neighbourhoods compared to their CSD counterparts (50 per cent, versus 36 per cent were very attached), despite the fact that NUD respondents had, on average, lived in the neighbourhoods for shorter periods of time (reflecting the relatively recent construction of these neighbourhoods).

Social interaction

We observed that the NUD respondents greeted their neighbours more often than respondents living in the CSDs, with 35 per cent reporting a greeting almost every time they were out for a walk, compared to 27 per cent for CSD households. NUD households also reported socializing face-to-face with their neighbours more often, with 40 per cent saying they did so several times a week, in contrast to the CSD households, 34 per cent of whom reported doing so.

Table 4 Summary of certain survey results: Perceptions of neighbourhood design

Perception of Neighbourhood Design (% of Total Respondents)	NUD Avg.	CSD Avg.
Streetscapes very pleasant for walking	85	44
Streets very safe for walking, biking	55	37
Very convenient to walk, bike to open space	70	47
Very attached to neighbourhood	50	36
Very satisfied with overall design of neighbourhood	60	34
Visit public open space several times a week	52	40
Architectural quality of the neighbourhood primary factor to locate there	29	6

Although CSD respondents were more likely to hold a membership in sports or social groups, households in NUDs attended more community events per year, on average, than their CSD counterparts.

These results are consistent with our finding that respondents from NUDs tended to walk and bike more than their counterparts in the CSDs, which might have facilitated their social interaction with neighbours. We also observed that the spatial extents of social interactions were slightly different between the two types of neighbourhoods, with respondents of CSDs tending to socialize more with immediate neighbours, while those who lived in NUDs tended to extend their networks to the entire neighbourhood.

General household travel behaviour

We found significant evidence to support the assumption that responding households in the NUDs walk and bike more than their CSD counterparts. Fully 51 per cent of NUD households reported walking and biking to local services and stores several times a week, compared to only 19 per cent for CSD households. Also, 64 per cent of NUD respondents said they stroll or bike for leisure several times a week in the warm months, compared to 52 per cent of CSD respondents. These findings are consistent with the earlier finding concerning resident perceptions of their environments: responding households found NUDs to be more pleasant and safer environments for walking and biking.

To test how changes in built form can affect household travel behaviour, we asked respondents about their travel behaviour in their previous home locations. We found that, since their move to the NUD, 37 per cent of these households reported they were walking a lot more than they did in the previous locations. In contrast, only 20 per cent of households in CSDs reported a lot more walking in their new location. In fact, a significantly larger percentage (26 per cent) of respondents reported a decline in their walking since their relocation to a CSD than those who relocated to a NUD (11 per cent). Since their relocation to the NUD, 39 per cent of respondents in NUDs reported a decline in their car use. Only 18 per cent of households in CSDs reported a decline in their driving since their move, while 47 per cent reported an increase in car use, compared to only 29 per cent of NUD respondents. These findings support the contention that the design characteristics of NUDs encourage higher walking and biking modal shares.[2]

Table 5 Summary of certain survey results: Social interaction

Social Interaction (% of Total Respondents)	NUD Avg.	CSD Avg.
Greet neighbours while out, almost every time	35	27
Socialize face-to-face with neighbours several times a week	40	34
10+ neighbours known by name	52	51
Member of neighbourhood club/group	32	41
Participate in community events, 4+/year	15	11

The survey also revealed that responding households in the NUDs were 24 per cent less likely to own more than one car than their CSD counterparts: only 61 per cent of NUD households owned two or more cars, while 80 per cent of CSD households did. Those moving to a NUD had similar rates of car ownership as in their last location. For example, 59 per cent of NUD respondants had two or more cars in both locations. However, those who had moved to CSDs showed increased rates of car ownership compared to their previous location, going from 70 per cent to 80 per cent of households having two or more cars.

A key characteristic of the built environment that influences travel behaviour is the availability of parking spaces. The greater availability of parking spaces is thought to promote higher levels of automobile ownership. Our results indicate that NUD respondents reported significantly lower parking capacity than their CSD counterparts. In general, 62 per cent of households in the CSDs reported having three or more parking spaces, compared with only 35 per cent of households in NUDs. Thus, households in NUDs tended to have lower parking access, own fewer cars and drive less than those in the CSDs.

24-hour travel diary analysis

The mode split analysis suggests that NUD respondents had a lower auto mode share (as a driver or passenger) than their CSD counterparts (78 per cent, versus 85 per cent). Walking mode share was significantly higher for NUDs than for CSDs (11 per cent, versus 5 per cent), especially

[2] As described later, further research in this area would enhance understanding of the influence of any self-selection bias.

for shopping trips (9 per cent, versus 2 per cent). As far as public transit is concerned, the NUD and CSD respondents reported the same transit mode share (both 9 per cent). This may reflect the fact that CSD counterpart communities were selected in part on the basis of their similarity to NUDs in terms of transit service and location.

In terms of trip purpose, the NUD respondents reported a higher share of trips for walking or biking for pleasure than their CSD counterparts (3 per cent, versus 1 per cent). Over 50 per cent more NUD households reported walking trips than did their CSD counterparts (21.3 per cent, versus 14 per cent). However, among those households reporting trips, the walking trips per household were not very different between the two types of neighbourhoods (2.3 for NUD respondents, versus 2.0 for the CSD respondents).

The analysis of the 24-hour vehicle kilometres travelled (VKTs) reported by each responding household indicates that the CSD respondents had a 24-per-cent higher level of VKTs per household than their NUD counterparts (46.0 km, versus 37.1 km).

Table 6 Summary of certain survey results: Travel behaviour

Travel Behaviour	NUD Avg.	CSD Avg.
Walk, bike to local services and stores, several times a week (% of total respondents)	51	19
Stroll, bike for leisure, several times a week (% of total respondents)	64	52
Walk a lot more than in previous location (% of total respondents)	37	20
Drive less than in previous location (% of total respondents)	39	18
Own two or more cars (% of total respondents)	61	80
Vehicle kilometres travelled (VKTs) per household	37.1	46.0
Households reporting walk trips (% of total respondents)	21.3	14.0
% trips by walking	11	5
% trips by automobile (as driver or passenger)	78	85
% trips by public transit	9	9

STATISTICAL ANALYSIS

In this section, we provide a statistical analysis of the results presented above. This analysis permits us to explore relationships among some of the variables presented above and help answer key research questions. The main question addressed in this section is "Are the differences in urban form linked to differences in travel behaviour in the study neighbourhoods?" We address this question by first conducting a series of one-to-one correlations between built-form variables and travel behaviour, as measured by our household survey, to identify significant relationships. We then proceed with a multivariate regression analysis of VKTs in order to examine the influences on VKTs and control for extraneous variables, such as household size and income.

The correlations are carried out using variables for which data was available at the household level and those for which data was aggregated to the neighbourhood level. Table 7 shows the results of one-to-one correlations using neighbourhood-level, built-form variables against travel behaviour variables captured or estimated at both the household and neighbourhood levels. The travel behaviour variables include survey responses to questions such as how frequently respondents walk or bike to neighbourhood destinations; how frequently they walk or bike in the neighbourhood with no destination; whether they walk more now than in their previous location; whether they drive less now than before; the number of walking trips reported by the household; and the number of household VKTs. These travel behaviour variables were all measured at the household level. Other travel behaviour variables were measured at the neighbourhood level, including average VKTs per household for each neighbourhood; percentage of neighbourhood households reporting walking trips; and neighbourhood average walking mode share.

Table 8 shows the results of one-to-one correlations using household-level, built-form variables and travel outcome variables captured at both the household and neighbourhood levels. The built-form variables include items that can be measured at the block or household level, such as whether there are sidewalks on the street where the house is located; the average setback on that street; the width of the street; and the pedestrian connectivity of a household at that particular location. The built-form variables also include responses to selected questions from the household survey,

Table 7 Correlations using neighbourhood-level, built-form variables against travel behaviour

Neighbourhood-Level Built-Form Variables	Household-Level Travel Behaviour Variables						Neighbourhood-Level Travel Behaviour Variables		
	Walk or Bike to N'hood Destin-ations	Walk or Bike in the N'hood With no Destination	Walk More Now than Before	Drive Less Now than Before	Number of Walking Trips	VKTs	Avg. VKTs per H'hold	% of H'holds Reporting Walking Trips	Avg. Walking Mode Share
Dwelling density	+	+	+	+	NS	-	-	-	+
Housing mix	+	+	+	+	+	-	-	-	+
Employment within 5 km	NS	+	NS	NS	-	-	-	-	-
Non-residential land uses within 1 km	+	-	-	NS	NS	-	-	-	NS
Pedestrian connectivity	+	+	+	NS	+	+	+	-	+
Street/lane density	+	NS	+	+	+	+	+	NS	+
% of site that is public open space	+	NS	+	NS	NS	+	+	+	-

+ = positive correlation significant at the 95% confidence level
- = negative correlation significant at the 95% confidence level
NS = not significant

Table 8 Correlations using household-level, built-form variables against travel behaviour

Neighbourhood-Level Built-Form Variables	Household-Level Travel Behaviour Variables						Neighbourhood-Level Behaviour Variables		
	Walk or Bike to N'hood Destin-ations	Walk or Bike in the N'hood With no Destination	Walk More Now than Before	Drive Less Now than Before	Number of Walking Trips	VKTs	Avg. VKTs per H'hold	% of H'holds Reporting Walking Trips	Avg. Walking Mode Share
Sidewalks	+	+	+	+	+	NS	-	+	+
Smaller setbacks	+	NS	+	+	NS	NS	-	+	-
Street width	NS	NS	NS	NS	NS	NS	NS	NS	NS
Pedestrian connectivity	+	NS	+	NS	NS	+	+	NS	+
Design satisfaction	+	+	+	+	NS	NS	-	+	+
Safe for walking or cycling	+	+	+	+	+	NS	-	+	+
Convenient access to public open space	+	+	+	+	NS	NS	-	+	+

+ = positive correlation significant at the 95% confidence level
- = negative correlation significant at the 95% confidence level
NS = not significant

including whether the respondents were satisfied with the design of the neighbourhood; whether they found the neighbourhood safe for walking and cycling; and whether they had convenient walking or biking access to public open space. The travel behaviour variables are the same as those in the previous table.

The results from both tables generally confirm expectations derived from the literature. Although the correlations are not as expected in all cases, the picture that emerges from the statistical analysis is that the urban design features that are thought to increase active modes of transport and reduce car use are in fact linked with more walking and biking behaviour and less car use in our eight study neighbourhoods. Taken together, the results suggest that VKTs are more strongly correlated to larger-scale factors, such as neighbourhood dwelling density, employment within 5 km, housing mix and non-residential land uses within 1 km. On the other hand, walking and cycling activity is more strongly linked to smaller-scale factors, such as the presence of sidewalks, setbacks and occupant perceptions of neighbourhood walkability.

To control for interrelated factors, we conducted a multivariate regression analysis on household VKTs. In developing our regression model, we collapsed built-form variables into a smaller number of synthetic variables. Using this approach, we identified three factors as follows:

- **Factor 1:** high dwelling density and jobs within 5 km
- **Factor 2:** public open space and high walkability (includes pedestrian connectivity, sidewalks, setbacks and street widths)
- **Factor 3:** mixed land use and a dense street network

We then estimated regression models where we regressed the VKTs of individual households as a function of the following: neighbourhood built form (presented by the three synthetic variables); number of adults per household; automobile ownership; housing type; and household income. Additional independent variables included survey responses on neighbourhood design satisfaction, walk/bike safety, convenience and pleasantness. We have included only those households in the sample who reported at least 5 VKTs in a day. The assumption here is that households reporting fewer than 5 VKTs may be outliers.

Table 9 presents the results of the regression model. Relationships that are significant at the 95-per-cent confidence interval are highlighted in bold and italics under the significance column. The adjusted R-square for the model is 12.73 per cent, suggesting a modest fit. The model fit reported here is similar to that of other studies that relied on disaggregated data.

Table 9 Results of the regression model for VKT

Independent Variables	Estimate	Std. Error	t Value	Significance
Constant	11.60	10.64	1.09	0.28
Mixed land use and high street density	-3.84	1.01	-3.78	***0.00***
Public open space and high walkability	-6.81	1.08	-6.33	***0.00***
High res. density and employment in 5 km	-4.47	1.22	-3.65	***0.00***
Cars owned	4.05	1.61	2.52	***0.01***
Adults in household	5.49	1.10	4.98	***0.00***
Household income categories*:				
$35,001 to $50,000	1.21	11.04	0.11	0.91
$50,001 to $75,000	6.25	10.48	0.60	0.55
$75,001 to $100,000	13.76	10.33	1.33	0.18**
$100,001 to $150,000	15.61	10.28	1.52	0.13**
Over $150,000	13.56	10.36	1.31	0.19**
Perception variables:				
N'hood very safe for walking	0.00	2.17	0.00	1.00
Very satisfied with urban design	0.94	2.32	0.41	0.68
N'hood very convenient for walking	-1.04	2.48	-0.42	0.68
N'hood very pleasant for walking	-0.78	2.65	-0.30	0.77
Single-detached housing unit	0.44	2.56	0.17	0.86
Adjusted R-square	12.73%			

* Base income category is less than $35,000
** When using a one-tail hypothesis, significance levels are all under 0.1 (90% confidence level)

To summarize, the regression model suggests that new urbanist design characteristics are associated with reduced VKTs, even when controlling for income, housing type, household size and automobile ownership. As expected, the model also indicates that VKTs rise with an increase in the number of cars owned, number of adults in the household and household income. For example, households with annual incomes over $75,000 drive from 13.5 to 15.6 more VKTs daily than those with incomes under $35,000. When we tested for the assumption that these higher income households would report higher VKTs than those earning under $35,000 (using only the upper tail of the distribution), the results show statistically significant coefficients at the 90-per-cent confidence level or better. Finally, the model also implies that household perceptions about the neighbourhood built form do not have a significant impact on VKTs nor does housing type.

Influence of self-selection bias

While these findings are statistically robust, they can be questioned on the basis of the so-called "self-selection bias" argument. Like most empirical research that shows a link between neighbourhood form and travel behaviour, our findings could be explained by hypothesizing that households that prefer walking over driving were drawn to the neighbourhoods with new urbanist characteristics and this is why we find less driving and more walking in the NUDs compared with the CSDs in our sample. This interpretation challenges the conclusion that urban form affects travel behaviour because it implies that the physical characteristics of the neighbourhood are not directly responsible for differences in walking and driving behaviour; it is the household preference for driving or walking that produces the observed differences.

In order to eliminate this as a possible explanation for our results, we developed a "walk predisposition" variable and added it as an explanatory variable in the regression analysis to see if it was a significant predictor of travel behaviour. The predisposition variable was based on the neighbourhood type choices of each household in our sample. Since we asked respondents about the location of their previous residence (before moving to their current residence in one of the eight neighbourhoods in our study), we could collect information about the neighbourhood surrounding the household's previous location. These "previous location" neighbourhoods were classified on a scale of 1 to 5 based on their walkability characteristics (including density, street density, number of jobs within 5 km, distance to Central Business District, mode split, and average travel distance to work).

Table 10 Results of the regression model for VKT

Independent Variables	Estimate	Std. Error	t Value	Significance
Constant	17.00	11.77	1.44	0.15
Mixed land use and high street density	-3.24	1.08	-3	0.00
Public open space and high walkability	-7.27	1.13	-6.44	0.00
High res. density and employment in 5 km	-3.92	1.44	-2.72	0.01
Cars owned	3.97	1.68	2.37	0.02
Adults in household	5.04	1.17	4.32	0.00
Household income categories*:				
$35,001 to $50,000	-1.59	12.17	-0.13	0.90
$50,001 to $75,000	2.85	11.62	0.25	0.81
$75,001 to $100,000	11.00	11.45	0.96	0.34
$100,001 to $150,000	11.89	11.35	1.05	0.30
Over $150,000				
Perception variables:	-0.08	2.28	-0.04	0.97
N'hood very safe for walking	1.61	2.44	0.66	0.51
Very satisfied with urban design	-1.77	2.63	-0.67	0.50
N'hood very convenient for walking	-1.49	2.80	-0.53	0.60
N'hood very pleasant for walking	0.60	2.65	0.23	0.82
Walk predisposition				
Households with medium walk predisposition	-7.61	4.293793	-1.77	0.077
Household with high walk predisposition	0.02	7.476533	0	0.998
Observations	1037			
Adjusted R-square	12.26%			

The eight "current location" neighbourhoods in our sample were also classified using the same definitions. Households that moved from one highly walkable to another highly walkable neighbourhood were deemed to have a "high walk predisposition" whereas those who moved from a mid-walkable to a highly walkable or from a highly walkable to a mid-walkable neighbourhood were given a "medium walk predisposition" score. All other households were given a "low walk predisposition" score.

The "walk predisposition" score did not return a statistically significant coefficient in the regression model (see table 10) suggesting that walk predisposition does not help explain the difference in VKTs among households and that the self-selection bias can be dismissed as an explanation for why we observed less driving in the NUDs compared with the CSDs in our sample. Thus, our finding remains that the built-form variables of the neighbourhoods in our sample are significant influencers of travel behaviour.

RESPONSES TO THE RESEARCH QUESTIONS

This study poses the question as to whether the NUDs achieved certain built-form design objectives and showed specific behavioural and attitudinal differences compared to those found in the CSDs. We are now in a position to address these questions in the context of the eight neighbourhoods surveyed in this study.

Design characteristics

Closer access to daily destinations: The four NUDs, on average, had 80 per cent more daily destinations, such as stores and schools, within 1 km of the neighbourhood centroid than did CSDs. They also had slightly more public open space as a percentage of the total site area than did the CSDs. While the NUDs had fewer jobs within 5 km than did the CSDs, this is related to the fact that each neighbourhood pair was selected to have a similar location and distance to the metropolitan core.

More pedestrian routes and connectivity: As measured by the ratio of straight line to pedestrian network distances, we found that the NUDs had a 5-per-cent higher pedestrian connectivity index than their CSD counterparts. Together, the path, street and lane density was about 36 per cent higher in the NUDs, on average, than in the CSDs. The NUDs had nearly three times the percentage of streets with sidewalks on both sides than the CSDs.

More housing choice: Generally, the NUDs had lower percentages of detached and semi-detached homes than the comparable CSDs (35 per cent, versus 76 per cent) and higher percentages of row houses and multi-family housing forms (65 per cent, versus 24 per cent). The NUDs offered a much richer mix of housing types than found in the CSDs.

Less land per housing unit: Housing densities in NUDs were 74 per cent greater, on average, than in CSDs, with NUDs having about 20.2 uph, against 11.6 uph in the CSD neighbourhoods. NUDs also had smaller setbacks and narrower streets than their CSD counterparts.

Behaviour and attitudes

Less car use for weekday urban travel: The mode split analysis suggests that NUD respondents had a lower auto mode share (as a driver or passenger) than their CSD counterparts (78 per cent, versus 85 per cent). The analysis of the 24-hour VKTs reported by each responding household suggests that the CSDs had 24 per cent higher VKTs per household than their NUD counterparts (46.0 km, versus 37.1 km). Moreover, respondents moving to NUDs were more likely to report a decrease in driving compared to their previous location, while respondents in CSDs were more likely to report an increase in car ownership and more driving in their new location.

More walking and bike use for daily destinations: We found significant evidence to support the assumption that responding households in the NUDs walk and bike more than their CSD counterparts. In fact, 52 per cent more NUD households reported walking trips than did their CSD counterparts (21.3 per cent, versus 14 per cent). Fully 51 per cent of NUD households reported walking and biking to local services and stores several times a week, compared to only 19 per cent for CSD households. Also, 64 per cent of NUD respondents said they stroll or bike for leisure several times a week in the warm months, compared to 52 per cent in the CSDs. Moreover, respondents from the NUDs were almost twice as likely as respondents from the CSDs to

report that they were walking a lot more in their current location than in their previous home (37 per cent, versus 20 per cent).

Greater use of public transit: The modal share of public transit was low in both types of developments, with, on average, no difference between the two (9-per-cent modal share). Although the NUDs had more transit-supportive densities, the levels of transit service to NUDs and their counterpart CSDs were similar, as were each pair's locations relative to the metropolitan core.

Higher resident satisfaction with neighbourhood design: The survey revealed that, in comparison with their CSD counterparts, nearly double (60 per cent, versus 34 per cent) the respondents in the NUDs reported being very satisfied with the physical design of the streets, landscaping and façades in their neighbourhoods. Similarly, double the respondents in the NUDs found the streetscapes very pleasant for walking, compared to the CSD households (85 per cent, versus 44 per cent). Likewise, the design of the streetscape was considered to be very safe for walking and biking by 51 per cent more NUD respondents than households residing in the CSDs (55 per cent, versus 37 per cent).

More use of public open/green space: A proportion of 52 per cent of NUD respondents reported visiting public open spaces several times a week, compared to only 40 per cent of the respondents in CSDs, even though our neighbourhood metrics showed that NUDs had only slightly more public open space than CSDs. Households in NUDs were much more likely to report that they found it very convenient to either walk or bike to parks than households in comparable CSDs (70 per cent, versus 47 per cent).

More interaction with neighbours: Most of our indicators suggest that NUD respondents had more interaction with their neighbours than did their CSD counterparts. They greeted their neighbours more often than did the respondents living in the CSDs, with 35 per cent reporting a greeting almost every time they were out for a walk, compared to 27 per cent for CSD households. NUD households also reported socializing face-to-face with their neighbours more often, with 40 per cent saying they did so several times a week, in contrast to CSD households, 34 per cent of whom reported doing so. Although CSD respondents were more likely to hold a membership in sports or social groups, households in NUDs attended more community events per year, on average, than their CSD counterparts.

Greater sense of neighbourhood attachment: Not surprisingly, given the higher degree of satisfaction with the neighbourhood design and with stronger indicators of social interaction, the NUD respondents were found to be more attached to their neighbourhoods than the CSD households (50 per cent, versus 36 per cent). This was the case, in spite of the fact the NUDs were more recently built and respondents had, on average, lived in them for fewer years than those living in the four CSDs.

CONCLUSIONS

Our overall conclusion is that there is considerable evidence that the four NUDs we studied achieved these objectives more successfully than their CSDs counterparts. The only exceptions were the modal share of transit (which was the same for both neighbourhood types) and jobs within 5 km. Both results reflect the fact that the CSDs were intentionally chosen to have similar levels of transit service and locations with respect to the metropolitan core as their NUD counterparts.

Our statistical analysis indicates that the built-form design features that are thought to increase active modes of transport and reduce car use are indeed linked with more walking and biking behaviour and less car use in our study neighbourhoods. VKTs are more strongly correlated to larger-scale factors, whereas walking and cycling activity is more strongly linked to smaller-scale factors. The regression model suggests that these design features are associated with reduced VKTs, even when controlling for income, housing type, household size and automobile ownership. As expected, the model also indicates that VKTs rise with an increase in the number of cars owned, number of adults in the household size and household income. Finally, the model also implies that household perceptions about the neighbourhood built form do not have a significant impact on VKTs nor does housing type.

We tested the self-selection bias as a possible explanation of these results and found that it is not a significant factor in explaining the differences in VKT in the presence of other explanatory variables.

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Comparaison de quartiers canadiens reflétant les principes du nouvel urbanisme avec des banlieues traditionnelles (nouvelle version)

CONTEXTE

Le nouvel urbanisme est un mouvement qui a vu le jour dans les années 1980 comme solution de rechange à l'aménagement traditionnel des banlieues de l'après-guerre. Les architectes à l'origine de ce concept[1] sont revenus à des normes d'aménagement antérieures au règne de l'automobile, afin de créer des quartiers dotés de rues interreliées et agréables pour les piétons, d'habitations diversifiées, de commerces locaux et d'équipements publics à la fois plus nombreux et plus esthétiques.

Les principes du nouvel urbanisme sont clairement énoncés dans la Charte du Nouvel Urbanisme adoptée en 1996. Ces caractéristiques conceptuelles visent à influer sur les comportements, notamment sur les modes de déplacement et les attitudes des résidents. Selon la Charte, l'urbanisation diversifiée favorise le recours à la marche à pied pour vaquer à nombre d'occupations quotidiennes. La mixité des habitations renforce les relations individuelles et collectives entre les particuliers si nécessaires à une véritable communauté. L'amélioration des réseaux piétonniers et du paysage des rues incite les gens à se déplacer à pied et leur permet de faire la connaissance de leurs voisins. Et enfin, les équipements publics renforcent le sentiment d'appartenance à la collectivité.

La recherche documentaire a fait ressortir l'existence de plusieurs études comparant les comportements de résidents habitant dans des vieux quartiers et dans des quartiers issus du nouvel urbanisme avec les comportements de résidents de quartiers de banlieue traditionnels. Or, ces études avaient tendance à porter sur un seul aspect de la question, comme les habitudes de déplacement, et n'étaient fondées que sur des exemples américains. Il existe manifestement une lacune en matière de recherche sur les aménagements canadiens et sur l'éventail complet des comportements sociaux et des habitudes de déplacement.

La présente étude se penche sur des exemples de quartiers de banlieue conçus au Canada, d'une part, suivant les principes du nouvel urbanisme et, de l'autre, suivant les principes des banlieues traditionnelles. Elle a pour but de vérifier l'hypothèse selon laquelle les caractéristiques conceptuelles du nouvel urbanisme sont effectivement associées à des choix plus durables en termes de mode de déplacement, à une interaction accrue entre les résidents et à une plus grande participation de ceux-ci à la vie de leur collectivité.

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[1] Les architectes américains Andrés Duany et Elizabeth Plater-Zyberk ont été les premiers à élaborer ce concept, qui a par la suite été adopté par le Congrès du Nouvel Urbanisme, fondé en 1993.

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OBJET

La présente étude a pour objet de recueillir des données relatives à des quartiers fondés les uns sur les principes d'aménagement du nouvel urbanisme (QNU) et les autres sur les principes d'aménagement des banlieues traditionnelles (QBT), afin de déterminer si les QNU ont mieux que les QBT permis d'atteindre les objectifs visés dans les domaines suivants :

Caractéristiques conceptuelles

- Accès plus aisé aux destinations quotidiennes, telles que les espaces verts et autres aires publiques ouvertes ou encore les établissements institutionnels ou commerciaux.
- Plus de connectivité et routes pour les piétons.
- Plus grand choix d'habitations.
- Moindre superficie de terrain requise par logement.

Comportements et attitudes

- Utilisation réduite de l'automobile pour les déplacements urbains en semaine.
- Augmentation des déplacements quotidiens à pied et à bicyclette.
- Recours plus fréquent au transport en commun.
- Plus grande satisfaction des résidents vis-à-vis de la conception de leur quartier.
- Utilisation accrue des espaces verts et autres aires publiques ouvertes.
- Interactions sociales plus fréquentes entre voisins.
- Plus grand sentiment d'appartenance au quartier.

La recherche dont les résultats sont relatés ci-après a par ailleurs utilisé des procédés statistiques pour analyser les relations entre les caractéristiques du milieu bâti et les choix de mode de déplacement observés au sein des divers quartiers pris en considération.

MÉTHODE D'ENQUÊTE

La présente étude aborde les questions à l'étude de façon empirique, et plus exactement en procédant à une comparaison intersectorielle de quatre quartiers fondés sur les principes du nouvel urbanisme et de quatre autres fondés sur les principes d'aménagement des banlieues traditionnelles au Canada. Les étapes de cette comparaison ont été les suivantes :

Analyse documentaire : La recherche a débuté par une analyse des écrits relatifs aux retombées des caractéristiques du nouvel urbanisme après la prise de possession des lieux par leurs occupants. Elle a porté tant sur les États-Unis que sur le Canada et s'est concentrée sur les habitudes de déplacement et les attitudes sociales susceptibles de varier suivant les caractéristiques conceptuelles des quartiers, telles que la densité, les utilisations mixtes du territoire, le tracé des rues et la qualité des réseaux piétonniers.

Analyse de l'environnement des QNU : Une analyse de l'environnement a ensuite permis de repérer les QNU se prêtant le mieux aux comparaisons voulues. Pour compléter les recherches effectuées à cette fin sur Internet et dans les archives des journaux, plusieurs informateurs clés dans différentes régions du pays ont été invités à suggérer des QNU. Cette analyse a abouti à la présélection de 38 quartiers distincts présentant des caractéristiques du nouvel urbanisme.

Sélection des QNU : Des renseignements plus détaillés ont été pris auprès du service d'urbanisme local de chaque QNU présélectionné au sujet du quartier en question, y compris son âge, sa superficie, le nombre de logements qui s'y trouvent et les utilisations non résidentielles de son territoire. La sélection définitive des QNU retenus aux fins de comparaison s'est appuyée sur ces renseignements.

Sélection des QBT comparables : Quatre quartiers aménagés en application de principes des banlieues traditionnelles ont été sélectionnés à leur tour en vue d'une comparaison valable avec les QNU retenus. Le choix a porté, pour chacun de ces derniers, sur un QBT situé non loin, à un emplacement similaire dans la région urbaine, et dont l'âge, la superficie et la population étaient comparables, au même titre que les fourchettes de prix des habitations et les possibilités d'accès au transport en commun.

Collecte de données sur la conception des quartiers : Le Système d'information géographique, diverses sources de données recueillies par satellite, et enfin, plusieurs enquêtes sur place complétées de renseignements fournis par les urbanistes locaux ont permis de dresser un tableau détaillé des caractéristiques conceptuelles de chaque quartier. Ces caractéristiques incluaient la superficie, le nombre de logements, les utilisations non résidentielles du territoire, la largeur des rues et les reculs des immeubles, etc.

Géocodage des caractéristiques des quartiers : Une bonne partie des données recueillies concernant la conception des quartiers a fait l'objet d'un géocodage aux fins de présentation spatiale et de tabulation.

Enquête auprès des ménages : Une enquête quantitative a été menée au sein des huit quartiers à l'étude, afin d'évaluer les habitudes de déplacement et les comportements sociaux de leurs résidents. Le questionnaire d'enquête invitait notamment les membres des ménages sondés à noter tous leurs déplacements durant une période de 24 heures. Ce questionnaire, que la plupart des répondants ont rempli en ligne, était aussi disponible en format imprimé, en plus de quoi les personnes intéressées pouvaient obtenir de l'aide au téléphone. La période d'enquête s'est déroulée du 30 août au 30 octobre 2006, durant laquelle 2 043 ménages ont soumis un questionnaire dûment rempli.

Géocodage des résultats de l'enquête : Les données spatiales (emplacement des domiciles et destinations quotidiennes) tirées des réponses à l'enquête ont fait l'objet d'un géocodage aux fins d'une analyse détaillée des distances parcourues.

Analyse des résultats de l'enquête : Les divers ensembles de données ont été analysés, de sorte à quantifier les différences entre les deux types de quartiers (QNU et QBT).

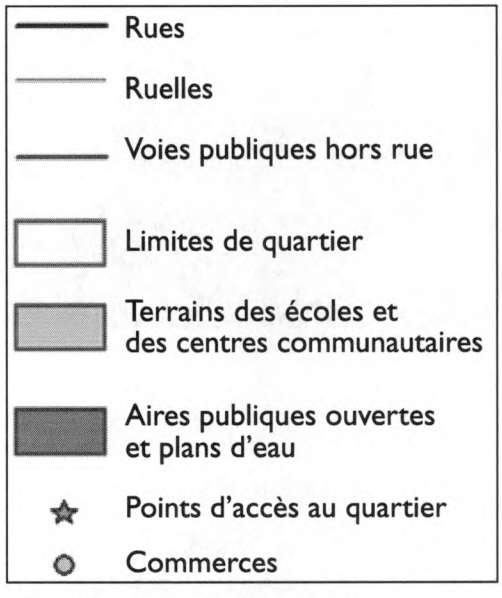
Analyse statistique : Une série de résultats choisis ont été soumis à une analyse de corrélation portant sur les liens entre les caractéristiques conceptuelles des quartiers et les modes de déplacement des résidents de ces derniers. Une analyse de régression a permis de cerner les principaux facteurs jouant sur l'utilisation de l'automobile dans les huit quartiers à l'étude.

LES QUARTIERS À L'ÉTUDE

Les quatre QNU et leurs QBT parallèles retenus aux fins de la présente étude sont énumérés au tableau 1.

Tableau 1 Les quartiers retenus aux fins de l'étude

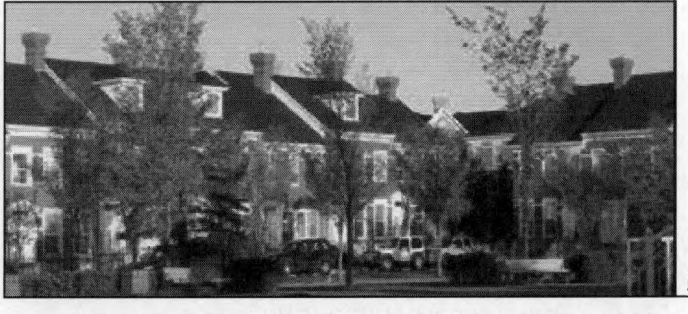
Nouvel urbanisme	Banlieue traditionnelle	Ville	Contexte urbain
McKenzie Towne	McKenzie Lake	Calgary	Banlieue lointaine
Garrison Woods	North Signal Hill	Calgary	Banlieue proche
Cornell	Woodbine North	Markham	Banlieue lointaine
Bois-Franc	Nouveau Saint-Laurent	Montréal	Banlieue proche

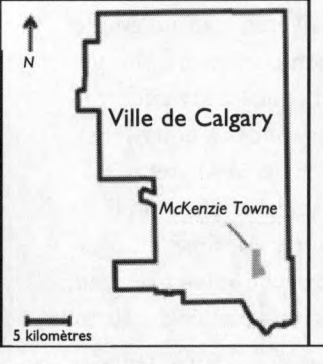


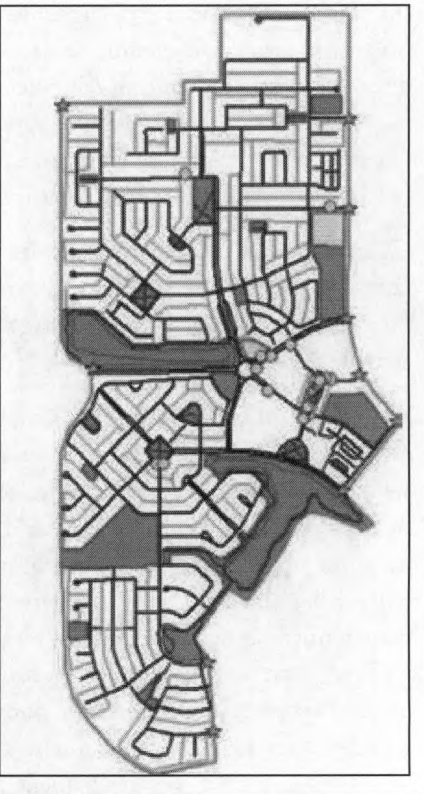
Légende des plans de quartiers (représentant l'état d'achèvement de la construction au moment de l'étude)

McKenzie Towne

- Situé à 20 km du quartier des affaires central (QAC) de Calgary.
- Superficie de la zone étudiée : 2,6 km²; 4 625 habitations achevées en 2006 sur les 8 000 prévues en tout.
- La densité brute est de 17,2 logements par hectare (lph), dont 60 % sont des maisons individuelles, le reste des maisons en rangée, des duplex et des appartements.
- 16 % de la superficie du quartier est réservée à des aires publiques ouvertes.
- Il y a un centre commercial sur place.
- Il y a 2 écoles à 1 km du centre du quartier.
- 83 % des rues ont un trottoir des deux côtés.

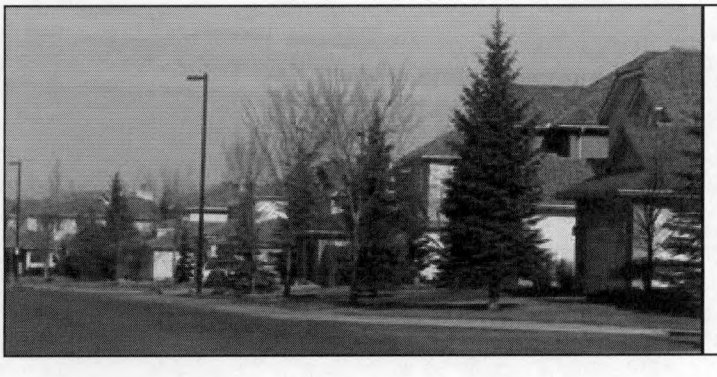


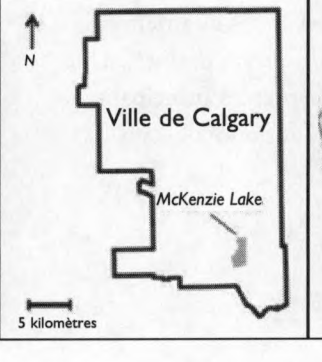


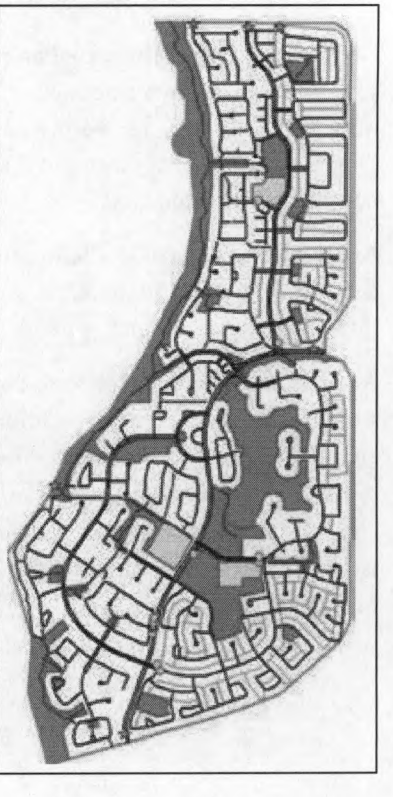


McKenzie Lake

- Situé à 20 km du QAC de Calgary.
- Superficie : 4,2 km²; 4 641 habitations achevées en 1999.
- 90 % des habitations sont des maisons individuelles, le reste des maisons en rangée, des duplex et des appartements; la densité brute est de 10,5 lph.
- Peu de commerces; 4 écoles dans un rayon de 1 km.
- 19 % du quartier est réservé aux aires publiques ouvertes.
- 40 % des rues ont un trottoir des deux côtés.

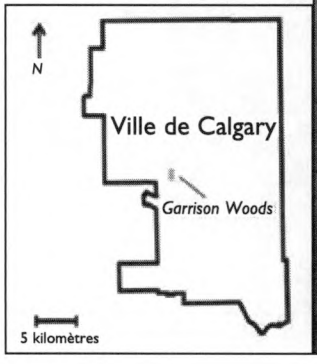


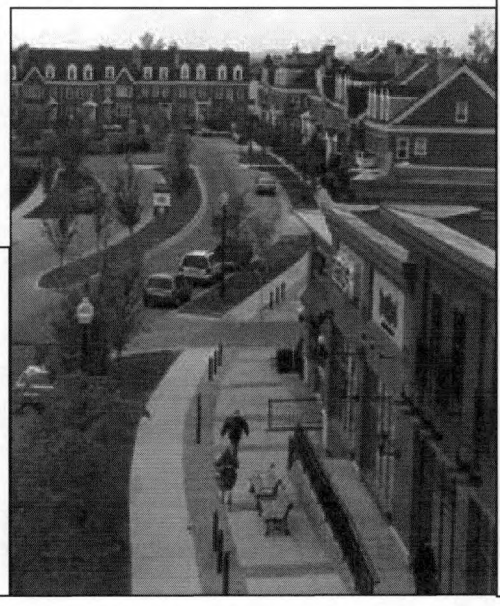


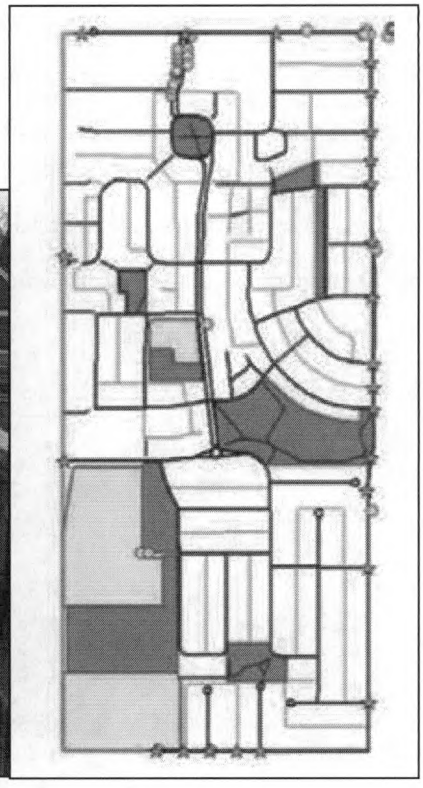


Garrison Woods

- Situé à 5 km du QAC de Calgary.
- Superficie : 0,77 km²; 1 535 habitations achevées en 2005.
- Les habitations incluent plus de 30 % d'appartements, de même que 20 % de maisons en rangée et 15 % de duplex; la densité brute est de 20 lph.
- Le quartier est formé à raison de 12 % d'aires publiques ouvertes (de qualité supérieure) et inclut plus de routes piétonnières par km² que les autres.
- Ce quartier inclut le plus d'utilisations non résidentielles dans un rayon de 1 km, y compris 11 écoles.
- 53 % des rues ont un trottoir des deux côtés.

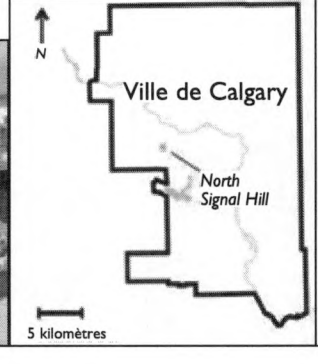


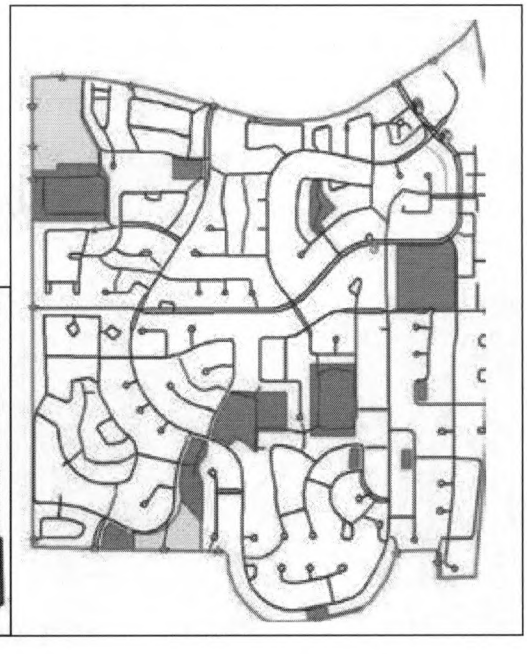




North Signal Hill

- Situé à 8 km du QAC de Calgary.
- Superficie : 2,5 km²; 3 114 habitations achevées dans les années 1990.
- 70 % de maisons individuelles; densité brute :12,6 lph.
- Moins d'utilisations commerciales que partout ailleurs, dont 1 école dans un rayon de 1 km.
- 8 % d'aires publiques ouvertes.
- 33 % des rues ont un trottoir des deux côtés.

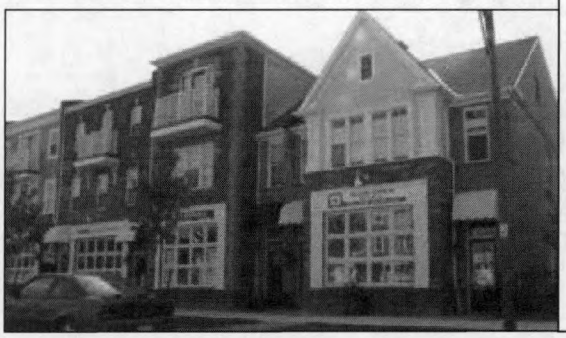




Comparaison de quartiers canadiens reflétant les principes du nouvel urbanisme avec des banlieues traditionnelles (nouvelle version)

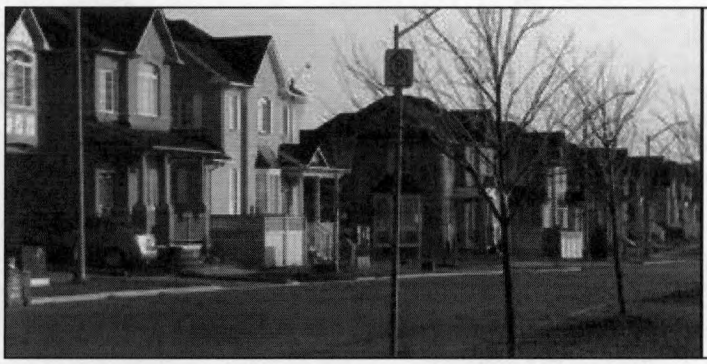
Cornell, Markham

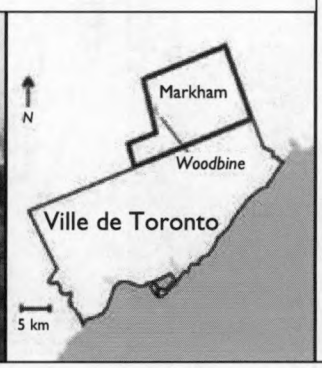
- Situé à 30 km du QAC de Toronto.
- Superficie de la zone étudiée : 1 km^2; premières habitations mises en chantier en 1999.
- Incluait 1 894 habitations au moment de l'étude; 10 000 sont prévues au total.
- 36 % des habitations sont des maisons individuelles, 46 % des maisons en rangée, 17 % des jumelés et 1 % des appartements; la densité brute est de 19,6 lph.
- Inclut des utilisations commerciales le long de la rue principale.
- Les aires publiques ouvertes forment 13 % de la superficie du quartier.
- Il y a 1 école dans un rayon de 1 km.
- 93 % des rues ont un trottoir des deux côtés.

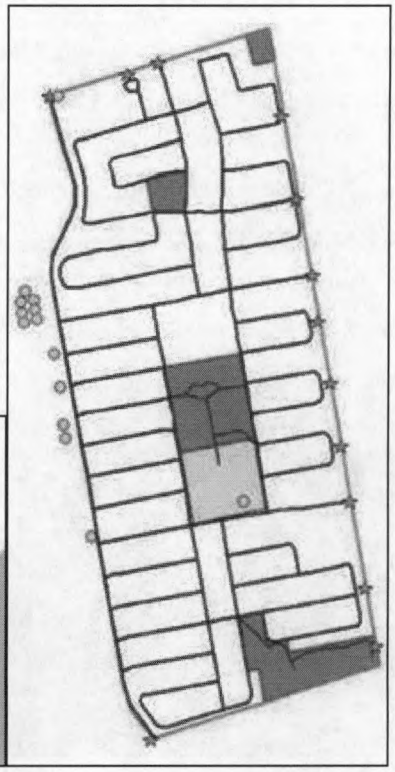


Woodbine North, Markham

- Situé à 28 km du QAC de Toronto.
- Superficie : 0,75 km^2; 1 218 habitations achevées en 2002.
- 64 % de maisons individuelles, 15 % de maisons en rangée et 21 % de jumelés; densité brute : 16,3 lph.
- Adjacent à un centre commercial; 1 école dans un rayon de 1 km.
- 10 % du quartier est constitué d'aires publiques ouvertes.
- 19 % des rues ont un trottoir des deux côtés.

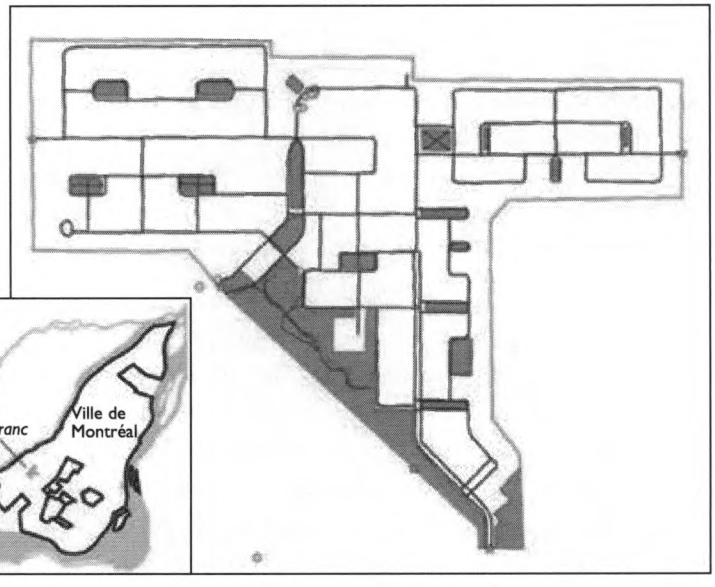






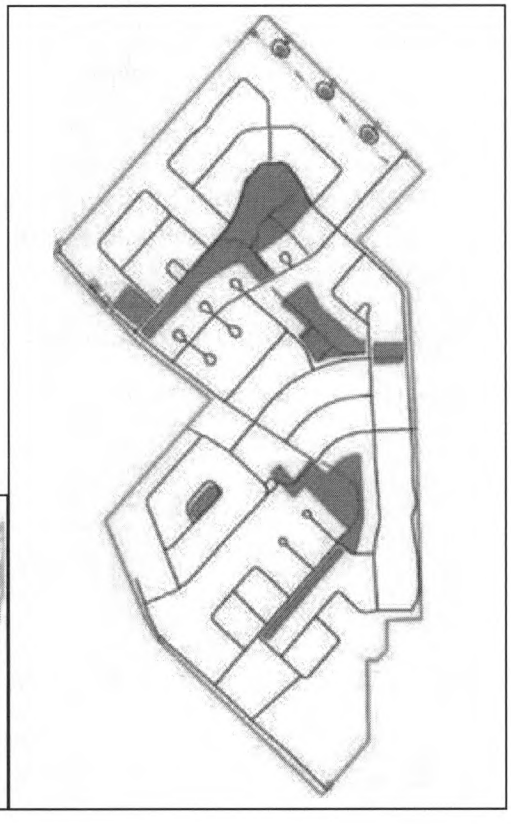
Bois-Franc

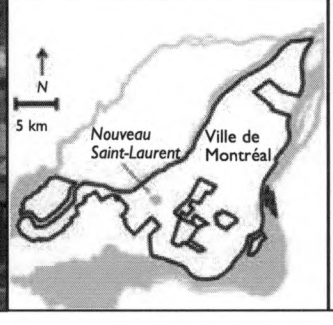
- Situé à 11 km du QAC de Montréal.
- Superficie de la zone étudiée : 0,9 km²; 2 605 habitations construites au moment de l'étude depuis la 1re mise en chantier en 1993, 5 300 prévues en tout.
- 43 % de maisons en rangée, 50 % de logements collectifs, 7 % de maisons individuelles et jumelées; densité brute : 30,7 lph.
- Un petit centre commercial.
- 13 % d'aires publiques ouvertes (de qualité supérieure).
- 4 écoles dans un rayon de 1 km.
- 81 % des rues ont un trottoir des deux côtés.



Nouveau Saint-Laurent

- Situé à 11 km du QAC de Montréal.
- Superficie de la zone étudiée : 0,9 km²; 970 habitations achevées au moment de l'étude, 1 200 prévues en tout.
- 52 % de maisons individuelles, 24 % de maisons en rangée, 4 % de jumelés et 20 % de logements collectifs; densité brute : 10,5 lph.
- Très peu d'utilisations commerciales, pas une seule école dans un rayon de 1 km.
- 10 % d'aires publiques ouvertes.
- 21 % des rues ont un trottoir des deux côtés.





PRINCIPALES CONSTATATIONS

Caractéristiques conceptuelles

L'une des principales caractéristiques de tout aménagement urbain est la densité d'occupation résidentielle. Globalement, la densité résidentielle brute relevée était de 2 021 logements par km² (soit 20,2 lph) dans les QNU, contre 1 163 logements par km² (soit 11,6 lph) dans les QBT, ce qui témoigne du fait que, des deux types d'aménagements à l'étude, les QNU sont de loin les plus compacts. Les QNU présentent aussi une bien plus grande variété d'habitations : nous y avons recensé une proportion de maisons individuelles inférieure de plus de moitié à celle observée dans les QBT et un pourcentage cinq fois supérieur de logements collectifs situés dans des immeubles comptant plus de cinq étages.

Le nombre de magasins et de services, de même que la quantité d'établissements d'enseignement et de loisirs, situés dans un rayon de 1 km du point central des quartiers à l'étude, est près de deux fois plus important dans les QNU que dans les QBT. Par contre, nous avons constaté que les emplois dans un rayon de 5 km du point central des quartiers sont 17 % moins nombreux dans les QNU que dans les QBT. À titre de rappel, les QBT pris en considération ont été choisis parce que leur distance relativement au noyau de la région métropolitaine était similaire à celle des QNU auxquels il était question de les comparer.

Les quatre QNU étudiés disposent d'un peu plus d'espaces verts et d'autres aires publiques ouvertes que les quatre QBT (14,4 % de leur superficie totale pour les premiers, contre 13,8 % pour les seconds). La densité des rues est à peu près identique dans les deux types de quartiers, mais en tenant compte aussi des ruelles, elle est supérieure de 38 % dans les QNU par rapport aux QBT. Pour ce qui est des voies publiques hors rue (à l'exclusion des trottoirs), elles sont plus denses au sein des QNU (2,3 km de longueur par nombre total de km²) que des QBT (1,9 km). Globalement, la densité rues/voies/ruelles des QNU dépasse, en moyenne, celle des QBT de 36 %.

Nous avons relevé un pourcentage très élevé de rues sans trottoirs dans les QBT (27,5 %) relativement aux QNU (2,8 %). Plus des trois quarts des rues des QNU sont bordées de trottoirs des deux côtés, contre seulement 28,5 % de celles des QBT. De même, les reculs des immeubles sont nettement plus courts dans les QNU que dans les QBT : 83,7 % des immeubles des QBT sont situés à plus de 5,5 mètres du bord de la rue, ce qui n'est le cas que de 43,1 % des immeubles des QNU. En ce qui a trait à la largeur moyenne des rues, les QNU possèdent environ trois fois plus de rues étroites (soit d'une largeur inférieure à 7,6 mètres) que les QBT (leurs proportions respectives étant de 11,5 et 3,9 %).

Nous avons constaté que les QNU offrent une connectivité piétonnière légèrement supérieure à celle des QBT. En calculant le rapport moyen des distances en ligne directe et des distances réelles au sein d'un réseau routier entre chaque habitation et toutes les autres habitations d'un quartier, il s'avère que les QNU présentent une connectivité un peu meilleure (0,78) à cet égard par comparaison aux QBT (0,74), l'écart entre les deux étant de l'ordre d'environ 5 %.

Certaines des caractéristiques conceptuelles observées sont résumées au tableau 2.

Tableau 2 Récapitulatif partiel des caractéristiques conceptuelles observées

Quartier	Superficie totale (km²)	Maisons individuelles (%)	Densité brute (lph)	Util. non rés. dans un rayon de 1 km*	Espaces verts/ aires publiques ouvertes (%)	Trottoirs des 2 côtés (%)	Reculs > 5,5 m (%)	Largeur des rues < 7,6 m (%)	Connec-tivité pour les piétons	Densité rues/ chemins/ ruelles
Bois-Franc	0,85	3	30,7	24	12,7	80,7	35,5	24,8	0,76	15,7
Nouv. St-Laurent	0,92	52	10,5	12	9,6	21,2	97,1	1,5	0,71	15,3
Cornell	0,97	36	19,6	22	12,8	93,1	32,4	2,1	0,82	25,9
Woodbine North	0,75	64	16,3	46	8,9	19,4	76,5	0	0,80	18,7
Garrison Woods	0,77	28	19,9	132	12,2	52,8	73,8	4,9	0,79	23,8
North Signal Hill	2,46	72	12,6	49	8,2	33,1	82,5	10,4	0,70	15,4
McKenzie Towne	2,69	59	17,2	45	16,2	83,2	31,0	13,9	0,74	21,8
McKenzie Lake	4,42	91	10,5	16	18,6	40,2	78,8	3,5	0,76	16,8
QNU (moyenne)	**1,32**	**31**	**20,2**	**55,8**	**14,4**	**77,4**	**43,1**	**11,5**	**0,78**	**21,8**
QBT (moyenne)	**2,14**	**70**	**11,6**	**30,8**	**13,8**	**28,5**	**83,7**	**3,9**	**0,74**	**16,0**

* inclut les utilisations du territoire à des fins commerciales et institutionnelles.

Conclusions de l'enquête auprès des ménages

Les conclusions présentées ci-dessous sont tirées des réponses des plus de 2 000 ménages qui ont participé au sondage évoqué plus haut.

Profils des ménages

Selon les réponses à notre enquête, les ménages des QBT comptent davantage de membres (3,3) que ceux des QNU (2,7). Nous avons par ailleurs constaté que les ménages des QBT sont proportionnellement plus nombreux à inclure des enfants que ceux des QNU. Le pourcentage d'étudiants est de ce fait nettement plus élevé dans les QBT que dans les QNU.

En ne tenant compte que des adultes parmi les ménages répondants, la population des QNU est plus jeune que celle des QBT. Les personnes de plus de 45 ans, en particulier, représentent 36 % des résidents des QBT, mais seulement 28 % des résidents des QNU. De plus, la population adulte des QNU inclut un plus fort pourcentage de personnes occupées que celle des QBT. Ces constatations donnent à penser que les QNU attirent des adultes comparativement plus jeunes, tandis que les QBT ont la faveur des adultes plus âgés qui ont des enfants. Autre résultat de l'enquête qui cadre bien avec cette interprétation : le revenu des ménages des QBT dépasse de près de 8 % celui des ménages des QNU. C'est ainsi que le revenu moyen des ménages dans tous les quartiers étudiés est supérieur à 100 000 $.

Comme on peut s'y attendre compte tenu de l'écart entre les deux types de quartiers sur le plan de la taille des ménages, les répondants des QBT occupent des logements plus spacieux que les ménages des QNU. Dans les QNU, 80 % des logements comportent par exemple au plus trois chambres, alors que dans les QBT, cette proportion est de 45 %. Vu leur moindre taille, les logements au sein des QNU sont, en moyenne, plus abordables que les logements au sein des QBT. Près de 38 % des logements des répondants des QBT sont d'une valeur inférieure à 450 000 $, par comparaison à 68 % au sein des QNU.

Bien que l'habitation soit comparativement moins chère dans les QNU, aucune différence significative n'a été relevée entre les deux types de quartiers sur le plan du mode d'occupation des logements. Dans les QNU comme dans les QBT, 96 % des répondants sont propriétaires de leur habitation.

Tableau 3 Résumé partiel des résultats d'enquête – Profils des ménages

Variable relative au ménage	QNU (moyenne)	QBT (moyenne)
Taille des ménages (nombre de personnes)	2,7	3,3
Membres des ménages ayant plus de 9 ans (nombre de personnes)	2,2	2,7
Revenu des ménages (en dollars)	110 000	119 000
Prix des habitations (en dollars)	411 000	495 000
Taille des habitations (nombre de chambres)	2,9	3,6

Perceptions des répondants à l'égard de leur quartier

Il ressort des résultats de l'enquête que par comparaison aux ménages des QBT, près du double (60 % contre 34 %) des répondants des QNU disent être très satisfaits de la conception des rues, de l'aménagement paysager et des façades des immeubles dans leur quartier. Pareillement, deux fois plus de répondants parmi ceux qui vivent dans un QNU comparativement à ceux issus des QBT (85 % contre 44 %) estiment que le paysage des rues de leur quartier rend la marche très agréable. Toujours dans la même veine, les répondants vivant dans un QNU sont 51 % plus nombreux que ceux qui habitent un QBT (55 % contre 37 %) à considérer les rues de leur quartier très sécuritaires pour les déplacements à pied ou à bicyclette. Ces perceptions éclairent dans une certaine mesure d'autres résultats d'enquête selon lesquels 70 % des ménages des QNU, contre à peine 47 % des ménages des QBT, trouvent qu'il est très facile de se rendre de leur domicile à des parcs, que ce soit à pied ou à bicyclette.

Qui plus est, 52 % des répondants au sein des QNU disent visiter plusieurs fois par semaine des espaces verts ou d'autres types d'aires publiques ouvertes, contre seulement 40 % des répondants au sein des QBT. Et ce, bien que les QNU n'aient que légèrement plus d'espaces ou d'aires de ce type que les QBT et que les ménages résidant dans ces derniers aient plus d'enfants.

Il semble aussi y avoir une différence entre les deux types de quartiers en ce qui concerne l'appréciation de leur qualité architecturale par leurs résidents. Une proportion importante (29 %) de répondants vivant dans un QNU ont évoqué la qualité architecturale des habitations et autres immeubles comme principal facteur les ayant incités à s'établir dans leur

quartier. Par comparaison, à peine 6 % des répondants vivant dans un QBT ont dit avoir basé leur décision d'habiter dans leur quartier principalement sur cette même raison. La qualité de leur propre logement a été citée par 22 % des répondants résidant dans un QBT comme le principal facteur les ayant motivés à aller vivre dans leur quartier plutôt qu'un autre, et par seulement 13 % des répondants vivant dans un QNU.

Les répondants des QNU se sont dits plus attachés à leur quartier que ceux des QBT (50 % y étaient très attachés dans le premier cas par rapport à 36 % dans le second cas), et ce, malgré le fait que la durée de résidence des premiers dans leur quartier était, en moyenne, bien plus courte que celle des seconds (ce qui reflète l'achèvement assez récent de la construction des QNU).

Tableau 4 Résumé partiel des résultats d'enquête – Perception de la conception des quartiers

Perception de la conception de leur quartier (% des répondants)	QNU (moyenne)	QBT (moyenne)
Paysage des rues rend la marche très agréable	85	44
Rues très sécuritaires pour les déplacements à pied et à bicyclette	55	37
Très facile d'atteindre des aires publiques ouvertes à pied ou à bicyclette	70	47
Très attachés à leur quartier	50	36
Conception globale du quartier très satisfaisante	60	34
Plusieurs visites des aires publiques ouvertes par semaine	52	40
Qualité de l'architecture principal facteur à la base de la décision d'emménager dans le quartier	29	6

Interactions sociales

Nous avons constaté que les répondants des QNU saluent leurs voisins plus souvent que ceux des QBT, 35 % des premiers disant faire signe à quelqu'un de leur voisinage à chaque sortie à pied ou presque, par comparaison à 27 % des seconds. Les ménages des QNU disent aussi parler à leurs voisins en personne plus souvent que ceux des QBT : 40 % d'entre eux rapportent qu'ils le font plusieurs fois par semaine, par comparaison à 34 % des ménages des QBT. Bien que les répondants vivant dans un QBT soient plus susceptibles d'être membres d'un club sportif ou social, les répondants des QNU participent annuellement, en moyenne, à un plus grand nombre d'événements communautaires que ceux des QBT.

Ces résultats cadrent bien avec notre constatation que les répondants des QNU ont tendance à se déplacer plus souvent à pied ou à bicyclette que ceux des QBT, ce qui pourrait faciliter les interactions sociales avec leurs voisins. Nous avons par ailleurs observé que le rayon dans lequel les interactions sociales ont lieu diffère quelque peu entre les deux types de quartiers. En effet, les répondants des QBT sont enclins à fréquenter davantage leurs voisins immédiats et ceux des QNU ayant tendance à tisser des liens avec des gens partout dans leur quartier.

Tableau 5 Résumé partiel des résultats d'enquête – Interactions sociales

Interactions sociales (% des répondants)	QNU (moyenne)	QBT (moyenne)
Saluer des voisins à chaque sortie ou presque	35	27
Parler à des voisins en personne plusieurs fois par semaine	40	34
Connaître 10 voisins ou plus par leur nom	52	51
Faire partie d'un club ou autre groupement du quartier	32	41
Participer à des événements communautaires, 4 fois par année ou plus	15	11

Habitudes de déplacement des ménages

Les éléments de preuve relevés tendent largement à confirmer l'hypothèse selon laquelle les répondants des QNU se déplacent plus souvent à pied et à bicyclette que ceux des QBT. Non moins de 51 % des répondants des QNU ont effectivement dit se rendre plusieurs fois par semaine à des commerces ou services de leur quartier à pied ou à bicyclette, par comparaison à seulement 19 % des répondants des QBT. De plus, 64 % des répondants des QNU disent se promener ou faire du vélo pour le plaisir dans leur quartier plusieurs fois par semaine à la belle saison, contre 52 % des répondants des QBT. Ces constatations cadrent bien avec d'autres résultats antérieurs relatifs aux perceptions des résidents à l'égard de leur quartier : les répondants des QNU ont été plus nombreux à décrire leur quartier comme plaisant et sécuritaire pour les déplacements à pied et à bicyclette.

Afin de vérifier si les changements dans la forme bâtie peuvent influer sur les habitudes de déplacement des ménages, nous avons interrogé les répondants sur leurs habitudes de déplacement à leurs lieux de résidence antérieurs. Il s'avère que 37 % des ménages habitant un QNU disent se déplacer bien plus souvent à pied depuis qu'ils ont emménagé à cet endroit. Par contraste, seuls 20 % des ménages des QBT disent faire beaucoup plus de marche depuis qu'ils y habitent. Au contraire, un pourcentage bien plus élevé (26 %) des répondants des QBT disent se déplacer moins souvent à pied qu'auparavant, tandis que ceux qui vivent dans un QNU ne sont que 11 % à rapporter que la fréquence de leurs déplacements à pied a diminué. Parmi les résidents des QNU, 39 % des répondants affirment utiliser leur voiture moins souvent qu'à leur lieu de résidence antérieur. D'un autre côté, 18 % des répondants des QBT disent se déplacer moins souvent en automobile depuis leur installation dans leur quartier, alors que 47 % d'entre eux disent prendre la voiture plus souvent (accroissement observé chez 29 % des répondants des QNU seulement). Ces résultats viennent appuyer l'hypothèse selon laquelle les caractéristiques conceptuelles des QNU encouragent une plus grande fréquence des déplacements à pied et à bicyclette[2].

L'enquête a également fait ressortir que les ménages des QNU sont 24 % moins susceptibles de posséder plus d'un véhicule que ceux des QBT : 61 % des ménages des QNU sont propriétaires de deux véhicules ou plus, contre 80 % des ménages des QBT. Les ménages des QNU possèdent un nombre similaire de véhicules qu'avant leur installation dans ce type de quartier. Par exemple, 59 % des répondants des QNU sont propriétaires de deux véhicules ou plus dans leur présent et ancien quartier. Or, ceux qui ont emménagé dans un QBT ont eu tendance depuis à acquérir davantage de véhicules par rapport à leur ancien quartier, puisque le nombre d'entre eux qui possèdent deux véhicules ou plus est passé de 70 % à 80 %.

Une caractéristique clé du milieu bâti qui influe sur les habitudes de déplacement est la disponibilité de places de stationnement. On croit qu'une plus grande disponibilité de telles places favorise la possession d'un nombre accru de véhicules. Selon les résultats de notre enquête, les répondants vivant dans un QNU ont accès à nettement moins de places de stationnement que les répondants qui résident dans un QBT. Dans l'ensemble, 62 % des ménages des QBT disent disposer de trois places pour stationner des voitures, sinon plus, contre 35 % des ménages des QNU. Ainsi, les ménages des QNU ont tendance à disposer d'un nombre réduit de places de stationnement, à posséder moins de voitures et à se déplacer moins souvent en automobile que ceux des QBT.

Analyse des comptes rendus de déplacements sur 24 heures

L'analyse plus poussée quant au mode de déplacement utilisé donne à penser que les répondants des QNU se déplacent moins souvent en automobile (que ce soit comme conducteur ou passager) que ceux des QBT (78 % du temps pour les premiers, 85 % du temps pour les seconds). La proportion de répondants qui se déplacent à pied est bien plus importante dans les QNU que dans les QBT (11 % et 5 %, respectivement), surtout pour faire des achats (9 % contre 2 %). En ce qui concerne la part des déplacements effectués en transport en commun, elle est la même chez les répondants des deux types de quartiers, soit 9 %. Ceci reflète peut-être le fait que le choix des QBT retenus aux fins de comparaison avec les QNU était fondé, en partie, sur leur

Tableau 6 Résumé partiel des résultats d'enquête – Habitudes de déplacement

Habitudes de déplacement	QNU (moyenne)	QBT (moyenne)
Plusieurs déplacements hebdomadaires à pied ou à bicyclette pour se rendre aux magasins ou services locaux (% des répondants)	51	19
Plusieurs déplacements hebdomadaires à pied ou à bicyclette pour le plaisir (% des répondants)	64	52
Marche à pied beaucoup plus fréquente qu'au lieu de résidence antérieur (% des répondants)	37	20
Conduite automobile réduite par rapport au lieu de résidence antérieur (% des répondants)	39	18
Possession de deux voitures, sinon plus (% des répondants)	61	80
Kilomètres parcourus en automobile (KPA) par ménage	37,1	46,0
Ménages disant se déplacer à pied (% des répondants)	21,3	14,0
Pourcentage (%) de déplacements effectués à pied	11	5
Pourcentage (%) de déplacements effectués en automobile (en tant que conducteur ou passager)	78	85
Pourcentage (%) de déplacements effectués en transport en commun	9	9

[2] Tel qu'indiqué plus loin, une recherche plus poussée dans ce domaine permettrait de mieux comprendre l'éventuelle incidence du biais d'autosélection.

similarité avec ces derniers sur le plan de l'accès au transport en commun (emplacement et fréquence des services).

En ce qui a trait à l'objet des déplacements, les répondants des QNU sont plus nombreux que ceux des QBT à dire qu'il leur arrive de marcher ou de faire de la bicyclette pour le plaisir (3 % par comparaison à 1 %). Les répondants des QNU sont plus de 50 % plus nombreux à dire qu'ils se déplacent à pied dans leur quartier que ceux des QBT (21,3 % contre 14 %). Le nombre de déplacements à pied effectués par les ménages qui disent marcher dans l'un ou l'autre type de quartier ne varie toutefois guère (2,3 pour les répondants des QNU et 2,0 pour ceux des QBT).

L'analyse du nombre de kilomètres parcourus en automobile (KPA) en l'espace de 24 heures par les divers répondants indique que les ménages des QBT ont un niveau de KPA de 24 % supérieur à ceux des QNU (46,0 km contre 37,1 km).

ANALYSE STATISTIQUE

La section que voici présente une analyse statistique des résultats que nous venons d'aborder. Cette analyse nous permet d'explorer les relations entre certaines des variables présentées ci-dessus, en plus de nous aider à répondre aux questions à l'étude. La principale question sur laquelle se penche cette analyse est celle de savoir s'il existe un lien entre les caractéristiques de l'aménagement urbain des quartiers à l'étude et les habitudes de déplacement des résidents de ces derniers. Dans un premier temps, nous examinons cette question en établissant une série de corrélations individuelles entre les variables du milieu bâti et les habitudes de déplacement constatées selon notre enquête auprès des ménages, afin de cerner tout lien important existant à cet égard. Ensuite, nous procédons à une analyse de régression à variables multiples des KPA, afin d'établir les facteurs qui influent sur ces derniers tout en tenant compte des variables parasites telles que la taille et le revenu des ménages.

Les corrélations ont été établies en utilisant des variables assorties des données disponibles à l'échelle des ménages ou groupées à l'échelle des quartiers. Le tableau 7 montre les résultats des corrélations individuelles fondées sur les variables du milieu bâti des quartiers par rapport aux habitudes de déplacement relevées ou estimées au niveau des ménages et des quartiers. Les variables relatives aux habitudes de déplacement incluent des réponses recueillies durant notre enquête à des questions portant notamment sur : la fréquence avec laquelle les répondants se rendent à pied ou à bicyclette à différentes destinations au sein de leur quartier; le nombre de fois qu'il leur arrive de faire de la marche ou de la bicyclette dans leur quartier sans destination particulière; dans quelle mesure leurs déplacements à pied ont augmenté par rapport à ce qu'ils étaient à leur lieu de résidence antérieur; dans quelle mesure leurs déplacements en automobile ont diminué; le nombre de trajets que chaque ménage effectue à pied; et enfin, le nombre de KPA pour chaque ménage. Ces variables relatives aux habitudes de déplacement ont toutes été mesurées au niveau des ménages. D'autres ont été mesurées au niveau des quartiers, notamment : le nombre de KPA par ménage dans chaque quartier; le pourcentage de ménages des divers quartiers disant faire des déplacements à pied; et la proportion moyenne des déplacements effectués à pied par les résidants de chaque quartier.

Le tableau 8 montre les résultats des corrélations individuelles établies entre les variables du milieu bâti touchant les ménages et les variables des déplacements relevées tant au niveau des ménages que des quartiers. Les variables du milieu bâti incluent des éléments mesurables à l'échelle d'un ménage ou d'un îlot urbain, tels que l'existence ou non de trottoirs sur la rue où habite un ménage; le recul moyen des immeubles sur cette rue; la largeur de la rue; et la connectivité piétonnière d'un ménage en fonction de l'emplacement de son habitation. Les variables du milieu bâti incluent aussi les réponses à des questions choisies du questionnaire d'enquête rempli par les ménages, y compris celles de savoir si les répondants sont satisfaits de la conception de leur quartier; si leur quartier leur semble sécuritaire pour les déplacements à pied et à bicyclette; et si les aires publiques ouvertes de leur quartier sont facilement accessibles à pied ou à bicyclette. Les variables liées aux habitudes de déplacement sont les mêmes qu'au tableau précédent.

Les données présentées sur les deux tableaux ci-dessus confirment dans l'ensemble les hypothèses fondées sur l'analyse documentaire. Bien que les corrélations établies ne soient pas toutes telles qu'attendu, il ressort de l'analyse statistique que les caractéristiques conceptuelles de l'aménagement urbain qu'on estime contribuer à un accroissement des modes de déplacement actifs et à une diminution de l'utilisation de l'automobile se traduisent bien par de tels résultats dans les huit quartiers à l'étude. Globalement, les résultats donnent à penser qu'il existe un lien plus fort entre les KPA et des facteurs de plus grande

Tableau 7 Corrélations entre les variables du milieu bâti au niveau des quartiers et les habitudes de déplacement

Variables du milieu bâti au niveau des quartiers	Variables des habitudes de déplacement au niveau des ménages						Variables des habitudes de déplacement au niveau des quartiers		
	Marche ou bicyclette vers des destinations dans le quartier	Marche ou bicyclette dans le quartier sans destination	Plus de marche qu'avant	Moins de conduite automobile qu'avant	Nombre de déplacements à pied	KPA	KPA en moyenne par ménage	% de ménages disant marcher	Part moyenne des déplacements faits à pied
Densité résidentielle	+	+	+	+	NS	-	-	-	+
Diversité des habitations	+	+	+	+	+	-	-	-	+
Emplois dans un rayon de 5 km	NS	+	NS	NS	-	-	-	-	-
Utilisations non résidentielles du territoire dans un rayon de 1 km	+	-	-	NS	NS	-	-	-	NS
Connectivité pour les piétons	+	+	+	NS	+	+	+	-	+
Densité des rues/ruelles	+	NS	+	+	+	+	+	NS	+
% de la superficie du quartier consacré à des aires publiques ouvertes	+	NS	+	NS	NS	+	+	+	-

+ = corrélation positive significative avec un intervalle de confiance de 95 %.
- = corrélation négative significative avec un intervalle de confiance de 95 %.
NS = corrélation non significative.

Tableau 8 Corrélations entre les variables du milieu bâti au niveau des ménages et les habitudes de déplacement

Variables du milieu bâti au niveau des ménages	Variables des habitudes de déplacement des ménages						Variables des habitudes de déplacement au niveau des quartiers		
	Marche ou bicyclette vers des destinations dans le quartier	Marche ou bicyclette dans le quartier sans destination	Plus de marche qu'avant	Moins de conduite automobile qu'avant	Nombre de déplacements à pied	KPA	KPA en moyenne par ménage	% de ménages disant marcher	Part moyenne des déplacements faits à pied
Trottoirs	+	+	+	+	+	NS	-	+	+
Reculs réduits	+	NS	+	+	NS	NS	-	+	-
Largeur des rues	NS	NS	NS	NS	NS	NS	NS	NS	NS
Connectivité piétonnière	+	NS	+	NS	NS	+	+	NS	+
Satisfaction à l'égard de la conception	+	+	+	+	NS	NS	-	+	+
Sécuritaire pour la marche ou la bicyclette	+	+	+	+	+	NS	-	+	+
Bonne accessibilité des aires publiques ouvertes	+	+	+	+	NS	NS	-	+	+

+ = corrélation positive significative avec un intervalle de confiance de 95 %.
- = corrélation négative significative avec un intervalle de confiance de 95 %.
NS = corrélation non significative.

envergure, tels que la densité résidentielle des quartiers, les possibilités d'emploi dans un rayon de 5 km, la diversité des habitations et les utilisations non résidentielles du territoire dans un rayon de 1 km. Par contre, les déplacements à pied et à bicyclette sont davantage liés à des facteurs de moindre envergure, tels que la présence de trottoirs, les reculs des immeubles et la perception par les résidents de la qualité de la marche à pied dans leur quartier.

Pour tenir compte de facteurs connexes, nous avons procédé à une analyse de régression à variables multiples des KPA des ménages. Aux fins de l'analyse de régression, nous avons condensé les variables du milieu bâti en une série limitée de variables synthétiques. Nous avons ainsi délimité les trois facteurs suivants :

- **facteur 1 :** forte densité d'habitations et d'emplois dans un rayon de 5 km;
- **facteur 2 :** aires publiques ouvertes et aménagements favorisant la marche (connectivité piétonnière, trottoirs, reculs des immeubles et largeur des rues);
- **facteur 3 :** utilisations mixtes du territoire et réseau routier dense.

Nous avons ensuite procédé par estimation pour établir des modèles de régression. Pour cela, nous avons régressé les KPA des ménages individuellement en fonction des éléments suivants : milieu bâti du quartier (selon les trois variables synthétiques); nombre d'adultes au sein du ménage; nombre de véhicules appartenant au ménage; type d'habitation; et enfin, revenu du ménage. Les variables indépendantes additionnelles que nous avons prises en considération sont les résultats d'enquête relatifs au degré de satisfaction vis-à-vis des caractéristiques conceptuelles du quartier, de même que les perceptions quant à savoir si les rues sont sécuritaires, commodes et agréables pour s'y déplacer à pied ou à bicyclette. Notre échantillon d'analyse ne regroupait que les ménages qui ont déclaré des déplacements quotidiens incluant au moins 5 KPA. Nous sommes ici partis du principe que les réponses des ménages ayant déclaré à cet égard moins de 5 KPA étaient peut-être des aberrations.

Le tableau 9 présente les résultats des calculs de régression. Les relations significatives avec un intervalle de confiance de 95 % sont mises en évidence en caractères gras et en italiques dans la colonne « Signification ». Le coefficient de détermination multiple ajusté (R au carré ajusté) pour ce modèle est de 12,73 %, ce qui dénote une corrélation modeste. La corrélation rapportée ici est similaire à celle observée dans d'autres études fondées sur des données non regroupées.

Tableau 9 Résultats des calculs de régression pour les KPA

Variables indépendantes	Estimation	Écart type	Valeur t	Signification
Constance	11,60	10,64	1,09	0,28
Utilisations mixtes du territoire, réseau routier très dense	-3,84	1,01	-3,78	***0,00***
Aires publiques ouvertes, aménagements favorisant grandement la marche	-6,81	1,08	-6,33	***0,00***
Forte densité d'habitations et d'emplois dans un rayon de 5 km	-4,47	1,22	-3,65	***0,00***
Nombre de véhicules appartenant à chaque ménage	4,05	1,61	2,52	***0,01***
Nombre d'adultes au sein de chaque ménage	5,49	1,10	4,98	***0,00***
Catégories de revenu des ménages*				
35 001 $ à 50 000 $	1,21	11,04	0,11	0,91
50 001 $ à 75 000 $	6,25	10,48	0,60	0,55
75 001 $ à 100 000 $	13,76	10,33	1,33	0,18**
100 001 $ à 150 000 $	15,61	10,28	1,52	0,13**
Plus de 150 000 $	13,56	10,36	1,31	0,19**
Variables subjectives (perceptions) :				
Quartier très sécuritaire pour la marche	0,00	2,17	0,00	1,00
Conception du quartier très satisfaisante	0,94	2,32	0,41	0,68
Quartier facilitant beaucoup la marche	-1,04	2,48	-0,42	0,68
Quartier où la marche est très agréable	-0,78	2,65	-0,30	0,77
Maisons individuelles	0,44	2,56	0,17	0,86
R au carré ajusté	12,73 %			

* La catégorie de revenu de base est inférieure à 35 000 $.

** Si on utilise une hypothèse unilatérale, les seuils de signification sont tous inférieurs à 0,1 % (intervalle de confiance de 90 %).

Essentiellement, les calculs de régression donnent à penser que les caractéristiques conceptuelles des quartiers aménagés suivant les principes du nouvel urbanisme vont de pair avec de moindres KPA, même après prise en compte du revenu, des types d'habitations et de la taille des ménages, de même que du nombre de véhicules que ces derniers possèdent. Comme on pouvait s'y attendre, ces calculs font également ressortir que les KPA augmentent en proportion du nombre de véhicules que possède un ménage, au nombre d'adultes que ce dernier inclut et au revenu dont il dispose. Par exemple, les ménages ayant un revenu annuel de plus de 75 000 $ ont enregistré entre 13,5 et 15,6 KPA par jour de plus que ceux qui ont un revenu inférieur à 35 000 $. Lorsque nous avons vérifié l'hypothèse selon laquelle les ménages ayant un revenu supérieur signalaient un plus grand nombre de KPA que les ménages dont le revenu était inférieur à 35 000 $ (en utilisant uniquement le niveau supérieur de la répartition du revenu), nous avons constaté que les coefficients s'avéraient statistiquement significatifs, avec un intervalle de confiance de l'ordre de 90 % ou mieux. Enfin, ces résultats laissent supposer que les perceptions des ménages à l'égard du milieu bâti de leur quartier n'ont aucune influence significative sur les KPA, pas plus que le type d'habitation dans lequel un ménage réside.

Influence du biais d'autosélection

Même si ces résultats sont statistiquement solides, on peut leur opposer l'argument du biais d'autosélection. Comme la plupart des recherches empiriques démontrant un lien entre la morphologie des quartiers et les habitudes de déplacement, nos résultats pourraient s'expliquer par l'hypothèse selon laquelle les ménages qui préfèrent marcher au lieu de conduire sont attirés par les quartiers possédant des caractéristiques du nouvel urbanisme, et cela expliquerait les habitudes de déplacement constatées dans les QNU comparativement aux QBT de notre échantillon. Cette interprétation va à l'encontre de la conclusion selon laquelle la morphologie urbaine influe sur les habitudes de déplacement parce qu'elle suggère que les caractéristiques physiques des quartiers ne sont pas directement responsables des différences entre les habitudes de marche et de conduite automobile. Ce serait plutôt la préférence des ménages pour la marche ou la conduite automobile qui donnerait lieu aux différences observées.

Afin d'éliminer cette possible explication de nos résultats, nous avons élaboré une variable « prédisposition à la marche » que nous avons ajoutée à titre de variable explicative à notre analyse de régression pour voir si elle constituait un prédicteur fiable des habitudes de déplacement. La variable de prédisposition est fondée sur les choix de type de quartier de chacun des ménages de notre échantillon. Puisque nous demandions aux répondants leur lieu de résidence antérieur (avant de déménager dans leur résidence actuelle dans un des huit quartiers étudiés), nous pouvions recueillir de l'information sur le quartier environnant cette résidence antérieure. Ces quartiers « de résidence antérieure » ont été classés sur une échelle de 1 à 5 selon leurs caractéristiques de « marchabilité » (y compris la densité, la densité des rues, le nombre d'emplois dans un rayon de 5 km, la distance du secteur central des affaires, les parts relatives des modes de déplacement, et la distance moyenne de déplacement pour aller au travail).

Les huit quartiers « de résidence actuelle » de notre échantillon ont été classés à l'aide des mêmes définitions. Les ménages qui quittaient un quartier très propice à la marche pour s'établir dans un autre quartier très propice à la marche ont reçu la cote « prédisposition élevée à la marche », tandis que ceux qui passaient d'un quartier moyennement propice à la marche à un quartier très propice à la marche, ou l'inverse, ont reçu la cote « prédisposition moyenne à la marche ». Tous les autres ménages ont reçu la cote « prédisposition faible à la marche ».

La cote « prédisposition à la marche » n'a pas donné de coefficient statistiquement significatif dans le modèle de régression (voir le tableau 10), ce qui suggère que la prédisposition à la marche n'aide pas à expliquer la différence de KPA entre les ménages et que le biais d'autosélection peut être éliminé comme explication de la plus faible part des déplacements en automobile dans les QNU comparativement aux QBT de notre échantillon. En conséquence, notre conclusion demeure la même, c'est-à-dire que les variables de l'environnement bâti des quartiers de notre échantillon influencent fortement les habitudes de déplacement.

RÉPONSES AUX QUESTIONS DE LA RECHERCHE

La présente étude visait à établir si les QNU se prêtent à l'atteinte de certains objectifs visés par la conception du milieu bâti et si les résidents de ces quartiers ont d'autres comportements et attitudes que ceux des QBT. Nous sommes désormais en mesure de répondre à ces questions

Tableau 10 Résultats des calculs de régression pour les KPA

Variables indépendantes	Estimation	Écart type	Valeur t	Signification
Constance	17,00	11,77	1,44	0,15
Utilisations mixtes du territoire, réseau routier très dense	-3,24	1,08	-3	0,00
Aires publiques ouvertes, aménagements favorisant grandement la marche	-7,27	1,13	-6,44	0,00
Forte densité d'habitations et d'emplois dans un rayon de 5 km	-3,92	1,44	-2,72	0,01
Nombre de véhicules appartenant à chaque ménage	3,97	1,68	2,37	0,02
Nombre d'adultes au sein de chaque ménage	5,04	1,17	4,32	0,00
Catégories de revenu des ménages** :				
35 001 $ à 50 000 $	-1,59	12,17	-0,13	0,90
50 001 $ à 75 000 $	2,85	11,62	0,25	0,81
75 001 $ à 100 000 $	11,00	11,45	0,96	0,34
100 001 $ à 150 000 $	11,89	11,35	1,05	0,30
Plus de 150 000 $				
Variables subjectives (perceptions) :	-0,08	2,28	-0,04	0,97
Quartier très sécuritaire pour la marche	1,61	2,44	0,66	0,51
Conception du quartier très satisfaisante	-1,77	2,63	-0,67	0,50
Quartier très favorable à la marche	-1,49	2,80	-0,53	0,60
Quartier où la marche est très agréable	0,60	2,65	0,23	0,82
Prédisposition à la marche				
Ménages ayant une prédisposition moyenne à la marche	-7,61	4,293793	-1,77	0,077
Ménages ayant une prédisposition élevée à la marche	0,02	7,476533	0	0,998
Observations	1037			
R au carré ajusté	12,26%			

dans le contexte des huit quartiers pris en considération aux fins de cette étude.

Caractéristiques conceptuelles

Accès plus aisé aux destinations quotidiennes : Les quatre QNU incluent, en moyenne, 80 % de destinations quotidiennes de plus que les QBT dans un rayon de 1 km de leur point central, telles que des magasins et des écoles. Une proportion légèrement plus importante de la superficie des QNU est par ailleurs consacrée à des aires publiques ouvertes que celle des QBT. Bien que les QNU offrent moins de possibilités d'emploi dans un rayon de 5 km que les QBT, cette constatation est liée au fait que les quartiers appareillés se trouvent les uns et les autres à un emplacement et une distance similaires en regard du noyau de la région métropolitaine.

Plus de routes pour les piétons et connectivité piétonnière accrue : Sous l'angle du rapport moyen des distances en ligne directe et des distances réelles au sein d'un réseau piétonnier, nous avons constaté que la connectivité piétonnière des QNU est de 5 % supérieure à celle des QBT. Globalement, la densité rues/voies/ruelles des QNU dépasse, en moyenne, celle des QBT de 36 %. Les QNU possèdent près de trois fois plus de rues bordées de trottoirs des deux côtés que les QBT.

Plus grand choix d'habitations : Dans l'ensemble, les QNU ont un plus faible pourcentage de maisons individuelles et de jumelés que les QBT (35 % contre 76 %) et un pourcentage plus élevé de maisons en rangée et de logements collectifs (65 % contre 24 %). Les QNU offrent un bien plus vaste choix de types d'habitations que les QBT.

Moindre superficie de terrain requise par logement : La densité résidentielle au sein des QNU dépasse en moyenne celle des QBT de 74 %, les QNU comptant environ 20,2 logements par hectare (lph), alors que les QBT en comptent 11,6. Les reculs des immeubles sont par ailleurs plus courts dans les QNU et les rues plus étroites que dans les QBT auxquels nous les avons comparés.

Comportements et attitudes

Utilisation réduite de l'automobile pour les déplacements urbains en semaine : L'analyse des modes de déplacement donne à penser que les répondants qui vivent dans un QNU se déplacent proportionnellement moins souvent en automobile (que ce soit comme conducteur ou passager)

que ceux des QBT (78 % contre 85 %). L'examen des KPA des ménages en l'espace de 24 heures permet de conclure que les KPA totaux par ménage au sein des QBT dépassent ceux des ménages des QNU de 24 % (46,0 km et 37,1 km, respectivement). De plus, les répondants des QNU sont plus susceptibles d'avoir déclaré que depuis leur installation dans leur quartier, leurs déplacements en automobile ont diminué. Par contre, les répondants des QBT sont plus susceptibles d'avoir au contraire rapporté une hausse du nombre de véhicules dont leur ménage est propriétaire et des déplacements plus longs ou plus nombreux en automobile par comparaison à leurs habitudes à leur lieu de résidence antérieur.

Augmentation des déplacements quotidiens à pied et à bicyclette : Nous avons relevé de nombreux éléments de preuve à l'appui de l'hypothèse selon laquelle les répondants des QNU se déplaceraient plus souvent à pied et à bicyclette que ceux des QBT. En fait, les ménages des QNU sont 52 % plus nombreux que ceux des QBT auxquels ils sont comparés à dire qu'ils se déplacent à pied (21,3 % contre 14 %). Non moins de 51 % des répondants des QNU disent se rendre plusieurs fois par semaine à pied ou à bicyclette à un magasin ou service de leur quartier, comparativement à seulement 19 % des répondants des QBT. Par ailleurs, 64 % des répondants des QNU font de la marche ou du vélo plusieurs fois par semaine pour le plaisir, durant la belle saison, par comparaison à 52 % des répondants des QBT. Enfin, les répondants des QNU sont près de deux fois plus susceptibles que ceux des QBT de dire que leurs déplacements à pied sont beaucoup plus fréquents dans leur quartier actuel que là où ils habitaient auparavant (37 % contre 20 %).

Recours plus fréquent au transport en commun : La proportion des déplacements effectués en transport en commun était faible dans les deux types de quartiers (9 %), sans différence au niveau du nombre de déplacements moyen. Bien que la densité des QNU se prête davantage au transport en commun, les niveaux de services de transport en commun sont similaires dans les QNU et les QBT, au même titre que l'éloignement des quartiers appareillés par rapport au noyau de la région métropolitaine.

Plus grande satisfaction des résidents vis-à-vis de la conception de leur quartier : L'enquête a révélé que les répondants des QNU sont presque deux fois plus nombreux que ceux des QBT auxquels ces derniers sont comparés (60 % contre 34 %) à se dire très satisfaits des caractéristiques conceptuelles des rues, des aménagements paysagers et des façades dans leur quartier. De même, près du double des répondants des QNU estiment que le paysage des rues de leur quartier rend la marche agréable, par comparaison à ceux des QBT (85 % contre 44 %). Enfin, les répondants des QNU sont 51 % plus nombreux que ceux des QBT à trouver que le tracé et l'aménagement des rues de leur quartier rend celles-ci très sécuritaires pour les déplacements à pied et à bicyclette (55 % contre 37 %).

Utilisation accrue des espaces verts et autres aires publiques ouvertes : La proportion des répondants des QNU qui disent fréquenter des aires publiques ouvertes plusieurs fois par semaine (52 %) dépasse celle des QBT (40 %), bien que les QNU ne disposent que de très peu d'aires publiques ouvertes de plus que les QBT. Les répondants des QNU sont bien plus susceptibles de rapporter qu'il est très aisé de se rendre à pied ou à bicyclette de leur domicile vers un parc de leur quartier que les répondants des QBT comparables (70 % contre 47 %).

Interactions sociales plus fréquentes entre voisins : La plupart de nos indicateurs tendent à montrer que les ménages des QNU interagissent davantage avec leurs voisins que ceux des QBT. Les résidents des QNU saluent leurs voisins plus souvent que ceux des QBT, 35 % des répondants du premier groupe disant faire un salut à au moins une personne chaque fois qu'ils sortent de chez eux, contre 27 % des répondants du second groupe. Les ménages des QNU rapportent aussi davantage d'interactions en personne avec leurs voisins, 40 % d'entre eux disant que celles-ci se produisent plusieurs fois par semaine, par contraste aux ménages des QBT, qui ne sont que 34 % à en dire autant. Bien que les répondants des QBT soient plus susceptibles de faire partie d'un groupement sportif ou social, ceux des QNU participent en moyenne à davantage d'événements communautaires par année.

Plus attachés à leur quartier : Constatation peu surprenante, vu leur plus grande satisfaction vis-à-vis de la conception de leur quartier et leurs indicateurs plus élevés d'interactions sociales avec leurs voisins, les répondants des QNU sont plus nombreux à se dire attachés à leur quartier que ceux des QBT (50 % contre 36 %). Ce résultat a été observé en dépit du fait que les QNU sont de construction plus récente que les QBT et que les répondants des QNU vivent, en moyenne, dans leur quartier depuis moins longtemps que les répondants des quatre QBT.

CONCLUSIONS

Nos observations nous permettent de conclure que les quatre QNU étudiés ont bien mieux permis d'atteindre les objectifs énoncés au départ que les QBT auxquels nous les avons comparés. Les seules exceptions à cet égard sont la part des déplacements effectués en transport en commun (identique dans les deux types de quartiers) et les emplois dans un rayon de 5 km. Les résultats recueillis en regard de ces deux exceptions reflètent le fait que les QBT retenus aux fins de comparaison ont été sciemment choisis parce que leur emplacement par rapport au noyau de la région métropolitaine et leurs niveaux de services de transport en commun sont similaires à ceux des QNU auxquels nous les avons appareillés.

Il ressort de notre analyse statistique que les caractéristiques conceptuelles du milieu bâti considérées comme favorables à des modes de déplacement plus actifs et à une réduction des déplacements en automobile ont effectivement produit de tels résultats dans les quartiers à l'étude. Les KPA sont plus étroitement liés à des facteurs de plus grande envergure, alors que les déplacements à pied ou à bicyclette sont davantage tributaires de facteurs de moindre envergure. Nos calculs de régression nous portent à croire que les caractéristiques conceptuelles des quartiers aménagés suivant les principes du nouvel urbanisme vont de pair avec de moindres KPA, même après prise en compte du revenu, des types d'habitations et de la taille des ménages, de même que du nombre de véhicules que ces derniers possèdent. Comme on pouvait s'y attendre, ces calculs font également ressortir que les KPA augmentent en proportion du nombre de véhicules que possède un ménage, au nombre d'adultes que ce dernier inclut et au revenu dont il dispose. Enfin, ils laissent supposer que les perceptions des ménages à l'égard du milieu bâti de leur quartier n'ont aucune influence significative sur les KPA, pas plus que le type d'habitation dans lequel un ménage réside.

Nous avons vérifié si le biais d'autosélection constituait une explication possible de ces résultats et conclu qu'il ne s'agit pas d'un facteur important expliquant la différence de KPA en présence d'autres variables explicatives.

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Aux termes de la partie IX de la ***Loi nationale sur l'habitation,*** le gouvernement du Canada verse des fonds à la SCHL afin de lui permettre de faire de la recherche sur les aspects socio-économiques et techniques du logement et des domaines connexes, et d'en publier et d'en diffuser les résultats.

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INTRODUCTION

Recent research focussing on the impact of new urbanism on travel behaviour has shown that built form characteristics such as mixed land uses, high density developments are often correlated with lower automobile use, higher frequency of walk trips, and other 'active' life style choices. While these results are welcomed as the evidence needed in support of building new urbanist developments (NUDs) instead of the status quo of building the conventional suburban developments (CSDs), others argue that lower automobile use observed for residents of high-density, mixes land use developments is merely an artifact of the households' predisposition to lifestyles that favour walking and transit-based mobility.

This so-called self-selection bias implies that households predisposed to a more active lifestyle characterised by more walking and less dependence on automobile are attracted to new urbanist neighbourhoods.

In an earlier comparative study of approximately 2,000 households living in four new urbanist and four conventional suburban developments we found strong evidence in support of the impact of built form on travel behaviour. Our analysis revealed that built form characteristics advocated by the new urbanist design were strongly correlated with lower automobile dependence. In the previous study we did not attempt to account for the self-selection bias. We address the bias in the present study.

It is important at the very outset of this study to have an agreement on the nomenclature that borrows from two distinct disciplines, i.e., urban planning and applied econometrics. In the econometrics literature self-selection bias (and endogeneity) has a specific meaning that may differ from how these concepts are understood as they relate to urban planning. In the econometrics literature sample selection bias refers to the condition where the dependent variable is observed for a restricted, non-random sample. Consider a model that estimates a wage equation for female employees. Since we would observe wages only for the employed women, i.e., and not for those who have withdrawn from the labour force to raise families, take care of aging parents, or enroll in school, we run into the sample-selection problem where the dependent variable is observed only for part of the sample.

Endogeneity, on the other hand, refers to a state where the dependent variable is observed for all, but one of the independent variables is in fact a choice variable. Consider now a wage equation for employees some of whom are unionized. We would observe the wage for all employees, unionised or otherwise, but using union membership as an independent variable could be problematic if union membership is in fact a choice variable. It could be true that workers with certain traits and predisposition opt for union membership and hence the estimated coefficient for union membership may be biased up or down.

In our previous study we regressed the vehicle kilometers travelled (VKTs) by households as a function of built form characteristics, household attributes, and the households' perception of neighbourhood's features, such as design, and safety for walking. We

observed in the previous study that the new urbanist design features were correlated with lower VKTs, which attracted the criticism that perhaps the choice for residing in a NUD is merely a result of those households preferred lifestyles that made them choose such neighbourhoods in the first place.

To address such criticism one may have to design an experiment where one would categorize the neighbourhood-level built form characteristics of a household's previous and current home location and then explicitly account for the transition from one type of neighbourhood to another type in the VKT regression to determine the type of transitions are associated with lower VKTs. Consider if the self-selection bias were to be true, and assume that one is able to control for all possible transition states between previous and current home locations in the model, one would then be able to identify the transition states that are associated with the reduction in VKTs. For instance, one will be able to determine the change in VKTs for households that relocated from a new urbanist neighbourhood to another similar neighbourhood.

Based on the above discussion we posit that the VKT regressions do not suffer from the sample selection bias because we do observe the VKTs for all households in the sample. We may, however, have the endogeneity problem where the choice between the new urbanist and the conventional suburb may not be controlled by merely including a dummy variable (1/0). The econometrics literature has identified several modeling techniques to deal with endogeneity that arises because of a choice variable that involves a binary choice, such as union membership. We believe that those techniques are not relevant for the current study because we are dealing with a very complex choice structure that is spread over a spectrum of neighbourhood types that households can relocate from and another spectrum of neighbourhood types that may relocate to. This is necessitated because unlike union membership, a neighbourhood can be categorized in several ways rather than being a CSD or a NUD.

Since we had valid address information for the previous home location for a large number of households in our sample, we were able to determine the built form characteristics of previous home locations of households in our sample who had settled in either a new urbanist or a conventional suburban development. We have used a combination of built form characteristics and travel behaviour attributes at the previous and current (2006) home locations of households in our sample to develop a 5-point walkability/car dependence scale where 1 represents the most car dependent neighbourhood and 5 represents the most walkable neighbourhood. This resulted in 25 possible transition states for households in our sample that we later used in the empirical analysis.

This report determines the impact of built form characteristics on travel behaviour while accounting for the impact of lifestyle choices on travel behaviour. The study areas consist of four new-urbanist (NUD) neighbourhoods: two in Calgary, Alberta; one in Montreal, Quebec; and one in Markham, Ontario (near Toronto). Each of these neighbourhoods has been paired with a conventional-suburban (CSD) neighbourhood within the same municipality.

This report follows up on an earlier report that presented a detailed literature review of self-selection bias in neighbourhood choices and travel behaviour. For background literature and discussion on the impact of self-selection bias we refer to the earlier report documenting the detailed literature review.

Table 1 – Sample Neighbourhoods

NUD Name	Acronym	CSD Name	Acronym	Location
Mackenzie Towne	MKT	Mackenzie Lake	MKL	Calgary, AB
Garrison Woods	GWD	North Signal Hill	NSH	Calgary, AB
Bois Franc	BFR	Nouveau St-Laurent	NSL	Montreal, QC
Cornell	CNL	Woodbine North	WBN	Markham, ON

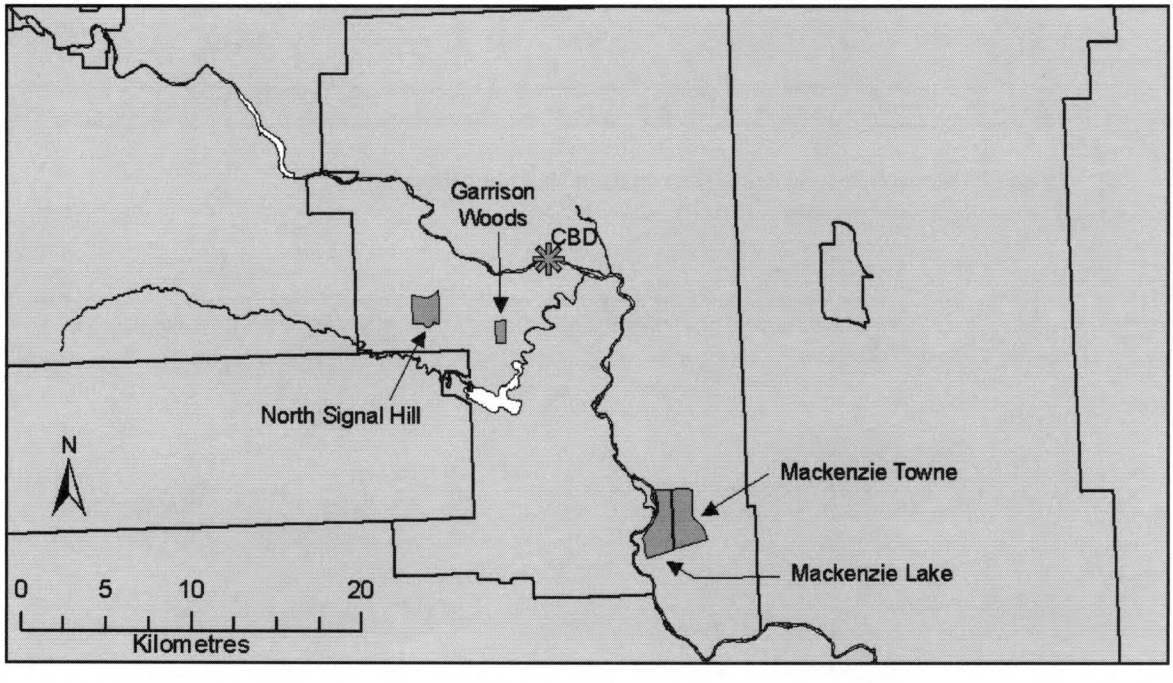

Figure 1 - Calgary Study Areas (Destination Neighbourhoods)

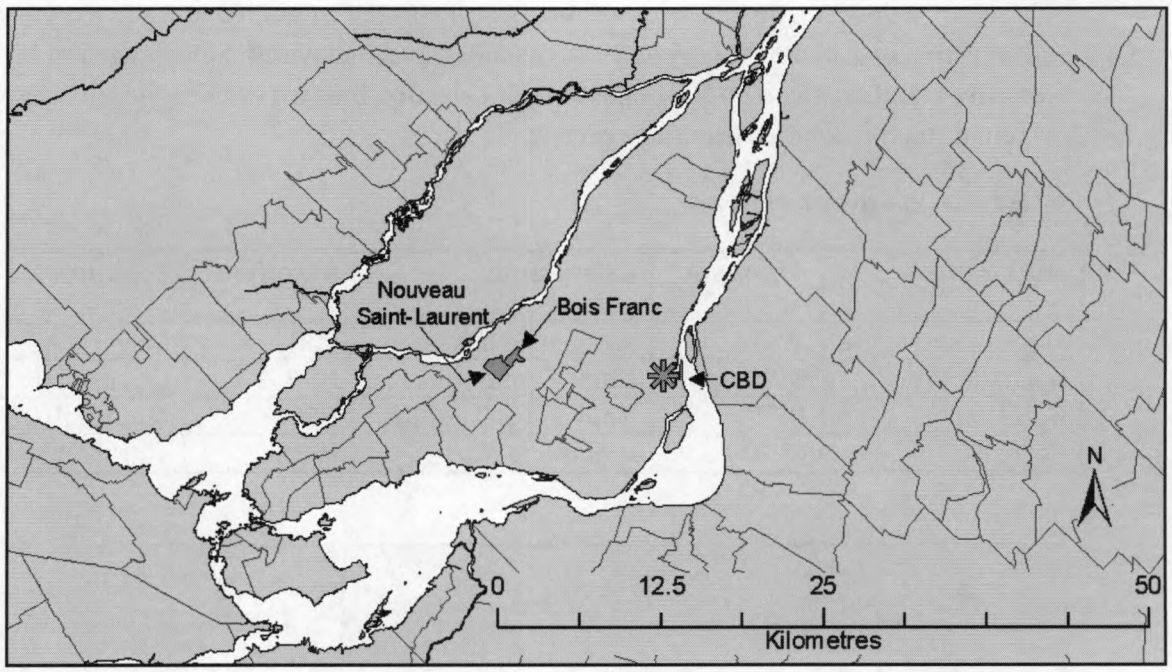

Figure 2 - Montreal Study Areas (Destination Neighbourhoods)

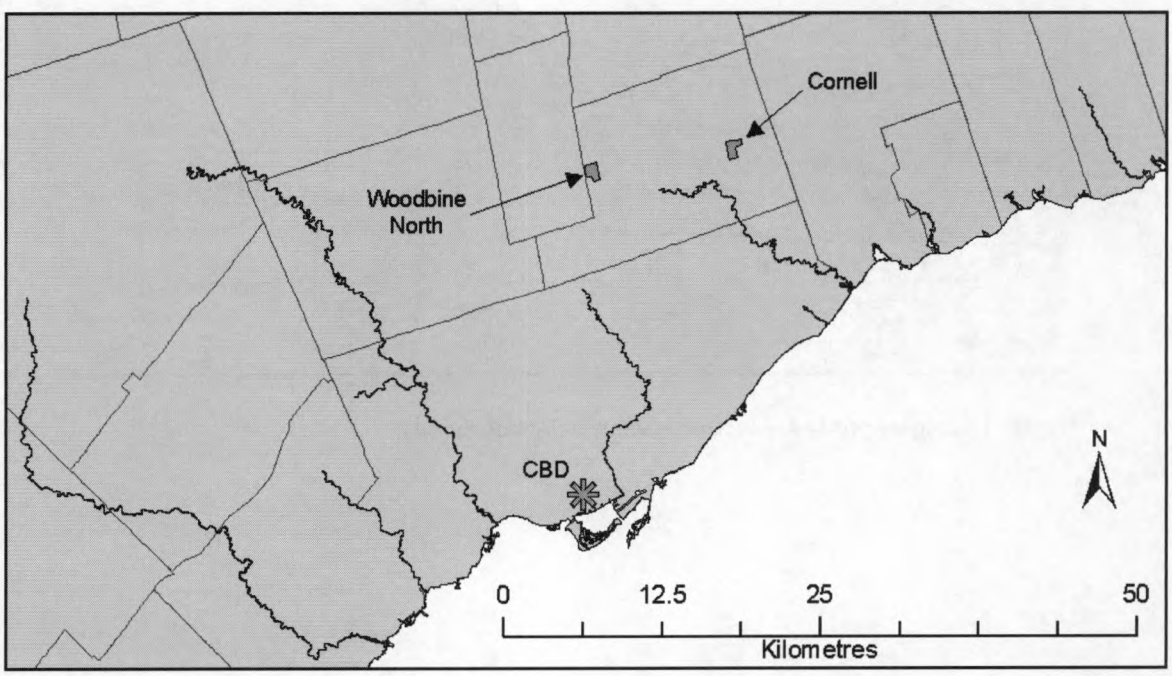

Figure 3 - Toronto (Markham) Study Areas (Destination Neighbourhoods)

METHODOLOGY

The following methodology was used in the study.

1. Using the household database, determine valid addresses for previous home locations of each household.
2. Geocode previous home locations for households with address information.
3. Develop a walkability/car dependency scale
4. Characterize previous and current neighbourhoods on the walkability/car dependency scale
5. Compute descriptive statistics using the scale for built form and travel behaviour characteristics
6. Estimate a regression model for Vehicle Kilometers Travelled (VKT) by each household using built form characteristics while accounting for self-selection bias using the walkability/car dependence scale
7. Draw conclusions about the impact of self-selection bias on travel behaviour.

GEO-CODING OF PREVIOUS HOMES

In order to map the previous dwellings of the sampled households, a multi-step geocoding procedure was employed. The initial geocoding was undertaken using the Yahoo! Geocoding API available at http://developer.yahoo.com/maps/rest/V1/geocode.html. This provides a URL request link which returns latitude/longitude coordinates for the address data. The link was embedded into an MS Excel table using Visual Basic, allowing the coordinate search procedure to be automated for each record. This resulted in a table with latitude-longitude coordinates assigned for each previous home address.

Because of concerns over the accuracy of the Yahoo! address database, two additional checks were undertaken. First, the coordinates were pasted online into the Google Maps database (which is independent from the Yahoo! database), with the resulting map location compared to the address information provided in the record. Second, the coordinates were plotted in a GIS software and were visually inspected for discrepancies using the DMTI street network files as a reference. Discrepancies between the coordinates and the street maps were rectified by geocoding manually through the use of a geocoding program at www.geocoder.ca. Discrepancies resulting from spelling and typographical mistakes were corrected and reran through the geocoding procedure. Of the 2043 original household records, 1873 (91.68%) had sufficient information for accurate geocoding.

The previous dwelling locations cover a broad range of neighbourhood types (large cities, small towns, rural, etc.), located in all provinces and territories except for the Yukon, Nunavut, New Brunswick, and Prince Edward Island. Most previous homes of the current residents were located within the same urban area as the corresponding destination neighbourhoods – although 15.85% were located in other areas. None of the previous dwellings were located outside of Canada.

Two additional distance variables were calculated for each household in the database for which previous home location was determined. We calculated the straight line distance in kilometres from each previous dwelling point to the Central Business District (CBD) of the urban area in which the household resided. We also calculated the straight line distance in kilometres from each previous dwelling to the centroid of the corresponding destination neighbourhood belonging to one of the eight neighbourhoods in the study.

The distance to CBD from previous residences was calculated for households located within the urban areas of Calgary, Montreal, and Toronto. The CBD of the respective cities was defined as follows: for Calgary, the intersection of Centre St. and 9th Ave. South; for Montreal, the intersection of Rue University and Rue St. Catherine; and for Toronto the intersection of Queen St. West and Bay St. There were 194 records not located in the three urban areas for which the distance to CBD variable is set to null. The reason for this decision was based on the realization that the CBD is not very well-defined as a concept for small towns and rural areas and hence the distance calculation would therefore be to an arbitrary point.

Data Sources for Previous Neighbourhood Characteristics

The previous home neighbourhoods were defined as circular buffers of 0.5 km radii around each previous dwelling point. Although some of the origin dwellings were within 0.5 km of each other, the neighbourhoods of previous dwellings were assumed to be independent of one another.

The additional data used in this section come from three different sources, and reflect the calculation of three different types of previous neighbourhood characteristics: demographic variables, land use variables, and street-form variables.

Demographic Variables

In order to create values for each origin neighbourhood, the previous dwelling points were overlaid on the Dissemination Area (DA) boundary file. Using GIS software, we captured DA data within a 0.5 km buffer around each origin point. This was necessary in instances where the previous home was located near the boundary of a DA and the 0.5 km buffer would include areas from one or more DAs. We therefore created spatial averages of these data, which was appended to each previous dwelling point. Because of the difficulty of averaging the data (which was in percentage and average format), we computed weighted average for each variable. For example, in calculating the mean number of persons per family, the values of each DA were weighted by the total number of families in each DA. Table 3 lists the weightings used for each variable. Mathematically, the procedure is illustrated in the following equation.

$$Neighbourhood\ Average = \frac{V_1 \cdot T_1 \cdot (a_1/A_1) + V_2 \cdot T_2 \cdot (a_2/A_2)}{T_1 \cdot (a_1/A_1) + T_2 \cdot (a_2/A_2)}$$

Where:
$V_1 = value\ of\ subject\ variable\ within\ DA\ \#\ 1\ (i.e.\ mean\ \#\ persons\ per\ family)$
$V_2 = value\ of\ subject\ variable\ within\ DA\ \#\ 2\ (i.e.\ mean\ \#\ persons\ per\ family)$
$T_1 = total\ variable\ base\ within\ DA\ \#\ 1\ (i.e.\ total\ number\ of\ families)$
$T_2 = total\ variable\ base\ within\ DA\ \#\ 2\ (i.e.\ total\ number\ of\ families)$
$a_1 = total\ area\ of\ DA\ \#\ 1\ within\ previous\ dwelling\ neighbourhood$
$a_2 = total\ area\ of\ DA\ \#\ 2\ within\ previous\ dwelling\ neighbourhood$
$A_1 = total\ area\ of\ DA\ \#\ 1$
$A_2 = total\ area\ of\ DA\ \#\ 2$

Figure 4 – Spatial Average Formula

Street Network Data

For each previous home neighbourhood, two physical street-form metrics were developed, i.e., mean node linkage and street density. These were calculated using a GIS vector file showing most public roads of all types in Canada.

Mean Node Linkage was calculated by counting all street network links connected to each node. Essentially, this provides a count of the number of street segments that meet at an intersection in the street file. A node with 1 link is a cul-de-sac; 2 links is a sharp bend; 3 links is a three-way intersection; 4 links is a four-way intersection; and so on. These data were then appended to the previous home table by determining the average number of node links within a 0.5 km radius around each previous dwelling point. This provided a measure of the interconnectedness of the street layout. A layout with a high average number of links per node is generally more interconnected than one with a lower average.

Street Density was calculated similarly by calculating the total length of streets within a 0.5 km radius around each previous dwelling point, and dividing by the area of a circle of 0.5 km radius (i.e., 0.785 sq. km). This provides the linear length of streets per square kilometre for each origin neighbourhood. In this case, a higher value is suggestive of smaller blocks and more walkable layout; a lower value is suggestive of larger blocks and a less walkable layout.

Land Use Data

Land use data were also obtained from the CanMap Route Logistics data series, from DMTI Spatial Inc. This consisted of a GIS layer showing the land-use categorization of most urban areas of all sizes within Canada. The categories provided in the DMTI data were reduced to a set of 5 categories: residential, commercial, industrial, government/institutional, and open areas. The land area of each category, within each previous dwelling "neighbourhood", was calculated. This captured the land area of each category within a 0.5 km radius, which was then transformed into a percentage of the land area within each neighbourhood. A land-use mix index, indicating the relative heterogeneity of land uses in each neighbourhood, was also calculated. It provides values between 0 (indicating a single land-use within the search radius) and a value of 1 (indicating an equal proportion for each land-use category):

Final Variable Set and Apriori Hypotheses

1868 records (91.4% of the original number of returned questionnaires) were successfully geocoded for previous home locations (Table 2). The share of the total number of valid records is not evenly divided among the study (destination) neighbourhoods. 17.99% of the total valid records are from residents in Mackenzie Towne, while only 5.30% are from Nouveau Saint-Laurent.

Table 2 – Valid Records by Destination Neighbourhood

New-Urbanist			Conventional-Suburban			
Destination Neighbour-Hood	Number of Valid Records	% of All Records	Destination Neighbour-Hood	Number of Valid Records	% of All Records	Urban Region
Mackenzie Towne	336	17.99%	Mackenzie Lake	307	16.43%	Calgary, AB
Garrison Woods	144	7.71%	North Signal Hill	262	14.03%	Calgary, AB
Bois Franc	253	13.54%	Nouveau St-Laurent	99	5.30%	Montreal, QC
Cornell	300	16.06%	Woodbine North	167	8.94%	Markham, ON
Total NUD	**1033**	**55.30%**	**Total CSD**	**835**	**44.70%**	

The final data set with 65 variables is shown in Table 3. It is hypothesized that the previous dwellings of NUD respondents will be more scattered than those of CSD respondents, because new-urbanist developments are unique in design and less common in availability than conventional types, and therefore are more likely to draw their residents from a wide range of neighbourhoods in a given urban area. Therefore, it is also believed that compared to NUDs, the previous residences of CSD respondents are within closer proximity as reflected in lower average distances from the CSD. It is hypothesized that compared to CSD respondents, NUD respondents will have a stronger tendency for originating from inner-city areas because these areas are more similar in their characteristics to the NUDs than the CSDs. Thus, despite being more scattered, previous residences of NUDs will have shorter average distances to their respective CBDs.

Eighteen variables are previous neighbourhood measures which relate specifically to new-urbanist design principles and goals. The general hypothesis is that dwellers of NUDs are more likely than CSD dwellers to have come from previous neighbourhoods that have new-urbanist-like features. Specifically, NUD dwellers will be more likely to come from areas with higher population density, increased street connectivity (indicated by higher mean node linkage and street density), a lower proportion of single-detached housing (and a higher proportion of all other types), a higher land-use mix index, and increased proportion of commuters using transit and walking/bicycling modes.

Other previous neighbourhood variables do not explicitly relate to new-urbanist design philosophy, but are thought to be related to the research question. It is therefore hypothesized that NUD respondents will be more likely to come from older neighbourhoods, as these tend to have features that are more new-urbanist than those of newer neighbourhoods, which are often conventional suburbs. It is also hypothesized that the previous neighbourhoods of NUD residents, in comparison to those of CSD respondents, will be more likely to have higher proportions of renters, lower income, and higher proportions of immigrants and non-official language spoken. Areas with more rentals will have higher proportions of apartment units, and therefore the size of housing will be smaller, as well as the size of families and lower number of children. It is thought that these areas contain fewer married couples, and thus higher proportions of young adults, but lower proportions of children and older adults.

There are slight differences in the measures employed by the census data and the questionnaire. The number of children for previous neighbourhoods was produced from census data that consider all children living with their parents as children, regardless of age, while the questionnaire considers children as specifically those below age 9. Age from the census data is given as the percentage of individuals of each age category compared to the total population; for the survey it is given as the age of the oldest individual in the household. It is thought that these differences will be minor enough to still allow a connection to be seen.

Table 3 – Independent Variable Set (continued next page)

Variable Type	Variable Name	How Measured	Spatial Weighting
Previous Neighbourhood Variables: Distance Variables			
Distance to CBD	Distance CBD	Straight-line distance from previous home point to main CBD of region (in km) (only for those records within 50 km)	N/A
Distance to Previous Neighbourhood	Distance Study Area	Straight-line distance from previous home point to destination neighbourhood (in km)	N/A
Previous Neighbourhood Variables: New-Urbanism Theory Variables			
Population Density	Population Density	Total population / area (sq km)	Area (sq km)
Urban Form	Street Linkage	Mean # of intersection per street node	N/A
	Street Density	Total length of roads (km) / area (sq km)	
Type of Housing	Fully-Detached	% of private dwellings fully-detached	# occupied
	Semi-Detached	% of private dwellings semi-detached	private
	Row	% of private dwellings as row-houses	dwellings
	Duplex	% of private dwellings as duplexes	
	High-rise Apartments	% of private dwellings as apartment buildings 5 or more floors	
	Low-rise Apartments	% of private dwellings as apartment buildings less than 5 floors	
Land-Use Mix	Residential	% of residential uses by land area	N/A
	Commercial	% of commercial uses by land area	
	Institutional	% of government / institutional uses by land area	
	Not-Built	% of not-built (open space, parks / recreational, and water body uses by land area)	
	Industrial	% of resource and industrial uses by land area	
	Land-Use Mix	Land-use mix index	
Commute Mode	Auto Commute	% of persons age 15 and over in labour force commuting to work by private auto (passenger or driver), motorcycle, taxi, or "other"	Population 15-plus
	Transit Commute	% of persons age 15 and over in labour force commuting to work by public transit	
	Walk Commute	% of persons age 15 and over in labour force commuting to work by walking or bicycle	
Previous Neighbourhood Variables: Demographic Variables			

Age of neighbourhood	Built <1946	% of occupied private dwellings built before 1946	# occupied
	Built 1946-1970	% of occupied private dwellings built 1946 - 1970	private
	Built 1971-1990	% of occupied private dwellings built 1971-1990	dwellings
	Built 1991-2006	% of occupied private dwellings built 1991-2006	
Tenure	Owner	% of private dwellings occupied by owner	# occupied
			private dwellings
Size of Housing	# Rooms	Mean number of rooms per occupied private dwellings	# occupied
	# Bedrooms	Mean number of bedrooms per occupied private dwellings	private dwellings
Average Personal Income	Personal income	Mean after-tax annual income of all persons age 15 and over	Population
	Less than $50 K	Mean after-tax annual income less than $50,000 (0 = no, 1 = yes)	15+
	$50 - $75 K	Mean after-tax annual income $50,000 to $74,999 (0 = no, 1 = yes)	
	$75 - $100 K	Mean after-tax annual income $75,000 to $99,999 (0 = no, 1 = yes)	
	Above $100 K	Mean after-tax annual income $100,000 or greater (0 = no, 1 = yes)	
	Unemployed	% of persons age 15 and over unemployed but seeking employment	Population 15+ employed or seeking employment
Family Size	# Persons	Mean # of persons per census family	# census families
	# Children	Mean # of children at home per census family; does not include singles without children	
Age	Age 0-19	% of all persons age 0 to 19	Total
	Age 20-29	% of all persons age 20 to 29	Population
	Age 30-44	% of all persons age 30 to 44	
	Age 45-64	% of all persons age 45 to 64	
	Age 65+	% of all persons age 65 and over	
Marital Status	Never Married	% of individuals age 15 and over never legally married	Population
	Married	% of individuals age 15 and over currently legally married	15+

	Separated	% of individuals age 15 and over currently classified as divorced, separated, or widowed	
Education level	No Secondary School	% of individuals age 25-64 without secondary school diploma	Population
	Secondary School Only	% of individuals age 25-64 with secondary school diploma only	25-64
	College	% of individuals age 25-64 with post-secondary diploma, but below university bachelor level	
	University	% of individuals age 25-64 with university bachelor degree or above	
Language	Non-Official Language	% of individuals who speak a non-official language at home	Total
			Population
Recent Migration	Internal Migrant	% of persons living in a different city or town within Canada 5 years prior	Total
	External Migrant	% of persons living outside of Canada 5 years prior	Population
Resident Questionnaire: Household Demographic Variables			
Household Annual Income	Household Income	Total household annual income from all sources (ordinal ranked)	N/A
	Less than $50 K	Total household annual income less than $50,000 (0 = no, 1 = yes)	
	$50 - $75 K	Total household annual income $50,000 to $74,999 (0 = no, 1 = yes)	
	$75 - $100 K	Total household annual income $75,000 to $99,999 (0 = no, 1 = yes)	
	Above $100 K	Total household annual income $100,000 or greater (0 = no, 1 = yes)	
Family Size	# Persons	Total number of persons in household	N/A
Children	# Children	Total number of person in household below age 9	N/A
	% Children	% of person in household below age 9	
Cars	# Autos	Total number of motor vehicles available for use by household	N/A
	Auto Availability	Total number of motor vehicles available divided by total number of persons age 9 or older	
Age of Household Head	Head Age	Age of oldest member of household	N/A
	16 – 24 years	Age of oldest member of household 16-24 years (0 = no, 1 = yes)	

	25 – 44 years	Age of oldest member of household 25-44 years (0 = no, 1 = yes)	
	45 – 64 years	Age of oldest member of household 45-64 years (0 = no, 1 = yes)	
	65 + years	Age of oldest member of household 65+ years (0 = no, 1 = yes)	

SPATIAL DISTRIBUTION RESULTS

This section presents the results for the spatial distribution of previous homes. The spatial distribution presents the previous home locations of households who relocated to the matched new urbanist and conventional suburban developments. The purpose of presenting the maps is to allow a visual comparison between the matched new urban and conventional suburb to see if there is prima facia evidence that households would prefer to locate to similar neighbourhoods that they have lived in in the past. This will help us establish the basis for assuming that people have a preference for certain types of neighbourhoods.

Previous dwelling locations for the respondents of each study neighbourhood are therefore presented below in maps. In order to allow a reasonably large-scale previous dwelling locations outside of each urban region are not included. Buffers of 5-km distance intervals from each study neighbourhood are also marked on the maps. Buffers' shape is not perfectly circular, as the study area boundaries (from which they were calculated), are not circular.

We have included graphs that capture the distance between previous home location and the CBD for the new urbanist and conventional suburb. The self-selection bias suggests that those who relocated to the new urbanist neighbourhoods would likely have moved from high-density neighbourhoods, which are often located closer to the CBD. The graphs thus present the comparison for each matched pair to see if there is any truth in the hypothesis.

We also provide graphs of distance from previous residence neighbourhood to destination neighbourhood. The graphs display the percentage of previous residences at distances of 5-km intervals. For graphs, the column "inside" accounts for the percentage of previous dwellings that are actually within the boundaries of the destination new urbanist/conventional suburban neighbourhood.

CALGARY NEIGHBOURHOODS

Both Mackenzie Towne (MKT) and Mackenzie Lake (MKL) are located in southeast Calgary less than 1 km apart and about 17 km from the CBD (Figure 5 and Figure 6). The MKL (CSD) previous dwellings are more concentrated in the southern portion of the city, with a secondary cluster in the eastern part of the city. The previous residences of MKT (NUD) dwellers, as expected, are more scattered throughout the region and include more locations close to the CBD. A dense cluster of previous residences immediately west of MKT is also apparent. In fact many of these latter points are located in or near Mackenzie Lake. About 23% of MKL, but only15% of MKT previous residences are within 5 km of the study neighbourhood, and only 37% of MKT compared to 43% of MKL prior residences are within 10 km of their study neighbourhood (Figure 7). However, beyond 50 km, MKL dwellers are in greater proportion – reflecting a higher proportion of them from areas outside Calgary.

This suggests a higher tendency for MKL dwellers to originate from areas outside Calgary than MKT dwellers. The previous residences of MKT (NUD) dwellers are more likely to be closer to the Calgary CBD than the previous residences of MKL dwellers. About 45% of previous residences of MKT (NUD) and only 30% of previous residences of MKL inhabitants are within 10 km of the CBD.

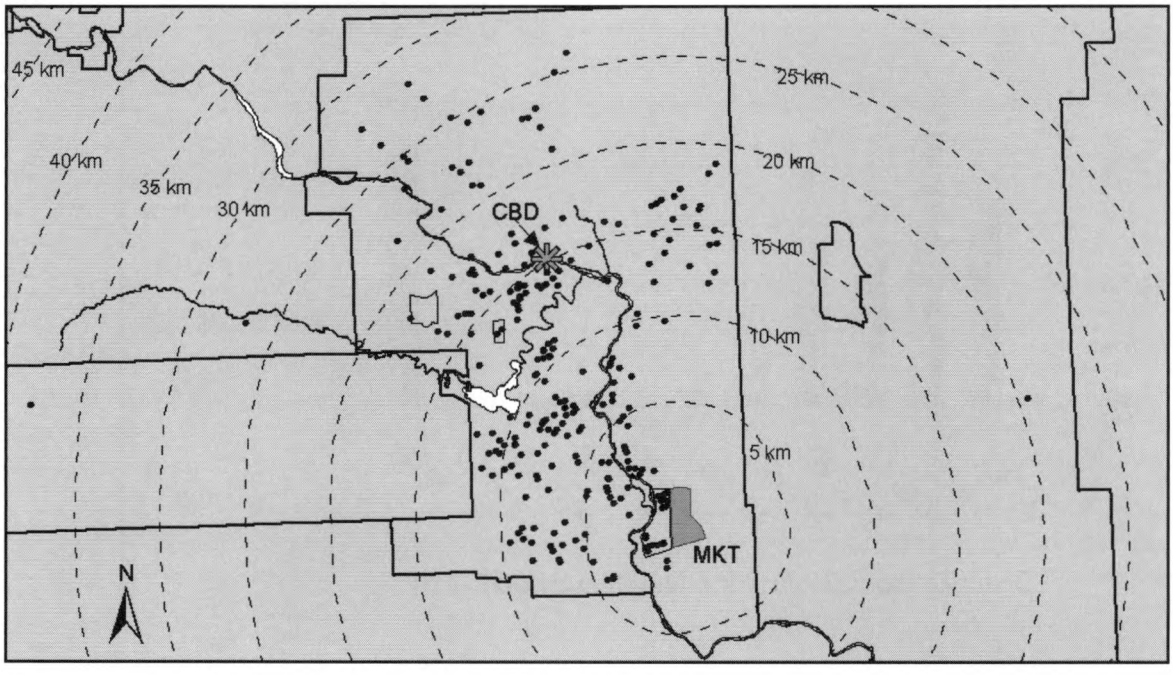

Figure 5 – Previous Dwelling Points for Mackenzie Towne Residents (NUD)

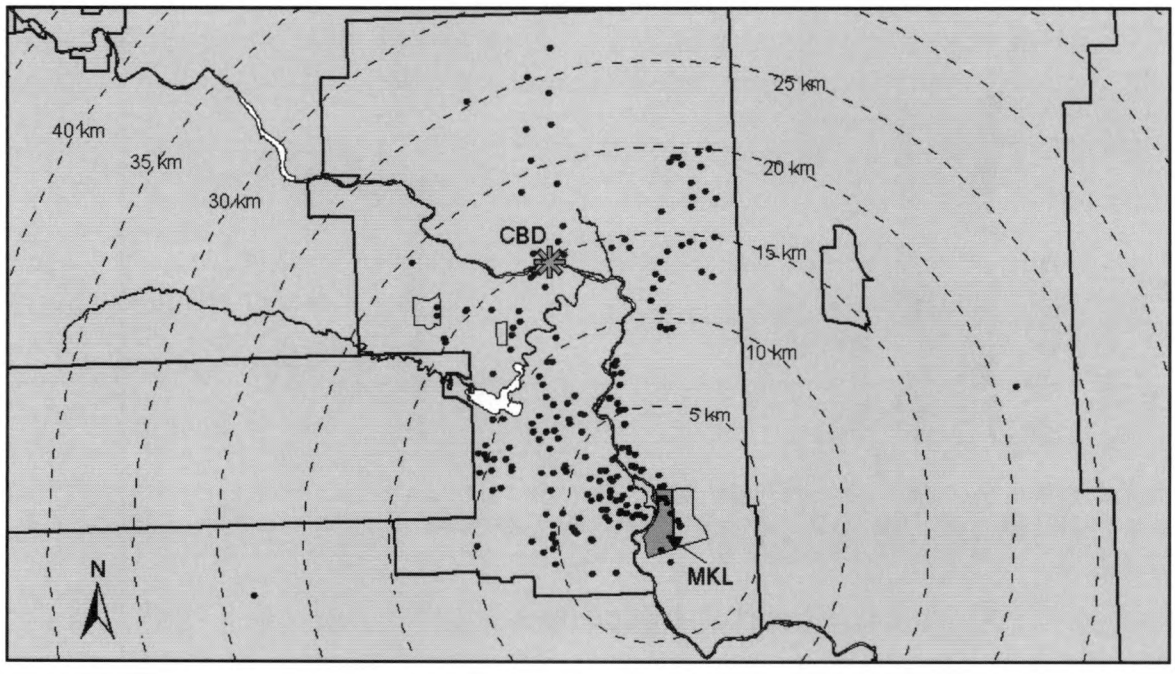

Figure 6 – Previous Dwelling Points for Mackenzie Lake Residents (CSD)

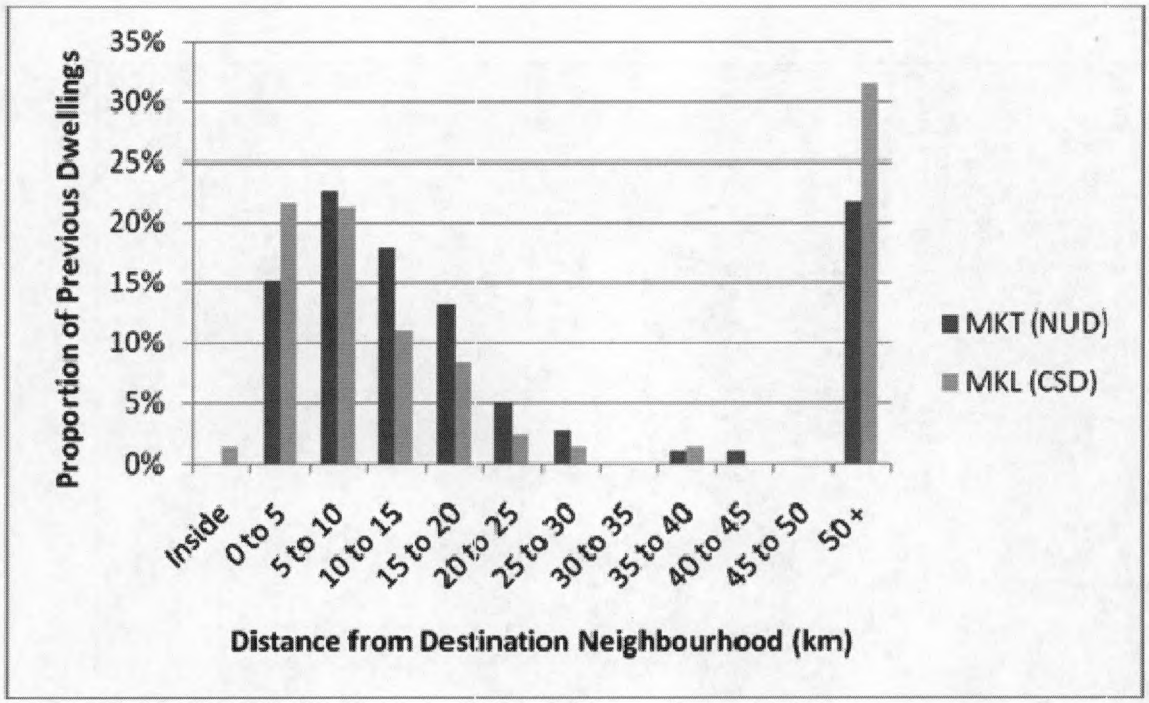

Figure 7 – Previous Dwelling Distance from Mackenzie Towne / Mackenzie Lake

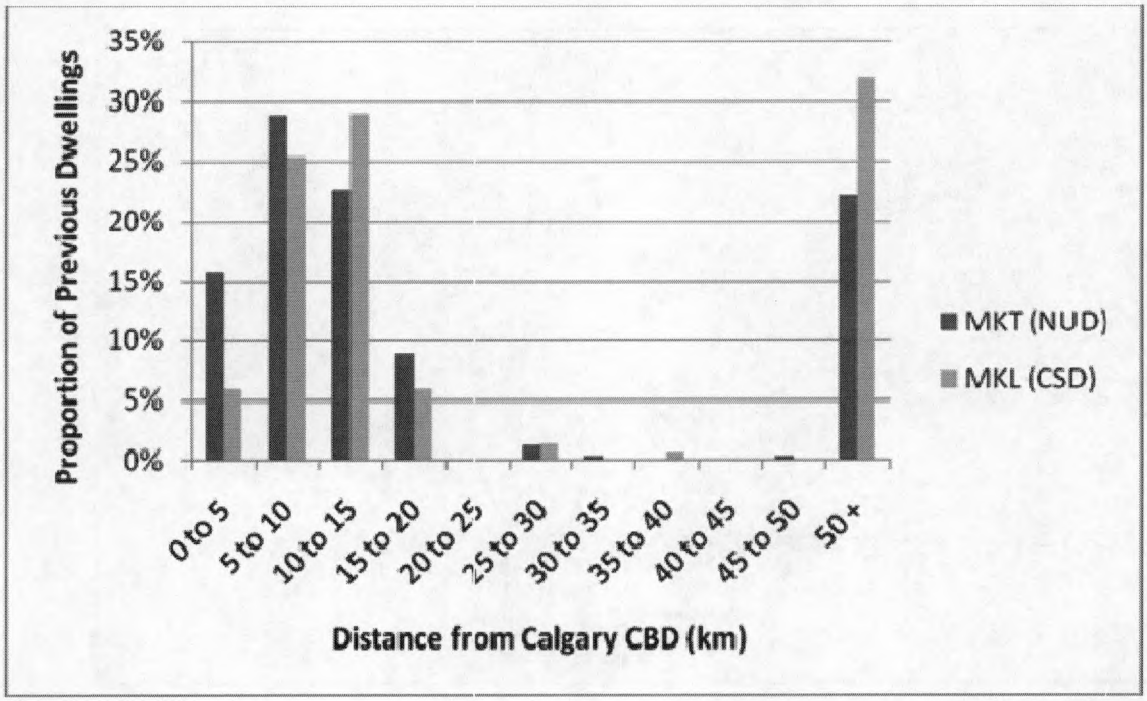

Figure 8 – Previous Dwelling Distance to CBD (Mackenzie Towne / Mackenzie Lake Respondents

Both Garrison Woods (GWD) and North Signal Hill (NSH) are located in southwest Calgary about 4-km apart. Unlike the other study pairs, distance from the CBD is varied: GWD is located about 4 km from the CBD, while NSH is located about 7 km (Figure 9 and Figure 10). Like MKL, the previous dwellings for North Signal Hill (CSD) are concentrated in nearby regions of the city, with almost

60% located within 10 km of NSH. A substantial portion of these are also near the CBD. As for GWD (NUD) a strong cluster of previous residences exists immediately northeast, between GWD and the CBD; almost 55% of previous residences lie within 5 km and 75% lie within 10 km of GWD (NUD).

This relative lack of scatter is in strong contrast to MKT (NUD). Not surprisingly, proximity to the CBD shows up more strongly for prior residences of GWD than of NSH, with almost half of the GWD past residences within 5 km of the CBD (Figure 12).

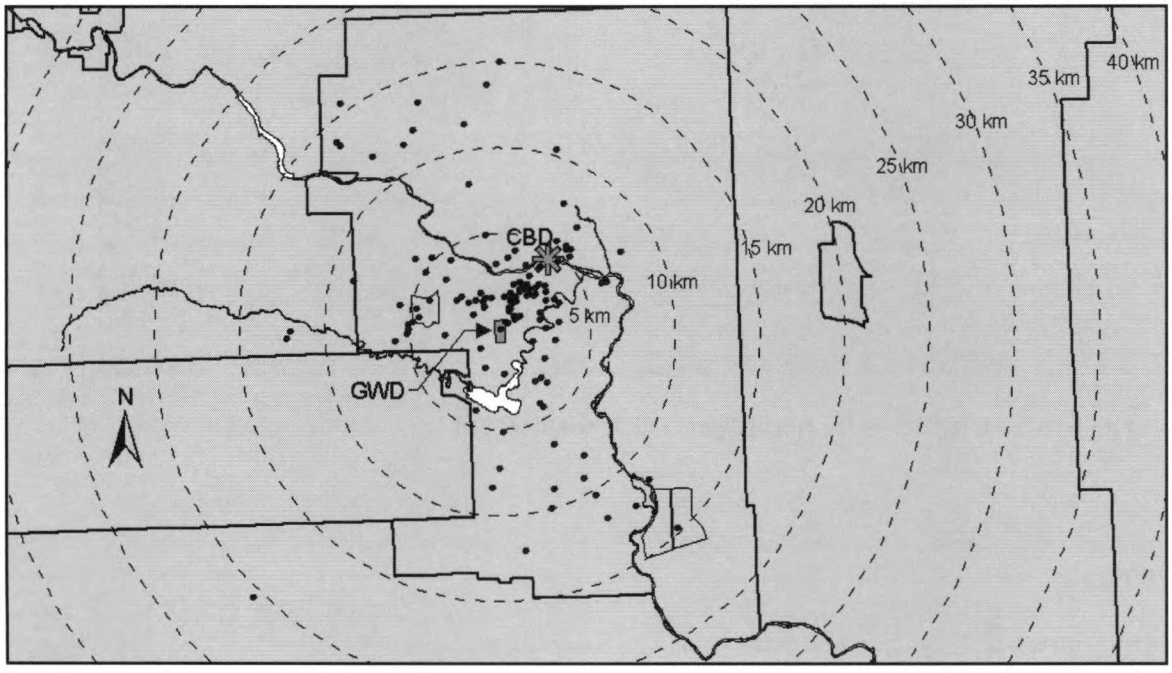

Figure 9 – Previous Dwelling Points for Garrison Woods Residents (NUD)

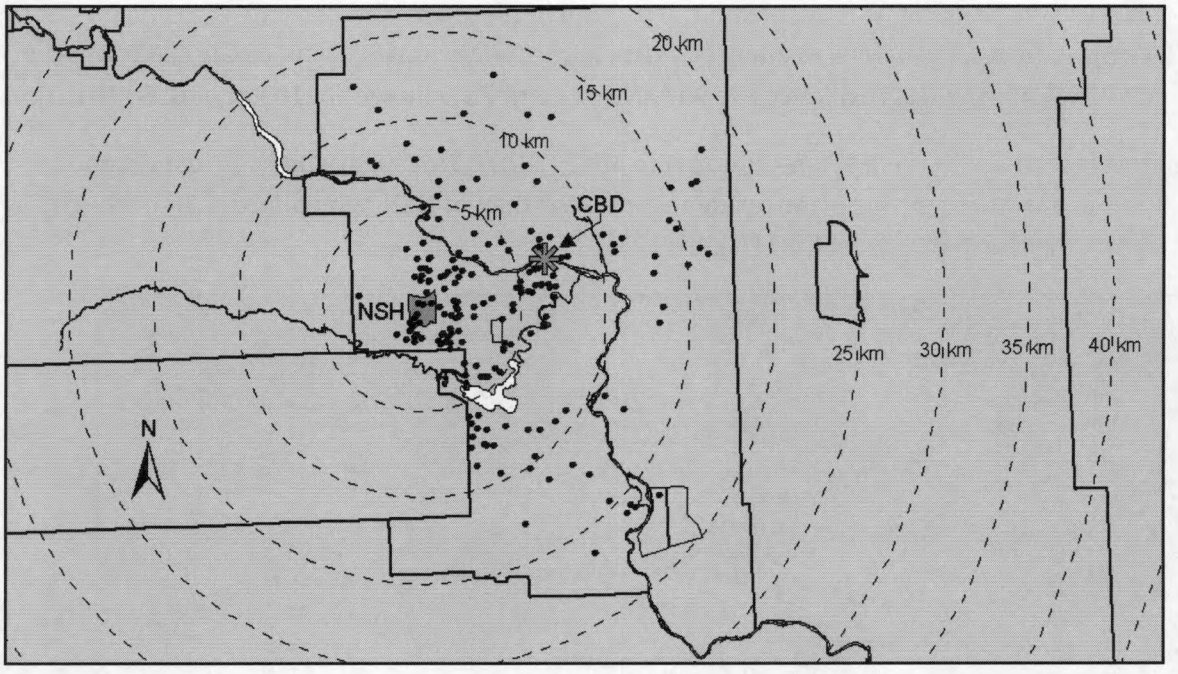

Figure 10 – Previous Dwelling Points for North Signal Hill Residents (CSD)

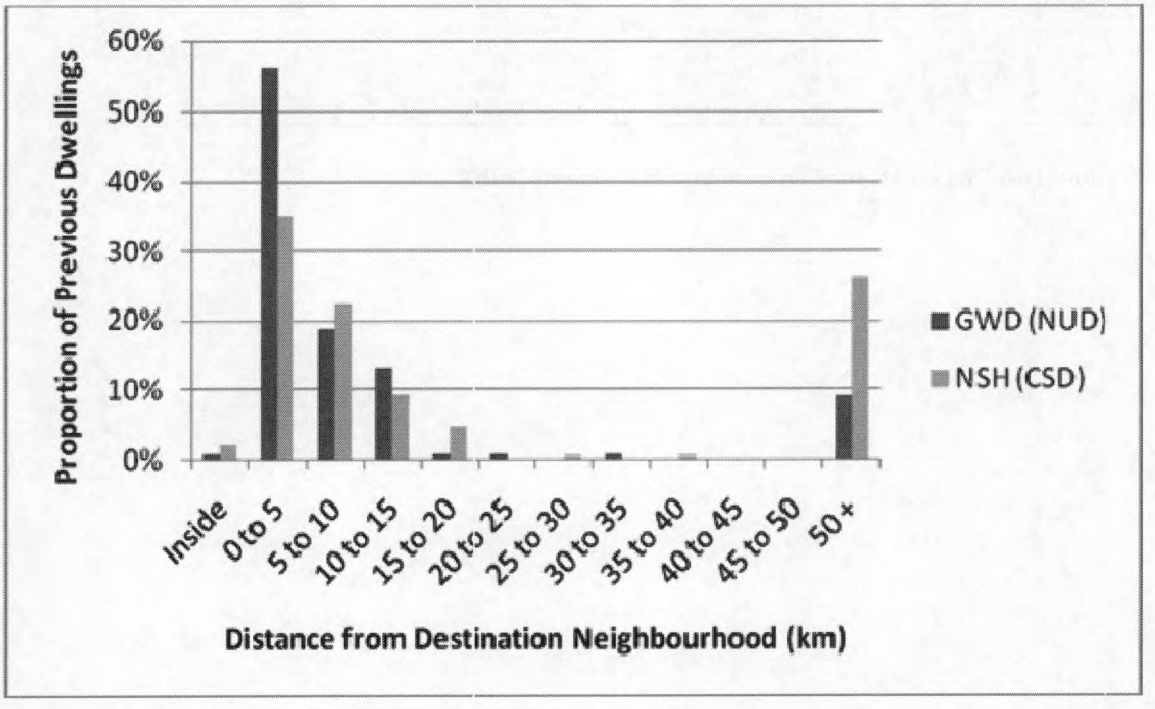

Figure 11 – Previous Dwelling Distance from Garrison Woods / North Signal Hill

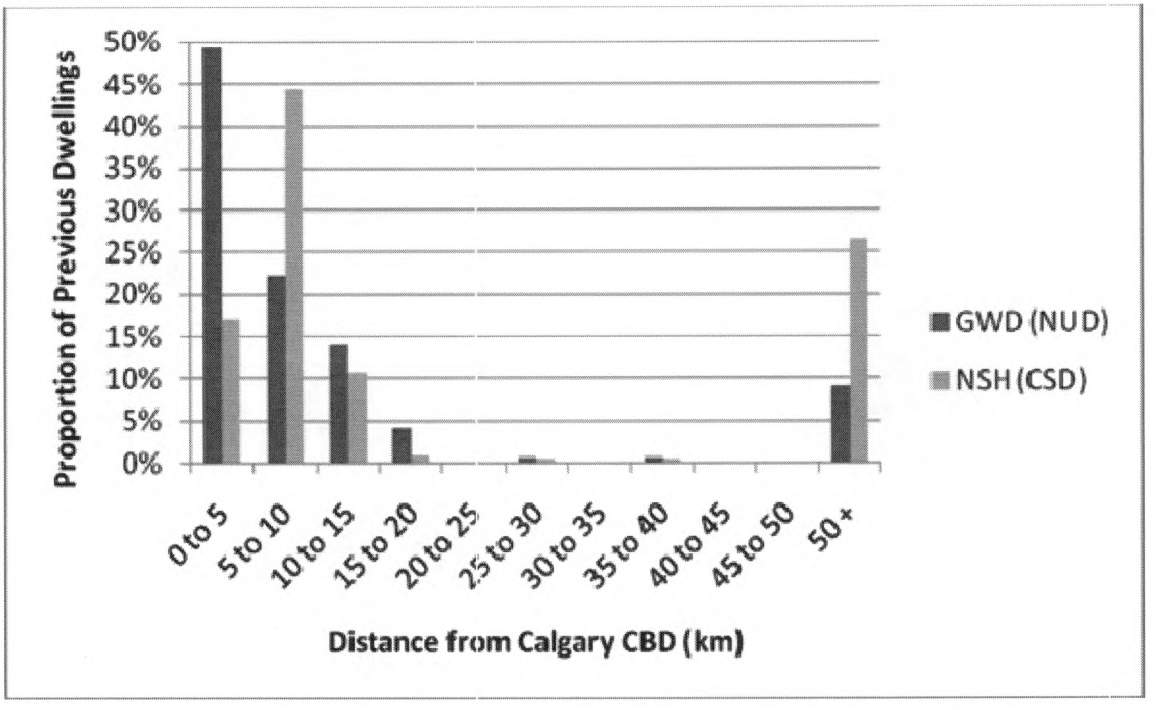

Figure 12 – Previous Dwelling Distance to CBD (Garrison Woods / North Signal Hill Respondents)

MONTREAL NEIGHBOURHOODS

Both Bois Franc (BFR) and Nouveau Saint-Laurent (NSL) are located in northwest Montreal (in the former municipality of Saint-Laurent), less than 1 km apart and about 12 km from the CBD (Figure 13 and Figure 14). Both BFR (NUD) and NSL (CSD) have a strong clustering of previous dwellings in the nearby vicinity. However, previous residences of BFR (NUD), like those of MKT, appear to have slightly more regional dispersion than previous residences of NSL, with a substantial cluster in older areas to the north and west of the CBD.

NSL does have some dispersion of previous residences in the suburban regions in the northeast of Montreal Island, but this is small compared to the proportion in vicinity to NSL itself. Over 45% of NSL (CSD) respondents, while only 30% of BFR (NUD) respondents moved less than 5 km from their prior residence (Figure 15), but 85% of BFR and 89% of NSL previous residences were within 10 km of the respondent's current home. As expected, a higher percentage of NUD than CSD previous residences are close to the CBD. About 60% of BFR (NUD) but only 45% of NSL (CSD) prior residences are within 10 km of the CBD.

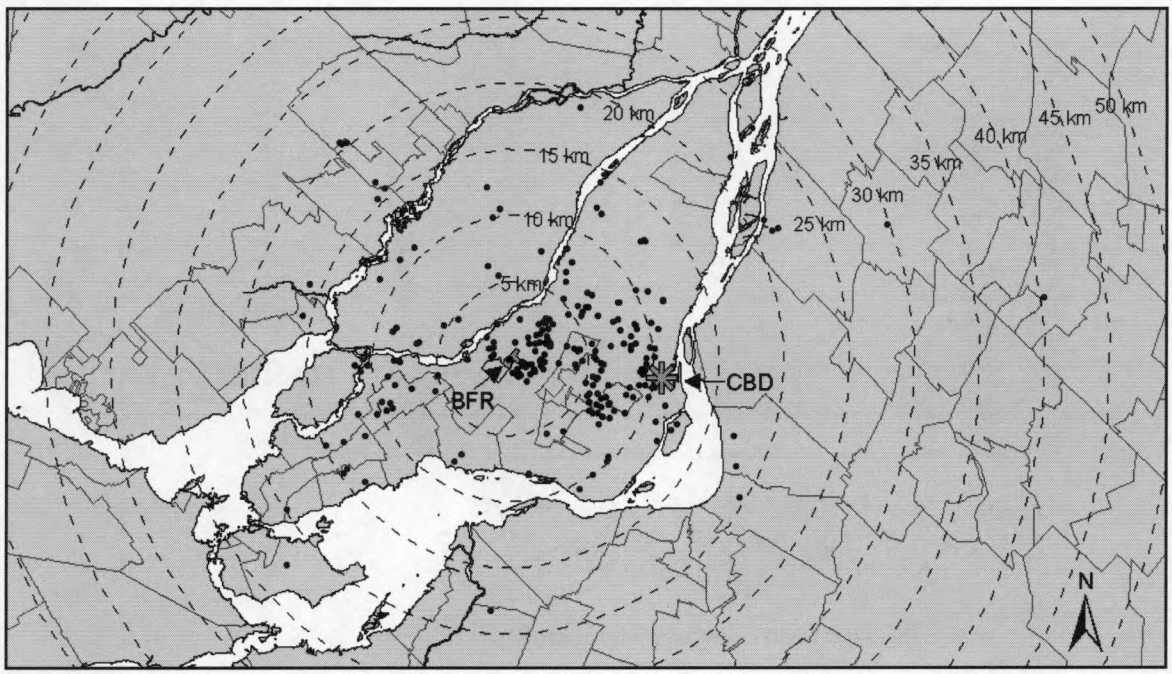

Figure 13 – Previous Dwelling Points for Bois Franc Residents (NUD)

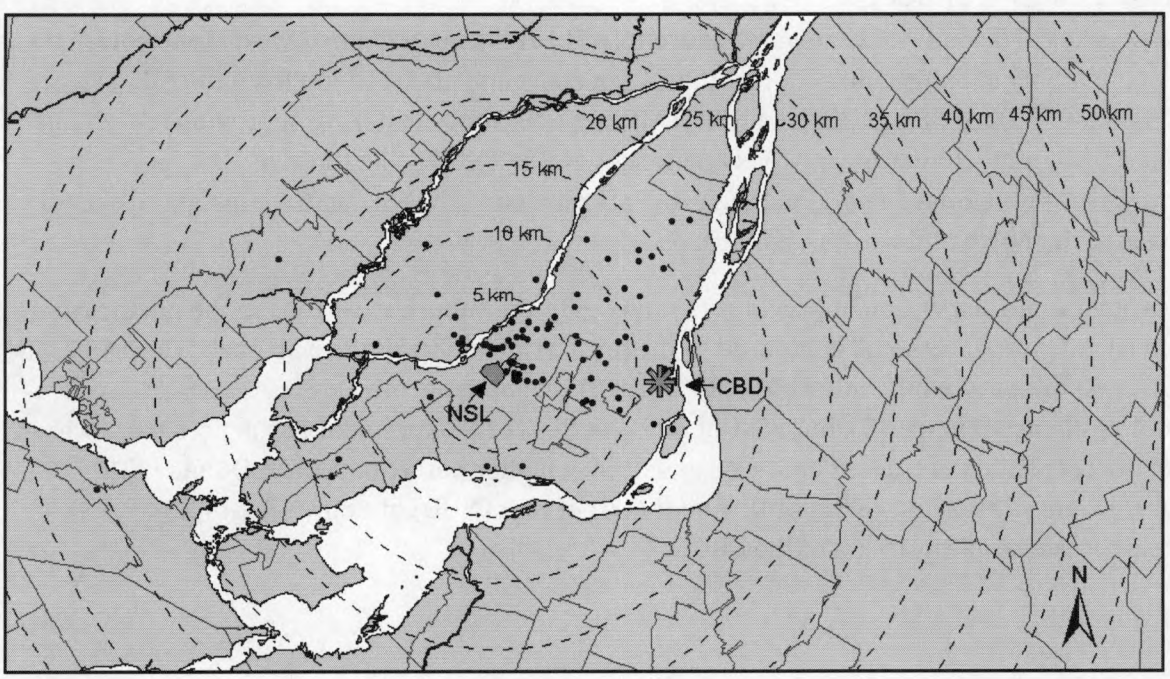

Figure 14 – Previous Dwelling Points for Nouveau Saint-Laurent Residents (CSD)

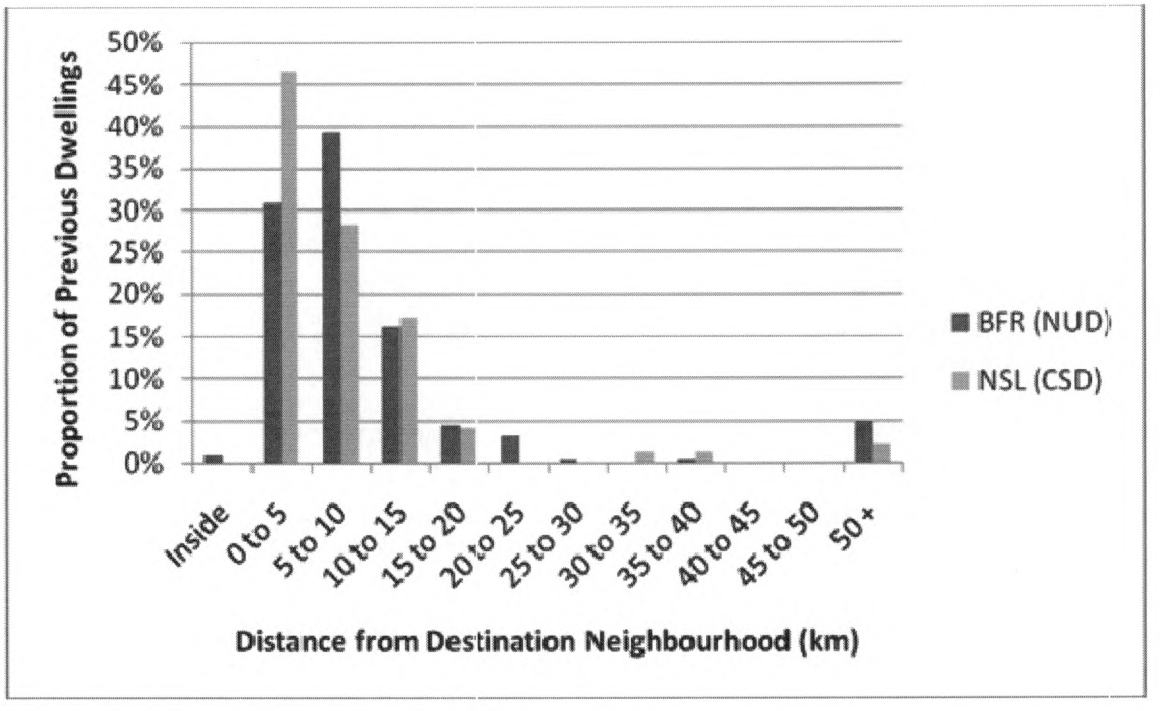

Figure 15 – Previous Dwelling Distance from Bois Franc / Nouveau Saint-Laurent

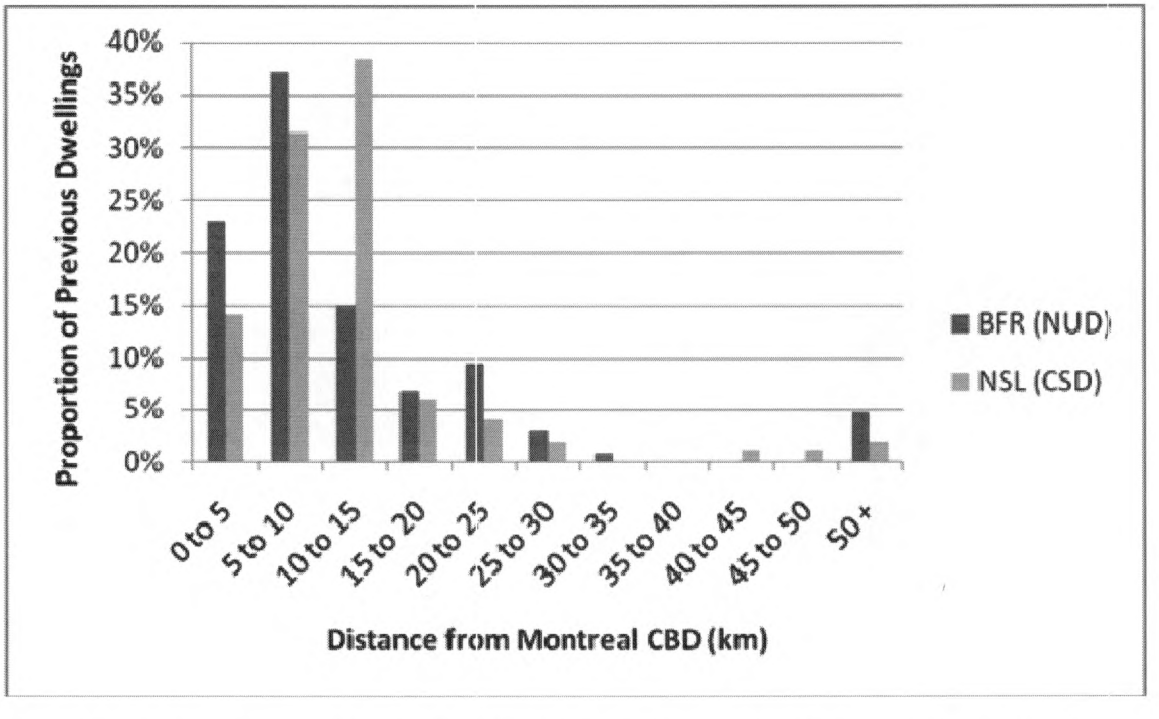

Figure 16 – Previous Dwelling Distance to CBD (Bois Franc / Nouveau Saint-Laurent Respondents)

TORONTO NEIGHBOURHOODS

Both Cornell (CNL) and Woodbine North (WBN) are located in Markham, Ontario, (north of Toronto), about 11 km apart and about 27 km from the Toronto CBD (Figure 17 and Figure 18). Similar to MKT and BFR, Cornell (NUD) previous dwellings appear to be more scattered than those for Woodbine North (CSD), with higher portions in older sections of Toronto especially to the southwest. Unlike the other NUDs, however, the CNL prior residences do not show a strong cluster immediately adjacent to the CBD. The WBN prior residences are less scattered. They concentrate in suburban locations in the general proximity of WBN, but without the strong cluster of locations in the immediate vicinity as was seen in CNL.

About the same proportion of CNL and WBN previous residences are found within 5 km of the study area; however, over half of the WBN, but only a third of the CNL (NUD) previous residences are located within 10 km of the study area (Figure 19). The contrast of this with the map appearance is likely due to the lower response rate of WBN dwellers. On the other hand, about half of the CNL (NUD) and only 20% of the WBN previous residences were more than 15 km from the study neighbourhood. Distance of previous residence to the CBD is similar to that of the other study pairs (Figure 20). A higher proportion of CNL (NUD) than of WBN respondents had previous residences within 10 km of the CBD. These percentages are much lower than those for the other study pairs.

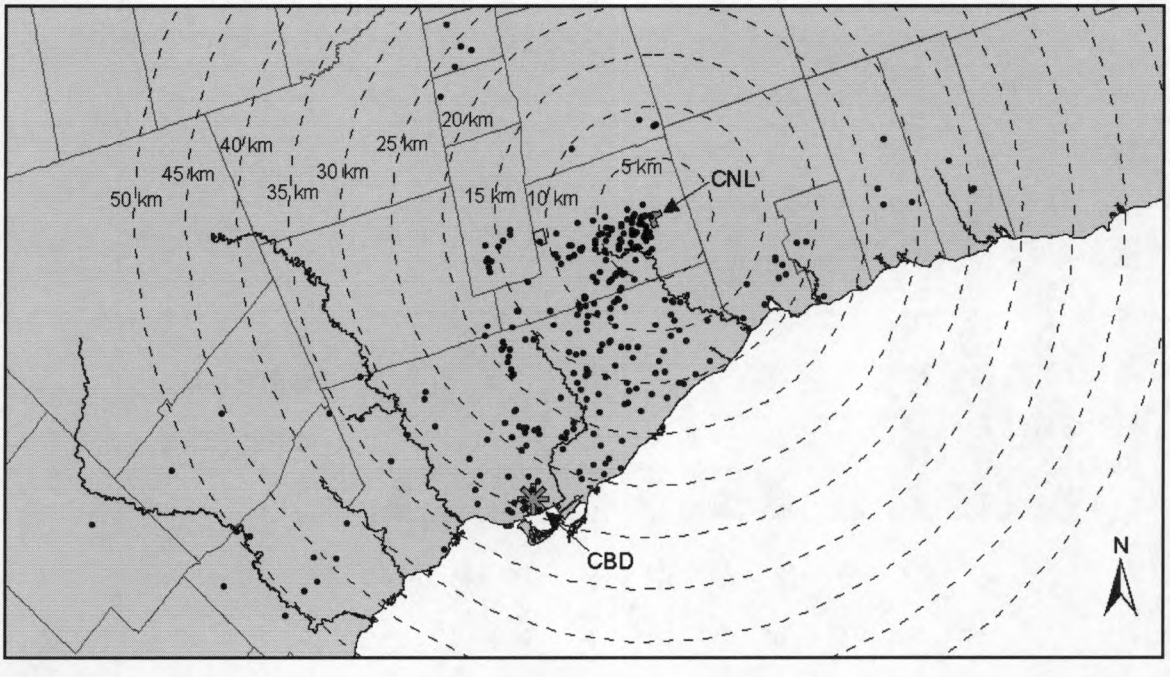

Figure 17 – Previous Dwelling Points for Cornell Residents (NUD)

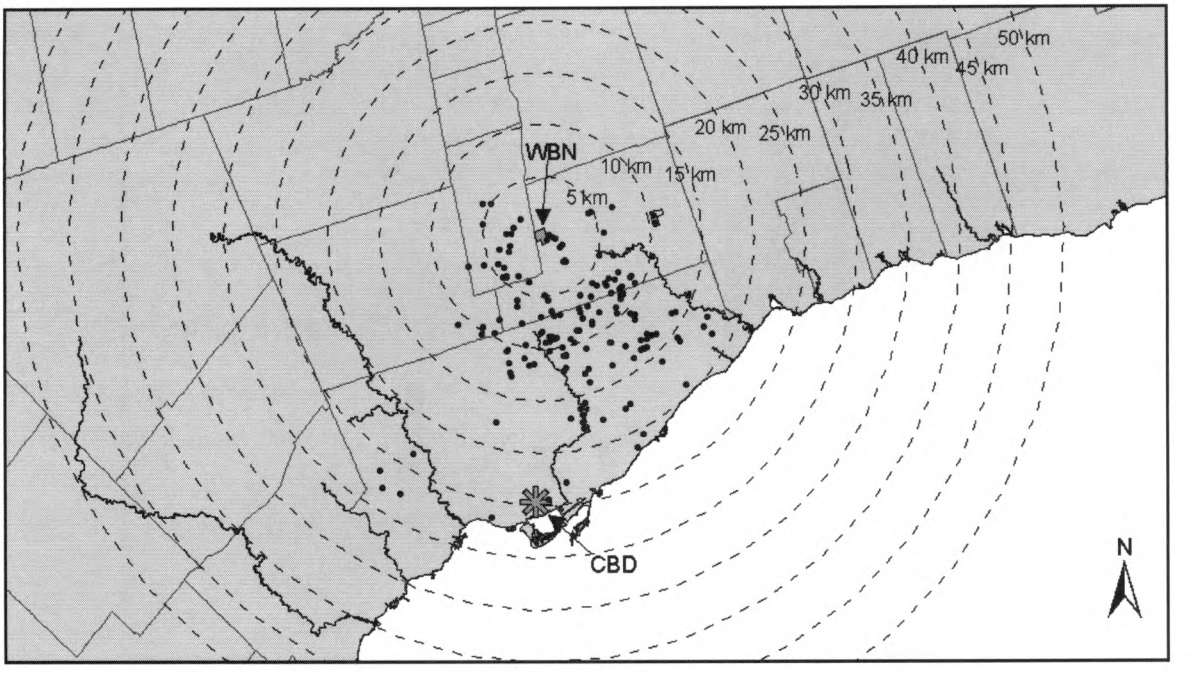

Figure 18 – Previous Dwelling Points for Woodbine North Residents (CSD)

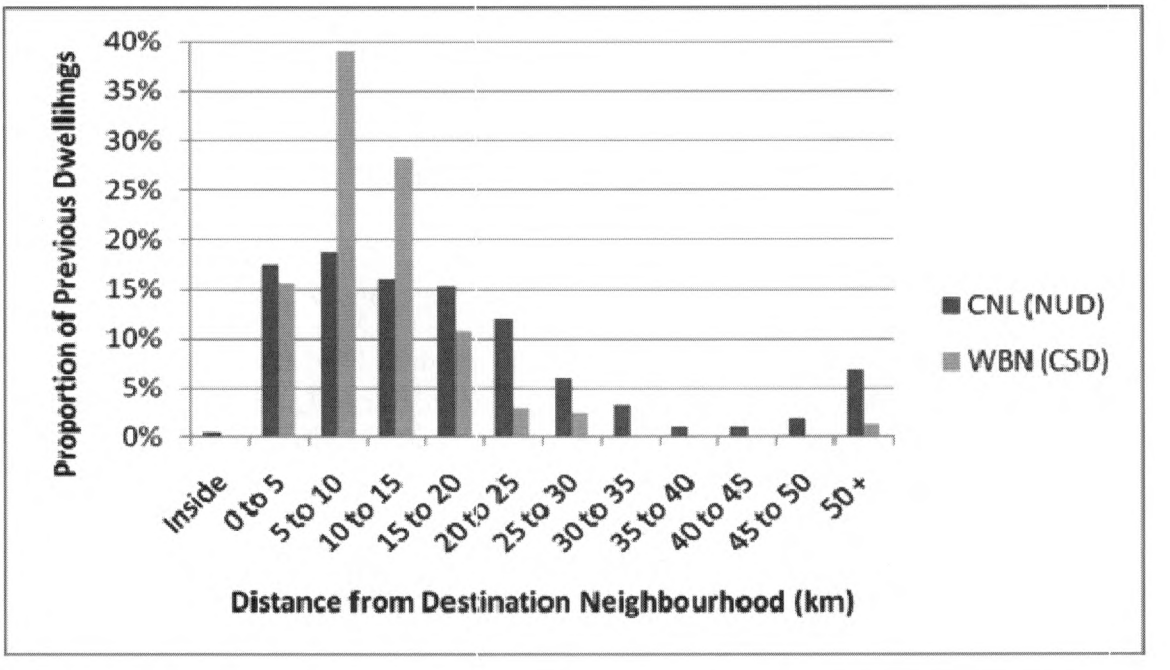

Figure 19 – Previous Dwelling Distance from Cornell / Woodbine North

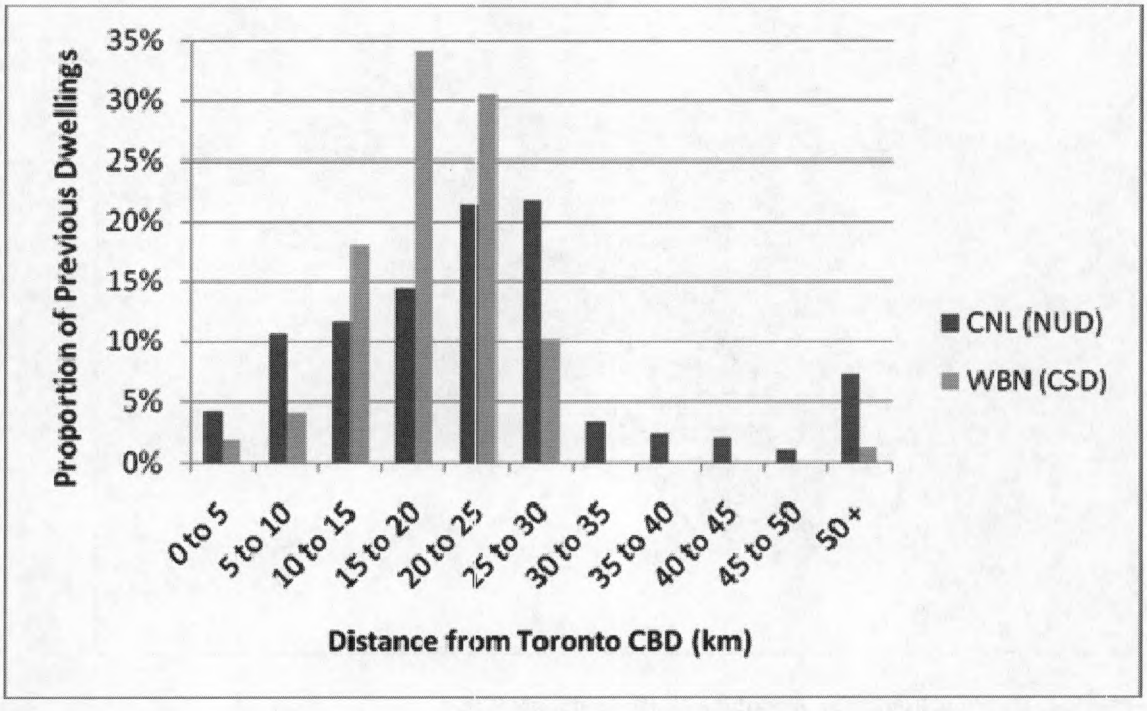

Figure 20 – Previous Dwelling Distance to CBD (Cornell / Woodbine North Respondents)

CONCLUDING REMARKS ON PREVIOUS HOME LOCATIONS

Although the patterns between study pairs vary, they have some key similarities. The distance of previous residence to the CBD suggests that a higher proportion of NUD previous residences than CSD previous residences are within 10-km of the CBD, which supports the contention that households would prefer to live in similar neighbourhoods that facilitate their preferred life styles thus suggesting that new urbanist residents often relocate from high-density neighbourhoods and are pre-disposed to active lifestyles. Thus, the overall patterns support the hypothesis that NUD dwellers are more likely than CSD dwellers to have prior residence in inner-city areas.

Distance of previous residence to destination neighbourhood is more varied between the study areas. Except for GWD, a higher proportion of CSD than NUD previous residences are within 10 km of the study area, and (excluding previous residences beyond 50 km) a higher proportion of NUD than CSD previous residences are beyond 15 km of the study area. The results from Table 5 reinforce this fact. At distances greater than 50 km, both Montreal and Toronto showed higher proportions of NUD than CSD previous residences, while both Calgary study areas showed higher proportions of CSD than NUD previous residences. The proportion of previous residences beyond 50 km for the four Calgary study areas ranged from 9-32%, which is much higher than the 1-7% in Montreal and Toronto.

The results of CNL (NUD) tend to reflect the findings of Skaburskis (2006), who found a high proportion of CNL residents originating in suburban neighbourhoods close by.

Table 4: Distance of previous home location to CBD

Neighbourhood	Mean distance to CBD	Standard Deviation	Observations
GWD	6.12	5.44	131
NSH	8.89	9.80	214
MKT	10.58	10.32	269
MKL	13.46	12.96	233
BFR	10.30	7.13	244
NSL	10.72	6.28	96
CNL	21.67	11.92	290
WBN	18.49	5.24	165
Total	13.13	10.87	1642

Table 5: Distance of previous home location to the corresponding NU/CSD neighbourhood

Neighbourhood	Mean distance to NHD	Standard Deviation	Observations
GWD	5.77	4.79	131
NSH	6.97	5.44	193
MKT	13.14	7.86	258
MKL	10.66	7.79	210
BFR	8.18	5.70	241
NSL	7.49	6.26	97
CNL	15.25	10.21	277
WBN	10.78	5.56	165
Total	10.45	7.91	1572

CHARACTERIZING PREVIOUS HOME NEIGHBOURHOODS

Published research in housing location choice suggests that households may be predisposed to a particular type of neighbourhood quality and if given an opportunity are likely to relocate to a similar neighbourhood. For instance, a household living in a high-density, mixed land use neighbourhood located near the urban core is likely to relocate to a similar neighbourhood elsewhere, provided their household characteristics do not change. This continuity is evidence for a neighbourhood type preference, which we will use later in the paper to test the self-selection bias hypothesis. In this section, we continue to review evidence for continuity in neighbourhood choice.

RESIDENTIAL DENSITY

The average population density observed at the last residence is presented for each neighbourhood in the study area in Table 6. It appears from the table that the residents of the new urbanist neighbourhoods have moved from higher density areas than the residents of CSDs. However, the reverse is true for the two study areas near Toronto.

Table 6: Average Population density at the last residence

Neighbourhoods	Mean	Std. Dev.	Freq.
GWD	5480	4711	144
NSH	4290	3853	261
MKT	4162	3102	335
MKL	3600	2482	306
BFR	9578	5939	253
NSL	8673	5436	99
CNL	6877	5546	300
WBN	8144	5406	167
Total	**5957**	**5000**	**1865**

A breakdown of previous residential densities suggests that the average population density in the last neighbourhood for the new urbanist neighbourhood residents was 6,463 persons per square km compared to 5,326 persons per sq km for the residents of the CSDs (Table 7). A t-test also confirms that the population density in the previous neighbourhoods of the NUD residents is higher than that for the CSD residents.

Table 7: Population density comparison between NUD and CSDs

```
Two-sample t test with unequal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
new urba |    1032    6462.941    164.7802    5293.523    6139.598    6786.284
  con SD |     835    5326.691    156.7868     4530.57    5018.948    5634.434
---------+--------------------------------------------------------------------
combined |    1867    5954.763     115.661    4997.571    5727.924    6181.601
---------+--------------------------------------------------------------------
    diff |             1136.25    227.4525                690.1606    1582.339
------------------------------------------------------------------------------
    diff = mean(new urba) - mean(con SD)                          t =   4.9955
```

```
Ho: diff = 0                     Satterthwaite's degrees of freedom =  1859.12

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

STREET NETWORK DENSITY

The street network density (SND) is measured as the ratio of linear length of roads in the neighbourhood divided by the area of the neighbourhood. The street network density breakdown is presented in Table 8 and the comparative densities between the new urbanist and conventional suburban development is presented in Table 9. Despite the small difference in SND between new NUD and CSD, the t-test suggests that those households who relocated to a NUD moved from neighbourhoods with slightly higher street network density.

Table 8: Street network density at the last residence

Neighbourhoods	Mean	Std. Dev.	Freq.
GWD	13.2	3.1	144
NSH	12.2	2.9	261
MKT	12.0	3.3	335
MKL	11.5	2.9	306
BFR	13.9	3.4	253
NSL	13.9	3.3	99
CNL	10.3	2.5	300
WBN	10.1	2	167
Total	**12**	**3**	**1865**

Table 9: Street network density comparison between NUD and CSDs

```
Two-sample t-test with unequal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
new urba |    1033      12.138    .1043828    3.354898    11.93317    12.34282
  con SD |     833    11.74609    .1059604    3.058201    11.53811    11.95407
---------+--------------------------------------------------------------------
combined |    1866    11.96304    .0747932    3.230858    11.81636    12.10973
---------+--------------------------------------------------------------------
    diff |            .3919097    .1487393                .1001937    .6836257
------------------------------------------------------------------------------
    diff = mean(new urba) - mean(con SD)                          t =   2.6349
Ho: diff = 0                     Satterthwaite's degrees of freedom =  1836.22

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9958         Pr(|T| > |t|) = 0.0085          Pr(T > t) = 0.0042
```

TRANSIT AND WALK MODE SPLIT FOR WORK TRIPS

The following table present tabulations for census-based mode split data for journey to work. Residents of NUD neighbourhood of Garrison Woods had relocated from neighbourhoods where the average *walk+transit* mode split was around 31% for journey to work trips. At the same time,

the residents of CSD in North Signal Hill relocated from neighbourhoods with *transit+walk* mode split of approximately 25%. The t-test reported in Table 11 suggests that the new urbanist neighbourhood residents relocated from neighbourhoods where transit and walk mode splits were higher.

Table 10: Transit and walk mode splits at previous neighbourhoods

Neighbourhoods	Mean	Std.Dev.	Freq.
GWD	0.31	0.16	144
NSH	0.25	0.15	261
MKT	0.24	0.14	335
MKL	0.19	0.11	306
BFR	0.39	0.19	253
NSL	0.34	0.16	99
CNL	0.28	0.17	300
WBN	0.30	0.13	167
Total	**0.27**	**0.16**	**1865**

Table 11: Previous neighbourhood mode split comparison between NUD and CSD residents

```
t-test transwalk, by(csd) unequal

Two-sample t-test with unequal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
new urba |    1032    .2961725    .0053876    .1730762    .2856005    .3067444
  con SD |     833    .2455342    .0049952    .1441695    .2357296    .2553388
---------+--------------------------------------------------------------------
combined |    1865     .273555    .0037681    .1627271    .2661649    .2809451
---------+--------------------------------------------------------------------
    diff |            .0506383     .007347                .0362291    .0650475
------------------------------------------------------------------------------
    diff = mean(new urba) - mean(con SD)                          t =   6.8924
Ho: diff = 0                     Satterthwaite's degrees of freedom =  1861.15

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

AVERAGE COMMUTE DISTANCE

We will analyze the impact of previous neighbourhood type on post-relocation commute distances later in the report. In the following tables we present tabulations for average commute distance observed in the previous neighbourhood from which these households have relocated. Table 12 suggests that the average commute distance, as was reported in the Census, is around 8.4 km. However, the t-test results reported in Table 13 indicate that the difference in commute distances observed at the previous home locations for the residents of NUD and CSD is statistically insignificant.

Table 12: Average commute distance observed for previous home location

Neighbourhoods	Mean	Std.Dev.	Freq.
GWD	8.67	1.70	143
NSH	8.40	1.54	253
MKT	7.99	1.98	319
MKL	8.27	3.50	301
BFR	8.62	0.98	253
NSL	8.62	0.77	98
CNL	8.54	1.33	299
WBN	8.28	0.80	167
Total	**8.38**	**1.95**	**1833**

Table 13: Comparison of average commute distance between CSD and NUD

```
           |  Summary of avg commute km in prev
           |                  nhd
    CSD = 1 |        Mean   Std. Dev.       Freq.
------------+------------------------------------
  new urban |   8.4047187   1.5725558        1014
     con SD |   8.3543011   2.3335662         819
------------+------------------------------------
      Total |   8.3821917   1.9492295        1833

. t-test Worker_comm_dist, by(csd) unequal

Two-sample t-test with unequal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
new urba |    1014    8.404719    .0493841    1.572556    8.307812    8.501626
  con SD |     819    8.354301    .0815414    2.333566    8.194246    8.514356
---------+--------------------------------------------------------------------
combined |    1833    8.382192    .0455283     1.94923    8.292899    8.471485
---------+--------------------------------------------------------------------
    diff |            .0504176    .0953299               -.1365898     .237425
------------------------------------------------------------------------------
    diff = mean(new urba) - mean(con SD)                          t =   0.5289
Ho: diff = 0                     Satterthwaite's degrees of freedom =  1378.38

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.7015         Pr(|T| > |t|) = 0.5970          Pr(T > t) = 0.2985
```

Distance to Central Business District

We have determined the average straight-line (linear) distance from each households' previous home location to the Central Business District (where applicable) for the respective city or town and have reported the results in the following tables.

The average distance to the Central Business District (CBD) for previous home location was 13.13 km for the entire sample (Table 14). The residents of the two new urbanist neighbourhoods in Calgary reported to have lower distances to CBD at their previous home locations than their CSD

counterparts, suggesting that the new urbanist residents have moved from more central locations than their CSD counterparts. However, the same differences are not observed for the neighbourhood pairs in Toronto and Montreal.

On average the new urbanist residents appear to have relocated from less centralized neighbourhoods (distance to CBD = 13.3 km) than their CSD counterparts with distance to CBD equalling 12.9 km at previous home locations (Table 15). However, this result is influenced by the trends observed in Cornell near Toronto. The difference in average distance to CBD at previous home locations for the current residents of CSD and NUD residents is statistically insignificant.

Table 14: Average distance to CBD at the last residence

Neighbourhoods	Mean	Std.Dev.	Freq.
GWD	6.12	5.44	131
NSH	8.89	9.80	214
MKT	10.58	10.32	269
MKL	13.46	12.96	233
BFR	10.30	7.13	244
NSL	10.72	6.28	96
CNL	21.67	11.92	290
WBN	18.49	5.24	165
Total	**13.13**	**10.87**	**1642**

Table 15: Comparison of distance to CBD between NUD and CSDs

CSD = 1	Summary of straight_distance_to_CBD Mean	Std. Dev.	Freq.
new urban	13.326381	11.201342	934
con SD	12.879068	10.419603	708
Total	13.133508	10.870178	1642

Two-sample t test with unequal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
new urba	934	13.32638	.3665191	11.20134	12.60708	14.04568
con SD	708	12.87907	.3915927	10.4196	12.11024	13.64789
combined	1642	13.13351	.2682564	10.87018	12.60735	13.65967
diff		.4473134	.5363591		-.6047405	1.499367

diff = mean(new urba) - mean(con SD) t = 0.8340
Ho: diff = 0 Satterthwaite's degrees of freedom = 1573.34

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.7978 Pr(|T| > |t|) = 0.4044 Pr(T > t) = 0.2022

EMPLOYMENT OPPORTUNITIES AT PREVIOUS HOME LOCATIONS

Using Dissemination Area data from Statistics Canada, we calculated the total job opportunities available within 5 km of the previous home location for the survey respondents. A neighbourhood by neighbourhood breakdown suggests that the new urbanist residents have (with the exception of Toronto) relocated from neighbourhoods with higher employment accessibility (Table 16). On average, the residents of NUDs relocated from neighbourhoods with 139,968 jobs available within a 5 km radius compared to 99,496 jobs at the previous home locations for the CSD residents. These differences are statistically significant (Table 17).

Table 16: Total employment opportunities within 5 km at the last residence

Neighbourhoods	Mean	Std.Dev.	Freq.
GWD	156,604	108,787	144
NSH	89,957	85,416	261
MKT	82,045	82,807	336
MKL	57,194	62,748	306
BFR	242,008	178,029	253
NSL	218,458	149,200	99
CNL	110,803	110,291	300
WBN	121,395	67,061	167
Total	**121,901**	**123,626**	**1866**

Table 17: Comparison of Total employment opportunities within 5 km at previous location

```
           | Summary of jobs within 5km of prev
           |                 nhd
   CSD = 1 |      Mean   Std. Dev.       Freq.
-----------+------------------------------------
 new urban |    139968   138058           1033
    con SD |     99496    98536            833
-----------+------------------------------------
     Total |    121901   123626.45        1866

Two-sample t test with unequal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
new urba |    1033      139968    4295.492    138058.5    131539.1    148396.9
  con SD |     833    99496.18    3414.101     98536.9    92794.91    106197.4
---------+--------------------------------------------------------------------
combined |    1866      121901    2861.907    123626.4    116288.1    127513.9
---------+--------------------------------------------------------------------
    diff |            40471.82    5487.016                29710.38    51233.26
------------------------------------------------------------------------------
    diff = mean(new urba) - mean(con SD)                          t =   7.3759
Ho: diff = 0                     Satterthwaite's degrees of freedom =  1837.93

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

In summary one can conclude the following from the results presented in this section. Compared to CSD residents, the NUD residents have relocated from neighbourhoods with generally:

- Higher population densities
- Higher street network density
- Higher transit and walk mode splits
- Higher employment opportunities within 5 km
- Similar distance to CBD
- Similar commute distance to work

CLUSTERING PREVIOUS NEIGHBOURHOODS FOR CATEGORIZATION

In the previous section we have presented a neighbourhood-level breakdown for the following six proxies for built form, land use, and travel behaviour:

- population density (from census);
- street density (from street maps);
- jobs within 5 km (from census);
- straight line distance to Central Business District (from land use maps)
- mode split from journey to work data (from census)
- avg. travel distance from journey to work data (from census).

Given the above discussion about how households do have a preferred life style that influences their choice of homes and neighbourhoods, we therefore need to account for these influences while we develop a regression model for VKTs. We have controlled for households' lifestyle choices as they relate to choice of neighbourhoods in the regression model by characterising the current and previous home location for each household in the sample using a walkability-car dependence scale where 1 implies most car dependent neighbourhood and 5 represents most walkable neighbourhood. For previous home locations, we have used the above-mentioned six proxies for built form and travel behaviour as an input in a k-mean clustering algorithm that explicitly categorized each household's previous home location on a 5-point scale. K-mean clustering is a standard multivariate statistical tool to create mutually exclusive clusters based on how similar individual observations are to each other. The average values for the above-mentioned six proxies are presented in the following table.

Table 18: Average values for the six variables contributing to the clustering algorithm

clust5	Population density	Street density	Transit +walk mode split	Distance to CBD (km)	Employment within 5 km	Commute distance (5 km)
most autodep	3,544	11.6	17.5%	18.0	33,337	7.3
autodep	5,138	11.6	25.6%	14.2	86,443	8.5
mean autdep	8,612	11.3	32.9%	13.2	158,940	8.5
walkable	8,984	14.3	43.7%	4.5	256,566	9.3
most walkdep	15,432	14.9	62.8%	2.8	545,055	9.2
Total	**6,340**	**12.2**	**29.1%**	**13.1**	**132,965**	**8.3**

A breakdown of previous neighbourhoods based on the clustering of individual households is presented below. Of the 1,640 households for which we had sufficient data recorded for their previous home locations, 593 (36%) relocated from most auto dependent neighbourhoods and merely 5% relocated from most walkable neighbourhood.

Table 19: Previous home categorization using cluster analysis

old nhd categories	Freq.	Percent	Cum.
most auto dependent	593	36.16	36.16
auto dependent	397	24.21	60.37
mean auto dependent	265	16.16	76.52
walkable	305	18.6	95.12
most walk dependent	80	4.88	100
Total	**1,640**	**100**	

A cross-tabulation between the eight neighbourhoods and the previous home categories is presented in the following table. Notice that most households who had lived in neighbourhoods categorized as most walkable moved to BFR and NSL in Montreal or Cornell in Toronto (Table 20). Further note that the four neighbourhoods in Calgary reported only one household relocating from a neighbourhood categorized as most walk dependent.

Table 20: Old and new neighbourhood cross tabulation (actual count)

2006 Neighbourhood	most autodep	autodep	mean autodep	walkable	most walkdep	Total
GWD	39	19	4	69	0	131
NSH	103	53	10	47	0	213
MKT	137	75	6	51	0	269
MKL	145	63	10	14	1	233
BFR	40	28	43	79	54	244
NSL	8	13	35	28	12	96
CNL	102	84	76	16	11	289
WBN	19	62	81	1	2	165
Total	**593**	**397**	**265**	**305**	**80**	**1640**

Pearson chi2(28) = 819.8644 Pr = 0.000

Table 21 suggests that generally neighbourhoods in Calgary and Cornell in Toronto attracted households from auto dependent neighbourhoods. Whereas the two neighbourhoods in Montreal attracted households from walkable neighbourhoods.

Table 21: Old and new neighbourhood cross tabulation as percentage of the old neighbourhoods

2006 Neighbourhood	most autodep	autodep	mean autodep	walkable	most walkdep	Total
GWD	6.6	4.8	1.5	22.6	0.0	8.0
NSH	17.4	13.4	3.8	15.4	0.0	13.0
MKT	23.1	18.9	2.3	16.7	0.0	16.4
MKL	24.5	15.9	3.8	4.6	1.3	14.2
BFR	6.8	7.1	16.2	25.9	67.5	14.9
NSL	1.4	3.3	13.2	9.2	15.0	5.9
CNL	17.2	21.2	28.7	5.3	13.8	17.6
WBN	3.2	15.6	30.6	0.3	2.5	10.1
Total	**100**	**100**	**100**	**100**	**100**	**100**

Also reported below is a cross-tabulation between old neighbourhood clusters and the new neighbourhoods categorized as new urbanist and conventional suburban developments. Table 22 suggests that approximately 39% of those who relocated to CSDs came from most auto dependent neighbourhoods compared to 34% of those who relocated to a NUD (χ^2 (4) = 56.3, $p < 0.00$). Similarly, 30% of households relocating to NUD moved from a walkable or most walk dependent neighbourhood compared to only 28% of those who relocated to a CSD.

Table 22: Cross tabulation between NUD/CSD developments and previous home neighbourhood categories

2006 Neighbourhood	most autodep	autodep	mean autodep	walkable	most walkdep	Total
new urbanist	34.1	22.1	13.8	23.0	7.0	100
con SD	38.9	27.0	19.2	12.7	2.1	100
Total	**36.16**	**24.21**	**16.16**	**18.6**	**4.88**	**100**

Pearson chi2(4) = 56.2740 Pr = 0.000

COMPARING NEIGHBOURHOOD PREFERENCES WITH TRAVEL BEHAVIOUR

In the household survey we had asked households of any changes in their travel behaviour since their relocation to the new neighbourhood. In this section, we report results of the correlation between previous home neighbourhood and various proxies of travel behaviour reported by respondents after they had located to a new urbanist or conventional suburban development. For instance, we asked the respondents if they had started to walk more or less after they had relocated to the new neighbourhood. We asked similar questions about driving and automobile ownership as well.

The cross tabulations between the walkability scale for previous home locations with the change in travel behaviour reported in the survey could help us answer questions about the self-selection bias. For example, if we find that households that relocated to NUDs increased their walking and reduced their driving, regardless of whether they came from walk or auto dependent neighbourhoods previously, this would provide evidence that neighbourhood design and not self-selection explains changes in travel behaviour.

IMPACT ON WALKING BEHAVIOUR

Table 23 presents the raw counts from cross-tabulation whereas Table 24 presents results in percentage terms. Almost 62% of those who relocated from neighbourhoods characterized as most automobile dependent reported walking a bit or a lot more after their move. This result suggests that given a chance to have an active lifestyle, individuals relocating from even the most automobile dependent neighbourhoods are likely to embrace active lifestyles. Similarly, 34% of those who relocated from most walkable neighbourhoods reported walking a bit more and another 16.3% reported walking a lot more.

This suggests that walking activity appears to have increased more for those who relocated from auto dependent neighbourhoods than those who moved from walkable neighbourhoods (χ^2 (20) = 54.8, $p < 0.00$).

Table 23: Walking more or less now and the impact of old neighbourhood (raw numbers)

Walk more or less	most autodep	autodep	mean autodep	walkable	most walkdep	Total
a bit less now	41	37	37	42	11	168
a bit more now	183	107	64	85	27	466
a lot less now	28	18	20	30	10	106
a lot more now	183	139	67	83	13	485
don't know	1	1	2	3	0	7
neither more or less	157	95	75	62	19	408
Total	593	397	265	305	80	1,640

Pearson chi2(20) =54.8383 Pr = 0.000

Table 24: Walking more or less now and the impact of old neighbourhood (%)

Walk more or less	most autodep	autodep	mean autodep	walkable	most walkdep	Total
a bit less now	6.9	9.3	14.0	13.8	13.8	10.2
a bit more now	30.9	27.0	24.2	27.9	33.8	28.4
a lot less now	4.7	4.5	7.6	9.8	12.5	6.5
a lot more now	30.9	35.0	25.3	27.2	16.3	29.6
don't know	0.2	0.3	0.8	1.0	0.0	0.4
neither more or less	26.5	23.9	28.3	20.3	23.8	24.9
Total	100	100	100	100	100	100

However, it would be more interesting to determine if those who relocated to NUDs experienced a greater shift in walking behaviour than those who moved to CSDs. The results are presented in the following tables. Those households who relocated to NUDs from most auto dependent neighbourhoods reported significantly higher shift in walking tendency (χ^2 (20) = 42, $p < 0.00$) than those who relocated to CSDs (χ^2 (20) = 55.5, $p < 0.00$).

Similarly, those who relocated from walkable neighbourhoods to NUDs reported a higher shift in walking preferences than those who moved from walkable neighbourhoods to CSDs. These results are indicative of a shift in walking preferences observed for households who have relocated from suburban type neighbourhoods to new urbanist neighbourhoods. This suggests that if given an opportunity for walking, households moving from conventional suburbs to communities where built form is conducive to walking will change their travel behaviour.

Table 25: Walking more or less now and the impact of old neighbourhood for CSD/NUD (%)

New Urbanist Walk more or less	most autodep	autodep	mean autodep	walkable	most walkdep	Total
a bit less now	5.4	3.9	7.8	10.2	10.8	6.9
a bit more now	31.8	29.1	24.8	30.7	35.4	30.2
a lot less now	1.6	2.4	3.9	4.7	10.8	3.4
a lot more now	37.1	43.2	37.2	34.4	15.4	36.3
don't know	0.0	0.5	0.8	0.5	0.0	0.3
neither more or less	24.2	20.9	25.6	19.5	27.7	22.8
Total	100	100	100	100	100	100

Pearson chi2(20) =42.0057 Pr = 0.003

Con SD Walk more or less	most autodep	autodep	mean autodep	walkable	most walkdep	Total
a bit less now	8.7	15.2	19.9	22.2	26.7	14.7
a bit more now	29.8	24.6	23.5	21.1	26.7	26.0
a lot less now	8.4	6.8	11.0	22.2	20.0	10.5
a lot more now	23.6	26.2	14.0	10.0	20.0	20.7
don't know	0.4	0.0	0.7	2.2	0.0	0.6
neither more or less	29.1	27.2	30.9	22.2	6.7	27.6
Total	100	100	100	100	100	100

Pearson chi2(20) =55.5263 Pr = 0.000

Impact on Driving behaviour

If the self-selection bias were instrumental, one would expect to see those moving from the most walkable neighbourhoods to be driving the same amount after relocating. Similarly, those who relocated from most automobile dependent neighbourhoods would be expected to drive at the same level as before. However, the results presented in the following tables indicate more nuanced interactions between travel behaviour and previous home neighbourhoods. The results on change in driving are presented in the following tables.

Table 26: Driving more or less now and the impact of old neighbourhood (raw numbers)

Drive more or less	most autodep	autodep	mean autodep	walkable	most walkdep	Total
a bit less now	115	59	26	44	10	254
a bit more now	93	93	47	58	16	307
a lot less now	102	38	17	21	5	183
a lot more now	66	66	74	78	33	317
don't know	1	0	2	1	0	4
neither more or less	216	141	99	103	16	575
Total	593	397	265	305	80	1,640

Pearson chi2(20) = 120.9137 Pr = 0.000

Table 27: Driving more or less now and the impact of old neighbourhood (%)

Drive more or less	most autodep	autodep	mean autodep	walkable	most walkdep	Total
a bit less now	19.4	14.9	9.8	14.4	12.5	15.5
a bit more now	15.7	23.4	17.7	19.0	20.0	18.7
a lot less now	17.2	9.6	6.4	6.9	6.3	11.2
a lot more now	11.1	16.6	27.9	25.6	41.3	19.3
don't know	0.2	0.0	0.8	0.3	0.0	0.2
neither more or less	36.4	35.5	37.4	33.8	20.0	35.1
Total	100	100	100	100	100	100

The above tabulations suggest that 26% of those who relocated from a walkable neighbourhood and 41% of those who relocated from the most walkable neighbourhoods reported driving a lot more after relocating. At the same time, only 16% of those who relocated from the most automobile dependent neighbourhoods reported driving a bit more and only 11% reported driving a lot more after relocation. These results suggest that households relocating from walkable neighbourhoods ended up driving more than the rest. This suggests that self-selection is not instrumental here since we see that those relocating from walkable neighbourhoods ended up driving more than the rest.

When we focus on those who relocated to NUDs, we find that 40% of those who relocated from most walkable neighbourhoods reported driving a lot more and another 19% of those who relocated from walkable neighbourhoods also reported driving a lot more (Table 28). In comparison, when we focus on those who relocated to CSDs, we see that 47% of those who relocated from the most walkable neighbourhoods reported driving a lot more and 41% of those who relocated from walkable neighbourhoods reported driving a lot more. This suggests that those who relocated to CSDs from walkable neighbourhoods ended up driving significantly more than those who relocated to NUDs.

Of those who moved from the most autodependent neighbourhoods to NUDs, only 8% reported driving a lot more in their new NUD neighbourhood and 10% of those from autodependent neighbourhoods report driving a lot more in their new NUD neighbourhood. For those moving to CSDs from the most autodependent neighbourhoods, 15% report driving a lot more and of those moving from autodependent neighbourhoods, 24% report driving a lot more. This suggests that those who relocated from autodependent neighbourhoods to NUDs increased their driving much less than those who moved to CSDs.

These results suggest that those who relocated to NUDs ended up driving less after relocating than those who relocated to conventional suburban developments, whether or not they came from walkable or autodependent neighbourhoods. This finding is consistent with the hypothesis that new urbanist urban design is influencing travel behaviour in favour of less driving and that self-selection is not a determining factor.

Table 28: Driving more or less now and the impact of old neighbourhood for CSD/NUD (%)

New Urbanist Drive more or less	most autodep	autodep	mean autodep	walkable	most walkdep	Total
a bit less now	27.4	21.4	13.2	17.7	12.3	20.8
a bit more now	10.1	19.4	16.3	14.9	18.5	14.7
a lot less now	22.6	14.1	7.8	8.4	6.2	14.3
a lot more now	7.9	10.2	24.0	19.1	40.0	15.4
don't know	0.0	0.0	0.8	0.0	0.0	0.1
neither more or less	32.1	35.0	38.0	40.0	23.1	34.7
Total	100	100	100	100	100	100

Pearson chi2(20) = 110.2892 Pr = 0.000

Con SD Drive more or less	most autodep	autodep	mean autodep	walkable	most walkdep	Total
a bit less now	10.2	7.9	6.6	6.7	13.3	8.5
a bit more now	22.2	27.8	19.1	28.9	26.7	24.1
a lot less now	10.9	4.7	5.2	3.3	6.7	7.1
a lot more now	14.9	23.6	31.6	41.1	46.7	24.5
don't know	0.4	0.0	0.7	1.1	0.0	0.4
neither more or less	41.5	36.1	36.8	18.9	6.7	35.5
Total	100	100	100	100	100	100

Pearson chi2(20) =57.7804 Pr = 0.000

IMPACT ON CAR OWNERSHIP

Households relocating from most walkable neighbourhoods have the lowest automobile ownership levels at 1.5 cars per household. At the same time households are relocating from most automobile dependent neighbourhoods reported the highest automobile ownership rates of approximately two cars per household. This suggests that households who moved from a car dependant environment maintain higher automobile ownership than the rest.

Table 29: Car ownership and the impact of old neighbourhood

Auto ownership	Mean	Std. Dev.	Freq.
mostauto	1.96	0.80	593
autodep	1.90	0.71	397
meanautd	1.82	0.65	265
walkable	1.67	0.78	305
mostwalk	1.53	0.59	80
Total	**1.8**	**0.8**	**1640**

At the same time, automobile ownership levels were significantly lower for those who relocated to NUD than those who relocated to CSDs regardless of the type of neighbourhood they relocated from.

Table 30: Car ownership and the impact of old neighbourhood for CSD/NUD

New Urbanist Auto ownership	Mean	Std. Dev.	Freq.
most auto	1.74	0.66	318
auto dep	1.72	0.62	206
mean auto dep	1.67	0.55	129
walkable	1.60	0.68	215
most walk	1.49	0.62	65
Total	**1.67**	**0.64**	**933**

Con SD

Auto ownership	Mean	Std. Dev.	Freq.
most auto	2.21	0.88	275
auto dep	2.10	0.75	191
mean auto dep	1.96	0.71	136
walkable	1.84	0.96	90
most walk	1.67	0.49	15
Total	**2.08**	**0.83**	**707**

IMPACT OF HOME LOCATION AND VKTS

Finally we present the impact of previous home locations on the vehicle-kilometers-travelled (VKTs) by households in the NUD and CSD. Again, we observe that the households relocating from auto dependent neighbourhoods are reporting higher VKTs whereas those who relocated from most walkable neighbourhoods report lower VKTs (Table 31). At the same time, households relocating to NUDs report lower VKTs than those who relocated to CSDs.

Table 31: Total household VKTs and the impact of old neighbourhood

Old neighbourhood type	Total VKT	New Urbanist	Con SD
most auto	40.9	36.3	45.8
auto dep	44.1	41.2	47.1
mean auto dep	45.6	47.9	43.3
walkable	35.3	36.1	33.7
most walk	35.0	33.5	40.4
Total	**41.1**	**38.8**	**43.9**

REGRESSION MODELS EXPLAINING IMPACT OF PREVIOUS HOME LOCATIONS ON VKTS

This report has focussed on the assumption that households will select neighbourhoods that are conducive to their life styles and these lifestyle choices are more important than neighbourhood design features in determining travel outcomes. If such biases do exist, they are likely to inflate the impact of observed correlations between certain built form characteristics and travel behaviour. For instance, in our earlier work based on the same data set we have illustrated that households living in neighbourhoods where built form characteristics conform to the new urbanist designs drive significantly less than the rest.

One can, however, argue that households driving less are in fact predisposed to such life style and hence they have relocated to the new urbanist neighbourhoods to continue with their preferred life style. This further implies that the decline in commuting observed for the households residing in the new urbanist neighbourhoods does not result in a net system-wide decline in commuting because households prone to less driving are relocating rather than multiplying. Lastly, one can also argue that the households residing in new urbanist neighbourhoods are predisposed to active life styles and that the built form characteristics of new urbanist neighbourhoods do not 'cause' the households to drive less and walk more.

With the above caveats in mind we designed the current study to account for the self-selection bias. Our preferred methodology is slightly different from other research on the same topic that has relied on an econometric technique called the instrumental variable (IV) approach. We illustrate the concept with an example. If one were interested in determining a wage equation for workers, we may use a simple regression model that explains wages earned as a function of education, age, experience, union membership and other factors. Note that the union membership may be affecting the relationship between wage and other explanatory variables. This would require us to estimate a model where the union membership may not be controlled for by merely introducing a dummy variable (1/0) to control for the impact of union membership. Econometric solutions exist to account for such self-selection bias using the Heckman's selection correction model. In this particular study, however, the Heckman correction model may not be sufficient because although it can capture an either/or selection choice, it is not capable of handling a spectrum of choices.

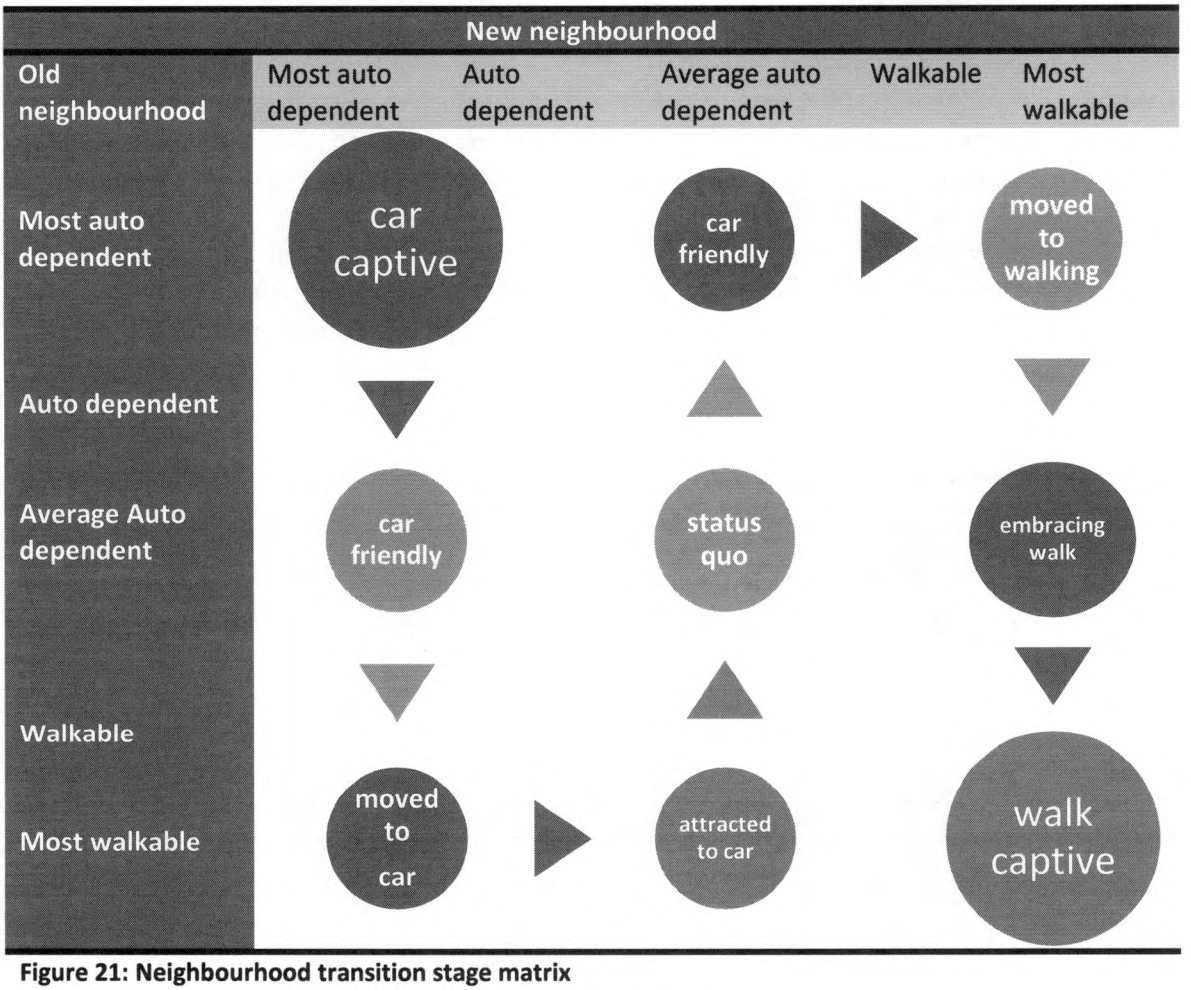

Figure 21: Neighbourhood transition stage matrix

Consider the household choices as they relate to a neighbourhood type. Instead of being a binary choice one can represent built form along a spectrum ranging from the most automobile dependent neighbourhood to a very walkable neighbourhood. In this study we have characterized previous and current home neighbourhoods of the households in our sample on a 5-point walkability scale where a household can relocate from a neighbourhood characterized as one of the five types to

another neighbourhood characterized on the same five-point scale. This creates a five-by-five matrix of 25 possible transition states, which we have tried to capture in Figure 21.

The extreme states in this transition spectrum are the households that either relocate from a very auto dependent neighbourhood to another auto dependent neighbourhood or that relocate from a very walkable neighbourhood to another very walkable neighbourhood. We have called those household car captive or walk captive respectively. Such households show a high degree of continuity in their choice of neighbourhood design. At the same time we may have other households who would relocate from a very auto dependent neighbourhood to a very walkable neighbourhood and vice versa. These households are embracing change in life style and they are moving over either 'to walking' or 'to car'. Similarly, there are other transition states that could be captured in the 25-state transition matrix.

We have categorized previous and current home locations on a five-point walkability scale where 1 represents most automobile dependent neighbourhood and 5 represents most walkable neighbourhoods. The following table presents the matrix capturing the 25 transition state possibilities the percentages represent the percent of households in a particular neighbourhood type at the current residence transiting from a particular neighbourhood type at the old residence.

The existing modeling techniques allow us to account for one transition state, e.g., being a member of a union or otherwise. The available econometrics techniques do not allow us to account for a self-selection bias that manifests on a spectrum of choices. For this reason we have opted for the Ordinary Least Squares model and have introduced the 24 transition states as explanatory variables, while the 25th state is held outside the model to allow for comparison.

Table 32: Interaction between previous and current home categories

		1	2	3	4	5	
		CSD/NUD categories					
	Previous home categories	most autodep	autodep	mean autodep	walkable	most walkdep	Total
1	most autodep	50.9	35.3	41.2	35.9	21.1	36.2
2	autodep	27.9	29.1	31.4	21.4	12.5	24.2
3	mean autodep	2.2	26.3	22.9	14.6	12.5	16.2
4	walkable	19.0	5.5	3.8	24.3	39.5	18.6
5	most walkdep	0.0	3.8	0.8	3.9	14.4	4.9
	Total	**100**	**100**	**100**	**100**	**100**	**100**

The previous study included a regression model where we explained the vehicle-kilometres travelled (VKT) by a household by various demographic attributes of the household and the built form characteristics of the neighbourhood. We observed that built form characteristics were indeed significant predictors of VKT suggesting that the new urbanist characteristics of the neighbourhood correlated with lower VKTs even after we controlled for socio-demographic attributes of the household. In the last study we did not account for the self-selection, which is the focus of the current study.

We have estimated a regression model where we accounted for the lifestyle influences in residential choices by using binary or dummy variables accounting for the 25 possible transition stages in addition to other explanatory variables. The model is presented in the following table.

The dependent variable is the VKT per household for the households that reported at least 5-km of commuting to exclude outlier households. This is consistent with the modelling approach used in the previous study. The model reported an adjusted R-square of 16 % suggesting a good fit for these types of models.

The regression model reported here does not include built form variables, such as street network density, population density, and other neighbourhood level attributes because we have used these variables to categorize neighbourhoods using K-means clustering. Re-introducing these variables in the regression model may result in multicollinearity and hence we have excluded them from the model reported here.

We first report the results for socio-demographic and other neighbourhood perception variables. The model suggests that automobile ownership is a statistically significant predictor of household VKTs where each additional automobile accounts for 4.1 additional VKTs, all else being equal. Note that we also account for household size in the model where each additional household member is correlated with an additional 6.13 VKTs, all else being equal. This implies that the marginal increase in VKTs due to higher auto ownership is observed when the household size is held constant.

The model suggests that in the presence of other predictors, household income is not a statistically significant predictor of VKTs. Similarly, employment opportunities within a 5 km radius is not a statistically significant predictor of VKTs, all else being equal. We also included a series of household perception variables about the attachment to the neighbourhood: satisfaction with the neighbourhood design, perception of convenience, pleasantness, and safety of the neighbourhood for walking. All perception variables were statistically insignificant in the presence of other explanatory variables.

The above-mentioned results, we argue, are free of the self-selection bias because we have explicitly accounted for the self-selection by introducing 24 transition state dummies that control for a household transiting from one type of a neighbourhood to another. Statistically significant coefficients are in bold and are further identified by an asterisk. Note that the base transition state, which is not included in the model accounts for households that move from the most auto dependent neighbourhood to another most auto dependent neighbourhood. Other reported coefficients are explained relative to the base case scenario.

Households that relocated from most auto dependent to most walkable neighbourhood reported 20.4 less VKTs than the base case of those who relocated from most auto dependent to another most auto dependent neighbourhood. Similarly, those households that relocated from auto dependent neighbourhood to the most walk dependent neighbourhood reported 23.8 fewer VKTs than the base case, all else being equal. In addition, those who relocated from a mean auto dependent neighbourhood to the most walk dependent neighbourhood also reported 17.6 fewer VKTs, all else being equal. Even households relocating from walkable to another walkable

neighbourhood reported 16.5 fewer VKTs while those who relocated from walkable to most walkable neighbourhood reported 18.3 fewer VKTs.

This is indeed evidence of induced behaviour where the move from auto dependent neighbourhoods to walkable neighbourhoods is associated with a statistically significant and a very large decline in VKTs. This is also true in reverse. Those households that relocated from walkable to auto dependent neighbourhoods reported 34.5 more VKTs than the base case, all else being equal. Also, when a household relocates from a mean auto dependent neighbourhood to a more auto dependent neighbourhood, one observes 22.7 more VKTs than the base, all else being equal.

Table 33: OLS regression of total household VKTs

Variables	Coefficients
From old nhd type to new nhd type	
from most autodep to autodep	2.8144
from most autodep to mean autdep	5.1524
from most autodep to walkable	-10.7696
from most autodep to most walkdep	**-20.4461****
from autodep to most autodep	3.1921
from autodep to autodep	8.6751
from autodep to mean autdep	11.3274
from autodep to walkable	-11.2963
from autodep to most walkdep	**-23.8405****
from mean autdep to most autodep	34.1772
from mean autdep to autodep	**22.7360*****
from mean autdep to mean autdep	1.877
from mean autdep to walkable	-17.6356
from mean autdep to most walkdep	**-17.6024***
from walkable to most autodep	4.3124
from walkable to autodep	**34.5290****
from walkable to mean autdep	8.2795
from walkable to walkable	**-16.4891***
from walkable to most walkdep	**-18.3389****
from most walkdep to most autodep	
from most walkdep to autodep	4.0013
from most walkdep to mean autdep	21.4962
from most walkdep to walkable	-10.096
from most walkdep to most walkdep	-14.3409
Automobiles owned by the household	**4.1164***
Adults in the household	**6.1306*****
Household income	
$35k < inc < $50k	2.6691
$50k < inc < $75k	7.6545
$75k < inc < $100k	15.369
inc >=$100k	18.0147
Jobs within 5km of CSD_NUD nhd	**0.0000**
Very attached with the neighbourhood	-1.1319
Very satisfied with urban design	1.6528
Nhd very convenient for walking	-1.8327
Nhd very pleasant for walking	2.1412
Nhd very safe for walking	-0.3676
Constant	6.7325
N	933

Adjusted R-square	0.1605

*legend: * p<0.05; ** p<0.01; *** p<0.001*

We then took a walk predisposition variable and added it as an explanatory variable in the full regression analysis from the original study, which included urban form variables, to see if it was a significant predictor of travel behaviour. Households that moved from one highly walkable to another highly walkable neighbourhood were deemed to have a "high walk predisposition" whereas those who moved from a mid-walkable to a highly walkable or from a highly walkable to a mid-walkable neighbourhood were given a "medium walk predisposition" score. All other households were given a "low walk predisposition" score.

The "walk predisposition" score did not return a statistically significant coefficient in the regression model (see Table 34) suggesting that walk predisposition does not help explain the difference in VKTs among households and that the self-selection bias can be dismissed as an explanation for why we observed less driving in the NUDs compared with the CSDs in our sample. Thus, our finding remains that the built form variables of the neighbourhoods in our sample are significant influencers of travel behaviour.

Table 34: Results of the full regression model for VKT

Independent Variables	Estimate	Std. Error	t value	Significance
Constant	17.00	11.77	1.44	0.15
Mixed land use and high street density	-3.24	1.08	-3	0.00
Public open space and high walkability	-7.27	1.13	-6.44	0.00
High res. density and employment in 5 km	-3.92	1.44	-2.72	0.01
Cars owned	3.97	1.68	2.37	0.02
Adults in household	5.04	1.17	4.32	0.00
Household income categories*:				
$35,001 to $50,000	-1.59	12.17	-0.13	0.90
$50,001 to $75,000	2.85	11.62	0.25	0.81
$75,001 to $100,000	11.00	11.45	0.96	0.34
$100,001 to $150,000	11.89	11.35	1.05	0.30
Over $150,000				
Perception variables:	-0.08	2.28	-0.04	0.97
Nhd very safe for walking	1.61	2.44	0.66	0.51
Very satisfied with urban design	-1.77	2.63	-0.67	0.50

Nhd very convenient for walking	-1.49	2.80	-0.53	0.60
Nhd very pleasant for walking	0.60	2.65	0.23	0.82
Walk Predisposition				
Households with medium walk predisposition	-7.61	4.293793	-1.77	0.077
Household with high walk predisposition	0.02	7.476533	0	0.998
Observations	1037			
Adjusted R-square	12.26%			

CONCLUSIONS

A long-standing critique of studies showing a relationship between built form characteristics and travel behaviour suggested that the correlation is merely an artefact of lifestyle choices of households. This would imply that if households living in new urbanist neighbourhoods report driving less, it is due to the fact that those households were predisposed to less driving than others and chose to live in a neighbourhood that would allow them to express this lifestyle choice. In this view, neighbourhood characteristics allow for the expression of a predisposition towards less driving but do not cause less driving in the absence of that predisposition.

The results presented in this study shed more light on how travel behaviour adjusts to neighbourhood characteristics. This study has demonstrated that when we account for lifestyle choices governing households' residential choices by controlling for the spectrum of transition states between old and new neighbourhoods, we observe that households relocating to walkable neighbourhoods from auto dependent neighbourhoods report the greatest decline in VKTs. Households that moved to neighbourhoods similar to their previous neighbourhood reported no statistically significant change in VKTs.

Our conclusions are as follows:

1. Households relocating to new urbanist neighbourhoods have usually moved from a higher density neighbourhood than those who relocated to CSDs.
2. Households relocating to new urbanist neighbourhoods have often moved from neighbourhoods with greater prevalence of high-rise dwellings than those who relocated to CSDs.
3. The previous home locations of CSD and NUD residents reported similar distances from the CBD. It appears that the NUD residents, in comparison with their CSD peers, have not necessarily relocated from centrally located neighbourhoods.
4. NUD residents have relocated from neighbourhoods with significantly higher employment accessibility.

5. Those who relocated from suburban neighbourhoods reported the highest increase in walking after their relocation. NUD residents reported higher walking behaviour than the CSD counterparts.
6. Car ownership was the highest amongst those who relocated from auto dependent neighbourhoods.
7. Comparatively, households relocating to NUDs demonstrated less driving than those who relocated to CSDs regardless of the type of neighbourhood they relocated from.
8. Household relocating from auto dependent neighbourhoods to walkable neighbourhoods reported the most decline in driving after relocation.
9. Households moving from a neighbourhood similar to the one that they lived in before reported no statistically significant change in driving behaviour.
10. The "walk predisposition" score did not return a statistically significant coefficient in the regression model. This suggests that walk predisposition does not help explain the difference in VKTs among households and that the self-selection bias can be dismissed as an explanation for why we observed less driving in the NUDs compared with the CSDs in our sample.

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