Eric Miller and Richard Soberman

neptis
THE ARCHITECTURE
OF URBAN REGIONS

This is the ninth in a series of inine ssue papers commissioned by the Neptis Foundation for consideration by the Central Ontario Smart Growth Panel established by the Government of Ontario.

Miller and Soberman describe transportation and land use as a "two-way, chicken-and-egg relationship": competitive, high-quality transit can be provided cost-effectively only where land use patterns support such services, but transit-supportive built forms can be built only if transit service is provided. They examine recent transportation trends in the Central Ontario Zone, including increased dependence on the automobile, and recommend a series of "smart growth building blocks," including road pricing to alter travel behaviour and the choice of vehicles, as well as altering transit subsidy programs to reward performance rather than costs, and providing municipalities and transit agencies with new sources of predictable revenue other than property taxes. Finally, they identify the barriers to implementing these recommendations and suggest several short-term measures to deal with congestion, support transit, and slow down urban sprawl.

Eric J. Miller, Ph.D. and Richard M. Soberman, Ph.D.
Dr. Miller is a Bahen-Tanenbaum Professor at the Department of Civil Engineering and Joint Program in Transportation at the University of Toronto. Dr. Soberman is a Professor Emeritus at the Department of Civil Engineering at the University of Toronto and a transportation consultant at Trimap Consultants.

This is the ninth in a series of nine issue papers commissioned by the Neptis Foundation for consideration by the Central Ontario Smart Growth Panel established by the Government of Ontario.

Research for the series has been coordinated by Dr. Pamela Blais, of Metropole Consultants

Neptis is an independent, privately-funded, registered charitable foundation, based in Toronto, Canada, that supports interdisciplinary research, education and publication on the past, present and future of urban regions.

Neptis Foundation
50 Park Rd.
Toronto, Ontario M4W 2N5
www.neptis@neptis.org

This report can be purchased as a CD or hard copy by contacting the Neptis Foundation.

neptis
THE ARCHITECTURE OF URBAN REGIONS

Table of Contents

Introduction

This paper, which was commissioned by the Neptis Foundation for input to the Central Ontario Smart Growth Strategy Sub-Panel's deliberations, discusses:

- key characteristics of and trends in the demand for travel in the Central Ontario Smart Growth Zone (COZ);
- the relationship between travel demand and urban form in the Zone;
- the implications of these trends and relationships for developing a Smart Growth policy for Central Ontario.

The paper introduces and defines the "transportation–land use" interaction and discusses its importance to the urban policy design debate. This is followed by an overview of recent trends in urban travel demand and empirical evidence of the transportation–land use interactions at work within Central Ontario. The remainder of the paper deals with elements of smart growth from a transportation–land use perspective; strategic and implementation tools for implementing a smart growth policy; barriers to implementing such policies; and a brief evaluation of the strengths and weaknesses of various strategic actions. The final section discusses short-term measures that might be implemented as first steps towards a long-term smart growth strategy.

Some definitions

A number of terms are used throughout this paper. To avoid possible misunderstandings concerning the meaning/connotation of these terms, we present the following definitions.

Travel demand: This refers to the physical flow of persons, vehicles, goods (freight) and services through and within the Central Ontario Zone. At times the paper focuses on either person travel or the movements of goods; at other times it deals with travel demand of all kinds.

Transportation system: The transportation system consists of:

- the complete set of transportation-related physical infrastructure (roads, highways, rail lines, stations, terminals);
- the vehicles that operate within the rights-of-way provided by the physical infrastructure (cars, trucks, buses, trains, bicycles);

The transportation system consists of the supply side of the transportation demand-supply interaction. The performance of the transportation system (travel times and costs, congestion levels, service reliability, etc.) depends directly on the nature and level of travel demand trying to use the system. Demand for a given transportation facility depends, in part, on the cost and quality of the service being provided.

- the operating system, laws/rules, and other means used to control vehicle and pedestrian movements within the rights-of-way (such as traffic signal systems; roadway signage; ITS-based real-time freeway control systems; speed limits);
- all transportation-related services operated within this physical infrastructure (including public transit, taxis, trucking, couriers).

Thus, the transportation system consists of the entire supply side of the transportation demand-supply interaction. The **performance** of the transportation system in terms of travel times and costs, congestion levels, service reliability and so forth depends directly on the nature and level of travel demand trying to use the system (for example, the level of congestion on a freeway obviously increases as more cars and trucks try to use the freeway). At the same time, demand for a given transportation facility depends, in part, on the cost and quality of service being provided by this facility (for example, if a freeway is extremely congested, trip-makers will try to find alternative routes, or perhaps even alternative modes of travel, to complete a given trip).

Urban form, urban structure, land use: These terms are used more or less interchangeably throughout the paper. They encompass:

- the built environment (that is, the physical distribution of houses, factories, stores, office buildings, parks and other elements that physically defines our villages, towns, suburbs and cities);
- the activities that occur within this built environment (in-home activities, jobs, retail services, recreational activities, etc.);
- the functional interconnections between physically dispersed activities (such as the links between place of residence and place of work).

It is important to explain the use of the term "urban." Although much of the Central Ontario Zone is clearly rural or otherwise non-urban, the majority of the population and economic activity is found in "urbanized" areas. For example, in 2001, 84% of the population and 85% of both employment and employed labour force within the "reduced COZ" (defined below) was located within the Greater Toronto Area and Hamilton. [1]

1. Unless otherwise indicated, all statistics in this report are derived from the Transportation Tomorrow Survey database for the year specified.

Further, the issue of smart growth is inherently one of how to manage continuing urbanization/urban development within the Central Ontario Zone, since this is the primary means by which growth will, inevitably, occur. Indeed, even growth in rural areas or small villages and towns is inherently one of urbanization, since it represents at least some increase in the density or intensity of development, and is invariably driven by pressures from and interactions with more developed towns and cities within the Central Ontario Zone.

While this paper speaks of "urbanization" and "urban development," this does not mean that it is concerned with "big-city" issues alone. Urbanization affects the entire COZ.

Thus, while this paper often speaks of urbanization or urban development, this does not mean that it is concerned with "big-city" issues alone. Urbanization affects the entire Central Ontario Zone. Indeed, in many important respects it is a more important issue for currently non-urban areas trying to cope with growth pressures than it is for already highly urbanized areas, which either are not facing the same pressures for growth or have in place infrastructure that allows them to cope with these pressures more readily.

Study area and sources of data

All of the travel demand data presented in this paper are derived from the Transportation Tomorrow Survey (TTS) series of travel surveys that have been undertaken within the region every five years, starting in 1986. The TTS provides high-quality, statistically reliable snapshots of travel behaviour for a "typical" weekday in the fall of each survey year. The survey area has evolved over time as more municipalities have joined the process. **Figure 1.1** shows this evo-

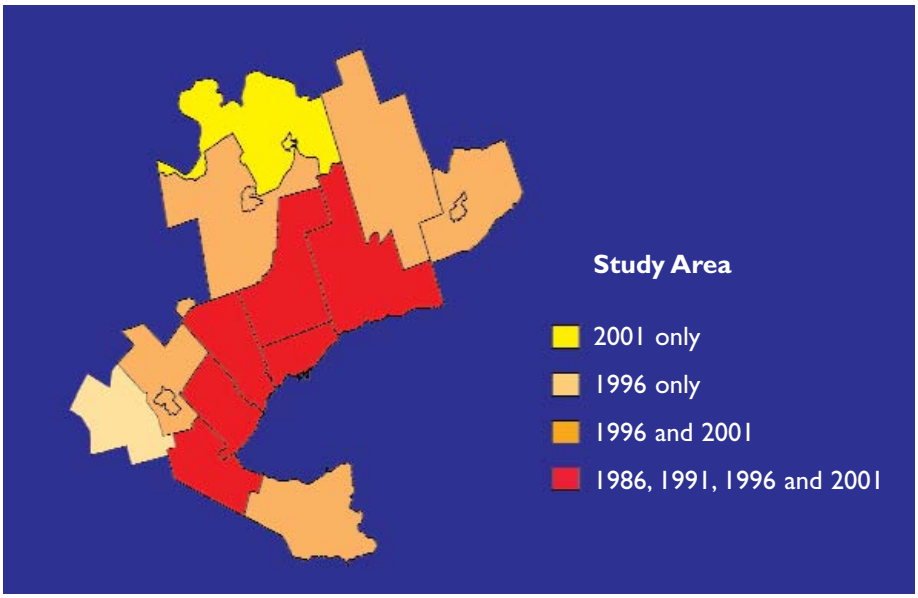


Figure 1.1 Transportation Tomorrow Survey (TTS) Study Areas

lution of the TTS study area from 1986 to the most recent 2001 survey. [2]
The TTS study area now encompasses most of the Central Ontario Zone. A notable exception is Kitchener-Waterloo, which participated in the 1996 TTS but elected not to take part in the most recent 2001 survey. This is an unfortunate development, since it means that current travel patterns and trends for Kitchener-Waterloo (both internally within the region and to and from the rest of the Central Ontario Zone) are not available.

The study area consists of the Central Ontario Zone, with the exception of the Kitchener-Waterloo area and a portion of Simcoe County.

In order to present a consistent set of data on current (2001) travel patterns and recent trends (1996-2001) in travel behaviour within the Central Ontario Zone, the study area for this paper is therefore the "reduced COZ" for which TTS data are available for both 1996 and 2001. Thus, both Kitchener-Waterloo and the portion of Simcoe County that was not included in the 1996 TTS are excluded from the analysis. Despite these exclusions, the study area is representative of travel behaviour and trends within the Central Ontario Zone as a whole, and serves as a good base for investigating the relationship between urban form and travel behaviour. In order to keep the terminology as simple as possible, this reduced COZ TTS-based study area will simply be referred to as the Central Ontario Zone or COZ whenever TTS data are presented.

Before 1996, the TTS study area consisted of the GTA (Toronto, Durham, York, Peel, and Halton) and what is now the amalgamated City of Hamilton (formerly the Region of Hamilton-Wentworth). Some of the analysis in this paper is based on data derived from these earlier surveys and so is restricted to this smaller region, which will be referred to as GTA+H in this paper. Again, although this area obviously excludes a considerable portion of the Central Ontario Zone, it still provides useful information, particularly given that much of the growth in the Central Ontario Zone has been (and continues to be) located within this region.

The relationship between travel demand and urban form

Once a land use pattern, as defined by the built urban form, is established, and once households and businesses make location choices within this built environment, then travel patterns tend to follow in a reasonably logical and predictable manner.

At an intuitive level, the relationship between urban form and travel demand is quite straightforward. Clearly, where people live, work, and shop is determined by where we build houses, offices, and stores. Similarly, most business establishments, such as stores, offices, or small manufacturers, locate within a built environment of available commercial floorspace of various types. Once the

2. Documentation on the TTS surveys and datasets is available from the Joint Program in Transportation, University of Toronto web site: www.jpint.utoronto.ca.

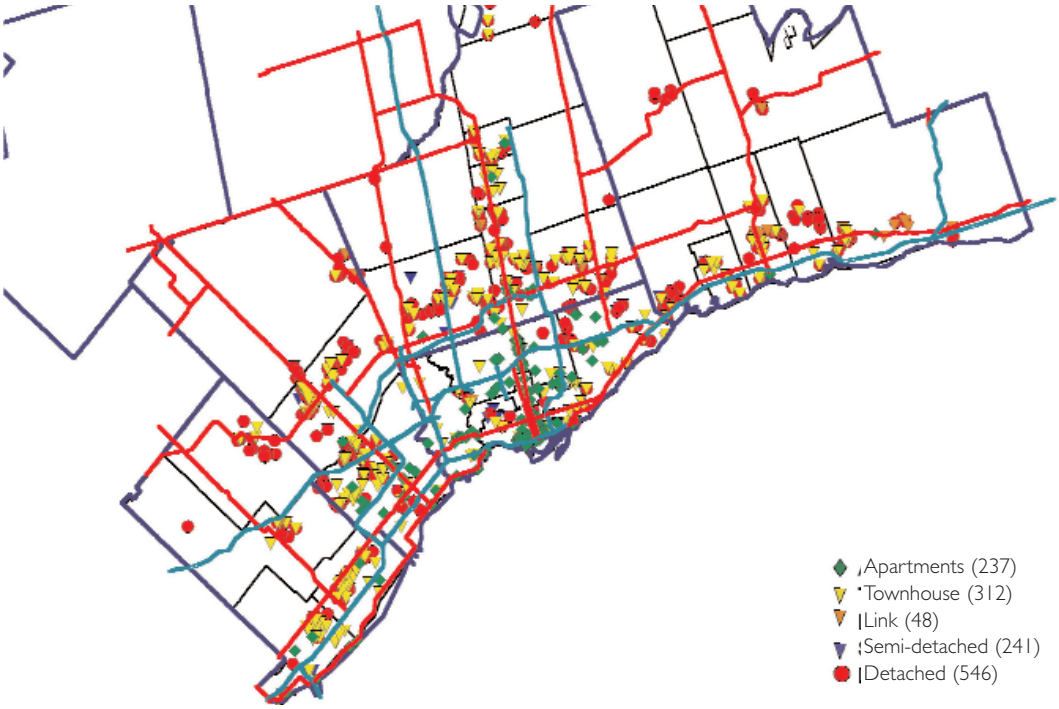


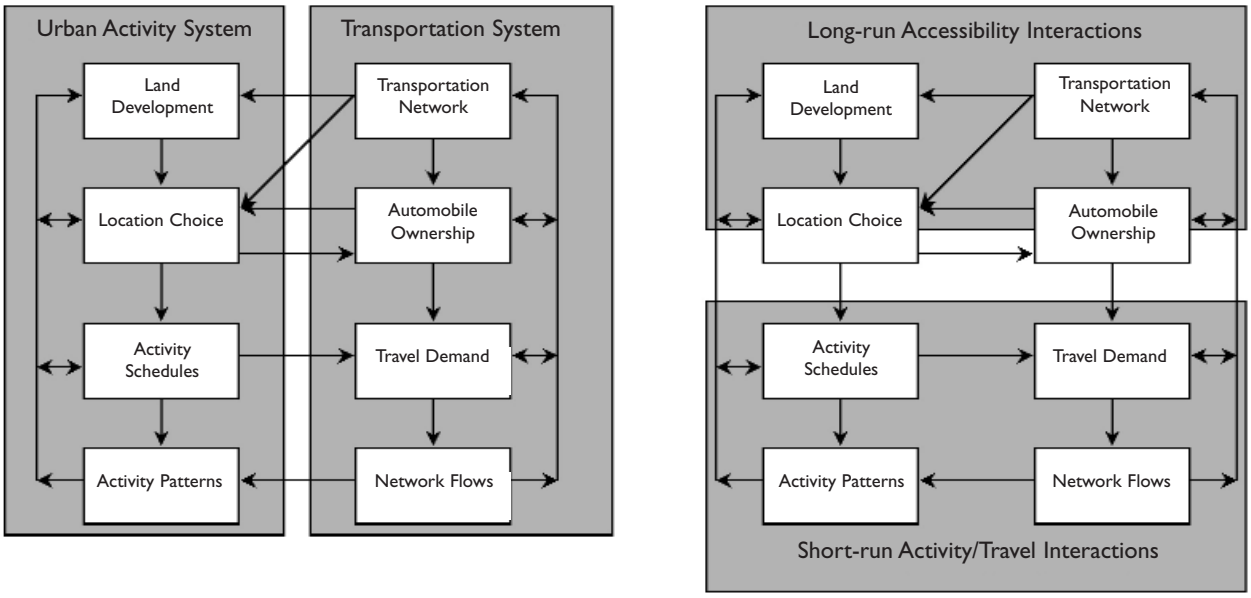
Figure 2.1 Relationship between New Housing Construction and Major Transportation Corridors Source: Haider (2002)

land use pattern, as defined by the built urban form, is established, and once households and businesses make location choices within this built environment, then travel patterns tend to follow in a reasonably logical and predictable manner. In addition, the types of transportation services that can cost-effectively serve these travel patterns is in large part determined by these travel patterns and the urban form which underlies and determines these patterns. Empirical evidence on the impact of urban form on travel behaviour (particularly travel mode choice) is presented in some detail later in this paper.

Accessibility is defined as the potential to travel conveniently and cost-effectively from a given point to other locations throughout the region.

The transportation system (both road and transit), in turn, can influence land development and location choices by providing different levels of **accessibility** at each point in the urban region, where accessibility is defined as the potential to travel conveniently and cost-effectively from a given point to activity locations throughout the region. For example, it is reasonable to expect that, all else being equal, households prefer to live in a neighbourhood that has high accessibility to well-paying jobs, good schools, attractive stores, parks, and other amenities. In the same way, businesses value accessibility to labour, other inputs (raw materials), and markets.

Figure 2.1 provides one example of the impact of transportation infrastructure on urban development patterns. In this figure, all new residential housing devel-



(a) The Urban Activity and Transportation Systems

(b) Systems Interactions

Figure 2.2 The Transportation- Land Use Interaction

opment projects of 10 units or more that were started between January 1997 and April 2001 within the GTA are plotted, along with major highways and rail lines. The impact of both road and transit facilities on decisions concerning where to locate new housing is quite evident in this map – most development has occurred close to one of these major transportation corridors.

A chicken-and-egg relationship

There is a the two-way, chicken-and-egg relationship between transportation and land use or urban form: competitive, high-quality transit can be provided cost-effectively only where land use patterns support such services, but such transit-supportive built forms can only be built if the appropriate transit service is provided.

Figure 2.2 summarizes the two-way, chicken-and-egg relationship between transportation and land use or urban form. [3] The challenge to urban planners and decision-makers is, first, to understand this interaction, and, second, to use that understanding to guide the evolution of the urban region in ways that meet societal goals as much as possible.

In particular, population and employment growth within any region clearly **must** translate into increased amounts of travel. One of the most important challenges to making this growth "smarter" is to do so in a way that:

3. Figure 2.2 may appear to focus on person travel, and this is true to the extent that auto ownership is explicitly included in the flowchart. With this exception, however, the figure holds equally well for businesses and the flows of good and services, and is intended to be interpreted in this extended manner.

1. minimizes the amount of additional travel that needs to be accommodated;
2. deals with travel growth in a way that minimizes increases in congestion, environmental damage, and other harmful effects.;
3. is as cost-effective as possible both to users of the transportation system and to society as a whole;
4. contributes to rather than compromises other societal goals such as economic growth or quality of life.

The private automobile is the dominant mode of travel in North America. In the COZ, for example, for 81% of the individual trips made during a typical weekday in 2001, the individual either drove or rode as a passenger in an automobile.

Not shown in **Figure 2.2,** but central to the entire urban transportation debate, are the relative roles played the various **modes** of transportation available within the transportation system, where a mode is defined by a specific combination of technology, infrastructure, and service characteristics. In particular, the private automobile (and the associated road system which provides the right of way for automobile use), public transit (in all its manifestations, including bus, rail and commuter rail "sub-modes"), and non-motorized (walk and bicycle) modes all play essential roles in serving the demand for personal travel in urban areas. Of these, the private automobile is the dominant mode of travel in North America. In the Central Ontario Zone, for example, for 81% of the individual trips made during a typical weekday in 2001, the individual either drove or rode as a passenger in an automobile.

The role of the automobile

The "appropriate" role of the automobile is the question facing transportation planners and decision-makers. On the one hand, the automobile represents mobility, but its adverse impacts include congestion, pollution, accidents, and excessive consumption of land.

Indeed, the "appropriate" role of the automobile is *the* question facing transportation planners and decision-makers. On one hand, the automobile has provided unprecedented mobility to the majority of North Americans and is by far and away the dominant means of social and economic interaction throughout North America. At the same time, automobile use generates a wide variety of adverse impacts, including:

- congestion (and associated stress and productivity losses);
- pollution (smog, particulates, other health-related hazards);
- greenhouse gas emissions (and their contribution to global warming/climate change);
- accidents (fatalities; personal injuries; property damage);
- "excessive" consumption of land (discussed below).

Historically, we have tolerated these adverse impacts for a variety of reasons, but mainly because:

- they were perceived to be small relative to the benefits obtained (for example, congestion historically was perceived as being within tolerable limits);
- the impacts were not well understood (for example, our awareness of the true costs of pollution and greenhouse gas emissions has grown over the years);
- we have more or less mindlessly chosen to ignore adverse impacts (for example, the death toll attributed to automobile accidents [4]).

The drawbacks of overdependence on the automobile are becoming increasingly apparent and increasingly onerous as our urbanized areas have grown. Most informed observers of urban trends question the environmental, social, and economic sustainability of our current urban form and its associated automobile-based transportation system.

The drawbacks of overdependence on the automobile, however, are becoming increasingly apparent and increasingly onerous as our urbanized areas have grown in size and population, to the point at which most informed observers of urban trends seriously question the environmental, social, and economic sustainability of our current urban form and its associated automobile-based transportation system. Indeed, the existence and mandate of the Central Ontario Smart Growth Panel is in no small part motivated by this very issue.

Smart growth and the automobile

The remainder of this paper makes the explicit assumption that a reduction in auto dependency is integral to any smart growth policy. This does not imply an anti-automobile approach, but rather one that accepts that "taming the automobile" is essential. Automobile use will clearly continue under any feasible vision of the future. In particular, local, short-distance trips (such as going to the grocery store, taking a child to the hockey arena or soccer field, short work commutes) are not, in many cases, overly problematical either with respect to congestion or environmental impact, since such trips are often not highway-based, often occur in non-peak times, and often involve multiple vehicle occupants (in which case, the energy efficiency and pollution per passenger-km are both relatively reasonable for modern cars).

At the same time, however, it must be recognized that overall auto usage in our urban areas is becoming pathological in terms of the ever-growing negative

4. More than 3,000 deaths occur each year on Canadian roads. It is inconceivable that we would tolerate this level of carnage from any other piece of technology and yet we do so from automobiles virtually without comment.

impacts. Experience within the Central Ontario Zone and elsewhere throughout the world shows that we cannot build our way out of these problems. In other words, more roads simply lead to more sprawl and more congestion. [5] Thus, alternatives to current modes of travel behaviour and urban development simply must be adopted. Inevitably, the alternative modes of travel consist of transit, non-motorized trip-making, and/or making fewer, shorter trips. Achieving this shift in travel behaviour will require significant changes in how we continue to develop our urban areas in the years to come.

We cannot build our way out of these problems. In other words, more roads simply lead to more sprawl and more congestion.

Moving goods and delivering services

Similar issues exist for the movement of goods and the delivery of services, although the modal options available are generally much more limited. Trucks, ranging from light vans up to large tractor-trailers, dominate goods movements within, to, from, and through the Central Ontario Zone. Rail still plays an important role in the movement of certain commodities between the Central Ontario Zone and other economic regions in North America, but historically rail has been losing market share to trucks for a variety of reasons, and today trucks tend to carry more heavy goods over longer distances. Ships are also important for a few industries, such as bringing raw materials to and taking products away from the Hamilton steel mills. In terms of the issues discussed in this paper, however, trucks and vans clearly dominate this sector, and, more often than not, represent the only feasible means of moving goods or delivering services.

The alternatives to overdependence on the automobile consist of using transit or non-motorized forms of transportation and/or making fewer, shorter trips.

The economic benefits of the efficient movement of goods throughout the Central Ontario Zone are well understood. The extent to which congestion interferes with these movements represents a direct economic loss to the Central Ontario Zone, and/or loss in economic competitiveness with respect to other North American regions. At the same time, of course, trucks contribute to roadway congestion, atmospheric pollution, and greenhouse gas emissions. They also contribute significantly to the overall safety or danger of our roads.

Trucks, ranging from light vans up to large tractor-trailers, dominate goods movements within, to, from, and through the COZ. The extent to which congestion interferes with these movements represents a direct economic loss to the COZ, although at the same time, trucks contribute to congestion.

Two sides of the same coin

The key message of Figure 2.2 is that, in considering growth policies for the Central Ontario Zone, one cannot focus on either the land-development

5. This is not to say that a new road or highway should never be built. It simply means that a transportation policy that focuses exclusively or even predominantly on road-building to solve transportation congestion is doomed to failure.

process or the transportation system in isolation from one another. If land development occurs without consideration for its implications for the demand and supply of transportation services, we may develop in a way that locks us into a transportation system with fewer benefits and greater economic, social, and environmental costs. At the same time, transportation-based solutions to problems of congestion or environmental degradation may be ineffective or infeasible in the absence of a land-development pattern and process that supports these transportation alternatives.

Over the last two or so decades in the COZ, little attention has been paid to the realities and ramifications of the transportation–land use interaction in the way the region has been allowed to develop and grow.

Unfortunately, it can be argued that over the last two decades or more in the Central Ontario Zone, little effective, practical attention has been paid to the realities and ramifications of the transportation–land use interaction in the way the region has been allowed to develop and grow. Development has generally occurred in ways that have directly exacerbated, rather than ameliorated, transportation-related problems of congestion and pollution, despite brave words in most municipalities' official plans and other planning documents concerning "sustainable development" and "smart growth." That is, although most municipalities have explicit policies that support sustainable, smart growth, actual development patterns, in too many cases, are not consistent with these policies.

Although most municipalities have explicit policies that support sustainable, smart growth, actual development patterns, in many cases, are not consistent with these policies.

This lack of regard for (or, at least, effective dealing with) transportation–land use interactions has manifested itself in a variety of forms, the most important of which include:

1. A development approval process that has permitted the proliferation of both housing and commercial developments in a dispersed and uncoordinated pattern that is extremely difficult to serve in any attractive, cost-effective way by transit and hence requires those who live and work in the developments to depend on automobiles for transportation. Transportation costs (in terms of congestion, pollution, greenhouse gas emissions, and accidents) have not been considered in any practical, effective way in the approval process.

The lack of regard for transportation–land use interaction manifests itself in a development approval process that allows dispersed, piecemeal development, an unquestioning acceptance of automobile-based urban design, and an inability to think creatively about improving the sustainability of the transportation system.

2. A largely unquestioning acceptance of road- and automobile-based urban design, both at the macro level of selecting sites for development and at the micro level of the layout and land use mix of residential neighbourhood and employment centres. Although municipal policies often strongly support developing transit-friendly environments, mechanisms for accomplishing this are rarely spelled out. As a result, the design and location of residential subdivisions, office parks, and other commercial establishments

typically turn out very auto-oriented.

3. Difficulty in thinking creatively about new means by which social (quality of life) and economic objectives associated with land development and regional growth can be met while improving the sustainability of the transportation system and its use. Again, presumably a major motivation for bringing Central Ontario Zone municipalities together within the Smart Growth Panel is to address this issue in a more constructive and effective manner than has generally been possible to achieve individually over the recent past.

These issues will be explored further in this report. First, we provide some empirical evidence on recent trends in travel behaviour within the Central Ontario Zone and their linkages with regional structure and development trends. The remainder of the report deals with policy options and issues that might address some of the concerns raised above and that might contribute towards a transportation-related smart growth plan for the region.

Trends in urban travel demand and their links to regional structure

In this section we consider recent empirical evidence for the Central Ontario Zone that illustrates in greater detail the travel demand–regional structure interaction discussed in general terms in the previous section. The focus of the discussion in this section is on trends in person travel. This focus reflects both the greater availability of data for person travel relative to what is available for goods movements, as well as a sense that, perhaps, urban form may have a greater direct impact on person travel than it does on goods movements. Section 4 below, however deals briefly with goods movements and their links to regional structure.

The competitiveness of public transportation relative to the private automobile depends on the relative travel time, convenience, and cost for the entire door-to-door trip. These factors in turn are influenced by transit route configuration, service levels, and fares, as well as the degree of integration among various transit providers.

In aggregate, person travel demand is influenced primarily by:

- socioeconomic and demographic characteristics (including, notably, auto ownership levels);
- the distribution of population and employment;
- development densities for both residential and commercial areas;
- work trip patterns;

- the network of road and transit facilities and services available.

In terms of modal choice, the competitiveness of public transportation relative to the private automobile depends primarily on the relative travel time, convenience, and cost for the entire door-to-door trip as influenced by transit route configuration, service levels, and fares, as well as the degree of integration (or "seamlessness") among various service providers. In much of the Central Ontario Zone (especially outside the GTA), current transit service, if it exists at all, typically is not competitive in terms of door-to-door travel time with the private automobile, and may also be more expensive on a perceived out-of-pocket cost basis as well [6], at least for trips that are not commuter trips into the Toronto central area.

The ability to provide cost-effective public transportation services that might compete with the private automobile depends primarily upon the travel patterns to be served – the general pattern of origins and destinations being the determining characteristic. Travel patterns are strongly influenced by land use, automobile ownership, demographic characteristics such as age and income, and by the spatial and service characteristics of the transit network itself, all of which are highly interrelated. Other factors, including pricing and special regulations such as priority treatment for transit vehicles, also influence transit attractiveness and effectiveness.

The number of people using transit depends on the level of service the transit system can provide relative to the auto option, but this level of service depends upon attracting sufficient patronage to make the service cost-effective.

Thus, a classic supply-demand relationship exists in which the number of people using transit depends on the level of service which the transit system can provide relative to the auto option, but this level of service depends upon attracting sufficient patronage to make the service cost-effective. Land use and urban form primarily determine the outcome of this supply-demand interaction by determining the spatial pattern and concentration of travel flows and, hence, the suitability of transit for serving these flows.

In 2001, 28% of all work and school trips with a straight-line distance of 5 km or less in the COZ were made by walking or cycling..

Non-motorized modes of travel (walking, bicycling) are also important for short trips: 28% of all 2001 work and school trips with a straight-line distance of 5 km or less in the Central Ontario Zone were made by walking or cycling.[7]

6. Automobiles are expensive to own and maintain (Miller, et al., 2002). The perceived cost of making an individual trip by car, however, is generally quite small, particularly if parking at the non-home end of the trip is free. One estimate of the perceived cost of auto travel which has been used to model mode choice behaviour in the GTA is 6.5 cents/km (1996 dollars) (Miller, 2001). In 1996 the average adult TTC fare was $1.71, however, which means that an individual would have to travel 26 km before the perceived cost of the trip by car within the TTC service area equalled the transit fare, in the absence of parking charges.

The benefits associated with such trips are considerable in terms of personal health, the lack of negative environmental impacts, reductions in the load on road and transit systems, and travel cost savings, while the societal costs associated with non-motorized travel are often negligible.[8]

For non-motorized modes to be an effective alternative to motorized travel requires (a) a land use pattern in which a mixture of activities co-exist within reasonable walking or cycling distances **and** (b) a micro-level neighbourhood street and building design that facilitates and encourages walking and cycling. These two prerequisites may exist at virtually any level of urbanization, from the small town or village right up to the densest urban centre.

For walking and cycling to be effective alternatives to motorized travel requires (a) a land use pattern in which a mix of activities (housing, shops, schools, etc.) co-exist within reasonable walking or cycling distances and (b) neighbourhood street and building design that facilitates and encourages walking and cycling.

A number of recent studies have documented current person travel demand patterns and trends in the Central Ontario Zone (or portions of it, such as the GTA or the GTA+H) and their implications for congestion, pollution, and greenhouse gas emissions. A selected bibliography of these studies can be found at the end of this paper. In the remainder of this section, we summarize the findings from these more detailed studies, with an emphasis on their implications for the transportation–land use interaction and for the formulation and implementation of smart growth policies.

Central Ontario Zone travel behaviour, 1996-2001

This section presents information on current travel patterns, as defined in the 2001 TTS, and recent trends in this behaviour over the period 1996 to 2001 in the reduced COZ study area.[9] In this analysis, the overall COZ study area is divided into 10 super-zones, shown in **Figure 3.1**. To supplement the trends discussed in this section, **Appendix II** contains comparable figures extracted from Miller and Shalaby (2000) who undertook a similar, but more extensive, analysis of longer-term trends in the GTA+H for the 1964-96 period.[10]

7. One weakness of the TTS is that travel on foot is documented only for trips to work and school. Comparable statistics for non-work/school travel cannot be reported.

8. Safety concerns, especially about using bicycles in mixed traffic streets, exist. Also, retrofitting bicycle lanes within an existing street system, or improving the "walkability" of a previously developed neighbourhood, clearly involves some capital costs.

9. The 2001 TTS data were released in "preliminary" form on October 31, 2002. Thus very little time has been available to analyse the 2001 data. What is presented in this paper represents a first cut at this analysis. Also, some statistics may change slightly once a final version of the database is eventually released.

10. Before 1996 the TTS survey area did not extend beyond the GTA+H. The 1964 data are obtained from the 1964 MTARTS study (see Miller and Shalaby, 2000).

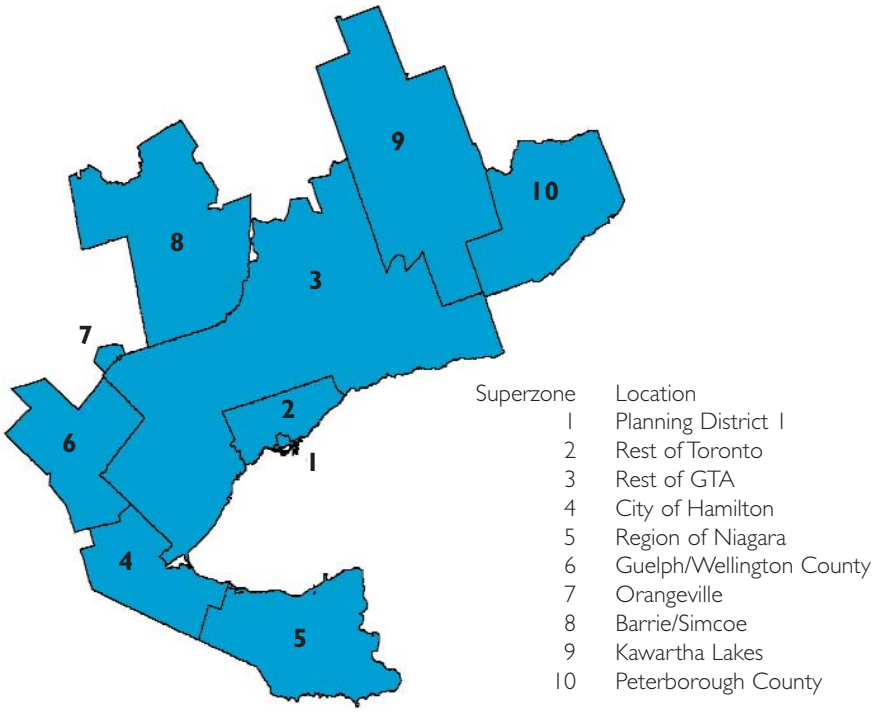


Figure 3.1 10 Super-zones in the COZ Study Area

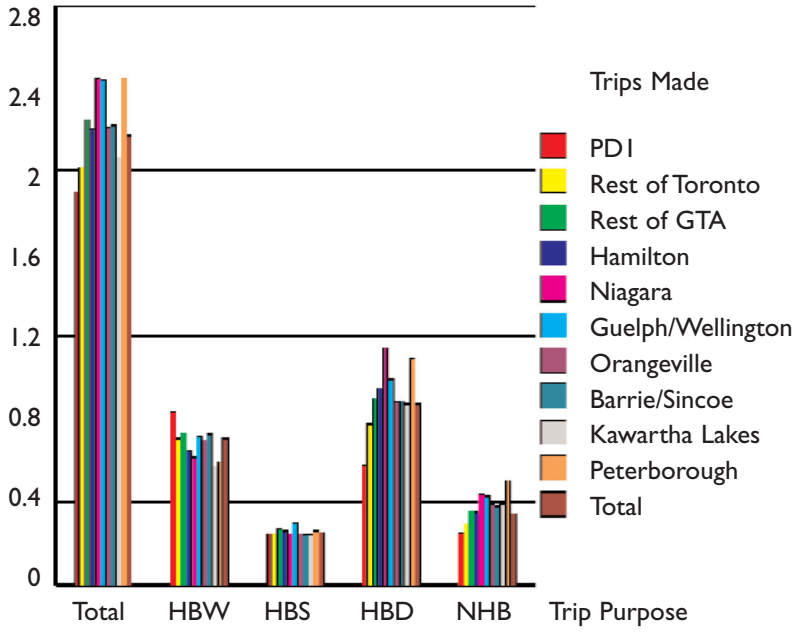


Figure 3.2 Average Person Trips/ COZ, 2001

The average number of trips made per day per person in the Central Ontario Zone is 2.17, according to the 2001 Transportation Tomorrow Survey. This number is probably too low, because (a) it does not include trips made by walking to destinations other than work or school, (b) the total number of trips is averaged over the entire population, including children, and (c) survey respondents often forget to mention some trips.

Figure 3.2 shows the average number of weekday trips per person by trip purpose and zone of trip-maker residence.[11]

11. In this and subsequent exhibits, the trip purpose definitions are as follows: HBx: a home-based trip for purpose x, where a home-based trip is one which either begins or ends at home; x =W other end of the trip is work; x = S: other end of the trip is school; x= D: other end of the trip is a discretionary activity other than work or school; NHB: a trip that does not have home as either one of its ends.

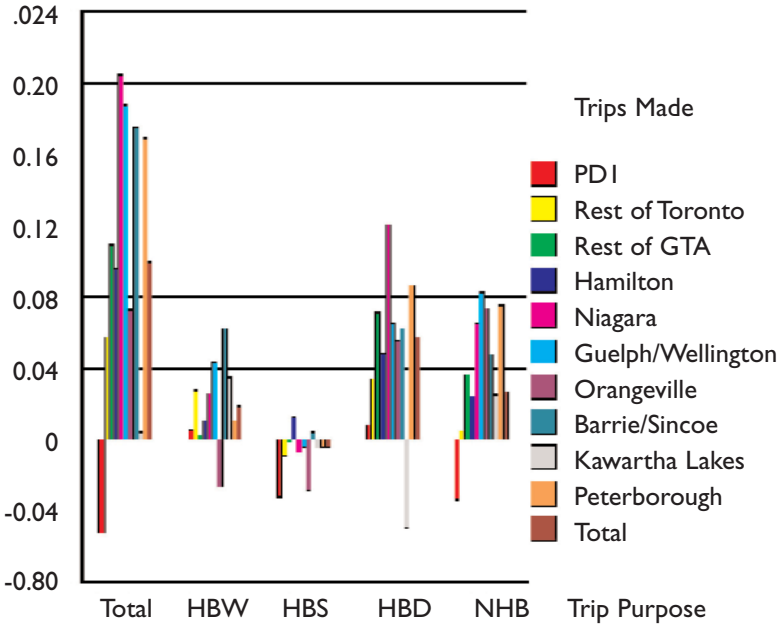


Figure 3.3 Change in Daily Person Trips COZ 1995-2001

As shown in **Figure 3.2**, outside the City of Toronto, total daily person trip rates vary over a relatively narrow band of a low of 2.07 (in Kawartha Lakes) to a high of 2.45 (in Peterborough) trips per day.[12] The COZ-wide average daily trip rate is 2.17 trips/person. The much lower daily trip rates reported for City of Toronto residents (and, in particular, Planning District 1 residents) almost certainly reflects missing walk trips for non-work/school trips (which are not collected in TTS), since home-based-work and home-based-school trips rates for Toronto are comparable to those for other areas, and there is no reason to believe that Toronto residents are inherently less mobile than other Central Ontario Zone residents. If this hypothesis is correct, then if one were to account for these missing walk trips, the non-Toronto COZ average daily rate of 2.27 trips would probably be more representative of overall COZ daily trip-making.

Over the last few decades, the number of trips made per person per day has steadily increased because of smaller household sizes, the tendency to drive children to school, land use patterns that require more automobile travel, and increased levels of activity related to work and leisure. Most of the increase represents automobile trips.

Figure 3.3 shows the changes in daily person trip rates by trip purpose between 1996 and 2001. With the exception of residents of Planning District 1, per-person trip rates have increased over the past five years across the Central Ontario Zone by 0.10 trips/day. This represents a continuation of a longer-term trend for the GTA+H, where rates increased by 0.05 trips/day between 1986 and

12. A daily trip rate of only 2 to 2.5 trips per person may sound low. Note, however, that this rate is averaged over all persons, including children under 11 years of age for whom trip information is not collected. Also TTS does experience some under-reporting of non-home-based trips that people simply forget to report in the survey.

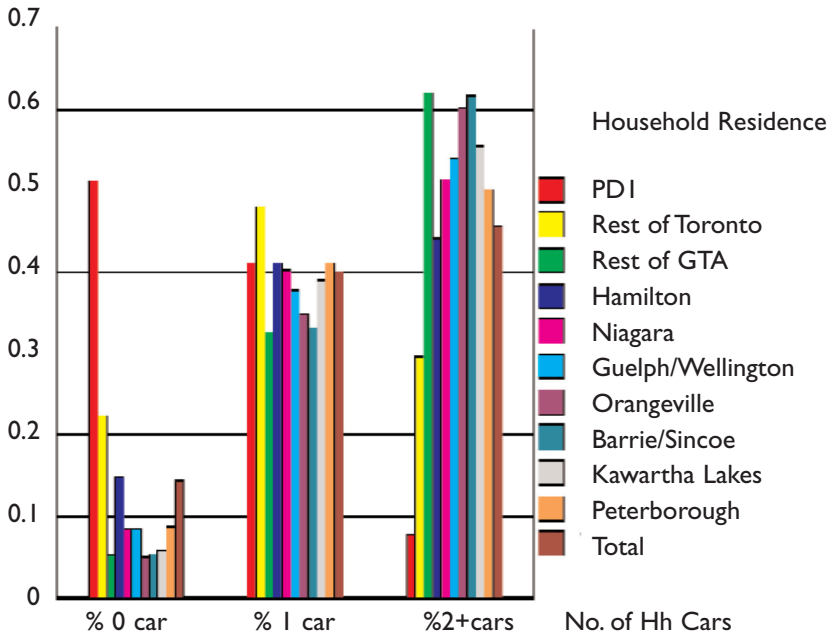


Figure 3.4 Household Auto Ownership COZ 2001

1996 and by 0.55 trips/day between 1964 and 1996 (**Figure II.1, Appendix II**). As in the earlier time periods, this growth in trip-making is largely due to an increase in trips that do not represent commuting to or from work or school and that often occur outside the traditional morning and afternoon peak periods.

Factors contributing towards increased average daily trips per person may include:

- smaller household sizes, without, perhaps, a commensurate reduction in household travel requirements (for example, someone still needs to shop for each household);
- an increased propensity to drive children to school rather than let them walk, bicycle, or take a bus;
- land development patterns that emphasize segregation of land uses and so require more (motorized) travel to execute a given activity pattern;
- increased personal activity levels due to increased work-related activities, increased leisure activities, or both.

Automobile ownership levels have also increased, from an average of 1.38 vehicles per household in 1996 to 1.44 vehicles per household in 2001.

Figure 3.4 shows the distribution of COZ household auto ownership levels (no car, one car, two or more cars) by household zone of residence. Only 14% of Central Ontario Zone households do not have access to a vehicle for personal

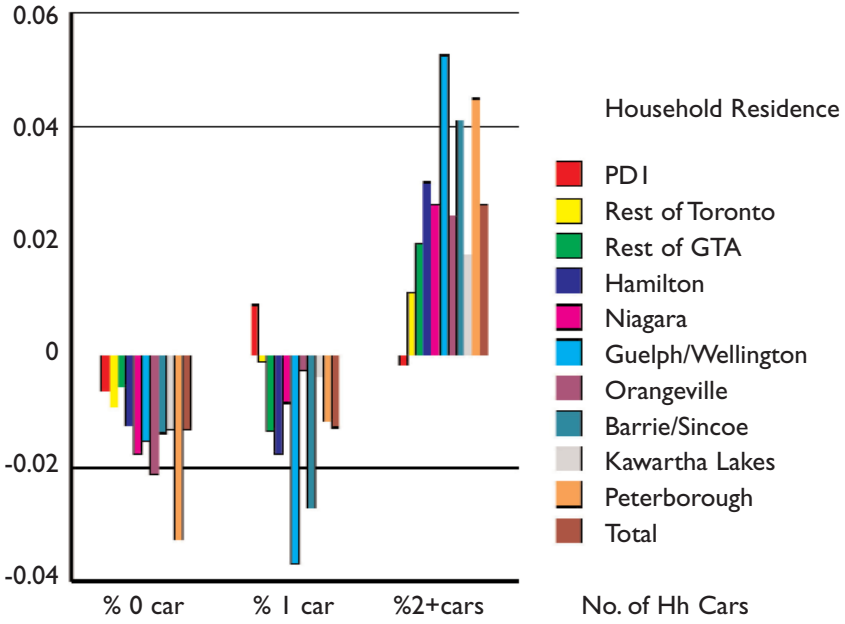


Figure 3.5 Change Household Auto Ownership COZ 1996 - 2001

use, while 46% have two or more cars. Of the households that do not have a car, 70% live within the City of Toronto.

Figure 3.5 documents the changes in auto ownership levels, 1996 to 2001. Households with no vehicles have declined on a percentage basis across the COZ (including downtown Toronto), while households with two or more cars have increased everywhere except Planning District 1 (where the percentage of one-car households increased). The result is a 4% increase in average auto ownership level over this five-year time period, from 1.38 to 1.44 vehicles per household. This, again, represents a continuation of a longer-term trend in increasing auto ownership levels (see **Figure II.2, Appendix II**).[13]

Between 1996 and 2001, the average number of trips made by driving a car increased while those made by transit, by riding as a passenger in a car, or by some other form of transportation all decreased. This trend reflects increased automobile ownership levels, a greater number of trips made outside peak periods, increased use of automobiles by women, and cutbacks in transit.

The growth in daily person trip rates discussed above translates into changes in average daily trips by mode as shown in **Figure 3.6**. As is evident from this figure, the growth in trips per person between 1996 and 2001 has occurred almost entirely through increased auto-drive trips per day. Trip rates for all other modes of travel exhibit only very small growth in a handful of cases (most notably, both auto-passenger and transit trips per person have increased slightly for GTA residents outside the City of Toronto), and more generally show no growth or else a small decline. As shown in **Figure 3.7**, this results in an across-

13. The 1991-1996 period actually saw a slight decline in average GTA+H household auto ownership levels (Figure II.2, Appendix II), undoubtedly due to the serious recession of the early 1990's. Analysis undertaken by Roorda, et al. (2000) indicates that household vehicle replacements/additions slowed down significantly during the 1990-1995 period.

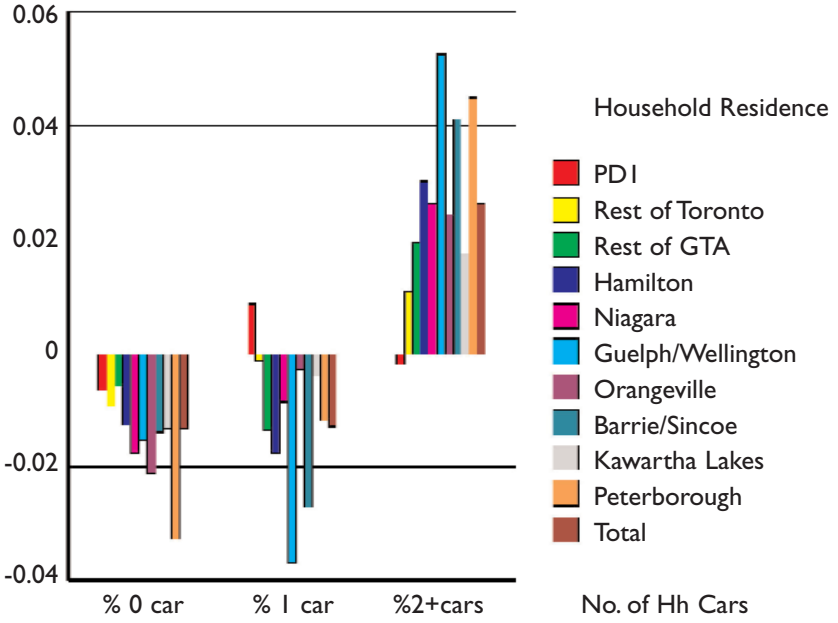


Figure 3.6 Change in Household Auto Ownership COZ 1996 - 2001

the-board increase in auto-drive mode shares (+1.5% overall for the COZ), with a corresponding universal decrease in mode shares for all other modes of travel (COZ-wide: -0.4% for auto-passenger, -0.8% for transit, -0.3% for non-motorized modes), with the single exception of extremely small increases in mode shares for transit and non-motorized modes for Planning District 1 residents. Again this trend is consistent with longer-term trends within the GTA+H (see **Figure II.3, Appendix II**).

Factors affecting this growth in auto mode splits include:

- a majority of the population and employment growth has occurred in auto-oriented suburban areas (discussed further below);
- increased household auto ownership levels (discussed above);
- la majority of trips occur outside peak periods and are made for non-work purposes, and so are more difficult to serve by transit;
- increased auto use by women (which, in turn, reflects long-term trends in female labour force participation rates, driver's licence possession rates and so forth);[14]
- reductions in transit service levels due to budget cuts.

14. See Miller and Shalaby (2000) for a more detailed discussion both of non-work, non-peak travel and of the evolution of female travel behaviour.

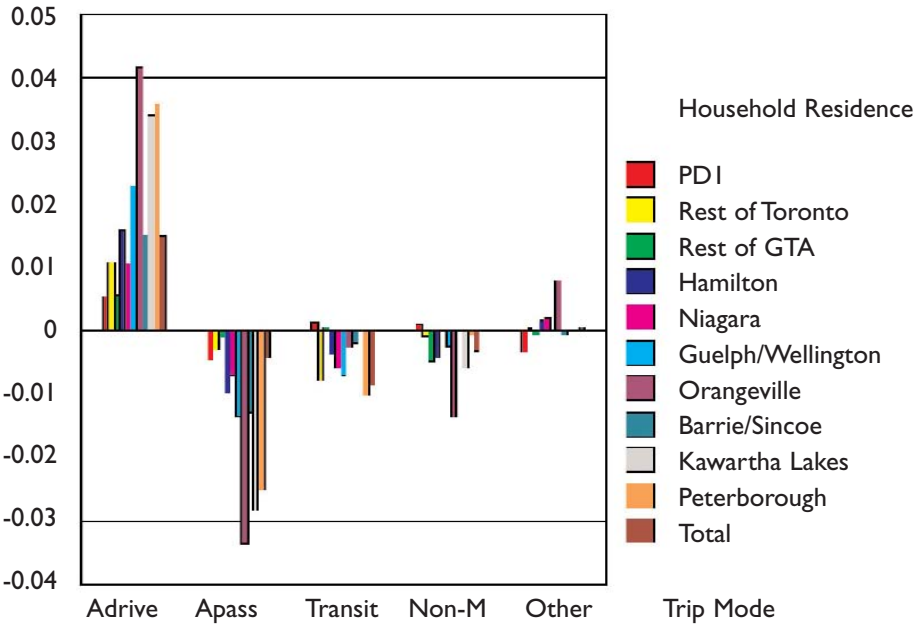


Figure 3.7 Change in Mode COZ 1996 - 2001

In recent years, because of a lack of operating support from senior levels of government, transit agencies in the Central Ontario Zone have been forced to cut service in many instances. As a result, the TTC and GO Transit are undoubtedly the most efficient transit agencies in North America in terms of operating cost-recovery ratios,[15] but this achievement has come at the expense at some loss in ridership, especially in the case of the TTC.

Equally important has been the inability over the past two decades to expand the transit system to keep pace with development. This is, for example, generally the case with GO Transit, which has historically been "supply constrained" – that is, the GO system could carry more riders if it had the capacity (including parking capacity at suburban stations) to do so.

The transit system has not expanded to keep pace with growth. The GO and TTC systems could carry more passengers if their capacities were increased.

A similar case can certainly be made for the TTC. In an examination of long-term GTA trends in work trip mode choice between 1964 and 1986, Badoe (1994) hypothesized that the significant increases in transit infrastructure that occurred during the 1960s and 1970s, including subway expansions and the introduction of GO Transit services, were able to keep transit work trip mode shares relatively constant over this period, despite significant suburbanization and growth in auto ownership.

15. This is not to say that these agencies were ever inefficient. Under the pre-1998 operating subsidy policies, the TTC recovered 67% of its operating costs, which was the highest level of any North American transit agency. Both the TTC and GO Transit now recover more than 80% of their operating costs through the fare box.

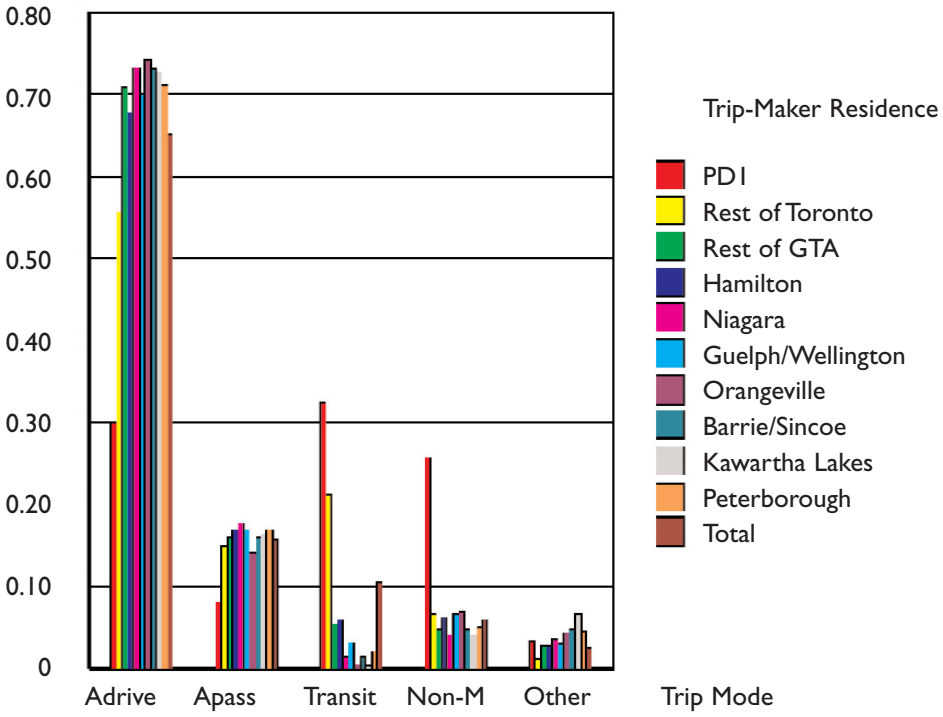


Figure 3.8 Trip Mode Shares, All Trips COZ 2001

Figure 3.8 shows the net effect of all these changes on 2001 COZ modal shares. Auto-drive is clearly the dominant mode of travel: 56-74% of all trips taken by residents outside Planning District 1 are made this way. Auto-passenger is also significant: 14-18% of trips by non-PD1 residents are made as a passenger in a car, and auto-passenger trips exceed the number of trips by transit and non-motorized means combined everywhere except the City of Toronto. Across the region, the automobile mode (drivers plus passengers) accounts for 81% of all weekday trips.

The number of trips made by automobile in the COZ has increased faster than the growth in the population.

Clearly, when an urban region grows in population and employment, as the Central Ontario Zone has, increased levels of travel will occur. This increase has been exacerbated, however, by increasing numbers of daily trips per person, increasing household auto ownership levels, and the increasing mode share for auto-drive. As a result, automobile trips in the Central Ontario Zone (and the associated congestion and pollution caused by these trips) have increased more than the growth of the population. **Figure 3.9** shows that total daily trips and daily auto-drive trips by Central Ontario Zone residents have increased faster than the population between 1996 and 2001. The greatest gaps between population and trip growth rates have generally occurred outside the GTA+H. Further, the growth rate for auto-drive trips exceeds the total trip growth rate everywhere except in Planning District 1.

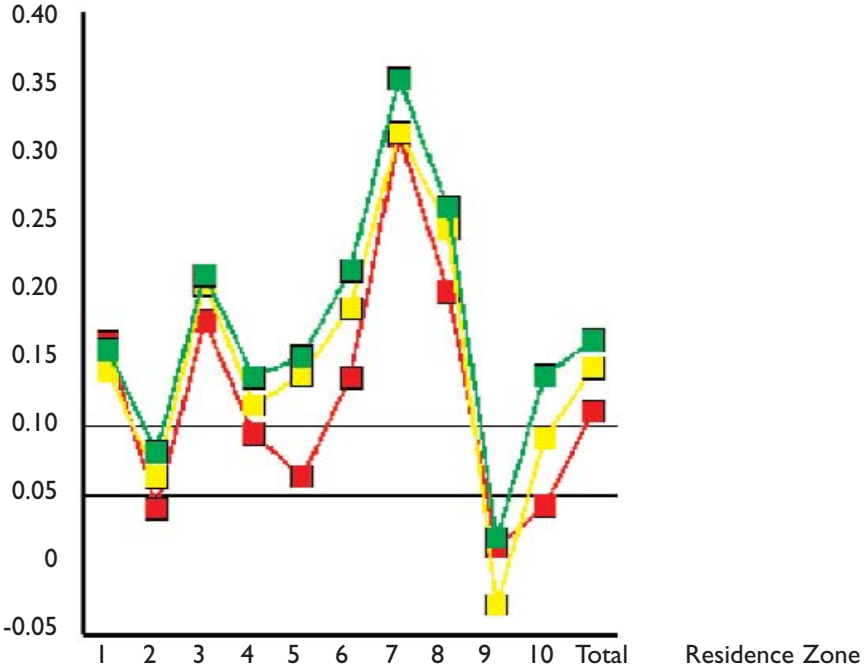


Figure 3.9 Growth in Travel vs. Population COZ 1996-2001

These figures support the assertion that current planning practice in the Central Ontario Zone has not been transit-supportive, despite policy statements to the contrary. Auto-passenger trips (including those made by ridesharing or car-pooling) and non-motorized trips (walking or cycling) have lost modal share to the auto-drive mode over the past five years. Many factors underlie this trend, including demographic and socioeconomic trends[16] and shortfalls in operating and capital support for alternatives to automobile travel.

Travel behaviour and urban form

These trends indicate that current planning practice in the COZ has not been transit-supportive, despite policy statements to the contrary.

It is difficult to identify the extent to which the increase in travel in general and automobile trips in particular can be attributed to the way in which urban form has evolved within the Central Ontario Zone, given the complexity of the processes involved. As **Figure 3.10** shows, all areas experienced considerable growth between 1996 and 2001 in households, population, employment, employed labour force (ELF), and trip-making. Very high growth rates occurred in Guelph/Wellington, Orangeville, and Barrie/Simcoe. Both down-

16. These have not been explored in detail in this paper, but are discussed in other studies, such as Miller and Shalaby (2000). Briefly, the aging of the baby boom generation and rising affluence in the COZ both tend to encourage automobile use and decrease transit use. Increasing labour force participation and "motorization" (i.e., possession of a driver's licence and access to a vehicle) among women also play a significant role in these trends.

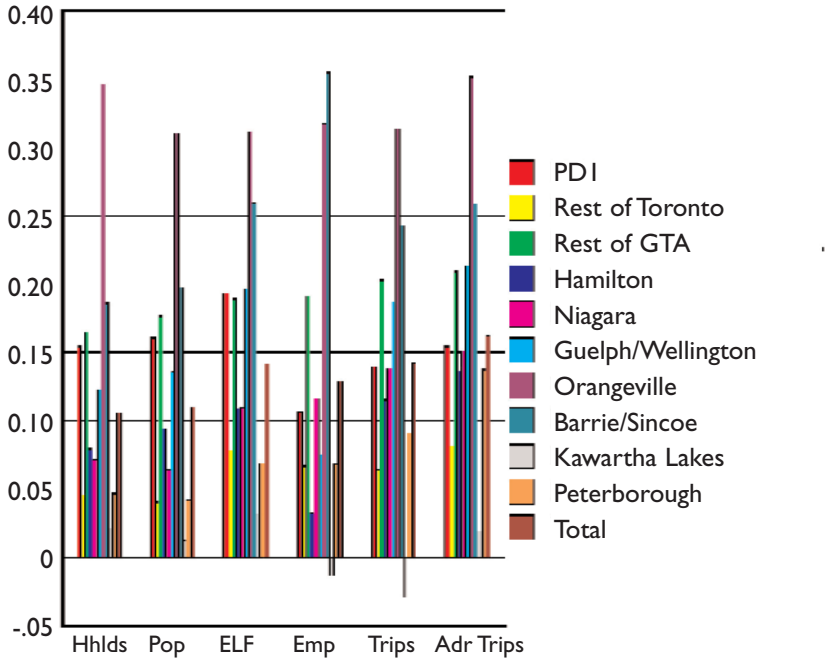


Figure 3.10 % Change in Key Statistics COZ 1996-2001

town Toronto and the GTA outside the City of Toronto also exhibited above-average growth rates for population and households, and, in the non-Toronto GTA, employment as well.

Between 1996 and 2001, about three-quarters of the growth in population and employment, two factors that generate increased levels of travel by individuals, occurred outside Toronto and Hamlilton, the two largest and most transit-oriented cities in the COZ.

In absolute terms, as shown in **Figure 3.11**, most growth in the Central Ontario Zone during this period occurred in the GTA outside Toronto (61% of the population growth; 56% of the employment growth; 58% of growth in resident-generated travel); 76% of total population growth and 73% of total employment growth occurred outside the cities of Toronto and Hamilton – that is, about three-quarters of the growth in the generators of person travel (population and employment) occurred outside the two largest and most transit-oriented cities in the Central Ontario Zone. Given the dominance of the automobile outside these cities, it is not surprising that auto-based travel (and associated road congestion) has grown considerably in recent years.

On a typical weekday, individuals make 14 million trips within the Central Ontario Zone, of which about 75% occur within the Greater Toronto Area.

Appendix III contains information on the net effect of Central Ontario Zone population and employment growth and distribution on person travel origin-destination flows in the region. Just under 14 million trips occur within the Central Ontario Zone on a typical weekday, which represents a 16.6% increase relative to 1996. Of these trips, 75% have both their origin and destination within the GTA, and another 3% involve a GTA origin or destination. The City

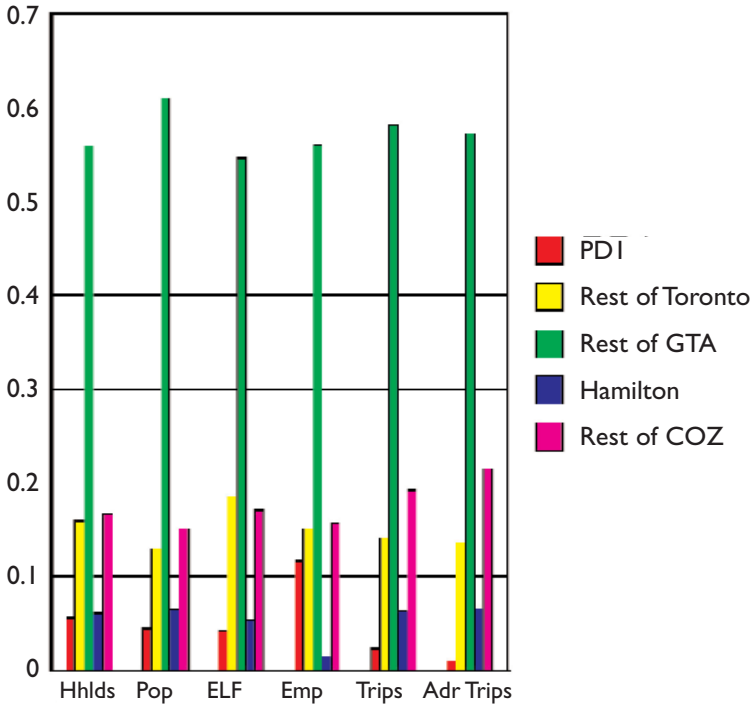


Figure 3.11 % of COZ Growth, Key Statistics COZ 1996-2001

of Toronto is the destination for 37% of all trips in the Central Ontario Zone (5.2 million a day) while the remainder of the GTA is the destination for 39.5% of all trips (5.5 million a day). Of the remaining 22% of trips that lie wholly outside the GTA, about half have their origin and destination within the same region, and the other half involve a trip between two different regions.

Guelph/Wellington, Orangeville, and Barrie/Simcoe all exhibited very high growth rates as both an origin and destination of trips. The non-Toronto GTA also had an above-average rate of growth on both an origin and destination basis and accounted for nearly half (49.5%) of the total growth in trips. Planning District 1 also experienced above-average growth for trips to and from most regions outside the City of Toronto.

The three forms of development – urban infill, expansion at the edge of the urban area, and leapfrog development – have different effects on road congestion and the environment. Leapfrog development has the greatest impact, because such development is very difficult to serve with transit.

Population and employment growth in a region occur in three main ways:

- infill or densification of the existing urbanized area;
- incremental growth at the periphery of the urbanized area (resulting in contiguous expansion of the urban boundary);
- leapfrogging beyond the urban fringe to create pockets of development

that are not directly connected to previously urbanized regions, leaving undeveloped portions of land separating these pockets from the urban boundary.

Although some infilling has occurred in recent years, especially in the Toronto Central Area, most growth for some time has occurred in the latter two ways. In general, the impact on roadway congestion and environmental degradation is greater for urban boundary expansion than for infill and greater still for leapfrog development patterns, since the potential to serve the resulting travel patterns by transit (or by non-motorized modes) declines consistently and dramatically.

Figures II.4, **II.5**, and **II.6** in **Appendix II** illustrate this assertion. **Figures II.4** and **II.5** show 1996 daily mode shares for transit and GO Rail, respectively for the GTA+H by trip origin zone. Transit usage clearly declines dramatically as one moves away from central city locations and major rail corridors. **Figure II.6** displays the estimated average CO2 emissions per household within the GTA+H in 1996 by the home traffic zone of trip-maker. That is, the CO2 generated by a given auto-drive trip is attributed to the driver's zone of residence, regardless of where the given trip occurs.[17] The increase in CO2 emissions as one's residential location moves away from the urban centres is clearly evident in this map.

The average emissions per household of carbon dioxide, a greenhouse gas, are consistently higher for households living further from urban centres.

In order to explore the relationship between travel demand and urban form in greater detail, **Appendix IV** presents an analysis of 1986 and 1996 TTS data for the GTA+H.[18] In this analysis, "trip density" is used as a simple surrogate measure of level of urbanization, where a zone's trip density is simply the total number of trip ends (that is, trip origins plus trip destinations) observed to occur within the zone over a 24-hour weekday period, divided by the zone's gross area. As is discussed in detail in Miller *et al*. (1990a), trip density provides a useful single index of the level of urban activity, or urbanization, in a zone, since it integrates both population and employment effects. That is, as either population or employment (or both) increases in a zone, so does the trip density. In particular, the 1990 study identified six classes or levels of urbanization which correlate well with specific ranges in trip density. These classes are

Transit use is higher in denser, more urbanized areas. Most of the growth in automobile travel – and in trips by all modes – has occurred in suburban and rural areas.

17. See Miller and Lee (2002) for further discussion of this analysis.

18. Given the very recent availability of the 2001 data, it was not possible to update this analysis to include 1996-2001 trends for the COZ as a whole. The conclusions drawn from this analysis of the GTA+H, however, generalize to the COZ as a whole.

defined in **Appendix IV**. Note that, while this is called an "urbanization" categorization, it includes rural and small municipality classes and so is applicable to the entire range of land uses and development levels found in the Central Ontario Zone.

Key findings from the **Appendix IV** analysis suggest that:

- Although considerable scatter exists in the data, transit usage clearly is positively correlated with urbanization level and trip density.
- Nearly 70% of population growth 1986-96 in the GTA+H occurred in rural or low density suburban locations, with over half of this (39% of total growth) occurring in formerly rural areas.
- 88.1% of the growth 1986-96 in auto-drive trip ends (trip origins or destinations) and 85.6% of the growth in total (all mode) trip ends occurred in rural and suburban locations.
- Transit trip ends actually declined slightly in the higher urban density classes. This likely reflects a combination of land use effects (the other ends of these trips are more suburbanized in 1996, resulting in less transit usage) and transit service cutbacks.
- Auto-drive trips and total trips increased at a greater rate than population in suburban zones. This may partially reflect employment-related trip generation effects in these areas, but it also is an indication that transit services in these zones tended to not keep pace with travel needs.

The location and density of employment may be more critical to the design and performance of the transportation system than the distribution of population, important as population density is.

Clearly the distributions of both population and employment within a region are critical to the determination of travel flows and mode shares. While the analysis to this point has tended to focus on the residential side of the equation, it may well be the case that the location and density of employment is more critical to the design and performance of the transportation system than is the distribution of population (important as population density is).[19] There are at least three reasons for this.

1. High employment density means that the non-home end of trips will generally be a short walk from a bus stop or a rail station, whereas lower den-

19. Employment is both a direct generator of work-based trips and a surrogate for many non-home activities that generate non-work/school travel (shopping, recreation, personal business, etc.).

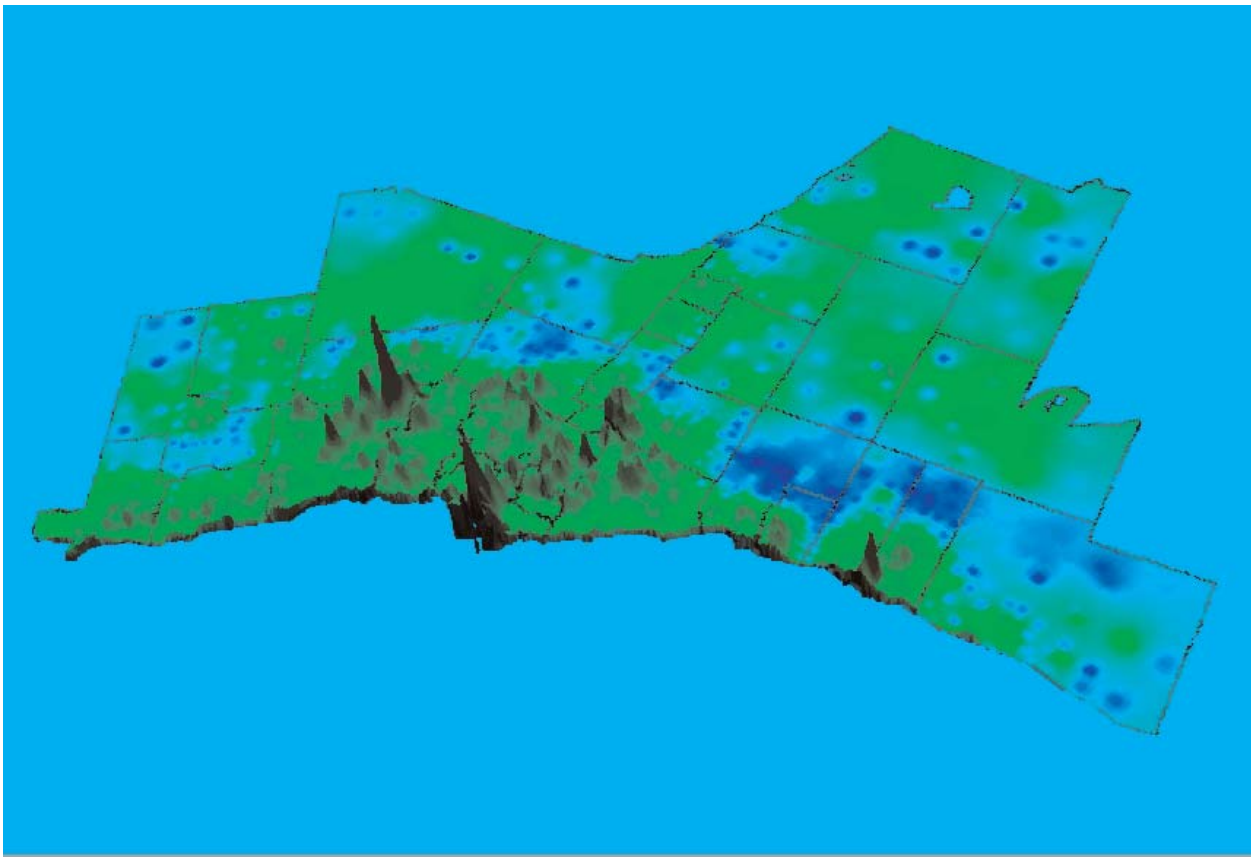


Figure 3.12 1996 GTA Employment by Traffic Zone Source: Haider (2002)

sities inevitably mean longer (and often more unpleasant) walking distances.

2. Higher densities allow for higher transit service frequencies and more extensive transit networks focused on the employment centre, thus improving the level and cost-effectiveness of transit service and its competitiveness relative to the auto.

3. If the magnitude and density of employment is sufficiently high, then higher-order transit services such as light or heavy rail become viable propositions, thereby further enhancing the attractiveness of transit.

The Toronto Central Area and the central-to-northeast Mississauga commercial areas (from Square One to Pearson Airport) represent the dominant two employment areas in the GTA and the COZ as a whole.

To illustrate these observations, consider **Figure 3.12**, which displays the 1996 distribution of GTA employment by TTS traffic zone. As is clear from this map, the GTA is a multi-centred region with major areas of employment in Toronto, Mississauga, and Oshawa, southern York Region and, to a lessor extent, along the QEW corridor in Oakville and Burlington. In particular, the Toronto Central Area and the central-to-northeast Mississauga commercial areas (from Square One to Pearson Airport) represent the dominant two employment areas

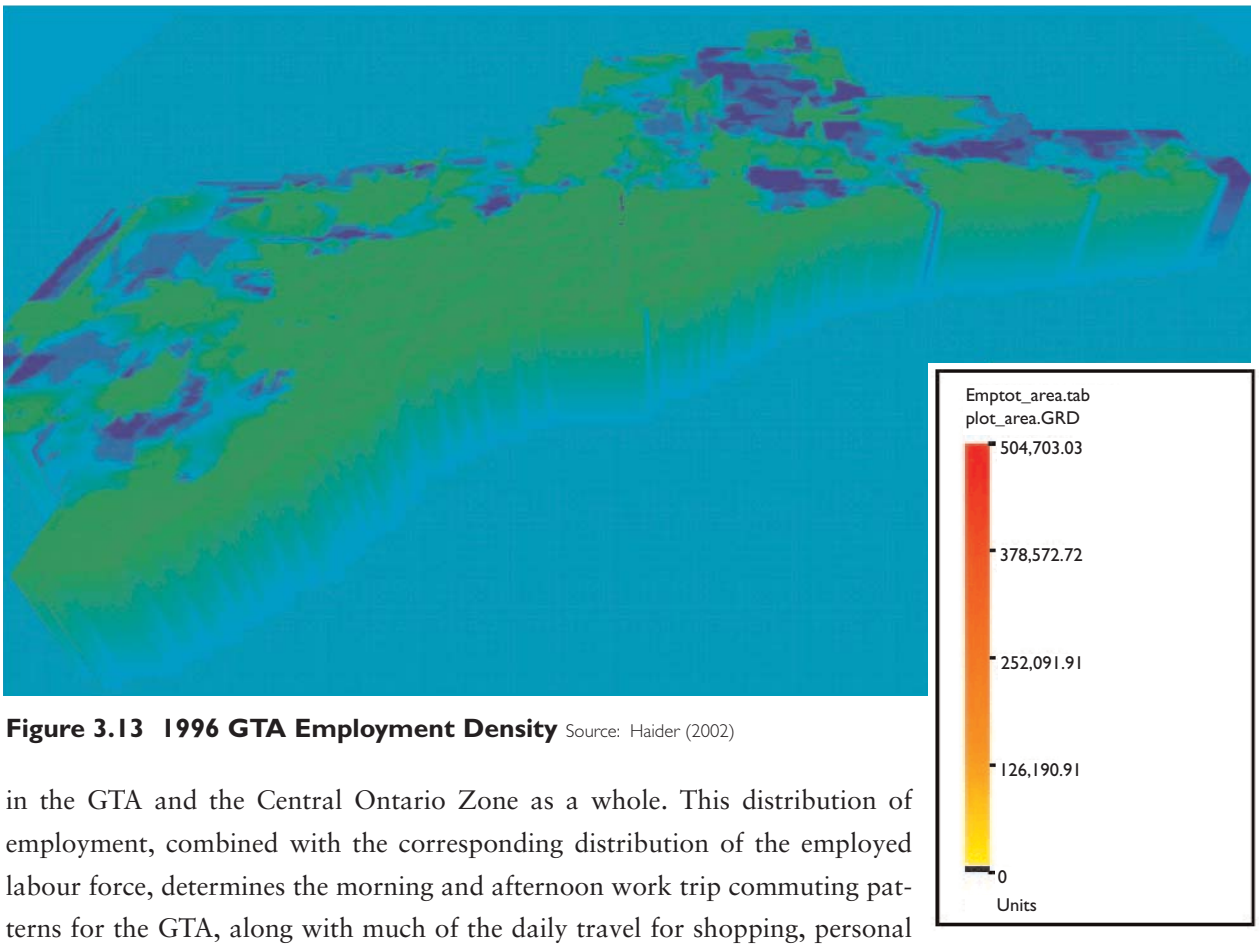


Figure 3.13 1996 GTA Employment Density Source: Haider (2002)

in the GTA and the Central Ontario Zone as a whole. This distribution of employment, combined with the corresponding distribution of the employed labour force, determines the morning and afternoon work trip commuting patterns for the GTA, along with much of the daily travel for shopping, personal business and other non-work/school activities.

The distribution of employment and the employed labour force determines the morning and afternoon work trip commuting patterns for the GTA and most of the patterns for non-work activities.

The ability to serve these employment-based trips by transit, however, depends not just on the magnitude of these trips, but upon their density. **Figure 3.13** replots the 1996 employment data in terms of zonal employment density. From the perspective of employment density, the GTA has a very different look: it appears to be almost totally monocentric, with a very high employment density in downtown Toronto and with virtually all the other employment centres identified in **Figure 3.12** "washing out" into a near-uniform density distribution – although the difference between the more developed inner GTA areas of Toronto, Mississauga, southern York Region, and the lakeshore corridor through Oakville and Burlington is clearly distinguishable from the less developed regions further away from Lake Ontario.

The ramifications of **Figure 3.13** for travel patterns and transit usage are dramatic. **Figures II.7** to **II.9** in **Appendix II** display the spatial distribution of 1996 GTA trip origins for all daily trips destined to the Toronto downtown,

Mississauga Square One and the Pearson Airport district, respectively.[20] Downtown Toronto and Square One travel patterns are similar in that both show a high density of nearby trip origins and then a decreasing density of trip ends as the distance from the employment centre increases. The Toronto pattern, of course, extends over a much greater area (essentially the entire GTA) than does Square One's, reflecting the much larger employment base of downtown Toronto and its correspondingly greater catchment area. The Pearson Airport pattern of trip origins is similar to downtown Toronto's in the sense that it, too, represents an extensive catchment area. Otherwise, however, it is very different, showing a much more dispersed pattern, with no significant concentration of origins, either close to the airport or along major transportation corridors (the later being another feature of the downtown Toronto pattern).

From the perspective of employment density, the GTA appears to be almost totally monocentric, with a very high employment density in downtown Toronto. This pattern has implications for transit ridership.

Table 3.1 shows the effect of the different employment densities and travel patterns on both morning peak-period and 24-hour transit use (including GO Rail) in 1996 for these three employment centres. Points to note from this table include the following.

- Downtown Toronto, with its very high employment density and high-capacity rail services (subway and commuter rail), achieves a dramatically different level of transit market share than the other two centres. These transit mode shares are comparable to, or exceed, those achieved by any other North American central city area, and are a testament to the high quality of transit service provided by the TTC and GO Transit into the

Table 3.1: Trip and Mode Shares by Trip Origin
Selected Major Employment Centres, COZ 1996

Total Daily Trips, All Trip Purposes
Trip Destination

Origin Area	Planning District 1	Mississauga Square One	Pearson Airport Emp. District	TOTAL
City of Toronto	711,269	18.803	42,807	772,879
Region of Peel	56,652	87,035	54,065	197,752
Rest of COZ	98,164	9,464	25,996	133,624
TOTAL	866,085	115,302	122,868	1,104,255

20. The Pearson Airport flows may include some GTA residents going to or from the airport as part of an air journey to or from another city. The trips captured in the survey, however, largely consist of "normal" weekday trips to work or for business purposes. The data do not include airport-based travel by visitors to the GTA, since such trip-makers are not included in the survey sample.

Table 3.1 (continued from previous page)

Transit Mode Share All-Day, All Trips
Trip Destination

Origin Area	Planning District 1	Mississauga Square One	Pearson Airport Emp. District
City of Toronto	0.377	0.147	0.063
Region of Peel	0.377	0.098	0.041
Rest of COZ	0.393	0.026	0.001
TOTAL	0.379	0.100	0.040

A.M. Peak Period Trips, All Trip Purposes
Trip Destination

Origin Area	Planning District 1	Mississauga Square One	Pearson Airport Emp. District	TOTAL
City of Toronto	230,072	3,584	19,056	252,712
Region of Peel	32,425	16,806	29,561	78,792
Rest of COZ	58,817	3,441	12,248	74,506
TOTAL	321,314	23,831	60,865	406,010

Transit Mode Share A.M. Peak, All Trips
Trip Destination

Origin Area	Planning District 1	Mississauga Square One	Pearson Airport Emp. District
City of Toronto	0.525	0.070	0.073
Region of Peel	0.535	0.099	0.047
Rest of COZ	0.523	0.017	0.003
TOTAL	0.525	0.083	0.046

Toronto Central Area, despite budget and service cuts in recent years.[21]

Regardless of trip origin, about 38% of all daily trips to the Toronto downtown are by transit, while in the morning peak-period approximately 53% of all trips are by transit.

- Also noteworthy is the uniform nature of transit mode shares for the Toronto Central Area: regardless of trip origin, about 38% of all daily trips to the Toronto downtown are by transit, while in the morning peak-period approximately 53% of all trips are by transit, again regardless of trip origin within the Central Ontario Zone.

- Transit usage for downtown Toronto destinations is not just a peak-peri-

21. Indeed, as has been previously noted, this performance is, in fact, supply-constrained, particularly in the case of GO Transit: if more commuter rail and transit service were provided into the Toronto Central Area, more people would use transit for certain trips.

od phenomenon, given that 38% of total daily trips to the downtown use some form of transit.

- Pearson Airport, with its low employment density, lack of any form of high-capacity transit service, and dispersed travel patterns naturally generates minimal transit usage.

Pearson Airport, with its low employment density, lack of any form of high-capacity transit service, and dispersed travel patterns naturally generates minimal transit usage. .

- Square One is a focus of the Mississauga transit system, and so does achieve modest levels of transit usage (a 10% daily transit mode share is fairly high by North American standards for this sort of suburban or edge city type of centre). The low employment density of this centre, perhaps along with its lack of any form of higher-order transit (bus- or rail-based), however, mitigates against its achieving downtown Toronto–type levels of transit usage. Undoubtedly the lower population densities in its primary catchment area contributes to its lower transit mode shares, although the more distant downtown Toronto area achieves four or five times greater transit mode shares in this same catchment area than Square One.

- Square One achieves a higher *daily* transit mode share than in the morning peak-period. This is almost certainly due to returning residents in the evening peak-period (most likely from Toronto destinations), rather than a reflection of all-day Square One–based trip attractions.

Square One is a focus of the Mississauga transit system, and so achieves modest levels of transit usage, although its low employment density and its lack of any form of higher-order transit mitigate against its achieving downtown Toronto–type levels of transit usage.

- The impact of residential density and transit network density/service levels is also evident in that transit mode shares f*rom* the City of Toronto to Pearson Airport area are higher than from Peel Region, even though longer trip distances are usually involved, and the Toronto to Square One mode shares are comparable to the within-Peel mode shares (the 14.7% all-day Toronto–Square One mode share is artificially high because it captures Mississauga residents returning home from Toronto workplaces, and so reflects neither Square One as an employment centre nor Toronto as a residential area).

The Toronto case study

Although this paper considers the entire Central Ontario Zone, Toronto lies at the centre of the region and dominates its economy, development patterns, and transportation issues. In addition, the City of Toronto (formerly Metropolitan Toronto) represents an ongoing, forty-year-plus experiment in transportation–land use coordination that is routinely studied and cited around the world. Therefore, it is reasonable to examine the Toronto case study in terms of what

we might learn from our own history that might help us set future policy, not just for Toronto, but for the Central Ontario Zone as a whole.

Comparisons between Toronto and Boston and Toronto and Melbourne shed light on the interrelationship of land use planning and transit planning.

Toronto, or more generally the GTA, has been described as "Vienna surrounded by Phoenix." [22] While allowing for some hyperbole in both parts of the analogy, there is truth in the notion that the GTA is a tale of two cities: a traditional, largely monocentric, reasonably dense, transit-oriented one, and a late-twentieth century, low-density, auto-oriented, suburban one. The travel patterns to downtown Toronto versus suburban activity centres such as Pearson Airport or Square One are evidence of this difference.

In looking ahead to future development decisions and their expected impacts on travel demand, we need to remember (and, in some cases, re-learn) what has worked in the past and to compare Toronto with comparable cities to get a better sense of what has worked and what hasn't. In particular, two recent studies – one comparing Toronto and Boston, and one comparing Toronto and Melbourne – can help us think more clearly about the Toronto case.

Schimek (1997) undertook a detailed comparison of land use and travel demand in the GTA and in the Boston urbanized region, which, he argues, are comparable urban areas in terms of population, land area, macro urban structure, extensive multi-modal transit systems, and economic functions. He found that Toronto's transit usage (measured in terms of either per capita ridership or mode splits) is considerably higher than Boston's. Why? Although differences in income, auto ownership levels, and gasoline prices between the two regions obviously play some role, Schimek argues that the key difference is in the coordinated land use–transportation policies of Metropolitan Toronto during Metro's critical growth period of the 1950s, 60s, and 70s. Because of these policies, the suburban areas of Etobicoke, North York, and Scarborough have higher population and employment densities than comparable areas in Boston, and it is precisely in these areas that transit ridership is significantly higher in Toronto than in Boston. Conversely, the central areas of both cities are very similar (indeed, Boston's central area is denser and more concentrated than Toronto's), as are the more recently developed suburbs (the "905" region and its Boston equivalent), and transit usage in both areas of the two cities (that is, central city and newer suburban) are generally comparable. Thus, although no-one would argue that Metro was consistently and universally successful in

Although Boston is similar to Toronto in many ways, transit use is higher in Toronto, largely because the suburban areas of Etobicoke, North York, and Scarborough have higher population and employment densities than comparable areas in Boston. It is precisely in these areas that transit ridership is significantly higher in Toronto than in Boston.

22. This phrase is attributed to Juri Pill, then TTC General Manager, Planning, in a Toronto Star article in February 1990.

coordinating land use and transportation policy, it did explicitly attempt to do so, with, as Schimek demonstrates, a discernable degree of success.

Mees (2000) conducted a similar comparative analysis of Toronto and Melbourne. He argues that Toronto and Melbourne are comparable in terms of population, size, age, transit systems (Melbourne's rail system is actually more extensive than Toronto's), and macro land use patterns. Yet Toronto's transit ridership is much greater than Melbourne's. In his discussion, Mees does not discount urban form as a factor in determining transit usage, but he argues that the key difference between Toronto and Melbourne is the high-quality, reliable, coordinated, centrally planned transit service provided by the TTC, as opposed to the uncoordinated, much less reliable service provided in Melbourne. Thus, the nature, level and quality of transit service offered (in terms of service frequency, coverage, coordinated transfers, and reliability) is as important as a transit-supportive land use policy in terms of determining transit usage.

The key difference between Toronto and Melbourne is the high-quality, reliable, coordinated, centrally planned transit service provided by the TTC, as opposed to the uncoordinated, much less reliable service provided in Melbourne. As a result, transit use is higher in Toronto.

Indeed, the two must go together: a high-quality transit service can be developed only if a supportive land use structure is in place, and a transit-supportive land use design will not succeed without an appropriate transit system providing a competitive, attractive alternative to the private automobile.

The arguments of Schimek and Mees indicate that the Metropolitan Toronto experiment of the 1950s–70s era in governance, land use planning, and transit system design was relatively successful, compared to the experience in similar cities elsewhere. This finding can be contrasted with the more recent experience of the past two decades of uncoordinated, non-transit-oriented growth in the GTA, as well as across the Central Ontario Zone.

Summary of empirical findings

This necessarily brief discussion of current (and longer-term) trends in the Central Ontario Zone provides a compelling case that the fundamental elements of transportation–urban form interaction are known and demonstrable based on experience within the Central Ontario Zone. Key findings include the following.

- Coordinated land use–transportation planning can work and can make a difference. The Metropolitan Toronto experience of the 1950s through the 1970s (the benefits of which we enjoy to this day) is clear and unambiguous evidence of this.

- Trends over the past 15 years equally clearly indicate that current land use and transportation policies are *not* promoting a smart or sustainable urban form or pattern of travel behaviour.

Empirical evidence exists in the COZ for the fact that coordinated land use–transportation planning can work and that recent and current land use and transportation policies are not promoting a smart or sustainable urban form or pattern of travel behaviour.

- Employment density is a critical element in transit-supportive urban form. The Toronto downtown obviously is the dominant example. Schimek argues, however, the relatively high employment densities in other parts of the City of Toronto and, arguably, other portions of the Central Ontario Zone, can also support transit, provided that other elements promoting transit usage are also in place.

- Residential density is also important for transit usage, but housing must be built in a way that is effective in providing convenient access to transit and in facilitating the provision of transit services.

- Mixed-use development, in which residential, commercial, and recreational activities are intermingled in a cohesive and attractive way, is critical to promoting non-motorized modes of trip-making. In most communities outside the City of Toronto, walking and cycling are more important modes of travel than transit. From any criterion imaginable – personal health, environmental impact, individual or societal costs – non-motorized trip-making is obviously optimal. Moreover, walkability is a hallmark of great urban centres and great small towns. Thus, promoting neighbourhoods that support walking and cycling should be a primary concern of town and city design. A notable failure of "classic" postwar suburban design (which, unfortunately, also applies to much *urban* design within this same time period) is the patent lack of walkability of such areas, because of the absence of mixed land uses and the physical layout of the built environment (including curvilinear streets, no sidewalks, the priority given to parking lots and vehicle movements, boring or even hostile streetscapes). Mixed-use and pedestrian-friendly neighbourhood design is also transit-supportive, for fairly obvious reasons.

Mixed-use development, in which residential, commercial, and recreational activities are intermingled, is critical to promoting walking and cycling, with all their personal and social benefits. A notable failure of typical postwar suburban (and much urban) design is its non-walkability.

- Coordinated, reliable, competitive transit services obviously must be provided if transit is to be a viable alternative to "choice riders" (trip-makers who have a choice between using transit and driving a car for a given trip). Downtown Toronto is the primary example, in which 53% of all morning peak-period trips and 38% of all daily trips are made by transit, many of them made by choice riders. The challenge for extending this sort of performance to other activity centres (appropriately scaled for the size of the given centre) is the chicken-and-egg nature of the transit–land

Coordinated, reliable, competitive transit services must be provided if transit is to be a viable alternative to the private auto. The challenge for extending this sort of performance to other centres is the chicken-and-egg nature of the transit–land use interaction.

use interaction: high-quality, competitive transit can be provided cost-effectively only where land use patterns support such services, but such transit-supportive built forms can only be built if the appropriate transit service is provided. The question of which comes first (the land use or the transit service) and of how to create such a symbiotic system (given the long lead times, high costs, and risks involved in the system's development and evolution) is, perhaps, the critical question facing planners and decision-makers in the urbanized portions of the Central Ontario Zone where such transit-oriented development makes the most sense.

After extending this discussion of the urban form–travel behaviour interaction to the question of goods movements in the next section, we will consider apply the lessons learned within the Central Ontario Zone so that in the coming decades the Central Ontario Zone can grow smarter.

Commercial vehicle movements and their links to regional structure

Unfortunately, no equivalent to the TTS person-travel data exists for intra-COZ goods movements[23], and so an empirically-based discussion of goods movements within the Central Ontario Zone is difficult to construct. However, it seems clear that there is a tremendous amount of goods movement and service delivery occurring throughout the Central Ontario Zone, during most of the day, encompassing a wide variety of origin-destination combinations. Because most goods movement and service delivery occurs by truck or van, these movements contribute to overall road congestion levels, and, in turn, suffer productivity losses caused by this congestion. This type of transportation consists of three types:

Commercial vehicle movements consist of trucks passing through but not stopping in the COZ, import/export movements between businesses in the COZ and other economic regions in North America, and movements of goods and services from origins to destinations within the COZ.

1. Trucks passing through but not stopping in the Central Ontario Zone. These movements contribute to the Canadian economy as a whole but not directly to the Central Ontario Zone economy. They do, however, contribute to roadway congestion levels.

2. Import/export movements between businesses in the Central Ontario Zone and other economic regions in North America. Given the strong export

23. As opposed to "NAFTA"-type freight movements between the COZ and the US border or other economic regions with which the COZ trades, for which good data exists. An ongoing intra-COZ goods movement data collection program similar to TTS in nature would be a cost-effective contributor to COZ transportation policy analysis, but, to date, this proposal has not been acted upon.

base of the Central Ontario Zone, these movements are essential to the economic well-being of the region. They both suffer from and contribute to higher congestion levels.

3. Movements of goods and services from origins to destinations within the Central Ontario Zone. Service delivery movements include private vehicles (such as plumbers making house calls), delivery vehicles (such as couriers), municipal service vehicles (such as garbage trucks), and other business-related travel not captured by TTS-type surveys (for example, the TTS does not attempt to capture all calls made by salespersons, nor does it completely capture other work-based trips for business purposes).

From a land use or urban design perspective, probably the most important impacts of commercial vehicle movements include the following.

- To the extent that commercial traffic increases congestion on Central Ontario Zone highways (most notably the 400-series highways) and other roads, they affect access by Central Ontario Zone residents and businesses to these roads. This, in turn, might influence land development decisions and/or location choices of households and firms.

- Building or expanding highways to accommodate freight movements will change access to roads for personal travel (unless such new facilities are restricted to trucks only). Again, this can influence housing and other land use and location choices unless strong land use control measures are implemented. Historically, the construction of Highway 401 provides a classic example of this effect. Originally billed as "the Toronto bypass" and designed largely to provide a route for through-traffic around Toronto, the highway instead facilitated the development of much of the GTA's current urban structure and has become the central artery for much of the GTA's travel, both person-based and freight. More recently, Highway 407 has had a similar effect on land development and travel patterns in York Region and elsewhere in the Central Ontario Zone.

Building or expanding highways to accommodate commercial vehicles leads to increased personal travel (unless the roads are restricted to trucks only). The 401 was originally built to allow trucks to bypass the city, but ended up influencing the pattern of surburban development north of the city.

- The parking and loading/unloading requirements involved in urban goods deliveries and service calls can result in significant losses of road capacity if these activities occur on the street. Thus, an important consideration at the level of actual building and street-level design is to provide appropriate off-street parking/loading-unloading facilities in order to minimize congestion impacts and productivity losses due to on-street parking of commercial vehicles.

- Manufacturers and other export/import oriented businesses generally need convenient access to major highways, and so will naturally try to locate near highways, particularly highway interchanges. These activities tend to be fairly extensive in their land requirements, and, as a result, generate very low-density, highly auto-based employment centres that are not easily serviced by transit (if they can be cost-effectively be served at all).

Manufacturers try to locate near highways, particularly interchanges. These businesses need large amounts of land, and, as a result, generate very low-density, highly auto-based employment centres that are not easily served by transit.

From the perspective of this paper, this last point may be the most important. In particular, it highlights one of the many difficult aspects of the land use–transportation design problem. Although one might wish employment centres to be constructed in a dense, centralized fashion to facilitate high-quality, cost-effective transit service, for many businesses, current (and foreseeable future) production methods and business practices dictate a land development pattern that is dispersed, low-density, and inherently road-oriented.

Further, while alternatives to automobile transportation may exist for some commercial vehicle movements in some areas (such as using bicycle couriers or using transit to get to business meetings), the need to transport bulky items (from toolboxes to sample cases to heavy equipment), dispersed origin-destination travel patterns, and tight timelines require a heavy, if not total, dependence on trucks, vans, and cars to accomplish these movements. Thus, one can argue that from an urban design perspective, the challenge is primarily one of building an urban area to minimize commercial vehicle trip lengths and the congestion caused by these movements, rather than to facilitate the diversion of these trips to other modes of travel. This clearly represents a contrast to the case of personal travel, in which modal diversion is both a much more viable and a much more necessary component of the overall design problem.

For many businesses, current production methods and business practices dictate a dispersed, low-density, and inherently road-oriented land development pattern. The challenge is to build an urban area to minimize commercial vehicle trip lengths and the congestion caused by these movements, rather than to facilitate the diversion of these trips to other modes of travel.

Elements of smart growth

The concept of smart growth embodies elements of livability, efficiency, affordability, and environmental protection, where:

- *Livability* describes a variety of factors including a choice of housing options, access to employment, schools, hospitals, shopping, and recreation, as well as reasonably safe and secure surroundings.
- *Efficiency* concerns how land is used and relates to the provision of both infrastructure and social facilities and services. In a growing region, an

important challenge includes using existing infrastructure more effectively rather than abandoning it in favour of investment in entirely new facilities and services.

- *Affordability* largely involves achieving a realistic tradeoff between expectations and fiscal resources that can be made available, an increasingly difficult task at a time when all governments are seeking to reduce (or at least not increase) taxation.
- *Environmental protection* involves both mitigation against well-known negative impacts associated with urban growth, as well as righting some of the wrongs that have already occurred. Thus, it involves elements of soil and water reclamation, improving air quality, and reducing greenhouse gas emissions.

The concept of smart growth embodies elements of livability, efficiency, affordability, and environmental protection. .

Numerous studies in Ontario and elsewhere concerned with smart, efficient, or sustainable growth management have reached general consensus on a number of key objectives including:

- placing limits on urban sprawl (the land area consumed to accommodate growth in population and employment);
- concentrating a mixture of urban activities in intensified, land use nodes and corridors to broaden the range of choice at the local community level;
- distributing growth in population and employment to reduce commuting distances;
- reversing the trend towards increased automobile dependence;
- making it easier to walk, cycle, or use transit for a larger proportion of trips;
- reviving small-town characteristics and pleasant streetscapes within local communities that collectively form large urbanized regions.

Key objectives of smart growth include placing limits on urban sprawl, concentrating a mix of urban activities in nodes and corridors, distributing growth in population and employment to reduce commuting distances, and reversing the trend towards increased automobile dependence.

In other words, the generally accepted prescription appears to stress using land more sensibly and altering travel demand, both of which are highly inter-related, as has been discussed above. Different issues/challenges obviously face communities of different types within the Central Ontario Zone with respect to achieving this overall objective. At the risk of over-simplification, different community types within the Central Ontario Zone consist of:

- rural and small town communities outside the GTA;
- larger towns and smaller to medium-sized cities outside the GTA;
- GTA communities outside Toronto;
- the City of Toronto.[24]

Summarizing the discussion of the previous three sections, key urban form–travel demand elements/issues of smart growth include:

Key urban form–travel demand elements of smart growth include achieving a good balance of jobs and housing, promoting mixed-use development, concentrating employment and housing into higher density centres, and investing in a balanced transportation system.

- achieving a jobs/housing balance, or avoiding the "bedroom community syndrome";
- promoting mixed-use development to support the use of non-motorized travel;
- concentrating employment into higher density centres that can become the focus of high-quality transit services;
- building medium to high residential densities in a transit-supportive fashion within corridors that can be cost-effectively served by high-quality transit;
- promoting infill, brownfield development and densification of both housing and activity centres to support non-motorized and transit travel, as well as to take better advantage of existing public infrastructure in general;
- making adequate and appropriate investments in a balanced transportation system to (a) provide a cost-effective competitive transit alternative to the automobile in markets where such competition is feasible, and (b) ensure the cost-effective and timely movement of goods and services within and through the Central Ontario Zone.

It is never too early to develop in a transit-supportive way in terms of ensuring a mix of uses, paying attention to roadway and streetscape design, or focusing major employment into concentrated activity centres, in anticipation of eventually developing a viable transit system as a community grows.

Table 5.1 provides a cursory summary of the extent to which each of these elements are likely to be applicable in each type of community.

Clearly, transit system improvements and associated residential and employment densification (either through infill or new development) apply most directly to the more urbanized portions of the Central Ontario Zone. However,

24. This categorization is not meant to be definitive, but only to structure the discussion somewhat.

Table 5.1: Land Use - Transportation Policies by Community Type

Total Daily Trips, All Trip Purposes
Trip Destination

	Community Type			
Policy	Rural & Small Town	Non GTA Urban	GTA Non-Toronto	Toronto
Jobs/housing balance	X	x	X	
Mixed-use development	X	X	X	X
Employment concentration		x	X	X
Residential density		x	X	X
Infill/densification		x	X	X
Transit Investment		x	X	X
Efficient goods movement	x	x	x	x

Very applicable	X
Moderately applicable	x
Low applicability	

it is never too early to develop in a transit-supportive way (in terms of ensuring a mix of uses, paying attention to roadway and streetscape design, or focusing major employment into concentrated activity centres) in anticipation of eventually developing a viable transit system as the community grows. Further, experiments with transit alternatives suited to lower-density communities (for example, van pooling, dial-a-ride, route deviation services, or jitneys) should be encouraged.

A major smart growth challenge will be how to retrofit single-use, auto-dominated suburbs into more walkable neighbourhoods.

As has already been discussed, mixed uses and other neighbourhood design features aimed at promoting walkability should be emphasized in all development projects at all urban scales. This is, however, often easier to do at either the small town scale or in urban centres. A major smart growth challenge is going to be how to retrofit the large number of single-use, auto-dominated suburbs within the GTA and elsewhere into more walkable neighbourhoods.

Compact development in rural areas and small towns should be encouraged, not just for transportation efficiency, but to preserve the natural and rural environment that is critical to a community's quality of life.

In the particular case of smaller communities, not only will this reduce auto dependency for local trip-making, but it will also contribute towards maintaining some of the small-town attributes that typically make such communities attractive places to live and work. Further, even in rural communities and small towns, land should be treated as a scarce resource. Thus, compact development should be preferred, not just for transportation efficiency reasons, but to preserve as much as possible of the natural and rural environment that is critical

to the community's quality of life.

The issue of jobs/housing balance has not been discussed in detail to this point in the paper, although it is one that has attracted considerable attention in the transportation and urban planning literature. Conceptually, it is clear that if, on average, workers live closer to their jobs, then less total travel is required for commuting and (more often than not), alternatives to driving a car are more feasible. Given the high level of residential and employment mobility, the diversity of household tastes for residential lifestyles, and the complexity of urban spatial economies, it is questionable to what extent an optimal jobs/housing balance can ever be achieved, or the extent to which a very rigid enforcement of such a balance is even socially desirable.

However, it is clear that a considerable amount of "excess commuting" occurs within the Central Ontario Zone because of the continuing development of residential bedroom communities on cheap land far removed from the employment centres that provide the jobs for the workers living in these communities. Such development is presumably rationalized as a means of providing affordable housing for low- to medium-income households, a way to improve a community's tax base (although it also increases the services that need to be provided from this tax base), and as a "natural" early stage in the urbanization process for the community.

Given residential and employment mobility, the diversity of household lifestyles, and the complexity of urban spatial economies, it is questionable to what extent an optimal jobs/housing balance can ever be achieved. .

Such development, however, comes with very high transportation and long-term urban development costs. Such bedroom communities generate a considerable number of long-distance, totally auto-based commuter trips which place a significant load on Central Ontario Zone roads. Every such trip carries a very high marginal social cost in terms of its contribution to congestion, pollution, and greenhouse gas emissions. This is a classic, even extreme, case of individuals not perceiving the true social costs of their actions.[25] As noted above, many households presumably are seeking out such residential locations primarily in the name of cheap (that is, affordable) housing. It can be strongly argued, however, that there is no such thing as cheap housing once the full personal and social costs of travel are accounted for.[26]

Automobile travel to and from far-flung bedroom communities is a classic case of individuals not perceiving the true social costs of their actions. It can be strongly argued that there is no such thing as cheap housing once the full personal and social costs of travel are accounted for.

25. As bad as this is for transportation sustainability, the "feedback" effects can further aggravate the situation. Once established, such communities often lobby for improved road facilities to relieve their onerous and congested commute as a "right" to which they feel entitled . Also, all local trip-making will be auto-based, given the single-purpose, relatively low-density nature of the typical development.

26. A study investigating the "total" cost of housing and travel in the GTA is forthcoming (see Miller et al., 2002) that addresses this question in detail.

Further, as one can see in older suburban developments built in this style, once the original, single-use, auto-dominated community style has been established, it is very difficult to retrofit it into a more efficient urban form. In addition, leapfrog development encourages additional low-density, auto-dominated infill between the leapfrog community and the previous urban boundary and tends to preclude more orderly, efficient, and transit-oriented development.

Once a single-use, auto-dominated community has been established, it is very difficult to retrofit it into a more efficient urban form.

While the development of bedroom communities can and has occurred throughout the GTA and other urban regions within the GTA, this issue is perhaps most critical for small towns and rural communities located in the outer portions of the GTA or outside the GTA altogether. For many rural or small town communities, smart growth might mean very little or no growth, since with significant growth often comes loss of many of the attractive attributes of rural and small town life. To the extent that growth is allowed in such communities, however, it should occur in such a manner that these desirable attributes are maintained or even enhanced whenever possible.

Leapfrog development encourages additional low-density, auto-dominated infill between the leapfrog community and the previous urban boundary.

Ideally, development in such areas should be balanced between jobs and housing, with employment taking the lead, to promote self-containment as much as possible. Promoting and maintaining an effective balance of jobs and housing is, of course, another chicken-and-egg process that is very difficult to accomplish. Nevertheless, the argument is that when significant development occurs in such communities, it should be employment-driven and should be in response to local growth needs, rather than driven by the "external" needs of the GTA housing market. Put another way, such growth should emerge out of the local aspirations and strengths of the individual community, and should be locally focused in terms of its primary activity and travel patterns, rather than driven by externally oriented development pressures.

Smart growth building blocks

For many rural or small town communities, smart growth might mean very little or no growth, since with significant growth often comes loss of many of the attractive attributes of rural and small town life. Any growth should be employment-driven and locally focused.

Accommodating growth in travel demand in ways that contribute to smarter growth requires guidelines for interrelated land use and transportation planning. Examples of building blocks that influence achieving smart growth are shown in **Figure 5.1.**

The most important elements of these guidelines include the following:

1. Increasing population densities through intensification of land use along corridors that can justify better levels of transit service.

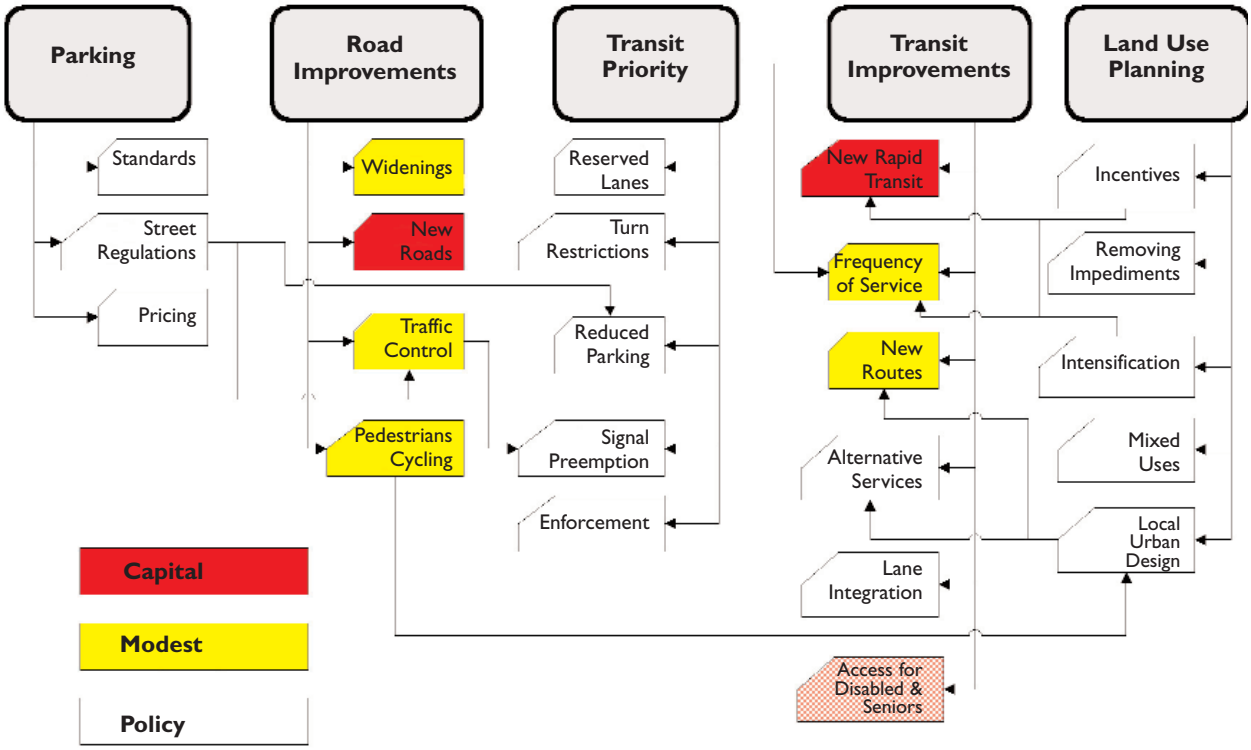


Figure 5.1, Transportation Building Blocks for Smart Growth

2. Similarly, concentrating employment in centres that can support better levels of transit service.

3. Approving local urban design and development plans that facilitate access by transit vehicles without circuitous routing, as well as encourage walking and bicycling for short trips.

4. Encouraging employers, including government agencies, to support transit use and car pooling rather than individual free parking and car allowances

5. Striving for mixed land use that reduces travel distances (and thus total vehicle-km of travel) for a variety of trips such as the journey to work and access to commercial, shopping, recreational, education, and health services.

6. Rationalizing land use planning among separate jurisdictions to create a region-wide master plan for growth management.

7. Modifying traffic engineering criteria to give higher priority to pedestrians, cyclists, and transit vehicles.

8. Reducing transportation emissions related to particulates and greenhouse

Accommodating growth in travel demand in ways that contribute to smarter growth requires a range of measures, from region-wide planning to innovative transportation technologies.

gases (through pricing, taxation, and fuel consumption standards).

9. Using cost-effective, and not necessarily capital-intensive, technologies for new transit services that are appropriate for anticipated levels of use and which deal with both ends of trips.

10. Increasing the productivity of transit vehicles and transit labour through priority measures and advances in information technology that increase average transit operating speeds.

11. Enhancing the coverage of transit services by introducing innovative, alternative forms of service delivery that complement the mainline components of the transit network.

12. Eliminating barriers to the use of transit that derive from jurisdictional boundaries to create seamless transit from the standpoint of potential users.

13. Introducing road pricing as a means of altering travel behaviour and the choice of vehicles, as well as a source of transit funding.

14. Altering transit subsidy programs to reward performance rather than costs, thereby creating incentives to attract higher ridership.

15. Providing municipalities and transit agencies with new sources of predictable revenue other than property taxes.

Fiscal measures that might improve transportation include Introducing road pricing to alter travel behaviour and the choice of vehicles, as well as altering transit subsidy programs to reward performance rather than costs, and providing municipalities and transit agencies with new sources of predictable revenue other than property taxes.

Pricing mechanisms

Pricing plays a significant role both in influencing travel demand and in helping shape urban development. Among the many possible pricing mechanisms available to governments, some of the more important current or potential instruments include the following.[27]

- **Fuel taxes.** The provincial and federal governments already tax Ontario fuel sales at moderately high rates (at least by North American standards). Fuel taxes tend to be a very blunt policy instrument for influencing travel demand, and, in particular, tend not to have much short-run effect on modal choice (Soberman and Miller, 1997, 1999). In the long run, higher fuel prices should encourage consumers to purchase more

Fuel taxes tend to be a blunt policy instrument for influencing travel demand, and tend to not to have much short-run effect on modal choice. Fuel costs would have to rise considerably before appreciable changes in travel behaviour would occur.

27. We have made no attempt to discuss the political feasibility of any of these pricing schemes, most of which are, in fact, quite contentious.

fuel-efficient vehicles and/or reduce auto travel in favour of less expensive modes of travel. For many trips, however, the out-of-pocket cost of auto travel is still very low relative to transit, and so fuel costs would probably have to rise considerably before appreciable changes in travel behaviour would occur, especially in the absence of significant improvements in transit service levels and significant changes in land use patterns.

- **Road/congestion pricing.** Road pricing involves charging tolls for the use of a given roadway. Tolls can be charged simply as a means of generating revenue from the facility (as in the case of Highway 407) or as a means of regulating travel behaviour. In particular, it is feasible to adjust the toll charged as a function of the time of day and/or the level of current congestion on the road to influence trip-makers choice of route, mode and/or trip start time. Road pricing is generally preferable to fuel taxes as a policy instrument, since it can be focused on specific trips, roads, or times of day. The sensitivity of Ontario drivers to road pricing is not completely clear, although anecdotal evidence from the 407 experience implies that the price elasticity of many drivers is very low.

  Road pricing, which involves charging tolls for the use of a given roadway, is generally preferable to fuel taxes as a policy instrument, since it can be used to influence travel on specific roads, types of trips, or travel at particular times of day.

  Road pricing is most likely to be effective when viable travel alternatives (for example, high-quality transit services) are available for the trip-makers who are "tolled off" the roadway to use. This may be why road pricing is often associated with travel to and from central cities. In the Central Ontario Zone, however, some of the most severe congestion is not necessarily associated with central city–oriented travel (which already captures a high transit modal share), but rather with cross-town or interregional travel that may be difficult to influence through road pricing unless a comprehensive tolling system (that is, one involving nearly all roads) is implemented. Further, if a centrally oriented pricing scheme were to be implemented while suburban activity centres were not tolled, this could have detrimental impacts on central area employment, and, hence, undesirable long-run impacts on urban form.

- **Parking charges.** Parking charges can have a significant impact on travel mode choices, particularly when long-term parking is required, such as for the journey to work. Indeed, one of the important factors influencing the high Toronto central area transit mode shares is the relatively high cost of parking in the central area (Miller, 1993). In most locations in the Central Ontario Zone, parking is either free or at a nominal charge. Parking lots and garages represent a significant land use in their own right. "Free" parking obviously comes at some cost to someone, since

  Parking charges can have a significant impact on travel mode choices. One of the important factors influencing the high Toronto central area transit mode shares is the relatively high cost of parking in the central area.

provision of this parking involves both capital and operating costs, as well as an opportunity cost associated with the land uses that have been forgone in favour of the parking facility. Elimination of free parking in office parks and other suburban land uses could potentially have a significant impact on travel mode choice, with the usual caveat that viable travel alternatives need to exist.

"Free" parking comes at some cost to someone, since it involves capital and operating costs, as well as an opportunity cost associated with the land uses forgone in favour of space for parking.

- **Vehicle Purchase/Licensing Taxes.** It has been observed that cars tend to be relatively cheap to operate, at least in terms of the short-run perceived cost of an individual trip. Cars are, however, relatively expensive to purchase, representing for most households the second biggest investment (with housing being the first) that they are likely to make. One option for controlling the size and fuel efficiency of automobiles would be to impose a significant tax on new and used vehicle purchases that is graduated to reflect the environmental footprint of the given vehicle.

The size and fuel efficiency of automobiles could be controlled by a tax on new and used vehicle purchases that is graduated to reflect the environmental footprint of each vehicle.

- **Development charges.** It is clear that current development charges in many municipalities play a major role in influencing the type of development that occurs. In particular, it is generally maintained that these charges, as currently structured, actively encourage low-density, single-family housing, even in situations in which developers believe a market exits for higher-density designs. It is also often argued that the income generated by development charges is a major stimulus for municipalities to encourage growth, at times without due regard for its long-term implications. Any smart growth strategy will require a detailed assessment of the past and current roles that development charges have played, as well as clear and careful decisions about how such charges should be levied in the future so that they can represent a positive force for smart, sustainable growth.

Any smart growth strategy will require a detailed assessment of the past and current roles that development charges and property taxes have played in the evolution of urban form.

- **Property taxes.** Similarly, property taxes play a role in land development and, more directly in the location choices of firms and households. The importance of property taxes in firm location choice varies with firm type, but certainly, all else being equal, any firm presumably would prefer to pay lower property taxes.[28] Thus, to the extent that a level playing field does not exist across Central Ontario Zone municipalities, this may introduce distortions into the evolution of urban form.

28. In location choice, all things are rarely equal, since, in principle every location is unique in its advantages and disadvantages. Thus, for example, major employment centres such as the Toronto Central Business District can, up to a point, have higher tax rates (as well as, of course, higher land rents) since firms are willing to pay (again, up to a point) for the location advantages they offer.

Strategic and implementation tools

Strategic tools are available to federal, provincial, and municipal governments that can significantly affect emerging urban structure.

The structure of urban growth within the region is obviously influenced by the nature and rate of population growth, changes in the economic base of the region, and strategic policies. For example, prospects for growth and economic development will be influenced by:

- provincial, national and even global economic conditions;
- inter-provincial and international immigration;
- the North American Free Trade Agreement;
- commercial decisions and marketing practices of key industries such as the automotive sector.

What federal, provincial, and municipal governments can do

Some of these factors depend upon events that are beyond the control of any level of government within Canada. Setting aside global economic conditions, however, strategic tools are available to federal, provincial, and municipal governments that can significantly affect emerging urban structure. Some of these are summarized briefly in **Table 6.1**.

Table 6.1

Policy Instruments and Strategies That Affect Urban Structure

Federal Government Strategies

Policy Instrument	*Components*
Income tax regulations	• Enforce existing regulations on car allowances, parking, etc. • Tax exemptions for employer-provided transit assistance
Acquisition of railway corridors	• Banking abandoned/discontinued railway corridors for urban planning and transportation purposes
Capital assistance for transit	• Performance-based contributions related to transit ridership and emission reductions
Research and development	• Alternative fuels • ITS applications to transit • Analytical methods for measurement, forecasting, and analysis
Demonstration pilot projects	• Conversion of streets to transit or semi-transit malls • Applications of IT to transit priority • Web-based trip planning

Provincial Government Strategies

Policy Instrument	*Components*
Regional planning oversight	• New entity to advance integrated regional land use planning • Elimination/alteration of Ontario Municipal Board's role
Modifications to the Planning Act	• Empower municipalities to generate new revenue sources
Modifications to the Highway Traffic Act	• Making vehicle owners responsible for certain driving offences to facilitate enforcement of transit priority • Permit ticketing on the basis of photographic methods and information technology
Protection of Hydro corridors	• Ensuring availability for future transit and transit related uses (e.g., bus rapid transit and commuter parking)
Integration of provincial highway planning with urban transportation planning	• Vetting provincial highway plans with affected municipal and regional agencies
Capital and operating cost programs for transit	• Performance-based contributions related to transit ridership and emission reductions in lieu of cost-based subsidies • Requirements for competitive bidding for transit vehicle acqui sition

Municipal Strategies

Policy Instrument	*Components*
Land use	• Type of activity (classification)
	• Densities
	• Allowances for mixed land use
Capital Investment in transportation	• Timing by mode and route
	• Balance preservation (rehabilitation), expansion, and vehicle replacement (for transit)
	• Appropriate technology
	• Bus-based: provide coverage, medium-capacity levels
	• Rail-based only where justified by traffic density
	• Competitive bidding for transit equipment
Design standards	• Capacity
	• Priorities for the use of road space
	• Level of service
	• Supply of parking
	• Loading and unloading facilities
Operating budgets	• Transit cost-recovery targets
	• Maintenance and operations
	• Expansion of service areas
Regulations	• Priority treatment for transit
	• On-street parking
	• Parking requirements for development applications
	• Truck routes
	• Traffic control (including ITS)
	• Rights of "foreign" operators
	• Cross-boundary integration
	• Entry control for new operators
	• Alternative service delivery
Pricing	• Objectives and targets (e.g., cost-recovery)
	• Mechanisms
	• Parking

Aside from immigration policies that affect where new immigration contributes to rates of growth, **federal government policies and strategies** can *indirectly* influence both land development patterns and travel behaviour through changes in taxation and direct financial contributions.

Provincial government policies and strategies, which can have a potentially more direct impact, include changes to the *Planning Act* and the *Highway Traffic Act*, in ways that provide more oversight at the regional level to integrate local municipal official plans, permit municipal organizations to broaden the range of revenue sources, and alter traffic control regulations in favour of improved transit competitiveness. Provincial municipal and regional transportation programs (both funding and planning), of course, also represent important tools for implementation.

Provincial governments can provide more regional oversight of municipal official plans, broaden the range of revenue sources available to municipalities and alter traffic control regulations in favour of improved transit competitiveness.

Municipal policies and strategies involve land use planning in the form of official plans, density and subdivision controls, priorities for spending on roads and transit, fares and cost recovery targets for transit, parking regulations associated with new development, and priorities for the use of road space. Municipal land use and transportation policies directly affect the form of land use development, mixed land use, performance of the transportation system, and both how, where and when individuals travel.

Municipal land use and transportation policies have a direct effect on the form of land use development, mixed land use, performance of the transportation system, and both how, where and when individuals travel.

Among these various policies and strategies are a number of well-known characteristics that influence urban structure and the resulting travel demands and behaviour. For example, automobile-oriented residential development and relatively modest transit services contribute to automobile dependency and lower use of transit. In addition, federal tax regulations, which influence automobile ownership and use and motor vehicle standards (including exemptions for vans and sports utility vehicles from voluntary industry standards for fuel consumption), influence vehicular emissions and therefore air pollution.

In addition, extensive experience in the Central Ontario Zone (and elsewhere) indicates that, by and large, travel choices appear to be influenced more by level of service than by fares. A large majority (more than 70%) of those who use GO Transit commuter rail services, for example, choose to do so even though they have an automobile available for the trip, largely because they view the service as competitive from the standpoint of travel time and reliability. Here, there are obvious strategic implications for other elements of the transit system, namely, to provide faster, more frequent, and more reliable surface transit service.

By and large, travel choices appear to be influenced more by level of service than by fares.

Funding

The general interpretation of strategy in the minds of most of those concerned with region-wide travel demand, sustainable development, and reduced auto-

mobile dependence usually boils down to the matter of funding, particularly the need for transit financial assistance from both senior levels of government. In this regard, two points should be considered.

Although municipal governments are unified on the need for external funding, it is by no means clear how such funding would be used.

The first concerns "funding for what." Although governments at the municipal level are unified on the need for external funding, it is by no means clear how such funding would be used and whether, in fact, it would be incremental to or a substitute for current municipal spending on transit. In some cases, municipalities, either directly or through joint submissions by such organizations as the Federation of Canadian Municipalities and the Canadian Urban Transit Association, are requesting financial aid without having established priorities for transit improvements. Moreover, there are several examples of "no-strings-attached" funding having been used for major capital projects of questionable value.

Second, for this reason, where funding strategies are indicated in **Table 6.1,** reference is made to performance-based, rather than cost-based funding contributions. This view is predicated on the assumption that new transit funding of any sort (capital or operating) is intended to increase transit ridership or maintain ridership that might be lost through deterioration in levels of service and reliability.

Investments to serve existing transit users should take precedence over investments to expand infrastructure that might divert automobile users to transit. Improvements include dealing with sources of delay, overcrowding, and congestion on heavily used routes, and reducing waiting times elsewhere in the system

For example, in attempting to reduce car dependence, it is important to emphasize the need to retain the transit habit for those who already use public transportation. In other words, requirements to serve *existing transit* users should take precedence over investment in expansion of infrastructure that *might* divert automobile users to transit. Although it is difficult to generate analytical estimates, given the large numbers of individuals who now use the transit system, it is likely that potential losses in ridership attributable to poor or unreliable service exceeds the number of new riders who can be convinced to take transit rather than drive.

Retaining existing passengers essentially means dealing with sources of delay, overcrowding, and congestion on heavily used routes, and reducing waiting times elsewhere in the system. The implication is that spending priorities (regardless of the source of funding) should be dictated by the need for:

- repair, rehabilitation, and modification of existing infrastructure to ensure safety and reliability of service;
- timely replacement of the existing fleet of transit vehicles;

- ensuring that planned expansion does not exacerbate existing problems of capacity and congestion.

Barriers to implementation

Achieving agreement in principle on how best to accommodate travel demand in the region is much easier than actually taking policy and investment decisions that support such concepts as seamless travel, reduced car dependence, or sustainable development, largely because of barriers to significant change. Some of these are briefly discussed below.

An unlevel playing field

Many current land use and transportation policies tend to favour low density, auto-oriented land development and auto rather than transit usage. Development charges that favour low-density, single-family housing developments, property taxes that favour one municipality relative to another, and federal tax laws that provide deductions for automobile use but not for transit are examples of policies that skew decision-making in ways that may be counterproductive from a smart growth objective. Often such policies (such as federal tax laws) are motivated by issues other than the urban form–travel demand interaction. Convincing the agencies generating these policies that this interaction is also of importance and should be considered in the evaluation of the policy is typically difficult.

Many current land use and transportation policies favour low-density, auto-oriented land development and auto rather than transit usage. Convincing the agencies generating these policies of the importance of the urban form–travel demand interaction is difficult.

Differing needs

Central Ontario Zone municipalities differ considerably in characteristics and needs. A single policy does not usually fit all. This diversity in needs and appropriate options can be a serious barrier to action by provincial and federal governments, who are often unwilling or unable to act in cases where a universal solution or program can not be constructed or is not comprehensively supported.

Strong opinions can harden into inflexible biases that present significant barriers to decision-making and change.

Embedded biases and conflicting objectives

We live in a democratic, pluralistic society in which many different groups hold strong opinions about the "correct" course of action. While this is generally a

healthy and desirable state of affairs, carried to an extreme, opinions can harden into inflexible biases that present significant barriers to decision-making and change. This can take many different forms, some of the more obvious of which include:

- the NIMBY (Not In My Back Yard) phenomenon of citizen opposition to almost any form of change within a neighbourhood;
- excessively strident single-issue groups who are often unrepresentative of a larger population and who are often willing to impose their issue on every initiative, regardless of its relevance to the matter at hand;
- beggar-thy-neighbour attitudes among municipalities who see urban development as a zero-sum, us-versus-them contest (rather than the synergistic, "whole-is-greater-than-the-sum-of-its-parts" process that it truly is);
- the lobbying and other activities of vested interests of all sorts that are motivated by narrow self-interest rather than any sense of broader social welfare.

Any policy may have conflicting impacts with respect to various objectives – this makes determining the "best" course of action a genuinely difficult task.e.

Society tries to achieve many objectives. Any policy may have conflicting impacts with respect to a given set of objectives that makes determining the "best" course of action a genuinely difficult task. Indeed, this is precisely why city building and transportation system development are inherently political with respect to all important decisions – ultimately such trade-offs can be made only within the political arena. Combined, however, with the single-issue orientation of many participants in the process (who typically attach absolute weight to their objective and little or no weight to any other objective), as well as with the manipulations of issues by vested interests, such conflicts often are difficult to resolve.

Institutional constraints and priorities

The ability to match transportation supply to demand is often constrained by jurisdictional boundaries and responsibilities.

Land development and the resultant patterns of travel demand transcend municipal and regional boundaries. Planning and decision-making concerning land use and transportation, as well as the provision of transit services, however, occur within individual municipal, regional and, sometimes, provincial agencies. As a result, the ability to match transportation supply to demand is often constrained by jurisdictional boundaries and responsibilities. In addition, the ability to plan development on a region-wide basis is similarly compromised

in many cases, given that each municipality or region is responsible for planning within its own boundaries and, at present, no agency has authority to plan on a wider basis. The funding of urban transportation involves jurisdictional issues: the federal government has traditionally been absent, and the province downloaded responsibility for urban transit to municipalities in 1998.

In today's public-sector fiscal environment, the opportunity to invest heavily in transportation is also limited by competing demands from other sectors of society (most notably health care and education), and by the desire at all levels of government to hold the line or, preferably, reduce overall taxation. Building or rebuilding a smarter urban form will, however, require significant investment in both the transportation system and the built environment.

The opportunity to invest heavily in transportation is limited by competing demands from health care and education, and by the desire at all levels of government to reduce taxation.

Reluctance to innovate

Well-established transit operating agencies, as well as road agencies, are typically reluctant to experiment with new methods of operation and service delivery. While demand has changed, the supply side often remains unaltered. Rather than focusing on how best to exploit advances in information technology (such as smart cards and camera-based enforcement of traffic regulations) or achieve higher priority for transit vehicles, political unacceptability is usually offered up as the main barrier to innovation. Alternative service delivery in low-density areas that could *augment* existing mainline services is a case in point. So also is more widespread application of proof-of-payment concepts that could reduce trip times and increase average transit speeds, as well as both vehicle and driver productivity.

Political unacceptability is usually offered as the main barrier to innovations such as smart cards, camera-based enforcement of traffic regulations, alternative service delivery in low-density areas, or proof-of-payment arrangements for transit users.

Similarly, innovation is needed in residential and activity centre design, use of greenspace, and other elements of planning to accomplish mixed-use, "effective" densities and pedestrian- and transit-friendly neighbourhoods in a cost-effective, marketable manner. Many developers, however, are (understandably) conservative in nature and reluctant to deviate from the tried-and-true development patterns that have served their industry well for the past few decades. Also, planning requirements and processes and development charges often reinforce the *status quo*.

Many developers are reluctant to deviate from the tried-and-true development patterns of the past few decades. Also, planning requirements and processes and development charges often reinforce the status quo.

Finally, successfully moving away from current dysfunctional land use and transportation trends is undoubtedly going to take significant leadership and risk-taking on the part of municipal and provincial politicians. It is often argued that it is difficult for political leaders to take strong stands on issues that

may bring long-term gain but that almost certainly *will* involve short-term controversy. City building, however, is inherently a long-term process. Vision, and the willingness to take risks and to lead an often balky electorate will all be required if a new, smarter growth pattern is to be achieved.

Political structure

Smart growth on a region-wide basis implies parallel region-wide decision making, integration, and coordination. As an arm of the provincial government,[29] for example, GO Transit has been better able to deal with cross-boundary travel than municipally owned transit agencies. Integrating transportation planning, however, has typically been found to be an easier challenge than integrating land use planning across municipal or even local community boundaries.[30]

Municipal elected officials are responsible to constituencies that are small in comparison to the smart growth region, and it is unrealistic to expect them to accept planning controls imposed by any supra-agency.

Municipal elected officials are responsible to constituencies that are small in comparison to the Central Ontario Zone, and it is unrealistic to expect them to readily accept planning guidelines and controls superimposed by any form of supra-agency. Otherwise, for example, there would already be an integrated region-wide transit system. In addition, even with more broadly based land use and transportation planning, equity in the incidence of costs and benefits among varied communities is not easily achieved. As a result, there are numerous examples of opposition to "broad picture" decisions, starting with the first amalgamation of Metropolitan Toronto in 1953, through the establishment of regional governments elsewhere within the GTA, to the recent amalgamation of the new cities of Toronto and Hamilton, and the establishment and later abolition of the Greater Toronto Services Board.

Thus, probably the single most important barrier to implementation of new planning and transportation strategies derives from a general unwillingness to relinquish control, unless doing so is tied to new and generous sources of revenue that filter through to the local level.

Strengths and weaknesses of strategic actions

Although the various strategies and their components listed in **Table 6.1** can

29. Except during the short interregnum of the GTSB.

30. This was true even for the former Metropolitan Toronto, in which transportation planning was more effectively integrated than land use planning, the real control of which, to a large extent, resided with the local area municipalities.

contribute, in varying degrees, to achieving smart growth, there are obviously constituencies that would be adversely affected. Also, some strategies imply legislative changes that would not be easily accomplished or which may be impractical for other reasons.

Table 8.1

Strengths and Weaknesses of Policy Instruments and Strategies

Federal government

Policy Instrument	*Strengths*	*Weaknesses*
Revised income tax regulations	• Helps level the playing field for modal choices based on costs • Some direct encouragement to use transit • Discourages some automobile use and ownership • Makes former parking areas available for other purposes • Increases senior government tax revenues	• Significant opposition from the business communiy • Incurs hardship on auto users for whom transit is not a viable alternative • Involves imposing solutions applicable to large urbanized area on a nation-wide basis including rural and small communities • Revenue Canada is rarely viewed as flexible and innovative
Acquisition of railway corridors	• Significantly reduces the costs of right-of-way acquisition • Provides opportunities not feasible elsewhere	• Involves opportunity costs and forgone revenue where corridors are not actually used
Capital assistance for transit	• Reduces the burden on property owners • Provides for needed rehabilitation and fleet replacement	• Reduces funding for other worthwhile programs • Municipalities may substitute funds for their own transit funding leading to little if any net gain • Limits flexibility with respect to changing government priorities • May perpetuate municipal spending on questionable capital projects • Raises wage expectations in the transit industry.
Research and development	• Assists in the application of cost effective means of increasing transit competitiveness • May improve vehicle fuel efficiency, greenhouse gas emissions.	• Little experience/competence to assess real needs • Likelihood of politically based support
Demonstration pilot projects	• Could encourage innovative municipal approaches	• Recent experience suggests funding would be used for "more of the same."

Table 8.1 (continued)

Provincial Government

Policy Instrument	*Strengths*	*Weaknesses*
Regional planning oversight	• Allows for better integration of municipal official plans to ensure development concentration in nodes and corridors that cross municipal boundaries • May also equalize parking minimums and maximums in accordance with goals for reduced auto dependence (and ensure that one municipality is not disadvantage with respect to another vis-à-vis attracting new development)	• Objections based on infringement of local rights with respect to choice of living styles • Reduction in authority of local planning officials • Usual opposition to any 'supra' authority • Questionable competence of any oversight authority to perform effectively
Modifications to the Planning Act	• Potential to develop predictable revenue flows that can be used for longer range transit planning	• Consumer opposition to any new form of taxation or pricing • Unwillingness to transfer powers
Modifications to the Highway Traffic Act	• Facilitates enforcement of transit priority schemes using modern IT • Increased ticketing revenues for municipalities • Increased productivity for parking control services	• Privacy issues (as for photo radar) • Transit labour opposition to new responsibilities • Possible impacts on local goods delivery
Protection of Hydro Corridors	• Significantly reduces the costs of right-of-way acquisition • Provides opportunities not feasible elsewhere • Corridors already acquired using public funds • Facilitates integration of local and express buses • Accommodates variety of users and vehicle types	• None
Integration of provincial highway planning with urban transportation planning	• Reduces conflict between goals for reduced car dependence and encouragement of more dispersed, auto-dependent development	• May impact negatively on goods movement
Performance-based capital and operating cost programs for transit	• Facilitates retention of current users through rehabilitation and vehicle replacement • Provides funding for system expansion • More easily changed as needs change than federal government funding	• Reduces funding for other programs • Municipalities may reduce their transit funding • May encourage questionable capital projects • Raises wage expectations in the transit industry.

Table 8.1 (continued)

Municipal government		
Policy Instrument	*Strengths*	*Weaknesses*
Land use	• Facilitate transit-effective services • Facilitate delivery of other hard and soft services	• Opposition to change at the local community level
Performance-based funding (capital and operating) •	• Rehabilitation and fleet replacement to retain current users • Provides for transit expansion • Improves level of transit service Maintains reasonable fares • Obtains better prices for equipment	• Minor impact on innovation and incentives for greater cost effectiveness • Diverts funding from other programs • Assists a relatively small constituency of the total transportation market • Maintains the status quo • Performance-based funding may reduce accessibility for disadvantaged segments of the community
Design standards and regulations	• Facilitates transit priority and car disincentives • Can improve goods movement and delivery • Encourages "seamless" travel	• Imposes additional costs and inconvenience to road users • Increases goods delivery costs • May result in cross-subsidies between efficient and inefficient operators • Opposition to alternative service delivery from transit managers and labour
Road pricing	• Generates new sources of revenue • Internalizes external costs • Affects choices of travel mode and vehicle type	• Consumer opposition to any new form of taxation or pricing • Opposition to paying for already funded public facilities • Organized opposition from special interest groups such as the CAA

Table 8.1 attempts to compare the strengths and weaknesses of these strategies with a view to, at least, highlighting weaknesses that derive from the some of the barriers treated in the previous section. In general terms, the weaknesses of some of the more important strategies relate to:

Some smart growth strategies imply legislative changes that would not be easily accomplished or which may be impractical

- negative impacts on road users (both costs and inconvenience) who constitute, by far, the largest segment of the urban transportation market;
- individual municipal aspirations for growth and development;
- reluctance of governments at any level to relinquish control and powers;
- opposition to new taxes and charges of any type;

- constraints imposed on individual travel decisions;
- flexibility to alter funding mechanism as needs and priorities change;
- funding available for other programs diverted to transportation;
- incentives created by matching fund programs to spend on ill-advised projects.

Short-term measures

Many of the tools of smart growth, particularly those requiring integrated actions by both the provincial and federal governments, are long-term, because it would take considerable time for governments to reach agreement on policies and legislative changes (such as tax reform).

Others can be implemented within a relatively short period, given adequate commitment on the part of municipalities within the Central Ontario Zone, as well as the government of Ontario.

In order to reach long-term objectives, short-term measures and decisions clearly represent important starting points in terms of both practical achievements and symbolic commitments. Taking account of the barriers, strengths, and weaknesses that have been identified, a number of short-term measures appear to have the greatest likelihood of moving in the direction of smart growth over the longer term. These are grouped into the following two categories:

- transit and non-motorized travel related measures; and
- land use and planning oversight measures.

Each of these groups of measures is discussed in the following sub-sections.

Measures related to transit and non-motorized travel

If alternatives to the automobile are required to meet smart growth and urban sustainability objectives, then transit and non-motorized modes must constitute a larger component of the travel market than they currently do. Appendix V lists and briefly discusses actions that could be taken in the short term (and expanded upon in the medium to longer term) with respect to improving transit service and ridership within portions of the Central Ontario Zone where

Measures to improve transit include establishing new, secure, adequate sources of funding for transit capital and operating costs, adopting performance-based criteria for allocating transit investments, and testing and adopting innovative means of delivering transit.

transit might represent a sensible alternative to the private automobile. Perhaps the key features of these transit-related measures are:

- establishing new, secure, adequate sources of funding for transit capital and operating costs;
- adopting performance-based criteria for allocating transit investments to ensure that funds are spent effectively and address high-priority needs;
- making a commitment to the testing and adoption of new, innovative means of delivering transit in an attractive, competitive fashion that is tailored to a given community's needs and opportunities (especially in smaller urban centres and lower density suburban communities);
- recognizing that, as with all major public infrastructure, investment in transit benefits the entire community, users and non-users alike.

Similarly, walking and bicycling must be encouraged for short-distance trip-making, whenever possible. Measures that would promote non-motorized travel include the adoption of design principles for new developments that encourage walking or cycling through:

Measures to encourage walking and cycling include requiring that streetscapes and roads be designed or retrofitted with the pedestrian and the cyclist in mind, not just the car. For example, sidewalks can be widened, pedestrian walkways and bicycle paths or lanes can be introduced, and parking lots and other barriers to pedestrian travel removed or relocated.

- insisting upon mixed uses within new developments, to provide the opportunity to satisfy at least some of people's needs through short, neighbourhood trips;
- requiring neighbourhood street patterns that facilitate and encourage walking and cycling through the creation of short, rectilinear blocks, wider sidewalks, pedestrian pathways, bicycle paths and lanes, and other features;
- requiring parking lots to be placed at the rear, rather than in front of commercial establishments (and other similar design measures), so that they do not act as an intimidating barrier to pedestrian access;
- more generally, requiring that streetscapes and roadways be explicitly designed with the pedestrian and the cyclist in mind, not just the car.

Similarly, municipalities should be aggressively looking for retrofit opportunities in existing developments and street systems to increase land use mix, widen sidewalks, introduce pedestrian walkways and bicycle paths or lanes, remove or relocate parking lots and other barriers to pedestrian travel, and improve streetscapes.

Virtually any measure designed to improve a neighbourhood's walkability will also improve its potential to support improved transit services and ridership. Further, it must be stressed that encouraging non-motorized travel is equally important and applicable in small town settings as it is in large urban centres.

Land use and planning oversight measures

There is clearly no quick fix for the urban form–travel demand problems that have been discussed above. The Central Ontario Zone's present form has been evolving over the past 50 years or more. It will undoubtedly take several more decades for a new, more sustainable urban form to be developed. As a result, land use policies are often dismissed as viable options, since they take so long to play out.

Because it will take decades for a new, more sustainable urban form to be developed, land use policies are often dismissed as viable options. But the only way we get to the long run is through the short run. We must take decisions now to make the COZ more sustainable.

This attitude, however, is fundamentally flawed, since the only way we get to the long run is through the short run, that is, through taking decisions and implementing actions today that cumulatively have impacts over the long run. In other words, if we want Central Ontario to be an improved place to live and work 20 or 30 years from now, we need to start to build that future region *now*. If we don't start today, 20 years from now we will still be stuck with the same dysfunctional urban form and the same problems of congestion, pollution, and loss of natural space, made worse by 20 years of inaction. Left unchecked, these problems could limit the Central Ontario Zone's ability to attract people and jobs, thereby acting as a barrier to continued economic and social growth within the region.

Left unchecked, congestion, pollution, and loss of natural space will likely limit the Central Ontario Zone's ability to attract people and jobs, thereby acting as a barrier to continued economic and social growth.

Initiatives that will play out over an extended period of time, but that **municipalities**[31] should start to undertake immediately include:

- beginning the process of reviewing Official Plans and development processes within each municipality to identify opportunities for more sustainable development plans and principles;
- reviewing development charges and their impacts on the type and density of development;
- developing policies and mechanisms for promoting contiguous growth, infill and mixed land usage rather than leapfrogging and single-use developments;

31. Ideally, with provincial support and coordination, in order to ensure consistency and comprehensiveness across municipalities. This is an attractive role for the Smart Growth Panel to undertake.

- developing policies and mechanisms for encouraging concentration of employment centres, especially offices and stores in transit-oriented nodes and corridors;
- reviewing design criteria to achieve "effective" residential densities that are conducive to providing cost-effective transit service.

Municipalities should start now to review plans and development processes, and develop policies and mechanisms to promote contiguous growth and encourage the concentration of employment centres.

At the same time, several land use measures can be implemented more quickly which would have immediate beneficial impacts. These include:

- changes to **municipal** zoning to permit higher density allowances near transit corridors and nodes;
- **municipal** promotion of transit-oriented design principles in all subdivision designs;
- **municipal** development incentives for employers to provide transit passes in lieu of free parking;
- **provincial** changes to the *Planning Act* to empower **municipalities** to reduce parking requirements for new development near transit corridors and nodes.

Land use measures that would have immediate beneficial impacts include changes to municipal zoning to permit higher density allowances near transit corridors and nodes and incentives for employers to provide transit passes in lieu of free parking.

Appendix I: Selected Bibliography

Anderson, W.P., P.S. Kanaroglou, and E.J. Miller (1996) "Urban Form, Energy, and the Environment: A Review of Issues, Evidence, and Policy," *Urban Studies*, Vol. 33, No. 1, pp. 7-35.

Badoe, D. (1994) *An Investigation into the Long Range Transferability of Work-Trip Discrete Mode Choice Models*, Ph.D. thesis, Toronto: Department of Civil Engineering, University of Toronto.

Badoe, D.A. and E.J. Miller (2000) "Transportation–Land-Use Interactions: Empirical Findings and Implications for Modeling." *Transportation Research D: Transport & Environment*, Vol. 5D, No. 4, pp. 235-263.

Badoe, D., E.J. Miller and K.S. Fan (1992) *Understanding and Modelling Modal Choice in the Greater Toronto Area, Volume II: Analysis of Spatial and Socio-Economic Variations in Work Trip Mode Choice Behaviour*, final report, Project No. 38215 for the Ministry of Transportation, Ontario, Toronto: Department of Civil Engineering, University of Toronto, March.

Bailey, G.K., E.J. Miller and G.N. Steuart (1990) *Understanding Urban Travel Growth in the Greater Toronto Area, Volume I, Travel to the Central Area of Toronto: A Descriptive Analysis & Policy Implications*, Report No. TDS-90-05, Toronto: Research and Development Branch, Ministry of Transportation Ontario, November.

Blais, P.M. (2000) *Inching Toward Sustainability: The Evolving Urban Structure of the GTA*, The Neptis Foundation Study, Toronto: University of Toronto, March.

DMG (2002) *2001 Transportation Tomorrow Survey Seminar*, Toronto: Data Management Group, Joint Program in Transportation, University of Toronto, October.

Fan, K.S., E.J. Miller and D. Badoe (1992) *Understanding and Modelling Modal Choice in the Greater Toronto Area, Volume I: Modelling Rail Access Mode and Station Choice*, final report, Project No. 38215 for the Ministry of Transportation, Ontario, Toronto: Dept. of Civil Engineering, University of Toronto, March.

GHK Canada (2002) *Growing Together: Prospects for Renewal in the Toronto Region*, report prepared for the City of Toronto, Toronto: GHK Canada.

Haider, M. (2002) *Spatio-Temporal Modelling of Determinants of Owner-Occupied Housing Supply*, Ph.D. thesis, Toronto: Department of Civil Engineering, University of Toronto, December.

IBI Group (2000) *Greenhouse Gas Emissions from Urban Travel: Tool for Evaluating Neighbourhood Sustainability*, Research Report, Healthy Housing and Communities Series, Ottawa: Canada Mortgage and Housing Corporation, February.

IBI Group (2002) *Toronto-Related Region Futures Study, Draft Interim Report: Implications of Business-As-Usual Development*, Toronto: Neptis Foundation, June.

Mees, P. (2000) *A Very Public Solution: Transport in the Dispersed City*, Melbourne: Melbourne University Press.

Miller, E.J.(1993) "Central Area Mode Choice and Parking Demand," *Transportation Research Record 1413*, pp. 60-69.

Miller, E.J. (2001) *The Greater Toronto Area Travel Demand Modelling System, Version 2.0, Volume I: Model Overview*, Toronto: Joint Program in Transportation, University of Toronto, January.

Miller, E.J. and A. Ibrahim (1998) "Urban Form and Vehicular Travel: Some Empirical Findings," *Transportation Research Record 1617*, pp. 18-27.

Miller, E.J. and A. Lee (2002) *A Personal Use Vehicle Emissions Audit for the Greater Toronto Area*, final project report to the Toronto Atmospheric Fund, Toronto: Joint Program in Transportation, University of Toronto, January.

Miller, E.J. and M.J. Roorda (2002) *Estimating CO2 Emissions and Other Transportation Impacts of Alternative Urban forms, Report II: Summary of Base Network Model Test Results, in Growing Together: Prospects for Renewal in the Toronto Region*, Background Reports, report to the City of Toronto, Toronto: GHK Canada, May, pp 17-40.

Miller, E.J., M.J. Roorda, A. Mohammadian, M. Haider, J. Hoss and W.W.L. Wong (2002) *Transportation and Housing Costs in the Greater Toronto Area: An Empirical Analysis, 1986-1996*, Volume I: Final Project Report, report to Neptis Foundation, Toronto: Joint Program in Transportation, University of Toronto, December.

Miller, E.J. and A. Shalaby (2000) *Travel in the Greater Toronto Area: Past and Current Behaviour and Relation to Urban Form*, The Neptis Foundation Study, Toronto: University of Toronto, January.

Miller, E.J., G.N. Steuart and D. Jea (1990a) *Understanding Urban Travel Growth in the Greater Toronto Area, Volume III, Future Travel Trends and Their Implications for Transportation Policy in the Greater Toronto Area*, Report No. TDS-90-07, Toronto: Research and Development Branch, Ministry of Transportation Ontario, November.

Miller, E.J., G.N. Steuart, D. Jea and J. Hong (1990b) *Understanding Urban Travel Growth in the Greater Toronto Area, Volume II, Trip Generation Relationships in the Greater Toronto Area*, Report No. TDS-90-06, Toronto: Research and Development Branch, Ministry of Transportation Ontario, November.

Roorda, M. J., A. Mohammadian and E.J. Miller (2000), "Toronto Area Car Ownership Study: A Retrospective Interview and Its Applications," *Transportation Research Record 1719*, pp. 69-76.

Schimek, P. (1997) *Understanding the Relatively Greater Use of Public Transit in Canada Compared to the USA*, unpublished Ph.D. thesis, Cambridge MA: Department of Urban Studies and Planning, Massachusetts Institute of Technology.

Soberman, R.M. (2001) *Reducing Automobile Dependence: Transportation Options for the City of Toronto, Toronto: City of*

Toronto, Urban Development Services, April.

Soberman, R.M. (2002) *Transportation Building Blocks for the Official Plan*, Toronto: City of Toronto, Urban Development Services, June.

Soberman, R.M. and E.J. Miller (1997) *Full Cost Pricing and Sustainable Urban Transportation: A Case Study of the Greater Toronto Area*, report to the Ontario Ministry of Transportation, Toronto: Department of Civil Engineering, University of Toronto, July.

Soberman, R.M. and E.J. Miller (1999) *Sensitivity of Travel Forecasts to Road Pricing*, final report to Natural Resources Canada, Toronto: Department of Civil Engineering, March.

Soberman, R.M. and E.J. Miller (1999) "The Impacts of Full Cost Pricing on the Sustainability of Urban Transportation: Towards Canada's Kyoto Commitments," *Canadian Journal of Civil Engineering*, Vol. 26, No. 3, pp. 345-354.

Appendix II: Travel Behaviour Trend Data: GTA Plus Hamilton, 1964-96

This appendix presents a series of exhibits that describe the trends in travel behaviour in the combined GTA and amalgamated City of Hamilton region, referred to in this report as the "GTA+H," for the period 1964 to 1996. The 1964 data in these charts are from the Metropolitan Toronto and Region Transportation Study (MTARTS) survey, while the 1986, 1991, and 1996 data are all from TTS.

These exhibits are taken from previous reports, full citations for which are in the bibliography. Sources for these exhibits are as follows: Figures II.1-2, II.4, II.5, II.7-9: Miller and Shalaby (2000); Figure II.3: DMG (2002); Figure II.6: Miller and Lee (2002).

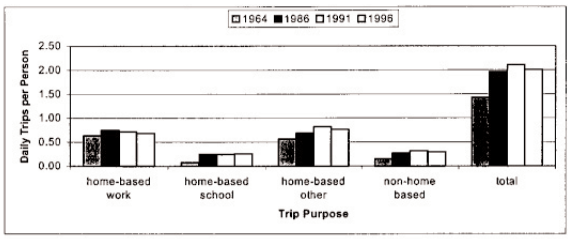


Figure II.1 GTA+H Daily Person Trip Rates by Trip Purpose and Year

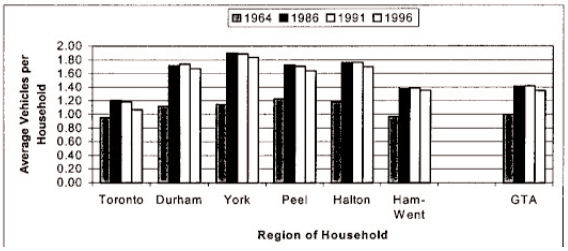


Figure II.2 Average Household Auto Ownership by Region of Residence

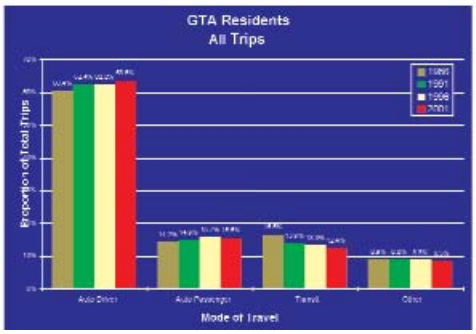


Figure II.3 GTA+H Mode Split Trend, 1986-2001

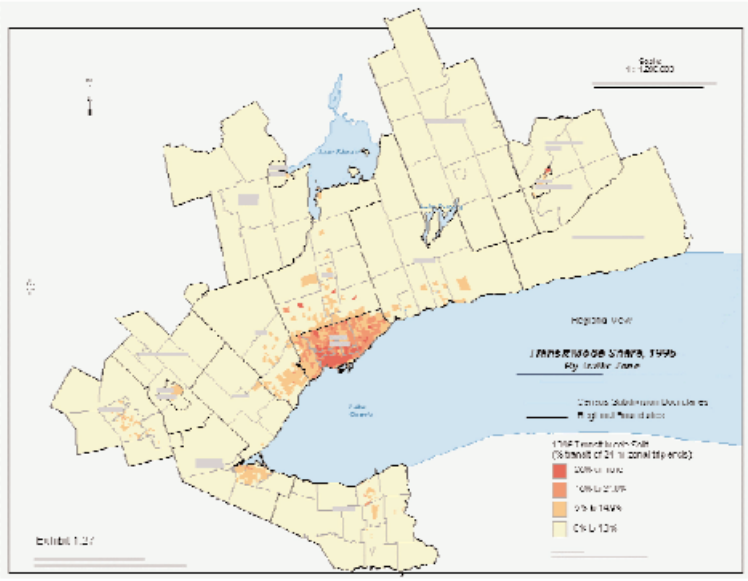


Figure II.4 Transit Mode Share, 1996 by Traffic Zone

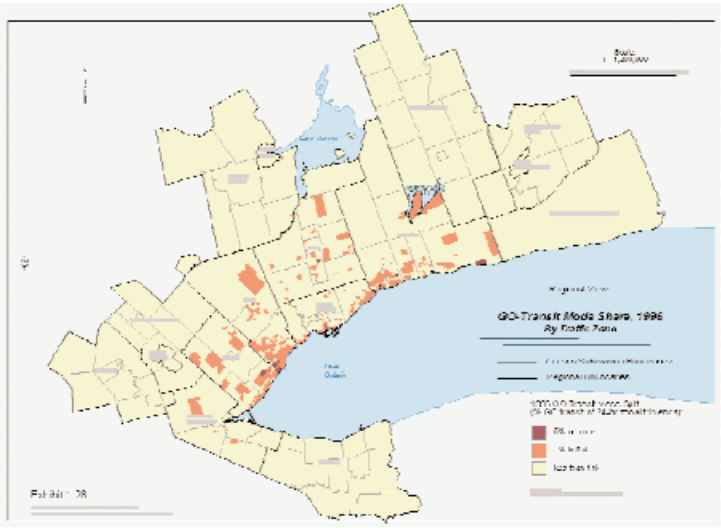


Figure II.5 GO Rail Mode Share, 1996 by Traffic Zone

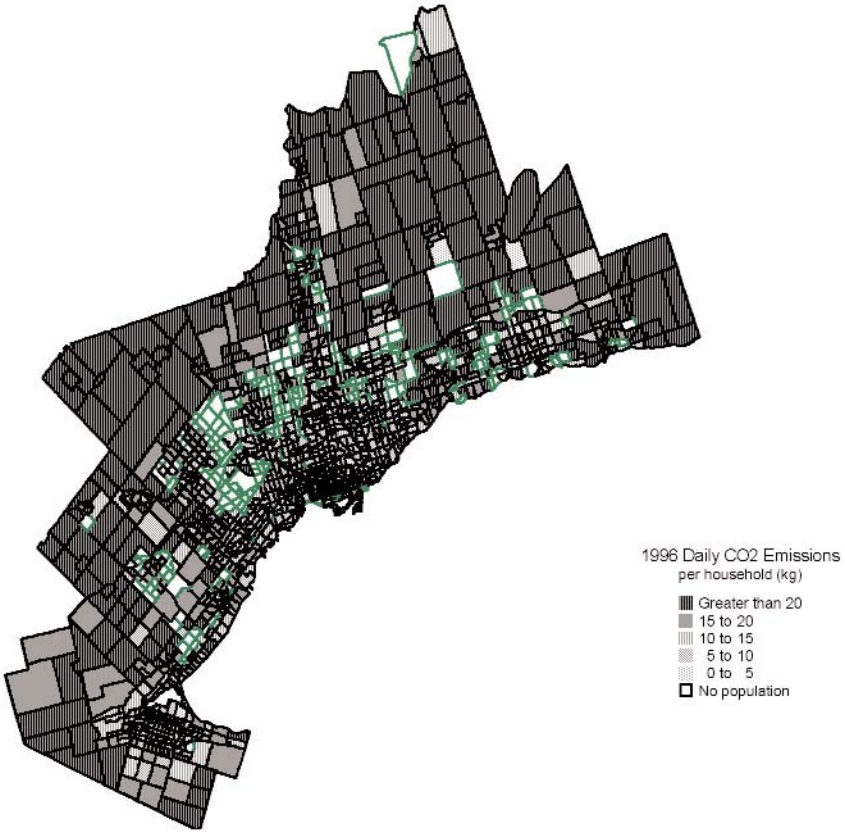


Figure II.6 Daily Average Household CO2 Emissions by Zone of Residence, 1996

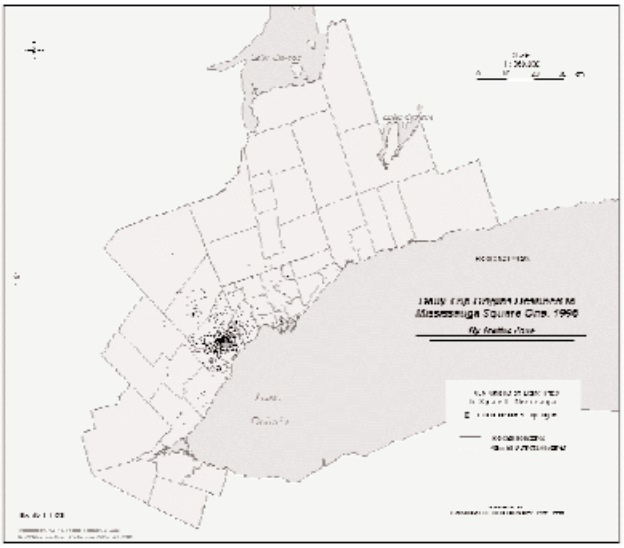


Figure II.7 Daily Trip Origins Destined to Toronto Downtown, 1996 by Traffic Zone

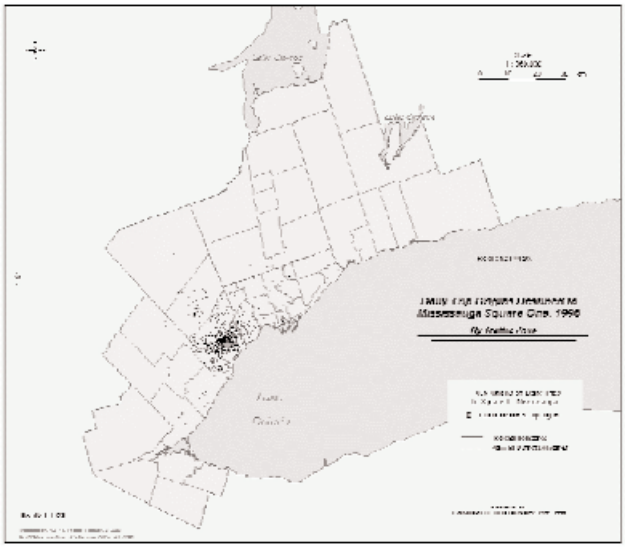


Figure II.8 Daily Trip Origins Destined to Mississauga Squre One, 1996 by Traffic Zone

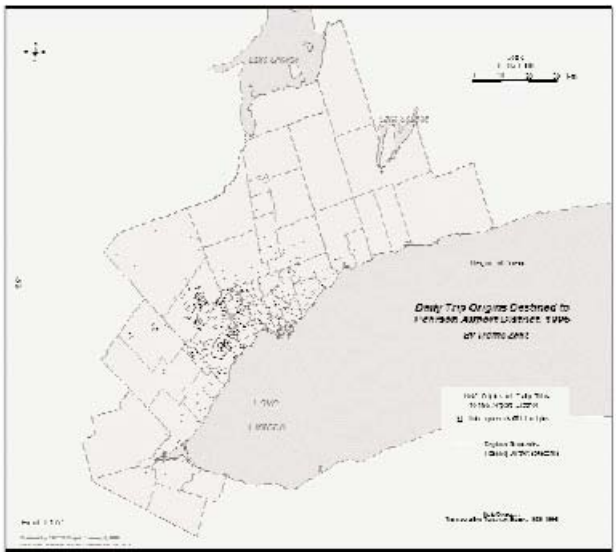


Figure II.9 Daily Trip Origins Destined to Pearson Airport District, 1996 by Traffic Zone

Appendix III: Central Ontario Zone Origin-Destination Travel Flows, 1996-2001

This appendix presents a series of tables that present 24-hour weekday origin-destination flows for the Central Ontario Zone for 2001 and changes in these flows between 1996 and 2001. The ten "super-zone" system described by Figure 3.1 is used to define trip origins and destinations in these tables. All data are from the 1996 and 2001 TTS.

ZONE

Table III.1 B 2001 Trips by Origin-Destination Regions, All Purposes, All Modes

	PD1	Toronto	GTA	Hamilton	Niagara	Guelph	Orangev.	Barrie	K.Lakes	Peterb.	Total
PD1	234233	436443	162200	6339	2181	2116	595	3510	555	706	848878
Rest of Toronto	435780	3158504	692853	7695	3604	3351	1692	14193	1989	2206	4321867
Rest of GTA	165489	692890	4483996	85470	14106	19745	10640	40361	11016	7787	5531500
Hamilton	6476	7727	84718	901216	23980	3438	136	351	365	242	1028649
Niagara	2573	2786	13803	23611	960596	892	78	442	218	16	1005015
Guelph/Wellington	2092	3042	19436	3516	824	306069	1890	337	39	154	337399
Orangeville	734	1806	10245	142	78	1848	48729	986	59	0	64627
Barrie/Simcoe	3468	14338	40210	293	380	437	1076	391147	410	112	451871
Kawartha Lakes	381	1800	10782	370	78	22	20	311	93544	9001	116309
Peterborough	707	2078	7031	254	57	154	18	169	9000	256192	275660
TOTAL	851933	4321414	5525274	1028906	1005884	338072	64874	451807	117195	276416	13981775

ZONE

Table III.2 B Change in Origin-Destination Trips, 1996-2001, All Purposes, All Modes

	PD1	Toronto	GTA	Hamilton	Niagara	Guelph	Orangev.	Barrie	K.Lakes	Peterb.	Total
PD1	15522	17245	26467	1421	-85	250	345	656	44	132	61997
Rest of Toronto	17260	204913	90023	323	-384	35	403	2378	183	606	315740
Rest of GTA	26321	91718	982514	13516	1969	4760	2721	10254	25	1531	1135329
Hamilton	1605	354	12493	92057	2335	247	77	-422	311	134	109191
Niagara	407	-1453	1744	1955	140591	166	-38	119	218	-22	143687
Guelph/Wellington	276	-221	4726	373	156	55898	1027	-121	-38	17	62093
Orangeville	485	447	2274	142	-37	1120	16616	292	59	0	21398
Barrie/Simcoe	573	2295	10286	-562	-2	9	279	102212	103	-230	114963
Kawartha Lakes	-93	-351	164	203	78	-69	20	39	-4865	1491	-3383
Peterborough	93	293	1161	73	-52	114	18	-173	1633	21488	24648
TOTAL	62449	315240	1131852	109501	144569	62530	21468	115234	-2327	25147	1985663

ZONE

Table III.3 B Percentage Change in Total COZ Trips by O-D, 1996-2001, All Purposes, All Modes

	PD1	Toronto	GTA	Hamilton	Niagara	Guelph	Orangev.	Barrie	K.Lakes	Peterb.	Total
PD1	0.8%	0.9%	1.3%	0.1%	-0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.1%
Rest of Toronto	0.9%	10.3%	4.5%	0.0%	-0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	15.9%
Rest of GTA	1.3%	4.6%	49.5%	0.7%	0.1%	0.2%	0.1%	0.5%	0.0%	0.1%	57.2%
Hamilton	0.1%	0.0%	0.6%	4.6%	0.1%	0.0%	0.0%	-0.0%	0.0%	0.0%	5.5%
Niagara	0.0%	-0.1%	0.1%	0.1%	7.1%	0.0%	-0.0%	0.0%	0.0%	-0.0%	7.2%
Guelph/Wellington	0.0%	-0.0%	0.2%	0.0%	0.0%	2.8%	0.1%	-0.0%	-0.0%	0.0%	3.1%
Orangeville	0.0%	0.0%	0.1%	0.0%	-0.0%	0.1%	0.8%	0.0%	0.0%	0.0%	1.1%
Barrie/Simcoe	0.0%	0.1%	0.5%	-0.0%	-0.0%	0.0%	0.0%	5.1%	0.0%	-0.0%	5.8%
Kawartha Lakes	-0.0%	-0.0%	0.0%	0.0%	0.0%	-0.0%	0.0%	0.0%	-0.2%	0.1%	-0.2%
Peterborough	0.0%	0.0%	0.1%	0.0%	-0.0%	0.0%	0.0%	-0.0%	0.1%	1.1%	1.2%
TOTAL	3.1%	15.9%	57.0%	5.5%	7.3%	3.1%	1.1%	5.8%	-0.1%	1.3%	100.0%
	% of Total										
	2.5-5%										
	5-10%										
	10-50%										
	>50%										

ZONE

Table III.4 B % Change in Trips by O-D, 1996-2001, All Purposes, All Modes

	PD1	Toronto	GTA	Hamilton	Niagara	Guelph	Orangev.	Barrie	K.Lakes	Peterb.	Total
PD1	7.1%	4.1%	19.5%	28.9%	-3.8%	13.4%	138.0%	23.0%	8.6%	23.0%	7.9%
Rest of Toronto	4.1%	6.9%	14.9%	4.4%	-9.6%	1.1%	31.3%	20.1%	10.1%	37.9%	7.9%
Rest of GTA	18.9%	15.3%	28.1%	18.8%	16.2%	31.8%	34.4%	34.1%	0.2%	24.5%	25.8%
Hamilton	33.0%	4.8%	17.3%	11.4%	10.8%	7.7%	130.5%	-54.6%	575.9%	124.1%	11.9%
Niagara	18.8%	-34.3%	14.5%	9.0%	17.1%	22.9%	-32.8%	36.8%		-57.9%	16.7%
Guelph/Wellington	15.2%	-6.8%	32.1%	11.9%	23.4%	22.3%	119.0%	-26.4%	-49.4%	12.4%	22.6%
Orangeville	194.8%	32.9%	28.5%		-32.2%	153.8%	51.7%	42.1%			49.5%
Barrie/Simcoe	19.8%	19.1%	34.4%	-65.7%	-0.5%	2.1%	35.0%	35.4%	33.6%	-67.3%	34.1%
Kawartha Lakes	-19.6%	-16.3%	1.5%	121.6%		-75.8%		14.3%	-4.9%	19.9%	-2.8%
Peterborough	15.1%	16.4%	19.8%	40.3%	-47.7%	285.0%		-50.6%	22.2%	9.2%	9.8%
TOTAL	7.9%	7.9%	25.8%	11.9%	16.8%	22.7%	49.5%	34.2%	-1.9%	10.0%	16.6%

16.6-33.2%
33.2 -100%
>100%

ZONE

Table III.5 B Percentage of 2001 Trips by Destination for Each Origin Region, All Purposes, All Modes

	PD1	Toronto	GTA	Hamilton	Niagara	Guelph	Orangev.	Barrie	K.Lakes	Peterb.	Total
PD1	27.6%	51.4%	19.1%	0.7%	0.3%	0.2%	0.1%	0.4%	0.1%	0.1%	100.0%
Rest of Toronto	10.1%	73.1%	16.0%	0.2%	0.1%	0.1%	0.0%	0.3%	0.0%	0.1%	100.0%
Rest of GTA	3.0%	12.5%	81.1%	1.5%	0.3%	0.4%	0.2%	0.7%	0.2%	0.1%	100.0%
Hamilton	0.6%	0.8%	8.2%	87.6%	2.3%	0.3%	0.0%	0.0%	0.0%	0.0%	100.0%
Niagara	0.3%	0.3%	1.4%	2.3%	95.6%	0.1%	0.0%	0.0%	0.0%	0.0%	100.0%
Guelph/Wellington	0.6%	0.9%	5.8%	1.0%	0.2%	90.7%	0.6%	0.1%	0.0%	0.0%	100.0%
Orangeville	1.1%	2.8%	15.9%	0.2%	0.1%	2.9%	75.4%	1.5%	0.1%	0.0%	100.0%
Barrie/Simcoe	0.8%	3.2%	8.9%	0.1%	0.1%	0.1%	0.2%	86.6%	0.1%	0.0%	100.0%
Kawartha Lakes	0.3%	1.5%	9.3%	0.3%	0.1%	0.0%	0.0%	0.3%	80.4%	7.7%	100.0%
Peterborough	0.3%	0.8%	2.6%	0.1%	0.0%	0.1%	0.0%	0.1%	3.3%	92.9%	100.0%
TOTAL	6.1%	30.9%	39.5%	7.4%	7.2%	2.4%	0.5%	3.2%	0.8%	2.0%	100.0%

ZONE

Table III.6 B Percentage of 1996-2001 Growth in Trips by Destination for Each Origin Region, All Purposes, All Modes

	PD1	Toronto	GTA	Hamilton	Niagara	Guelph	Orangev.	Barrie	K.Lakes	Peterb.	Total
PD1	25.0%	27.8%	42.7%	2.3%	-0.1%	0.4%	0.6%	1.1%	0.1%	0.2%	100.0%
Rest of Toronto	5.5%	64.9%	28.5%	0.1%	-0.1%	0.0%	0.1%	0.8%	0.1%	0.2%	100.0%
Rest of GTA	2.3%	8.1%	86.5%	1.2%	0.2%	0.4%	0.2%	0.9%	0.0%	0.1%	100.0%
Hamilton	1.5%	0.3%	11.4%	84.3%	2.1%	0.2%	0.1%	-0.4%	0.3%	0.1%	100.0%
Niagara	0.3%	-1.0%	1.2%	1.4%	97.8%	0.1%	-0.0%	0.1%	0.2%	-0.0%	100.0%
Guelph/Wellington	0.4%	-0.4%	7.6%	0.6%	0.3%	90.0%	1.7%	-0.2%	-0.1%	0.0%	100.0%
Orangeville	2.3%	2.1%	10.6%	0.7%	-0.2%	5.2%	77.7%	1.4%	0.3%	0.0%	100.0%
Barrie/Simcoe	0.5%	2.0%	8.9%	-0.5%	-0.0%	0.0%	0.2%	88.9%	0.1%	-0.2%	100.0%
Kawartha Lakes	2.7%	10.4%	-4.8%	-6.0%	-2.3%	2.0%	-0.6%	-1.2%	143.8%	-44.1%	100.0%
Peterborough	0.4%	1.2%	4.7%	0.3%	-0.2%	0.5%	0.1%	-0.7%	6.6%	87.2%	100.0%
TOTAL	3.1%	15.9%	57.0%	5.5%	7.3%	3.1%	1.1%	5.8%	-0.1%	1.3%	100.0%

ZONE

Table III.7 B Percentage of 2001 Trips by Origin for Each Destination Region, All Purposes, All Modes

	PD1	Toronto	GTA	Hamilton	Niagara	Guelph	Orangev.	Barrie	K.Lakes	Peterb.	Total
PD1	27.5%	10.1%	2.9%	0.6%	0.2%	0.6%	0.9%	0.8%	0.5%	0.3%	6.1%
Rest of Toronto	51.2%	73.1%	12.5%	0.7%	0.4%	1.0%	2.6%	3.1%	1.7%	0.8%	30.9%
Rest of GTA	19.4%	16.0%	81.2%	8.3%	1.4%	5.8%	16.4%	8.9%	9.4%	2.8%	39.6%
Hamilton	0.8%	0.2%	1.5%	87.6%	2.4%	1.0%	0.2%	0.1%	0.3%	0.1%	7.4%
Niagara	0.3%	0.1%	0.2%	2.3%	95.5%	0.3%	0.1%	0.1%	0.2%	0.0%	7.2%
Guelph/Wellington	0.2%	0.1%	0.4%	0.3%	0.1%	90.5%	2.9%	0.1%	0.0%	0.1%	2.4%
Orangeville	0.1%	0.0%	0.2%	0.0%	0.0%	0.5%	75.1%	0.2%	0.1%	0.0%	0.5%
Barrie/Simcoe	0.4%	0.3%	0.7%	0.0%	0.0%	0.1%	1.7%	86.6%	0.3%	0.0%	3.2%
Kawartha Lakes	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.1%	79.8%	3.3%	0.8%
Peterborough	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	7.7%	92.7%	2.0%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

ZONE

Table III.8 B Percentage of 1996-2001 Growth in Trips by Origin for Each Destination Region, All Purposes, All Modes

	PD1	Toronto	GTA	Hamilton	Niagara	Guelph	Orangev.	Barrie	K.Lakes	Peterb.	Total
PD1	24.9%	5.5%	2.3%	1.3%	-0.1%	0.4%	1.6%	0.6%	-1.9%	0.5%	3.1%
Rest of Toronto	27.6%	65.0%	8.0%	0.3%	-0.3%	0.1%	1.9%	2.1%	-7.9%	2.4%	15.9%
Rest of GTA	42.1%	29.1%	86.8%	12.3%	1.4%	7.6%	12.7%	8.9%	-1.1%	6.1%	57.2%
Hamilton	2.6%	0.1%	1.1%	84.1%	1.6%	0.4%	0.4%	-0.4%	-13.4%	0.5%	5.5%
Niagara	0.7%	-0.5%	0.2%	1.8%	97.2%	0.3%	-0.2%	0.1%	-9.4%	-0.1%	7.2%
Guelph/Wellington	0.4%	-0.1%	0.4%	0.3%	0.1%	89.4%	4.8%	-0.1%	1.6%	0.1%	3.1%
Orangeville	0.8%	0.1%	0.2%	0.1%	-0.0%	1.8%	77.4%	0.3%	-2.5%	0.0%	1.1%
Barrie/Simcoe	0.9%	0.7%	0.9%	-0.5%	-0.0%	0.0%	1.3%	88.7%	-4.4%	-0.9%	5.8%
Kawartha Lakes	-0.1%	-0.1%	0.0%	0.2%	0.1%	-0.1%	0.1%	0.0%	209.1%	5.9%	-0.2%
Peterborough	0.1%	0.1%	0.1%	0.1%	-0.0%	0.2%	0.1%	-0.2%	-70.2%	85.4%	1.2%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Appendix IV: Trip Density, Urban Form, and Transit Usage in the Inner Study Area

Urban form is very difficult to analyse, given its multidimensional nature. It depends upon the distributions of both population and employment (or, more generally, "activity centres" of all types), as well as the interconnections between these locations. In a previous analysis (Miller, *et al.*, 1990a), it was found that "trip density" was a useful, simple indicator of the level of "urbanisation" in a given zone, where the trip density in a given traffic zone is simply the sum of the total trip origins plus trip destinations that are observed to occur within the zone over a twenty-four weekday period, divided by the zone area. Since both population and employment can generate trips within a zone, this measure integrates both effects: regardless of the details of the actual land use in a zone, if the trip density is high, it indicates a high level of development/urbanization, while a low trip density indicates a relatively lower level of development.

In the previous study, six trip-density classes were established which, although ultimately somewhat arbitrary, seem to correlate well with different levels of urban development. These classes are presented in Table IV.1. Using these 6 classes, Figure IV.1 maps the trip density distribution for the "GTA+H" (consisting of Toronto, Hamilton, Durham, Halton, Peel and York) in 1986, while Figure III.2 presents the same information for 1996. These figures indicate that the trip density distribution indeed corresponds well to the spatial pattern of urban development within the GTA+H, as well as to how it has changed over the 1986-96 period.

Definition of Urbanization Classes

Class No.	*Description*	*Trip Density Range (24-hr trip ends)/hectare*
1	Rural	0 # trip density < 9.27
2	Suburban, Low	9.28 # trip density < 47.94
3	Suburban, High	47.95 # trip density < 115.48
4	Urban, Low	115.49 # trip density < 184.67
5	Urban, Medium	184.68 # trip density < 359.24
6	Urban, High	359.24 < trip density

The remainder of this appendix presents a series of charts which, first, document the distribution of population growth in the ISA in recent years relative to urbanisation level, and, second, explore the relationship between urban form and travel demand – in particular, transit usage.

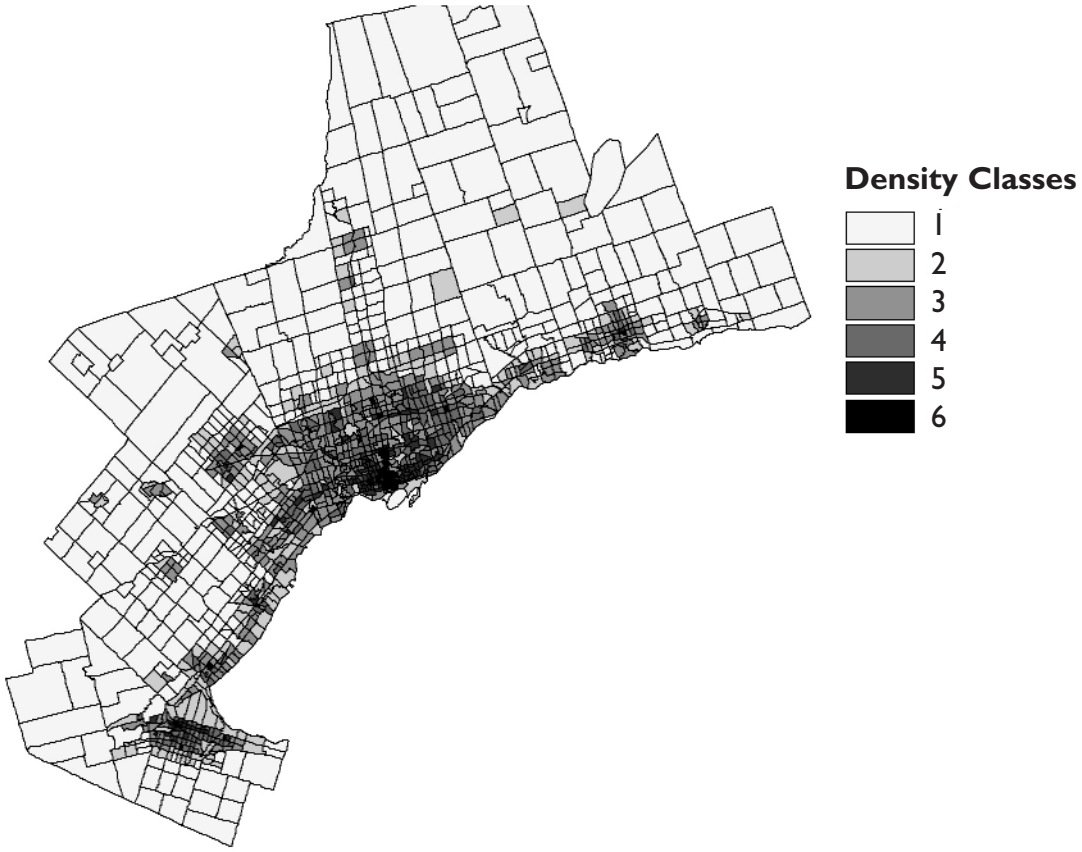


Figure IV.1 Zonal 24-Hour Trip Density Classes, 1986

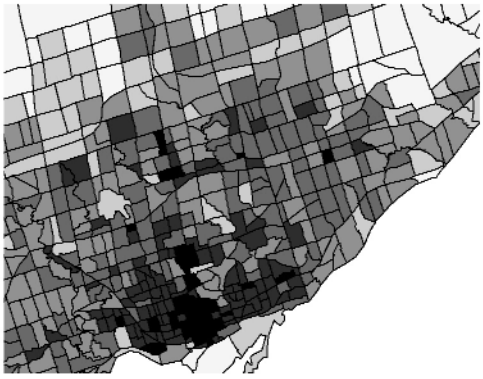


Figure IV.2 Zonal 24-Hour Trip Density Classes, 1996

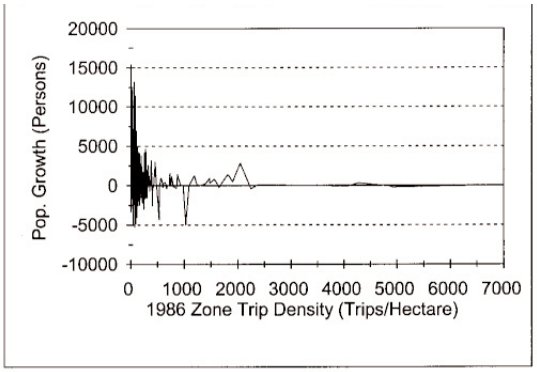


Figure IV.3 Zone Population Growth 1986-96 vs. 1986 Zone Trip Density

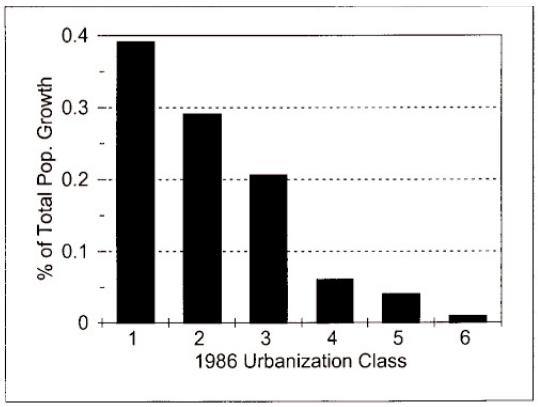


Figure IV.4 Distribution of Population Growth, 1986-96 by 1986 Urbanization Class

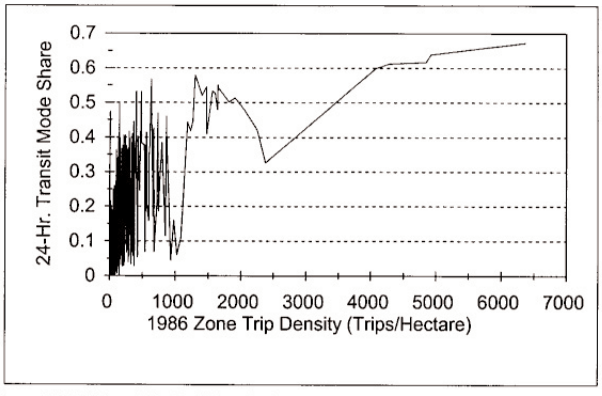


Figure IV.5 1986 Zonal 24-Hour Trip End Transit Mode Share vs. Zone Trip Density

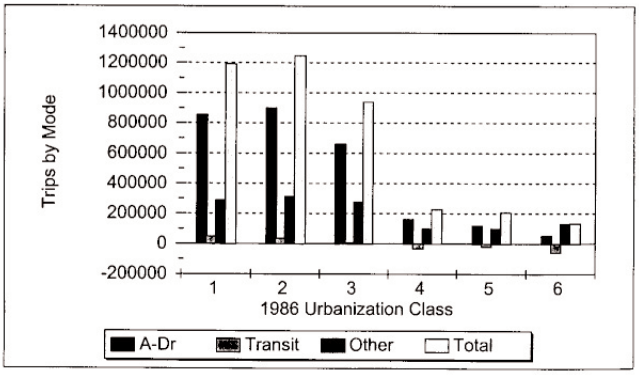


Figure IV.6 24-Hour Trip End Mode Splits, 1986 & 1996 by Trip Density Class

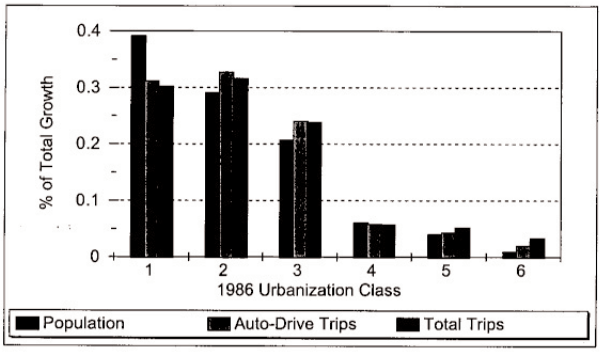


Figure IV.7 Percentage of Total Growth by Trip Density Class, Selected Variables

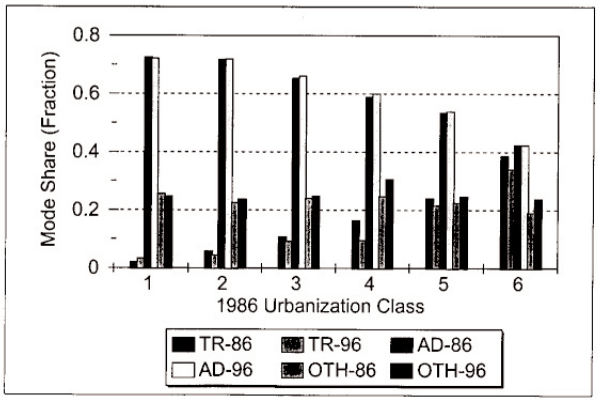


Figure IV.8 Trip End Mode Shares, 1986 & 1996 by Trip Density Class

Appendix V: Short-Term Measures for Improving Transit Service and Ridership

Improving Transit Cost-Effectiveness and Productivity

These measures include increased emphasis on transit priority to increase competitiveness, capacity of surface transit services, and the productivity of vehicles and drivers. Key elements involve:

- Coordinated municipal by-laws for a extensive network of reserved transit lanes where service frequency is high (for example, all bus routes with, say, more than 20 buses per hour, all streetcar routes in the City of Toronto);
- **municipal** application of more aggressive transit vehicle responsive traffic signals that give transit vehicles priority at intersections;
- **municipal** by-laws to restrict on-street parking over extended periods on all transit routes;
- **municipal** expansion of proof-of-payment fare systems to reduce times spent at transit stops (and thus increase average transit speeds and vehicle and driver productivity) by allowing all vehicle doors to be used for loading and unloading;
- **provincial** changes to the *Highway Traffic Act* that facilitate enforcement by: (a) making vehicle *owners*, rather than *drivers*, responsible for violations related to the use of reserved transit lanes, as well as (b) permitting the issuance of tickets for such traffic offences on the basis of photographic or other automated mechanisms.

Reducing the Capital Costs of Transit Infrastructure

These measures concern the acquisition of new transit rights-of-way and the choice of cost-effective technology. They include:

- **provincial** protection of easements within all existing hydro corridors for possible use as municipal and inter-regional express bus routes and commuter parking lots;
- **municipal** requirements to use competitive bidding (as opposed to sole sourcing) for the procurement of all new transit vehicles;
- **municipal** experimentation with alternative means of service delivery to augment or supplement existing publicly operated transit services;
- **federal** government acquisition of discontinued or abandoned railway corridors to be banked for transit or other municipal public purposes.

Facilitating Seamless Inter-regional Transit

In order to facilitate cross boundary transit travel within the Zone, fare *integration* and *simplicity* are key to encour-

aging the diversion of travel from the automobile to transit through:

- **provincial/municipa**l cooperation in developing a transit fare medium (smart cards, prepaid cards, inter-regional passes) that can be used on any transit system within the designated smart growth area;
- **provincial/municipal** development of computer-based applications to monitor transactions and allocate transit revenues on an equitable basis;
- special **provincial transfer** payments to ensure that impacts on individual municipal transit operators attributable to fare integration are revenue neutral.

Increasing Transit Mode Split

Recognizing that some highway expansion such as the widening and extension of 400-series provincial highways conflicts with municipal transportation visions of reduced car dependence, there is a need to reconcile provincial highway planning with municipal Official Plan policies. Such reconciliation should involve:

- **provincial** expansion of commuter rail service frequencies over longer peak periods, as well as the expansion of suburban park-and-ride capacity;
- **provincial** policies to expand the number and capacity of commuter parking lots adjacent to freeway interchanges that would (a) increase opportunities for car pooling, and (b) provide frequent inter-regional bus service as an alternative to driving;
- **provincial** policies to incorporate reserved bus lanes and queue by-passes on highways wherever justified by frequency of service.

Funding

Now considered the number-one issue faced by all transit operators within the smart growth zone, the main short-term measures include:

- **provincial** legislative changes to empower municipalities to generate income from a variety of new sources other than property taxes such as: fuel, vehicle ownership, and parking levies; taxes on employer-provided free parking; and road pricing on a selective basis;
- **provincial/municipal** development of a new funding formula for possible new capital and operating subsidy programs (provincial and/or federal) that are performance- rather than cost-based and that provide incentives for transit operators to increase ridership.