

# Comparing the Sustainability of Hamilton Neighbourhoods

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## INTRODUCTION

In 2001, Citizens for a Sustainable Community received funding from the Ontario Trillium Foundation to undertake the Hamilton Ecological Footprint Project. The project had three major components: (1) a conference on ecological footprints addressed by Dr. William Rees; (2) a series of workshops that provided a summary of the conference to fifteen community meetings; and (3) a research project exploring the relative sustainability of Hamilton neighbourhoods. This paper presents the results of the third component.

## ECOLOGICAL FOOTPRINTS

Dr. William Rees and his doctoral student Mathias Wackernagel developed the concept of ecological footprints in the early 1990s as a means of measuring the impact of various populations on the planetary environment and their to continue doing so into the future. The ecological footprint of a specified population is defined as the area of land and water ecosystems required, today and into the foreseeable future, to produce the resources that the population consumes, and to assimilate the wastes that the population produces, wherever on Earth the relevant land/water may be located (Rees 2001).

Rees and Wackernagel explained their concept and its application in a 1996 book titled *Our Ecological Footprint: Reducing Human Impact on the Earth*. The planet's human population has now exceeded 6.2 billion, but there are only about 12 billion hectares of productive land and water ecosystems on earth, leaving less than 2 hectares per person. Recent calculations suggest that the average Canadian footprint is approximately 8.8 hectares (BBC 2002). This suggests that if the earth's human population were all to live like Canadians, we would need to find at least three additional planets. In the summer of 2002, the US National Academy of Science reported evidence that humanity's resource use exceeds the capacity of the planet (Redefining Progress).

Ecological footprint analysis is primarily conducted at the national level where sufficient data is available to allow calculations of total apparent national consumption. For example, in his presentation in Hamilton in November 2001, Dr. Rees provided a sample calculation for grain consumption for Canada. He took the total domestic production, added total imports and subtracted total exports to arrive at an apparent national consumption. When this was divided by the average yield of grain per hectare in Canada, the result was a reasonable estimate of the total area of land required to provide grain for Canadians. Dividing this by the country's human population, provided the per capita eco-footprint of the average Canadian's utilization of grain.

Calculations done on the basis of 1996 data found that the average Canadian's ecological footprint is 7.7 hectares. This can be divided into four broad categories: food 2.9 ha (37%); housing 1.5 ha (19%); transportation 1.7 ha (22%); and goods and services 1.7 ha (22%) (Onisto 1999 *et al.*). In footprint calculations, each of these broad categories is further subdivided to account for the physical footprint of the component (surface area occupied), the fossil energy

utilized in its production, use and disposal, and the amounts of ecological productive lands (including forested, pasture and arable portions) used directly in its production or consumption.

### **Applying Ecological Footprinting to Neighbourhoods**

Some efforts have been made to apply footprint calculations to specific urban areas, but this research is hampered by the lack of sufficient available data. Onisto, Krause and Wackernagel (1998) estimated the size of Toronto's ecological footprint by comparing the consumptive patterns of Torontonians to those of the average Canadian. For example, the consumption of food makes up about 38% of Canadians' footprint. Onisto *et al.* noted that Torontonians spend more money on food purchases than the average Canadian and consequently estimated that this portion of their footprint was higher than that of the average Canadian. They concluded that this exercise was "only a beginning" and called for more extensive studies.

Onisto (2002) also provided an estimate of the footprint for the new City of Hamilton, and each of its former municipalities, and calculated the additional lands that each would require in order to meet the current consumptive activities of their residents. The total footprint for the new City was estimated to be over 3.6 million hectares, or 32 times the amount of land contained within the municipality's political boundaries. However, this calculation assumed that the consumptive activity of Hamiltonians is identical to that of average Canadians. The total footprint was thus determined simply by multiplying the population of Hamilton by the footprint of the average Canadian.

The problems encountered by researchers trying to determine average footprints for cities are further compounded at the level of individual neighbourhoods within urban areas. The shopping basket data provided for cities by Statistics Canada, for example, is not collected at the neighbourhood level, or even for the City of Hamilton as a whole. No data is available on how much food residents of a particular neighbourhood consume, nor on what types of food they prefer, nor on what distance that food may have travelled to their plates (a major determinant of the fossil fuel energy required). The latter portion of the food 'footprint' alone may account for 12 to 20 percent of the total footprint of the average North American (BBC 2002).

Measuring the neighbourhood consumption of goods and services is also plagued by the lack of available data, and there is only limited information about some of the components that make up the housing and the transportation portions of the footprint.

There is some knowledge of the occupied surface area of the housing footprint, but none on the construction and operation portion (forest land and fossil energy use). The occupied land portion accounts for only one-quarter of the housing footprint of the average Canadian or about 5% of their total footprint.

A similar situation prevails in transportation. Some municipalities collect data on surface area degraded by pavement (although this often doesn't include driveways and parking lots). There is also some information available at the neighbourhood level on commuting patterns. The 1996 Canadian footprint for transportation was 0.2 hectares for degraded land (roads, parking lots, driveways), and 1.4 hectares for fossil fuel use. However, both of these include elements such as production (including mining, smelting, manufacture and the resulting wastes) that are not measured at the neighbourhood level.

This suggests that an attempt to determine the average ecological footprint of the residents of a particular neighbourhood using current data must rely overwhelmingly on the calculations done at the national level for average Canadians. Unfortunately, this will tell us very little about the relative sustainability of these neighbourhoods. This is not to say that ecological footprints can't be calculated at the neighbourhood level. However, considerable new data would need to be collected before such an attempt could reasonably be expected to bear fruit. And some problems would still remain at that point.

Recalling that national footprint calculations take account of imports and exports, it is unclear how this could be incorporated into calculations of neighbourhood footprints. For example, at the national level, and even at the city-wide level, the area of land devoted to commercial activities can be determined, and it is defensible to allocate an equal portion of this to all the residents of the nation or city being examined. However, this approach breaks down at the neighbourhood level. In many cities, commercial and industrial activities are separated from residences. Some neighbourhoods are only composed of residences, but the people living there still must shop somewhere. If 20% of the land in neighbourhood A is devoted to a large shopping mall, and only 2% is set aside for commercial in neighbourhood B, that obviously doesn't necessarily mean that the residents of neighbourhood A are 'consuming' more lands for their commercial activities. Similar problems arise with the allocation of regional parkland, expressways and large civic institutions to the footprints of specific neighbourhoods.

In the face of these difficulties, and without the resources to conduct large scale surveys, the Hamilton Ecological Footprint Project set out to explore other ways of evaluating the relative sustainability of Hamilton neighbourhoods.

## **NEIGHBOURHOODS EXAMINED IN THE STUDY**

The first step was the selection of a representative sample of neighbourhoods to examine. The single largest source of comprehensive neighbourhood data is provided by Statistics Canada in the national census conducted every five years. The most recent complete data set is for the 1996 census, and it provides specific information for a range of parameters for "census tracts". In Hamilton there are over 175 census tracts. In the urban areas, these usually cover about 60 to 100 hectares each, and their boundaries are usually major arterial roads and/or significant topological features such as the Niagara Escarpment, local streams and Hamilton Harbour. Our research selected six of these census tracts as the 'neighbourhoods' to be evaluated.

The six census tracts were chosen using a set of criteria designed to allow for meaningful comparison. We attempted to hold some potential variables relatively constant, and to ensure diversity in other variables to allow an exploration of the impact of these latter variables on the sustainability of selected neighbourhoods. Three factors guided our selections. We chose to examine neighbourhoods that were all primarily residential, but had variable ages of housing construction and variable geographic locations.

We began by compiling a table of all urban census tracts that included their 1996 population, the number of households (including the number owned and the number rented), and a breakout of the temporal period of construction of the housing stock (pre-1946, 1946-1960, 1961-1970, 1971-1980, 1981-1990, 1991-1996).

## Selection Criteria

The initial selection criteria for potential neighbourhoods were as follows:

Eliminate all census tracts whose residential areas are outside the urban boundary

Eliminate all census tracts with large commercial or industrial areas

Avoid census tracts with fewer than 2000 residents

Avoid census tracts with more than 20% of their area undeveloped

Choose only census tracts where at least 65% of dwellings are owned rather than rented

Choose at least one census tract where at least 70% of dwellings have a period of construction

- before 1946
- between 1946 and 1960
- between 1960 and 1980
- after 1980

Choose at least four census tracts in the old city of Hamilton

Choose at least one census tract outside the old city of Hamilton

Choose at least two census tracts below the Niagara Escarpment

- choose one census tract within 2 km of intersection of the Central Business District at the intersection of King and James (the area between Wentworth Street and Highway 403)
- choose one census tract more than 2 km from the Central Business District

Choose at least two census tracts above the escarpment

- choose one census tract north of Mohawk Road
- choose one census tract south of Mohawk Road

These selection criteria narrowed the list of possibilities to a very small number. One additional criterion was added, requiring that no tract be chosen that included high-rise apartment buildings with underground parking. This would have made it impossible for us to conduct a windshield survey of vehicles in the neighbourhoods because we could not get access to the garages.

The six neighbourhoods selected generally fulfilled the criteria. To achieve the greatest variation in period of construction, it was necessary to lower the criteria from 70% of residences constructed within the set time period to 60%. However this was only done where the overwhelming majority of other construction in the neighbourhood took place within ten years of the primary construction period.

In one instance, we also had to modify the criteria restricting the selection to tracts with minimal industrial lands. This difficulty arose because nearly all the neighbourhoods within two kilometres of the Central Business District were dominated by rental housing, much of it highrise apartments. Consequently, the selected neighbourhood from this area does include a substantial industrial

area, but it is confined to one portion of the tract, and the residential section is compact and separated from the industrial section by major transportation corridors.

The selection criteria imposed other constrictions which limited the variability of the selected neighbourhoods. In particular, it was not possible to include areas where significant new housing development was taking place during the study, or had taken place since 1996.

### The selected neighbourhoods

Five of the six neighbourhoods chosen fall within the boundaries of the former City of Hamilton, an administrative entity that ceased to exist on January 1, 2001 with the amalgamation of Ancaster, Dundas, Flamborough, Glanbrook, Hamilton, and Stoney Creek into the new City of Hamilton. The sixth neighbourhood lies within the boundaries of the former City of Stoney Creek.

Three of the six neighbourhoods are located below the Niagara Escarpment and three are located on top of it in the area known locally as “the Mountain”. The lower city locations are widely separated, with one each in the west end and the east end of the former city of Hamilton, and the third located in the portion of Stoney Creek that lies below the escarpment. The three upper city neighbourhoods are also widely separated, with one in the south-east area, one in the south-west, and one in the north-central portion of the urban area.

**Table 1: Comparing the Selected Census Tracts (Neighbourhoods)**

Census Tract	Lower Suburban ( <i>LS</i> )	Lower East End ( <i>LE</i> )	Lower West End ( <i>LW</i> )	Mountain East ( <i>ME</i> )	Mountain Central ( <i>MC</i> )	Mountain West ( <i>MW</i> )
Former Municipality	Stoney Creek	Hamilton				
Population	2375	2768	2849	5147	4076	3347
Average Household Income	65,100	49,820	50,021	55,410	51,703	51,836
Main construction period	71-90	46-60	pre-46	80-96	pre-46-60	60-80
– Percent in main period	70%	59%	70%	81%	91%	63%
Percent of Units Owned	97%	71%	59%	76%	81%	73%
Distance from Central Business District	13km	7km	2km	7.5km	2km	5km
Distance from Steelmills	10km	4km	6km	8.5km	5km	8km

There is also good variation in the period of construction, with one overwhelmingly in the pre-1946 period, one straddling the pre-1946 and the 1946-1960 period, one mainly in the 1946 to 1960 period, one in the 1960 to 1980 period, one in the 1970 to 1990 period, and the final one in the 1980 to 1996 period.

All but one of the tracts had home ownership rates exceeding 70%, with the other tract registering a rate of 59%. Populations in 1996 ranged from 2375 to 5147 with three of the six lying between 2750 and 3350. Table 1 on the previous page summarizes the six neighbourhoods according to the selection criteria and other descriptive parameters. The location of the census tracts is illustrated on Map 1 (next page).

## **The City of Hamilton**

The first European settlers arrived in Hamilton toward the end of the eighteenth century. The area grew slowly through the nineteenth century, but its excellent natural port led to the establishment of primary steelmaking in the community early in the twentieth century. This sector was spurred by rapid industrial growth during the century's two world wars, and by 1975 Hamilton was the premier industrial city of Canada and home to the country's two largest integrated steelmaking operations. When the decline of this sector began in the late 1970s, there were 48,000 workers employed along the industrialized bayfront, making this area by far the largest employment centre in the region. By the late 1990s, the bayfront industrial workforce had been more than halved, but still represented a significant employment centre. Over much of this period, total employment in the former City of Hamilton declined in absolute numbers. By 1991, 16% of the workforce was commuting to the Greater Toronto Area. (Hamilton-Wentworth 1995).

The total population of Hamilton in 1996 was 468,000, an increase of about 3.6% from the time of the 1991 census. Only about six thousand residents listed French as their mother tongue, compared to over 100,000 who identified a non-official language. About 20% of the latter group listed Italian as their mother tongue.

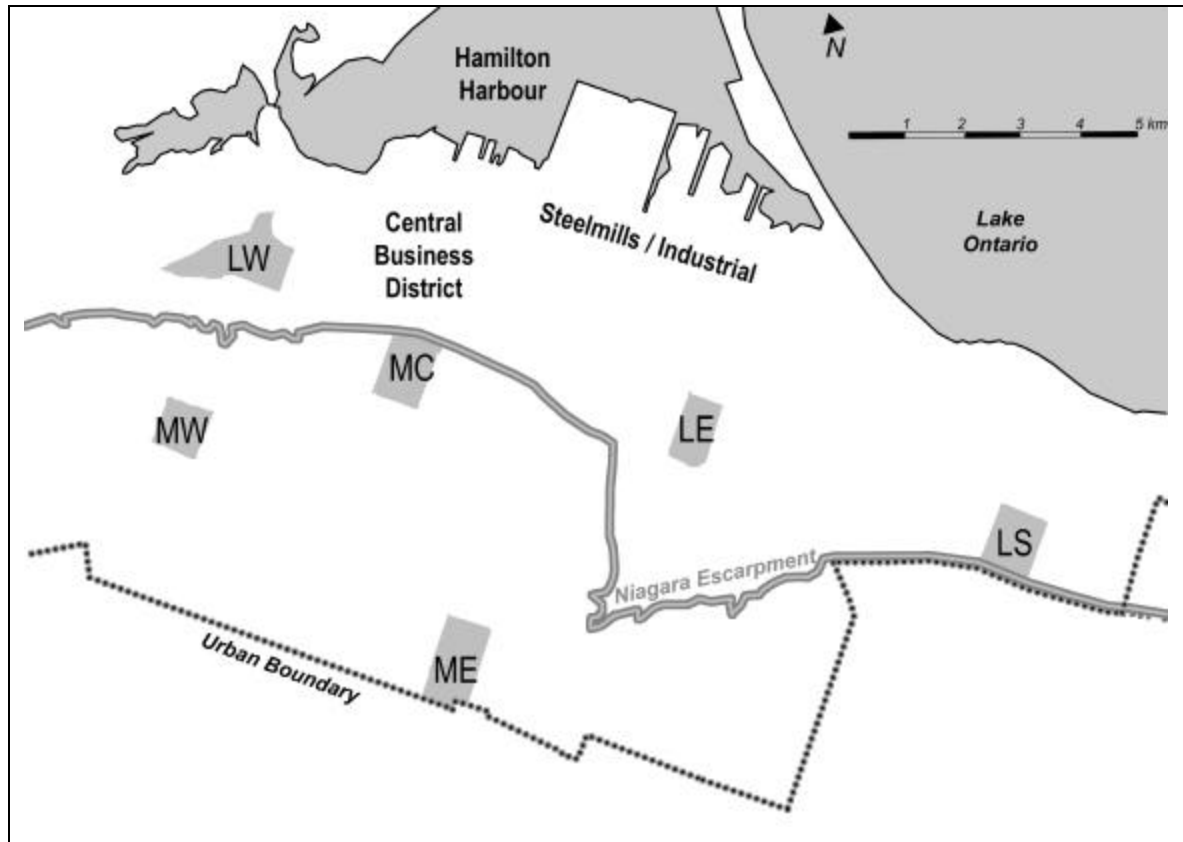
Average family income in 1996 was \$56,223, while 18.3% of families fell below Statistics Canada's low income cutoff. Rented dwellings made up 37% of the total residences.

The census also reports the period of construction of residences. About 22% were built prior to 1946 and an almost identical number in the period from 1946 to 1960. An additional 18% of the stock was constructed in each of the following two decades, and 14% more in the 1980s, with the remainder built in the first half of the 1990s.

The six selected census tracts represent a variety of Hamilton neighbourhoods. They are identified in this report as:

- ***LS*** (Lower Suburban)
- ***LE*** (Lower East End)
- ***LW*** (Lower West End)
- ***ME*** (Mountain East)
- ***MC*** (Mountain Central)
- ***MW*** (Mountain West)

**Map 1: Location of the Census Tracts/Neighbourhoods Studied**



### **Neighbourhood *LS***

This nearly square census tract covers about 95 hectares in the former City of Stoney Creek, lying between the CPR railway at the foot of the Niagara Escarpment and Highway 8. The latter is a major east-west thoroughfare running the length of the City. It is variably named Main Street and Queenston Road. The other neighbourhood boundaries are Green Road and Millen Road, both major north-south arterials.

This community has a high residential content with commercial areas limited to its northern edge along Highway 8, and no industrial zoning. There are both public and separate elementary schools, as well as a large central park area. Nearly 80% of the housing stock was built between 1970 and 1990, with all of the remainder constructed in the preceding 15 years. In 1996, more than 97% of the residences were owned by their occupants. Almost all of the housing is single family detached. There are no apartment buildings and only 6% of the housing stock is townhomes. The population stood at 2375 in 1996, a decline of 3.3% over the previous five years. Only 55% of the population listed English as their mother tongue. Non-official languages accounted for the remainder. There was no French-speaking component. The largest non-English group identified in the census was Italian at about 16%. Average family income in 1996 was \$65,100. The incidence of low-income families was 5.3%. There was an average of 3.4 persons per census economic family.

### **Neighbourhood *LE***

This census tract covers 73 hectares in the eastern part of the former City of Hamilton. Its shape is slightly rectangular. Like *LS*, its northern boundary is Highway 8 (here called Queenston Road) and its southern boundary is the CPR line (although here the railway is some distance from the foot of the escarpment). The other boundaries of the neighbourhood are Parkdale Avenue and Cochrane Avenue, both major north-south arterial roadways. Commercial areas in this community are located primarily along its northern boundary (Queenston Road) and along King Street, a second major east-west thoroughfare that cuts across the southern portion of the tract.

There is a public elementary school centrally located in the neighbourhood and including a large playground, but no other significant sized parkland. However the south east portion of the neighbourhood is close to a large natural ravine formed by Hamilton's second largest creek.

More than 70% of the housing stock in this neighbourhood was constructed between 1946 and 1960. An additional 20% was built in the 1970s and most of the remainder since 1980. An infill development of 40 homes has been constructed since 1996 but is locally confined and was not included in the windshield vehicle survey. In 1996, 73% of the homes were owner-occupied. There is one large apartment tower in the tract (but with a visible parking area) and several others adjacent to but just outside the area. There are also several low-rise apartments. Together apartments account for slightly less than 15% of the homes. Nearly all the remaining residences are single-family detached.

Total population of this tract stood at 2812 in 1996, a decline of 1.6% over the previous five years. Over 77% of the population listed English as their mother tongue. The largest non-English group identified was Italian at slightly under 6%. French was listed as a mother tongue by about 3.5%. Average family income in 1996 was \$49,820. The incidence of low-income families was 12.2%. There was an average of 2.8 persons per census economic family.

### **Neighbourhood *LW***

This census tract covers 166 hectares but only about 53 hectares of this is devoted to residential and commercial zoning. The remainder includes old industrial properties, and an expressway and rail corridor. The latter forms the western and northern boundaries of the residential neighbourhood. The two remaining boundaries are major arterial roadways. The northern boundary runs parallel to and within 100 metres of Main Street (which as noted above forms the northern boundary of the other two lower city neighbourhoods). There are both public and separate elementary schools but with only small associated open spaces, and other parkland is also quite limited.

This tract is a little less than two kilometres from Hamilton's Central Business District, but has a fairly diverse business community. Commercial activity is concentrated on the eastern boundary and along a second north-south arterial that runs parallel to this boundary.

Seventy percent of the residences were constructed prior to 1946 and a further 15% in the 1946-1960 period. Rental accommodation makes up nearly 41% of the tract, the majority located in a number of low rise apartment buildings. Less than two percent of the housing stock is townhomes. Average household size is 2.3.

Average family income in 1996 was \$50,021 with 24.9% of families falling into the low-income category. These parameters have likely improved since 1996 as this area has become more attractive for upwardly mobile Hamiltonians.

### **Neighbourhood *ME***

This is the Templemead neighbourhood located on the southern boundary of Hamilton mountain. Its other three sides are major arterial streets (Upper Gage Avenue, Upper Ottawa Avenue, and Stone Church Road). Rymal Road (Highway 53) crosses the southern end of the tract in an east-west direction. Rectangular in shape, the tract covers about 134 hectares, with about 89 being devoted to residential lands. The remainder includes a large block of industrial zoning in the south east corner of the tract and a large school and park area located in the centre of the residential area. Commercial areas are located primarily along Rymal Road and around the intersection of Upper Ottawa and Stone Church.

A little over 75% of the housing stock was owner occupied in 1996. Since there is only one small apartment building, it is likely that the rental accommodation is concentrated in the 30% of residences that are townhomes. Construction of the homes in this neighbourhood occurred primarily in the 1980s (50.2%) and the 1991-1996 period (30.8%), but no further significant residential development has occurred since 1996.

Average family income in 1996 was recorded as \$55,410, just slightly lower than the average for all of Hamilton. However, 20.1% of the families fell below the Statistics Canada low-income cutoff. There were 3.5 persons per family.

### **Neighbourhood *MC***

This neighbourhood is located in the older section of the Hamilton mountain community, close to the lip of the Niagara escarpment which forms its northern boundary. The other three sides are major arterial streets (Upper Wellington, Fennell and Upper Wentworth). A fourth major arterial, Concession Street, crosses the neighbourhood near its northern limit. Roughly rectangular in shape, the tract covers a little over 100 hectares, with about 90% of this devoted to residential areas. Non-residential areas are scattered along Concession Street, and also include a small central park area, and a public school and former school site. Commercial activity is primarily centred on Concession Street, but individual stores are found along most of the neighbourhood's boundaries, plus a few on a minor arterial street that crosses it from east to west.

Slightly less than 70% of the housing was owned in 1996. The rental accommodation includes one large apartment building and several walk-ups that account for about two-thirds of the rental units. There are no townhomes, suggesting that about 15% of the single-family homes are rented. About 35% of the residential units were constructed prior to 1946, with almost all the remainder built in the 1946-1960 period.

Average family income in 1996 was recorded as \$51,703, about 8% lower than the average for all of Hamilton. Low income families made up 11.9% of the neighbourhood. There were 2.9 persons per family.

## **Neighbourhood MW**

This census tract is located in the south western area of Hamilton mountain, just north of the Lincoln Alexander Parkway which forms its southern boundary. The other three boundaries are major arterial roads (Garth, Mohawk and Upper Paradise). Almost square, it comprises a little under 76 hectares. The net residential area is about 61 hectares. Non-residential lands include a 10 hectare central park and school property, some small commercial areas on Mohawk and lands included in the right-of-way for the expressway. The main commercial activity associated with this neighbourhood is outside its boundaries on the north side of Mohawk Road.

Construction of this neighbourhood was spread out over three decades, with 26% in the 1960s, 38% in the 1970s and 28% in the 1980s. About 73% of the homes are owner-occupied. There is only one small apartment building. Most of the rental accommodation is likely found in the townhomes that make up a third of the dwellings in this neighbourhood.

Average family income in 1996 was recorded as \$51,836. Low-income families made up 21.1% of the neighbourhood. Average family size was 3.4 persons.

## **INDICATORS OF SUSTAINABILITY**

Twelve indicators of sustainability were examined in this study. They were chosen on the basis of the availability of suitable data, and their potential to illustrate some aspect of the relative sustainability of the six neighbourhoods under investigation. The twelve indicators examined were:

- \_\_\_ Number of households per residential hectare
- \_\_\_ Number of rooms per adult per household
- \_\_\_ Number of vehicles per household
- \_\_\_ Litres of vehicle fuel used per annum per household
- \_\_\_ Vehicle kilometres travelled per day per household
- \_\_\_ Length of average commute by private vehicle per household
- \_\_\_ Number of transit stops in neighbourhood per week per household
- \_\_\_ Percent of daily trips utilizing transit
- \_\_\_ Percent of employees who work at home, or cycle or walk to work
- \_\_\_ Length of neighbourhood roads per household
- \_\_\_ Number of high-use type neighbourhood area stores weighted by use and location.
- \_\_\_ Distance from centre of neighbourhood to nearest food supermarket

Each indicator is examined below. The methodological approach to each is described, together with a discussion of its context and significance. This is followed by a presentation and discussion of the findings of our study.

## **Sustainability Score**

For each indicator a table is provided giving the actual results of this indicator in the appropriate units for the six neighbourhoods. This is followed by two or three measures of the relative sustainability of the six neighbourhoods. The first merely ranks them from one (best) to six (worst) in terms of sustainability. The other ranking(s) presents a weighted score arrived at by dividing the results of all the neighbourhoods by the lowest result. This generates a score that ranges from 1.00 upwards.

Where this weighting generates a higher score for greater sustainability, this ranking becomes our Sustainability Score. However, where the weighting shows a lower score for greater sustainability, we have re-calculated the actual results to show a Sustainability Score which ranks the least sustainable neighbourhood as 1.00 and the remaining neighbourhoods as multiples of 1.00. This has been done to allow for ease of comparison between the twelve indicators, and for the eventual generation of a composite sustainability score.

Most of the data utilized in this study is for the year 1996, the date of the last set of complete census data for Hamilton neighbourhoods and the most recently published Transportation Tomorrow Survey which also took place in 1996. However, some information was also gathered by direct observations in the neighbourhoods during 2002 and consequently may reflect some changes that have taken place in the neighbourhoods in the intervening period.

### **Indicator 1: Number of households per residential hectare**

The density of housing has been identified by many researchers as one of the most important indicators of neighbourhood sustainability (CMHC 2000). Low density areas not only consume higher quantities of land and require greater lengths of roads, water and sewer pipes, and other infrastructure. They also decrease the efficiency of transit, school, police and ambulance servicing. The first report from the Central Ontario's Smart Growth Panel (2002) specifically recognizes this link. Their second recommendation declares: "The only way to accommodate future growth without more gridlock and air pollution is to design communities around transit access and provide the necessary transit services." Some researchers (Nozzi 1999) argue that every doubling of density reduces single-occupancy vehicle trips by 30%. Our study compares the net density of only the residential areas of the selected neighbourhoods.

#### *Methodology*

We used 1:3000 aerial photography supplied by the City of Hamilton to measure the total area of a particular neighbourhood, as well as the area of non-residential uses such as industrial zones, school properties, large institutions, large parks and natural areas, and exclusively commercial zones. The non-residential areas were excluded although commercial areas where residences were located above the stores were counted as residential. The excluded areas were subtracted from the total area of the neighbourhood to determine the net area occupied by residences (and their associated properties, sidewalks, streets, etc.). This was divided by the number of households to determine the average number of square metres occupied by each household in the neighbourhood.

## Results and Discussion

Table 2 shows the average surface area occupied by each household as well as the resulting residential units per hectare. There are significant differences between the six neighbourhoods. The density in *LS* is much lower than for all other tracts studied and is less than 45% of *LW*. The other four neighbourhoods are roughly similar in densities and fall about half way between these two extremes.

**Table 2: Density of Residential Areas in Square Metres per Household**

Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Area per Household	970.27	528.55	420.51	587.87	544.72	603.00
Units per Hectare	10.31	18.92	23.78	17.01	18.36	16.58
Sustainability Rank	6	2	1	4	3	5
Sustainability Score	1.00	1.84	2.31	1.65	1.78	1.61

None of the six neighbourhoods reaches the 25 units per hectare required to make frequent transit service feasible (Alexander and Tomalty 2001), although *LW* comes close. The very low density in the Stoney Creek neighbourhood may reflect the influence of different planning policies during the period when Hamilton and Stoney Creek were separate jurisdictions.

### Indicator 2: Number of rooms per household

This indicator was chosen as a surrogate for the average size of dwelling. Housing comprises a significant part of the ecological footprint of Canadians, with larger homes usually imposing bigger footprints because they occupy more physical space, utilize more materials in their construction and maintenance, require greater amounts of energy to heat and air-condition, and generally contain more consumer goods.

#### Methodology

The 1996 census tract data provided by Statistics Canada records the average number of rooms per household. We have utilized this unmodified data as a direct indicator of sustainability. For comparison purposes, we have also calculated the number of rooms per person, and the number per adult, using the population and household information data provided in the census.

#### Results

The results for the six neighbourhoods are presented in Table 3. The three older neighbourhoods (*LW*, *LE* and *MC*) have the three smallest number of rooms per dwelling, while the three newer neighbourhoods have the three largest. However, the trend is certainly not a straight line.

**Table 3: Rooms Per Dwelling**

Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Number of Rooms per Dwelling	7.9	5.9	5.8	7.2	6.2	7.4
Sustainability Rank	6	2	1	4	3	5
Weighted Score	1.36	1.02	1.00	1.24	1.07	1.28
Sustainability Score	1.00	1.34	1.36	1.10	1.27	1.07

Table 4 illustrates the period of construction of the six neighbourhoods and is provided to allow for comparison with the rooms per dwelling results.

**Table 4: Period of Construction of Residential Dwellings**

Variable	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Main construction period of residential dwellings	1971-1990	1946-1960	pre-1946	1980-1996	pre-46-1960	1960-1980
Rank by period of construction	5	3	1	6	2	4
Rank by rooms per dwelling	6	2	1	4	3	5

In Table 5 we have also provided the results re-stated as rooms per person and rooms per adult. These reflect factors such as numbers of persons per household and numbers of children per household.

**Table 5: Rooms per Adult and Per Inhabitant**

Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Number of rooms per adult	2.92	3.00	3.11	3.09	3.14	3.00
Number of rooms per inhabitant	2.46	2.56	2.54	2.13	2.56	2.27

### **Indicator 3: Number of Vehicles Per Household**

The number of vehicles per household is a key indicator of sustainability. Recent research on greenhouse gas emissions from urban travel in the Toronto area concluded that the number of vehicles per household is the single largest influence on the number of kilometres travelled by a household (CMHC 2000). Vehicles also impose a large footprint during their manufacture and from the resource extraction, smelting and other industrial processes utilized in the acquisition and preparation of their materials. The number of vehicles owned by Canadian families has been steadily increasing, providing an impetus to the paving of larger and larger portions of cities and other areas, and the construction of larger and larger home garages.

## *Methodology*

Unfortunately, the census data does not provide information on vehicles per household. Consequently, we conducted field surveys to determine this information. During this survey we also were able to determine the types of vehicles in the neighbourhoods.

The method adopted was a 'windshield' survey, but one that was carried out in a more environmentally friendly fashion (on a bicycle). The observer visited each neighbourhood in turn on a Sunday morning during the spring and early summer of 2002. Sunday mornings were chosen on the assumption that that was the best time to observe the maximum number of vehicles. It was recognized, however, that some vehicles would still not be found at homes, especially since the Hamilton steelmills operate continuously.

No surveying took place on the Sundays of holiday weekends, and all observations were completed prior to the end of the school year and the beginning of summer holidays. The count was conducted between the hours of 6 am and 9 am.

In all but one case, an entire neighbourhood was covered in one morning. In the exception, poor weather resulted in counts being conducted on two subsequent Sundays in clearly distinct portions of the neighbourhood.

Pre-testing of this methodology identified the difficulty of counting vehicles that were not visible because they were in home garages. Where the vehicles were located in inaccessible underground parking associated with a high-rise apartment building, the difficulty proved unresolvable and neighbourhoods with such buildings were consequently excluded from the study. For other neighbourhoods, a protocol was developed to address this challenge.

When one or more vehicles were parked in the driveway in front of the garage doors, it was assumed that no vehicle was in the garage. When there were no vehicles in the driveway and the garage door was closed, it was assumed that a vehicle was present in the garage. Where there was a two-vehicle garage and only one vehicle in the driveway, it was assumed a second vehicle was in the garage. The number of such 'phantom' vehicles was recorded by the observer as a separate 'garage' category. They varied from a low of 2% of total vehicles in *LW* to a high of 22% in *LS*. Older neighbourhoods generally had lower percentages because they had far fewer garages. The average was 10%.

## *Results and Discussion*

Table 6 displays the total number of observed and estimated vehicles found in the six neighbourhoods together with a calculation of vehicles per household. The average number of vehicles found in the six neighbourhoods was 1.27 per household. The average in Canada is 1.4 while the comparable number in the United States is 1.78 (USTD 2000).

The variation between the neighbourhoods is substantial with households in *LS* having nearly 80% greater numbers of vehicles than those in the lowest scoring neighbourhood (*LW*). The Transportation Tomorrow Survey for 1996 reported that there were 1.4 vehicles per household in their survey area which includes the Greater Toronto Area and surrounding communities including Hamilton. The comparable figures for Hamilton were 1.38. However the 1991 TTS survey examined individual municipalities and found that the old City of Stoney Creek (where *LS*

is located) had 1.77 vehicles per household compared to the old City of Hamilton at 1.24. This is borne out in our results, although even within the former City of Hamilton the differences between some neighbourhoods exceeds 60%.

**Table 6: Numbers of Vehicles per Household**

Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Number of households	740	1200	1250	1520	1685	1025
Number of vehicles*	1270	1333	1209	2446	1806	1503
Vehicles per household	1.72	1.11	0.97	1.61	1.07	1.47
Sustainability Rank	6	3	1	5	2	4
Weighted Score	1.77	1.15	1.00	1.66	1.11	1.51
Sustainability Score	1.00	1.55	1.77	1.07	1.60	1.17

\* includes 'phantom' vehicles

It is noteworthy that the neighbourhoods with the highest number of vehicles are also located the furthest distances from the bayfront steelmills and the Central Business District, as illustrated in Table 7. The ranking of the six neighbourhoods is identical to their ranking by number of vehicles. The bayfront and the downtown are the two largest employment centres in Hamilton. In 1991, they respectively accounted for 33,700 and 37,600 jobs, about half of the city's total. By comparison, the Stoney Creek Business Park ranked a distant third with 9,400 jobs (Hamilton-Wentworth 1995).

The 2000 CMHC study referred to earlier concluded that distance to the Central Business District had the second strongest influence on vehicle use (after number of vehicles per household). Our findings suggest that a better fit is provided by a combination of the Central Business District and the other major employment centres.

**Table 7: Distance of Neighbourhood from Key Local Travel Destinations**

Variable	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Distance from CBD (km)	13	7	2	7.5	2	5
Distance from Steelmills	10	4	6	8.5	5	8
Combined Distance	23	11	8	16	7	13
Rank by Distance	6	3	1	5	2	4
Weighted Score	3.29	1.57	1.14	2.29	1.00	1.86

Period of construction of the neighbourhoods may also be a factor affecting vehicle ownership. Older neighbourhoods have considerably less physical space set aside for vehicles in the form of driveways and home garages. The oldest three neighbourhoods score the lowest on both these indicators, while the newest three score the highest. Table 8 compares the age of the neighbourhoods to their vehicle ownership per household.

**Table 8: Comparing Vehicle Ownership to Period of Construction of Residences**

Variable	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Main construction period of residential dwellings	1971-1990	1946-1960	pre-1946	1980-1996	pre-46-1960	1960-1980
Rank by period of construction	2	4	6	1	5	3
Rank by vehicle ownership	1	4	6	2	5	3

Another potential explanation of the differences in vehicle ownership is the relative income levels of households in the selected neighbourhoods. Vehicles constitute a major household expense, both in purchase and in operation. In the year 2000, Canadians spent an average of \$7580.00 on transportation – more than they spent on food and second only to housing expenditures (Statistics Canada 2001). Transportation spending represented 17% of after tax spending. In 1999, only 47% of households in the lowest income quintile owned a vehicle, compared to 97% in the highest quintile. Sixty-four percent of the latter group owned two or more vehicles (Statistics Canada 2000).

In our findings, the three highest ranking tracts by income were identical to the three highest by vehicle ownership. However, the income differences are much less significant than the difference in vehicles per household as shown in Table 9. While *LS* had a significantly higher average household income, the differences between the remaining five neighbourhoods are relatively small.

**Table 9: Comparative Incomes for the Selected Neighbourhoods**

Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Average Household Income	65,100	49,820	50,021	55,410	51,703	51,836
Rank by income	1	6	5	2	4	3
Rank by vehicle ownership	1	4	6	2	5	3
Weighted Score by Income	1.31	1.00	1.00	1.11	1.04	1.04

#### *Additional Data*

Subsequent to carrying out the windshield surveys, we were able to obtain access to the detailed data sets accumulated from the Transportation Tomorrow Survey (TTS) of 1996. This study is undertaken every five years for municipalities in the Greater Toronto Area by the Joint Program in

Transportation at the University of Toronto. This comprehensive telephone survey of 5% of households provides extensive data, including numbers of trips per day, origin and destination, trip length, trip mode and other transportation information. Participants are asked to report all trips by all members of the household on the previous weekday. TTS data is available at the level of census tracts, but should be used with caution because of the small size of the sample. The number of surveyed households in each tract we examined ranged from 60 to 85.

The total TTS survey calculated that the average household in Hamilton (then Hamilton-Wentworth) had 1.4 vehicles. This finding suggests that our survey methodology, as expected, slightly under-estimated the number of vehicles in each neighbourhood.

The TTS data also allows a calculation of vehicles per household at the neighbourhood level, although with the caution noted above. In addition, separate TTS data was not available for one of the six census tracts in our study, making complete comparisons impossible.

In the TTS data, *LS* is combined with the adjacent tract (84.02). This adjacent tract is closer to the central business district and significantly different in character. While *LS* is 94% single-family dwellings, more than a third of the households in CT84.02 are townhomes. Average family income is also \$5000 higher in *LS* than in the adjacent tract. This suggests that the vehicles per household calculated using TTS data likely underestimates the actual numbers for *LS*. The results from the TTS data calculation are presented in Table 10, although we have not used it for the purposes of further calculations.

**Table 10: Vehicles Per Household (TTS 1996)**

Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Households	740	1200	1250	1520	1685	1025
Number of Vehicles	1301	1610	1458	2154	2258	1775
Vehicles/household	1.76	1.34	1.17	1.42	1.34	1.73

**Indicator 4: Litres of vehicle fuel used per annum per household**

This indicator was developed to provide a measure of the fossil fuel consumption of the various neighbourhoods. A higher level of sustainability was assumed to correlate with a lower level of vehicle fuel consumption. We utilized the results of our windshield survey, separated vehicles according to their fuel efficiency, and calculated total fuel use per neighbourhood and per household.

Using fuel efficiency data calculated by the United States Environmental Protection Agency, motor vehicles were divided into five categories and an average fuel efficiency determined for each category (USEPA 2002). The categories chosen were vans, SUVs, pickup trucks, small fuel-efficient cars, and other cars. The dividing line between the latter two categories was an average fuel efficiency in city driving of 30 miles per gallon. Vehicle types that scored at or above this efficiency were put in the “small cars” category and a list of these models was compiled prior to conducting the neighbourhood surveys. Vans and mini-vans were considered one category.

The average fuel efficiency in each category was determined using all listed year-2000 models except electric and hybrid vehicles. Note that this method puts all vehicle types on an equal footing, but obviously the numbers of each model actually sold vary dramatically. The average fuel efficiencies thus determined were as follows:

Vans and Minivans = 15.33 litres per 100 km

SUVs = 14.13 litres per 100 km

Pickup Trucks = 15.20 litres per 100 km

Small cars = 8.73 litres per 100 km

Other Cars = 12.66 litres per 100 km

The second step was to conduct field surveys to determine the number of vehicles of each type in each neighbourhood. The methodology and results are described in the previous indicator.

It was assumed that the types of garage ‘phantom’ vehicles were proportionately similar to the numbers of visible vehicles in that neighbourhood. Thus if 16% of the visible vehicles were vans, it was assumed that 16% of the garage vehicles were also vans.

**Table 11: Percent of Vehicle Types Per Neighbourhood**

Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Small Cars	16.6%	14.1%	28.0%	17.5%	17.2%	20.5%
Other Cars	50.0%	51.1%	40.4%	44.6%	51.3%	50.1%
Sport Utility Vehicles (SUVs)	5.8%	4.2%	7.0%	5.8%	4.7%	3.3%
Vans and Minivans	15.3%	17.3%	13.0%	22.2%	18.0%	18.8%
Pickup Trucks	12.3%	13.3%	8.5%	8.7%	9.4%	7.3%

Table 11 provides a breakdown by type of the vehicles in each neighbourhood. Most notable is the much higher percentage of small fuel-efficient vehicles found in *LW*, and the relatively high proportion of vans in *ME*. There are substantial variations in the percentages of sport utility vehicles, but the low numbers of these vehicles reduce the impact of these differences on total neighbourhood fuel consumption.

Having determined the approximate numbers of vehicles of each type associated with each neighbourhood, this was multiplied by the average fuel efficiency of vehicles in that category, and the totals added to determine the total fuel use of all neighbourhood vehicles.

It was assumed that each vehicle travels a total of 17,000 kilometres per year – the average distance calculated by Transport Canada (2002) for light vehicles in Ontario in the year 2000. This allowed a calculation of the total litres of gasoline consumed on an annual basis for the entire neighbourhood, and subsequently an amount per household.

## Results and Discussion

**Table 12: Litres of vehicle fuel used per annum per household**

Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Litres of Fuel Consumed	3738.16	2448.79	2006.19	3521.42	2326.90	3141.05
Sustainability Rank	6	3	1	5	2	4
Weighted Score	1.86	1.22	1.00	1.76	1.16	1.57
Sustainability Score	1.00	1.53	1.86	1.06	1.61	1.19
Vehicle Numbers Score	1.00	1.55	1.77	1.07	1.60	1.17

The results are presented in Table 12. They suggest a very substantial difference in the fuel consumption of various neighbourhoods, and consequently of their relative sustainability. The major contributing factor appears to be number of vehicles per household, with a minor effect evident from the types of vehicles found in each neighbourhood. We have repeated the sustainability score for vehicles per household at the end of this table for comparative purposes. The largest impact is evident in *LW*, apparently because of the higher percentage of small cars found in that neighbourhood.

### **Indicator 5: Vehicle kilometres travelled per day per household**

Motor vehicles are the single largest source of air pollution in Canadian cities and play a major role in the premature death of 16,000 Canadians a year from air pollution. Across the country, vehicles are responsible for 70% of carbon monoxide emissions and 65% of benzene pollution, as well as 50% of the nitrous oxides that are a key precursor of smog (Simmons 2002). Vehicles also account for one-quarter of Canada's carbon dioxide emissions, the main greenhouse gas driving climate change. Decreasing these pollutants by reducing vehicle use represents an important step toward greater sustainability.

#### *Methodology*

This indicator was measured using the data collected in the Transportation Tomorrow Survey. All trips for all purposes by a driver of a vehicle were included. Trips by transit, or as a vehicle passenger or by taxi or motorcycle were not included. The total kilometres travelled on an average weekday by the entire neighbourhood were calculated and then divided by the number of households that the census records for that neighbourhood. Note that the TTS data for *LS* suffer from the same problems described earlier. Once again the numbers for this neighbourhood are likely underestimated.

The TTS data is for weekdays. Vehicle travel is somewhat reduced on weekends, although only by an average of 11% per day. Saturday and Sunday combined account for 26.3% of total weekly travel (Transport Canada 2002).

## Results

The results of the calculations are presented in Table 13. The average is a little less than 39.5 kilometres per day. The three inner city neighbourhoods also scored best on this indicator, with *LE* well in front of the other two.

**Table 13: Vehicle kilometres travelled per day per household**

Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Kilometres per day	48.13	18.32	34.74	44.64	40.54	50.12
Sustainability Rank	5	1	2	4	3	6
Sustainability Weight	2.63	1.00	1.90	2.44	2.21	2.74
Sustainability Score	1.04	2.74	1.44	1.12	1.24	1.00

Once again there are significant differences between the six neighbourhoods, but they don't seem to completely reflect the vehicles per household results. The most striking anomaly is *LE*. While this neighbourhood ranked third (very close to second) in vehicles per household, it is far below all other tracts in the actual use of vehicles. Indeed, usage levels in *LE* are less than 50% of all other neighbourhoods except one (*LW*). Table 14 may shed some light on this surprising result.

**Table 14: Percentage of Residents Over the Age of 65**

Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Percent Women +64	5.91	13.90	7.89	1.65	11.90	4.33
Percent Men +64	5.27	9.93	5.79	1.65	8.47	3.89
Percent of Population	11.18	23.83	13.68	3.30	20.37	8.22

It reports the percentage of residents in each neighbourhood that are over the age of 65, and therefore likely retired. *LE* ranks first in this demographic, and this may help to explain the lower levels of vehicle usage. Age may also be a factor in lowering the vehicle kilometres per day in *LW* and *MC*, although this effect on *ME* is less evident.

### **Indicator 6: Length of average commute by drivers of private vehicles**

Commuting to work forms a significant part of total private vehicle use in Canada, although less than is commonly thought. Transport Canada (2002) reported that trips to and from work or school accounted for approximately 22% of total kilometres travelled by light vehicles. An additional 4% was utilized in work-related activities. Most of this travel also occurs during peak traffic periods when the resulting congestion may increase total vehicle emissions.

The average commute by all modes of transportation for residents of the Hamilton census metropolitan area (which also includes the neighbouring City of Burlington) was 7.4 kilometres in 1996 (Statistics Canada 1998a). About 36% of Hamilton commuters travelled less than 5

kilometres to work, while over 20% went further than 20 kilometres. The comparative figures for Canada as a whole were 39.5% and 17.7% respectively (Statistics Canada 1998b). The tendency to longer commutes by Hamiltonians reflects the fact that 22.7% of Hamilton's workforce was employed outside the city in 1996 (Hamilton-Wentworth 1999). Approximately 78% of Hamilton commuters drove to work. An additional 7% travelled as passengers in a private vehicle, with the remainder were divided between public transit, walking and other means of transportation.

### *Methodology*

Data for this indicator was obtained from the Transportation Tomorrow Survey. For this indicator, we included only work trips made by a driver of a private vehicle. Trips by taxi and motorcycle were not included. Neither were trips by passengers in private vehicles, or commutes using public transit, walking or cycling modes. The database provides numbers of trips for each distance measured in kilometres, and also provides an expansion of the 5% data to the full census tract. The total distance travelled by all residents in each tract was calculated and divided by the total number of trips to obtain the average distance travelled to work.

### *Results and Discussion*

Differences in work trip length were found to be relatively minor for five of the six neighbourhoods, but dramatically shorter for **LE**. Unfortunately, the problems noted earlier with the TTS data for **LS** may have affected the results for that neighbourhood, likely by lowering the average distance travelled. Table 15 presents the results.

A calculation was also made using TTS data for the number of vehicle trips per household on an average weekday. This is presented in Table 16. This may provide a better indicator of sustainability than vehicle kilometres travelled. Once again, the data for **LS** is problematic. Note that **LE** again records the best score and that the three inner city older neighbourhoods measure better than the newer areas located further from the main centres of employment.

**Table 15: Length of average work commute as driver of a vehicle**

Census Tract	<b>LS</b>	<b>LE</b>	<b>LW</b>	<b>ME</b>	<b>MC</b>	<b>MW</b>
Commute Length	15.40	7.53	14.45	14.32	13.28	18.39
Weighted Score	2.05	1.00	1.92	1.90	1.76	2.44
Sustainability Score	1.19	2.44	1.27	1.28	1.39	1.00

**Table 16: Number of vehicle trips per household per weekday**

Census Tract	<b>LS</b>	<b>LE</b>	<b>LW</b>	<b>ME</b>	<b>MC</b>	<b>MW</b>
Trips per household	4.77	2.82	3.40	4.07	3.78	4.38
Sustainability Rank	6	1	2	4	3	5
Weighted Score	1.69	1.00	1.21	1.44	1.34	1.55
Sustainability Score	1.00	1.69	1.40	1.17	1.26	1.09

The lower number of trips per day in *LE* helps account for the fewer total kilometres driven per household per day noted in the previous indicator. It would appear that residents of *LE* drive less often, drive shorter distance to work and drive shorter distances to other destinations than their counterparts in the five other neighbourhoods.

**Indicator 7: Number of transit stops in neighbourhood per week per household**

The availability of public transit to a neighbourhood was considered a possible indicator of its use or potential use by the residents of the neighbourhood, with a resultant decrease in transportation emissions and an increase in relative sustainability. Public transit consumes less fossil fuels per trip than most private vehicle trips. The measure utilized was the number of scheduled stops per week in the neighbourhood by the Hamilton Street Railway (HSR) public transit system.

*Methodology*

Route maps and schedules were obtained from the HSR for all neighbourhoods. The daily scheduled stops in the neighbourhood were multiplied by five and added to the stops scheduled on Saturdays and Sundays to obtain the weekly total. In Hamilton, many of the bus routes follow the arterial roads that often form the boundaries of the neighbourhoods studied. We counted only those stops scheduled to take place inside the neighbourhood boundaries. Thus a bus travelling along the boundary of a neighbourhood would stop inside the neighbourhood while going in one direction, but outside the neighbourhood when returning in the opposite direction. Only the former stops were included. This had the effect of favourably weighting transit service that passed through the neighbourhood, and was thus accessible to more residents, over that which only travelled along its boundaries. The resulting total numbers of stops per week was divided by the number of households in the neighbourhood to obtain the final score for this indicator.

*Results and Discussion*

The results are provided in Table 17. They show significant variations in the level of transit service provided to the six neighbourhoods. These differences are partly the result of location and partly the result of historical circumstances, as well as of the public transit policy and configuration in Hamilton.

**Table 17: Transit Service Per Week Per Household**

Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Total HSR Stops Per Week	2160	7616	4962	4559	18634	2801
Stops Per Household	2.92	6.35	3.97	3.00	11.06	2.73
Rank	5	2	3	4	1	6
Sustainability Score	1.07	2.33	1.45	1.10	4.05	1.00

The results for *MC* are enhanced because of its unique location at the top of the main arterial road down the escarpment to downtown Hamilton. The Hamilton transit system uses the downtown as a hub for the majority of its routes. As a result, seven different routes pass by or through *MC*. A large number of routes also pass through or by *LE* because of its location astride or adjacent to

the lower city’s two major east-west thoroughfares. Service here includes the only express route in Hamilton (rush hours only) as well as three other lines, one of which has multiple divisions. *LW* ranks third making the three inner city neighbourhoods also the most serviced. There are only two bus routes servicing *LW*, but it also has the smallest area of the six neighbourhoods examined. A portion of the service passes through this tract, thus increasing its overall score.

Bus service is provided along at least three of the borders of both *ME* and *MW* but the frequency is less than some of the buses servicing inner city areas and the location of the service along the borders of these neighbourhoods means only stops on one side of the street were counted. Transit service to *LS* in the former City of Stoney Creek has historically been limited because the former City purchased service from Hamilton. The two bus routes that do service this neighbourhood are restricted to the northern 20% of the tract, and the curvilinear street pattern further complicates pedestrian accessibility to these services. There is no Sunday service on either route.

An alternative way of evaluating transit service is based on the number of bus runs that occur through or past the neighbourhood on an average hour. Transit service varies on different routes, but usually begins at 5 am and continues until 1 am the following day for a total of 20 hours per day. Thus we have divided the runs per week by 140 (7 x 20) to determine the average number of runs per hour. Table 18 displays the results of this approach.

**Table 18: Transit Service Per Neighbourhood Per Hour**

Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Total HSR Runs Per Week	432	2089	579	1271	2573	903
Runs Per Hour	3.09	14.92	4.14	9.08	18.38	6.45
Rank	6	2	5	3	1	4
Sustainability Score	1.00	4.83	1.34	2.94	5.95	2.09

This approach gives us substantially different results, primarily because the number of households in the neighbourhood is no longer factored into the result. As a result *ME* particularly benefits. On the other hand *LW* drops from second place to fourth, partly because of a relatively high number of households and also because it loses the advantage gained by having buses run through the neighbourhood rather than just along its edge. Note that this calculation only records the number of times a bus travels through some portion of the neighbourhood and thus has limitations as a measure of the relative accessibility of the transit system to individual residents.

**Indicator 8: Percent of daily trips utilizing transit**

This indicator assumed a greater level of sustainability in neighbourhoods where there was a higher level of usage of public transit services. This should provide a more accurate measure of sustainable behaviour, although it should be affected by the actual availability of transit services reported above.

## Methodology

Once again, data was available from two sources: the census and the Transportation Tomorrow Survey. For this indicator, we chose to use the TTS data because it records all trips, while the census data is limited to work trips. However, we have presented the latter data for comparison. In this case, we assume that problems noted earlier with the TTS data for *LS* will result in an overestimation of transit usage.

## Results and Discussion

Table 19 presents the results of the TTS data set. The high level of transit service available to residents of *MC* does not appear to have resulted in a comparable high level of usage of the service. In fact, the residents of *ME*, located on the outskirts of the transit area scored slightly higher than *MC*. This may reflect the fact that *ME* is too far away from both employment and cultural centres of the community to get there by walking or cycling (as noted earlier).

It may also be significant that the more than 20% of the families in *ME* are low income, compared to only 11% in *MC*. An inverse relationship between income and transit use has been reported for Canadian commuters (Statistics Canada 1993).

**Table 19: Transit Trips as a Percent of Total Trips**

Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Percent Transit Trips	2.6	11.5	3.8	6.4	6.3	5.1
Sustainability Rank	6	1	5	2	3	4
Sustainability Score	1.00	4.42	1.46	2.46	2.42	1.96

The results for *LS*, on the other hand, may well reflect the low levels of transit availability in this neighbourhood. Similarly, both *LW* and *MW* have relatively low levels of transit service, especially in runs per hour, and have comparably low rates of transit usage.

The high score for *LE*, clearly the best of the six neighbourhoods, may reflect its location on the only transit corridor in the City that provides an express service to the Central Business District (along with relatively high frequency service outside of rush hours). This neighbourhood also enjoys a direct transit connection to the other major employment area on the bayfront. This high use of transit in *LE* may also help to explain the low vehicle usage and vehicle kilometres travelled per day that we noted in an earlier indicator.

Overall, transit usage accounts for only a small percentage of total trips. Use of private vehicles is clearly the first choice of the majority of residents of all neighbourhoods examined, but if this choice is unavailable or rejected, then residents' options include walking and cycling as well as transit. Unfortunately, TTS interviewers do not collect data on walking trips other than those to work or school (Dalton 1999). Since the majority of trips are discretionary, this omission makes the TTS data unreliable in providing totals for walking, cycling and transit trips combined.

### Indicator 9: Percent of employees who work at home, or cycle or walk to work

This indicator is intended to measure the percentage of employees who do not utilize fossil fuels to get to their place of work. While car pooling and public transit reduce the generation of air pollutants and greenhouse gases per person, the most sustainable transportation choices entirely eliminate the use of fossil fuel.

#### Methodology

Census data records the number of people who work at home, and also includes a division of commuters by mode of travel to work. The modes recorded are driver of a vehicle, passenger in a vehicle, transit, walk, and other. The other category includes bicycles, taxis and motorcycles. Data collected by the Transportation Tomorrow Survey indicates that taxi and motorcycle use provide only a minuscule portion of the total. Consequently, we have included the “other” category in this indicator. In Canada as a whole, 73.3% of commuters drive to work. A further 7.4% are passengers in a private vehicle. Public transit accounts for 10.1%, and 7.0% walk. The remaining 2.2% fall into the “other category. Transit usage among females is 13.2% compared to 7.5% among males (Statistics Canada 1998b).

In the Hamilton census metropolitan area (which includes Burlington), 78.1% drove, 7.2% were driven, 8% took public transit, and 5.2% walked (Statistics Canada 1998c). The distribution by mode of travel to work for the six neighbourhoods is presented in Table 20.

**Table 20: Mode of Getting to Work as a Percent of Total Work Trips**

Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Drove to work	86.1%	77.9%	65.9%	83.2%	77.7%	76.6%
Passenger in vehicle	9.3%	4.5%	7.0%	5.8%	6.0%	8.3%
Public Transit	3.8%	12.6%	12.8%	8.9%	8.6%	9.2%
Walked to work	0.8%	4.1%	11.6%	1.3%	6.9%	3.3%
Other	0.0%	0.9%	2.7%	0.9%	0.9%	1.2%

The relatively large “passenger” category in *LS* combined with the lowest transit usage noted in indicator eight is noteworthy. The combined “passenger” and “transit” percentages in *LS* are similar to *ME* and *MC*, but transit usage in the latter two is more than twice as high. This may be partly the result of the relatively poor transit service provided to *LS*. Improved transit availability may capture some of those individuals who are currently dependent on being driven to work in a private vehicle, or worse, are compelled to drive themselves because of the lack of an alternative means of transportation.

The results for *LW* are also significant, with more than 10% fewer commuters choosing to drive to work than in other neighbourhoods, and a relatively high percentage selecting the walking and “other” categories. The relative high transit score is interesting in light of the relatively low percentage of total trips by transit noted in indicator eight. This indicates that transit is under utilized for discretionary trips by residents of *LW*. This may be a good sign, indicating that many

discretionary trips are achieved by walking because of the close proximity of shopping destinations. Alternatively, it may indicate that discretionary destinations are not easily accessible by transit, leading *LW* residents to use their vehicles. The former seems more likely than the latter, given the low number of vehicles per household in *LW* and the fact that average driving distance per day is lowest of the six neighbourhoods examined.

To calculate the indicator, we added the number of people who work at home, to the number who were recorded in the census as walking to work and the number using “other” modes of travel. This was compared to the census data for total numbers of employees in the neighbourhood.

*Results and Discussion*

The results are presented in Table 21. The differences are the most striking of any indicator examined in the study with the highest scoring neighbourhood (*LW*) having more than six times as many employees who don’t use fossil fuels to get to work as the lowest scoring neighbourhood (*LS*).

**Table 21: Percent of Employees Who Don’t Use Fossil Fuel Transportation**

Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Percentage	2.9	10.1	19.4	6	12.5	7
Sustainability Rank	6	3	1	5	2	4
Sustainability Score	1.00	3.48	6.69	2.07	4.31	2.41

Scores for the other two inner city neighbourhoods also rank ahead of the three neighbourhoods that are situated further from the main areas of employment. However, this indicator is likely less related to that factor than it is to the relative availability of workplaces within a very short distance of homes. It is unlikely, for example, that many residents of *MC* on top of the escarpment, either walk or cycle to employment below the escarpment, whether in the Central Business District or on the bayfront. Employment opportunities in the area of *MC* include the commercial district on Concession Street and the Henderson Hospital and Cancer Clinic further to the east.

Residents of *LW* and *LE* might be more likely to walk or cycle to the major employment centres, but there are also a relatively high number of commercial employment opportunities within or close to these neighbourhoods.

The location of commercial employment in relation to the neighbourhoods may also be a factor in the likelihood of residents walking to work. In the three suburban neighbourhoods, commercial areas are concentrated on or near the edge of the neighbourhoods (see indicators 11 and 12), while in the three inner city tracts, stores tend to be spread out and thus accessible to a higher percentage of the residents.

## **Indicator 10: Length of neighbourhood roads per household**

This indicator was chosen to reflect the amount of paved area in each neighbourhood on a per household basis. In 1996, Canada had 901,904 kilometres of roads, more than 31 metres per person (Statistics Canada 2002). Streets consume between 25 and 35 percent of a subdivision and the numbers are even higher for more traditional grid patterns (CMHC 2001).

Paved areas represent one of the most irretrievably degraded land uses. Increasing amounts of pavement generate increasing amounts of runoff during storm events resulting in higher erosion and sedimentation rates in nearby creeks and rivers and greater impacts on receiving bodies of water. This may also be true for other impervious surfaces such as buildings, but these can be ameliorated through the disconnecting of downspouts and/or collection of roof runoff in rain barrels or cisterns.

However, it is not clear that road length on its own is a good measure of sustainability. For example, roads in modern suburban areas consume from 16 to 25% less land than the traditional grid pattern favoured by advocates of new urbanism (CMHC 2001). The curving streets and predominance of cul-de-sacs don't increase the amount of land consumed by roads, but they obviously make walking, and transit less efficient means of getting around. We have added indicator 10A to compare the neighbourhoods on these aspects.

Total paved areas within neighbourhoods would be increased if the average length of driveways was also included, but collection of that data was beyond the scope of the study. There is considerable variation in Hamilton neighbourhoods in this parameter, with some older areas relying almost exclusively on on-street parking, and some newer areas including driveways wide enough for two or more vehicles at most homes.

### *Methodology*

The length of all roads within, and on the boundaries of, neighbourhoods were measured from 1:3000 aerial photos provided by the City of Hamilton. The total distance in metres was divided by the number of households recorded by the 1996 census as present in the neighbourhood. Consideration was given to refining this indicator by also measuring road widths but it was concluded that this would make little difference to the overall score. Arterial roads are wider than most residential streets. However, in our study, most arterial roads were located on the boundaries of census tracts and were thus shared with the adjacent neighbourhoods. Thus only 50% of the width of these major roadways could reasonably be attributed to each adjacent neighbourhood.

### *Results and Discussion*

Table 22 presents the results of the calculations. They show a considerable variation between the values for neighbourhoods *LW* and *LS* with the latter having more than twice the length of road per household as the former. The remaining four neighbourhoods all had road lengths about 50% greater than *LW*, but only about two-thirds the length of *LS*.

**Table 22: Length of Neighbourhood Roads per Household**

Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Metres per household	14.24	8.64	6.06	9.08	9.81	9.25
Rank	6	2	1	3	5	4
Weighted ranking	2.35	1.43	1.00	1.50	1.62	1.53
Sustainability Score	1.00	1.65	2.35	1.57	1.45	1.54

This indicator might provide a surrogate measure of residential density, with a higher amount of road length per household indicating lower housing density per hectare in the neighbourhoods. Our data showed that the neighbourhoods who ranked first and second in density, also ranked first and second in length of roads per household. Those ranking third, fourth and fifth varied between the two indicators, while the neighbourhood ranking sixth was the same for both.

A calculation was also performed for road length per person (as opposed to per household) and is presented in Table 23. This resulted in a somewhat smaller range of 2.66 metres per person to 4.44. The lowest score was again achieved by *LW* and the highest by *LS*. However, *ME* moved into second place in the ranking with a 2.68 score, nearly identical to *LW*. *MW* also scored much better in metres per person, while *LE* and *MC* did relatively more poorly. These changes appear to reflect the fact that the three older neighbourhoods (*LW*, *LE*, and *MC*) have higher numbers of one and two-person households, while the remaining three newer neighbourhoods are dominated by young families.

**Table 23: Length of Neighbourhood Roads per Person**

Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Metres per person	4.44	3.75	2.66	2.68	4.05	2.83
Rank	6	4	1	2	5	3
Weighted ranking	1.67	1.41	1.00	1.01	1.52	1.06
Sustainability Score	1.00	1.18	1.67	1.66	1.10	1.57

The per household measure is likely more reflective of long-term neighbourhood sustainability than the per person measure. As demographic transition takes place, the numbers of children and others in households will vary. A change in the number of available dwelling places, however, is less likely to occur, and the amount of pavement is also unlikely to be reduced.

### **Indicator 10A: Interconnectivity of Neighbourhood Roads**

Many commentators (Randall 2001) have noted the importance of street layout to neighbourhood sustainability. Most favour a traditional grid pattern that permits easier access for transit vehicles than the curvilinear streets that characterize many modern suburban developments. Another significant consideration is the ability of residents to move through the neighbourhood, either by

vehicle or on foot, and to get to their destination by a route that is not much longer than “the crow flies”. A 1999 study in Portland, Oregon concluded that increased street connectivity resulted in improved vehicle travel over both short and longer distances (Daisa et al.).

*Methodology*

Different approaches can be taken to determining the relative connectivity provided by a specific street pattern. The one utilized here is the interconnectivity index described in the Transportation Demand Management Encyclopedia prepared by the Victoria Transport Policy Institute (2002). It is computed by dividing the number of roadway links by the number of roadway nodes, where nodes are intersections, and links are the sections of road between intersections. Intersections between cul-de-sacs and through streets are counted as nodes, just like any other intersection, but the number of links they generate is lower. VTPI argues that an index of at least 1.4 is required for a walkable neighbourhood.

The links and nodes for each neighbourhood were counted off enlarged road maps which permitted easy identification.

*Results*

Table 24 shows the results of calculating the interconnectivity index for each neighbourhood. Note the low scores for *ME* and *LS*, the two neighbourhoods who also recorded the lowest levels of walking. The other four neighbourhoods exceed the VTPI’s minimum criteria for walkability.

**Table 24: Interconnectivity of Neighbourhood Road System**

Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Index of interconnectivity	1.29	1.59	1.56	1.11	1.63	1.48
Rank	6	4	1	2	5	3
Weighted ranking	1.16	1.43	1.41	1.00	1.47	1.33
Sustainability Score	1.26	1.03	1.04	1.47	1.00	1.10

**Indicator 11: Accessibility of high-use type neighbourhood area stores**

The availability of discretionary destinations of various types was considered a potential indicator of the sustainability of the neighbourhood. The assumption was that the presence of local destinations for discretionary travel would decrease the average distances travelled and would increase the likelihood of some trips being made by bicycle or on foot. Both effects would reduce consumption of fossil fuels and thus enhance sustainability.

*Methodology*

A windshield survey (again on bicycle) was conducted of each neighbourhood to identify all potential destinations in the neighbourhood, including those outside the neighbourhood but facing it across one of the arterial boundary streets.

Only stores identified as ‘neighbourhood’ type outlets that might potentially be accessed by pedestrians from the neighbourhood were included. Thus specialty shops such as computer sales, appliance repair, clothing and shoe stores, and other outlets serving a city-wide clientele were not counted. The following types of destinations were included: supermarkets, other food stores, convenience and variety stores, fast food outlets, restaurants and pubs, video stores, banks, postal outlets, library branches, hair stylists, pharmacies, doctors and dentists, dry cleaners and liquor and beer stores.

The resulting list of stores was then weighted in two ways – by location, and by frequency of use. This was done to more appropriately represent the significance of the outlet to the local neighbourhood in terms of its relative accessibility and attractiveness. Thus stores located within the neighbourhood were considered more accessible than those on the boundary or outside..

To estimate relative attractiveness, an informal poll of 40 individuals was conducted to determine average usage rates for each type of outlet. Respondents were asked to indicate the number of times they or members of their family visited this type of outlet over a one month period.

The results led to adoption of the following weighting procedure, with more frequent use outlets given a greater weight:

- 1 Dentists, Doctors, Dry Cleaners
- 1.5 Hair Stylists, Beer and Liquor Outlets, Video Stores, Post Offices
- 2 Restaurants and Pubs, Pharmacies, Banks
- 2.5 Fast Food and Take Out, Variety and Convenience, Bakeries, Libraries
- 4 Supermarkets

The location of each outlet was also noted on a map of the neighbourhood, and they were divided into three location categories and weighted as follows:

- 1 Outlet located outside the boundary of the neighbourhood but within one block
- 2 Outlet located inside the neighbourhood but on its boundary
- 3 Outlet located inside the neighbourhood by at least one block

Using these two factors, each outlet was scored and the total for each neighbourhood determined. This was divided by the number of households in the respective neighbourhoods to achieve the “weighted score”. Table 25 presents the results.

**Table 25: Value of Local Neighbourhood Stores**

Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Number of outlets	14	34	39	37	36	20
Weighted Score	28.5	123	133.5	165	117	46.5
Rank	6	3	2	1	4	5
Sustainability score	1.00	4.32	4.68	5.79	4.11	1.63

This indicator also shows substantial differences among the six neighbourhoods in both numbers of neighbourhood stores and their relative value according to type and location. Some neighbourhoods benefit from the location weighting because major arterial streets passed through the centre of the neighbourhood rather than only being found on the boundaries. *ME* and *LE*, and to a lesser extent *MC*, were the main beneficiaries of this factor. *LS* and *MW* suffered both from a smaller number of local stores, and because those that were present were nearly all located near only one of the four neighbourhood boundaries. This means that residents of those two neighbourhoods on average must travel further to access any neighbourhood store.

### **Indicator 12: Distance from centre of neighbourhood to nearest food supermarket**

This indicator was chosen to reflect one aspect of the length of discretionary vehicle trips to and from the neighbourhood. This forms a significant portion of total vehicle trips. In 2000, shopping trips in Canada represented over one-quarter of all trip purposes and of all vehicle-kilometres driven (Transport Canada 2002). This exceeded work/school trips on both parameters.

Food marketing in Canada is highly concentrated, with the top six supermarket companies controlling 86% of total market share (Kubas and Simmons 2000). In Ontario, A&P and Loblaws account for fully half of the market (Industry Canada 2000). The latter company is the largest retailer in Canada and controls over 30% of retail food sales. This concentration of ownership has increased strongly over the past 20 years in Ontario where the number of corporate food retail chains has dropped from 24 to 13 (Faye Clack 2002), and is expected to continue (Ryerson 2000).

This concentration is strongly reflected in Hamilton where Fortinos and No Frills represent the Loblaws empire, and Food Basics and the Barn help carry A&P's banner. Together they have over 30 large outlets. The competition among these very powerful food retailers appears to be leading to fewer supermarket locations. A&P closed two of its stores early in 2002 and converted one of the Barns into a Food Basics. Fortinos has recently opened two superstores, replacing three of its own smaller outlets and also apparently causing the closure of one of the Barn outlets. These moves by the two major chains have thus resulted in the loss of four outlets in the past year. Fortino's has signalled its intention to create at least two more superstores in the near future.

### *Methodology*

Only major full-service supermarkets were considered for this indicator. These included both major chains as well as large independent food markets that offer a full range of fresh vegetables, meats and other food products. The centre of the neighbourhood was defined as the point at which lines drawn from opposite corners intersected. The distance was measured using a City road map.

The poll of individuals noted above indicated that average numbers of visits to supermarkets were nearly twice as high as to any other category of discretionary destination.

## Results and Discussion

The results are presented in Table 26. Our review found that four of the six neighbourhoods currently enjoy relatively close access to a major supermarket, but the differences between these and the other two are substantial.

Residents of *LE* actually have a choice of two large food retailers just outside the boundaries of each end of the neighbourhood. Residents of *ME* are even more favoured, having two supermarkets actually within the neighbourhood's boundaries. *LW* also has a large food retailer inside the northern boundary of the community, as well as a bakery and a particularly large version of a convenience store. *MW* residents can access one supermarket just outside the northern boundary of their neighbourhood and a second one a short distance to the west.

**Table 26: Distance from centre of neighbourhood to nearest food supermarket**

Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Distance in kilometres	1.50	0.53	0.45	0.40	1.38	0.60
Rank (highest 1)	6	3	2	1	5	4
Weighted score	3.75	1.33	1.13	1.00	3.45	1.50
Sustainability Score	1.00	2.83	3.33	3.75	1.09	2.50

*MC* and *LS* are less favoured. The latter has very limited commercial activity within or near its border. A portion of *MC* lies at the western end of the long-established Concession Street commercial area. In 1999 its Business Improvement Area committee won a sustainable community award for its efforts to revitalize this district.

## SUMMARY OF SUSTAINABILITY SCORES

Table 27 presents a list of all the sustainability indicators examined in this study. This allows for quick comparison of the results and provides an introduction to a discussion of the overall findings of the study. Recall that the higher the score, the greater the relative sustainability.

**Table 27: Sustainability Scores for All Indicators**

Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>
Density of Residential Area	1.00	1.84	2.31	1.65	1.78	1.61
Rooms per Household	1.00	1.34	1.36	1.10	1.27	1.07
Vehicles per Household	1.00	1.53	1.79	1.07	1.58	1.24
Litres of Fuel Consumed	1.00	1.52	1.86	1.00	1.59	1.27
Length of Trips per Hhld.	1.04	2.74	1.44	1.12	1.24	1.00
Length of Commute	1.19	2.44	1.27	1.28	1.39	1.00
Transit Stops per Hhld.	1.07	2.33	1.45	1.10	4.05	1.00
Trips Using Transit	1.00	4.42	1.46	2.46	2.42	1.96
Percent of non Fossil Fuel	1.00	3.48	6.69	2.07	4.31	2.41
Length of Roads	1.00	1.65	2.35	1.57	1.45	1.54
Neighbourhood Stores Value	1.00	4.32	4.68	5.79	4.11	1.63
Distance to Supermarket	1.00	2.83	3.33	3.75	1.09	2.50

### *Discussion*

The summary table of sustainability scores displays a number of patterns. At the overall scale, *LW* was ranked first on six of the twelve indicators, including the first four. *LE* had three firsts and *ME* scored first on two indicators, while *MC* scored first on one indicator. Both *LS* and *MW* failed to score any firsts.

Overall, *LS* appears to be the least sustainable neighbourhood examined. It had three fifth place scores and was last on the other nine indicators. It is the tract lying furthest from the two major centres of employment in Hamilton, and the second most recently constructed neighbourhood. This tract also had the lowest percentage of rental accommodation, and the highest average family income.

Along with its six firsts, *LW* had three second place scores, one third, one fourth and one in fifth place. This suggests it is likely the most sustainable neighbourhood in the survey. In contrast to *LS*, this neighbourhood is the oldest of the six examined, and ranked a close second in distance from the two major Hamilton employment centres. Again in contrast to *LS*, this tract had the highest percentage of rental units. The average annual income here was second lowest, although only slightly below *MC*.

Beyond these two extremes, *LE* scored second best with four seconds to add to its three first place scores, and five third place finishes. *ME* had two first place scores, and one second, and two thirds; while *MC* had one first, four seconds, and four thirds.

The other neighbourhood, *MW*, had no scores above a fourth.

## COMPOSITE SCORING

Preparing a composite score, that compares the six neighbourhoods directly, posed a challenge because of the obvious disparity in the significance of the twelve indicators. The approach we adopted was to seek the advice of a number of individuals with strong experience in sustainability issues.

### *Methodology*

We asked 15 individuals to rank the twelve indicators in a three-step process. In the first step, the respondents were asked to rank the indicators according to the estimation of how well they might be expected to reflect the relative sustainability of a neighbourhood. They were instructed to assign the number 12 to the indicator they felt best reflected a sustainable neighbourhood, 11 to the second best, and so on down to 1 for the indicator they felt would give the least information about neighbourhood sustainability. For the second step, the respondents were asked to square each score, giving a ranking from 144 down to 1. Then as a third step, they were invited to modify their scores up or down to better reflect the actual weight they felt was appropriate, but without changing their order of selection. Thus the indicator they scored in step two as 36 (6x6) could be altered to any number between 49 (7x7) and 25 (5x5).

The respondents included three university faculty involved in teaching sustainability, three professional planners, and a range of other individuals working in the field or leading volunteer organizations focused on sustainability issues.

The scores supplied by the 15 respondents were totalled and divided by the lowest score to establish a composite factor for each of the twelve indicators. The range of this weighting factor was from 1.0 to 5.0. Given that each individual's scores ranged from 1 to 144, the relatively close range of the average of the scores is noteworthy and perhaps reflects the lack of a common definition of sustainability.

The indicator that scored highest in this poll was "vehicle kilometres travelled per household per day". Three of the respondents selected this as their first choice, and six as their second choice. The indicator that scored second was "litres of vehicle fuel used per household per annum". It was selected first by four of the respondents, but had no second place choices. However, most other respondents included it in their top four choices. The indicator that ranked third in composite score was "number of households per residential hectare" which also received three first place votes. The lowest ranking indicator was "number of rooms per household". It had seven last place choices but its total score still came to almost exactly one-fifth of the score registered by the leading indicator.

**Table 28: Weighted Sustainability Scores for Selected Indicators**

Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>	Weight
Density of Residential Area	3.70	6.81	8.55	6.11	6.59	5.96	3.7
Rooms per Household	1.00	1.34	1.36	1.10	1.27	1.07	1.0
Vehicles per Household	1.40	2.17	2.48	1.50	2.24	1.64	1.4
Litres of Fuel Consumed	4.10	6.27	7.63	4.35	6.60	4.88	4.1
Length of Trips per Hhld.	5.20	13.70	7.20	5.60	6.20	5.00	5.0
Length of Average Commute	4.06	8.31	4.33	4.37	4.71	3.40	3.4
Transit Stops per Hhld.	2.35	5.13	3.19	2.42	8.91	2.20	2.2
Trips Using Transit	3.40	15.03	4.96	8.36	8.23	6.66	3.4
Percent of non Fossil Fuel	3.40	11.83	22.75	7.04	14.65	8.19	3.4
Length of Roads	1.30	2.14	2.35	3.05	1.57	1.45	1.5
Neighbourhood Stores Value	3.20	13.82	14.98	18.53	13.15	5.22	3.2
Distance to Supermarket	2.40	6.79	7.99	9.00	2.62	6.00	2.4
COMPOSITE SCORE	35.51	93.34	87.77	71.43	76.74	51.67	
Census Tract	<i>LS</i>	<i>LE</i>	<i>LW</i>	<i>ME</i>	<i>MC</i>	<i>MW</i>	

### *Results and Discussion*

The factors for the twelve indicators are shown in the right hand column of Table 28. This factor has been multiplied by the sustainability scores for each indicator and the results are shown in the table.

The neighbourhood with the resulting highest composite score is *LE*, closely followed by *LW*. The third position is occupied by the other older inner city neighbourhood, *MC*, but is quite closely followed by *ME*. Not surprisingly, *MW* and *LS* ranked fifth and sixth with the latter achieving a composite score of barely more than a third of the highest ranking neighbourhood.

### **MAJOR FINDINGS AND CONCLUSIONS**

The study utilized readily available data to measure indicators that reflect the relative sustainability of six varied Hamilton neighbourhoods. It found that there are quite dramatic differences both in the factors that might affect the sustainability of the neighbourhoods and also in the actual consumption of fossil fuels in transportation. This suggests that the footprint of individual urban neighbourhoods varies substantially, at least in the categories of transportation and housing. To examine the footprint categories of food and of goods and services will require a more comprehensive set of data than was available to this research project.

The study found that older inner city neighbourhoods appear to be considerably more sustainable than newer subdivisions being built on the outskirts of cities like Hamilton. The inner city neighbourhoods swept the top three positions in seven of the twelve indicators, and two of the top three positions in the other five. Comparing the composite scores of the three older inner-city neighbourhoods with the three outer suburban tracts, we find that the former may be twice as sustainable as the latter.

Seven of the twelve indicators measured aspects of transportation. The inner city neighbourhoods scored first in each of the transportation indicators, and second in six out of the seven.

The three inner city neighbourhoods scored much better on indicators that measured fuel consumption and therefore likely make much smaller contributions to transportation-related air pollution and greenhouse gases.

The inner city neighbourhoods were the most compact, had the fewest vehicles per household and the smallest number of rooms per dwelling. They also recorded the shortest average daily trip lengths, the lowest consumption of fossil fuels for transportation, and the highest likelihood of not using fossil fuels to get to work.

*ME* had the best composite score of the three suburban neighbourhoods. It had the highest density score for the suburban neighbourhoods as well as the best scores overall on accessibility of commercial outlets. It also ranked second overall in the use of public transit.

Some pairs of indicators produced similar results. For example, the vehicles per household indicator scored almost exactly the same as the litres of fuel consumed. Not surprisingly perhaps, the percent of the neighbourhood workers not using fossil fuels for their work commute also had the same ranking.

Similarly, the ranking of the density scores was identical to the ranking of the rooms per household indicator, although the differences were considerably more dramatic in the former than the latter. This makes sense because as dwelling units have more rooms (get larger) the number per hectare is likely to be reduced.

Transit stops per household did not appear to be a major determinant in percentage of trips utilizing transit. However transit runs per hour correlated much more strongly with percentage usage of transit, with scores for five of the six neighbourhoods being very similar. The exception was *ME* where transit usage was comparatively high despite relatively low levels of service.

The relative accessibility of neighbourhood stores and supermarkets does not appear to have any significant impact on the number of kilometres driven each day. Unfortunately, walking data was not available for comparison.

The length of average daily commute does not appear to correlate with any other indicator examined, except in the case of *LE*. In the other five neighbourhoods, there was little difference in the average length of commute.

Overall, the study suggests that development trends in Hamilton over the past several decades appear to have generated neighbourhoods of decreasing sustainability. Municipal transit policies, zoning and neighbourhood planning appear to have some responsibility for this decline. On the other hand, this also suggests that local decision-makers may be capable of significantly improving the sustainability of neighbourhoods, and consequently of the city as a whole.

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